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Dr. Abhijat Sheth, President, National Board of Examinations in Medical Sciences, New Delhi introduced the course and explained the importance

Place the dominating hand on centre part of chest of the patient

Place the other hand on the top of the first hand and interlock the fingers

Before giving breath, open airway by using head tilt chin lift method

A pocket mask can be used, if available for mouth to mouth breath. If you failed to two breath in 10 seconds, resume cardiac compression.

The cycle of 30 compressions and two breath will be continued till the help arrive

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EDITORIAL

CPR Awareness Program Conducted by NBEMS for the Nation

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Elaborating on the National Board of Examinations in Medical Sciences' (NBEMS) commitment to societal welfare, the CPR Awareness Program conducted on December 6th, 2023, at 09:30 am across the nation represents a significant stride towards bolstering public health preparedness and community resilience. By organizing this comprehensive initiative, NBEMS aims to address a crucial gap in emergency response capabilities by equipping thousands of youths and non-medical personnel with the necessary skills and knowledge to effectively administer CPR.

The overarching goal of the CPR Awareness Program is twofold - firstly, to raise widespread awareness about the importance of CPR in saving lives during cardiac emergencies, and secondly, to provide practical training to participants, thereby empowering them to respond swiftly and competently in critical situations.

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The rising trends of heart disease in India

COVID-19 is known to affect multiple organ systems, including the cardiovascular system. Complications such as myocarditis (inflammation of the heart muscle), arrhythmias, and blood clotting issues can arise during or after a COVID-19 infection. These complications can predispose individuals to long-term heart problems, potentially leading to an increased incidence of heart disease post-pandemic.

Perhaps most concerning is the demographic most affected by these accidents. Over 60% of the victims are young individuals, aged between 18 and 35 years old. This not only highlights the tragic loss of life but also the impact on the future of the nation, as young people are disproportionately affected by these preventable incidents.

In response to these distressing statistics, the government has set an ambitious target to halve the number of

road accidents by 2030. This goal reflects a commitment to improving road safety and protecting the lives of citizens.

CPR (Cardiopulmonary Resuscitation) is not only crucial in response to cardiac arrests but also plays a significant role in providing emergency care for individuals involved in road accidents.

Apart from road accidents, trauma and other emergency, in-house heart attacks can be sudden and life-threatening emergencies, highlighting the crucial importance of prompt action, including the application of CPR (Cardiopulmonary Resuscitation) techniques. CPR plays a vital role in maintaining blood flow and oxygenation to the vital organs, particularly the brain until professional medical help arrives.

The importance of the CPR awareness and training program

In the critical moments following a heart attack, every second counts. CPR allows bystanders to take immediate action, providing essential care while waiting for emergency medical services to arrive. Starting CPR promptly can significantly increase the chances of survival. During a heart attack, the heart's ability to pump blood effectively may be compromised. CPR helps maintain circulation by manually compressing the chest, thereby delivering oxygen-rich blood to vital organs such as the brain and heart muscle. This circulation is crucial for preventing permanent damage and increasing the likelihood of recovery.

The National Board of Examinations (NBE) has taken the initiative to conduct a live demonstration of CPR (Cardiopulmonary Resuscitation) techniques & coupled with educational

programs, it is of paramount importance. A brief description in images is given in the article by Sheth et al. [1].

In our recent CPR Awareness Program held on December 6th, 2023, we observed a commendable trend in participant demographics. Notably, out of the total attendees, a significant majority of 70,754 individuals, constituting 62.3%, were females. This statistic is a testament to the proactive engagement of women in recognizing the importance of CPR skills during emergencies. It also reflects the success of our targeted outreach initiatives tailored to promote awareness and participation among female demographics.

Similarly, we had 42,726 male participants, comprising 37.6% of the total attendees. Although slightly lower in number compared to females, the substantial presence of male participants underscores the universal relevance of CPR training across gender boundaries. It reaffirms the inclusivity of our program, welcoming individuals from all gender identities to engage and contribute to community health initiatives.

Furthermore, it is noteworthy, that, the NBEMS program also saw the attendance of 15 transgender individuals, representing a small yet significant fraction of 0.01% of the total participants. This inclusivity demonstrates NBEMS's unwavering commitment to diversity and ensuring that individuals from all walks of life have equitable access to life-saving skills, regardless of gender identity.

Education-based interpretation of outcome

The breakdown of participants based on their educational qualifications in the CPR awareness program provides

valuable insights into the demographics and educational backgrounds of the attendees. This analysis sheds light on the diverse representation of individuals with varying levels of educational attainment, each contributing to the collective effort to promote CPR awareness and preparedness within their communities.

Among the total participants, 2,532 individuals, comprising 2.2% of the attendees, held above post-graduate qualifications. This cohort likely includes individuals with advanced degrees such as master's or doctoral degrees, who bring a depth of knowledge and expertise to the program. Their participation underscores the importance of continued education and professional development in the healthcare domain, as well as their dedication to enhancing their skill set to better serve their communities.

The largest contingent of participants, **numbering 78,865 individuals, accounted for 69.5% of the total attendees, indicating that they were pursuing undergraduate qualifications at the time of the program.** This substantial representation underscores the program's success in engaging young adults and students, who are often eager to acquire practical skills and make meaningful contributions to their communities. Their active involvement in the CPR awareness program highlights the potential for cultivating a generation of informed and empowered individuals capable of responding effectively to emergencies.

This analysis highlights the diverse range of institutions and their respective contributions to the program, underscoring the collective commitment to enhancing public health awareness and equipping individuals with life-saving skills.

The largest segment of participants comprised students, with 84,151 institutions represented, accounting for a significant 74.1% of the total. This high level of student engagement reflects the program's appeal to the next generation of healthcare professionals and underscores the importance of early exposure to essential skills like CPR during their education and training.

CPR awareness program – post-demonstration quiz

After the CPR program's demonstration, a post-demonstration quiz was administered to gauge participants' perceptions of the program's effectiveness & the results are reproduced in the article by Sheth et al. [1].

Conflicts of interest

The authors declares that they do not have conflict of interest.

Funding

No funding was received for conducting this study.

Reference

1. A. Sheth, M. Bajpai, R. Sharma et al. Empowering Communities: NBEMS's Nationwide Cardio-Pulmonary Resuscitation Awareness Program. Natl. Board Exam. J. Med. Sci. 2024;2(4):289-298: DOI:10.61770/NBEJMS.2024.v02.i04.002

ORIGINAL ARTICLE

Empowering Communities: NBEMS's Nationwide Cardio-Pulmonary Resuscitation Awareness Program

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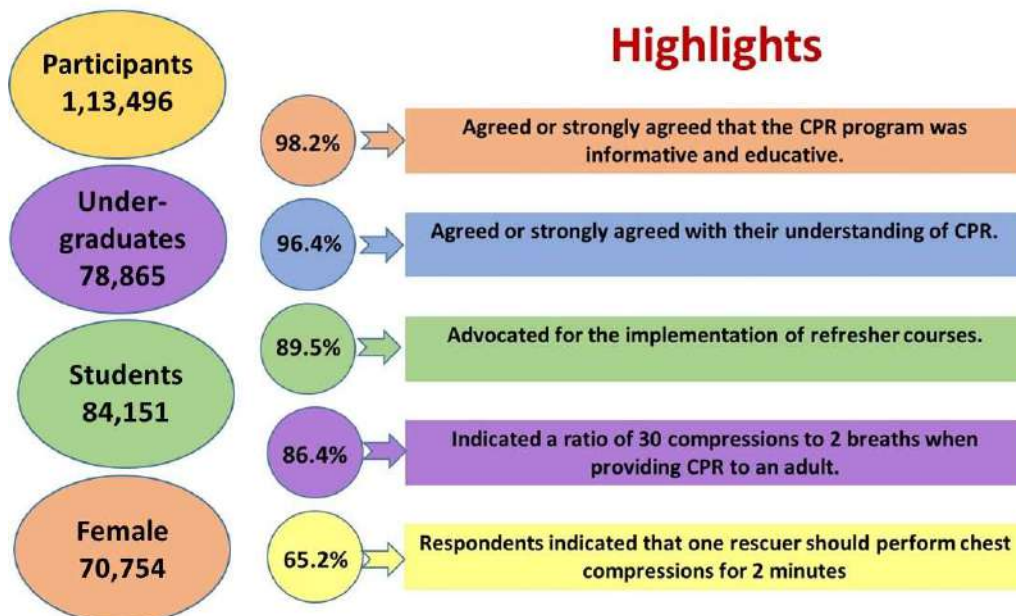
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Introduction

Elaborating on National Board of Examinations in Medical Sciences (NBEMS) commitment to societal welfare, the CPR Awareness Program slated for December 6th, 2023, at 09:30 AM across the nation represents a significant stride towards bolstering public health preparedness and community resilience. By organizing this comprehensive initiative, NBEMS aims to address a crucial gap in emergency response capabilities by equipping thousands of youths and non-medical personnel with the necessary skills and knowledge to effectively administer CPR.

The overarching goal of the CPR Awareness Program is twofold - firstly, to raise widespread awareness about the importance of CPR in saving lives during cardiac emergencies, and secondly, to provide practical training to participants, thereby empowering them to respond swiftly and competently in critical situations.

Through a meticulously planned curriculum, NBEMS endeavors to demystify the process of CPR, ensuring that participants grasp its fundamental principles and techniques. By imparting hands-on training, supplemented by educational resources and instructional materials, NBEMS seeks to instill confidence and proficiency in CPR administration among attendees, irrespective of their medical background.

The program's inclusive approach underscores NBEMS's commitment to reaching a diverse demographic, encompassing youths and individuals from various professions and walks of life. By engaging a broad cross-section of society, NBEMS endeavors to foster a culture of collective responsibility, wherein every citizen plays an active role in safeguarding community health and well-being.

Furthermore, the nationwide scope of the program underscores NBEMS's dedication to extending its impact far and wide, transcending geographical boundaries to reach communities in both urban and rural settings. By orchestrating simultaneous events across the country, NBEMS maximizes its outreach, ensuring that individuals from all corners of the nation have access to vital CPR training and education.

Background
The rising trends of heart diseases in India

COVID-19 is known to affect multiple organ systems, including the cardiovascular system. Complications such as myocarditis (inflammation of the heart muscle), arrhythmias, and blood clotting issues can arise during or after a COVID-19 infection. These complications can predispose individuals to long-term heart problems, potentially leading to an increased incidence of heart disease post-pandemic [1].

The COVID-19 pandemic has brought about significant stress and lifestyle changes for many individuals, including increased sedentary behavior, unhealthy eating habits, disrupted sleep patterns, and heightened psychological stress. These factors can contribute to the development or exacerbation of risk factors for heart disease, such as obesity, hypertension, diabetes, and dyslipidemia. Some individuals experience lingering symptoms long after recovering from acute COVID-19 infection, a condition often referred to as "long COVID" or "post-COVID syndrome." Cardiovascular symptoms, such as chest pain, palpitations,

and shortness of breath, are among the reported long-term effects [2,3]. These symptoms can contribute to the burden of heart disease in the post-pandemic period.

Accidents, Trauma, Stroke, and other emergency situations

The latest Global Status Report on Road Safety by the World Health Organization (WHO) reveals concerning trends regarding road traffic deaths worldwide. Despite a slight global reduction in the annual number of road traffic deaths, the report highlights persistent challenges, particularly in countries like India, where the numbers continue to rise [4].

The burden of road accidents in India is a pressing concern, as highlighted by Union Minister of Road Transport and Highways, Nitin Gadkari. His statement underscores the gravity of the situation, emphasizing the need for urgent action to address this growing problem.

According to Gadkari, the latest statistics reveal alarming figures: 53 road accidents and 19 deaths occur every hour across the country. This staggering frequency underscores the severity of the issue and the urgent need for effective measures to mitigate it.

Furthermore, the data indicates a troubling trend of increasing road accidents and related fatalities. Gadkari noted a 12% rise in road accidents and a 10% increase in road accident-related deaths, indicating a worsening situation that demands immediate attention.

Perhaps most concerning is the demographic most affected by these accidents. Over 60% of the victims are young individuals, aged between 18 and 35 years old. This not only highlights the tragic loss of life but also the impact on the future

of the nation, as young people are disproportionately affected by these preventable incidents.

In response to these distressing statistics, the government has set an ambitious target to halve the number of road accidents by 2030. This goal reflects a commitment to improving road safety and protecting the lives of citizens [2].

CPR (Cardiopulmonary Resuscitation) is not only crucial in response to cardiac arrests but also plays a significant role in providing emergency care for individuals involved in road accidents.

Apart from the road accident, trauma and other emergency situation, in-house heart attacks can be sudden and life-threatening emergency, highlighting the crucial importance of prompt action, including the application of CPR (Cardiopulmonary Resuscitation) techniques. CPR plays a vital role in maintaining blood flow and oxygenation to the vital organs, particularly the brain, until professional medical help arrives.

The importance the CPR awareness and training program

In the critical moments following a heart attack, every second counts. CPR allows bystanders to take immediate action, providing essential care while waiting for emergency medical services to arrive. Starting CPR promptly can significantly increase the chances of survival. During a heart attack, the heart's ability to pump blood effectively may be compromised. CPR helps maintain circulation by manually compressing the chest, thereby delivering oxygen-rich blood to vital organs such as the brain and heart muscle. This circulation is crucial for preventing

permanent damage and increasing the likelihood of recovery.

CPR also helps oxygenate the blood by artificially ventilating the lungs through rescue breaths. By providing oxygen to the body's tissues, CPR helps sustain cellular function and prevents organ damage due to oxygen deprivation. Heart attacks often occur when professional medical assistance may not be immediately available. CPR buys precious time, keeping the person alive until advanced medical care, such as defibrillation or medications, can be administered by trained professionals.

Training individuals in CPR empowers them to take action in emergency situations. With the knowledge and skills to perform CPR, bystanders can become invaluable first responders, potentially saving lives within their own homes or communities.

The National Board of Examinations (NBE) has taken an initiative to conduct live demonstrations of CPR (Cardiopulmonary Resuscitation) techniques, coupled with educational programs, is of paramount importance. A brief description in images is given below (Figures 1 to 24):

Figure 1. Dr. Abhijat Sheth, President, National Board of Examinations in Medical Sciences, Delhi introduced the course and explored the importance

Figure 2. Dr. Debashis Dhar (Left) Dr. Sanjeev Mittal (Right), Sir Ganga Ram Hospital, Delhi explained the condition, when and how to use CPR technique

Figure 3. Ask the nearby person to get the emergency kit, automated external defibrillator (AED) and activate emergency.
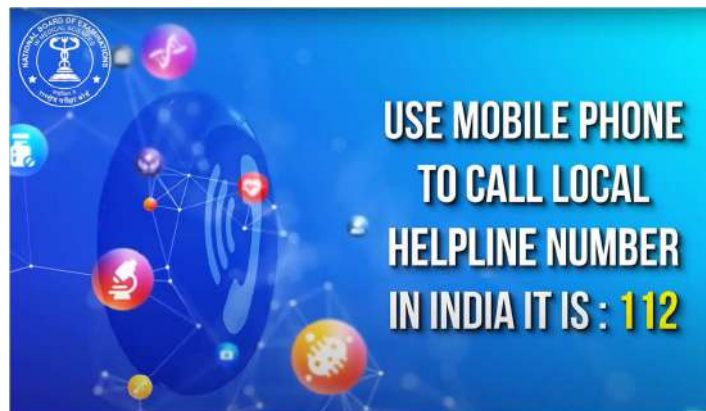
Figure 4. If no one is available, use your mobile phone to call the local helpline number (in India it is 112) and activate the emergency response system.

Figure 5. While help is on the way check for the carotid pulse. The technique of carotid pulse is feel for the trachea at the centre, slide two to three fingers a side of the neck and check for the breathing. Ensure to finish the examination within 5 to 10 seconds.

Figure 6. If unresponsive, no breathing or gasping, no pulse, start the CPR immediately.

Figure 7: Ensure the person is lying on hard surface, remove the cloths from the chest.

Figure 8. Start CAB sequence of CPR i.e. compression, airway and breathing.

Figure 9. Place the dominating hand on centre part of chest of the patient.

Figure 10. Place the other hand on the top of the first hand and interlock your fingers

Figure 11. Elbow should be straight, Position yourself vertically, presses should be from shoulders.

Figure 12. Compress to a depth of 5-6 cms. Allow complete chest recoil

Figure 13. Start chest compressions at the rate of 100-120 per minute
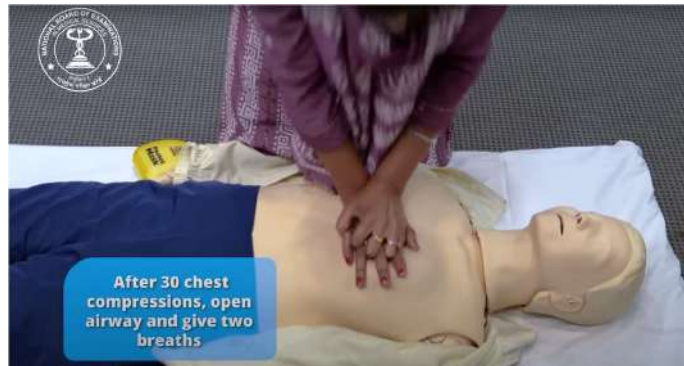
Figure 14. After 30 chest compression, open airway and give two breath

Figure 15. Before giving breath, open airway by using head tilt chin lift method.

Figure 16. A pocket mask can be used, if available for mouth to mouth breath. If you failed to two breath in 10 seconds, resume cardiac compression. This process should be continued till the AED or help arrives.

Figure 17. Switch on AED and follow voice commands of AED

Figure 18. AED operation have two steps, first step is switching on the AED and second is to follow the voice command. The rescuer continued the cardiac compression and operation of AED.

Figure 19. Place the adhesive pads on the chest of victim according to the picture displayed on the AED pads. Place one pad on the right side of chest just below the collar bone and second pad on the left side of the nipple on left side of chest. After placing the pads, AED plugged with pads it will take 10-15 second to analyze the rhythm.

Figure 20. If a shock is advised charge AED and press the orange button.

Figure 21. If needed, continue CPR without removing the AED pads just turn it off.

Figure 22. The cycle of 30 compressions and two breath will be continued till the help arrive. The medical experts then will take the charge of the victim.

Figure 23. Summary of CPR – In eight steps

Figure 25. The procedure to enroll for the participation and generating digital participation certificate from NBEMS.

Outcome of the activity (Results)
Gender base outcome of the participants

The participation of 113,496 individuals in the CPR awareness program organized by NBEMS on the 6th of December, 2023, underscores the significant impact and reach of the initiative. This diverse turnout reflects a collective commitment towards enhancing community health and safety through education and training in cardiopulmonary resuscitation (CPR).

Education base interpretation of outcome

The breakdown of participants based on their educational qualifications in the CPR awareness program, provides valuable insights into the demographics and educational backgrounds of the attendees. This analysis sheds light on the diverse representation of individuals with varying levels of educational attainment, each contributing to the collective effort of promoting CPR awareness and preparedness within their communities.

Among the total participants, 2,532 individuals, comprising 2.2% of the attendees, held above post-graduate qualifications. This cohort likely includes individuals with advanced degrees such as master's or doctoral degrees, who bring a depth of knowledge and expertise to the program. Their participation underscores the importance of continued education and professional development in the healthcare domain, as well as their dedication to enhancing their skill set to better serve their communities.

The presence of 15,347 participants with post-graduate qualifications, constituting 13.5% of the total, highlights the engagement of individuals with bachelor's degrees or equivalent qualifications. These attendees likely possess a solid foundational understanding of healthcare concepts and may include professionals from diverse fields such as nursing, allied health sciences, or public health. Their involvement in the program demonstrates a proactive approach towards expanding their skill set and contributing to public health initiatives beyond their academic or professional roles.

Similarly, 16,751 participants, representing 14.8% of the total, reported

graduate qualifications. This cohort likely comprises individuals pursuing bachelor's degrees or equivalent undergraduate programs across various disciplines. Their participation reflects a diverse range of interests and backgrounds, indicating a broad cross-section of society invested in learning life-saving skills like CPR. It also underscores the program's accessibility and appeal to individuals at different stages of their educational journey, from recent graduates to those currently enrolled in undergraduate studies.

The largest contingent of participants, **numbering 78,865 individuals, accounted for 69.5% of the total attendees, indicating that they were pursuing undergraduate qualifications at the time of the program.** This substantial representation underscores the program's success in engaging young adults and students, who are often eager to acquire practical skills and make meaningful contributions to their communities. Their active involvement in the CPR awareness program highlights the potential for cultivating a generation of informed and empowered individuals capable of responding effectively to emergency situations.

Institution base participation and types of Institution

The breakdown of institutions participating in the CPR awareness program provides valuable insights into the collaborative efforts of various educational and professional entities in promoting emergency preparedness and healthcare training. This analysis highlights the diverse range of institutions and their respective contributions to the program, underscoring the collective commitment towards enhancing public health awareness

and equipping individuals with life-saving skills.

Out of the total 22,640 participating institutions, dental colleges and staff accounted for 998 institutions, representing 0.9% of the total. This category includes institutions specializing in dental education and practice, emphasizing the importance of oral health professionals in emergency medical response. Their participation reflects a recognition of the broader healthcare landscape and the crucial role dentists and dental staff can play in emergency situations requiring CPR.

Medical colleges, faculty, and staff comprised 4,239 institutions, constituting 3.7% of the total participants. As hubs of medical education and training, medical colleges play a central role in shaping the future healthcare workforce. The active involvement of faculty and staff from these institutions underscores their commitment to comprehensive medical education, including essential skills like CPR, which are vital for both students and practicing healthcare professionals.

Similarly, 3,427 institutions accredited by NBEMS participated in the program, accounting for 3.0% of the total. These institutions adhere to NBEMS standards and guidelines, ensuring the quality and consistency of medical education and training. Their participation reinforces the credibility and endorsement of the CPR training program by a reputable accrediting body, instilling confidence in participants regarding the program's effectiveness and relevance to medical practice.

Nursing colleges, faculty, and staff represented the largest contingent, with 10,886 institutions participating, accounting for 9.6% of the total. Nursing professionals play a critical role in

healthcare delivery, often serving as frontline responders in emergency situations. The significant participation of nursing colleges and staff underscores the importance of nursing education in imparting essential skills like CPR and emphasizes the pivotal role nurses play in ensuring timely and effective patient care.

Pharmacy colleges, faculty, and staff accounted for 5,223 institutions, constituting 4.6% of the total participants. Pharmacists are integral members of the healthcare team, and their participation in CPR training reflects their commitment to expanding their scope of practice beyond medication management to include emergency response and patient care.

Professional organizations, faculties, and staff, representing 1,758 institutions, contributed 1.5% to the total participation. These organizations serve as advocacy groups and forums for professionals across various healthcare disciplines. Their involvement in the CPR training program underscores their dedication to advancing best practices in healthcare and promoting continuous professional development among their members.

The largest segment of participants comprised students, with 84,151 institutions represented, accounting for a significant 74.1% of the total. This high level of student engagement reflects the program's appeal to the next generation of healthcare professionals and underscores the importance of early exposure to essential skills like CPR during their education and training.

CPR awareness program – post-demonstration quiz

After the CPR program's demonstration, a post-demonstration quiz was administered to gauge participants' perceptions of the program's effectiveness. Respondents were asked to indicate their agreement or disagreement with the statement: **"The program was very informative and educative."** The results of the quiz are as follows:

A. Agree: 28,868 participants
B. Disagree: 435 participants
C. Strongly agree: 82,623 participants
D. Strongly disagree: 1,569 participants

The majority of participants, **totaling 111,491 (98.2%) individuals, either agreed or strongly agreed that the CPR program was informative and educative. This response indicates a high level of satisfaction and perceived value among the participants regarding the content and delivery of the program**. Additionally, the relatively low number of participants who disagreed or strongly disagreed suggests that the program effectively met the educational objectives and fulfilled participants' expectations. Overall, the positive feedback from the post-demonstration quiz underscores the success of the CPR program in disseminating essential knowledge and skills related to cardiopulmonary resuscitation.

In the next question participants were asked to **indicate their understanding of CPR**. The responses are as follows:
A. Agree: 11,341 participants
B. Hands-on training is a must: 8,125 participants
C. Not understood: 499 participants
D. Strongly agree: 98,530 participants

The majority of participants, **totaling 109,466 (96.4%) individuals, either agreed or strongly agreed with their understanding of CPR.** Additionally, a significant number of participants, 8,125 individuals, recognized the importance of hands-on training in CPR, emphasizing the practical aspect of acquiring CPR skills. However, a small portion of participants, 499 individuals, expressed that they did not fully understand CPR.

The responses indicate a widespread understanding and acknowledgment of CPR among the participants, with an emphasis on the necessity of hands-on training for effective skill acquisition. The majority's strong agreement suggests confidence in their grasp of CPR concepts, reinforcing the program's success in imparting essential knowledge and practical skills related to cardiopulmonary resuscitation.

Reflecting on the administration of future CPR programs, participants were asked to **provide feedback on potential improvements**. The responses regarding the necessity of refresher courses are as follows:

A. Annual refresher course is required: 33,267 participants
B. Cannot comment: 8,130 participants
C. No refresher course is required: 3,826 participants
D. Refresher course every six months is required: 68,272 participants

The majority of participants, totaling **101,539 (89.5%) individuals, advocated for the implementation of refresher courses**, with 68,272 specifically suggesting a refresher course every six months. This response underscores the recognition of the importance of maintaining and updating CPR skills regularly to ensure proficiency and readiness in emergency situations.

Additionally, a significant portion of participants, **33,267 (29.2%) individuals, endorsed the need for annual refresher courses**, indicating a consensus on the value of ongoing education and skill reinforcement. However, it's noteworthy that a substantial number of participants, 8,130 individuals, refrained from commenting, suggesting a potential area for further engagement or clarification regarding the necessity and frequency of refresher courses.

Conversely, a smaller group of participants, 3,826 individuals, expressed the opinion that no refresher course is required. While this viewpoint represents a minority, it still highlights the importance of considering diverse perspectives and addressing any concerns or misconceptions regarding the necessity of ongoing CPR training.

Based on the responses provided, the interpretation of the ratio of chest compressions to breaths when providing CPR to an adult can be determined as follows:

A. 10 compressions to 2 breaths: 5,183 respondents
B. 100 compressions to 2 breaths: 3,842 respondents
C. 15 compressions to 2 breaths: 6,399 respondents
D. 30 compressions to 2 breaths: 98,071 respondents

The majority of respondents, totaling 98,071 (86.4%) individuals, indicated that the ratio of chest compressions to breaths when providing CPR to an adult is 30 compressions to 2

breaths. **This response aligns with the standard CPR guidelines, which recommend a ratio of 30 compressions to 2 breaths for adult patients.**

While other ratios were provided by a smaller number of respondents, such as 10 compressions to 2 breaths, 100 compressions to 2 breaths, and 15 compressions to 2 breaths, these ratios are not consistent with widely recognized CPR protocols. Therefore, the majority consensus on the ratio of 30 compressions to 2 breaths suggests a clear understanding among respondents of the recommended CPR technique for adults.

Based on the responses provided, the interpretation regarding which of the following is not a component of Cardiopulmonary Resuscitation (CPR) is as follows:

A.   Airway: 760 respondents
B.   Breathing: 1,235 respondents
C.   Chest compressions: 5,316 respondents
D.   Providing food: 90,760 respondents

The majority of respondents, totaling 90,760 (80%) individuals, identified "Providing food" as not being a component of CPR. This response is correct, as providing food is not a component of CPR. Instead, CPR primarily involves three main components: maintaining an open airway, providing rescue breaths (breathing), and performing chest compressions. These components aim to restore circulation and oxygenation to a person in cardiac arrest.

While smaller numbers of respondents identified "Airway" and "Breathing" as not being components of CPR, these responses are incorrect. In CPR, establishing and maintaining an open airway to ensure the passage of air into the lungs and providing rescue breaths are essential components of the technique.

Therefore, the consensus among respondents regarding "Providing food" as not being a component of CPR reflects a clear understanding of the key components of this life-saving technique.

Based on the responses provided, the interpretation regarding how long one rescuer should do the chest compression in one go as part of a multi-rescuer team is as follows:

A.   2 min: 74,119 respondents
B.   3 min: 10,384 respondents
C.   4 min: 3,904 respondents
D.   5 min: 25,088 respondents

The majority of respondents, totaling 74,119 (65.3%) individuals, indicated that one rescuer should do chest compressions for 2 minutes in one go as part of a multi-rescuer team. This response aligns with standard CPR guidelines, which recommend rotating chest compressors every 2 minutes to prevent rescuer fatigue and maintain effective compression quality.

While smaller numbers of respondents selected longer durations, such as 3 minutes, 4 minutes, and 5 minutes, these responses are not consistent with widely recognized CPR protocols. Prolonged periods of chest compressions by a single rescuer may lead to decreased effectiveness and fatigue, which can compromise the quality of CPR delivery.

Based on the responses provided, the interpretation of what a single rescuer with just awareness and basic training of CPR, and no available equipment, should do when witnessing a

cardiac arrest in an adult until help arrives is as follows:

A. Do chest compressions only: 14,670 respondents
B. Do rescue breathing only: 2,864 respondents
C. Don't try to help him: 2,666 respondents
D. Try full CPR with 30 chest compressions: 93,295 respondents

The majority of respondents, totaling **93,295 (82.2%) individuals, correctly identified that a single rescuer should perform full CPR, including 30 chest compressions, until help arrives. This response aligns with standard CPR guidelines, which emphasize the importance of immediate chest compressions to maintain blood flow and oxygenation to vital organs in the event of a cardiac arrest.**

While smaller numbers of respondents selected alternative actions, such as performing chest compressions only or rescue breathing only, these responses do not fully adhere to standard CPR protocols. Chest compressions are prioritized in CPR protocols due to their critical role in sustaining circulation and increasing the likelihood of survival.

Additionally, a small number of respondents suggested not trying to help the individual experiencing cardiac arrest. However, it is essential for any bystander witnessing a cardiac arrest to intervene and provide assistance to the best of their ability, as prompt CPR can significantly improve the chances of survival.

Therefore, the consensus among respondents regarding the importance of performing full CPR, including 30 chest compressions, underscores a clear understanding of the recommended actions for a single rescuer in the event of witnessing a cardiac arrest in an adult until help arrives.

Conclusion

The post-CPR demonstration quiz yielded positive feedback regarding the program's effectiveness and educational value. Among the participants:

A significant majority, 98.2% individuals, either agreed or strongly agreed that the CPR program was informative and educative. The majority of participants, 96.4% either agreed or strongly agreed with their understanding of CPR. A substantial number of participants recognized the importance of hands-on training in CPR, emphasizing the practical aspect of skill acquisition. The majority of participants 89.5% advocated for the implementation of refresher courses, with a significant number suggesting refresher courses every six months. This feedback underscores the recognition of the importance of maintaining and updating CPR skills regularly to ensure proficiency and readiness in emergency situations.

The majority of respondents 86.4% indicated a ratio of 30 compressions to 2 breaths when providing CPR to an adult, aligning with standard CPR guidelines. Participants demonstrated a clear understanding of the components of CPR, with the majority 80% correctly identifying "Providing food" as not being a component of CPR. The majority 65.2% of respondents indicated that one rescuer should perform chest compressions for 2 minutes in one go as part of a multi-rescuer team, consistent with standard CPR guidelines.

The positive feedback and understanding demonstrated by participants reflect the success of the CPR program in

disseminating essential knowledge and skills related to cardiopulmonary resuscitation. These insights provide valuable guidance for future CPR training programs, emphasizing the importance of effective educational delivery, hands-on training, and regular skill maintenance.

References

1. Alqahtani MS, Abbas M, Alsabaani A, Alqarni A, Almohiy HM, Alsawqaee E, Alshahrani R, Alshahrani S. The Potential Impact of COVID-19 Virus on the Heart and the Circulatory System. Infect Drug Resist. 2022 Mar 22;15:1175-1189.

2. Betty Raman, David A. Bluemke, Thomas F. Lüscher, and Stefan Neubauer. Long COVID: post-acute sequelae of COVID-19 with a cardiovascular focus. Eur Heart J. 2022; 43(11): 1157–1172.

3. Shrestha AB, Mehta A, Pokharel P, Mishra A, Adhikari L, Shrestha S, Yadav RS, Khanal S, Sah R, Nowrouzi-Kia B, Padhi BK, Chattu VK. Long COVID Syndrome and Cardiovascular Manifestations: A Systematic Review and Meta-Analysis. Diagnostics (Basel). 2023 Jan 29;13(3):491.

4. Global status report on road safety 2023. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO.

5. Yogima Seth Sharma. 19 people died every hour in road accident in India last year. The Economic Times. Oct. 31, 2023

ORIGINAL ARTICLE

Comparative Analysis of MRI and 3D CT in Quantifying Glenoid Bone Loss: A Study on Anterior Shoulder Instability

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Abstract
Background: The glenohumeral joint is characterized by its ball and socket configuration, offering the widest range of motion among major human joints. However, its shallow glenoid socket predisposes it to instability. This instability is mitigated by static and dynamic stabilizers. Glenoid bone loss, including Osseous Bankart and compression deformity, contributes to recurrent instability. Various imaging modalities, such as CT and MRI, are employed to assess glenoid bone loss, with methods like the Griffith Index and best-fit circle used for quantification. This study aims to evaluate MRI's accuracy in quantifying bone loss in glenoid compared to 3D CT in participants with anterior shoulder instability. **Materials and Methods:** The research was carried out at a specialized medical facility offering tertiary care services in south India. Approval was obtained from the ethical committee, and consent waiver was granted for PACS utilization. MRI and CT examinations were performed on participants to assess glenoid bone loss. MRI utilized a 1.5-T Ingenia system, while CT scans were conducted using multidetector CT scanners. Image analysis involved the best-fit circle method was employed to quantify bone loss. **Results:** Fifty-seven male participants with an average age of 30.72 ± 7.32 years participated. Bone loss measurements were comparable between CT and MRI. ICC and correlation coefficients indicated strong agreement between CT and MRI measurements. MRI detected Hill-Sachs lesions more frequently than CT ($p<0.05$) and identified ALPSA, rotator cuff, and labral ligamentous injuries not diagnosed by CT. **Conclusion:** MRI demonstrates high accuracy in quantifying bone loss in glenoid and diagnosing soft tissue injuries, making it a valuable tool for anterior shoulder instability assessment. By reducing the need for additional CT scans and minimizing radiation exposure, MRI emerges as the preferred imaging modality in such cases.

Keywords: Anterior shoulder instability, Glenoid bone loss, MRI, 3D CT, Soft tissue injuries

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Graphical Abstract

Comparative Analysis of MRI and 3D CT in Quantifying Glenoid Bone Loss: A Study on Anterior Shoulder Instability

Shobana Umapathy, Jeevithan shanmugam, Seetharaman Cannane, Sumathi Natarajan and Mathew Cherian

Introduction
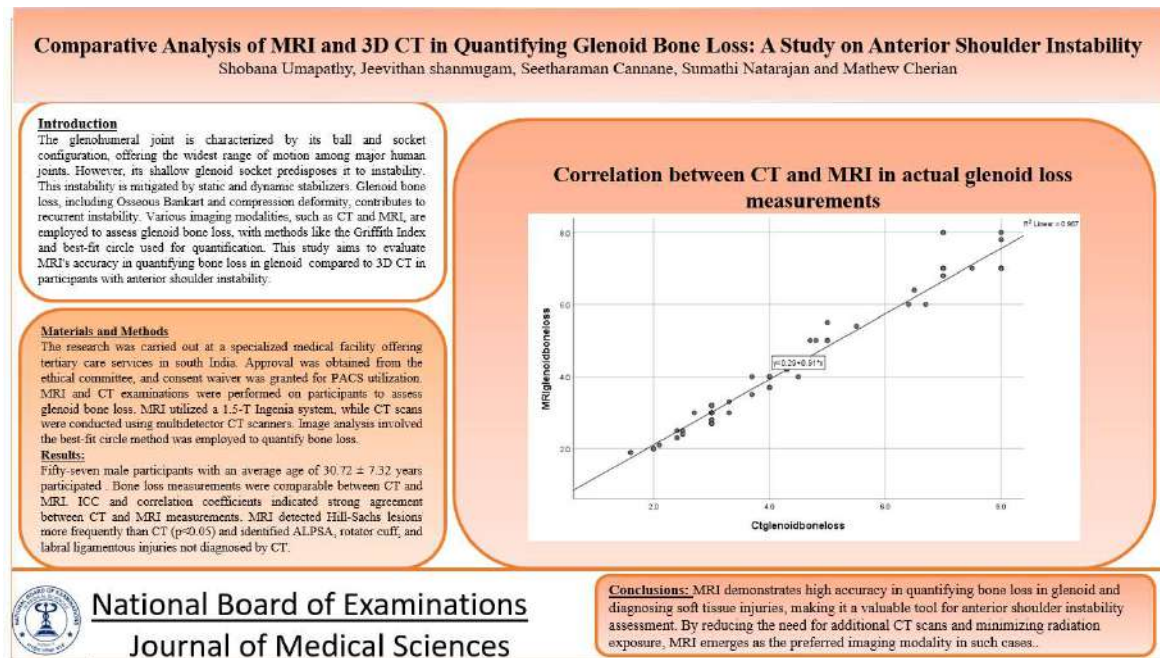
The glenohumeral joint is characterized by its ball and socket configuration, offering the widest range of motion among major human joints. However, its shallow glenoid socket predisposes it to instability. This instability is mitigated by static and dynamic stabilizers. Glenoid bone loss, including Osseous Bankart and compression deformity, contributes to recurrent instability. Various imaging modalities, such as CT and MRI, are employed to assess glenoid bone loss, with methods like the Griffith Index and best-fit circle used for quantification. This study aims to evaluate MRI's accuracy in quantifying bone loss in glenoid compared to 3D CT in participants with anterior shoulder instability.

Materials and Methods

The research was carried out at a specialized medical facility offering tertiary care services in south India. Approval was obtained from the ethical committee, and consent waiver was granted for PACS utilization. MRI and CT examinations were performed on participants to assess glenoid bone loss. MRI utilized a 1.5-T Ingenia system, while CT scans were conducted using multidetector CT scanners. Image analysis involved the best-fit circle method was employed to quantify bone loss.

Results:

Fifty-seven male participants with an average age of 30.72 ± 7.32 years participated . Bone loss measurements were comparable between CT and MRI. ICC and correlation coefficients indicated strong agreement between CT and MRI measurements. MRI detected Hill-Sachs lesions more frequently than CT (p<0.05) and identified ALPSA, rotator cuff, and labral ligamentous injuries not diagnosed by CT.

Correlation between CT and MRI in actual glenoid loss measurements

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Conclusions: MRI demonstrates high accuracy in quantifying bone loss in glenoid and diagnosing soft tissue injuries, making it a valuable tool for anterior shoulder instability assessment. By reducing the need for additional CT scans and minimizing radiation exposure, MRI emerges as the preferred imaging modality in such cases..

Introduction

The glenohumeral joint constitutes a ball and socket configuration, created by meeting of the glenoid fossa in the scapula with that of the humerus head. This anatomical arrangement affords the glenohumeral joint the widest range of motion. Nonetheless, its inherent instability arises from the shallow nature of the glenoid socket. To counteract this instability, the joint relies on a multifaceted system of both static and dynamic stabilizers. Static stabilizers encompass various structural components such as bone, cartilage, capsule, and ligaments, which provide passive support to the joint structure. Conversely, dynamic stabilizers encompass the muscular elements surrounding the shoulder joint. These muscles play an active role in maintaining stability by dynamically adjusting tension and controlling movement across the joint. Through coordinated contraction and relaxation, they stabilize the joint during various movements and positions, thereby mitigating the risk of dislocation or injury [1].

There are two important types of glenoid bone loss in the context of shoulder injuries: Osseous Bankart and glenoid compression deformity or erosion. Osseous Bankart refers to a fracture that happens along the front lower part of the glenoid rim. On the other hand, compression lesions involve the flattening of the front edge of the glenoid bone [2]. Both acute bony Bankart injuries and gradual bone erosions resulting from recurrent instability contribute to glenoid bone loss. In first-time traumatic dislocations, the prevalence of glenoid bone loss stands at 40%, while in cases of recurrent dislocations, it rises significantly to 85% [3].

A spectrum of imaging modalities is employed to assess glenoid bone loss, encompassing classic radiographs, CT scans with both 2D and 3D reconstructions, MRI, and MR arthrography. In each various techniques exist to quantify glenoid bone loss using CT and MRI imaging. Among the prevalent methods for calculating glenoid bone loss are width measurements, exemplified by the Griffith Index, and the best-fit circle method. These approaches provide quantitative assessments of bone loss and aid in treatment planning for shoulder instability [4].

Glenohumeral dislocations can result in injuries to the surrounding soft tissues and bones of the shoulder. While MRI is commonly used to assess soft tissue and cartilage damage post-dislocation, computed tomography (CT) with 3D reconstructions is regarded as the preferred non-invasive method for evaluating glenoid bone loss. Nevertheless, CT scans subject patients to notable radiation exposure, equivalent to approximately 25.75 conventional chest radiographs [5].

To comprehensively evaluate both soft tissue and bony injuries, current protocols often involve a combination of CT followed by MRI. However, given the radiation exposure and the need for multiple imaging modalities, there's growing interest in using MRI as a reference standard. MRI not only assesses ligamentous injuries and soft tissue pathology but can also accurately quantify glenoid bone loss.

The objective of this study was to estimate the precision of MRI in measuring glenoid bone loss in comparison to 3-dimensional CT, focusing on the application of the best-fit circle method, particularly in instances of anterior shoulder instability.

Materials and Methods

This study (cross-sectional) was undertaken at a specialized medical facility offering tertiary care services in the western region of South India, with prior endorsement from the IHEC (Institutional Human Ethics Committee). Consent waiver was obtained from the ethical committee for utilizing the Picture Archiving and Communication System (PACS). The study included individuals who underwent both CT and MRI examinations to assess bone loss in glenoid.

MRI examinations of the affected shoulders were performed using a 1.5-T Ingenia system by Philips Medical Systems. The MRI protocol involved acquiring sequences of the glenoid with an 8-channel shoulder coil at 1.5T. A sagittal oblique T1-weighted sequence was selected to accurately depict bony anatomy and measure glenoid bone loss. The parameters used for MRI were as follows: field of view (FOV) of 140 x 140 mm, matrix of 308 x 221, bandwidth of 265 Hz/pixel, acquisition time of 3 minutes and 17 seconds, and slice thickness of 3 mm.

During the study, all patients underwent CT examinations utilizing multidetector CT scanners, specifically the Bright speed VCT 16-slice CT scanner. The CT protocol involved acquiring 3 mm axial images of the glenoid, subsequently reconstructed into 1-mm oblique sagittal and coronal 2D reconstructions. CT parameters were set as follows: 16 x 0.625-mm acquisition, tube voltage of 120 kV, tube current auto mA, and a pitch of 1.375:1. Following data acquisition, 3D reconstructions of each glenoid were generated for further analysis.

For image analysis, the oblique sagittal T1-weighted image of the glenoid was selected. The typical glenoid surface presents a smooth, rounded anterior contour, resembling a pear shape, with the inferior two-thirds resembling a circle [6]. A best-fit circle was delineated on the inferior two-thirds of the glenoid, ensuring maximal contact with the glenoid rim [7]. The Saller axis, representing the long axis of the glenoid, was marked, and the transverse width of the glenoid was measured perpendicular to the Saller line. Additionally, the diameter of the defect in the glenoid bone was measured using the best-fit circle as a guide. The loss of bone was quantified as the width of the best-fit circle not engaged by glenoid bone, expressed both in absolute terms (millimeters) and as an overall best-fit circle width percentage. This meticulous approach allowed for precise assessment and quantification of glenoid bone loss, facilitating comprehensive analysis of the condition. All the images were interpreted by a senior Radiologist who had more than 13 years of experience.

The data collected were entered into Microsoft Excel and subsequently exported for analysis using IBM SPSS version 27. Mean ± SD were used to describe continuous variables, while frequency and percentages were the methods used for categorical variables. To measure the correlation between CT and MRI

in total bone loss and percentage bone loss, intra-class correlation coefficients (ICC) were calculated. Additionally, Pearson correlation coefficients were computed to ensure the correlation between the two imaging modalities. To assess the association between CT and MRI in diagnosing Hill-Sachs signs, the chi-square test was employed. P<0.05 was considered significant.

Results

A total of 57 patients were included in the study, The mean age of the study population was 30.72 ± 7.32 with a range of 19-49 years. Among the study participants, 59.6% (34) were between 19- 30 years of age, another 29.8%(17) were between 31 and 40 years and the rest 10.5%(6) were between 41 and 50 years of age. All the study participants were males. The actual bone loss and percentage bone loss in

Ct/MRI were more or less similar. (Table 1) Reliability analysis was performed between CT and MRI Values. The reliability measure between CT and MRI showed that MRI values were very much consistent with the CT Values. The Intraclass correlation coefficient (Agreement statistics) was 0.979 for absolute measurement and 0.995 for Percentage loss measurements. The correlation between absolute measurements was 0.984 and for percentage loss measurements was 0.996 signifying a nearly perfect correlation (Figures 1 and 2). In addition, MRI images was able to find out Hill Sachs lesion in 80.7% compared to 61.4% in CT Scan (CSV: 5.160, P<0.05). Additionally MRI was able to find out ALPSA in 22.8%, rotator cuff injury in 43.9% and Labral Ligamentous injury in all the study participants which was not been diagnosed by CT scan (Tables 2 and 3).

Table 1. Descriptive measures of Parameters measured

Parameter	Sub classification	Minimum	Maximum	Mean	Std. Deviation
AGE		19	49	30.72	7.319
Glenoid bone loss	MRI	1.9	8.0	4.391	1.8209
	CT	1.6	8.0	4.514	1.9730
Percentage loss	MRI	7.5	28.3	16.872	6.5020
	CT	7.0	29.0	17.012	6.7183

Table 2. ICC values for actual loss measurement and percentage loss measurement between CT and MRI

Parameter measured	ICC	95% Confidence Interval		Significance	
		Lower limit	Upperlimit	F Value	P Value
Actual loss	0.979	0.962	0.988	100.933	<0.001
Percentage loss	0.995	0.991	0.997	406.969	<0.001

Table 3. Additional findings observed in MRI

Findings observed	Frequency	Percentage	Frequency	Percentage	CSV	P Value
Hill Sachs Lesion	46	80.7	35	61.4	5.160	0.023
ALPSA	13	22.8	0	0	Not Applicable	
Rotator Cuff Injury	25	43.9	0	0		
Labral/ Ligamentous Injury	57	100	0	0		
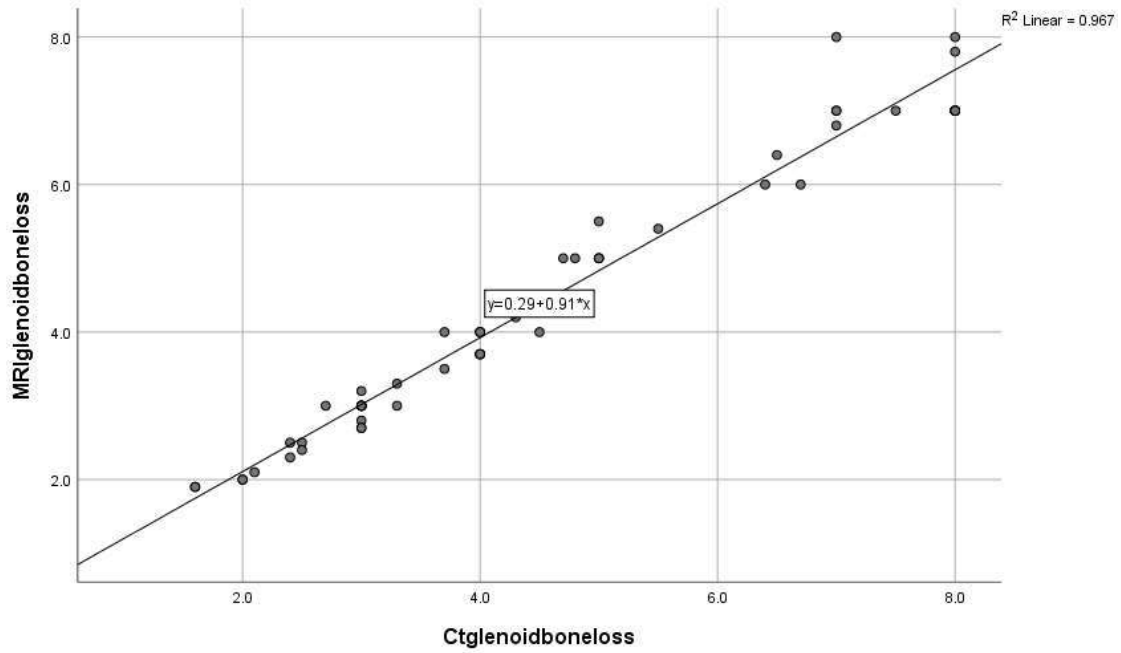
Figure 1: Correlation between CT and MRI in actual glenoid loss measurements
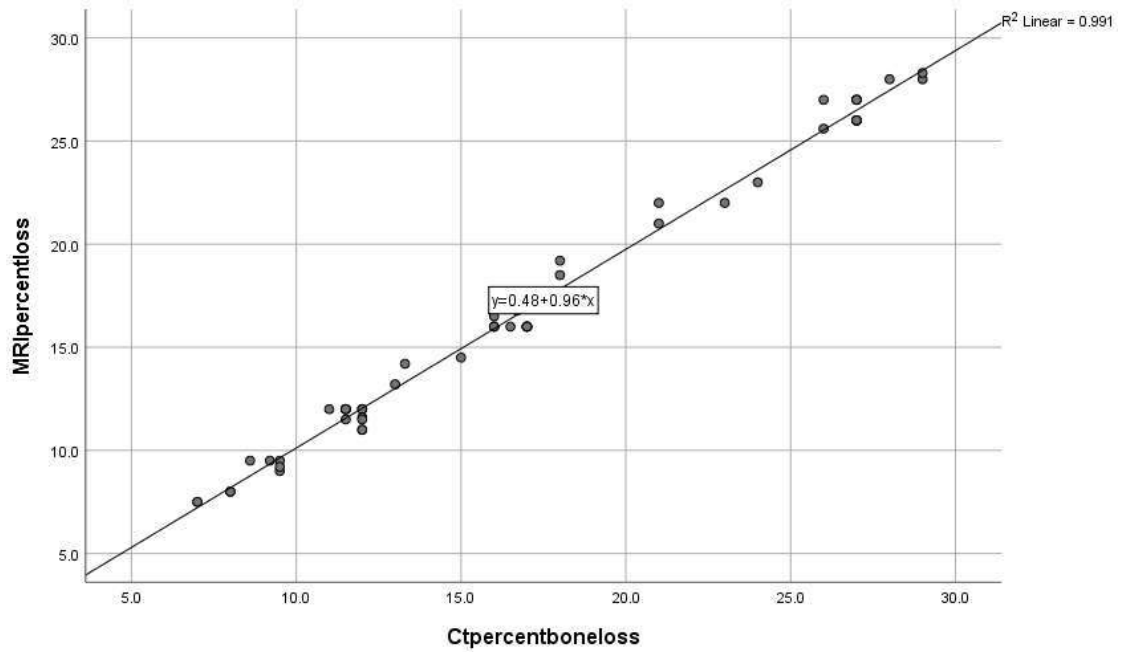
Figure 2. Correlation between CT and MRI in Percentage glenoid loss measurements

Discussion

This study (cross sectional) was done with the aim to find out the role of MRI in assessing the glenoid bone loss in those who encounter a shoulder dislocation. A total of 57 participants who did both CT and MRI were involved in the study.

Anterior shoulder instability stands as the most prevalent form of glenohumeral dislocation injuries, frequently afflicting young males engaged in active sports. Such instability can lead to a spectrum of injuries involving bones, ligaments, and the rotator cuff [8].

Accurate measurement of bone loss in glenoid and associated injuries in soft tissue via imaging is crucial to prevent recurrent dislocation and the need for revision surgeries. Key prognostic factors in anterior shoulder instability include the extent of bone loss in glenoid and the presence of concomitant soft tissue or osseous injuries [10].

Determining what constitutes "severe" bone loss in glenoid lacks universal consensus. Some studies propose critical thresholds, such as 13.4% or 25%, to guide treatment decisions. Mild to moderate bone loss may be managed arthroscopically, while significant bone loss may necessitate open surgery with bone augmentation [3,11,12].

Various imaging modalities, including radiography, arthroscopy, CT, and MRI, aid in quantifying glenoid bone loss. CT, with its multiplanar reformations, has traditionally served as the reference standard due to its accuracy in measuring bone loss. However, concerns arise regarding its failure to assess periarticular soft tissue injuries comprehensively. CT has traditionally been the reference standard due to its availability and ability to provide detailed multiplanar reconstructions. While 3D CT is accurate for surgical planning, it may not adequately address periarticular soft tissue injuries, leading to the incorporation of MRI in some studies [3,13-18].

Comparative studies between 2D or 3D CT and MRI reveal no significant differences in measuring glenoid bone loss. MRI, particularly with the best-fit circle method, exhibits nearly perfect correlation with CT measurements. Additionally, MRI allows for the assessment of associated osseous and soft tissue lesions [19].

MRI emerges as an alternative tool for measuring glenoid bone loss, with comparable accuracy to CT. Studies demonstrate that MRI can effectively diagnose soft tissue injuries, such as stretched inferior glenohumeral ligaments, anterior hyperlaxity, or unrecognized capsular laxity, which may contribute to recurrent instability [19-22].

While 3D MRI reconstructions offer promising capabilities, manual segmentation limits reproducibility and practicality. However, advancements in MRI technology, such as axial 3D dual echo-time T1-weighted sequences with Dixon-based water-fat separation, exhibit potential for accurate measurement of glenoid bone loss [23].

Research by Stecco et al. [19] and Gyftopoulos et al. [23] found that both MRI and CT measurements are equally efficacious in determining bone loss. Our study aligns with these findings, demonstrating a nearly perfect correlation between MRI and CT in quantifying glenoid bone loss using the best-fit circle method.

In addition, our study explores the frequency of associated osseous and soft tissue lesions due to instability of anterior shoulder. Notably, all those with bone loss

in glenoid exhibited labral ligamentous injuries, with a 61.5% incidence of rotator cuff tears. This comprehensive evaluation supports MRI's role as a valuable diagnostic tool, accurately quantifying glenoid bone loss and identifying concomitant soft tissue injuries in a single examination. This not only streamlines the diagnostic process but also eliminates the need for an additional CT scan, thereby reducing associated costs and radiation exposure [3].

Conclusion

MRI proves invaluable in quantifying bone loss in glenoid and diagnosing injuries of soft tissue, offering a comprehensive evaluation in a single examination. By obviating the need for additional CT scans, MRI reduces costs and minimizes radiation exposure, making it the preferred imaging modality for anterior shoulder instability assessment.

Statements and Declarations
Conflicts of interest
The authors declares that they do not have conflict of interest.

Funding
No funding was received for conducting this study.

Ethics approval
Ethical approval obtained from all patients.

Human and animal rights
This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent
For this type of study formal consent is not required.

References

1. Abboud JA, Soslowsky LJ. Interplay of the static and dynamic restraints in glenohumeral instability. ClinOrthopRelat Res. 2002 Jul (400):48–57.
2. Gyftopoulos S, Hasan S, Bencardino J, Mayo J, Nayyar S, Babb J, et al. Diagnostic Accuracy of MRI in the Measurement of Glenoid Bone Loss. American Journal of Roentgenology. 2012 Oct 1; 199(4):873–8.
3. Griffith JF, Antonio GE, Yung PSH, Wong EMC, Yu AB, Ahuja AT, et al. Prevalence, pattern, and spectrum of glenoid bone loss in anterior shoulder dislocation: CT analysis of 218 patients. AJR Am J Roentgenol. 2008 May;190(5):1247–54.
4. Saliken DJ, Bornes TD, Bouliane MJ, Sheps DM, Beaupre LA. Imaging methods for quantifying glenoid and Hill-Sachs bone loss in traumatic instability of the shoulder: a scoping review. BMC MusculoskeletDisord. 2015 Jul 18;16:164.
5. Biswas D, Bible JE, Bohan M, Simpson AK, Whang PG, Grauer JN. Radiation exposure from musculoskeletal computerized tomographic scans. J Bone Joint Surg Am. 2009 Aug;91(8):1882–9.
6. Griffith JF, Antonio GE, Tong CWC, Ming CK. Anterior shoulder dislocation: quantification of glenoid bone loss with CT. AJR Am J Roentgenol. 2003 May;180(5):1423–30.
7. Huijsmans PE, Haen PS, Kidd M, Dhert WJ, van der Hulst VPM, Willems WJ. Quantification of a glenoid defect with three-dimensional computed tomography and magnetic resonance imaging: a cadaveric study. J Shoulder Elbow Surg. 2007 Dec;16(6):803–9.
8. Gyftopoulos S, Albert M, Recht MP. Osseous Injuries Associated With Anterior Shoulder Instability: What the Radiologist Should Know. American

Journal of Roentgenology. 2014 Jun;202(6):W541–50.

9. Jana M, Gamanagatti S. Magnetic resonance imaging in glenohumeral instability. World J Radiol. 2011 Sep 28;3(9):224–32

10. Provencher MT, Bhatia S, Ghodadra NS, Grumet RC, Bach BR, Dewing CB, et al. Recurrent shoulder instability: current concepts for evaluation and management of glenoid bone loss. J Bone Joint Surg Am. 2010 Dec;92Suppl 2:133–51.

11. Kwong CA, Gusnowski EM, Tam KK, Lo IK. Assessment of bone loss in anterior shoulder instability. Ann Jt. 2017 Nov 1;2(2):63.

12. Rabinowitz J, Friedman R, Eichinger JK. Management of glenoid bone loss with anterior shoulder instability: indications and outcomes. Current reviews in musculoskeletal medicine. 2017 Dec 1;10(4):452-62.

13. Sugaya H. Techniques to evaluate glenoid bone loss. Curr Rev Musculoskelet Med. 2014 Feb 2;7(1):1–5.

14. Griffith JF, Yung PSH, Antonio GE, Tsang PH, Ahuja AT, Chan KM. CT compared with arthroscopy in quantifying glenoid bone loss. AJR Am J Roentgenol. 2007 Dec;189(6):1490–3.

15. Moroder P, Resch H, Schnaitmann S, Hoffelner T, Tauber M. The importance of CT for the pre-operative surgical planning in recurrent anterior shoulder instability. Arch Orthop Trauma Surg. 2013 Feb;133(2):219–26.

16. Chuang T-Y, Adams CR, Burkhart SS. Use of preoperative three-dimensional computed tomography to quantify glenoid bone loss in shoulder instability. Arthroscopy. 2008 Apr;24(4):376–82.

17. Shah AS, Karadsheh MS, Sekiya JK. Failure of operative treatment for glenohumeral instability: etiology and management. Arthroscopy. 2011 May;27(5):681–94.

18. Boileau P, Villalba M, Héry J-Y, Balg F, Ahrens P, Neyton L. Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. J Bone Joint Surg Am. 2006 Aug;88(8):1755–63.

19. Stecco A, Guenzi E, Cascone T, et al. MRI can assess glenoid bone loss after shoulder luxation: inter- and intra-individual comparison with CT. Radiol Med. 2013 May 27;118(8):1335–43.

20. Lee RKL, Griffith JF, Tong MMP, Sharma N, Yung P. Glenoid bone loss: assessment with MR imaging. Radiology. 2013 May;267(2):496–502.

21. Yanke AB, Shin JJ, Pearson I, Bach BR, Romeo AA, Cole BJ, et al. Three-Dimensional Magnetic Resonance Imaging Quantification of Glenoid Bone Loss Is Equivalent to 3-Dimensional Computed Tomography Quantification: Cadaveric Study. Arthroscopy. 2017 Apr;33(4):709–15.

22. Vopat BG, Cai W, Torriani M, Vopat ML, Hemma M, Harris GJ, et al. Measurement of Glenoid Bone Loss With 3-Dimensional Magnetic Resonance Imaging: A Matched Computed Tomography Analysis. Arthroscopy. 2018 Dec 1;34(12):3141–7.

23. Gyftopoulos S, Yemin A, Mulholland T, Bloom M, Storey P, Geppert C, et al. 3DMR osseous reconstructions of the shoulder using a gradient-echo based two-point Dixon reconstruction: a feasibility study. Skeletal Radiol. 2013 Mar;42(3):347–52.

ORIGINAL ARTICLE

Anatomy as a Basic Medical Science: Perceptions of Allied Health Science Students in an Indian Medical School

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Abstract
Introduction: Anatomy courses in health science disciplines, including allied health programs, face criticism for being extensive and lacking focus on career-relevant competencies. **Objectives:** To evaluate allied health students' perceptions of the anatomy syllabus using feedback analysis to identify areas for improvement and align the curriculum with their needs. **Methods:** A qualitative study gathered feedback from 100 second, third, and fourth-year allied health students through an anonymous questionnaire comprising of eight items, six of which were rated using a five-point Likert scale, while two comprised open-ended questions. By recording the number and percentage of students responding to each item and calculating mean ratings. **Results:** Over 75% of students find the anatomy syllabus extensive, requiring memorization. About 70% believe it addresses essential competencies, but 60% feel practical aspects receive inadequate emphasis. Half note a lack of clear distinction between anatomy and physiology in textbooks. **Conclusion:** Tailoring the anatomy syllabus to specific allied health courses is crucial, focusing on appropriateness, conciseness, and well-defined learning outcomes. Students' perceptions highlight the need for a more targeted and simplified approach, aligning the curriculum with practical demands for professional success. Collaborative efforts between educators and students are vital for ongoing refinement and optimization.

Keywords: Anatomy, allied health occupations, educational needs assessment

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Graphical Abstract
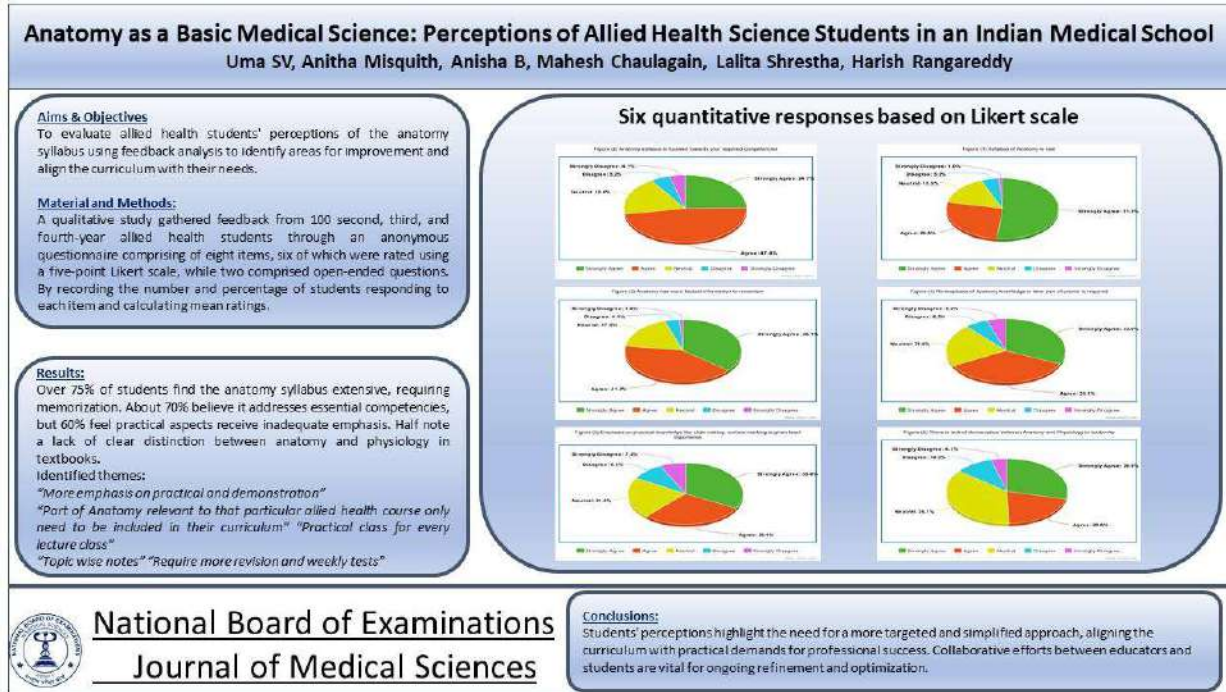
Introduction

Anatomy holds a pivotal position as a foundational basic science course in the realm of health science disciplines [1]. Frequently perceived as a subject inundated with factual information and terminologies requiring rote memorization, its true value comes to light when applied in a clinical context, making clinical exposure a driving force for motivation [1, 2]. During the initial year of health science studies, the extent of students' engagement with the subject is often influenced by the evaluation process, while the realization of its true significance occurs when anatomy is integrated into the understanding and management of diseased conditions within the realm of healthcare practice [2]. The existing literature also highlights a common perception among allied health students that anatomy is learned solely for examination purposes, leading to concerns regarding retention and application of the acquired knowledge in their respective fields. Furthermore, a lack of confidence is observed in applying anatomical knowledge to practical situations within their professional practice [3].

Allied health sciences (AHS) students express that human anatomy and physiology are perceived as challenging due to the use of scientific language and the incorporation of numerous new terminologies, leading to content overload [4]. Similarly, medical students also regard anatomy as a subject with an extensive syllabus, yet essential for its significant clinical applications. In a study by Gupta S et al, a more streamlined approach to the anatomy curriculum in MBBS, focusing on general concepts to impart a functional understanding of the subject is advocated [5]. This embeds the perception of

information overload among medical and AHS students leading them to view anatomy as an extensive and demanding discipline.

Noteworthy is the distinctive significance of anatomy among the basic sciences, as it presents unique advantages by providing visual cues for effective learning and facilitating the establishment of connections between theoretical knowledge and practical application, particularly in clinical practice, thereby proving advantageous for students [6]. However, the lack of integration between basic medical sciences and clinical practice during the educational process may pose a challenge to the relevance of these subjects. Consequently, achieving proficiency in basic medical science knowledge becomes imperative as it serves as a fundamental prerequisite for augmenting the understanding of clinical medicine and optimizing the overall learning experience [7].

Despite the significance of anatomy as a foundational course in allied health science programs, there exists a prevailing opinion among different stakeholders that the syllabus is excessively extensive and lacks the necessary focus on competencies essential for their careers. Additionally, practical anatomy sessions that form core competency are found to be insufficiently emphasized within the curriculum. A notable trend in basic medical science subjects reveals a relatively higher frequency of failures in anatomy compared to other disciplines.

In light of these concerns, our study aims to gain insight into the perceptions of allied health science (AHS) students regarding various aspects of anatomy as a fundamental medical science. Through an assessment of students' feedback and perceptions, this research endeavors to improve the anatomy curriculum, enhancing the overall learning experience in medical education. Understanding students' perspectives on the anatomy learning process is vital for identifying areas that require improvement and exploring opportunities to make the instruction more effective and relevant. By gathering and carefully analyzing student feedback, we can identify the strengths and weaknesses of the current anatomy education approach and develop strategies to optimize the efficacy of anatomy instruction. Through these endeavors, we can bridge the gap between the curriculum and students' needs, ensuring a comprehensive and enriching educational experience in the realm of allied health science programs.

Methods

Study design: Cross Sectional descriptive study including both quantitative as well as qualitative components.

Setting: The study was carried out at Sapthagiri Institute of Medical Sciences & Research Center, a tertiary health care and a teaching hospital in urban South India under Rajiv Gandhi University of Health Sciences in 2019.

Participant and sampling: The allied health sciences students were informed in person about the study purpose with a description by the researchers. To increase the heterogeneity of the sample second, third year students and interns of AHS were sampled purposively. Sample size (n) for the

survey was calculated with the following equations: $x = Z\ (c/100)^2 r\ (100-r)$ and $n = N\ x/((N-1)\ E2+x)$, where N is the population size, E is the margin of error (10%), r is the fraction of responses (50%), and Z (c/100) is the critical value for the confidence level c (5%). The estimated student population of Sapthagiri Institute of Medical Sciences at the time of conduct of study was >1000. We initially assumed a margin of error of 10%. The margin of error (E) was calculated with the following equations: $x = Z\ (c/100)^2\ r\ (100-r)$ and $E = \mathrm{Sqrt}\ [(N-n)\ x/_{n\ (N-1)}]$, where N is the population size, r is the fraction of responses that we were interested in, and Z (c/100) is the critical value for the confidence level c. Sample size obtained was 96 which was rounded off to 100. The AHS students from specific undergraduate programs falling under the umbrella of allied health students viz., cardiac care technology, perfusion technology, respiratory care technology, imaging technology, medical laboratory technology, anaesthesia technology, operation technology and renal dialysis were included. While the paper provides a general context of allied health science programs, specifying individual programs was avoided to maintain a broader focus on the overall perception of anatomy education among allied health students and moreover all these programs had the same curriculum.

Data collection tool: A structured questionnaire was used for data collection. The questionnaire (Table 1) has eight items, of that six using the Likert five-point grading scale with a maximum of 5 and a minimum of 1 with a range of score of 0.8 and two open ended questions. The items of the questionnaire were adapted based on previous literature [5]. Pilot testing of the questionnaire was done on the first group of twenty students. The internal reliability of the questionnaire was found to be satisfactory (Cronbach's alpha of 0.70).

Prior to participating in the study, students were comprehensively briefed about the objectives, methodology, and the nature of the questionnaire. The importance of honest and thoughtful responses was emphasized. This ensured that participants had a clear understanding of the study's purpose and the significance of their contributions. The inclusion of informed participants adds validity to the gathered feedback.

After obtaining ethical clearance from the institutional ethics committee of Sapthagiri Institute of Medical Sciences and Research Center, the cross sectional descriptive study with convenient sampling methodology was conducted. A total of 100 students including the second year, third year students and the fourth year interns of allied health science courses have been included in the study as convenient sampling method during the mid of 2019. The First year AHS students who were studying anatomy as one of their first year subjects and the students who had not passed Anatomy exam till august 2019 were excluded from the study. The second year (n=40), third year (n=35) students and interns (n=25) were included as they have completed anatomy and are engaged in their clinical posting, so they are more aware about the anatomy syllabus which they learnt and its application in clinical side. Among the 100 students, girls were 54

(n=54) and boys were 46 (n=46) and their age ranges from 19 to 24 years.

Steps were taken to ensure that the researchers involved in the subject selection process remained impartial and did not introduce personal biases. This involved having a separate team responsible for participant questionnaire administration and data collection, which was not part of the study.

Data analysis: The number and percentage of students responding to each item noted. SPSS version 16 software was used for calculation of the mean rating for each item and then tabulated. For the quantitative section, descriptive calculations of frequency and percentage were done, and for the open ended questions section, an inductive approach was used; themes were extracted by analyzing the content of participants' opinions.

Results

Among the hundred students invited to participate, ninety-seven successfully completed the questionnaire, as shown in Table 1.

Table 1. Questionnaire and responses of the participants

Sl. No.	Item Please respond to the following Course: Year:	Strongly agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly disagree N (%)
1.	Syllabus in anatomy is too vast	50 (51.54)	26 (26.8)	15 (15.46)	5 (5.15)	1 (1.03)
2.	Is anatomy syllabus focused toward your required competencies?	24 (24.74)	46 (47.42)	18 (18.56)	5 (5.15)	4 (4.1)
3.	More of factual information in subject to remember	35 (36.08)	40 (41.23)	17 (17.52)	4 (4.1)	1 (1.03)
4.	Re- emphasis of anatomy knowledge in latter part of course is required	31 (31.96)	34 (35.05)	21 (21.65)	6 (6.18)	5 (5.15)
5.	Emphasis in practical knowledge like slide making, surface marking of blood vessels are given least importance	32 (32.99)	28 (28.87)	21 (21.65)	9 (9.27)	7 (7.21)
6.	There is lack of clear cut demarcation between anatomy and physiology in their textbooks	28 (28.87)	20 (20.61)	35 (36.08)	10 (10.30)	4 (4.1)

	Open ended questions
	    1. Mention two methods you prefer to learn anatomy
	    2. Give two reason for more failures in anatomy					

The findings of the six quantitative responses based on Likert scale are as follows

1. Syllabus in anatomy is too vast

This item has a majority in the Agree category (51.54% Strongly Agree, 26.8% Agree). It suggests that a significant portion of respondents feel the syllabus is indeed vast as shown in Figure 1.
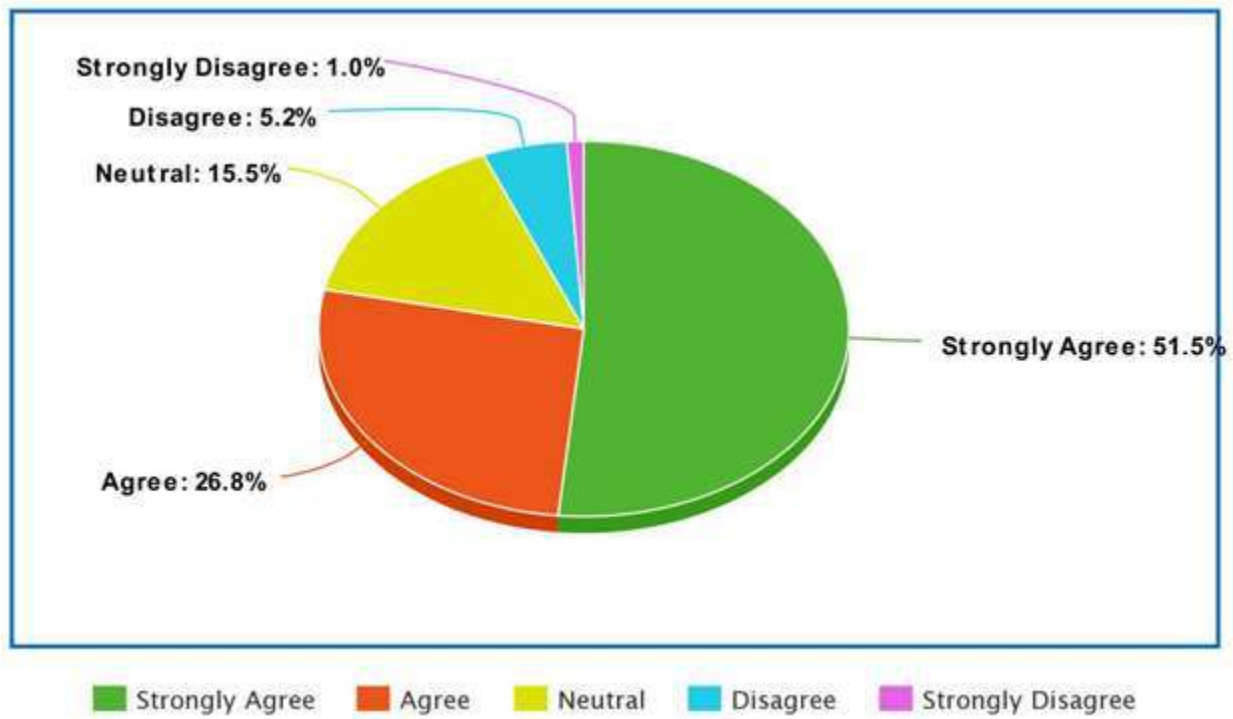
Figure 1. Syllabus of anatomy is vast

2. Is anatomy syllabus focused toward your required competencies?

A majority here as well in the Agree category (24.74% Strongly Agree, 47.42% Agree), indicating that respondents generally feel the syllabus is focused on required competencies depicted in Figure 2.

3. More of factual information in the subject to remember:

The majority falls in the Agree category (36.08% Strongly Agree, 41.23% Agree), suggesting agreement that the subject contains a significant amount of factual information revealed in Figure 3.
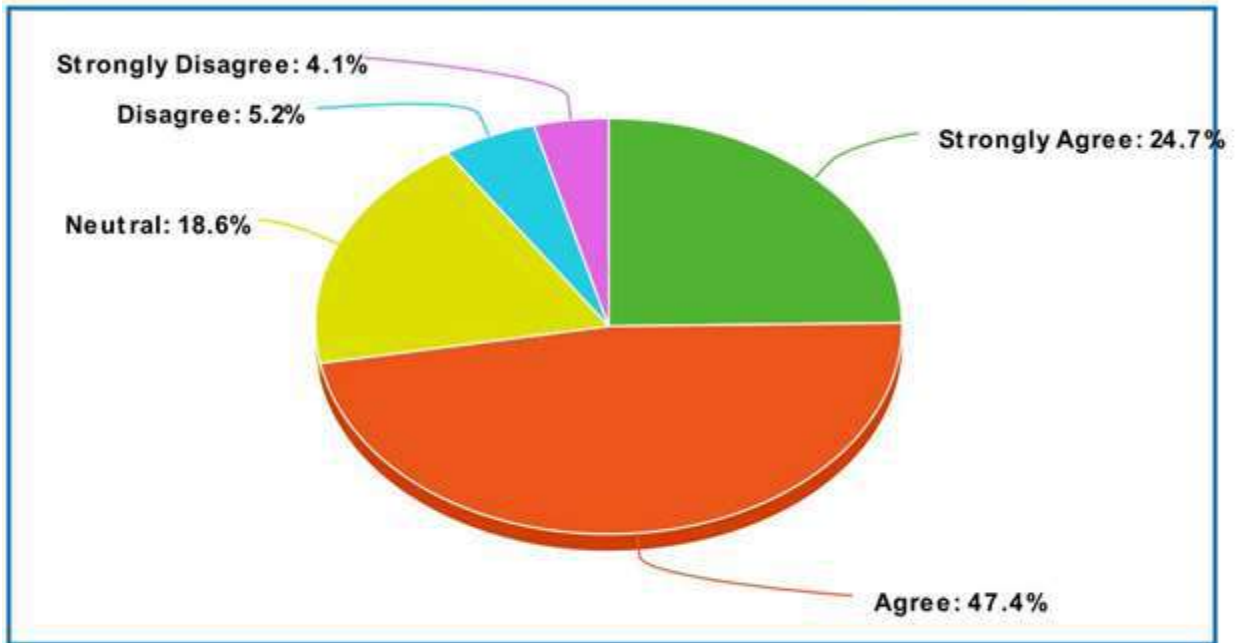
Figure 2. Anatomy syllabus is focused towards your required competencies
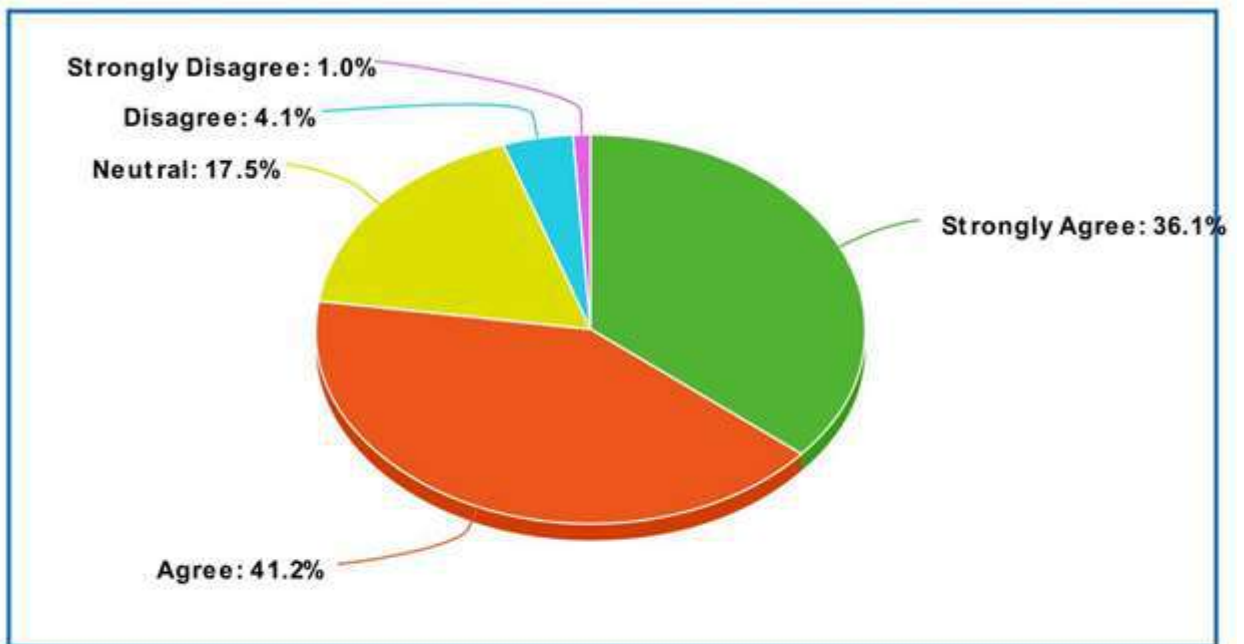
Figure 3. Anatomy has more factual information to remember

4. Re-emphasis of anatomy knowledge in the latter part of the course is required:

Responses are spread, but a substantial portion agrees (31.96% Strongly Agree, 35.05% Agree) that re-emphasis in the latter part of the course is needed as shown in Figure 4.
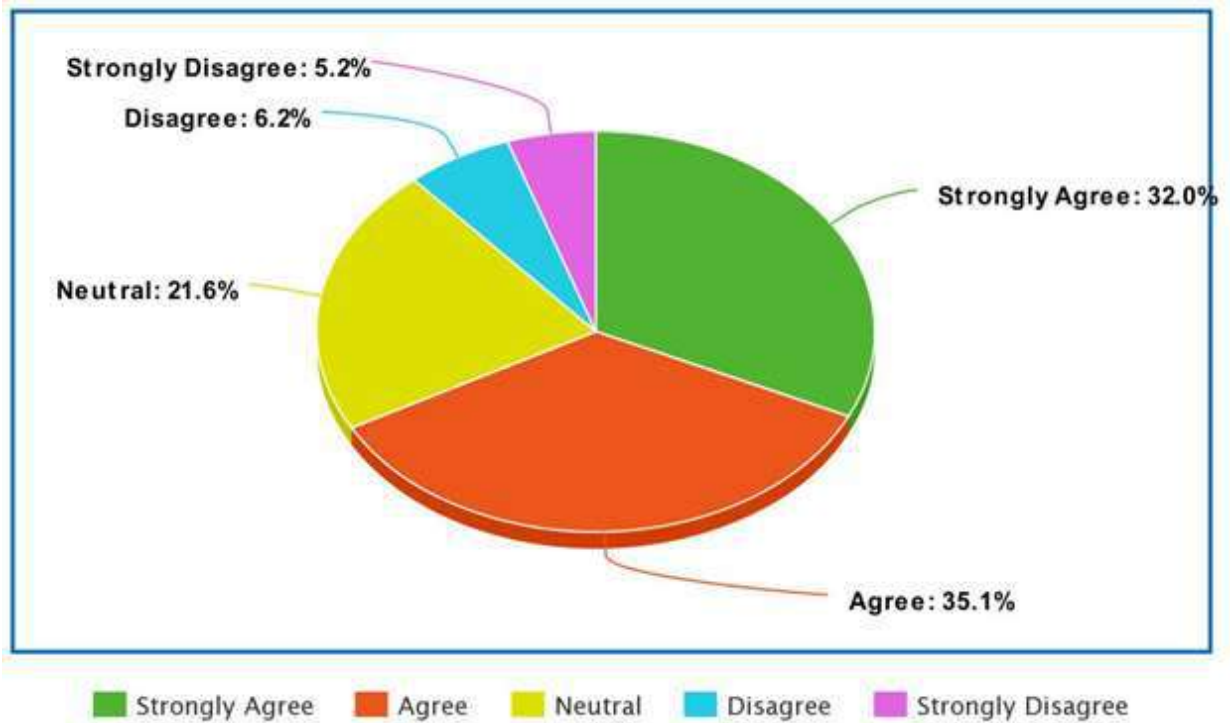
Figure 4. Re-emphasis of anatomy knowledge in later part of course is required.

5. Emphasis in practical knowledge like slide making, surface marking of blood vessels are given least importance:

There is a mixed response, but a considerable portion agrees (32.99% Strongly Agree, 28.87% Agree) that practical knowledge is given less importance as depicted in Figure 5.
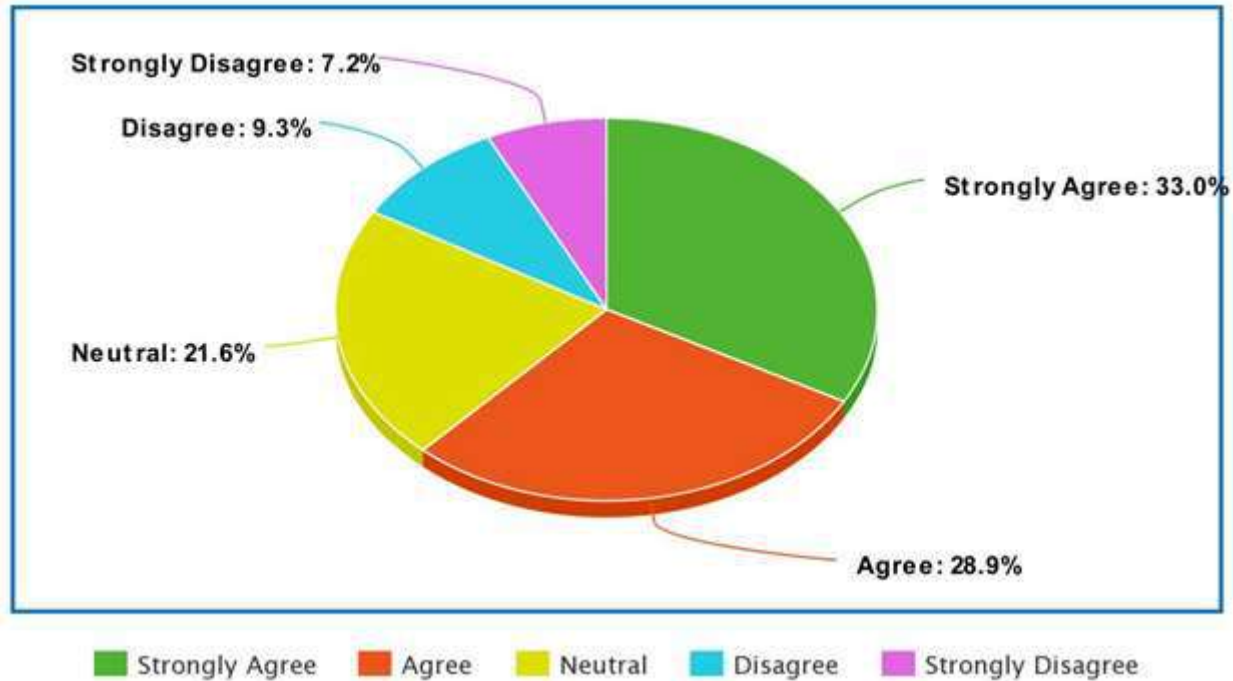
Figure 5. Emphasis on practical knowledge like slide making, surface making is given least importance.

6. There is a lack of clear-cut demarcation between anatomy and physiology in their textbooks:

A mixed response, with the highest percentage in the Neutral category (36.08%). This suggests uncertainty or neutrality regarding the demarcation between anatomy and physiology in textbooks as revealed in Figure 6.
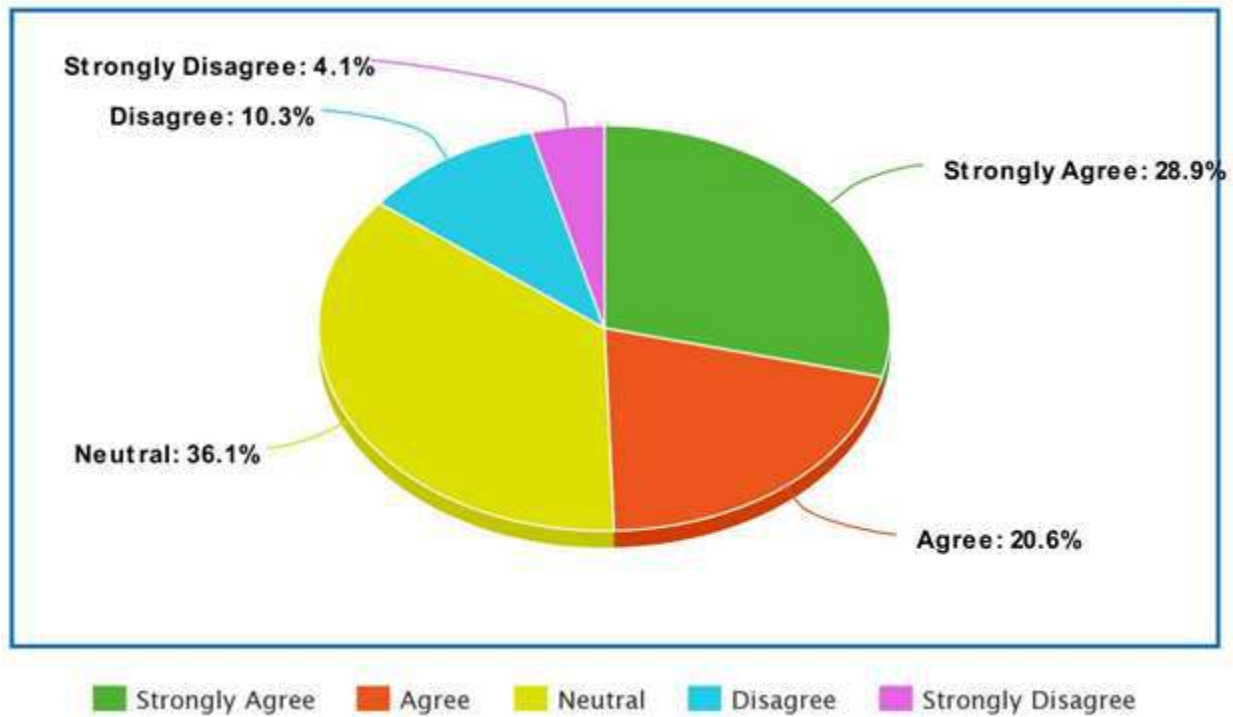
Figure 6. There is lack of demarcation between anatomy and physiology in textbooks

More than 75% of students felt that the Anatomy syllabus is vast and more factual information to remember. The summarized responses reveal that a significant majority, over 75% of students, perceive the Anatomy syllabus as extensive, demanding memorization of copious factual information. Around 70% of students acknowledge that the anatomy syllabus caters to their required competencies. However, 60% of students express concern about the limited emphasis on practical knowledge, such as slide making and surface marking of blood vessels.

For the open-ended questions of the methods they prefer for learning anatomy, the students responses include:

"More emphasis on practical and demonstration"

"Part of Anatomy relevant to that particular allied health course only need to

be included in their curriculum" *"Practical class for every lecture class"*

"Topic wise notes" *"Require more revision and weekly tests"*

According to the local university recommendation, the first year of all allied health courses like Respiratory care, Cardiac care, Medical lab technology, Renal dialysis, Operational technology all have a common syllabus as far as Anatomy is concerned. This makes the students feel their syllabus is vast. As the reasons for more failures in Anatomy, the students cited the following reasons:

"Syllabus of anatomy is too vast"

"Lots of new terminologies to understand"

"Textbook of anatomy is a common one and not according to their stream of courses"

"Less number of practical classes"

"Strict evaluation of the exam paper and increased requirement of 50 % pass percentage"

"Language problem and Students not comfortable asking doubts"

"More factual information in the subject so volatile and students find it difficult"

Furthermore, half of the students indicate a perceived lack of clear-cut demarcation between anatomy and physiology in their textbook. These findings provide valuable insights into the students' perspectives on the anatomy curriculum, highlighting both commendations and areas of potential improvement. Such feedback is instrumental in guiding curriculum refinement and enhancing the educational experience for the participating students.

Thematic analysis of the responses from the student questionnaire yielded four prominent themes that shed light on various aspects of their perceptions regarding the anatomy syllabus in allied health science programs.

1. *Perception of Vast and Factual Nature:* A significant number of students, over 75%, conveyed a common sentiment that the anatomy syllabus appears vast and overwhelming. They expressed apprehension about the extensive factual information that needs to be memorized, which may contribute to feelings of academic burden. This theme underscores the need to address the perception of content overload and explore strategies to streamline the syllabus while ensuring essential concepts are retained.

2. *Alignment with Required Competencies:* Approximately 70% of students acknowledged that the anatomy syllabus is generally aligned with the competencies required for their future careers in allied health sciences. This positive perception indicates that the curriculum is designed to equip students with fundamental anatomical knowledge relevant to their professional roles. This theme highlights the importance of maintaining the alignment between curriculum content and the practical skills needed in the healthcare field.

3. *Inadequate Emphasis on Practical Knowledge:* A notable proportion, 60% of students, expressed concern about the limited emphasis on practical aspects of anatomy education, such as slide making and surface marking of blood vessels. Students considered these practical skills crucial for their clinical practice and emphasized the need for more hands-on experiences. This theme underscores the significance of incorporating practical sessions into the curriculum to enhance students' application-oriented learning.

4. *Ambiguity in Anatomy and Physiology Demarcation:* Half of the students perceived a lack of clear-cut demarcation between anatomy and physiology within their textbook. This finding suggests that the boundaries between these two essential subjects are not clearly delineated, which may lead to confusion in understanding their distinct concepts. This theme highlights the importance of clarifying and organizing

the curriculum to facilitate better comprehension and integration of these foundational sciences.

Collectively, these identified themes provide valuable insights into the students' perspectives on the anatomy syllabus. Addressing these themes in curriculum planning and implementation can lead to more focused and effective anatomy education, promoting a positive and enriching learning experience for allied health science students.

Discussion

The results of the present study are in line with the findings reported by other researchers globally, indicating that the perceptions and challenges surrounding anatomy education are prevalent across various medical and allied health science disciplines. In Gupta et al.'s study involving 200 MBBS students of different professional years, the issue of curriculum overload, particularly in anatomy, was identified as a significant problem faced by students [5]. This aligns with the current study's theme of "Perception of Vast and Factual Nature," where more than 75% of allied health science students felt that their anatomy syllabus is extensive and laden with factual information. The perception of content overload, leading to overburdened study and limited time for other subjects, resonates with both studies.

Similarly, Bergman's study on undergraduate perceptions of anatomy across 76 students revealed that clinical exposure acted as a prime motivating factor for studying anatomy [2]. This corresponds with the current study's theme of "Alignment with Required Competencies," where around 70% of students acknowledged that the anatomy syllabus aligned with their essential competencies. The significance of clinical application and its role in motivating students to learn anatomy was evident in both studies.

Additionally, the findings from a study conducted in the United Kingdom (UK), focused on learning anatomy in the context of speech and language science students, are consistent with the current study's theme of "Inadequate Emphasis on Practical Knowledge" [3]. The UK study reported that students struggled with learning anatomy, found the amount of material daunting, experienced difficulty in memory retention, and lacked confidence in their knowledge base. These challenges are mirrored in the current study, where 60% of allied health science students expressed concern about the inadequate emphasis on practical knowledge like slide making and surface marking of blood vessels.

In the context of Australian University, a study focused on Biomedical Science (BMS) students revealed valuable insights into their perceptions of teaching methods employed in a first-year introductory anatomy and physiology unit. The BMS students recommended greater utilization of blackboard teaching, increased use of cadavers, and a higher number of dissections. Moreover, the students emphasized that their interest and engagement in a particular unit were driven by its relevance to their degree program [8]. This observation underscores the importance of tailoring anatomy education to the

specific needs of each branch within Allied Health Sciences (AHS). By providing detailed and focused anatomy content relevant to their future practice, students are more likely to become deeply interested and enthusiastic learners. For instance, a renal dialysis student would be more engaged in learning detailed renal anatomy, which is directly applicable to their practice.

Across different geographical and cultural backgrounds, a study in Ethiopia found that medical students displayed a positive attitude toward basic medical science subjects, particularly anatomy and physiology, as they perceived them to be highly relevant to their clinical practice [9]. A similar view was shared by medical students at all stages of their course, regardless of whether they were in their first year or final year [10]. These findings reinforce the significant role of anatomy in medical education and clinical studies.

Experts recommend that enhancing anatomy education can be achieved through the integration of relevant clinical applied anatomy and adopting active learning techniques [11, 12]. Vertically integrating anatomy education has also been suggested as a valuable approach, allowing students to participate more directly in their learning and yielding more favorable results compared to traditional passive methods [13].

In the United Kingdom, life science nurse educators collaborated with the Anatomical Society to develop a detailed discipline-specific core anatomy syllabus, systematically organized system-wise with defined learning outcomes. This syllabus enables nurse educators to emphasize the

relevance of anatomy to nursing practice, enhancing students' understanding and application of anatomy principles [14]. Similarly, involving allied health science practitioners and anatomy teachers in planning the syllabus for each allied course, incorporating defined learning outcomes, can create a curriculum that resonates with students and highlights the practical relevance of anatomy in their clinical practice.

The findings from various studies align with the current research, emphasizing the significance of tailoring anatomy education to meet the needs of specific disciplines within AHS. By incorporating relevant clinical applied anatomy, adopting active learning techniques, and creating well-structured syllabi with defined learning outcomes, educators can promote student engagement and interest in anatomy, leading to a more enriched and applicable learning experience. The similarity between the results of the present study and the findings from other researchers globally indicates a shared set of concerns and perceptions regarding anatomy education. These consistencies highlight the need for concerted efforts to address curriculum design, emphasize practical aspects, and ensure alignment with students' future professional needs.

In the context of improving teaching and learning in Anatomy, the integration of virtual learning methods can be a valuable approach. Virtual learning technologies offer innovative and interactive tools that can enhance students' understanding and engagement with anatomical concepts. Virtual anatomy platforms provide realistic

3D models and interactive simulations, allowing students to explore anatomical structures in a dynamic and immersive manner. Through these virtual environments, students can manipulate anatomical structures, visualize complex relationships, and gain a deeper understanding of spatial anatomy, which may be challenging to achieve through traditional teaching methods alone [15, 16].

Moreover, virtual learning platforms enable self-paced learning, allowing students to revisit challenging concepts and review materials as needed. This flexibility accommodates different learning styles and ensures that students can grasp fundamental anatomical knowledge at their own pace. Incorporating virtual anatomy dissection experiences can also be beneficial, particularly in cases where access to cadavers or physical dissection labs is limited. Virtual dissection tools provide a safe and ethical alternative for students to explore anatomical structures and practice dissection techniques (15, 16).

Additionally, virtual learning platforms can facilitate collaborative learning experiences. Students can engage in virtual group discussions, share insights, and work together on complex anatomical cases, promoting active learning and knowledge exchange. However, while virtual learning offers numerous advantages, it is essential to recognize its potential limitations. Some students may require additional support and guidance to navigate virtual platforms effectively, and educators should ensure that adequate training and resources are provided to facilitate seamless integration.

Limitations and suggestions

Limitations of this study include the potential for data saturation in the qualitative analysis. Although efforts were made to gather a diverse set of responses from 100 students, the sample size may not have been sufficient to reach data saturation. As a result, certain perspectives or insights from students might not have been fully captured, limiting the comprehensiveness of the study findings. Response bias is another noteworthy limitation. While the questionnaire was designed to maintain anonymity and encourage honest responses, students may have been inclined to provide socially desirable answers or refrain from expressing their true opinions due to various reasons such as fear of judgment or desire to conform to perceived norms. This bias could have influenced the reported perceptions, potentially leading to an underrepresentation or overrepresentation of certain viewpoints. Despite these limitations, the study provides valuable insights into the perceptions of allied health science students regarding their anatomy syllabus. To mitigate the limitations, future studies could employ larger sample sizes and diverse data collection methods, such as focus group discussions or interviews, to ensure data saturation and minimize response bias, thereby yielding more comprehensive and robust findings. The analysis did not specifically consider gender differences in perceptions. The primary focus was on understanding overall trends and commonalities in the perceptions of allied health students regarding the anatomy curriculum. While gender-specific analysis

could provide additional insights, it was beyond the scope of this particular study.

Conclusion

In conclusion, a significant majority of students, approximately three-fourths, perceive the anatomy syllabus to be extensive and overwhelming. Additionally, 60% of students express concerns about the insufficient emphasis on practical knowledge, such as slide making and surface marking of blood vessels, while half of the students identify a lack of clear-cut distinction between Anatomy and Physiology in their textbooks. To address these findings, it is crucial to tailor the anatomy syllabus for each allied health science course, incorporating defined learning outcomes that align with the specific needs of students in their future clinical practice. Moreover, the integration of practical skills relevant to their professional roles is essential to enhance the students' engagement and interest in anatomy education. By adapting the curriculum to meet the unique requirements of each allied health discipline and incorporating practical applications, educators can foster a more meaningful and enriching learning experience for the students. This approach will better prepare them for their respective healthcare roles and nurture a deeper appreciation for the importance of anatomy in their clinical practice.

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Authors' contributions

SVU, AM, AB, MC, LS, HR-All the authors participated in the process of the initial writing of the manuscript, its revision, presentation of the idea and initial design, and collection and analysis of data. Moreover, all authors accept the responsibility for the accuracy and correctness of the contents of the present manuscript and approve the final version of the manuscript.

Conflict of interests

The authors report no actual or potential conflict of interest.

Ethical considerations

This study was conducted based on the principles of the Declaration of Helsinki. Before the study, the approval of the Institutional Ethics Committee of Sapthagiri Institute of Medical Sciences and Research Center (No. IEC NO SIMS&RC/IECC06/2012) was obtained.

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References

1. Notebaert AJ. Student perceptions about learning anatomy. ProQuest Diss Theses. 2009; 148. Available from: https://search.proquest.com/docview/304904306.

2. Bergman EM, de Bruin AB, Herrler A, Verheijen IW, Scherpbier AJ, van der

Vleuten CP. Students' perceptions of anatomy across the undergraduate problem-based learning medical curriculum: a phenomenographical study. BMC Med Educ. 2013 Nov 19;13:152. doi: 10.1186/1472-6920-13-152.

3. Smith CF, Martinez-Álvarez C, McHanwell S. The context of learning anatomy: does it make a difference? J Anat. 2014 Mar;224(3):270-8. doi: 10.1111/joa.12089. Epub 2013 Aug 12.

4. Sturges D, Mauner T. Allied Health Students' Perceptions of Class Difficulty: The Case of Undergraduate Human Anatomy and Physiology Classes. Internet J Allied Heal Sci Pract. 2013;11(4).

5. Gupta S, Gupta AK, Verma M, Kaur H, Kaur A, Singh K. The attitudes and perceptions of medical students towards basic science subjects during their clinical years: A cross-sectional survey. Int J Appl Basic Med Res. 2014 Jan;4(1):16-9. doi: 10.4103/2229-516X.125675.

6. Abdelrahman NuggedAlla MA. Perception and Significance of Basic Sciences for Clinical Studies. Int J Hum Anat. 2018;1(2):26–32.

7. Ginzburg SB, Brenner J, Cassara M, Kwiatkowski T, Willey JM. Contextualizing the relevance of basic sciences: small-group simulation with debrief for first- and second-year medical students in an integrated curriculum. Adv Med Educ Pract. 2017 Jan 18;8:79-84. doi: 10.2147/AMEP.S124851.

8. Anderton RS, Chiu LS, Aulfrey S. Student Perceptions to Teaching Undergraduate Anatomy in Health Sciences. Int J High Educ. 2016;5(3):201–16.

9. Teshome D, Tiruneh C, Berhanu L, Berihun G. Medical Students' Attitude and Perception Towards Basic Medical Science Subjects at Wollo University, Northeast Ethiopia. Adv Med Educ Pract. 2021 May 3;12:431-438. doi: 10.2147/AMEP.S309440.

10. Moxham BJ, Plaisant O. Perception of medical students towards the clinical relevance of anatomy. Clin Anat. 2007 Jul;20(5):560-4. doi: 10.1002/ca.20453. PMID: 17149736.

11. Staśkiewicz GJ, Walczak E, Torres K, Torres A, Mazgaj M, Kostek H, et al. What do clinicians think of the anatomical knowledge of medical students? Results of a survey. Folia Morphol (Warsz). 2007 May;66(2):138-42. PMID: 17594673.

12. Waterston SW, Stewart IJ. Survey of clinicians' attitudes to the anatomical teaching and knowledge of medical students. Clin Anat. 2005 Jul;18(5):380-4. doi: 10.1002/ca.20101.

13. Lunsford E, Diviney M. Changing Perspectives on Anatomy & Physiology: From Killer Class to Gateway Course. Bioscene: The Journal of College Biology Teaching. 2020; 46: 3-9.

14. Connolly SA, Gillingwater TH, Chandler C, Grant AW, Greig J, Meskell M, et al. The Anatomical Society's core anatomy syllabus for undergraduate nursing. J Anat. 2018 May;232(5):721-728. doi: 10.1111/joa.12782. Epub 2018 Feb 7.

15. Narang K, Imsirovic A, Dhanda J, Smith CF. Virtual Reality for Anatomy and Surgical Teaching. Adv Exp Med Biol. 2023;1397:135-149. doi: 10.1007/978-3-031-17135-2_8.

16. Gloy K, Weyhe P, Nerenz E, Kaluschke M, Uslar V, Zachmann G, et al. Immersive Anatomy Atlas: Learning Factual Medical Knowledge in a Virtual Reality Environment. Anat Sci Educ. 2022 Mar;15(2):360-368. doi: 10.1002/ase.2095. Epub 2021 Jun 30.

ORIGINAL ARTICLE

Infection Related Glomerulonephritis in Adults: A Prospective Observational Study from South India

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Abstract

Introduction: Infection-related glomerulonephritis, IRGN in adults is increasing in prevalence in India. However, there are only a few prospective studies from south India on the long term prognosis of this disease. **Materials and Methods:** This is a prospective observational study on patients above 18 years of age, with biopsy proven IRGN, at a tertiary care centre in south India with a minimum follow up of 6 months. **Results:** A total of 100 patients were included in the study. Peak incidence was in the age group of 40-60 years (n=45, 45%) with a male preponderance (n=56,56%). The most common co-morbidities were diabetes mellitus (n=27, 27%) and alcohol intake (n=13,13%). The most common source of infection was skin and soft tissues (n=41, 41%). Streptococcus and Staphylococcus were the most common isolated organisms. One patient had IRGN following SARS C0V-2 virus infection. Twenty three (n=23, 23%) required dialysis initiation. The mean follow up was 31.4 weeks. 3 patients died within 1 month of illness. At the end of 6 months, out of the 97 surviving patients, 34 (n=34,35%) patients had chronic kidney disease,CKD (eGFR <60 ml/per/1.73 m^2) and 9 (n=9,9.27%) were dialysis dependant. Age >40 years, associated diabetes mellitus,underlying CKD, dialysis requiring renal failure at presentation,presence of crescentric GN and moderate to severe Interstitial Fibrosis and Tubular Atrophy in renal biopsy were identified as risk factors for development of CKD by univariate analysis. **Conclusion:** Adult IRGN is as an important cause of CKD and end stage renal disease in Indian adults especially in diabetics and those above 40 years of age.

Keywords: Adult IRGN, South India, Clinical profile, Outcome

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Graphical Abstract

Introduction:

The prevalence of adult Infection related glomerulonephritis, IRGN is increasing in India. This is a study on the long term outcome of adult IRGN.

Materials and methods:

Study design: Prospective observational study
Study center: Tertiary care center in south India
Study population:
- ≥ 18 years of age
- Biopsy proven IRGN
- Fulfilling the diagnostic criteria of IRGN *
- Minimum follow up of 6 months

We excluded patients who died/lost follow up before 6 months of disease onset

Results:
No. of Study participants: 100
Peak age: 40-60 years
Male:Female: 56:44
Most common co-morbidities:
- Diabetes mellitus: 27%
- Alcohol intake: 13%

Most common source of infection:
- Skin and soft tissue: 41%
- Upper respiratory tract: 19%

Most common organisms:
- Streptococcus and Staphylococcus
- Rare observation: SARS CoV-2 virus

Clinical presentation:
- Acute nephritic syndrome: 57%
- Rapidly progressive renal failure: 10%
- Nephrotic syndrome: 5%
- Nephrotic range proteinuria: 38%

Mean serum creatinine at presentation: 3.47±0.61mg/dl
Dialysis requirement at presentation: 23%
Hypocomplementemia: 82%
Renal biopsy features: DPGN*: 63%
- Endocapillary proliferative: 22%
- Crescentic GN[1]: 8%
- Mesangioproliferative GN[1]: 7%
- IgA dominant IRGN: 4%

Mean duration of hospital stay: 42.4 days
Mean duration of follow up: 31.4 weeks
Outcome: At the end of 6 months

➢ Mortality: 3%
➢ CKD: 35%
   (eGFR by CKD-EPI <60 m//min/1.73 m2)
➢ Dialysis dependency: 9.27%
➢ Persistent hypertension: 26.80%
➢ Persistent proteinuria: 32.98%

Risk factors associated with poor renal outcome (CKD/ESRD) at the end of 6 months:

➢ Age >40 years
➢ Diabetes mellitus
➢ Underlying CKD
➢ Dialysis requiring renal failure at presentation
➢ Presence of crescentric glomerulonephritis
➢ Moderate to severe Interstitial fibrosis and tubular atrophy in renal biopsy

* Adopted from Nasr SH, Radhakrishnan J, D'Agati VD. Bacterial infection-related glomerulonephritis in adults. Kidney Int 2013;83:792–803.
*Diffuse proliferative glomerulonephritis
[1]Glomerulonephritis

Conclusion:

Adult IRGN is as an important emerging cause of CKD/ESRD in Indian adults especially in the elderly and diabetics. Early identification and eradication of source of infection is critical in preventing this disease and its associated long term renal morbidity.

Introduction

Infection-related glomerulonephritis (IRGN) is an immune complex-mediated acute glomerulonephritis occurring in association with a variety of non-renal infections [1]. The incidence and prevalence of postinfectious glomerulonephritis in India, based on data from biopsy studies, is 39.24 cases per year and 10.14 cases per 100,000 population respectively [2]. Also its prevalence in adults has been increasing in recent decades [2] thereby causing significant renal morbidity. However, there are limited studies on the long-term prognosis of this disease in adults from South India.

Materials and Methods

We did a prospective observational study on patients with biopsy-proven IRGN from June 2017 to July 2021, at Government Kilpauk Medical College and Government Royapettah Hospital, Chennai, India. We included patients above 18 years of age with the diagnosis of IRGN and were followed up for a minimum period of 6 months. The diagnosis of IRGN was done based on the criteria put forth by Nasr et al. [3], which require the presence of at least three of the following five criteria: (i) clinical or laboratory evidence of infection preceding or at the onset of glomerulonephritis; (ii) depressed serum complement; (iii) endocapillary proliferative and exudative glomerulonephritis; (iv) C3-dominant or co-dominant glomerular immunofluorescence staining; and (v) hump shaped sub-epithelial deposits on electron microscopy (EM).

Demographic data, co-morbidities, and clinical presentation were documented. Investigations namely complete blood count, random blood sugar; renal function tests, urine analysis; urine protein–creatinine ratio (uPCR); serum electrolytes; liver function tests; serological tests for HIV, hepatitis B

and hepatitis C; and complement levels (C3 and C4) were done in all patients.

Renal biopsy was done by trained nephrologists under ultrasonic guidance and sent for histopathological examination to the renal pathologist. Immuno-fluorescence (IF) and light microscopic (LM) examination were done in all samples. Haematoxylin and eosin, periodic acid–Schiff, Jone's methenamine silver and Masson's trichrome stains were used for light microscopic study. Electron Microscopy (EM) was done only in selected patients in whom EM was needed to fulfill the adopted diagnostic criteria.

Complete physical examination, and investigations to find the infective foci namely echocardiography, chest X-ray, ultrasound abdomen and cultures of blood, urine, pus and other appropriate samples in individual patients were done. ENT (ear, nose, throat) opinion, dental opinion, dermatologist opinion for infective foci were obtained in all patients even in those with an identifiable source of infection to rule out multiple foci. The clinical presentation of patients was classified based on the following definition

1. Acute nephritic syndrome: defined by the occurrence of hematuria, proteinuria, and edema, often with hypertension and azotemia in temporal relation.
2. Rapidly progressive renal failure: defined by a rapid decline in GFR over days to weeks.
3. Nephrotic proteinuria: defined by the presence of more than 3.5 gm of proteinuria per day.
4. Nephrotic syndrome: defined by the triad of nephrotic range proteinuria (more than 3.5 gm of proteinuria per day), edema and hypoalbuminemia.

All patients were treated with standard of care for the management of IRGN namely salt and fluid restriction; blood pressure control with antihypertensives and diuretics. Calcium channel blockers were used as the first choice anti-hypertensives. Dialysis initiation was done in patients who presented with severe renal failure (serum creatinine >7 mg/dl), or if encephalopathy/ refractory pulmonary edema/ metabolic acidosis/ hyperkalemia occurred. Steroids were used in patients who presented with dialysis-dependent renal failure and/or in those with crescents in renal biopsy study after ruling out all possible sources of active infection. Our steroid regimen was injection Methylprednisolone 250 mg/day for 3 consecutive days followed by oral prednisolone of 0.5 mg per kg for 4 weeks and rapid tapering over the next two weeks.

All patients were followed up with weekly visits in the first month and with monthly visits after that, for 5 months. Blood pressure, renal function and proteinuria were monitored in each visit. Glomerular filtration rate, eGFR was calculated using the CKD-EPI (chronic kidney disease epidemiology collaboration) formula. Complement levels were not repeated in all of our patients in view of unaffordability.

The primary objective was to analyse the risk of CKD (eGFR $<$ 60 m/min/1.73 m^2)/dialysis dependency at the end of 6 months and the secondary objective was to analyse the risk factors associated with CKD/dialysis dependency at the end of 6 months. Patients who died and those who lost follow-up were excluded from the final analysis.

Statistical analysis was performed using SPSS for Windows version 15.0. Univariate analysis was done using Fischer's exact test. The Institutional Ethics

Committee approval was obtained with IEC Protocol No. 816/2022.

Results

A total of 100 patients were included in the study. Peak incidence was in the age group of 40–60 years (n=45,45%) with a male preponderance (n=56,56%) (Table 1). Eleven patients (n=11,11%) were above 60 years of age (Table 1). The most common co-morbities observed were diabetes mellitus (n=27, 27%) and alcohol intake (n=13,13%) (Table 1). The most common source of infection was skin and soft tissues (n=41,41%) in both diabetics and non-diabetics followed by the upper respiratory tract (n=19,19%) (Figure 1). About twenty-three patients (n=23,23%,) had no identifiable infection source despite a meticulous search (Figure 1). Streptococcus and Staphylococcus were the most common organisms identified in our study. One of our patients had IRGN in association with SARS CoV-2 infection.

The clinical presentations are shown in Table 2. Edema and proteinuria were universally present. New onset hypertension was seen in 82 (n=82,82%) patients and macrohaematuria in 32 (n=32,32%) patients. Acute nephritic syndrome was the most common renal syndrome at presentation (n=57,57%); ten (n=10,10%) presented with Rapidly progressive renal failure (RPRF).

Nephrotic range proteinuria was present in 38 (n=38, 38%) patients. Sixty nine (n=69, 69%) patients had renal failure at presentation. The mean serum creatinine at admission was 3.47±0.611 mg/dl. Thirty (n=30,30%) patients presented with serum creatinine >4.0 mg/dl and twenty three (n=23,23%) required initiation of haemodialysis. Hypocomplementaemia was seen in 82 (n=82,82%) patients, out of which 74 (n=74,74%) had low C3 with normal C4, and eight (n=8,8%) had low C3 with low C4.

In the renal biopsy study (Table 3), C3 with IgG (n=61,61%) and isolated C3 (n=23,23%) were the most common immunofluorescence pattern seen. About four patients (n=4,4%) had IgA-dominant IRGN. Diffuse proliferative glomerulonephritis (DPGN) (n=63,63%) and endocapillary proliferative glomerulonephritis (n=22,22%) were the most common light microscopic finding Crescents were seen in twenty-eight (n=28,28%) patients, while crescentic glomerulonephritis (GN) was seen in eight (n=8,8%) patients. Thirteen out of the 27 diabetics had coexisting diabetic nephropathy. Steroids were used in fifteen of our patients.

The mean duration of hospital stay was 42.4 days.The mean follow-up was 31.4 weeks. Three patients died within 1 month of the onset of illness. All 3 patients were elderly males who presented with dialysis requiring renal failure. Two of them were diabetics with diabetic foot syndrome and coronary artery disease and died of sepsis/septic shock. Steroids were not given to them. Steroids were given to the other non-diabetic who presented with crescentric GN; nil identifiable source of infection. He did not respond to steroids and subsequently developed CRBSI/sepsis/septic shock and expired.

Table 1. Demographic Factors

Demographic Factors	
Male : Female	56:44
Age in years	No. of patients (%)
<20	16 (16%)
20-40	28 (28%)
40-60	45 (45%)
>60	11 (11%)
Co-morbidities	No. of patients (%)
Diabetes mellitus	27 (27%)
Alcoholism	13 (13%)
Pre-existing Hypertension	6 (6%)
Smoking	11 (11%)
Pre-existing chronic kidney disease	7 (7%)
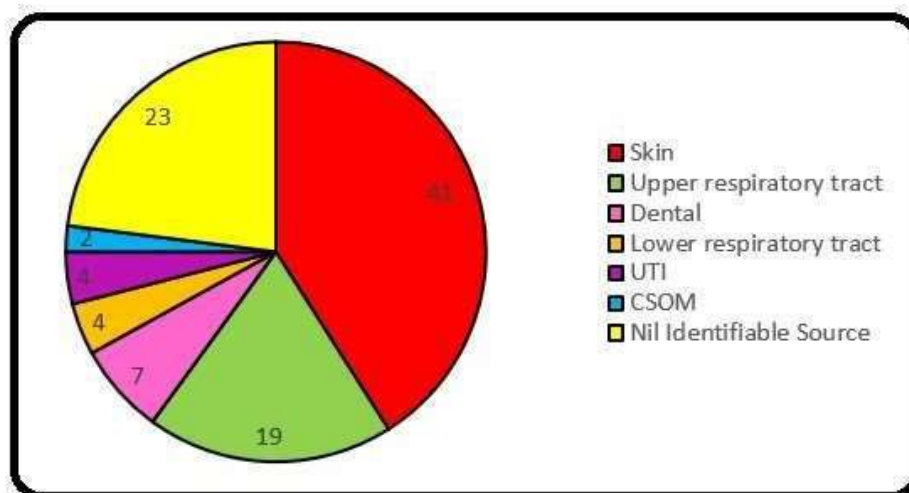
Figure 1. Source of infection

UTI-Urinary Tract Infection, CSOM-Chronic Suppurative Otitis Media

Table 2. Clinical Presentation

Clinical presentation	No. of patients (%)
New onset hypertension (>140/90 mm hg)	82 (82%)
Renal failure (Sr. creatinine >1. 2 mg/dl)	69 (69%)
Serum creatinine 1. 2-4 mg/dl	39 (39%)
Serum creatinine >4	30 (30%)
Dialysis requirement	23 (23%)
Acute Nephritic syndrome	57 (57%)
Renal failure with Nephrotic proteinuria	22 (22%)
Renal failure with sub-nephrotic proteinuria	6 (6%)

Rapidly progressive renal failure	10 (10%)
Nephrotic syndrome	5 (5%)
Macrohaematuria	32 (32%)
Nephrotic proteinuria (urine protein >3.5 mg/dl)	38 (38%)
Low C3 and low C4	8 (8%)
Low C3 and normal C4	74 (74%)

Table 3. Renal Biopsy Features

Renal biopsy features	No. of patients (%)
Light microscopic features	
Diffuse proliferative glomerulonephritis	63 (63%)
Endocapillary proliferative Glomerulonephritis	22(22%)
Crescentric Glomerulonephritis (>50% glomeruli with crescents)	8(8%)
Mesangioproliferative Glomerulonephritis	7(7%)
Crescents	28 (28%)
Co-existing Diabetic nephropathy	13 (48.14%)
Moderate IFTA[*]	7 (7%)
Severe IFTA[*]	3 (3%)
Immunofluorescence study	**No. of patients (%)**
c3+IgG c3 alone c3+IgG+IgM c3+IgA c3+IgG+c1q	61 (61%) 23 (23%) 11 (11%) 4 (4%) 1 (1%)

[*]IFTA-interstitial fibrosis and tubular atrophy

Table 4. Outcome of Adults with IRGN

Outcome	No. of patients (%)
Death	3 (3%)
Chronic kidney disease (e-GFR<60 ml/min/1.73 m^2)	34 (35%)
Dialysis dependant	9 (9. 27%)
Persistent hypertension	26 (26.80%)
Persistent proteinuria	32 (32.98%)

Table 5. Factors Associated with Progression to CKD

Factors	**Normal renal function at end of 6 months (n=63)**	**CKD (e-GFR ≤60 ml/min/1. 73 m²) at 6 months (n=34)**	**pvalue (<0.05)**	**Odds ratio**
Age >40	26 (41.26%)	27 (79.41%)	0.0005	5.489 (2.0789 to 14.4929)
Males	32 (50.79%)	21 (61.76%)	0.39	1.5649 (0.6689 to 3.6611)
Diabetes Mellitus	10 (15.87%)	15 (44.11%)	0.0035	4.1842 (1.6077 to 10.8900)
Alcoholism	7 (11.11%)	5 (14.70%)	0.75	1.3793 (0.4023 to 4.7291)
Underlying CKD	1 (1.58%)	5 (14.70%)	0.0191	10.6897 (1.1941 to 95.6944)
Presenting creatinine >4	15 (23.80%)	12 (35.29%)	0.24	1.7455 (0.7015 to 4.3429)
Crescentric GN	1 (1.58%)	5 (14.70%)	0.0191	10.6897 (1.1941 to 95.6944)
Crescents	15 (23.80%)	13 (38.24%)	0.1619	1.9810 (0.8034 to 4.8848)
IgA dominant IRGN	3 (4.76%)	1 (2.94%)	1.0	0.6061 (0.0606 to 6.0615)
Moderate To Severe IFTA	2 (3.17%)	6 (17.64%)	0.0206	6.5357 (1.2406 to 34.4318)
HD requirement at presentation	4 (6.35%)	16 (47.05%)	0.00001	13.1111 (3.8857 to 44.2394)
Diabetic Nephropathy	7 (11.11%)	5 (14.70%)	0.75	1.3793 (0.4023 to 4.7291)

At the end of 6 months, out of the 97 surviving patients, 34 (n=34,35%) patients had persistent renal dysfunction,CKD (eGFR by CKD-EPI <60ml/per/1.73 m²)) and 9 (n=9,9.27%) were dialysis dependant. (Table 4). Age >40 years, associated diabetes mellitus,underlying CKD, dialysis requiring renal failure at presentation, the presence of crescentric GN and moderate-to-severe IFTA in renal biopsy were identified as risk factors for the development of CKD by univariate analysis (Table 5).

Discussion

The classical post-streptococcal glomerulonephritis comprises of an initial infectious episode, usually a pharyngitis or a skin infection followed by a symptom-free period of 2 to 3 weeks and an acute nephritic syndrome; usually affecting children and young adults [4,5]. Over the past few decades, there has been a shift in the epidemiology of this disease. Its prevalence among adults has been increasing over the past few decades in developing countries like India [2]. Also, we could evidence that the mean or the peak age of presentation of adult

IRGN in India has increased over the years. Most recent studies have observed peak incidence in those above >40 years of age [6-8] similar to our study.

A bimodal distribution of cases with respect to age, with peaks in the second and fourth to fifth decades was observed in a study from south India [7]. In our study, the peak incidence in females was at 20-40 years of age and among males was 40-60 years.

The prognosis of post-infectious glomerulonephritis among elderly patients more than 60 years of age is poor, with 44% progressing to CKD and 33% progressing to end stage renal disease [9]. Also, biopsy studies from South India have reported IRGN as the common renal biopsy finding in the elderly and the very elderly thereby contributing to renal morbidity in the elderly and very elderly [10]. A single-centre observational study from South India reported 10% of patients to be above 60 years of age [7]. In our study, 11% were above 60 years of age.

There was a male predominance in our study similar to the observation in most other studies [9,11-14].

About one-third of adults with post-infectious glomerulonephritis have been found to have one or more comorbidities in recent studies [12]. This is in contrast to the earlier reports published, in which most of the affected patients had no notable medical history [15,16].

The various co-morbidities that have been identified are diabetes mellitus, alcohol intake, malignancy, prosthetic heart valve, intravenous drug use and retroviral disease [9,12]. Among these, most studies have observed diabetes mellitus and alcoholism [6,7,17] as the most common co-morbidities similar to our study.

The various sites of infection identified to be associated with IRGN in adults include the upper respiratory tract, skin, lung, heart, urinary tract, oral cavity, bone and deep-seated visceral or somatic abscess [3] out of which, the upper respiratory tract and skin are the most common sites [3,6,7]. As per literature evidence, skin has been found to be the most common site in the elderly and diabetics [9], in contrast to dental infection in those consuming alcohol [17]. An infective source was identified in 77% of our patients and the most common source was skin and soft tissues

Though acute nephritic syndrome is the most common presentation in adult IRGN [3,7,18], they can also present with rapidly progressive renal failure and nephrotic syndrome, unlike children. Also a significant number of adult patients present with dialysis requiring renal failure at presentation [6,7,9,13,18].

The majority of our patients presented with acute nephritic syndrome, classically defined by the occurrence of haematuria, proteinuria, edema often with hypertension and a mild degree renal impairment occurring in temporal relation. Edema and proteinuria were universally present in our patients. New onset hypertension was present in 82% of patients and macrohaematuria in 32% of patients.

Nephrotic-range proteinuria was rarely observed in earlier literature [19]. However nephrotic range proteinuria has been a frequent presentation in recent studies ranging from 13.8% to as high as 60% in a few studies [6,13]. In our study, nephrotic proteinuria was seen in 38% of our patients.

Nephrotic syndrome is a rare presentation in adults [6,13] and was observed in 5% of our patients.

The reported incidence of RRT requirement in Indian studies has been high in recent years, ranging from 17.5 to 35.6% [6,7,13] in contrast to earlier studies [14]. In

our study, 23% required RRT initiation at presentation.

Hypocomplementaemia occurs in 35–80% of adults with IRGN [9,12,20]. In our study, hypocomplementaemia (low C3 with or without low C4) was observed in 82% of patients.

The diverse organisms reported to be associated with postinfectious glomerulonephritis have been increasing over recent years namely group A streptococci, groups C and G streptococci, staphylococci, gram-negative bacilli, mycobacteria, parasites, fungi, and various viruses [20]. However, the predominant association is with staphylococcus and gram-negative bacteria [9].

In our study, Streptococcus and Staphylococcus were the most common isolated organisms.

Though IRGN has been classically expressed following bacterial infections, there are reports of IRGN following viral infections [21]. One of our patients had IRGN in association with covid-19 infection [22] which is rare in literature [23].

The glomerular picture in IRGN can vary depending on the characteristics of the host and invading organism. The different pathological features, include diffuse proliferative glomerulonephritis (DPGN), endocapillary proliferative GN, crescentric GN, mesangioproliferative GN and rarely membranoproliferative GN [12]; the most common being diffuse proliferative glomerulonephiritis [6,12,14]. We had similar observations in our study. DPGN and endocapillary proliferative glomerulonephritis were the most common histopathologies observed in our study. Mesangioproligerative and crescentric GN were observed in a few patients.

In immunofluorescence study, granular deposition of complement C3 is observed commonly, often with IgG and occasionally with IgM and rarely IgA. Isolated C3 and C3 with IgG were the common IF findings in our study.

IgA-dominant IRGN is rare and it usually occurs in association with diabetes and in those with staphylococcal infection [12] and carries a poor prognosis [24]. We observed IgA-dominant IRGN in 4 of our patients.

Treatment of acute postinfectious glomerulonephritis has been predominantly supportive considering the benign course of the disease and that the disease resolves with tthe eradication of the infection source. However, current insight into the pathophysiology of IRGN is such that the cascade of glomerular inflammatory events continues despite removal of the triggering insult especially in those with glomerulonephritis secondary to Staphylococcus aureus [12]. In these situations, treatment with corticosteroids or cytotoxic agents might help [25,26]. A single-center randomized control trial from south India reported that the use of corticosteroids in patients with IRGN and serum creatinine >1.5 mg/dl did not increase the rate of complete renal recovery at 6 months and that the infectious complications occurred more often in the steroid arm [27]. However, multicentric randomized clinical trials are needed to test the usefulness of immunosuppressants in IRGN.

In our study, we restricted the usage of corticosteroid to patients who presented with dialysis-dependant renal failure and/or in those with crescents in renal biopsy after ruling out ongoing infection with a meticulous search for all possible active sources of infection in each patient.

The prognosis of IRGN in children especially those occurring as epidemics has

an excellent prognosis [28,29] in contrast to adult and sporadic IRGN [15,30]. The prognosis has been found to be worse in the elderly and those with co-morbidities [9].

In our study 35% had persistent renal dysfunction (CKD) at the end of 6 months and 9.27% of patients were dialysis dependent at the end of 6 months.

Various poor prognostic factors have been enlisted in IRGN that can predict the progression to CKD [11,14]. In our study, age >40 years, diabetes mellitus, underlying CKD, dialysis requiring renal failure at presentation, crescentic GN and moderate to severe IFTA were identified as risk factors by univariate analysis.

The strengths of our study are the inclusion of only biopsy-proven cases and prospective follow-up for 6 months. However limitations include short follow-up period and not excluding cases of C3 GN with repeat complement levels during follow-up.

Conclusion

This study highlights the changing trend in the epidemiology of this disease;the increasing significance of this disease as an important cause of CKD/ESRD in adults especially in low-income countries and the risk factors associated with the progression to CKD/ESRD. Because of the increasing incidence and poor prognosis, it is important for the physician to be aware of this emerging entity and the importance of early identification and eradication of the infection source. This study also emphasizes the need for future research on the usefulness of immunusupressive therapy in adult IRGN.

Conflicts of interest

The authors declare that they do not have any conflict of interest.

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References

1. Nadasdy T, Hebert LA. Infection-related glomerulonephritis: Understanding mechanisms. Semin Nephrol 2011;31:369–75.

2. Narasimhan B, Chacko B, John GT, Korula A, Kirubakaran MG, Ja ob CK. Characterization of kidney lesions in Indian adults: towards a renal biopsy registry. J Nephrol. 2006 Mar-Apr;19 (2):205-10. PMID: 16736422.

3. Nasr SH, Radhakrishnan J, D'Agati VD. Bacterial infection-related glomerulonephritis in adults. Kidney Int 2013;83:792–803.

4. Rammelkamp CH, Weaver RS. Acute glomerulonephritis: The significance of the variation in the incidence of the disease. J Clin Invest 1953;32:346-58.

5. Poon-King T, Mohammed I, Cox R, et al. Recurrent epidemic nephritis in SouthTrinidad. N Engl J Med 1967;277:728-33.

6. S. Arivazhagan, D. Rajasekar, N. Gopalakrishnan, R. Sakthirajan, J. Dhanapriya, T. Dinesh Kumar, T. Balasubramanian, N. Malathy. Clinicopathological profile and outcome of adult infectionrelated glomerulonephritis: A prospective follow-up study. Natl Med J India 2000;33:260–4.

7. Sanathkumar HT, Fernando EM, Kurien AA, Srinivasaprasad ND, Suren S, Thirumalvalavan K. Clinical profile, histopathology, and outcomes in infection-related glomerulonephritis – single-center experience. Indian J Nephrol 2022;32:546-54.

8. Clinicopathological Profile Of Patients With Infection Related Glomerulonephritis In A Tertiary Care Centre. Elsa Thomas, Aneeb Raj V. P, Renny Issac, Usha Nagadevi C S. Int J Acad Med Pharm 2023; 5 (1); 103-107.

9. Postinfectious Glomerulonephritis in the Elderly Samih H. Nasr, Mary E. Fidler,Anthony M. Valeri,Lynn D. Cornell,Sanjeev Sethi,Amy Zoller,Michael B. Stokes,Glen S. Markowitz, and Vivette D. D'Agati. J Am Soc Nephrol 22: 187–195, 2011.

10. Infection-related glomerulonephritis is the most common finding in renal biopsies in the very elderly in India Anila A. Kurien1, K. S. Jansi Premal and Natarajan Gopalakrishnan2 Clinical Kidney Journal, 2021, vol. 14, no. 1, 454–456.

11. Moroni G, Pozzi C, Quaglini S, Segagni S, Banfi G, Baroli A, et al. Long-term prognosis of diffuse proliferative glomerulonephritis associated with infection in adults. Nephrol Dial Transplant 2002;17:1204–11.

12. Nasr SH, Markowitz GS, Stokes MB, Said SM, Valeri AM, D'Agati VD, et al. Acute postinfectious glomerulonephritis in the modern era: Experience with 86 adults and review of the literature. Medicine (Baltimore) 2008;87:21–32.

13. The epidemiology, clinical features, and outcome of infection-related glomerulonephritis from East India: A single center experience. Trivedi M, Pasari A, Chowdhury AR, Kurien AA, Pandey R. Indian J Nephrol 2017;27:307-12.

14. Follow-Up Study of Post-Infectious Glomerulonephritis in Adults: Analysis of Predictors of Poor Renal Outcome Gopalakrishnan Natarajan, Sakthirajan Ramanathan, Dhanapriya Jeyachandran, Balasubramaniyan T., Srinivasa Prasad N. D., Dineshkumar Thanigachalam. Saudi J Kidney Dis Transpl 2014;25 (6):1210-1216.

15. Baldwin, D. s., Gluck, M. C., schacht, r. G. &Gallo, G. The long-term course ofpoststreptococcal glomerulonephritis. Ann. Intern. Med. 80, 342–358 (1974).

16. Lien, J. w., Mathew, T. H. & Meadows, r. Acute post-streptococcal glomerulonephritis in adults: a long-term study. Q. J. Med. 48, 99–111 (1979).

17. Keller CK, Andrassy K, Waldherr R, Ritz E. Postinfectious glomerulonephritis –Is there a link to alcoholism? Q J Med 1994;87:97–102.

18. Aditya, S, Bhushan, S, Mythri, S, Kishan, A, Gireesh, R, Ranjitha, S, Viswas, T, Gouri, S, Sravani, V, Sreedhara, CG. Institute of Nephrourology, Nephrology, Bangalore, India Kidney International Reports (2022) 7, S463–S530.

19. Sarkissian, A. et al. An epidemic of acute postinfectious glomerulonephritis in Armenia. Arch. Dis. Child. 77, 342–344 (1997).

20. Montseny, J. J., Meyrier, A., Kleinknecht, D. & Callard, P. The current spectrum of infectious Glomerulonephritis, experience with 76 patients and review of the literature. Medicine (Baltimore) 74, 63–73 (1995).

21. Komatsuda, A. et al. endocapillary proliferative glomerulonephritis in a patient with parvovirus B19 infection. Am. J. Kidney Dis. 36, 851–854 (2000).

22. Gandhi TS, Angusamy S, Jeyachandran D, Ramudu V, Thopalan B. Infection-related glomerulonephritis with reactive arthritis in a patient with COVID-19 infection. Indian J Kidney Dis 2022;1:22-5.

23. Pérez A, Torregrosa I, D'Marco L, Juan I, Terradez L, Solís MÁ, Moncho F, Carda-Batalla C, Forner MJ, Gorriz JL. IgA-Dominant Infection-Associated Glomerulonephritis Following SARS-CoV-2 Infection. Viruses. 2021 Mar 31;13 (4):587.

24. Dhanapriya J, Balasubramaniyan T, Maharajan SP, Dineshkumar T, Sakthirajan R,Gopalakrishnan N, et al. IgA-dominant infection-related glomerulonephritis inIndia: A single-center experience. Indian J Nephrol 2017;27:435–9.

25. el-Husseini, A. A., sheashaa, H. A., sabry, A. A.,Moustafa, F. e. & sobh, M. A. Acute postinfectious crescentic glomerulonephritis: clinicopathologic presentation and risk factors. Int. Urol. Nephrol. 37, 603–609 (2005).

26. Raff, A., Hebert, T., Pullman, J. & Coco, M. Crescentic post-streptococcal glomerulonephritis with nephrotic syndrome in the adult: is aggressive

therapy warranted? Clin. Nephrol. 63, 375–380 (2005).

27. Srinivasan Arivazhagan et al. Efficacy of Corticosteroids in Infection-Related Glomerulonephritis–A Randomized Controlled Trial. Kidney Int Rep (2022) 7, 2160–2165.

28. Lien, J. w., Mathew, T. H. & Meadows, r. Acute post-streptococcal glomerulonephritis in adults: a long-term study. Q. J. Med. 48, 99–111 (1979).

29. Berrios, X. et al. Post-streptococcal acute glomerulonephritis in Chile—20 years of experience. Pediatr. Nephrol. 19, 306–312 (2004).

30. Hinglais, N., Garcia-Torres, R. & Kleinknecht, D. Long-term prognosis in acute glomerulonephritis. The predictive value of early clinical and pathological features observed in 65 patients. Am. J. Med. 56, 52–60 (1974).

ORIGINAL ARTICLE

Estimation of Stature From Foot Length: An Anthropometric Study

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Abstract
Background: Identification is a crucial objective in autopsies, particularly when dealing with unknown, decomposed, or mutilated bodies. Various parameters are employed to establish the identity of a human being, and among them, stature holds significant importance in forensic casework. Stature estimation is pivotal in determining identity, especially when confronted with skeletal remains, fragmented bodies resulting from mass disasters, or mutilated corpses. **Objectives:** The main objective of the present study was to determine the relation between foot length and the stature of individual by using correlation coefficient in both sexes. To provide a linear regression model for estimation of stature from foot length in both males and females. **Methodology:** This cross-sectional study was conducted on 400 medical students aged between 20-25 years, studying at Andhra Medical College, Visakhapatnam, Andhra Pradesh, India. The length of both right and left foot from the posterior most part of the heel to the longest toe is taken using measuring tool and height of the individual is measured using standard scale and both are compared. Using all the data the study aims to establish a linear regression model for estimation of stature from foot length in both male and female. **Conclusion:** In all the groups, a significant and positive correlation between stature and foot length was established, and regression equations were derived for both the feet. An attempt was made to study the correlation between stature and foot length separately in both the sexes. However, owing to no significant difference in the results obtained, entire study sample was taken as a single unit for deriving the regression equation. In conclusion, the individual foot length proves to be useful for stature estimation, offering crucial support for forensic experts and anthropologists.

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Graphical Abstract

Title: ESTIMATION OF STATURE FROM FOOT LENGTH: AN ANTHROPOMETRIC STUDY
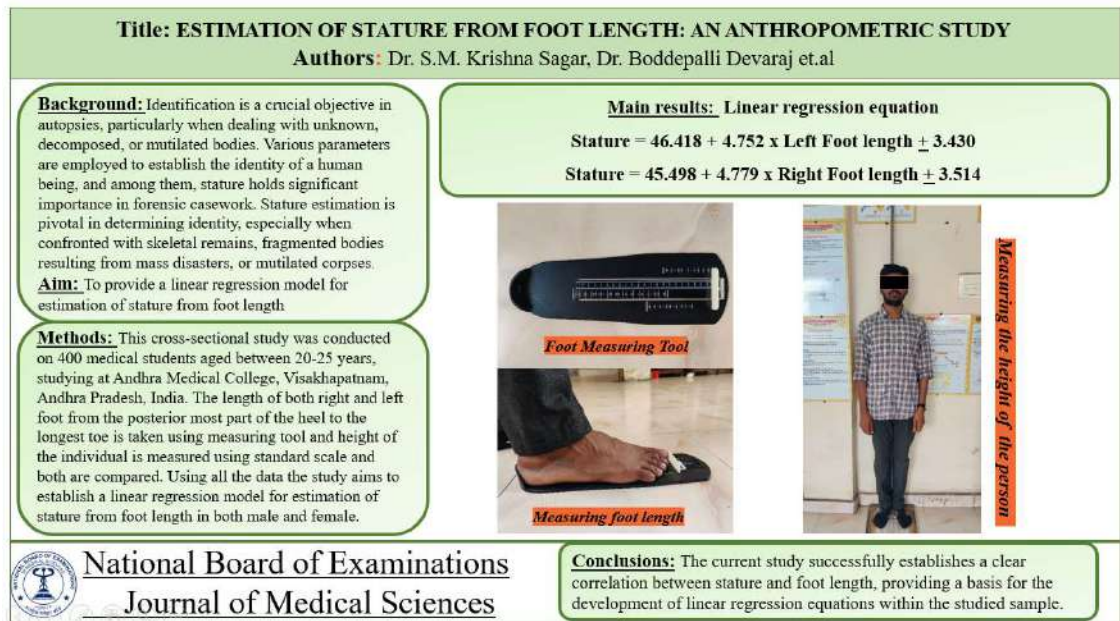**Authors:** Dr. S.M. Krishna Sagar, Dr. Boddepalli Devaraj et.al

Background: Identification is a crucial objective in autopsies, particularly when dealing with unknown, decomposed, or mutilated bodies. Various parameters are employed to establish the identity of a human being, and among them, stature holds significant importance in forensic casework. Stature estimation is pivotal in determining identity, especially when confronted with skeletal remains, fragmented bodies resulting from mass disasters, or mutilated corpses.
Aim: To provide a linear regression model for estimation of stature from foot length

Methods: This cross-sectional study was conducted on 400 medical students aged between 20-25 years, studying at Andhra Medical College, Visakhapatnam, Andhra Pradesh, India. The length of both right and left foot from the posterior most part of the heel to the longest toe is taken using measuring tool and height of the individual is measured using standard scale and both are compared. Using all the data the study aims to establish a linear regression model for estimation of stature from foot length in both male and female.

Main results: Linear regression equation

Stature = 46.418 + 4.752 x Left Foot length $\pm$ 3.430

Stature = 45.498 + 4.779 x Right Foot length $\pm$ 3.514

Foot Measuring Tool

Measuring foot length

Measuring the height of the person

National Board of Examinations Journal of Medical Sciences

Conclusions: The current study successfully establishes a clear correlation between stature and foot length, providing a basis for the development of linear regression equations within the studied sample.

Introduction

Identification involves determining an individual's identity based on specific physical characteristics such as age, sex, and stature. Positive and negative identification are crucial aspects of forensic medicine, playing pivotal roles in investigations. Opinions formed through identification can serve as valuable investigative leads, and well-evaluated opinions can contribute to solving cases. In the investigation of the assassination of former Prime Minister of India, Rajiv Gandhi, foot length and footwear became critical pieces of evidence, aiding in collecting adjoining mortal remains and guiding the investigation.

Estimating stature is a vital factor in forensic investigation, particularly in forensic anthropology. The association between stature and the length of various body parts, such as long bones, trunk, and extremities, has been well-researched by the scientific community. Traditionally, stature has been estimated using long bones like the tibia, ulna, and humerus. Foot length has also been employed for the same purpose by several researchers. The field of foot studies in forensic contexts is continually expanding, with a notable example being Forensic podiatry—a specialized branch that utilizes podiatric expertise to investigate and establish connections between individuals and crime scenes, addressing legal inquiries related to feet, footwear, and foot function. Forensic identification from the foot and its parts remains relevant even in the DNA era, especially in mass disasters like explosions, bomb blasts, and transportation accidents. The recovery of feet, often enclosed in shoes, is common and helpful. Moreover, choosing foot length for stature estimation can yield more precise results compared to long bones, given that the foot reaches its maximum length earlier, typically during adolescence. Variations in stature estimation from limb measurements are observed among individuals from different population groups and have been documented in published literature. To understand the relationship between stature

and foot length further, a cross-sectional study was conducted to explore the connection among our study participants.

Materials and Methods
Study Design
This cross-sectional study was conducted over a period of three-months from June to August 2023 among 400 healthy subjects, medical students at Andhra Medical College, Visakhapatnam, Andhra Pradesh who belong to south India.

Inclusion Criteria
M.B.B.S. students of Andhra Medical College who belong to south India, aged 20-25 years, without skeletal deformities, who had not undergone any surgical procedures on their limbs or foot skeleton, were included in the study.

Exclusion Criteria
Age below 20 and above 25, subjects diagnosed with lower limb and foot deformities and those who had sustained recent injuries, Obese individuals and Other than south Indians were excluded from the study.

Materials & Methodology
An anthropometer, a stadiometer, a foot measuring tool which can measure in millimetres, a computer with SPSS software. After taking informed written consent, stature of all subjects was measured using stadiometer in upright position with bare foot while standing on flat surface, heels, middle of the shoulders, buttocks and back of head touching stadiometer, with chin parallel to ground. The dimensions of both the left and right feet of each individual were measured and recorded on a data collection form separately. The maximum foot length was measured in sitting position to avoid error due to weight bearing, from the acropodion (tip of the hallux or second toe when the latter is longer than the hallux) to the pterion (most prominent point on the back of the heel), nails crossing the nailbeds were removed and measured. For the purpose of this study, the stature was defined as the vertical distance between the vertex and the floor when the head was held in the Frankfurt Horizontal (F.H) plane. The measurements are taken in the forenoon to avoid diurnal variations. The measurements are not rounded off. All findings were recorded in a proforma. The data analysis was carried out using Statistical Packages for Social Sciences, SPSS 26 (Figures 1 to 3).

Figure 1. Foot Measuring Tool

Figure 2. Measuring foot length

Figure 3. Measuring the height

Results

A total of 400 subjects (200 boys and 200 girls) participated in this study, their minimum and maximum heights, mean height, range, standard deviation and standard error are summarised in Table 1. Gender wise distribution of the stature is tabulated under Table 2. Distribution of foot lengths in males and females is tabulated under Tables 3,4 respectively. An attempt was made to study the correlation between stature and foot length separately in both the sexes. However, owing to no significant difference in the results obtained, entire study sample was taken as a single unit for deriving the regression equation. Similarly, the preliminary statistics calculated showed a promising difference between left and right foot. Hence, separate regression equations were derived. Pearson's correlation (r) between the stature and foot lengths is tabulated under Table 5. Right and left foot length measurement in both males and females combined together is tabulated under Table 6. Regression equations for stature from foot length is tabulated under Table 7.

Table 1. Height in All the Subjects

Total Number(n)	400
Minimum Height (cm)	143
Maximum Height(cm)	188
Mean Height(cm)	166
Range(cm)	45
Standard Deviation (SD)	9.27
Standard Error (SE)	0.4634

Table 2. Gender Wise Distribution of the Stature

Stature in cm	Male(n=200)	Percentage %	Female(n=200)	Percentage %
143-150	0	0%	11	5.5%
151-160	03	1.5%	110	55.0%
161-170	69	34.5%	71	35.5%
171-180	107	53.5%	08	4.0%
181-188	21	10.5%	0	0%

Table 3. Distribution of Foot Lengths in Males

Foot Length (cm)	Male(n=200)	
	Left foot	Right foot
23-26	76	79
26.1-27.5	86	87
27.6-30	38	34

Table 4. Distribution of Foot Lengths in Females

Foot Length (cm)	Female(n=200)	
	Left foot	Right foot
20-23	40	38
23.1-25	127	124
25.1-28	33	38

Table 5. Right and Left Foot Length Measurememt in Both Males and Females Combined Together

	Left Foot	Right Foot
Minimum Foot length(cm)	20.1	20.3
Maximum foot length(cm)	29.8	30
Mean foot Length(cm)	25.2206	25.2715
Range of foot Length(cm)	9.7	9.7
Standard Deviation	1.694756	1.678177
Standard Error	0.0847378	0.08390885

Table 6. Pearson's Correlation (R) Between the Stature and Foot Lengths

	r	r^2	P value
Left foot	0.869	0.755	<0.001
Right foot	0.865	0.749	<0.001

Table 7. Regression Equations for Stature from Foot Length

	Value of Constant **(A)**	Regression coefficient **(B)**	Error	Regression Equation
Left foot	46.418	4.752	3.430	46.418 + 4.752 x LFL $\pm$3.430
Right foot	45.498	4.779	3.514	45.498 + 4.779 x RFL $\pm$3.514

Figures 4 and 5 shows the scatter plot of relation between the height and foot length of left and right foot respectively. X-axis - Foot measurements & Y-axis - Height of the individual.
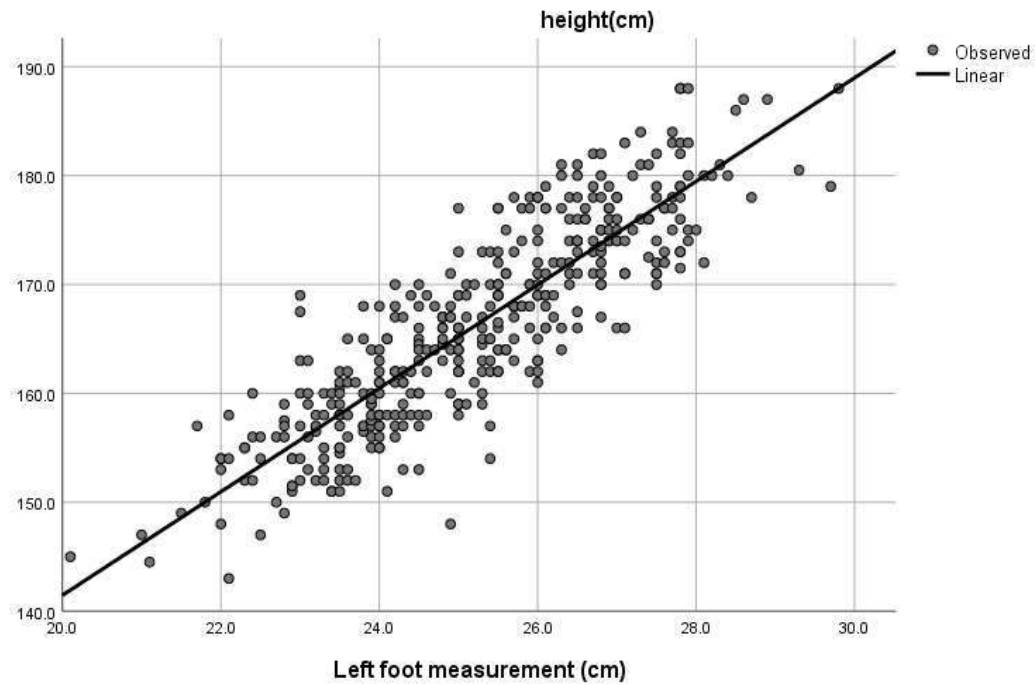
Figure 4. Scatter Plot –Relation between the height and left foot length.
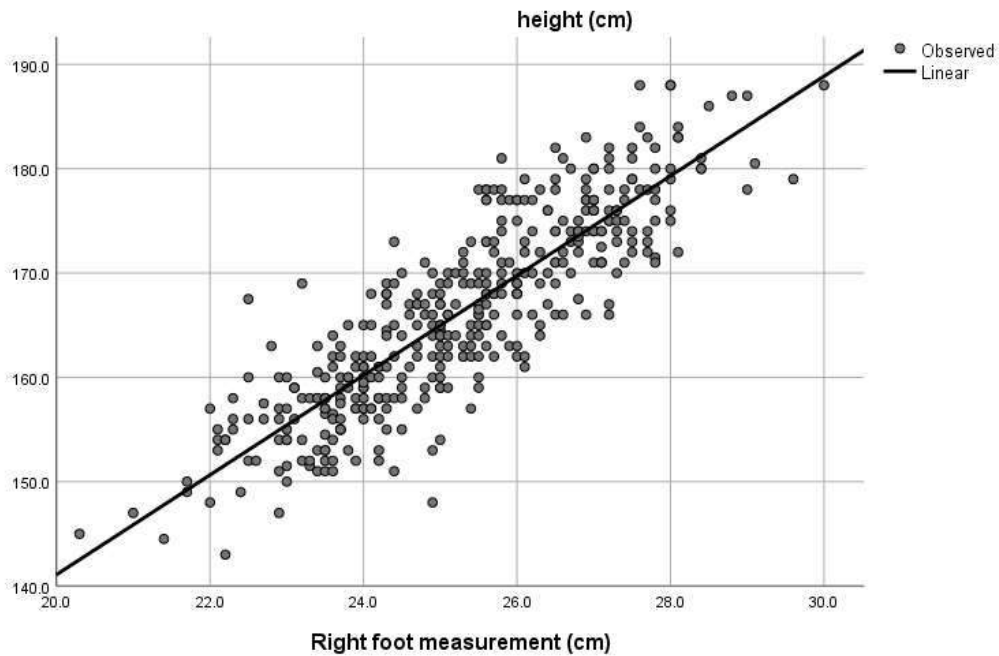
Figure 5. Scatter Plot –Relation between the height and right foot length.

The correlation coefficients between the parameters height and foot lengths are positive. "The low standard errors of estimates (SEE) for both left (4.5932) and right (4.6514) foot lengths, along with highly significant one-way Analysis of Variance (ANOVA) results (F=1226.587, P<0.001 for left foot; F=1186.247, P<0.001 for right foot), suggest that foot length is a significant and reliable predictor in estimating stature. This significance implies that the foot length provides highest reliability and accuracy in estimating stature of an unknown individual.

Based on this study, Regression equation is established for both left and right foot.

STAURE (S) = VALUE OF CONSTANT (A) + REGRESSION COEFFECIENT (B) x FOOT LENGTH $\pm$ ERROR

S (LEFT FOOT) = 46.418 + 4.752 x LF length $\pm$ 3.430

S (RIGHT FOOT) = 45.498 + 4.779 x RF length $\pm$ 3.514

Discussion

Several studies were carried out for estimation of human stature so far and researchers employed a multitude of methods. However, regression equation was used as a statistical tool by most of them. The chronological order of a few studies is summarized in the Table 8 below.

Table 8. Data from a few previous studies on estimating stature from foot length in a chronological order.

S. No	Authors (Year of study) (Place of study)	Sample size (Male+Female) (Age)	Regression Equation	Correlation Coefficient (r)
1.	Krogman Pg.no. 175,177 **Macdonnel** (2001)	3000 (>21yrs)	**Height** =166.45716+4.0301 x Foot Length – 25.68770 $\pm$ 2.94453	N.A
2.	**Hilmi Ozden et al.** [1] (2004)	569 (294+275) (>19yrs)	**Right foot**: stature = 47.93 + 1.083 (maximum foot length) + 0.788 (shoe length) x 1.813 (shoe number).	RF: 0.579 0.500
			Left foot: stature = 47.33 + 1.139 (maximum foot length) + 0.593 (shoe length) x 1.924 (shoe number)	LF: 0.614 0.490
3.	**Bhavna et al.** (2005) Delhi	N.A	**Height** = 119.74 + 1.92 x Foot length $\pm$ 4.77 Multiplication factor to calculate stature from foot length to be 6.76	N.A
4.	**Arun Kumar Agnihotri MD et al.** (2006) Mauritius [2]	250 (125+125) (18-30yrs)	Stature = 67:568 + 3:862 RFL + 3:393 Sex + 0:437 Age (Sex: M =1, F =0) Male Stature= 68:586 + 4:036 RFL Female Stature=77:059 + 3:536 RFL	Mean: 0.877 Male:0.720 Female:0.608
5.	**Tanuj Kanchan et al.** (2007) Punjab [3]	200 (100+100) (18-80yrs males 18-65yrs females)	**Males:** RFL 93.269 + 2.819(RFL) $\pm$ 3.878 LFL 90.275 + 2.930(LFL) $\pm$ 3.842	0.759 0.764
			Females: RFL 103.270 + 2.365(RFL) $\pm$ 4.398 LFL 105.200 + 2.287(LFL) $\pm$ 4.427	0.512 0.502
6.	**Theodoros Grivas et al.** (2007) [4]	5093 school children	**Mean Height**= 17:369 + 5:879 x (right foot length) cm 17:592 + 5:861 x (left foot length) cm	
			Boys: Height = 34:113 + 3:716 (right foot length) cm + 2:499 (age) years 33:869 + 3:689 (left foot length) cm + 2:533 (age)years	Boys: RF = 0.903 LF =0.898
			Girls: Height = 34:113 + 3:716 (right foot length) cm + 1:558 + 2:499 (age)years 33:869 + 3:689 (left foot length) cm +1:774 + 2:533(age) years	Girls: RF =0.855 LF =0.841

7.	**Gulsah Zeybek et al.** (2008) Turkey [5]	249 (136 + 113) 18-44yrs	• **Stature** = 545.070 + 3.707 x RFL - 0.308 x RFW + 1.583 x RFMH + 2.058 x RFNH $\pm$ 38.69.	RF: M:0.741 F:0.678 LF: M: 0.711 F:0.667
8.	**Derya Atamturk et al.** (2008) Ankara, Turkey [6]	516 (253+263) (17.6-82.9yrs)	• S = 5.295 x FL + 38.903 $\pm$ 5.142 • S = (4.211 x FL) + (4.981 · Sex) + 62.208 $\pm$ 4.835 (sex; female = 0 and male = 1)	Height and FL: 0.737 Height, FL and Sex: 0.768
9.	**Jaydip Sen and Shila Ghosh** (2008) Darjeeling, West Bengal [7]	350 (175+175)	<u>Male</u>: S= 83.518 + 3.282(FL) RFL 84.041 + 3.264(RFL) LFL 84.076 + 3.255(LFL) **Females**: S= 67.009 + 3.707(FL) RFL 68.642 + 3.638(RFL) 0.682 LFL 68.663 + 3.632(LFL) 0.682	0.626 0.624 0.623 0.692 0.682 0.682
10.	**Tanuj Kanchan et al.** (2009) Punjab [8]	100 (50+50) (18-32yrs)	**RFL**: Males: H= 88.116 + 3.007 (RFL) $\pm$ 3.746 Female: H= 106.709 + 2.219 (RFL) $\pm$ 4.313 **LFL**: Males: H=95.202 + 2.737 (LFL) $\pm$4.024 Female: H=104.302 + 2.324 (LFL) $\pm$ 4.387	 0.750 0.558 0.704 0.536
11.	**Nivedita Pandey et al.** (2011) Mumbai [9]	200 (100+100) (18-23 years)	**Males:** S = 128.951+1.695(RFL) $\pm$ 0.339 S = 106.265 +2.236 (LFL) $\pm$ 0.385 **Females:** S = 118.533 +1.692 (RFL) $\pm$ 0.368 S = 128.233 +1.726 (LFL) $\pm$ 0.344 **Mean:** Males: S = 128.039+0.761 (RFL)+0.971 (LFL) $\pm$ 3.176 Females: S = 106.623+0.297(RFL)+2.520 (LFL) $\pm$ 1.492	**Males:** 0.451 0.452 **Females:** 0.421 0.506

12.	**Petra Uhrova et al.** (2012) Slovakia [10]	71 (18-27yrs)	**Right foot**: 54.354 + 4.715 RFL $\pm$ 4.652 **Left foot**: 52.999 + 4.755 LFL $\pm$ 4.765 **Multiple regression**: 53.125 + 3.455 RFL + 1.304 LFL $\pm$ 4.668	**Females:** RFL:0.722, LFL:0.704 **Males:** RFL:0.759, LFL:0.755
13.	**Sonali khanapurkar et al.** (2012) Maharashtra [11]	1000 (536+464) (19-22 yrs)	'Height = 55.5+4.5 x Foot length'. The correlation coefficient for foot length in females and males was 0.702 and 0.645 respectively.	Females and males were 0.702 and 0.645 respectively.
14.	**Mansur et al.** (2012) Nepal [12]	440 (258+182) (17-25yrs)	**Mean:** Height = 3.179 x foot length + 87.65'.	**Mean:** 0.703
			Males: Height = 2.738 x left foot length + 100.2 Height = 2.74 x right foot length + 100.1	**Male:** 0.689 0.688
			Females: Height = 2.66 x left foot length + 96.40 Height = 2.66 x right foot length + 96.31	**Female:** 0.589 0.587
15.	**Kewal Krishan et al.** (2012) Himachal Pradesh [13]	246 (123 +123) (17-20 years)	**Males**: 69.544 + 3.995 (FL) **Females**:74.820 þ 3.579 (FL)	N.A
16.	**Mohanty et al.** (2012) Odisha [14]	300 (206+94) (18-25yrs)	**Males:** H = -27.77 + 7.695x FL **Females:** H = 77.85 + 3.58 x FL	N.A
17.	**Saranabasavappa Karaddi et al.** (2013) Gulbarg [15]	100 Males (18-23yrs)	**Right foot:** H = 86.9 + 3.40(RFL) **Left foot:** H =112 + 2.41(LFL)	0.82 0.80
18.	**Patel et al.** (2014) Gujrat	150 (72+78) (18-22yrs)	**Males** = 75.45 + 3.64 x Foot length **Females** = 75.41 + 3.43 x Foot length	0.65 0.80
19.	**Sunita Arvind Athavale et al.** (2015) [16]	200 (100+100) (20-30yrs)	**Stature** = 81.978 +.294 x foot length $\pm$ 6.91	0.554 0.550

No.	Author	Sample	Formula	R
20.	**Arif Rasheed Malik et al.** (2015) Lahore, Pakistan [17]	291 (>20yrs)	**Left foot length:** **Mean:** S = 58 .101+ 4.261(LFL) **Males:** S=104.455 + 2.591(LFL) **Females:** S= 8 8.210 + 2.9 3(LFL)	0.807 0.590 0.630
21.	**Phang et al.** (2016) Malaysia [18]	150 (75 +75) (20-30 years)	**Mean:** H= 56.6471 + (4.408 x FL) ± 6.2571	0.815
			Male: H= 98.8059 + (2.792 x FL) ± 11.2328	0.594
			Female: H = 60.9966 + (4.167 x FL) ± 11.6854	0.697
22.	**Chauhan Viral et al.** (2017) Gujarat [19]	208 (105+103) (10-60yrs)	**Stature** = 55.427 + 4.633 x Foot length ± 5.126	0.806
23.	**Arun S. Karmalkar** (2021) Kolhapur [20]	1000 (18–50 years)	**Stature**= 63.1858×intercept+1.7392×right foot length –0.2278× left foot length – 2.801×right foot breadth +2.7907×left foot breadth +0.4377×right hand length +2.7687×left hand length – 4.7225×right hand breadth +5.5211×left hand breadth ± 4.689	0.670
24.	**Trishna Priya Devi et al.** (2021) Assam [21]	200 males (18-65yrs)	**Height** = 4.56414(RFL) + 58.58265	0.9720
			Height = 4.71546(LFL) + 55.78708	0.9749
25.	**Kumar et al.** (2023) South India [22]	200 (100+100) (21-40 y	Mean: Stature=53.591+4.489×RFL Stature=55.195+4.469×LFL	Mean: 0.811 0.823
			Males: Stature=89.297+3.158×RFL Stature=89.163+3.189×LFL	0.677 0.707
			Females: Stature=84.203+3.087×RFL Stature=82.477+3.203×LFL	0.592 0.582

Our study established a positive correlation between stature and foot length, aligning with findings in several other studies as detailed in Table 8 and we used a linear regression method for deriving the regression formula. However, our results indicated no significant differences in estimating stature from foot length, irrespective of left or right side and gender. This observation is consistent with the findings of Hilmi Ozden et al. (2005).[2] Nonetheless, some other studies have suggested that the standard error of estimate is lower when a multiple regression equation is utilized for stature estimation, as opposed to linear regression. Additionally,

among females, the standard error of estimate is lower compared to males. This implies that the accuracy of stature estimation is higher in females, as highlighted by Tanuj Kanchan (2007) [5]

Future studies on estimating stature from foot length in India need to consider a multitude of neglected aspects within this subject. Firstly, existing research predominantly focuses on intact foot and more research is needed on relationship between skeletal foot length and stature. The roots of this research lie in dry bones, and delving further into that can help standardise this method further. Secondly, while some studies touch upon parameters like the breadth of the foot and the height of the malleolar bone, there remains a need for more extensive investigations utilizing these metrics in stature estimation. Thirdly, the majority of studies conducted thus far have centred around the living, potentially overlooking the impact of postmortem changes on measurements. Future research should emphasize studies on the deceased, recognizing the potential errors that may arise due to postmortem alterations and ensuring the applicability of findings in forensic contexts. By the same taken, considering the diverse regional demographics in India, it is imperative to conduct age-wise distributions based on previous studies. This approach will not only enhance the specificity of stature estimation methods but also provide valuable data for different age groups, contributing to a more nuanced understanding of the population.

Furthermore, as research on stature estimation in India has yielded varied regression formulas from different states, there is a pressing need for a multicentric project involving several medical colleges in different states. Such an initiative would

consolidate findings from across the country, facilitating a standardized approach to stature estimation with an acceptable margin of error.

In advancing future studies on stature estimation from foot length in India, a crucial avenue to explore involves incorporating radiology data. Utilizing large datasets from clinical cases where foot X-rays are routinely taken can significantly enhance the precision of regression formulas. By obtaining consent and recording the height of individuals undergoing foot X-rays for clinical purposes, researchers can establish comprehensive databases.

Estimating stature from foot length has become a popular medical school project for many individuals, and existing literature in this context is abundant. However, the need to delve deeper into standardizing these methods is evident, as the established relationship between stature and foot length may vary across populations. It is crucial to recognize that data generated in one population cannot be universally applied to another. Therefore, the next phase of research requires the compilation of comprehensive datasets to further refine and standardize these techniques. This is especially pertinent for practical applications in forensic anthropology settings, where accurate and population-specific stature estimations are essential.

Conclusion

The current study successfully establishes a clear correlation between stature and foot length, providing a basis for the development of regression equations within the studied sample. Notably, during the calculation of the regression equation, a consistent linear relationship between

stature and foot length is observed, aligning with findings from previous studies. The established regression equations offer a valuable tool for forensic practitioners in scenarios such as mass disasters, cases involving dismembered bodies post-homicide, bomb explosions, accidents, and other situations where only partial remains are recovered.

Ethics committee approval

The present study was approved by the Ethics Committee of Andhra Medical College, Visakhapatnam vide reference (Serial no. 243/IEC AMC/OCT 2023).

Conflict of Interest

The authors declares that they do not have conflict of interest.

List of abbreviations used in the table or in the study as a whole

LF= Left foot, RF: Right foot, LFL: Left foot length, RFL: Right foot length, H= Height, S= Stature, FL= Foot Length, RFW= Right Foot Width, RFMH= Right foot Malleolar height, RFNH= Right foot Navicular height, M=Male, F=Female, r = Correlation coefficient, N.A: Not Available.

References

1. Hilmi Ozdena Y, Balcib C, Demirustu A, Turgutd M. Stature and sex estimate using foot and shoe dimensions. Forensic Science International 2004;147:181–4.

2. Kumar Agnihotri A, Purwar B, Googoolye K, Agnihotri S. Nilima Jeebun. Estimation of stature by foot length. Journal of Forensic and Legal Medicine 2007;14:279–83.

3. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK. Stature estimation from foot dimensions. Forensic Sci Int 2008;179:241.e1-241.e5. https://doi.org/10.1016/j.forsciint.2008.04.029.

4. Grivas TB, Mihas C, Arapaki A, Vasiliadis E. Correlation of foot length with height and weight in school age children. J Forensic Leg Med 2008;15:89–95. https://doi.org/10.1016/j.jflm.2007.05.007.

5. Zeybek G, Ergur I, Demiroglu Z. Stature and gender estimation using foot measurements Forensic Science International 181. Forensic Science International 2008;181.

6. Atamturk D, Duyar I. Age-related factors in the relationship between foot measurements and living stature and body weight. J Forensic Sci 2008;53:1296–300. https://doi.org/10.1111/j.1556-4029.2008.00856.x.

7. Sen J, Ghosh S. Estimation of stature from foot length and foot breadth among the Rajbanshi: An indigenous population of North Bengal. Forensic Sci Int 2008;181:55.e1-55.e6. https://doi.org/10.1016/j.forsciint.2008.08.009.

8. Kanchan T, Menezes RG, Moudgil R, Kaur R, Kotian MS, Garg RK. Stature estimation from foot length using universal regression formula in a north Indian population. J Forensic Sci 2010;55:163–6. https://doi.org/10.1111/j.1556-4029.2009.01243.x.

9. Pandey N, Roshan S, Kharate R, Sonawane M, Bhivate V, Ujwal NS. Prediction of stature based on foot length. Journal of Nobel Medical College. 2011.3(1 Issue 5).

10. Uhrová P, Beňuš R, Masnicová S. Stature estimation from various foot dimensions among Slovak population. J Forensic Sci 2013;58:448–51. https://doi.org/10.1111/1556-4029.12059.

11. Khanapurkar S, Radke D. Estimation of stature from the measurement of foot length, hand length and head length in Maharashtra region. . IJBAMR 2012 Mar;1:77–85.

12. Mansur DI, Haque MK, Sharma K, Karki RK, Khanal K, Karna R. Estimation of stature from foot length in adult Nepalese population and its clinical relevance. Kathmandu Univ Med J (KUMJ) 2012;10:11–5. https://doi.org/10.3126/kumj.v10i1.6907.

13. Krishan K, Kanchan T, Sharma A. Multiplication factor versus regression analysis in stature estimation from hand and foot dimensions. J Forensic Leg Med 2012;19:211–4. https://doi.org/10.1016/j.jflm.2011.12.024.

14. Mohanty BB, Agrawal D, Mishra K, Samant singhar P, Chinara PK. Bhubaneswar, Odisha, India; Estimation of height of an individual from foot length: A study on the population of Odisha International Journal of Review in Life Sciences 2012;2(2):69-74

15. Karaddi DS, Suntnoore DD, Garampalli DS, Hiremath DR, Mugadlimath DA. Estimation of stature by foot length in males. Int J Biomed Adv Res 2013;4:443. https://doi.org/10.7439/ijbar.v4i7.400.

16. Geetha GN. Estimation of stature from hand and foot measurements in a rare tribe of Kerala state in India. J Clin Diagn Res 2015. https://doi.org/10.7860/jcdr/2015/13777.6582.

17. Malik AR, Akhter N, Ali R, Farrukh R, Aziz K. A study on estimation of stature from foot length: A study on estimation of stature from foot length. Prof Med J 2015;22:632–9. https://doi.org/10.29309/tpmj/2015.22.05.1304.

18. SF Phang, AI Normaizatul, PS Lai. Stature and sex estimation using foot measurements. J Forensic Sci criminal. 2017;5(1). Available from: http://dx.doi.org/10.15744/2348-9804.5.105

19. Viral N.C, Sunil M.D, Mangal H.M, Viral J.A, Prince J.M, Raghurajsinh D.V. Estimation of stature from foot length in population of Rajkot region, Gujarat. Indian Journal of Forensic Medicine and Pathology

2017;10(1):37–41. Available from: http://dx.doi.org/10.21088/ijfmp.0974.3383.10117.7

20. Karmalkar AS, Nikam VR. Prediction of stature from long bones versus hand and foot measurements: A comparative study of the Kolhapur population. Natl Med J India. 2021;34(3):154–7. Available from: http://dx.doi.org/10.25259/NMJI_79_20

21. Devi TP, Kumar P, Pratim KP, Chandravanshi LP, Chauhan M. Estimation of Stature from foot length in male indigenous population of Assam Region. Foot (Edinb). 2021;49(101840):101840. Available from: http://dx.doi.org/10.1016/j.foot.2021.101840

22. Kumar SV, Shruthi K, Anand PB, Tejas J. A cross sectional descriptive study for estimation of stature from foot length in south Indian population. Jiafm. 2023;45(2):146–8. Available from: http://dx.doi.org/10.48165/jiafm.2023.45.2.12

ORIGINAL ARTICLE

Prevalence of hypertension in adult population and adherence to treatment among hypertensives in an urban area

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Abstract

Introduction / background: Hypertension is one of the most common non-communicable diseases and is an important public health problem around the world. Poor adherence to anti-hypertensive medication is one of the biggest challenges in the control of hypertension. Study was undertaken with the aim to study the prevalence of hypertension and adherence to treatment among hypertensives in our study area.

Methodology: A community based cross-sectional study was conducted using systemic random sampling among 560 individuals (aged ≥ 30years). Informed Consent was taken from all the study subjects, WHO STEPS questionnaire was used for prevalence and MMAS-8 was used for adherence. Chi square test/t-test and regression were applied to determine association between various risk factors and level of adherence.

Results: The present study concluded that 27.9% of the study population had hypertension. According to MMAS-8 scale the level of adherence among the participants with hypertension after ruling out the newly diagnosed hypertensive from the total hypertensive was high in 77 (57%), moderate in 29 (21.5%) and low in 29 (21.5%) Forgetfulness was the most common (21.9%) reasons for the poor adherence. On multivariate regression age <50 years and non-working status showed statistically significance with level of adherence with odds of 3.61 (1.29-10.13) and 3.296 (1.16-9.36) respectively.

Conclusions: The population under investigation had a moderate level of medication adherence. Enhancing the study population's literacy could help overcome these obstacles, and actions need be taken to ensure that behaviour modification and health education are communicated effectively.

Keywords: Adherence, Hypertensives, Risk factor, Morisky Medication Adherence scale-8.

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Graphical Abstract

Prevalence of hypertension in adult population and adherence to treatment among hypertensives in an urban area
Authors: Abhishek Pokkuluri, Gudipally Monica*,Praveena Ganapa

Background: Hypertension is one of the most common non-communicable diseases and is an important public health problem around the world. Poor adherence to anti-hypertensive medication is one of the biggest challenges in the control of hypertension. Study was undertaken with the aim to study the prevalence of hypertension and adherence to treatment among hypertensives in our study area.

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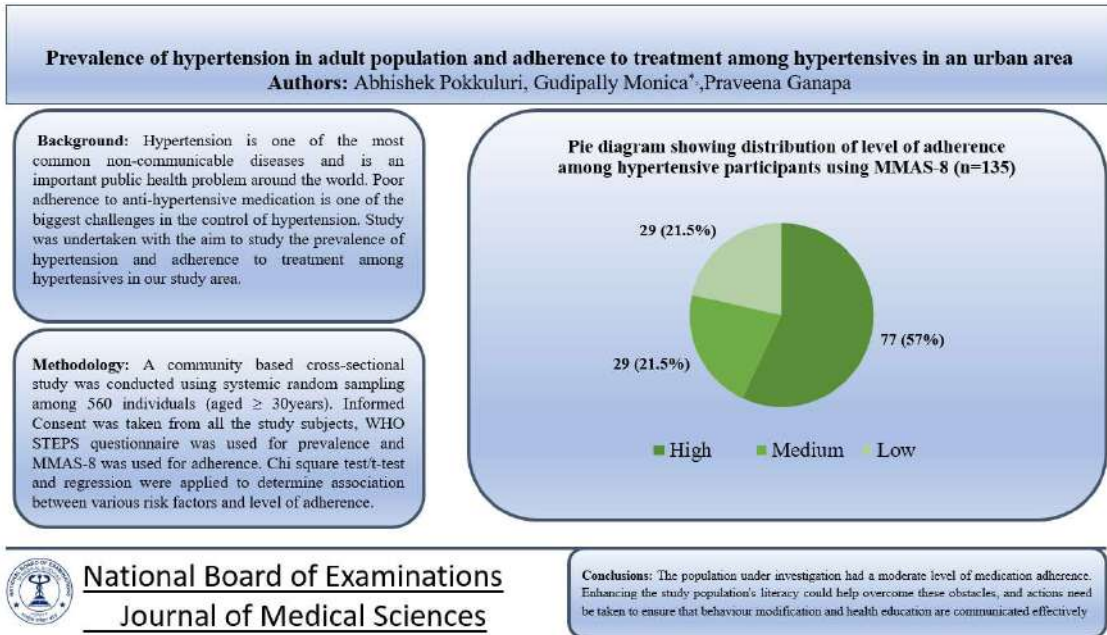
Pie diagram showing distribution of level of adherence among hypertensive participants using MMAS-8 (n=135)

29 (21.5%)
77 (57%)
29 (21.5%)

■ High ■ Medium ■ Low

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Journal of Medical Sciences**

Conclusions: The population under investigation had a moderate level of medication adherence. Enhancing the study population's literacy could help overcome these obstacles, and actions need be taken to ensure that behaviour modification and health education are communicated effectively

Introduction

Hypertension is one of the most common non-communicable diseases and is an important public health problem around the world. It is one of the major risk factors of cardiovascular mortality which account for 20 to 50% of the deaths worldwide [1].

According to the Joint National Committee 7 (JNC-7), Hypertension is defined as systolic BP level of ≥140 mmHg and/or diastolic BP level ≥ 90 mmHg [2]. The area falling between 120–139 mmHg systolic BP and 80–89 mmHg diastolic BP is defined as "prehypertension". Although prehypertension is not a medical condition in itself, prehypertensive subjects are at more risk of developing hypertension.

In India, the prevalence of hypertension in males ranges from 3%–34.5% and from 5.8%–33.5% in females. Recent studies show a prevalence of 24-30 % in urban areas and 12-14% in rural areas

[3]. Worldwide, 13.5% of premature deaths, 54% of strokes, and 47% of ischemic heart disease cases were attributed to hypertension [4]. An estimated 1.56 billion adults will be suffering from high blood pressure by 2025 [5].

Poor adherence to anti-hypertensive medication is one of the biggest challenges in the control of hypertension [1]. It also compromises the efforts of the health care system, policy makers and health care workers in improving the health of population. Failure to comply causes medical and psychological complications of the disease, reduces patients' quality of life, wastes health care resources and erodes public confidence in health systems [6]. This poses a greater responsibility on the health services especially in developing countries like India; where there is a greater strain on available health infrastructure and delivery systems.

Accurate estimate of hypertension prevalence and adherence are necessary to plan effective control measures. Very few studies have been done on similar lines. The present study was done to assess prevalence of hypertension and adherence to treatment among hypertensive in urban field practice area of a tertiary care teaching hospital in Nalgonda, Telangana.

Objectives: 1) To determine prevalence of hypertension in urban field practice area of a medical college. 2) To study the association between various risk factors (modifiable and non-modifiable) and hypertension. 3) To study the extent of adherence to anti- hypertensive medication. 4) To study the various socio demographic and other risk factors influencing adherence to anti- hypertensive medication

Materials and methods

This was a community based cross-sectional study done in urban field practice area of a tertiary care teaching hospital and medical college in Narketpally, Nalgonda, Telangana state. According to a study done by Ajeet Bhadoria et al. [7] the prevalence of hypertension was 25% in urban areas. So considering relative Precision as 15% and using the formula

$$n = \frac{Z_{1-\alpha/2}^2 p(1-p)}{d^2}$$

Where, n = minimum sample required

Z = Standard normal deviate = 1.96 ≈ 2

p = prevalence of Hypertension which is 0. 25% = 25/100

q = 100 – p i.e. 100 – 25 i.e. 0.75%==75/100

L = Relative precision i.e. 15% =15/100x0. 25= 0.0375

Substituting the values, n = (4 x 0.25 x0. 75) / $(0.0375)^2$ = 533

By calculating 5% non-response rate it is rounded to **560**.

Study period: October 2017 to September 2019

Sampling Technique

Systematic random sampling was used for this study, wherein a sampling frame was formed. The urban field practice area covers the total of 3215 households.

Sample interval (SI) = total population /sample size

= 3215 / 560 = 5.74 = 6

Every household is given number and the required sample is obtained by dividing total households with the sample size and the number 6 obtained as sample interval. A number is chosen randomly between 1 to 6 which becomes the first household. Here number 2 is chosen. From there every 6th household will be visited, ex : 2, 8, 14, 20, 26…..

Eligible individual above 30 years were taken into study. If the selected family has more than one available eligible person, then one was chosen randomly by using lottery method. In case of nonavailability of eligible person in a selected household, at the time of survey, the adjacent household was selected.

Inclusion Criteria
- Subjects above 30 years of age both male and female.
- Should be residing in urban field area for 6 months.
- Ability to provide information about medication in use.

Exclusion Criteria

- Subjects not giving consent and those not willing to participate will be excluded
- Seriously ill, pregnant women. Congenital cardiac disorders.

Study tool and data collection

A pretested and semi structured questionnaire was used for data collection. WHO stepwise approach to chronic disease risk factor surveillance (STEPS) was used for hypertension risk factors and disease prevalence and Morisky medication adherence scale (MMAS)-8 was used to assess adherence. Omron Blood pressure device, Libra weighing machine, anthropometry rod and measuring tape were used to measure blood pressure and anthropometry respectively.

All the subjects were personally contacted in their house, examined and interviewed.

Blood pressure measurement

Blood pressure was measured using the Omron BP apparatus and stethoscope in the sitting position on the right arm. Three readings were taken in an interval of 3 to 5 min and the average of the readings was taken.

Anthropometry

All the anthropometric measurements were done by the following standardized technique. Weight was measured by Libra weighing machine having an accuracy of 0.1 kg and height was measured by using a steel anthropometry rod with accuracy of 0.1 cm using standard techniques. Body Mass Index was calculated using the following formula: BMI = weight (kg)/height (mt)^2.

Based on BMI obtained, the subjects were classified into different categories according to the WHO global classification.

Adherence

The extent to which a person's behaviour-taking medication, following a diet, and /or executing lifestyle changes, corresponds with agreed recommendations from a health care provider. In the present study adherence was measured using Morisky Medication Adherence Scale -8 (MMAS-8). Highly adherent were given a score of 8, medium were given a score of 6 to<8, Low adherence < 6.

Ethical considerations

All methods were carried out in accordance with relevant guidelines and regulations, The study was approved by Institutional Ethics Committee (Ref No: ETHICS COMMITTEE/KIMS/NKP/2017). The participants were briefed about the purpose of the study and prior informed consent was taken.

Data management and analysis

Data was entered in Microsoft Excel. Data analysis was done using SPSS Version 20. Appropriate like Chi Square test were applied.

Results

Among the 560 study participants in our study majority of the participants were in the age group of 30-60 years (69.8%) followed by 45-60 years (28.1%) and least (2.1%) above 75 years age group. Males were comparatively more than females (55.4% Vs 44.6%). More than half were not having any formal education (52.3%) and self-employed (61.4%). About 99

(17.7%), 153 (27.3%) and 03 (0.5%) were in prehypertension, stage 1 hypertension and stage 2 hypertension respectively according to JNC 7 classification. Most of the participants were in age group of 46-60 in hypertensive group whereas in normative group 30-45years age group was more. Mean age of the participants was more in hypertensive group compared to normotensive group (51.41 ± 12.69 Vs 58.33 ± 11.29) was showing a statistically significant association with p<0.05. Gender-wise difference was not seen with the hypertensive status in our study. Level of education was showing a statistically significant association with level of hypertensive with majority of them with no formal education. Socio-economic status, amount of salt intake, vegetables & fruits servings and BMI didn't show any association with the hypertensive status. Family history of hypertension was more in hypertensive group than in normotensive group and was showing significant association (61.9% Vs 38.1%).

Marital status, alcohol consumption and tobacco consumption were showing statistically significant association with hypertensive status with P<0.05.

According to MMAS-8 scale the level of adherence among the participants with hypertension after ruling out the newly diagnosed hypertensive from the total hypertensive was high in 77(57%), moderate in 29(21.5%) and low in 29(21.5%). On univariate regression marital status of being single and non-working status were showing significant association with low level of adherence. Whereas in multivariate regression marital status of being single lost its significance and age <50 years and non-working status were statistically significant with odds of 3.61 (1.29-10.13) and 3.296 (1.16-9.36) respectively. "Forgetfulness" was the most common (21.9%) reasons for the poor adherence followed by "felt better so stopped" (18.5%) and "no money buy to buy medicines". (17.2%) (Tables 1-3 and Figures 1-2).

Table 1. Distribution of the study population according to JNC 7 Classification (N=560)

Classification	Frequency (%)
Normal	305 (54.5)
Pre-hypertensive	99 (17.7)
Stage 1 Hypertension	153 (27.3)
Stage 2 Hypertension	03 (0.5)

Table 2. Distribution of socio-demographic profiles among Hypertensive and Normotensive participants (N=560)

Variable	Category	Normotensive n=404 (72.1)	Hypertensive N=156 (27.9)	P-value
Age	30-45	163 (84.9)	29 (15.1)	0.00
	45-60	139 (69.8)	60 (30.2)	
	60-75	98 (62.4)	59 (37.6)	
	75-90	04 (33.3)	08 (66.7)	
	Mean ± SD	51.41 ± 12.69	58.33 ± 11.29	0.00
Gender	Male	228 (73.5)	82 (26.5)	0.41
	Female	176 (70.4)	74 (29.6)	
Education	No formal schooling	195 (66.6)	98 (33.4)	0.01
	Less than primary	22 (81.5)	05 (18.5)	
	Primary	41 (69.5)	18 (30.5)	
	Secondary	23 (79.3)	06 (20.7)	
	High school	90 (77.6)	26 (22.4)	
	College	33 (91.7)	03 (8.3)	
Occupation	Government employee	06 (100)	0 (0)	0.03
	Non-government employee	08 (66.7)	04 (33.3)	
	Self-employed	258 (75)	86 (25)	
	Home-maker	71 (73.2)	26 (26.8)	
	Retired	61 (60.4)	40 (39.6)	
SES	I (Upper)	26 (68.4)	12 (31.6)	0.92
	II (Upper middle)	247 (71.8)	97 (28.2)	
	III (Middle)	101 (72.7)	38 (27.3)	
	IV (Lower Middle)	21 (75)	07 (25)	
	V (Lower)	09 (81.8)	02 (18.2)	
Marital status	Never married	09 (90)	01 (10)	0.00
	Currently Married	359 (74.3)	124 (25.7)	
	Separated/Divorced	04 (100)	0 (0)	
	Widowed	32 (50.8)	31 (49.2)	

|				
Family history	Present	53 (38.1)	86 (61.9)	0.00
	Absent	351 (83.4)	70 (16.6)	
Alcohol Consumption	Yes	97 (61.8)	60 (38.2)	0.00
	No	307 (76.2)	96 (23.8)	
Smoking Consumption	Yes	93 (58.9)	65 (41.1)	0.00
	No	311 (77.4)	91 (22.6)	
Salt intake	≤5g	55 (82.1)	12 (17.9)	0.05
	>5g	349 (70.8)	144 (29.2)	
Vegetable	≤5 servings	137 (77.4)	40 (22.6)	0.06
	>5 servings	267 (69.7)	116 (30.3)	
Physical activity	Yes	94 (76.4)	29 (23.6)	0.23
	No	310 (70.9)	127 (29.1)	
BMI	Underweight	22 (66.7)	11 (33.3)	0.33
	Normal	147 (70)	63 (30)	
	Overweight	204 (75.6)	66 (24.4)	
	Obese	31 (66)	16 (34)	
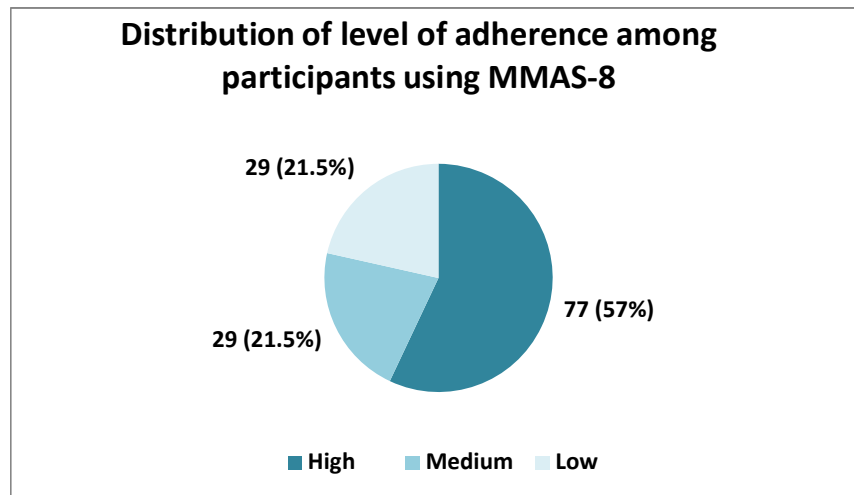
Figure 1. Pie diagram showing distribution of level of adherence among hypertensive participants using MMAS-8 (n=135)

Table 3. Association between level of adherence and risk factors among hypertensive participants (n=135)

Variable	Univariate regression		Multivariate regression	
	p-value	OR (CL)	p-value	OR (CL)
Age				
≥50 years		1		
<50 years	0.38	1.44 (0.64-3.26)	0.02	3.61 (1.29-10.13)
Gender				
Male				
Female	0.75	1.12 (0.57-2.22)	0.16	0.49 (0.18-1.33)
Marital status				
Married				
Unmarraied/divorce/window	0.04	2.44 (1.06-5.59)	0.199	1.95 (0.70-5.43)
Alcohol				
No		1		
Yes	0.08	0.52 (0.26-1.08)	0.27	0.58 (0.22-1.53)
Smoking				
No		1		
Yes	0.64	0.85 (0.43-1.69)	0.497	1.37 (0.55-3.38)
Occupation				
Working		1		
Non-working	0.02	2.37 (1.17-4.79)	0.03	3.296 (1.16-9.36)
SES				
Upper				
Lower	0.44	0.51 (0.09-2.75)	0.71	0.69 (0.097-4.88)
BMI				
Underweight	0.75	1.25 (0.32-4.83)	0.69	0.73 (0.16-3.39)
Normal		1		
Overweigh	0.90	1.05 (0.49-2.22)	0.77	1.15 (0.45-2.96)
Obese	0.13	0.34 (0.09-1.36)	0.24	0.37 (0.07-1.94)
Salt				
≤5g		1		
>5g	0.61	0.73 (0.22-2.40)	0.61	0.71(0.18-2.72)
Vegetable serving				
≤5		1		
>5	0.63	1.22 (0.55-2.70)	0.34	1.58 (0.61-4.07)
Fruit servings				
≤5		1		
>5	0.995	1.01 (0.22-4.67)	0.73	1.42 (0.20-10.03)
Sedentary behavior				
≤1hr		1		
>1hr	0.22	1.59 (0.76-3.32)	0.46	1.45 (0.55-3.83)
Family history				
Absent		1		
Present	0.67	1.16 (0.58-2.30)	0.299	1.53 (0.69-3.41)

Reasons for poor adherence

Do not perceive hypertension as a dangerous/ life threatening disease — 30 (15.6)

Taking traditional remedies — 4 (6.8)

Taking medicines lifelong — 19 (9.9)

Side effects of medicines — 15 (7.8)

Fear of dependence — 8 (4.1)

No money to buy medicines — 33 (17.2)

Felt better hence stopped medicines — 36 (18.8)

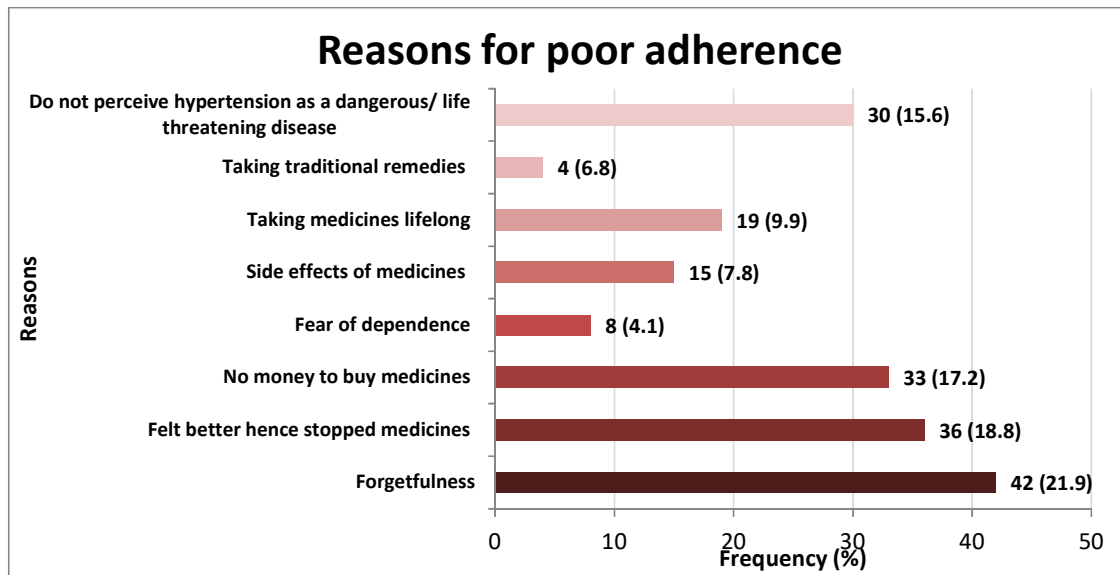Forgetfulness — 42 (21.9)

Reasons

Frequency (%)

Figure 2. Reasons for poor adherence among Hypertensive participants

Discussion

In chronic and frequently asymptomatic diseases like hypertension, medication adherence is a critical concern. Medication non-adherence can lead to life-threatening consequences. The present study conducted to fill the gaps in data in our study setting. According to JNC VII standards, 27.9% of participants in the current study had hypertension. Studies by Shukla et al. [8] Prabhakaran et al. [9], Anand et al. [10] and Shymalkumar et al. [11] reported results that were similar. Nonetheless, the frequency in this investigation was lower than that of investigations conducted in Trivandrum by Joseph et al. [12] (~36%) and Gupta et al. [13] (~32%). But the prevalence was higher than in a study by Mohan et al. [14] (14%) conducted in Chennai among persons aged 20 to 60 years.

The present study found that increasing age is an important risk factor for hypertension. The prevalence of hypertension increased from 15.1% in 30 to 45 years age group to 66.7% in 75 to 90 age. Similar increase with age were observed in studies by Shukla et al. [8] Gupta et al. [13], Rao et al. [15] and Mohan et al. [14]. Hypertension was showing statistically significant association with age in our study similar to finding by Laxmaiah et al. [16] which might be due to age related atherosclerotic changes.

Our study's findings on female predominance and hypertension were in line with those of Mahmood et al. [17] and different from those of Kumar et al. [18] and Rao et al. [15]. The current investigation revealed a significant association with schooling. These findings were consistent with the study conducted by Sathya Prakash Manimunda et al. [19] where prevalence of hypertension was greater in illiterates. A study by Rao et al. [15] shown that as educational status increased, prevalence decreased. Similar to results from a study conducted in Ahmedabad, Gujarat, by Parikh et al. [20]

our study also demonstrated a statistically significant variation in prevalence based on marital status.

Studies by Deswal et al. [21], Madhumitha et al. [22], Chandwani et al. [23] and Singh et al. [24] found a significant association between family history and an increased prevalence of hypertension. Contradiction to Shanthirani et al. [25] statistically significant connection was established between hypertension prevalence and alcohol intake in our study although Saunders [26] exhibited comparable findings. 41.1% of smokers were found to have hypertension with statistical significance. There have been reports of an acute blood pressure rise associated with tobacco use, but it is unclear if long-term smoking causes persistent hypertension. A comparable relationship was found by Pais et al. [27].

Adherence to antihypertensive medications as measured using MMAS-8 in our study was 57% whereas it was 67.8% in a study by Asgedom et al. [28] due to difference in dichotomising the MMAS-8 score. Sutar et al. [29], Hema et al. [6] and Kumarswamy et al. [30] it was more than current study whereas less in studies by Kumar et al. [18] and Shelini et al. [31] which might be due to difference in study settings and medication scale used.

A number of variables were assessed for their impact on medication non-adherence; however, there was occasionally inconsistency in their correlation. While Kumarawamy et al. [30] found that affordability was the primary factor contributing to medication non-adherence; our study found that forgetfulness was the primary cause of non-adherence, in line with studies by Deepthi et al. [32] and Bhandari et al. [33].

The results of the current study are consistent with the analysis of other studies, which shows that the most frequent causes of non-adherence are forgetfulness, inability to pay, the asymptomatic nature of the illness, or a lack of awareness of any risk or potentially fatal consequence.

In our univariate analytic study, the probability of unmarried/divorced/window subjects not adhering to their hypertension medication was 2.44 times higher than that of married participants. This finding is comparable to the study of Ahmad et al. [34], which found a 1.95-fold increase in odds. Additionally, Ahmad et al. demonstrated univariate association adherence with characteristics like as age, family history, lifestyle choices, etc. that are not present in our study. Age groups under 50 and non-working individuals had dependent associations on multivariate analysis, which differs from Pedro Pallangyo et al. [35] findings, which are related to differences in the variables included and the adherence scale.

Conclusion

The study's findings indicate that the population under investigation had a moderate level of medication adherence. A few of the demographic traits significantly impacted adherence. Providing health education and counselling during hospital visits and home visits by healthcare professionals can raise the adherence rate, which is essential for managing chronic illnesses. Enhancing the study population's literacy could help overcome these obstacles, and actions should also be taken to ensure that behaviour modification and health education are communicated effectively

Strengths of the study

This is a first of its kind study in our study settings with an appropriate sample size. Using a MMAS-8 scale to measure adherence which is highly valid and reliable is an added strength.

Limitation of the study

Recall bias could have affected our study because we did not do a follow up study. Certain factors that could influence adherence, like medication history and specifics of the healthcare facility were not included in the analysis.

Recommendations

Based on the observations of the present study, the following recommendations are made regarding prevention and control of hypertension.

1. Group meetings have to be organized for risk groups and screening has to be done for health promotion, behavioural modification and early detection of cases.
2. The formation of Hypertension clubs, which meet once or twice a week, can help increase medication adherence. Doctors should emphasise the value of treatment adherence during review visits and home visits, and hypertension clubs can help.

Conflicts of interest

The authors declares that they do not have conflict of interest.

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References

1. World Health Organization (WHO). Global Status Report on Non Communicable diseases. 2018. Available from: https://www.who.int/publications/i/item/9789241514620
2. Chobanian A V, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JLJ, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003 May;289(19):2560–72.
3. Sidenur B, Shankar G. A Cross-Sectional Study of Hypertension among 20–40 Years Old Residing in an Urban Area of Bagalkot City, North Karnataka. Indian J Community Med. 2023;48(1). Available from: https://journals.lww.com/ijcm/fulltext/2023/48010/a_cross_sectional_study_of_hypertension_among.14.aspx
4. Murarkar S, Pokale A, Gothankar J, Deshmukh R, Gupta V. Prevalence of hypertension and associated risk factors in urban slums: A community based cross sectional study in India. Indian J Public Health. 2023;67(3):474–6.
5. Singh S, Shankar R, Singh GP. Prevalence and Associated Risk Factors of Hypertension: A Cross-Sectional Study in Urban Varanasi. Int J Hypertens. 2017;2017:5491838.
6. Hema DK, Padmalatha DP. Adherence to medication among Hypertensive patients attending a tertiary care hospital in Guntur, Andhra Pradesh. In 2015. Available from: https://api.semanticscholar.org/CorpusID:32981098
7. Bhadoria AS, Kasar PK, Toppo NA, Bhadoria P, Pradhan S, Kabirpanthi V. Prevalence of hypertension and associated cardiovascular risk factors in Central India. J Family Community Med. 2014 Jan;21(1):29–38.

8. Shukla AN, Madan T, Thakkar BM, Parmar M, Shah K. Prevalence and Predictors of Undiagnosed Hypertension in an Apparently Healthy Western Indian Population. Adv Epidemiol. 2015;2015:1–5. Available from: https://api.semanticscholar.org/CorpusID:72714716

9. Prabakaran J, Vijayalakshmi N, Venkatarao E. Prevalence of Hypertension among Urban Adult Population (25-64 years). In 2013. Available from: https://api.semanticscholar.org/CorpusID:5148719

10. Anand MP. Prevalence of hypertension amongst Mumbai executives. J Assoc Physicians India. 2000 Dec;48(12):1200–1.

11. Das SK, Sanyal K, Basu A. Study of urban community survey in India: growing trend of high prevalence of hypertension in a developing country. Int J Med Sci. 2005;2(2):70–8.

12. Joseph A, Kutty VR, Soman CR. High risk for coronary heart disease in Thiruvananthapuram city: a study of serum lipids and other risk factors. Indian Heart J. 2000;52(1):29–35.

13. Gupta R, Gupta VP, Sarna M, Bhatnagar S, Thanvi J, Sharma V, et al. Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. Indian Heart J. 2002;54(1):59–66.

14. Mohan V, Deepa R, Rani SS, Premalatha G. Prevalence of coronary artery disease and its relationship to lipids in a selected population in South India: The Chennai Urban Population Study (CUPS No. 5). J Am Coll Cardiol. 2001 Sep;38(3):682–7.

15. Rao CR, Kamath VG, Shetty A, Kamath A. High blood pressure prevalence and significant correlates: a quantitative analysis from coastal karnataka, India. ISRN Prev Med. 2013;2013:574973.

16. Laxmaiah A, Meshram II, Arlappa N, Balakrishna N, Rao KM, Reddy CG, et al. Socio-economic & demographic determinants of hypertension & knowledge, practices & risk behaviour of tribals in India. Indian J Med Res. 2015 May;141(5):697–708.

17. Mahmood SE, Ahmad A, Kashyap S. Prevalence and predictors of hypertension among adults of urban Lucknow, India: A community-based study. Hear India. 2019;7:43.

18. Kumar S, Ray D, Durge PM, Ferdows S, Ghose G. Prevalence and covariates of adult hypertension: A community-based cross-sectional study in the rural areas of Nagpur. Med J Dr DY Patil Univ. 2015;8:153. Available from: https://api.semanticscholar.org/CorpusID:72122442

19. Manimunda SP, Sugunan AP, Benegal V, Balakrishna N, Rao MV, Pesala KS. Association of hypertension with risk factors & hypertension related behaviour among the aboriginal Nicobarese tribe living in Car Nicobar Island, India. Indian J Med Res. 2011 Mar;133(3):287–93.

20. Singh RB, Beegom R, Ghosh S, Niaz MA, Rastogi V, Rastogi SS, et al. Epidemiological study of hypertension and its determinants in an urban population of North India. J Hum Hypertens. 1997 Oct;11(10):679–85.

21. Deswal BS, Satyamoorthy TS, Dutta PK, Ganguly SS. An Epidemiological Study Of Hypertension Among Residents In Pune. Indian J Community Med. 1991;16:21. Available from: https://api.semanticscholar.org/CorpusID:74664087

22. Madhumitha M, Naraintran S, Manohar CR, Revathi S, Biradar MK, Patil RS. HYPERTENSION - Prevalence and Risk Factors Among Urban Population In North Karnataka. Int J Curr Res Rev. 2014;6:39–45. Available from: https://api.semanticscholar.org/CorpusI

D:58260279

23. Chandwani HR, Pandor J, Jivarajani PJ, Jivarajani HP. Prevalence and correlates of hypertension among adults in the urban area of Jamnagar, Gujarat, India. In 2010. Available from: https://api.semanticscholar.org/CorpusID:55256791

24. Ragoobirsingh D, McGrowder D, Morrison EY, Johnson P, Lewis-Fuller E, Fray J. The Jamaican hypertension prevalence study. J Natl Med Assoc. 2002 Jul;94(7):561–5.

25. Shanthirani CS, Pradeepa R, Deepa R, Premalatha G, Saroja R, Mohan V. Prevalence and risk factors of hypertension in a selected South Indian population--the Chennai Urban Population Study. J Assoc Physicians India. 2003 Jan;51:20–7.

26. Saunders JB, Beevers DG, Paton A. Alcohol-induced hypertension. Lancet (London, England). 1981 Sep;2(8248):653–6.

27. Pais P, Fay MP, Yusuf S. Increased risk of acute myocardial infarction associated with beedi and cigarette smoking in Indians: final report on tobacco risks from a case-control study. Indian Heart J. 2001;53(6):731–5.

28. Asgedom S, Atey T, Desse T. Antihypertensive medication adherence and associated factors among adult hypertensive patients at Jimma University Specialized Hospital, southwest Ethiopia. BMC Res Notes. 2018;11.

29. Sutar PA, Shah HK. A study of adherence pattern toward antihypertensive therapy (antihypertensive drugs, dietary habits, and physical activity) and certain factors affecting it. Int J Med Sci Public Heal. 2017;6:1. Available from: https://api.semanticscholar.org/CorpusID:78190888

30. Kumaraswamy RC, Kauser M, Jagadeesh Mk, Kumar Ru, Afreen A, Kumar SR, et al. Study of determinants of nonadherence to anti-hypertensive medications in essential hypertension at a Teaching Hospital in Southern India. CHRISMED J Heal Res. 2015;2:57.

31. Sheilini M, Hande HM, Prabhu MM, Pai MS, George A. Impact of multimodal interventions on medication nonadherence among elderly hypertensives: a randomized controlled study. Patient Prefer Adherence. 2019;13:549–59.

32. Denny DC, G. Andhuvan. Evaluation Study on Anti-Hypertensive Adherence in Hypertensive Population. Indo Am J Pharm Res. 2013;3:6304–11. Available from: https://api.semanticscholar.org/CorpusID:70616995

33. Bhandari Phd B, Bhattarai M, Bhandari M, Ghimire A, Pokharel P, Morisky D. Adherence to Antihypertensive Medications: Population Based Follow up in Eastern Nepal. 2015;13:38–42.

34. Ahmad S. Assessment of adherence to antihypertensive treatment among patients attending a health care facility in North India. In 2015. Available from: https://api.semanticscholar.org/CorpusID:31652195

35. Pallangyo P, Komba M, Mkojera ZS, Kisenge PR, Bhalia S, Mayala H, et al. Medication Adherence and Blood Pressure Control Among Hypertensive Outpatients Attending a Tertiary Cardiovascular Hospital in Tanzania: A Cross-Sectional Study. Integr Blood Press Control. 2022;15:97–112.

ORIGINAL ARTICLE

Clinical Utility of DECT in Fat Fraction Assessment of Rotator Cuff Tears: A Comparative Analysis with MRI

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Abstract
Introduction: Rotator cuff tears are common musculoskeletal injuries, often associated with fatty degeneration (FD) of the rotator cuff muscles. While MRI has been the gold standard for assessing FD, dual-energy CT (DECT) shows promise in providing quantitative measurements. This study aims to compare FD quantification using DECT and MRI fat fraction values in patients with rotator cuff tears.
Materials and Methods: Thirty patients diagnosed with rotator cuff tears underwent DECT and MRI scans for FD assessment. Imaging parameters and techniques were standardized for both modalities. Fat fraction values were obtained using region-of-interest (ROI) analysis. **Results:** The mean age of participants was 55.73 ± 10.16 years, with a majority classified as Goutallier stage 1. Significant differences were observed between fat fraction values measured by DECT and MRI. The ICC revealed moderate reliability (0.549, $p<0.001$), while the Pearson correlation coefficient indicated a strong positive correlation (0.808, $p<0.001$) between the two modalities. **Conclusion:** While DECT shows potential in preoperative assessment, MRI remains superior to DECT in assessing fat fraction in rotator cuff tears. Further research comparing DECT and MRI fat fraction performance is needed to determine their respective roles in clinical practice.

Keywords: Rotator cuff tears, fatty degeneration, dual-energy CT, MRI, fat fraction

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Graphical Abstract

Clinical Utility of DECT in Fat Fraction Assessment of Rotator Cuff Tears: A Comparative Analysis with MRI

Kartheek Guthikonda, Jeevithan Shanmugam, Seetharaman Cannane, Gopinath Periaswamy, Navya Christopher, Mathew Cherian

Introduction

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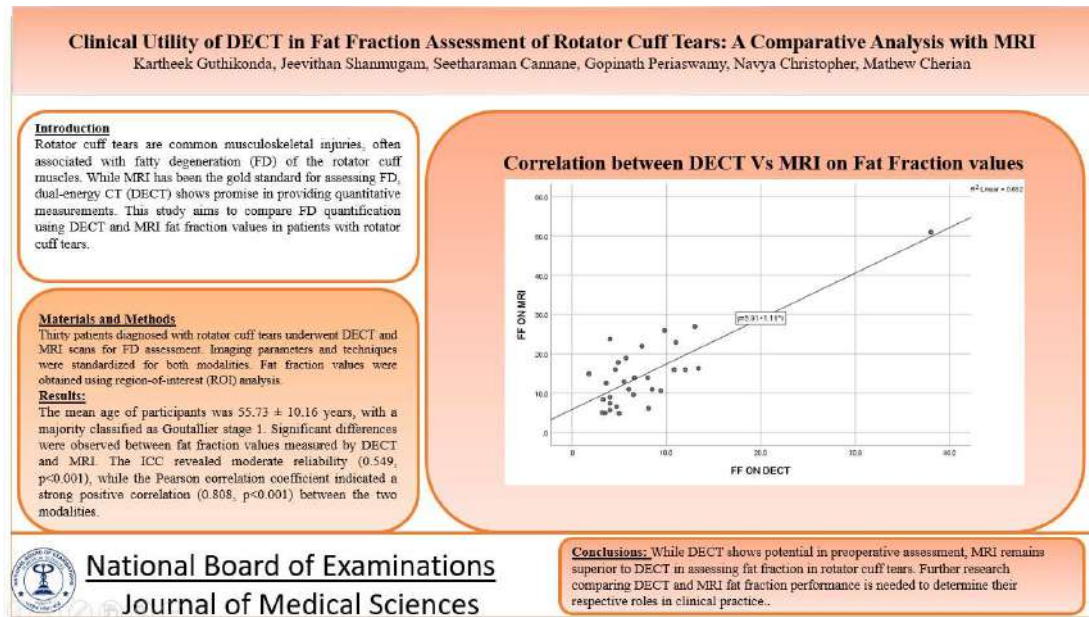
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The mean age of participants was 55.73 ± 10.16 years, with a majority classified as Goutallier stage 1. Significant differences were observed between fat fraction values measured by DECT and MRI. The ICC revealed moderate reliability (0.549, p<0.001), while the Pearson correlation coefficient indicated a strong positive correlation (0.808, p<0.001) between the two modalities.

Correlation between DECT Vs MRI on Fat Fraction values

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Conclusions: While DECT shows potential in preoperative assessment, MRI remains superior to DECT in assessing fat fraction in rotator cuff tears. Further research comparing DECT and MRI fat fraction performance is needed to determine their respective roles in clinical practice..

Introduction

The rotator cuff constitutes the supraspinatus, infraspinatus, teres minor, and subscapularis muscles, playing a crucial role in shoulder mobility. Shoulder abduction initiation hinges significantly on the functional capacity and structural soundness of the supraspinatus muscle, in conjunction with the coordinated actions of the remaining rotator cuff muscles and their associated tendons [1].

Rotator cuff tendon disorders are classified into three categories: absence of tear, tendinopathy without tear, and tendinopathy with tear. Tears can be further classified as partial or complete. It's noteworthy that rotator cuff tears are found in up to 39% of individuals without symptoms. Moreover, the incidence of rotator cuff tears tends to rise with age [1,2]. Fatty degeneration (FD) occurring in the infraspinatus and subscapularis muscles has been linked to a heightened risk of recurrent tears in the supraspinatus tendon. This correlation may be attributed to reduced depressor capability, potentially leading to impingement of the supraspinatus tendon [3].

During the pre-operative assessment of rotator cuff tears, it is crucial to look for muscle abnormalities namely muscular atrophy and fatty degeneration. Fatty degeneration in the context of rotator cuff tears typically develops in muscles as a result of substantial and long-standing tendon tears. Studies have shown that the risk of rotator cuff retear is linked to the severity of fatty degeneration in the corresponding muscles before surgery.[3] Therefore, it is essential to assess the degree of fatty degeneration in rotator cuff muscles during pre-operative evaluations to determine surgical indications and anticipate the risk of recurrence.

Goutallier introduced a semi-quantitative grading system for fatty degeneration (FD). However, this system has faced inherent challenges. Studies indicate that the Goutallier score demonstrates moderate reproducibility, even among experienced observers. Qualitative assessments are further hindered by relatively high levels of inter-observer and intra-observer variability. To enhance assessment accuracy and reliability, a dependable quantitative

measurement method is necessary, as it helps minimize both inter and intra-observer variability. Presently, the Dixon method in MRI stands as the gold standard for quantifying fatty degeneration in rotator cuff muscles. Its superiority lies in its ease of reproducibility and accuracy in providing quantitative measurements [4].

Quantitative measurement of muscle density using computed tomography (CT) is recognized for its reliability and reproducibility. Dual-energy CT (DECT) emerges as a promising tool due to its capability to distinguish X-ray attenuation across different tissue types using various X-ray energy spectra. This unique ability enables the decomposition of materials and separation of fat, thereby improving the quantitative assessment of muscle density. DECT's potential for fat quantification presents a potentially stronger measure of fatty degeneration compared to MRI quantification using the Dixon method. The advantage of DECT lies in its ability to produce virtual mono-energetic images with reduced CT number variability compared to single-energy CT [4].

While individual studies have separately assessed CT and MRI quantification of fatty degeneration and correlated them with tendon severity, there remains a gap in data comparing DECT and MRI fat fractions. Therefore, this study has been planned to determine the amount of fatty degeneration of rotator cuff muscles using the DECT method and compare it with MRI fat fraction values in patients with rotator cuff tears. By comparing DECT and MRI fat fractions, the study aims to elucidate their potential roles in the clinical management of rotator cuff tears.

Materials and Methods

This cross-sectional study was conducted at a tertiary care teaching hospital in the western region of South India and received prior approval from the ethical committee. A consent waiver was granted by the ethical committee to utilize the MRI Picture Archiving and Communication System (PACS). After Institutional Ethics Committee approval and obtaining informed consent, all patients diagnosed with rotator cuff tears via MRI between February 2021 and August 2021 were considered for inclusion.

Participants under 18 years old or with a history of prior rotator cuff repair were excluded from the study. The primary investigator contacted eligible participants who met the inclusion and exclusion criteria. The study's objectives, necessity, participants' rights, and ethical considerations were thoroughly discussed. Patient information sheets were provided, allowing participants adequate time to review and comprehend the study's details. Upon expressing willingness to participate, written informed consent was obtained from each participant before undergoing DECT. The total number of patients included in the study was 30.

DECT Technique

- Imaging was conducted using a Siemens dual-energy 384 slice Computerised Tomography (CT) machine (Somatom Force, Siemens Healthcare, Erlangen, Germany).
- Parameters included tube voltage at 100/150 kV with a tin filter along with automatic exposure control settings of 415 mAs for low and 208 mAs for high quality reference x-ray tube energies respectively.
- Detector collimation of 192×0.6mm (with a z-flying focal spot) and a pitch of 0.6.
- The specified volume CT dose index (CTDIvol) was 24.1 mGy. Actual CTDIvol varied according to patient

size with the automatic exposure control (CAREDose4D, Siemens Healthcare).

- Images acquired at 100 kV and 150 kV were reconstructed in the parasagittal and axial planes of the shoulder using a soft-tissue smooth kernel (QR44) and an iterative reconstruction strength setting of 3 (ADMIRE; Siemens Healthcare).
- Slice thickness and interval were 1mm and 0.6 mm, respectively.
- Monochromatic images at 70 keV were generated using post-processing software (Syngo.via VB50).
- ROIs were drawn for each rotator cuff muscle in the parasagittal plane using Syngovia VB 50, Vnc application, which generated the fat fraction value for each muscle.

MRI Technique
- Imaging was performed on a Philips Ingenia 1.5T MRI scanner.
- The MRI protocol for diagnosing rotator cuff tears included PD fs sequence in oblique coronal, oblique sagittal, and axial planes; T2 TSE sequence in oblique coronal, oblique sagittal, and axial planes; a T1-weighted TSE sequence in oblique coronal, oblique sagittal planes; and mDixon method in the oblique sagittal plane for fat quantification.
- ROIs were drawn for each rotator cuff muscle in mDixon sequences using Philips ISP software, which generated fat fraction values for each muscle.

Free hand ROI was done along the outer margin of the cross section of the muscles in both the CT and MRI in the corresponding images.

Statistical analysis

The collected data were entered into Microsoft Excel and later exported for analysis using IBM SPSS version 27. Descriptive statistics was represented as mean and standard deviation, while categorical variables were expressed as frequency and percentages. t test was done to compare the association between Fat Fraction assessed by DECT and MRI. To assess the correlation between CT and MRI in fat fraction, intra-class correlation coefficients (ICC) were computed. Additionally, Pearson correlation coefficients were calculated to confirm the correlation between the two imaging modalities. A significance level of $p<0.05$ was deemed statistically significant.

Results
A total of 30 participants were enrolled in the study. The mean age of the study participants was 55.73 ± 10.16 with age ranging from 36-73. Females constituted 53.3% (16) and males 46.7% (14). 36.7% (11) had a normal BMI, another 60% (18) were overweight and the rest 3.3% (1) was obese. According to Goutallier classification, 76.7% (23) were stage 1, 20% (6) were stage 2 and the rest 3.3% (1) was stage 4. 36.7% (11) had supraspinatous tear, another 26.6% (8) had infraspinatous tear and the rest 36.7(11) had subscapularis tear. None had teres minor tear. According to tendon tear severity, 10% had full thickness tear, 73.3% had partial tear less than 25%. The rest 16.7% (5) had either 50% or 75% tear (Table 1).

The association between Fat Fraction measured with MRI and CT scan was measured. There was a significant difference between both. (Table 2)

The intraclass correlation coefficient was also 0.549(P<0.001) indicating a moderate reliability (Table 3). The pearson correlation coefficient was 0.808 (P < 0.001) exhibiting a very high positive correlation (Fig. 1).

Table 1. Socio demographic characteristics of the study population

Parameter	Frequency	Percentage
Age		
35-45	5	16.7
46-55	9	30
56-65	10	33.3
66-75	6	20
Sex		
Male	14	46.7
Female	16	53.3
BMI		
Normal	11	36.7
Over weight	18	60
Obese	1	3.3
Goutallier Classification		
Stage 1	23	76.7
Stage 2	6	20
Stage 4	1	3.3
Position of Tear		
Supraspinatous tear	11	36.7
Infraspinatous tear	8	26.6
Subscapularis tear	11	36.7
Tear minor	0	0
Tear severity of Tendon		
Full thickness	3	10
Partilal < 25	22	73.3
Partial 25-50%	2	6.7
Partial high grade	3	10

Table 2. Mean comparison of Fat Fraction between DECT and MRI

MRI		DECT		Mean Diff	t value	p Value
Mean	SD	Mean	SD			
14.79	9.36	7.68	6.53	7.11	-6.938	<0.001

Table 3. ICC between DECT vs MRI on Fat Fraction values

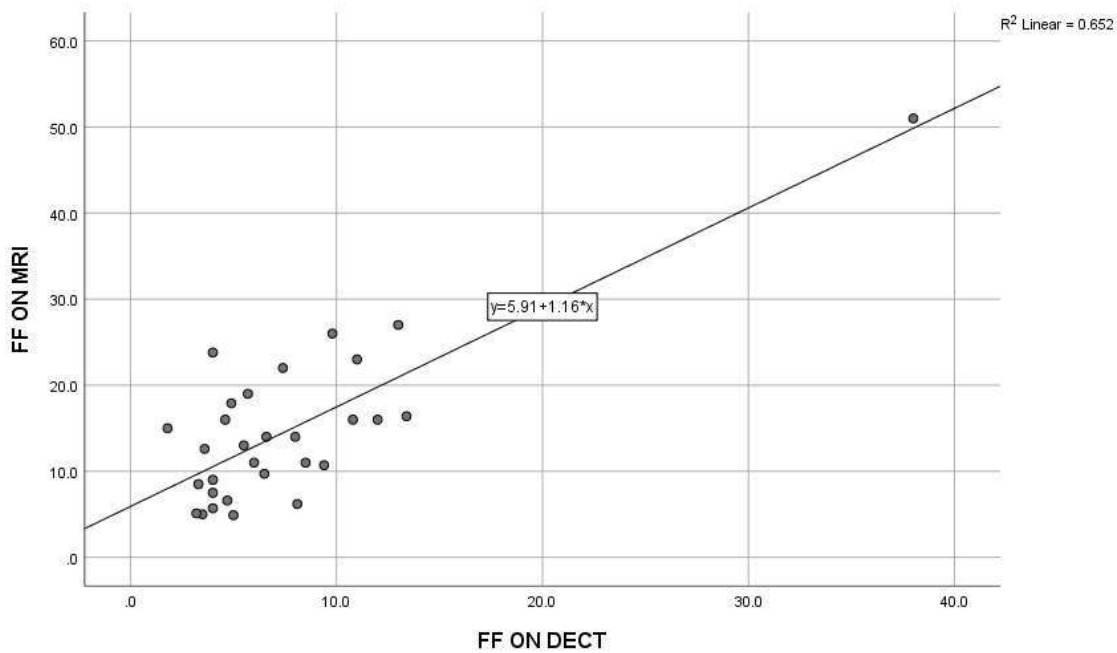| Parameter measured	ICC	95% Confidence Interval		Significance	
		Lower limit	Upperlimit	F Value	P Value
Fat Fraction	0.549	-0.074	0.825	7.267	<0.001

Fig 1. Correlation between DECT vs MRI on Fat Fraction values

Discussion

The cross-sectional study conducted on 30 participants aimed to understand the performance of Dual-energy computed tomography (DECT) in assessing Fat Fraction compared to routine Magnetic Resonance Imaging (MRI). The findings suggested a considerable statistically significant difference between the mean values, suggesting that MRI images outperformed DECT in detecting Fat Fraction. The Intraclass correlation coefficient of 0.549 indicated moderate reliability, while the Pearson correlation coefficient of 0.8 indicated a strong correlation between the two imaging modalities. However, despite the strong correlation, DECT was deemed inferior to MRI in Fat Fraction assessment.

DECT utilized material decomposition of iodine, fat, and soft tissue to assess Fat Fraction. This method was chosen due to limitations in MRI techniques. Qualitative assessment of fat on MRI using T1-weighted images was found to be limited in accuracy for fat quantification. Additionally, MR spectroscopy, while offering advantages, had drawbacks such as low spatial resolution and T2 bias [5,6].

Study by Muller et al. highlighted various aetiologies for fatty infiltration, including traction neuropathy and muscle tension loss, leading to architectural and physiological changes. They also demonstrated that the degree of tear retraction had a significant influence on the extent of fatty infiltration, as observed in a sheep model [7].

Dual-energy computed tomography (DECT) and magnetic resonance imaging (MRI) each have distinct strengths and limitations in identifying and quantifying fat fraction in rotator cuff tears [8-11].

1. Tissue Differentiation: MRI is superior to DECT in tissue differentiation, particularly in

distinguishing between adipose tissue and muscle due to its high soft tissue contrast resolution. This capability allows MRI to accurately identify and quantify fat fraction within the rotator cuff muscles.

2. Quantitative Accuracy: MRI using techniques such as the Dixon method provides highly accurate and reliable quantitative measurements of fat fraction in rotator cuff muscles. This method has been extensively validated in various studies, demonstrating its reliability in assessing fatty degeneration in rotator cuff tears.

3. Resolution and Detail: MRI typically offers higher spatial resolution and detailed anatomical visualization compared to DECT. This higher resolution allows for precise delineation of muscle boundaries and fat infiltration within the muscles, contributing to accurate fat fraction calculations.

4. Clinical Validation: MRI-based fat fraction measurements have been extensively validated in clinical studies and have become the standard method for assessing fatty degeneration in rotator cuff tears. Numerous research articles have demonstrated the clinical utility and reliability of MRI in evaluating fatty infiltration in rotator cuff muscles.

Despite the advantages of MRI-based fat quantification techniques, MRI is less readily available and more costly compared to CT. Non-contrast CT is routinely obtained in preoperative shoulder evaluations. However, the performance of DECT Fat Fraction against MRI Fat Fraction has not been extensively reported.

Conclusion

While DECT offers potential advantages in certain clinical scenarios, such as preoperative assessment, the study suggests that MRI remains superior to DECT in assessing Fat Fraction in rotator cuff tears. Further research comparing DECT and MRI Fat Fraction performance is warranted to provide more comprehensive insights into their respective roles in clinical practice.

Statements and Declarations
Conflicts of interest
The authors declares that they do not have conflict of interest.

Funding
No funding was received for conducting this study.

Ethics approval
Ethical approval obtained from all patients.

Human and animal rights
This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent
For this type of study formal consent is not required.

References
1. David WS. MRI In Orthopaedics & Sports Medicine David W. Stoller. 3rd ed. Wolters Kluwer Health. 2006: pp.1220-1240.
2. Sambandam SN, Khanna V, Gul A, Mounasamy V. Rotator cuff tears: An evidence-based approach. World journal of orthopaedics. 2015 Dec 18;6(11):902.
3. Morag Y, Jacobson JA, Miller B, De Maeseneer M, Girish G, Jamadar D. MR

imaging of rotator cuff injury: what the clinician needs to know. Radiographics. 2006 Jul;26(4):1045-65.

4. Baillargeon AM, Baffour FI, Yu L, Fletcher JG, McCollough CH, Glazebrook KN. Fat quantification of the rotator cuff musculature using dual-energy CT– A pilot study. European Journal of Radiology. 2020 Sep 1; 130:109145.

5. Lee S, Lucas RM, Lansdown DA, Nardo L, Lai A, Link TM et al. Magnetic resonance rotator cuff fat fraction and its relationship with tendon tear severity and subject characteristics. Journal of shoulder and elbow surgery. 2015 Sep 1;24(9):1442-51.

6. Pfirrmann CW, Schmid MR, Zanetti M, Jost B, Gerber C, Hodler J. Assessment of fat content in supraspinatus muscle with proton MR spectroscopy in asymptomatic volunteers and patients with supraspinatus tendon lesions. Radiology 2004; 232:709-15

7. Müller CT, Buck FM, Mamisch-Saupe N, Gerber C. Good correlation of Goutallier rating of supraspinatus fatty changes on axial and reformatted

parasagittal computed tomographic images. Journal of computer-assisted tomography. 2014 May 1;38(3):340-3.

8. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. Clin Orthop Relat Res. 1994 Jul;(304):78-83.

9. Thomazeau H, Boukobza E, Morcet N, Chaperon J, Langlais F. Prediction of rotator cuff repair results by magnetic resonance imaging. Clin Orthop Relat Res. 1997 Nov;(344):275-83.

10. Kanda T, Ishii K, Kawaguchi H, Kitajima K, Takenaka D. High signal intensity in the dentate nucleus and globus pallidus on unenhanced T1-weighted MR images: relationship with increasing cumulative dose of a gadolinium-based contrast material. Radiology. 2014 Mar;270(3):834-41.

11. Micevych PS, Garg A, Buchler LT, Marra G, Saltzman MD, Parrish TB, Seitz AL. Optimizing methods to quantify intramuscular fat in rotator cuff tears with normalization. Skeletal Radiol. 2019 Jul;48(7):1111-1118.

ORIGINAL ARTICLE

Assessment of Lung Involvement in COVID-19 Patients on HRCT and impact of Vaccination on CT severity: Insights from the Second Wave in Kerala, India

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Abstract

Background: COVID-19 is primarily a respiratory illness and the severity of lung involvement can have a substantial effect on the prognosis of the disease. The state of Kerala was among the most affected in India. The objective of this cross-sectional study was to assess the lung involvement among those infected with COVID-19 Pandemic at the time of second wave in Kerala, India. **Methodology**: The study was done in 2021 and included COVID-19 patients who underwent CT scan of thorax. The socio-demographic variables and vaccine status of the patients were collected. **Results**: The results showed that the severity of lung involvement increased with age, with more than 60% of the study population being above 55 years of age. Additionally, unvaccinated patients had more severe lung involvement compared to vaccinated patients, with males being more affected than females. **Conclusion**: The study highlights the importance of vaccination and early intervention in managing severe COVID-19 cases.

Keywords: COVID-19, Lung involvement, HRCT

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Graphical Abstract

Assessment of Lung Involvement in COVID-19 Patients on HRCT and impact of Vaccination on CT severity: Insights from the Second Wave in Kerala, India

Dr. Puthiya Maliyakkal Sineeraz[1], Dr. Praharsha Surya[2], Dr. Jeevithan Shanmugam[3], Dr. Archana Ramachandran[4]*

Background

COVID-19 is primarily a respiratory illness, and the severity of lung involvement can have a substantial effect on the prognosis of the disease. The state of Kerala was among the most affected in India. The objective of this cross-sectional study was to assess the lung involvement among those infected with COVID-19 Pandemic at the time of second wave in Kerala, India.

Methods:

A cross-sectional record-based study was conducted on 1,538 COVID-19 patients(diagnosed by RTPCR) who underwent thoracic CT scans between May and November 2021. Lung involvement was classified as mild, moderate, or severe based on the CT scans. Socio-demographic data and vaccination status were also recorded. Patients not eligible for vaccination during the study were also noted. Informed consent was obtained, and data were analyzed using SPSS 27. Descriptive statistics were reported as frequencies and percentages. Chi-square analysis examined associations between vaccination status, sex, age, and CT scores predicting COVID-19 severity.

Results: main table

		Mild	Moderate	Severe	Chi square Value	P value
Table 1 : Association between age and severity of covid						
Age group	Less than 18	8(100)	0 (0)	0(0)	76.241	<0.001
	18-25	17(77.3)	5(22.7)	0(0)		
	25-35	95(58.3)	51(31.3)	17(10.4		
	35-45	94(36.4)	123(47.7)	41(15.9)		
	45-55	96(31.7)	157(51.8)	50(16.5)		
	55-65	118(33.5)	156(44.3)	78(22.2)		
	>65	188(45.0)	175(41.9)	55(13.2)		
Table 2 : Association between gender and severity of covid						
Gender	Male	308(37)	364(43.8)	160(19.2)	18.773	<0.001
	Female	308(44.5)	303(43.8)	81(11.7)		
Table 3: Table 3 : Association between Vaccination status and severity of covid						
Vaccination status	Not given	346(35.2)	458(46.5)	180(18.3)	46.533	<0.001
	Given	220(52.8)	160(38.4)	37(8.9)		
	Not eligible during the study perios	50(80.4)	49(78.2)	24(41.5)		

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Conclusions: Our study shows a clear link between age and COVID-19 severity, indicating increased severity with age. Males demonstrate greater lung involvement compared to females. Unvaccinated patients exhibit higher severity levels than vaccinated individuals, highlighting the importance of vaccination in reducing disease severity. Larger, longitudinal studies are needed to confirm and understand causality.

Introduction

The COVID-19 pandemic, due to SARS-CoV-2 virus, has emerged as one of the most severe public health catastrophes in recent years, causing extensive morbidity and mortality worldwide. As of February 2022, the pandemic has affected over 40 crore humans, with over 60 Lakh deaths reported globally. India has been severely impacted by the pandemic, with a high number of COVID-19 cases and also deaths [1]. Kerala was one of the worst impacted areas during the second wave of the pandemic in India [2]. COVID-19 is primarily a respiratory illness that affects the lungs, and the severity of lung involvement can have a significant impact on the prognosis of the disease. A computed tomography (CT) scan of the thorax has been proven to be an efficient method for detecting lung involvement in COVID-19 patients [3].

Several studies have been conducted to evaluate the extent of lung involvement in COVID-19 patients using CT scan imaging. These studies have shown that COVID-19 primarily affects the lungs, with characteristic features such as ground-glass opacities, consolidations, and crazy-paving patterns observed in CT scans of the thorax. These features are indicative of varying degrees of lung involvement and can be used to assess the severity of the disease [4,5].

Ai et al. in China discovered that CT scan imaging was more sensitive than reverse transcription-polymerase chain reaction (RT-PCR) testing in diagnosing COVID-19 infection in patients presenting with clinical symptoms. The authors also reported that the extent of lung involvement observed on CT scans was associated with the severity of the disease and the need for hospitalization [6,7]. A similar study conducted by Long et al. in the United States reported that CT scans were more sensitive in the detection of COVID-19 infection than RT-PCR testing and also

showed a significant association between the extent of lung involvement observed on CT scans and disease severity [8].

In this research, we designed to evaluate the severity of lung involvement in COVID-19 infection during the second Pandemic wave in Kerala, India, using CT scan imaging. We also assessed the impact of socio-demographic variables and vaccine status on the severity of lung involvement.

Materials and Methods

A cross sectional record based study was done on a sample of 1,538 patients of COVID-19 who underwent CT scan of thorax between May and November 2021. Complete enumeration of all the patients who were diagnosed as COVID-19 infection positive by RTPCR and referred for CT thorax were included. Based on the CT scan of thorax the lung involvement in COVID-19 patients, were classified into mild, moderate, or severe. In addition socio-demographic data and vaccine status of the patients were recorded. When the study was designed, the vaccination against the infection was given in a phased manner starting with the elderly, front line and health care workers with gradual shift towards younger population in decreasing order of age. So those who were not in the age group for vaccination during the study period were considered as Not eligible for vaccination. Prior written Informed consent was obtained. Microsoft excel was used for data entry and SPSS 27 was used for analysis. Descriptive results were presented as frequency and percentages. Chi square analysis was performed to measure the association between Vaccination status, sex and age with CT scores predicting the COVID 19 disease severity.

Results

A total of 1,538 COVID-19 patients who underwent CT scan of thorax were included in the study. The study population consisted a slight majority of males (55%). The majority of the patients (70.4%) were above 45 years of age, with more than 60% of the study population being above 55 years of age (Table 1).

Majority of about 91.9% were eligible for vaccination during the study period. About 27.4% among the total had received at least one dose of any of the approved COVID-19 vaccine, with 11% having received both the recommended doses then. In total about 72% had not received the vaccine.

The CT scores showed that 40.4% of the patients had mild lung involvement, 43.8% had moderate lung involvement, and 15.8% had severe lung involvement. Higher proportion of people in the age group of more than 45 years had severe disease than who were 45 and below ($p<0.01$) (Table 2). Significantly a higher proportion of males had severe lung disease than the females (Table 2). The severity of lung involvement was also significantly higher among unvaccinated patients (18.3% in not received and 19.5% in the not eligible category) compared to vaccinated patients (8.9%). Majority of them in the not eligible category (40.6%) and those having received vaccine (52.8%) had CT scores suggestive of mild disease. Whereas among those who were eligible but had not taken the vaccine majority (46.5%) were in the moderate category (Table 3). The severity of lung involvement increased with age, with the highest percentage of patients with severe lung involvement being above 55 years of age.

Table 1. Association between age and severity of covid

Age group	Mild		Moderate		Severe		Chi square Value	P value
	Number	%	Number	%	Number	%		
Less than 18	8	100	0	0	0	0	76.241	<0.001
18-25	17	77.3	5	22.7	0	0		
25-35	95	58.3	51	31.3	17	10.4		
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Male	308	37	364	43.8	160	19.2	18.773	<0.001
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Given	220	52.8	160	38.4	37	8.9		
Not eligible during the study perios	50	80.4	49	78.2	24	41.5		

Discussion

This cross-sectional study aimed to assess the correlation between vaccination status and the extent of lung involvement among COVID-19 patients in Kerala, India, amidst the second wave of the pandemic.

Age and COVID 19 disease

The findings indicated a positive correlation between patient age and the severity of lung involvement, aligning with existing research demonstrating a higher incidence of COVID-19 among older individuals. Aging is often associated with a compromised immune system, rendering individuals more susceptible to viral infections. Moreover, elderly populations frequently contend with underlying health issues, further heightening their risk of experiencing severe manifestations of COVID-19. In this discourse, we will examine pertinent literature elucidating the connection between age and COVID-19 incidence, alongside exploring potential mechanisms underpinning this association.

A research endeavor carried out by scientists in Italy revealed a notable rise in COVID-19 incidence corresponding to age, with the most pronounced rates observed among individuals aged 80 years or older [9]. Another study conducted in China similarly highlighted a greater incidence of COVID-19 among older adults, emphasizing that individuals aged over 60 faced an elevated risk of infection [10]. A comprehensive systematic review and meta-analysis encompassing 22 studies from diverse countries revealed a substantial escalation in the risk of severe COVID-19 illness and mortality in tandem with advancing age [11].

Several factors may underlie the heightened incidence of COVID-19 among older adults. One potential mechanism is immunosenescence, which denotes age-related alterations in the immune system leading to a diminished capacity to mount a robust immune response against viral infections [12]. Additionally, the prevalence of underlying health conditions, including cardiovascular disease, diabetes, and chronic respiratory ailments, tends to be higher among older individuals, thereby amplifying the susceptibility to severe manifestations of COVID-19 [13].

Moreover, older adults may face an elevated risk of virus exposure owing to factors like residing in long-term care facilities, which have been sites of COVID-19 outbreaks. Social dynamics also play a role, with age-related declines in social support and heightened social isolation potentially contributing to the heightened vulnerability of older adults to COVID-19 [6,14].

Yang et al. [15] have demonstrated that advanced age stands as a significant risk factor for severe COVID-19 disease and its associated complications. Numerous studies further corroborate age as a pivotal risk factor for both the incidence and severity of COVID-19. The mechanisms underscoring this correlation encompass immunosenescence, underlying health conditions, and heightened susceptibility to virus exposure. These insights underscore the critical importance of prioritizing older adults for vaccination and implementing preventive measures to mitigate the risk of COVID-19-related morbidity and mortality.

Gender and COVID

Multiple studies have consistently observed a higher severity of lung involvement in male COVID-19 patients compared to females. This gender disparity has been documented across various

regions worldwide, including the United States, China, and Italy. For instance, a study conducted in New York City, USA, underscored that male individuals diagnosed with COVID-19 faced a greater risk of severe lung disease and a heightened mortality rate compared to their female counterparts [16]. Similarly, a study conducted in Wuhan, China, highlighted that male COVID-19 patients exhibited a higher incidence of severe pneumonia and a heightened mortality rate compared to females [17]. Likewise, findings from Italy underscored that male individuals diagnosed with COVID-19 had a higher incidence of severe respiratory failure in comparison to female patients [18].

The underlying reasons behind the gender disparity in COVID-19 lung involvement remain somewhat elusive. Some studies propose that biological factors could contribute to this phenomenon. For instance, research indicates that females often exhibit more robust immune responses compared to males, potentially shielding them from severe manifestations of COVID-19 [19]. Additionally, the female hormone estrogen has been posited as a protective factor against severe COVID-19. Estrogen is known for its anti-inflammatory properties and may aid in mitigating the cytokine storm, a potentially harmful immune response associated with severe COVID-19 cases [20].

Indeed, behavioral and environmental factors could also contribute to the observed gender differences in COVID-19 lung involvement. For instance, males often exhibit higher rates of smoking compared to females, which is known to compromise lung health and elevate the risk of severe COVID-19 outcomes. Additionally, males are more likely to engage in occupations that entail exposure to air pollution, a factor that can also impair lung function and heighten susceptibility to severe COVID-19 complications. These behavioral and environmental disparities may contribute to the increased vulnerability of males to severe lung involvement in COVID-19 [21].

Jin et al. [22] in their study also revealed that the severity of lung involvement was higher among males than females, reported that males have an increased risk of severe COVID-19 infection and mortality. The evidence that are currently available suggests that COVID-19 lung involvement is higher in males compared to females, although the reasons for this gender difference are not entirely clear. Biological factors such as immune response and hormone levels may play a role, as well as behavioral and environmental factors. Further research is imperative to comprehensively unravel the mechanisms underlying the gender disparity in COVID-19 lung involvement.

Vaccination and Covid Severity

The study underscores a crucial finding: unvaccinated patients exhibit a higher severity of lung involvement in contrast to vaccinated individuals, highlighting the protective efficacy of COVID-19 vaccination against severe disease and its associated complications. Numerous studies corroborate this observation, consistently demonstrating elevated COVID-19 lung involvement among unvaccinated individuals compared to their vaccinated counterparts. The principal rationale behind this trend lies in the demonstrated effectiveness of vaccines in preventing severe COVID-19 illness and mitigating the risk of hospitalization and mortality [23,24].

A substantial retrospective cohort study conducted in the United States unveiled that unvaccinated individuals faced a heightened risk of hospitalization and mortality in comparison to vaccinated counterparts [24]. Similarly, a study carried out in the United Kingdom highlighted that individuals who were either unvaccinated or partially vaccinated exhibited a greater propensity for hospitalization and mortality when contrasted with fully vaccinated individuals [23].

The mechanism behind the higher COVID-19 lung involvement among unvaccinated individuals is related to the immune response. Vaccines stimulate the production of neutralizing antibodies that can bind to the virus and prevent it from entering cells. They also activate T cells that can identify and kill infected cells. Thus, vaccinated individuals are more likely to have a robust immune response that can prevent severe lung involvement in case of COVID-19 infection [25].

Moreover, unvaccinated individuals are at a higher likelihood of COVID-19 exposure and subsequent severe disease development. Vaccines play a crucial role not only in safeguarding individuals but also in curbing virus transmission within communities. Consequently, the overall risk of exposure diminishes as the spread of the virus is mitigated through vaccination efforts [26]. The COVID-19 lung involvement is higher among unvaccinated individuals compared to vaccinated individuals. This is due to the fact that vaccines stimulate a robust immune response that can prevent severe lung involvement in case of COVID-19 infection. Additionally, vaccines reduce the risk of exposure to the virus in the community. Therefore, it is important to promote vaccine uptake to reduce the severity of COVID-19 disease and prevent its spread.

Conclusion

The results of our study indicate a direct correlation between age and the severity of lung involvement in COVID-19 patients, with increasing age corresponding to heightened severity. Additionally, our findings reveal that males exhibit greater severity of lung involvement compared to females. These observations underscore the critical role of COVID-19 vaccination in mitigating the risk of severe disease, as evidenced by higher lung involvement among unvaccinated patients relative to vaccinated counterparts. To further validate these findings and ascertain causality, future studies with larger sample sizes and longitudinal designs are warranted.

Limitations: The data was gathered from a single center, and the sample size was modest. The cross-sectional study design makes it more difficult to prove causation. The effect of comorbidities on lung involvement in COVID-19 participants was not assessed in this study.

Conflicts of interest

The authors declares that they do not have conflict of interest.

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References

1. Ministry of Health and Family Welfare. (2021). COVID-19 Statewise Status. Retrieved from https://www.mohfw.gov.in/
2. India Today. (2021). Kerala records highest single-day Covid-19 spike, 29,682 new cases reported. Retrieved

from
https://www.indiatoday.in/coronavirus-outbreak/story/kerala-records-highest-single-day-covid-19-spike-29-682-new-cases-reported-1848514-2021-08-22

3. Kanne JP, Little BP, Chung JH, Elicker BM. (2020). Essentials for radiologists on COVID-19: an update-radiology scientific expert panel. Radiology. 2020; 296(2): E113-E114. https://doi.org/10.1148/radiol.2020200527

4. Salehi S, Abed A, Balakrishnan S, Gholamrezanezhad A. (2020). Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients. AJR. American journal of roentgenology.2020; 215(1): 87-93. https://doi.org/10.2214/AJR.20.23034

5. Simpson S, Kay FU., Abbara S, Bhalla S, Chung JH, Chung M, Henry TS, Kanne JP, Kligerman SJ, Ko JP, Litt H, Maldjian P, Reilly C, Tomography C. (2020). Radiological Society of North America Expert Consensus Statement on Reporting Chest CT Findings Related to COVID-19. Endorsed by the Society of Thoracic Radiology, the American College of Radiology, and RSNA. Radiology: Cardiothoracic Imaging.2020; 2(2): e200152. https://doi.org/10.1148/ryct.2020200152

6. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, Tao Q, Sun Z, Xia L. Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology. 2020;296(2): E32-E40. doi: 10.1148/radiol.2020200642.

7. Li K, Wu J, Wu F. The clinical and chest CT features associated with severe and critical COVID-19 pneumonia. *Invest. Radiol.* 2020;55(6):327–331. doi: 10.1097/RLIK.0000000000000672

8. Long C, Xu H, Shen Q, Zhang X, Fan B, Wang C, Zeng B, Li Z, Li X, Li H. Diagnosis of the Coronavirus disease (COVID-19): rRT-PCR or CT? *Eur. J. Radiol.* 2020;126:108961. doi: 10.1016/j.ejrad.2020.108961

9. Onder G, Rezza G, Brusaferro S. Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. JAMA. 2020;323(18):1775–1776.

10. Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72314 Cases From the Chinese Center for Disease Control and Prevention. JAMA. 2020;323(13):1239–1242.

11. Huang I, Lim MA, Pranata R. Diabetes mellitus is associated with increased mortality and severity of disease in COVID-19 pneumonia - A systematic review, meta-analysis, and meta-regression. Diabetes Metab Syndr. 2020;14(4):395–403.

12. Nikolich-Žugich J. The twilight of immunity: emerging concepts in aging of the immune system. Nat Immunol. 2018;19(1):10–19.

13. Madjid M, Safavi-Naeini P, Solomon SD, Vardeny O. Potential Effects of Coronaviruses on the Cardiovascular System: A Review. JAMA Cardiol. 2020;5(7):831–840.

14. Burton JK, Bayne G, Evans C, et al. Evolution and effects of COVID-19 outbreaks in care homes: a population analysis in 189 care homes in one geographic region. Lancet 2020.;1(1):E21-E31.

15. Yang X, Yu Y, Xu J, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med. 2020;8(5):475-481.

16. Guan WJ, Ni ZY, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med. 2020;382(18):1708-20. doi:10.1056/NEJMoa2002032

17. Chen T, Wu D, Chen H, et al. Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study. BMJ. 2020;368:m1091. doi: 10.1136/bmj.m1091

18. Grasselli G, Zangrillo A, Zanella A, et al. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy Region, Italy. JAMA. 2020;323(16):1574-1581. doi:10.1001/jama.2020.5394

19. Klein SL, Dhakal S, Ursin RL, et al. Biological sex impacts COVID-19 outcomes. PLoS Pathog. 2020;16(6):e1008570. doi:10.1371/journal.ppat.1008570

20. Bukowska J, Frazier-Jessen M, Ries W. COVID-19 susceptibility and outcomes: A sex-specific and hormonal perspective. J Clin Med. 2020;9(5):1645. doi:10.3390/jcm9051645

21. Bhopal SS, Bhopal R. Sex differential in COVID-19 mortality varies markedly by age. Lancet. 2020 Aug 22;396(10250):532-533. doi: 10.1016/S0140-6736(20)31748-7.

22. Jin JM, Bai P, He W, et al. Gender differences in patients with COVID-19: Focus on severity and mortality. Front Public Health. 2021;9:152.

23. Keehner J, Horton LE, Pfeffer, MA, Longhurst CA, Schooley RT, Currier JS, Shah NH. Real-world evidence for lower morbidity and mortality of mRNA COVID-19 vaccination. Med.2020: 2(7); 779-790.e4. https://doi.org/10.1016/j.medj.2021.05.005.

24. Tenforde MW, Self WH, Zhu Y, Naioti EA, Gaglani M, Ginde AA, Jensen K, Talbot HK, Casey JD, Mohr NM, Zepeski A, McNeal T, Ghamande S, Gibbs KW, Files DC, Hager DN, Shehu A, Prekker ME, Erickson HL, Gong MN, Mohamed A, Johnson NJ, Srinivasan V, Steingrub JS, Peltan ID, Brown SM, Martin ET, Monto AS, Khan A, Hough CL, Busse LW, Lohuis CT, Duggal A, Wilson JG, Qadir N, Chang SY, Mallow C, Rivas C, Babcock HM, Kwon JH, Exline MC, Botros MM, Lauring AS, Shapiro NI, Halasa N, Chappell JD, Grijalva CG, Rice TW, Jones ID, Stubblefield WB, Baughman A, Womack KN, Rhoads JP, Lindsell CJ, Hart KW, Turbyfill C, Olson S, Murray N, Adams K, Patel MM; Influenza and Other Viruses in the Acutely Ill (IVY) Network. Protection of Messenger RNA Vaccines Against Hospitalized Coronavirus Disease 2019 in Adults Over the First Year Following Authorization in the United States. Clin Infect Dis. 2023: 8;76(3):e460-e468. doi: 10.1093/cid/ciac381.

25. Bar-On YM, Goldberg Y, Mandel M, Bodenheimer O, Freedman L, Kalkstein N, Mizrahi B, Alroy-Preis S, Ash N, Milo R, Huppert A. Protection of BNT162b2 Vaccine Booster against Covid-19 in Israel. New England Journal of Medicine.2021; 385(15): 1393–1400. https://doi.org/10.1056/nejmoa2114255

26. Krammer F. SARS-CoV-2 vaccines in development. Nature.2021: 586(7830), 516–527. https://doi.org/10.1038/s41586-020-2798-3.

ORIGINAL ARTICLE

Emphysematous Pyelonephritis: Demographics, Clinical Predictors, Management & Outcomes: Our Experience at a Tertiary Care Centre

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Abstract
Background: Emphysematous pyelonephritis, a urological emergency, is characterized by an acute renal infection, associated with necrotic changes, due to gas-forming organisms. Though nephrectomy was considered as the traditional gold standard treatment, there is a change in the management due to improvement in outcomes with minimally invasive procedures like stenting and percutaneous drainage. Hence, in recent years, there is a notable shift towards this minimalistic approach, with or without need for nephrectomy. **Methods:** This is a retrospective observational study performed on patients who were treated in our hospital for EPN between October 2022 and March 2023. The poor prognostic factors assigned were altered mental status, shock on initial presentation, thrombocytopenia, Low albumin and need for emergency hemodialysis. Retrospective data including age, gender, comorbidities, imaging, laboratory investigations, necessity of emergency dialysis, treatment details and outcome was collected. The clinical predictors, treatment modalities employed and outcomes were analysed. **Results:** Thirty eight patients with EPN, from October 2022 to March 2023, were studied. Elderly patients were most commonly affected by EPN. All our patients were diabetic. We found that Klebsiella was involved in maximum number of cases followed by E. coli as the second most involved pathogen. In our study, the left kidney alone was involved in 44.7% of the patients and the opposite (right) kidney alone was involved in 36.8% individuals. Of our 38 patients, 34 (89.4%) had two or more unfavourable prognostic factors. 32 patients had high grade/extensive EPN, [class 3(73.4%) and class 4(11.8%)]. **Conclusions:** In our study of patients with EPN, elderly diabetic women were most commonly affected with Klebsiella being the most frequently isolated pathogen. Though two or more bad prognostic factors and along with extensive EPN (class 3/4) was seen in a large number of our patients, medical management with minimally invasive therapy provided a siginificant success rate of 94.7% with only few (2) patients succumbing and they were not fit for nephrectomy also. Hence, we support early aggressive medical and minimally invasive treatment and also, we suggest that major procedures like nephrectomy should be considered in patients only if they are not improving with minimally invasive treatment.

Keywords: Emphysematous pyelonephritis, Gas forming uro-pathogens, Percutaneous catheter drainage, DJ stenting, Minimally invasive therapy, Emergency nephrectomy

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Graphical Abstract

Emphysematous Pyelonephritis: Demographics, Clinical Predictors, Management & Outcomes: Our Experience at a Tertiary Care Centre

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Introduction
Emphysematous pyelonephritis, a urological emergency, is characterized by an acute renal infection, associated with necrotic changes, due to gas-forming organisms. Though nephrectomy was considered as the traditional gold standard treatment, there is a change in the management due to improvement in outcomes with minimally invasive procedures like stenting and percutaneous drainage. Hence, in recent years, there is a notable shift towards this minimalistic approach, with or without need for nephrectomy

Materials and Methods
This is a retrospective observational study performed on patients who were treated in our hospital for EPN between October 2022 and March 2023. The poor prognostic factors assigned were altered mental status, shock on initial presentation, thrombocytopenia, Low albumin and need for emergency hemodialysis. Retrospective data including age, gender, comorbidities, imaging, laboratory investigations, necessity of emergency dialysis, treatment details and outcome was collected. The clinical predictors, treatment modalities employed and outcomes were analysed.

Results:
Thirty eight patients with EPN, from October 2022 to March 2023, were studied. Elderly patients were most commonly affected by EPN. All our patients were diabetic. We found that Klebsiella was involved in maximum number of cases followed by E. coli as the second most involved pathogen. In our study, the left kidney alone was involved in 44.7% of the patients and the opposite (right) kidney alone was involved in 36.8% individuals.

Age Distribution

National Board of Examinations Journal of Medical Sciences

Conclusions: In our study of patients with EPN, elderly diabetic women were most commonly affected with Klebsiella being the most frequently isolated pathogen. Though two or more bad prognostic factors and along with extensive EPN (class 3/4) was seen in a large number of our patients, medical management with minimally invasive therapy provided a siginificant success rate of 94.7% with only few (2) patients succumbing and they were not fit for nephrectomy also.

Introduction

Emphysematous pyelonephritis (EPN) is an emergency in urology characterized by an acute necrotizing renal parenchymal and surrounding tissues infection caused by gas-forming organisms [1]. Excess accumulated glucose in the tissues in diabetic patients, provides a favorable microenvironment for gas forming microbes. Females are more commonly affected, 6:1 [2]. This is due to the higher rate of UTIs (Urinary tract infections) in females [2].

Formation of gas is rapid, and the continued gas production denotes active infection and inadequate antibiotic treatment. Urinary tract infections which are becoming emphysematous pyelonephritis, are due to the presense of gas-forming bacteria, high tissue glucose concentration, increased proliferation of the bacteriae, vascular deficiency with ischemia/infarct [2].

EPN is a life-threatening disease. It has been noticed that the mortality rate has improved drastically with recent advances in antibiotics, medical treatment of diabetes, resuscitation and minimally invasive therapy. The mainstay is fluid resuscitation, strict glycemic control and judicious use broad-spectrum antibiotic cover [2].

The classical teaching stated that the treatment should be aggressive, and nephrectomy was considered as first line treatment of choice. Now there is a change in the treatment aspect due to significant recent advances in non-invasive modalities like percutaneous catheter drainage (PCD) [2]. Recent protocols recommend PCD placement in patients with localized EPN and functioning parenchyma. This renders patient to retain the renal function, hence preventing ESRD and need for RRT. Since recent times, there is progressive shift towards this approach, and nephrectomy will be considered if required [3].

Aim and Objectives

The aim of our research is to emphasize the importance of early

diagnosis and minimally invasive treatment of EPN cases.

The objectives are to elucidate the outcomes of patients with EPN with relation to demographics, clinical predictors, radiological classification, treatment modalities, and the effect of bad prognostic factors on the outcome.

Material and Methods

This is a retrospective study conducted on patients who attended SVIMS with the disease between October 2022 and March 2023. A total of 38 patients with EPN admitted under urology, nephrology and medicine departments, whose complete case details were available were included. The poor prognostic factors assigned were altered mental status, shock on initial presentation (systolic BP<90), thrombocytopenia (<1.2 lakhs), low albumin (<3 gm/dl) and need for emergency HD were included in the study. The data were collected which included age, sex, comorbidities, laboratory investigations, imaging, need for emergency dialysis, management details and outcomes. The clinical predictors, treatment modalities and outcomes were studied.

Observations and Results

Thirty eight patients with EPN, from October 2022 to March 2023, were studied. Elderly patients were most commonly affected by EPN. All our patients were diabetic. We found that Klebsiella was involved in maximum number of cases followed by E. coli as the second most involved pathogen. In our study, the left kidney alone was involved in 44.7% of the patients and the opposite (right) kidney alone was involved in 36.8%

individuals. Of our 38 patients, 34 (89.4%) had two or more unfavourable prognostic factors. 32 patients had high grade/extensive EPN, [28 out of the total 38 patients come under class 3 category (73.4%) and remaining belonged to class 4(11.8%)]. All these patients had more than two bad prognostic factors. In our study, 12 patients required emergency Hemodialysis. Of these severe category patients, combined medical and minimally invasive treatment was successful in 30 patients and was not sufficient in 2 patients (expired). In our study, 12 patients required emergency Haemodialysis. 4 out of 38 patients had bilateral EPN, of whom 3 patients responded to a combined medical therapy, bilateral DJ stenting and percutaneous drainage with a catheter, while one patient succumbed.

Discussion

Elderly diabetic females had been maximum affected [3]. In this study of ours, the female predominance was more glaring (F:M = 12:1) as compared to other available research articles. In women the increased occurrence of EPN is probably because of more pronounced susceptibility and frequency of infections of the urinary tract in them [4].

Our patients had bad glycemic control as contemplated by way of high average HbA1c. Other than DM (Diabetes mellitus), our patients had no significant or bothersome predisposing elements such as obstructive uropathy that usually lead to the development of EPN. In our observation of the, renal stones were present only in two patients, inflicting obstructive uropathy in one patient. Similar findings had been reported by RA Misgar et al. [5] (Figures 1 to 6).
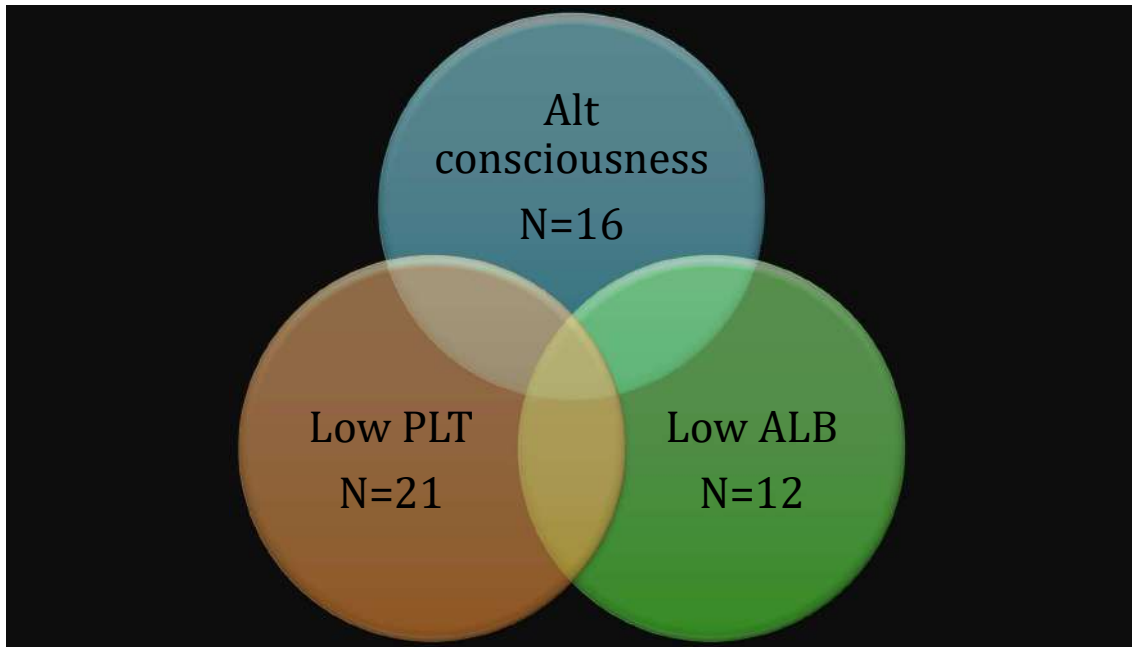
AGE
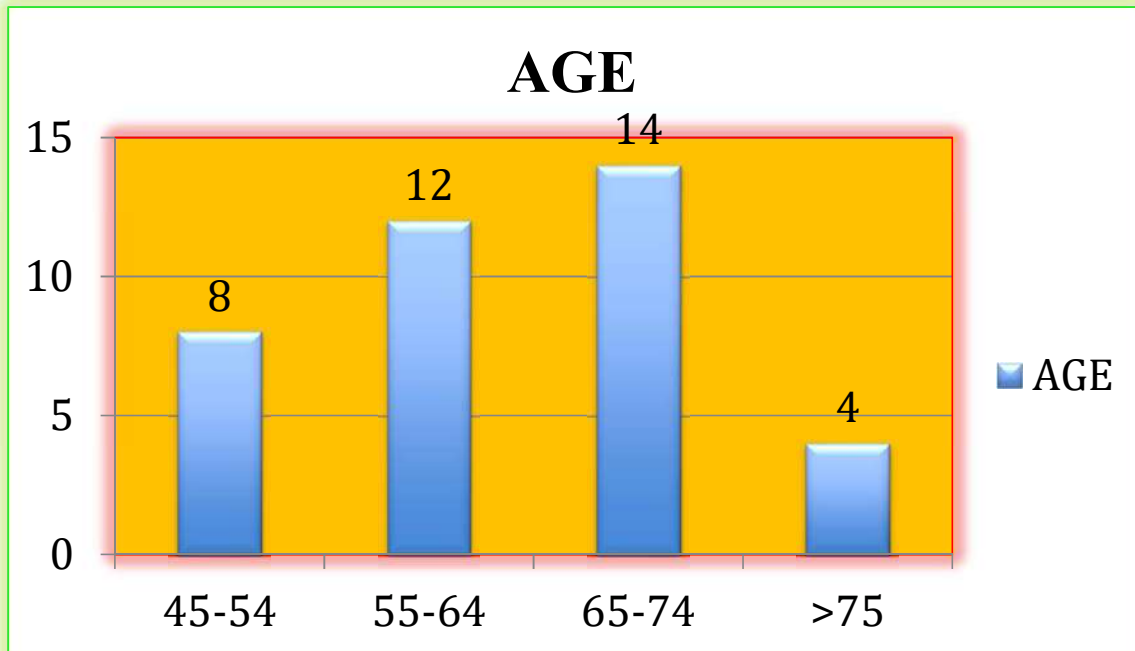
Figure 1. Age distribution
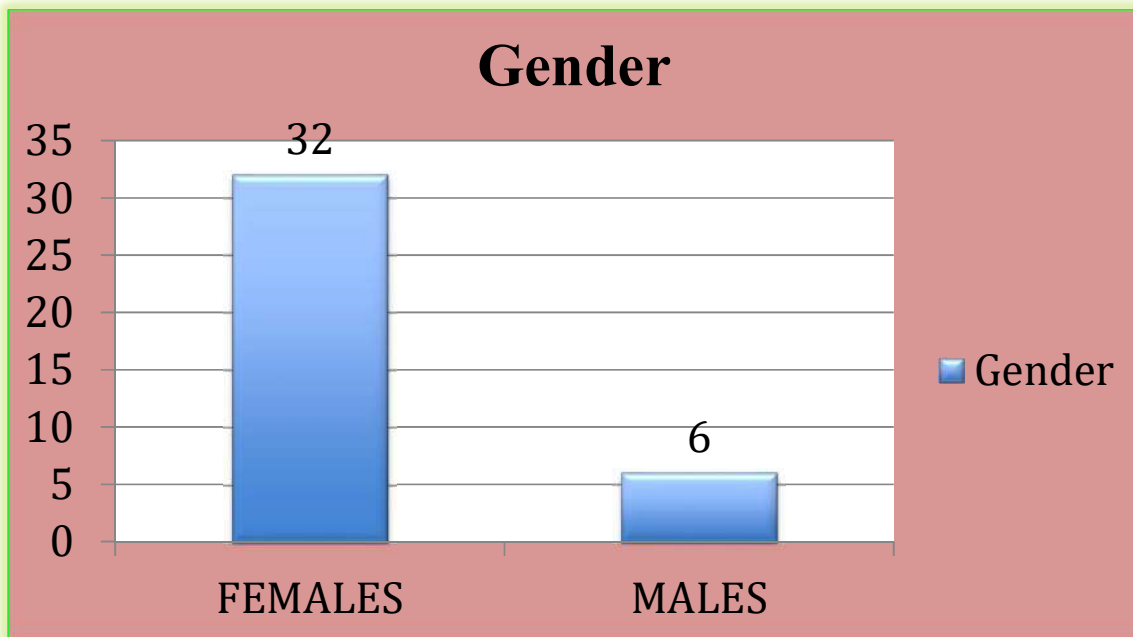
Gender

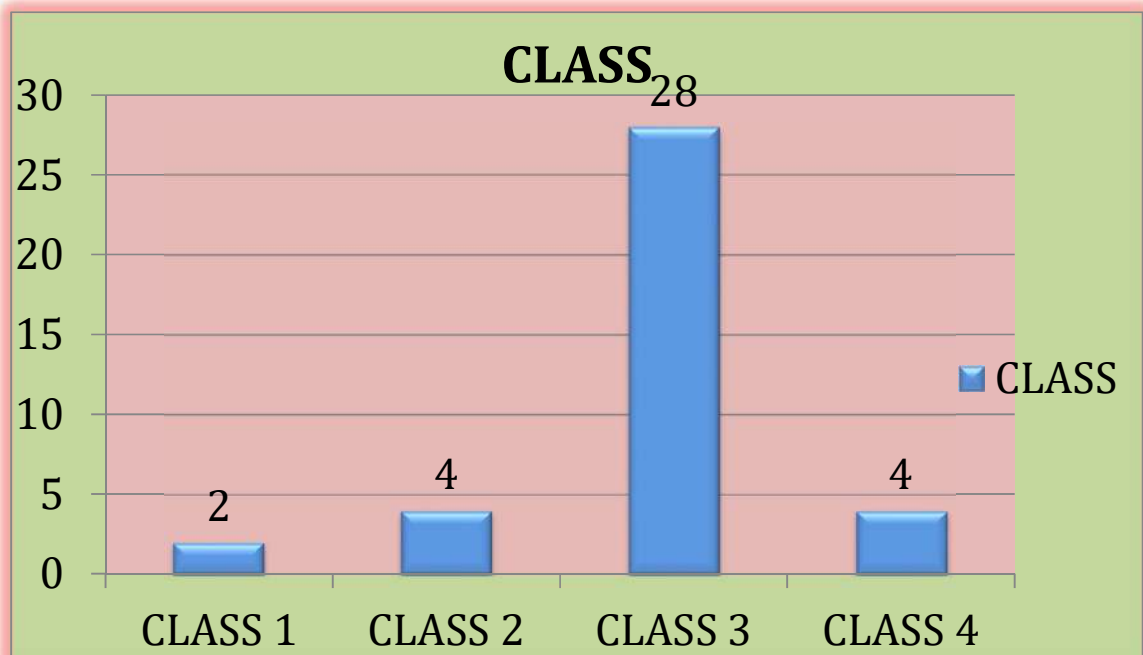Figure 2. Gender distribution

Figure 3. Poor prognostic factors

Figure 4. CT Classification: (Huang–Tseng)

CASES	11	13	7	4	3
	E COLI	KLEBSIELLA	E FECALIS	S AUREUS	PSEUDOMONAS
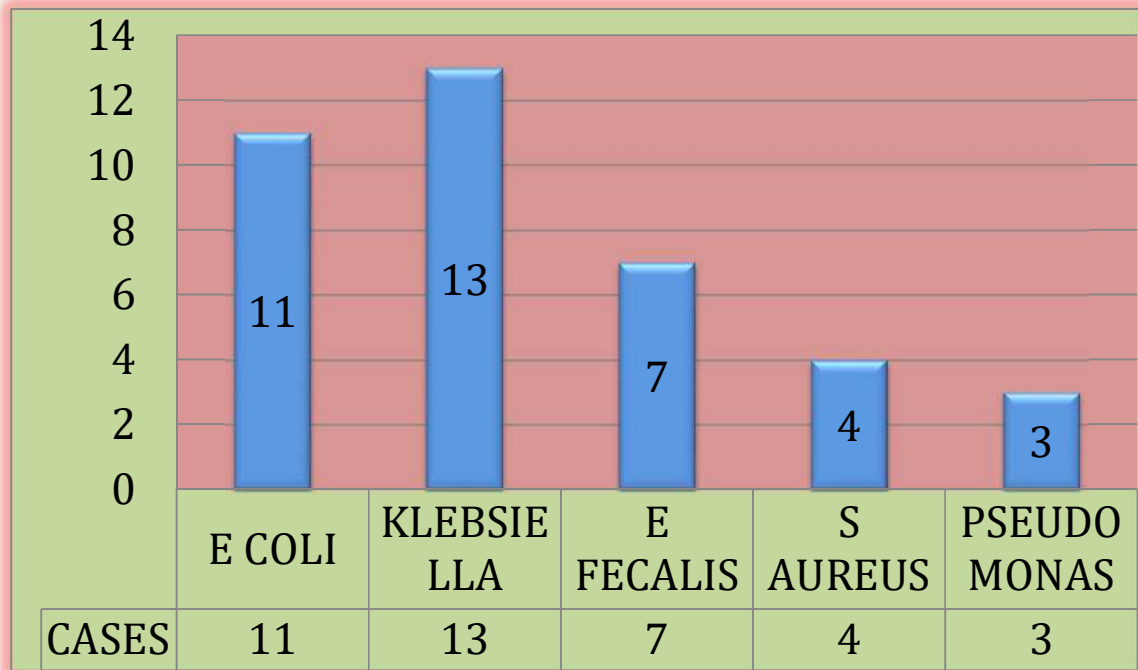
Figure 5. Causative organisms

CT CLASS	BAD PROGNOSTIC FACTORS	TREATMENT			OUTCOME	
		MEDICAL AND DJS	MEDICAL DJS & PCD	NEPHRECTOMY	SURVIVED	DEAD
1&2 (N=6)	<2(N=4)	4	0	0	4	0
	≥2(N=2)	2	0	0	2	0
3&4 (N=32)	<2(N=0)	0	0	0	0	0
	≥2(N=32)	26	6	0	30	2

Figure 6. The CT class, prognostic factors, TX and outcome:

E. coli is usually considered as the most frequent culprit causing EPN and has been isolated in about 47–90% of the cases.[5] The other commonly involved organisms included Proteus mirabilis, Klebsiella pneumoniae, Enterococcus species, and Pseudomonas aeruginosa. In contrast to the available literature, we, in our study, found that Klebsiella species was involved in maximum number of cases and E. coli was noted as the second most frequently grown pathogen in the cultures of our study [5].

In EPN, as per existing literature, left kidney was more commonly involved (cause unknown) than the right [6]. One of the meta-analysis done recently reported that 52% of all the EPN patients had left-sided disease, 37.7% suffered right-sided kidney involvement and 10.2% had bilateral pathology. Huang et al., in their study, reported that, out of the 48 patients with EPN they evaluated 67%, 25%, and 8% of the patients had left alone, right alone and bilateral involvement, respectively [7]. In our study of EPN, the left kidney alone was involved in 44.7% patients and the right sided pathology was observed in 36.8% patients. Bilateral occurrence was noted in 10.5% of patients.

Huang et al. also commented that initial presentation with severe proteinuria, thrombocytopenia, shock (defined by systolic BP <90 mmHg), altered sensorium and spread of the infection beyond the kidney, i.e., to the perinephric area were considerably linked with mortality and morbidity [7]. One more recent meta-analysis reported that patients suffering with EPN had a significantly high mortality rate when in association with shock. One more study done recently reported that severe hypoalbuminemia (with serum albumin <3 g/dl), necessity to start emergency hemodialysis and infections of polymicrobial origin are poor prognostic factors in patients affected by EPN.[5] Of our 38 patients, 34 (89.4%) had two or more poor prognostic factors. In our series, 32 patients had extensive EPN (class 3 or 4) and all these patients had ≥2 bad prognostic factors, of whom, conservative minimally invasive therapy successfully improved 30 patients but was, for reasons unknown, unsuccessful in 2 patients who later expired.

Huang et al., in their study of 48 patients, finalized that nephrectomy presents the best possible management option and should be executed early for extensive form of EPN with a likely fulminant course (like those with ≥2 poor prognostic factors) [7]. Our data challenges this ideology, which is quite radical, as 30 out of the 32 patients, in our study, with severe and extensive (class 3/4) EPN improved with conservative management. Results, quite comparable to this, have been presented by Lu et al. [8].

Controversial and debatable is the treatment of EPN as such. Traditionally and historically, early nephrectomy was believed as the treatment of choice in those suffering from EPN with few reports even indicating that there was likely an increased mortality rate with medical and minimally invasive management when compared to surgical management. But surgery is frequently poorly tolerated in cases of EPN because of their poor hemodynamic condition. In an article by Ahlering et al., the mortality rate in those who underwent emergency nephrectomy was a staggering 42% [9]. A study by Kapoor et al. reported that an early nephrectomy, when performed, was linked with a higher mortality rate as compared to immediate conservative approach [10]. Chen et al., in 1996, presented an article, which stated that a proper antibiotic therapy in conjunction with CT (Image)-guided percutaneous aspiration or drainage was a reasonably good and acceptable alternative to upfront nephrectomy [11].

One more meta-analysis of recent times emphasized that in comparison to emergency nephrectomy, drainage by percutaneous route along with medical management was associated with an arguably lower mortality rate. Our findings

do positively reflect the ongoing trend in the treatment of EPN, because, in our analysis, the successful resolution of EPN with conservative treatment alone is 89.4%. Performing nephrectomy in these patients would have increased the probability of lifelong need for renal replacement therapy. Success of non-surgical treatment of EPN afflicting both the kidneys has already been previously reported by some authors. The probable reasons, for the encouragingly low mortality (<5.2%) in the present case series, are quick and adequate glycemic control, early and appropriate fluid resuscitation, combined use of potent antibiotics, and, in the majority of them, absence of any extra risk factors or bothersome elements other than DM for the development of EPN.

Limitations

Ours is a single centre study with a small number of patients.

Conclusion

In this series of patients with EPN, elderly diabetic women were most commonly affected and klebsiella was the most frequently isolated pathogen. Though two or more poor prognostic factors along with extensive EPN (class 4 or 3) was seen in a major part of our study group, medical management with minimally invasive therapy afforded a successful resolution rate of 94.7% with only two patients succumbed and they were not fit for nephrectomy also.

Hence, we support early aggressive medical and minimally invasive treatment and also, we suggest that major procedures like nephrectomy should be considered in patients only if they are not improving with minimally invasive treatment.

Statements and Declarations
Ethics approval and consent to participate–

This study was approved by the ethics committee of Sri Venkateswara Institute of medical sciences (SVIMS), Tirupati, Andhra Pradesh, India. The patient provided written consent on the condition that his personal details are not revealed anywhere.

Consent for publication

Obtained from the patient and approved by Institutional Ethics Committee (IEC).

Availability of data and material

Approval of competent authority taken for retrieval and usage of data/privacy concerns addressed.

Competing interests
None.

Authors' contributions

Conceptualization: AKN. Methodology: NVT. Software: NVT. Validation: AKN. Formal analysis: NVT. Investigation: AKN. Resources: All authors. Data Curation: All authors. Writing - Original Draft: NVT. Writing - Review & Editing: AKN. Visualization: NVT. Supervision: AKN. Project administration: All authors. Funding acquisition:

References

1. Shokeir AA, El-Azab M, Mohsen T, El-Diasty T. Emphysematous pyelonephritis: A 15-year experience with 20 cases. Urology. 1997;49:343–6.

2. Kuchay M., Laway B., Bhat M., Mir S. Medical therapy alone can be sufficient for bilateral emphysematous pyelonephritis: report of a new case and review of previous experiences. Int Urol Nephrol. 2014;46(1):223–227.

3. Ubee S., McGlynn L., Fordham M. Emphysematous pyelonephritis. Br J Urol Int. 2011;107(9):1474–1478.

4. Schultz EH, Jr, Klorfein EH. Emphysematous pyelonephritis. J Urol. 1962;87:762–6.

5. Misgar RA, Mubarik I, Wani AI, Bashir MI, Ramzan M, Laway BA. Emphysematous pyelonephritis: A 10-year experience with 26 cases. Indian J Endocrinol Metab. 2016 Jul-Aug;20(4):475-80. doi: 10.4103/2230-8210.183475. PMID: 27366713; PMCID: PMC4911836.

6. Aboumarzouk OM, Hughes O, Narahari K, Coulthard R, Kynaston H, Chlosta P, et al. Emphysematous pyelonephritis: Time for a management plan with an evidence-based approach. *Arab J Urol.* 2014;12:106–15.

7. Huang J., Tseng C. Emphysematous pyelonephritis: Clinicoradiological classification, management, prognosis, and pathogenesis. Arch Intern Med. 2000;160(6):797–805.

8. Lu Y.C., Chiang B.J., Pong Y.H. Emphysematous pyelonephritis: clinical characteristics and prognostic factors. *Int J Urol.* 2014;21:277–282.

9. Ahlering TE, Boyd SD, Hamilton CL, Bragin SD, Chandrasoma PT, Lieskovsky G, et al. Emphysematous pyelonephritis: A 5-year experience with 13 patients. *J Urol.* 1985;134:1086–8.

10. Kapoor R, Muruganandham K, Gulia AK, Singla M, Agrawal S, Mandhani A, et al. Predictive factors for mortality and need for nephrectomy in patients with emphysematous pyelonephritis. BJU Int. 2010;105:986–9.

11. Chen M., Huang C., Chou Y., Huang C., Chiang C., Liu G. Percutaneous drainage in the treatment of emphysematous pyelonephritis: 10-year experience. J Urol. 1997;157(5):1569.

ORIGINAL ARTICLE

Anthropometric Measures for Predicting the Risk of Hypertension in Young Adults: Insights from a Representative Population

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Abstract
Background: Obesity is linked to an unhealthy diet and lack of exercise, elevating the risk of hypertension. Elevated blood pressure and a higher risk of hypertension are linked to an increased BMI. Lifestyle changes in adults, like inactivity and poor diet, contribute to the rise in cardiovascular diseases among younger people. **Objectives:** This study aimed to evaluate the relationship in a young adult population between Mean Arterial Pressure (MAP) and Body Mass Index (BMI), Relative Fat Mass (RFM), Waist-to-Hip Ratio (WH ratio), and Waist-to-Height ratio (WHtR). Additionally, the study objective was to determine the predictive value of BMI and RFM for hypertension in young adults. **Methods:** Participants were selected using opportunistic sampling of medical students presenting for the Physiology practical as a representative sample of young adults in this cross-sectional study. The anthropometric measurements of BMI, RFM, WH ratio, and WHtR were measured and compared between subjects with MAP≤90 mmHg and MAP>90 mmHg. **Results:** The chi-square test revealed a strong association between obesity and elevated mean arterial pressure (>90 mmHg). Employing a BMI cut-off (>25kg/m^2) demonstrated 67.74% sensitivity and 77.78% specificity for hypertension detection, while RFM (cut-off 36.6) exhibited 52.17% sensitivity and 64.52% specificity. There was a significant positive correlation of BMI with MAP (r = 0.408, p < 0.001) and a significant difference between groups (p < 0.001). **Conclusion:** The effectiveness of BMI and WHtR in our study underscore the significance of multiple anthropometric indices for comprehensive obesity and cardiovascular risk assessment. Future prospective studies play a crucial role in uncovering the clinical importance of modern anthropometric measurements and biomarkers, providing valuable information to improve tools for assessing obesity and accurately representing public health.

Keywords: waist-hip ratio, waist-to-height ratio, body mass index, hypertension

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Graphical Abstract

Anthropometric Measures for Predicting the Risk of Hypertension in Young Adults: Insights from a Representative Population

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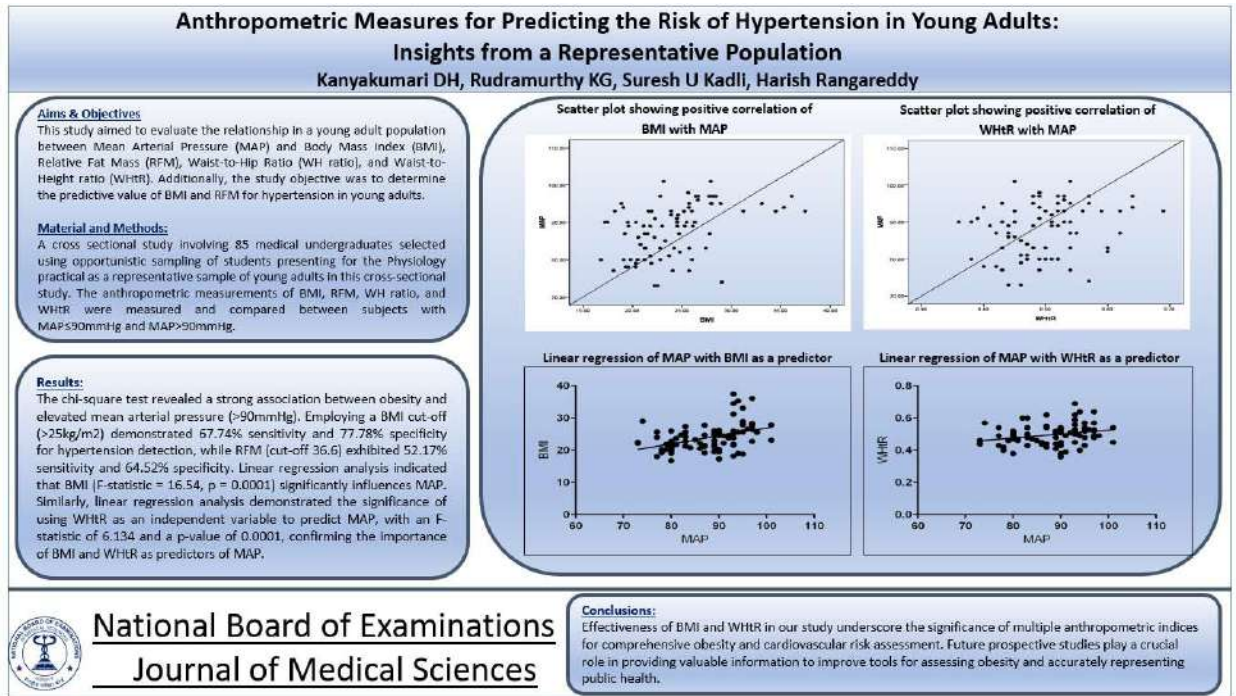
Introduction

Cardiovascular diseases remain a global concern, requiring thorough risk assessment. Anthropometric measurements are significant indicators, associated with cardiovascular risk factors [1]. The classification of overweight and obesity is done by body mass index (BMI), a trend that is on the rise worldwide. Obesity is associated with a poor diet and lack of physical activity, increasing the chance of developing hypertension [2]. Higher BMI is linked to elevated blood pressure and greater chance of developing hypertension [3,4]. Changes in lifestyle, such as lack of physical activity and unhealthy eating habits, are leading to an increase in cardiovascular diseases among younger individuals [5]. Relative fat mass (RFM) calculates body fat percentage using waist circumference, height, and gender. RFM is more effective at anticipating dyslipidemia and metabolic syndrome [6]. Our study explores the link between anthropometric measures and hypertension in young adults. The primary objectives of this study were to assess the correlation between Body Mass Index (BMI), Relative Fat Mass (RFM), Waist-to-Hip Ratio (WH ratio), and Mean Arterial Pressure (MAP) in a young adult population. Additionally, the study aimed to determine the predictive value of BMI and RFM for hypertension in young adults.

Methods

Study setting and design

Cross-sectional study conducted at a tertiary medical center and teaching hospital.

Sample size was determined using the formula:

$$n = Z^2 \times \frac{p \times q}{e^2}$$
$$= 1.96^2 \times \frac{0.50 \times 0.50}{0.1^2}$$
$$= 97$$

where, at 95% Confidence Interval (CI), Z= 1.96 and n=minimum necessary sample size When calculating the maximum sample size, p= prevalence is taken to be 50%.
q = 1-p, e = 10% margin of error
For a finite population, the sample was modified as follows:
97 / [1+{97-1) / 600}] = n' = n / [1+{(n-1) / N}]= 83.6
In this case, n'= modified sample size
N= finite population of medical students in the Medical College, 600
The calculated minimum required sample size was 84.

Participants

The study involved a sample of 85 young adults (aged 18-21 years) recruited from Basaveshwara Medical College Hospital and Research Center, Chitradurga. Participants were selected using opportunistic sampling of medical students presenting for the Physiology practical and is a representative sample of young adults. Subjects suffering from any cardiovascular disease, respiratory illness any other chronic illness were excluded. Young adults were defined as age spanning between 18 to 26 years according to the Committee on Improving the Health, Safety, and Well-Being of Young Adults; Board on Children, Youth, and Families; Institute of Medicine; National Research Council of United States of America [7].

Data Collection
Anthropometric Measurements

The waist and hip circumferences were measured with a flexible tape measure. Waist circumference (WC) was calculated by measuring the horizontal distance across the abdomen at the navel level. Hip circumference (HC) was measured as the horizontal distance between the two top hip bones (ilia).

Height was measured with a roll ruler wall-mounted growth stature meter and body weight was measured using a medical scale with SECA 803 digital flat scale respectively, by a standardized procedure with an accuracy of 0.1 kg and 0.1 cm, respectively. Participants stood with their backs straight, heels together, barefoot, and in light clothing for both measurements.

Indicators of Obesity

To assess obesity in women, the following factors were examined:

- BMI was computed using the formula: BMI = body weight (kg)/height (m) ^{2}. Participants were classified as underweight (<18.5 kg/m^2), normal weight (18.5-22.9 kg/m^2), overweight (23.0-24.9 kg/m^2), or obese ($\geq$25 kg/m^2) based on consensus guidelines for the diagnosis of obesity among Asian Indians [8].

- The relative fat mass (RFM) index was calculated using the formula:

RFM = 76 – [20 × {height (m)/waist circumference (m)}] [9]

RFM aims to provide a more accurate assessment of body fat percentage,

particularly in individuals with different body shapes or proportions.

- The waist-to-hip ratio (WH ratio) was computed using the following formula:
  Waist circumference (WC) in cm / Hip measurement in cm
- The waist-to-height ratio (WHtR) was obtained using the formula:
  (WC) (cm)/height (cm)

Blood Pressure Measurement

The method of Korotkoff sound was utilized for blood pressure measurement using a digital sphygmomanometer. Measurements were conducted based on the guidelines provided by the American Heart Association. The right upper limb artery was examined while sitting. Before measuring blood pressure, it was ensured that the body was in the correct position, a period of rest was taken, an appropriately-sized cuff was used, and external factors that could affect blood pressure (such as drinking coffee and tea) were minimized. The Mean Arterial Pressure (MAP) was determined by using the equation: MAP = DBP + 1/3 (SBP - DBP).

Data Analysis

The normality of the data was evaluated using the Kolmogorov-Smirnov test and was determined to be normally distributed. Mean ± SD was used to present descriptive statistics. The researchers performed independent samples t-tests to compare anthropometric measures between individuals with hypertension and individuals with normal blood pressure. Correlations between BMI, RFM, WH ratio, and MAP were evaluated using Pearson correlation coefficients. A significance level of $p < 0.05$ was established. Data analysis was performed using Statistical Product and Service Solutions (SPSS), SPSS Statistics for Windows, version 16.0 (SPSS Inc., Chicago, Ill., USA).

The study followed ethical standards by obtaining permission from the Institutional Ethics Committee. All participants provided consent prior to taking part in the study, with only the 85 individuals who volunteered being included. Information was made anonymous in order to safeguard the privacy of participants.

Results

This cross-sectional study involved a sample of 85 young adults aged 18-21 years, comprising 48 males and 37 females. The subjects were classified considering the MAP as Group 1 MAP≤90mmHg and Group 2 MAP>90mmHg. The means were compared using the Independent 't' test as shown in Table 1.

Table 1. Comparison of means between the two groups using the Independent 't' test

Parameter	Group 1, n=51 (MAP≤90mmHg) Mean ± SD	Group 2, n=34 (MAP>90mmHg) Mean ± SD	'p' value
Mean arterial pressure (mmHg)	83.41±5.03	94.79±2.47	**<0.001**
Body mass index (kg/m^2)	22.31±2.84	26.44±4.78	**<0.001**
Relative fat mass (%)	29.83±7.32	31.46±7.07	0.311
Waist-hip ratio	0.83±0.06	0.84±0.05	0.253
Waist-to-Height ratio	0.4782±0.0577	0.5224±0.0651	**<0.01**

Out of the 34 students with MAP>90mmHg, 7 had family history of either the father or mother having hypertension. Chi-square test results indicated a robust association between obesity and increased mean arterial pressure (>90mmHg). Utilizing a BMI cut-off of >25kg/m^2, we observed a sensitivity of 67.74% and specificity of 77.78% for detecting hypertension in young adults. Conversely, RFM with a cut-off of 36.6% exhibited a sensitivity of 52.17% and specificity of 64.52% for predicting hypertension.

Regarding BMI, a positive correlation was noted with MAP (r = 0.408, p < 0.001) which was statistically significant as shown in Figure 1. The t-test revealed a notable difference in BMI between groups (t = -4.986, df = 83, p < 0.001). However, for RFM, no significant correlation with MAP was found (r = -0.039, p = 0.725), and the t-test indicated no significant difference in RFM between groups (t = -1.019, df = 83, p = 0.311).
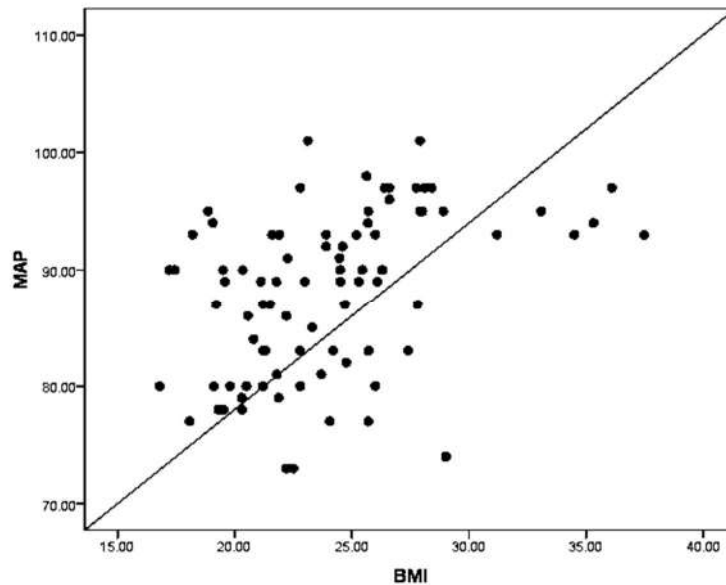
Figure 1. Scatter plot showing the positive correlation of BMI with MAP

Similarly, there was no significant correlation between the WH ratio and MAP (r = 0.102, p = 0.353), and the t-test revealed no notable variation in WH ratio between the groups (t = -1.151, df = 83, p = 0.253).

WHtR showed a significant positive correlation with MAP (r=0.2623, p=0.015) as shown in Figure 2, Independent 't' test revealed significant difference between groups (t=-3.279, p<0.01).
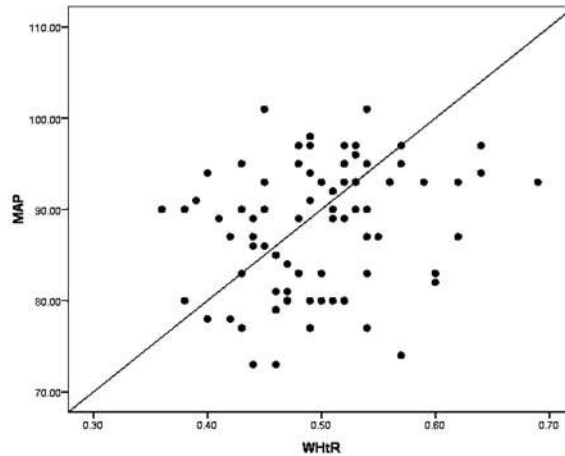
Figure 2. Scatter plot showing the positive correlation of WHtR with MAP

The linear regression analysis using BMI as a predictor and MAP as the dependent variable showed an F-statistic of 16.54 (Y = 0.2468*X + 2.252) with a p-value of 0.0001, indicating a significant impact of body fat mass on MAP. Moreover, when conducting linear regression analysis using WHtR as an independent variable and MAP as the target variable, the F-statistic yielded 6.134 (Y = 0.002408*X + 0.2841) with a significant p-value of 0.0001. Therefore, BMI and WHtR were found to be important predictors of MAP in the examination, as demonstrated in Figure 3 and Figure 4, respectively.
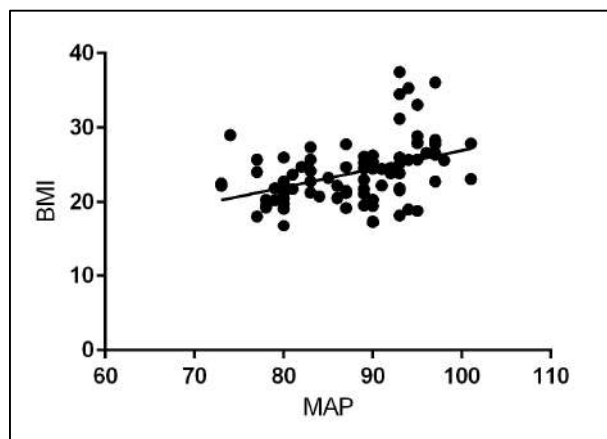
Figure 3. Linear regression of MAP with BMI as a predictor
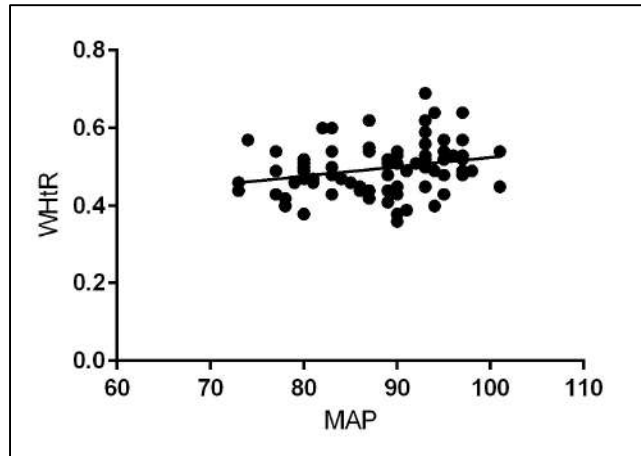
Figure 4. Linear regression of MAP with WHtR as a predictor

These findings shed light on the complex relationships between anthropometric measures and hypertension risk in young adults, emphasizing the importance of BMI and WHtR as predictors of increased mean arterial pressure.

Discussion

Our study revealed that approximately 40% of medical students fell into the category of obesity based on the BMI cut-off. This finding is slightly higher compared with the prevalence reported in a study conducted in Nepal by Aryal V et al, estimating obesity prevalence as 31.67% [10]. However, our results show a lower prevalence compared to the Korean population, where obesity prevalence reached around 50% [11]. In contrast, studies conducted in a teaching hospital in northern Israel and an urban slum of Karachi reported much higher obesity prevalence, reaching 83.70% and 89%, respectively, surpassing the prevalence observed in our study [12,13]. Gender-based distribution of obesity in our study revealed a higher proportion in males (41.66%) compared to females (29.72%) which contrasts the findings by Aryal et al. [10]. The diversity in obesity prevalence underscores the importance of understanding regional and population-specific variations in anthropometric measures. A study conducted by Purohit G et al found that BMI showed negative correlation with SpO2 (r= -0.0504, p<0.05) and pulse rate, but positive correlation with systolic blood pressure (r=0.2736) and diastolic blood pressure (r=0.0275) [14].

RFM, utilizing height and waist circumference, emerged as a simple model for assessing obesity in our study. The mean RFM values for MAP≤90 mmHg and MAP>90mmHg individuals were 29.83±7.32 and 31.46±7.02, respectively. The values in this study are similar to those found by Paek et al. in the Korean adult population, where RFM displayed a diagnostic accuracy in identifying excess body fat percentage that was similar to BMI [15]. Despite the promising aspects of RFM, our study did not demonstrate its

effectiveness in predicting hypertension when compared to BMI. Notably, our study did not include other parameters, preventing a comprehensive assessment of RFM's superiority in predicting different risk factors. These findings are similar to the study in the Chinese population by Yu P et al who prospectively observed that both men and women showed that WHtR and RFM had the highest area under the curve (AUC) values in analysis of ROC, but they were not statistically different from BMI and WC in men or women. The predictive ability of the RFM-based model was similar to that of the anthropometric measures viz., BMI, WC, and WHtR in predicting hypertension in the Chinese population, indicating that RFM could be a reliable predictor. However, in terms of predictive accuracy it does not outperform WC, WHtR and BMI [16].

Kankaria et al, observed that among the residents of Manipur, boys and hypertensive individuals exhibited elevated mean Waist-to-Height Ratio (WHtR), with WHtR positively correlating with weight and male gender; however, the diagnostic efficacy of WHtR for hypertension, as indicated by the AUC in ROC was low [17].

In the CASPIAN-IV study by Payab M et al, the intake of sweetened beverages showed a notable relationship with both body measurements and blood pressure readings. Furthermore, an important relationship was found between fast food intake, blood pressure, and body measurements (except for WHtR and WHR). Consuming sweetened beverages showed a strong connection with anthropometric measurements while consuming salty snacks was only linked

significantly to height, hip circumference, and waist-to-hip ratio (WHR). Individuals who rarely ate sweets had a reduced chance of developing overall obesity and abdominal obesity in comparison to those who ate them every day. Likewise, students who rarely drank sweetened beverages were less likely to be generally obese compared to those who consumed them every day [18]. In our study dietary history was not considered. However, following the study the students with obesity and MAP>90mmHg were advised to exercise regularly and diet charts were provided.

Armitage et al. conducted an experimental study using rabbits equipped with telemetric devices to measure renal sympathetic activity and hemodynamic parameters. They found that rabbits on a high-fat diet exhibited a rapid increase in renal sympathetic tone, blood pressure, and heart rate, along with a decrease in baroreflex function [19]. However, the mechanisms underlying renal denervation influencing blood pressure regulation in obesity remain unclear. It is uncertain whether disrupting sympathetic vasomotor connections outside the kidneys could lead to improvements in blood pressure and other cardiovascular alterations in obesity. Additionally, animal models with obesity-related mutations in the ob gene or LepR often develop heart failure, suggesting a potential connection between leptin and cardiovascular disease [20]. Studies have shown that blocking leptin receptor signaling in pro-opiomelanocortin (POMC) neurons can prevent exogenous leptin from elevating blood pressure, reinforcing the role

of leptin as a crucial hormone linking hypertension and obesity [21].

Obesity is characterized by increased plasma volume and sodium accumulation, which are relevant factors in the development of high blood pressure. Studies conducted over time have demonstrated that changes in kidney excretory function precede the onset of obesity-related hypertension in both animals and humans, suggesting that kidney dysfunction may contribute to elevated blood pressure in obesity [22,23,24].

Large prospective studies are essential to uncover the long-term clinical significance of newer anthropometric measurements, shedding light on their potential advantages over traditional measures. These studies could provide valuable insights into refining obesity assessment tools for a more accurate representation of the population's health status.

Conclusion

In conclusion, this study sheds light on the intricate link between anthropometric measurements and cardiovascular risk in a representative young adult population. The significant associations found, particularly with BMI, WHtR, and MAP, advocate for the inclusion of comprehensive anthropometric assessments in cardiovascular risk stratification models for this demographic. Further research is warranted to validate and extend these findings, ultimately contributing to enhanced preventive strategies for cardiovascular diseases in young adults.

Authors' contributions

KKDH and SUK were involved in the initial writing, revision, idea presentation, initial design, and data collection and analysis of the manuscript. RKG HR took part in reviewing the manuscript, analyzing data, and making revisions to the manuscript. Additionally, all authors take on the responsibility for the validity of the content in the current manuscript and endorse the final draft of the manuscript.

Conflict of interests

The authors declares that they do not have conflict of interest.

References

1. Hassan S, Oladele C, Galusha D, Adams OP, Maharaj RG, Nazario CM, Nunez M, Nunez-Smith M; ECHORN Writing Group. Anthropometric measures of obesity and associated cardiovascular disease risk in the Eastern Caribbean Health Outcomes Research Network (ECHORN) Cohort Study. BMC Public Health. 2021 Feb 25;21(1):399. doi: 10.1186/s12889-021-10399-3.

2. World Health Organization. Obesity and Overweight Geneva: World Health

Organization; 2020. Apr 1, [2024 Mar 08;]. Available from: http://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

3. Kaur M. Correlation between body mass index and blood pressure in adolescents. Pak J Physiol. 2016;12(1):47–50.

4. Weng C, Shen Z, Li X, Jiang W, Peng L, Yuan H, Yang K, Wang J. Effects of chemerin/CMKLR1 in obesity-induced hypertension and potential mechanism. Am J Transl Res. 2017 Jun 15;9(6):3096-3104.

5. Raj M, Sundaram KR, Paul M, Deepa AS, Kumar RK. Obesity in Indian children: time trends and relationship with hypertension. Natl Med J India. 2007 Nov-Dec;20(6):288-93.

6. Kobo O, Leiba R, Avizohar O, Karban A. Relative fat mass is a better predictor of dyslipidemia and metabolic syndrome than body mass index. Cardiovasc Endocrinol Metab. 2019 Sep 10;8(3):77-81. doi: 10.1097/XCE.0000000000000176.

7. Committee on Improving the Health, Safety, and Well-Being of Young Adults; Board on Children, Youth, and Families; Institute of Medicine; National Research Council; Bonnie RJ, Stroud C, Breiner H, editors. Investing in the Health and Well-Being of Young Adults. Washington (DC): National Academies Press (US); 2015 Jan 27. 1, Introduction. Available from: https://www.ncbi.nlm.nih.gov/books/NBK284791/

8. Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al. Consensus statement for diagnosis of obesity, abdominal obesity, and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. J Assoc Physicians India. 2009;57:163–70.

9. Woolcott OO, Bergman RN. Relative fat mass (RFM) as a new estimator of whole-body fat percentage ─ A cross-sectional study in American adult individuals. Sci Rep. 2018 Jul 20;8(1):10980. doi: 10.1038/s41598-018-29362-1.

10. Aryal V, Ghimire D, Kandel S, Majumder A, Manna S. Obesity among Medical Students of a Medical College: A Descriptive Cross-sectional Study. JNMA J Nepal Med Assoc. 2022 Nov 2;60(255):943-946. doi: 10.31729/jnma.7519.

11. Yang YS, Han BD, Han K, Jung JH, Son JW; Taskforce Team of the Obesity Fact Sheet of the Korean Society for the Study of Obesity. Obesity Fact Sheet in Korea, 2021: Trends in Obesity Prevalence and Obesity-Related Comorbidity Incidence Stratified by Age from 2009 to 2019. J Obes Metab Syndr. 2022 Jun 30;31(2):169-177. doi: 10.7570/jomes22024.

12. Sahib AS, Majid HS, Mahdi TR, Hussein RQ. Factors Associated With Incidence Of Obesity And Overweight Among Students Of Medical Sciences. British Journal of Medical & Health Sciences (BJMHS). 2020;2:602-615.

13. Amin F, Fatima SS, Islam N, Gilani AH. Prevalence of obesity and overweight, its clinical markers and associated factors in a high-risk South-Asian population. BMC Obes. 2015 Mar 18;2:16. doi: 10.1186/s40608-015-0044-6.

14. Purohit G, Shah T, Harsoda JM. Prevalence of Obesity in Medical students and its correlation with cardiovascular risk factors: Emergency Alarm for Today? Kathmandu Univ Med J (KUMJ). 2015 Oct-Dec;13(52):341-5. doi: 10.3126/kumj.v13i4.16834.

15. Paek JK, Kim J, Kim K, Lee SY. The usefulness of relative fat mass in estimating body adiposity in Korean adult population. Endocr J. 2019 Aug 29;66(8):723-729. doi: 10.1507/endocrj.EJ19-0064.

16. Yu P, Huang T, Hu S, Yu X. Predictive value of relative fat mass algorithm for incident hypertension: a 6-year prospective study in Chinese population. BMJ Open. 2020 Oct 16;10(10):e038420. doi: 10.1136/bmjopen-2020-038420.

17. Kankaria A, Narang R, Saxena A, Ramakrishnan S, Desai A, Thangjam RS, Krishnan A. Determinants of Waist-to-Height Ratio and Its Relation to Hypertension among School Children in India: A Multicenter Study. Indian J Pediatr. 2022 Jun;89(6):546-552. doi: 10.1007/s12098-021-03879-2.

18. Payab M, Kelishadi R, Qorbani M, Motlagh ME, Ranjbar SH, Ardalan G, Zahedi H, Chinian M, Asayesh H, Larijani B, Heshmat R. Association of junk food consumption with high blood pressure and obesity in Iranian children and adolescents: the CASPIAN-IV Study. J Pediatr (Rio J). 2015 Mar-Apr;91(2):196-205. doi: 10.1016/j.jped.2014.07.006.

19. Armitage JA, Burke SL, Prior LJ, Barzel B, Eikelis N, Lim K, Head GA. Rapid onset of renal sympathetic nerve activation in rabbits fed a high-fat diet. Hypertension. 2012; 60:163–171.

20. Greer JJ, Ware DP, Lefer DJ. Myocardial infarction and heart failure in the db/db diabetic mouse. Am J Physiol Heart Circ Physiol. 2006 Jan;290(1):H146-53. doi: 10.1152/ajpheart.00583.2005.

21. Dubinion JH, do Carmo JM, Adi A, Hamza S, da Silva AA, Hall JE. Role of proopiomelanocortin neuron Stat3 in regulating arterial pressure and mediating the chronic effects of leptin.Hypertension. 2013; 61:1066–1074.

22. Grubbs V, Lin F, Vittinghoff E, Shlipak MG, Peralta CA, Bansal N, Jacobs DR, Siscovick DS, Lewis CE, Bibbins-Domingo K. Body mass index and early kidney function decline in young adults: a longitudinal analysis of the CARDIA (Coronary Artery Risk Development in Young Adults) Study.Am J Kidney Dis. 2014; 63:590–597.

23. Kassab S, Kato T, Wilkins FC, Chen R, Hall JE, Granger JP. Renal denervation attenuates the sodium retention and hypertension associated with obesity. Hypertension. 1995; 25(4 Pt 2):893–897.

24. Yang S, Cao C, Deng T, Zhou Z. Obesity-Related Glomerulopathy: A Latent Change in Obesity Requiring More Attention. Kidney Blood Press Res. 2020;45(4):510-522. doi: 10.1159/000507784.

CASE REPORT

COVID 19: Is the Curse Still Haunting us or a New One Arriving?

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Abstract
COVID 19 started as an epidemic in the country of China which later became a pandemic taking many lives around the globe during the later half of 2020 to 2022. Our combined efforts to eliminate the pandemic were successful to an extent till the end of 2022 when the cases started declining. But the recent increasing trend of COVID like illness even though RT PCR is negative raises a question whether we are really living in a COVID free world?

Keywords: COVID 19, ARDS – acute respiratory distress syndrome, RT PCR negative, non invasive ventilation, respiratory failure

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Introduction

CORONA virus was first identified in Wuhan, China on December 2019. The quick spread of the disease made it a global pandemic. Symptoms range from mild fever, runny nose to severe ARDS and death. WHO declared it as a global pandemic on March 11, 2020. It covered whole world at a devastating rate with two waves, the later being the worse than the former. After vaccination and all precautionary measures COVID cases are at a declining trend in India since the later part of 2021. But the real question is "IS COVID 19 REALLY OVER"

Many experts stated that this Covid virus may reach an endemic stage in India rather than disappearing completely. So the people should learn to live with virus.

Cases

We are discussing a series of 6 cases in the span of about 2 months which presented with COVID like illness but are RTPCR negative for COVID 19.

Initially all the cases with similar complaints like dry cough, low grade fever, shortness of breath (MMRC 2 – 4), malaise. All the patients initially have some existing comorbidities. HRCT chest findings include ground glass opacities and reticular thickening in bilateral diffuse lung fields, submetacentric mediastinal nodes. These reports conclude possible infective aetiology. All the patients are vaccinated for COVID 19 at various timelines in the past.

All patients were initially admitted into ICU. Treatment has been started with iv antibiotics (beta lactams + macrolide), antivirals (oseltamivir), nasal oxygen, proton pump inhibitors, anticoagulants (Xa inhibitors, low molecular weight heparins), vitamin supplements, iv fluids and continuing the previous medication of patients according their comorbidities. Remdesivir was not given as RT-PCR turned out to be negative. Initially saturations maintained by nasal oxygen. But gradually by the third day most patients needed non-invasive ventilation due continuous fall in saturations up-to 50–60%. Patients were even tried with newer drugs like i.v Aviptadil in escalating dose for up to 3 days. Fresh frozen plasmas transfused. Bronchodilators, mucolytics, nebulization's, glucocorticoids and continuous oxygen supply has been provided to the patient. Repeat ABG are done to check the metabolic and respiratory status of the patient. Monitoring of fluid intake, urine output, nutrition, vitals has been done every two hours.

Despite aggressive treatment by the end of a week stay in ICU most patients condition deteriorated gradually. Nasal oxygen was changed to non-invasive ventilation and then subsequently on machinal ventilation due to severe respiratory failure. Tachypnea and tachycardia gradually increased. Saturation levels kept on declining despite ventilatory support and finally patient landed in cardio respiratory arrest (Table 1 and Figures 1 to 2).

Table 1. Insights into Presentations, Histories and outcome for patients

	AGE	SEX	PRESENTING COMPLAINTS	CO-MORBIDITIES	HRCT FINDINGS	NO OF DAYS SAY IN ICU	TYPE OF VENTILATION	OUTCOME
Patient no 1	33Yrs	F	S/P LSCS with High grade fever with dry cough with shortness of breath for 2 days	No co-morbidities	- Segmental lower lobe consolidation with air bronchogram and ground glass haze opacities seen in both lungs mainly in b/l lower lobes with patchy reticular bands noted - Few subcentric mediastinal nodes noted - s/o infective aetiology?	10 days	NIV ventilation for 10 days Mechanical Ventilation for 2 hrs	DEATH
patient no 2	55Yrs	M	Severe respiratory distress with dry cough with SOB with chest pain with fever for 3 days	No co-morbidities	- both lungs show patchy confluent ground glass haze opacities with superimposed reticular thickening and focal air bronchogram mainly in subpleural region - mild b/l pleural thickening noted - mild borderline cardiomegaly - few sub centric mediastinal node noted - s/o ARDS- infective aetiology	4 days	NIV ventilation for 4 days	Recovered|
Patient no 3	59 Yrs	M	Acute respiratory distress for 2 days with dry cough with fever with severe headache for 8 days	No co-morbidities	- Patchy and confluent ground glass opacities with lobar consolidation and air bronchogram seen in both lungs involving all segments with patchy reticular thickening - b/l pleural effusion with pleural thickening noted	12 days	NIV ventilation for 11 days Mechanical ventilation for 1 day	DEATH

					- few sub centric mediastinal nodes noted - s/o infective aetiology			
Patient no 4	65 Yrs	M	SOB with dry cough with fever for 7 days	Type 2 DM	- ground glass attenuation seen in b/l upper, right middle, b/l lower lobes - s/o infective aetiology - atypical or viral pneumonia	11 days	NIV Ventilation for 11 days	DEAT H
Patient no 5	67Yrs	F	SOB (1 day) with dry cough (4-5 days) with multiple oral ulcers (1 month)	No co-morbidities	- Both lungs show diffuse ground glass opacities with smooth interlobular and interseptal reticular thickening noted with upper to lower lobe gradient and subpleural region. - Mild bronchiectatic changes with peri bronchial wall thickening in both lungs - Few sub centric mediastinal nodes noted - Mild b/l pleural thickening noted - s/o ILD?	7 days	3 days – nasal o2 and BIPAP with NIV ventilation 4 days – mechanical ventilation (SIMV)	DEAT H
Patient no 6	75Yrs	F	SOB with Dry cough with Fever for 2 days	HTN with Type 2 DM	- large confluent areas of alveolar space opacifications seen in both lungs predominantly at bases s/o bronchopneumonia - moderate right and mild left pleural effusion	2 days	NIV ventilation 1 day Mechanical ventilation 2 hrs	DEAT H

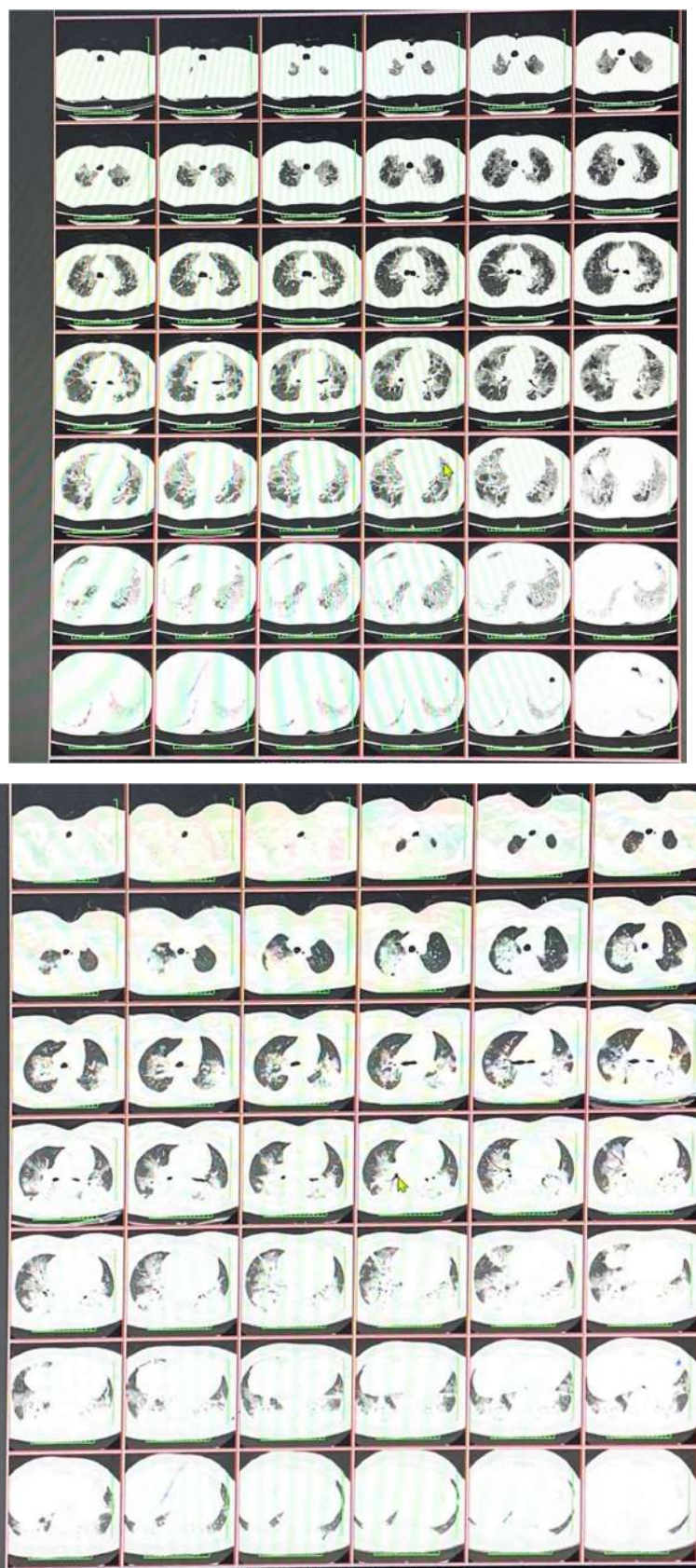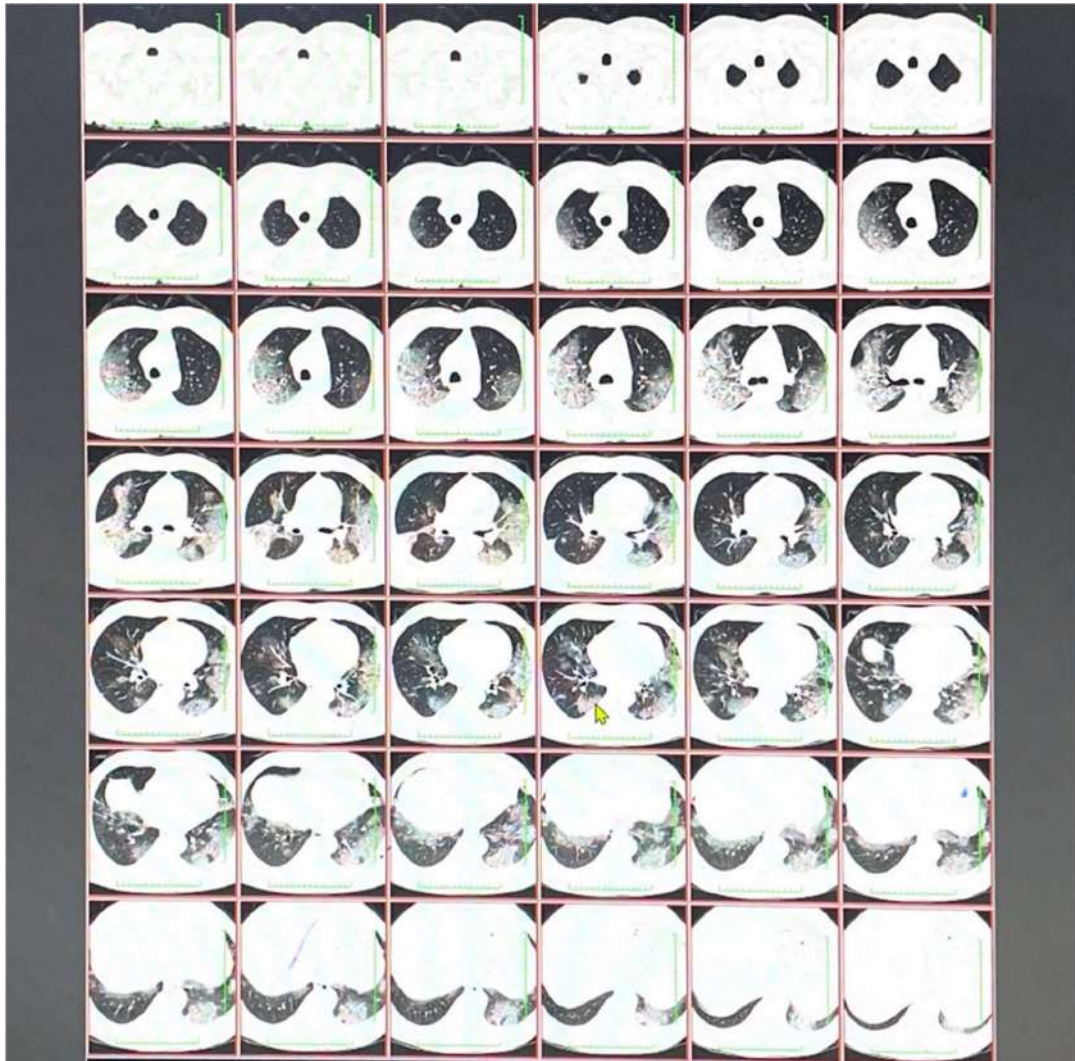All the above cases are negative for RT–PCR COVID

Figure 1. HRCT chest

Figure 2. HRCT CHEST - Both lungs show diffuse ground glass opacities with smooth interlobular and interseptal reticular thickening noted with upper to lower lobe gradient and subpleural region. Mild bronchiectatic changes with peri bronchial wall thickening in both lungs

Discussion

The first case of COVID 19 in India was reported on January 30th, 2020. Subsequently in the next month two more cases have been reported from India. Major number of cases were reported from Maharashtra, Tamil Nadu, Delhi, Gujarat [1]. ICMR mentioned the cases reported form India are mostly asymptomatic or mild [2]. About 80–85% of deaths in COVID 19 are reported in patients with comorbidities like hypertension, diabetes mellites, renal and cardiovascular diseases. The mortalities differ from nation to nation ranging from 0.7 to 10% [3].

Treatment include use of remdesivir, molnupiravir, ritonavir. The use of dexamethasone therapy is also recommended. Bronchodilators, mucolytics and airway supportive measures like NIV ventilation, invasive ventilation if needed. Convalescent plasma can be tried.

Monitoring D - dimer levels and prophylactic anticoagulation is recommended [4].

Total deaths due to covid can never be determined. Studies stated that total deaths due to COVID 19 are about 7 times more than that were reported officially [5].

Many adoptive mutations are now recently found in COVID 19 making it more deadly and resistant to newer therapeutic agents [6]. Many researchers even stated that Covid will be never be completely disappearing and people must learn to live with it [6].

Conclusion

We present a series of cases that presented and complicated like COVID 19 even though they are RT – PCR negative for the same. Despite the popular assumption that COVID 19 has been ended, we doubt that COVID 19 is still existing among us. Cases that present as pneumonitis with the classical radiological features on HRCT - chest which require ICU admission must be tested for covid and managed aggressively. Preventive measures should be taken to decrease transmission among the contacts. Public should be educated regarding the existence of Covid among us.

Statements and declarations
Conflicts of interest
The authors declares that they do not have conflict of interest.

References
1. Ministry of Health and Welfare, Government of India. COVID-19 India. Accessed June 9, 2020
2. ICMR. Published April 20, 2020. Accessed April 30, 2020.
3. Omer SB, Malani P, del Rio C. The COVID-19 pandemic in the US: a clinical update. JAMA. [published online April 6, 2020]. doi: 10.1001/jama.2020.5788
4. Cascella M, Rajnik M, Aleem A, et al. Features, Evaluation, and Treatment of Coronavirus (COVID-19).
5. Jha P, Deshmukh Y, Tumbe C, Suraweera W, Bhowmick A, Sharma S, Novosad P, Fu SH, Newcombe L, Gelband H, Brown P. COVID mortality in India: National survey data and health facility deaths. Science. 2022 Feb 11;375(6581):667-671. doi: 10.1126/science.abm5154.
6. Aleem A, Akbar Samad AB, Vaqar S. Emerging Variants of SARS-CoV-2 and Novel Therapeutics Against Coronavirus (COVID-19). 2023 May 8. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.

CASE REPORT

An uncommon presentation of gastric lymphoma in young male patient: mimicking acute necrotizing pancreatitis clinically and on blood investigations

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Abstract

Primary gastric lymphoma is considered most common primary type of extra-nodal non-Hodgkin's lymphoma and constitutes approx. 5% of total gastric malignancy. As the clinical symptoms of gastric lymphomas are nonspecific, diagnosis of gastric lymphoma is often difficult clinically. This case report presents a case of non-Hodgkin lymphoma which presents clinically and on blood investigations as acute necrotizing pancreatitis. This case is being prepared in view of its rarity and also to alert the treating physicians to consider underlying gastric lymphoma as an uncommon cause in some unexplained cases of pancreatitis.

Keywords: Gastric lymphoma, Pancreatitis, Non-Hodgkin lymphoma, Diffuse large B-cell lymphoma.

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Introduction

The incidence of lymphoma is on the rise in the last few decades [1]. The increase was observed especially in the extranodal variety of lymphomas [2]. Extranodal lymphoma cases are mostly the non-Hodgkin lymphoma (NHL) of the central nervous system followed by the gastrointestinal and skin lymphomas [3].

Stomach remains the most common extranodal site for non-Hodgkin lymphoma in gastrointestinal tract [4]. Overall, primary gastric lymphoma (PGL) is a n uncommon tumor occurring in 4% to 20% of total NHLs and approximately 5 percent of all primary stomach tumors. PGLs usually occur in patients over 50 years of age, but PGLs can also occur in patients younger than 50 years of age, in which the patients in 20s are also relatively commonly affected. Men are 2 to 3 times more commonly affected then female. Most of the primary gastric lymphomas are B-cell disease; a few are Hodgkin and T cell lymphomas [5].

Marginal zone B-cell lymphoma of mucosa associated lymphoid tissue (MALT) type of lymphoma is seen in approx. 38% of patients of primary gastric lymphomas, while diffuse large B-cell lymphoma (DLBCL) is present in 59% of patients. Other varieties, such as mantle cell lymphoma etc. occur less frequently.

Case Report

A 28-year-old male patient working as executive came to the Emergency Room with chief complaints of non-bilious vomiting, periumbilical abdominal pain and episodic fever from last 5 days. There is history of 3-4 kg weight loss in last month. No history of jaundice or diarrhea or malena. His vomiting was more when patient is in supine position and has been increasing in frequency. The patient denied history of alcohol or smoking abuse. There was no history of any prior surgery or procedure.

On examination it was revealed that he has mild fever (100.8°F). The fever is not associated with chills and rigors. Blood pressure was 124/84 mmHg, pulse rate of 105 beats per minute – slightly raised, and respiratory rate of 20 breaths/min. There was no pallor, icterus, lymphadenopathy, clubbing or cyanosis. Examination of other system did not reveal any abnormality.

His hemogram revealed slight elevation of WBC count (10500 per cumm), however rest of the hemogram, liver profile including SGPT, SGOT, bilirubin and thyroid function tests were absolutely normal. C-reactive protein (75 mg/L) and serum LDH were significantly raised. His serum lipase was significantly raised (800 U/L) and hence clinical diagnosis of pancreatitis was made. Rest of the blood investigations including RFT, Dengue profile and Typhoid profile was unremarkable.

Subsequently USG of Abdomen was performed, it showed large heterogeneously hypoechoic lesion in lesser sac area abutting stomach and liver with head and body part of pancreas not seen separately from the lesion. Tail region of pancreas was normal. There was intraluminal sludge in gall bladder. Right sided pleural effusion and mild ascites were present with areas of echogenic mesentery. Liver was normal otherwise, no evidence of any obvious extension or any other focal lesion was there. Gall bladder did not reveal any pathology. IHBR and CBD were non-dilated, no evidence of any calculus in common bile duct. Hence possibilities like pancreatic mass, acute necrotizing pancreatitis and large lymphnodal mass were suspected on USG. However with correlation of clinical, laboratory and USG findings primary diagnosis of acute necrotizing pancreatitis was made by clinician (Figure 1).
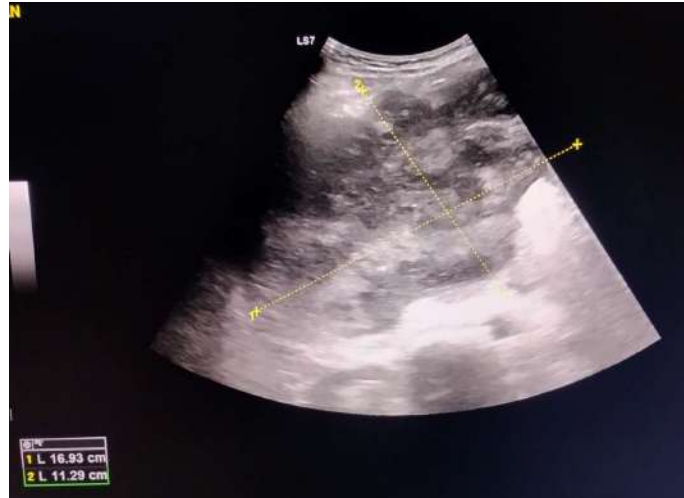
Figure 1. USG image showing heterogeneously hypoechoic mass lesion in lesser sac area, pancreas cannot be differentiated from lesion

After 2 days CT scan with contrast was performed, it showed gross thickening of wall of body and pylorus of stomach causing mild luminal narrowing. It showed significant exophytic extension, more towards posterior side with significant contrast enhancement. Soft tissue mass was indistinguishable from body of pancreas. Severe stretching of common hepatic and splenic arteries were noted at origin. Left gastric artery was supplying the mass and completely encased by it and markedly enlarged. Mesenteric engorgement was present. Mild ascites and right pleural effusion also seen. The findings are suggestive of gastric lymphoma with exophytic extensions (Figure 2).
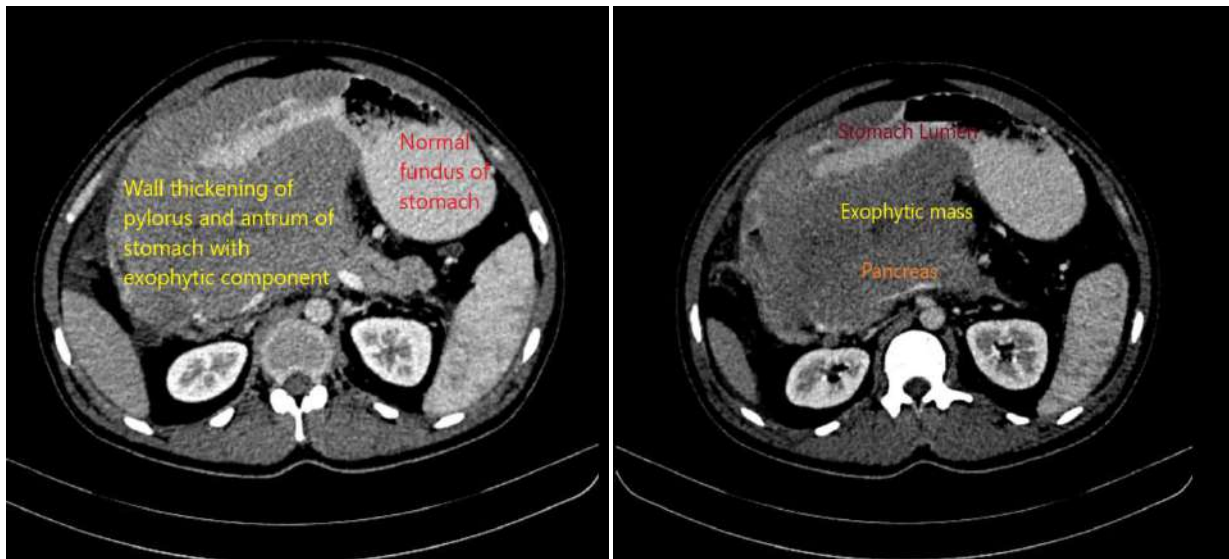
Figure 2. Post-contrast CT axial and coronal Image showing circumferential slightly irregular wall thickening of stomach with large exophytic component, loss of fat plane can be seen with head and body of pancreas. Fundus of stomach and tail of pancreas is normal

Hence upper GI scopy and biopsy were performed, which revealed high grade diffuse large B-cell lymphoma (DLBCL) on HPE. PET study was done subsequently which did not reveal any other lymph nodal mass or any other metastatic pathology. However, there was significant uptake of radiotracer in the lesion in PET study.

Discussion

Primary gastric lymphoma has vague and unpredictable clinical presentations and often presents with nonspecific abdominal pain or dyspepsia. Symptoms like fever, night sweats, weight loss may or may not be present. As clinically it is often difficult to predict, imaging or scopy remains the mainstay for diagnosis. As our patient presented with clinical features mimicking pancreatitis with significantly elevated lipase levels, it prompted for CT

abdomen that showed diffuse stomach wall thickening with large exophytic component obliterating head and body of pancreas accounting for features of pancreatitis clinically.

Acute pancreatitis as a complication of pancreatic adenocarcinoma is much common. It is mostly due to obliteration of pancreatic duct by the tumor, tumor microembolisation causing ischemia, tumor related hypercalcemia etc. There are only few reported cases in literature of acute pancreatitis as initial presentation of pancreatic lymphoma or nodal non Hodgkin lymphoma [6]. Endoscopic ultrasound is another modality which is helpful in assessing such cases with regards to better assessment, higher sensitivity as well as reduced possibility of seeding the tumor while doing needle cytology [7]. Symptoms of primary gastric lymphoma are often nonspecific until and unless it exerts mass effects on adjacent structures like pancreatic duct, common bile duct

or even duodenum, so diagnosis is often delayed and management become difficult.

Presentation as acute pancreatitis of primary gastric lymphoma is much less common, infact only few cases has been noted in the literatures. In our case, features of pancreatitis could be due to pancreatic side duct obliteration by direct extension or compression which cannot be identified on USG or even CT scan. Absence of significant peri-pancreatic fat stranding and any obvious intra-pancreatic collection rules out primary pathology of pancreas to major extent. CT scan abdomen is not routinely done in patients with pancreatitis unless there is uncertainty in diagnosis or any developing or established complications. However, significant index of suspicion is needed to look for uncommon causes like we have in our case.

Conclusion

Acute pancreatitis can become an uncommon presentation of primary gastric lymphoma (high grade DLBCL in our case) and in that case appropriate detailed evaluation can make much earlier diagnosis of primary pathology and hence early management as in our case. Therefore, in some unexplained cases of pancreatitis suspicion of primary gastric lymphoma should be kept in mind.

Conflict of interest

The authors do not have any potential conflict of interest

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References

1. Ghai S, Pattison J, Ghai S, O'Malley ME, Khalili K, Stephens M. Primary gastrointestinal lymphoma: spectrum of imaging findings with pathologic correlation. Radiographics 2007; 27:1371-88

2. Chiu B, Weisenburger D. An update of the epidemiology of non-Hodgkin's lymphoma. *Clin Lymphoma*. 2003;4(3):161–168.

3. Devesa S, Fears T. Non-Hodgkin's lymphoma time trends: United States and international data. *Cancer Res*. 1992; 52(suppl 19):5432s–5440s. [PMID: 1394149].

4. Ghimire P, Wu GY, Zhu L. Primary gastrointestinal lymphoma. *World J Gastroenterol*. 2011;17(6):697–707.

5. Herrmann R, Panahon AM, Barcos MP, et al. Gastrointestinal involvement in non-Hodgkin's lymphoma. *Cancer*. 1980;46(1):215–222.

6. Saif MW, Khubchandani S, Walczak M. Secondary pancreatic involvement by a diffuse large B-cell lymphoma presenting as acute pancreatitis. World J Gastroenterol 2007;13: 4909-11

7. Miljkovic' M, Senadhi V. Use of endoscopic ultrasound in diagnosing plasmacytoma of the pancreas. JOP. 2012 Jan 10;13(1):26-9.

CASE REPORT

A Rare Case of Paratesticular Leiomyoma Presenting as an Inguinal Hernia

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Abstract
Leiomyomas are rare, slow growing benign tumors originating from smooth muscle cells which can involve any region of the body. The presentation of leiomyoma in paratesticular region is very rare. Ultrasound imaging is variable and not specific in paratesticular pathologies. The treatment modality for paratesticular leiomyoma is simple excision, eliminating the need for orchiectomy. Here we present a case of paratesticular leiomyoma which presented with symptoms mimicking inguinal hernia.

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Introduction

All the scrotal pathologies are classified as intratesticular or paratesticular pathologies. Lipoma, adenomatous, leiomyoma, fibroma, hemangioma, neurofibroma and cystadenoma are the types of non malignant Paratesticular tumours. Leiomyoma is not a commonly found tumor. The incidence is also less [1,4].

Leiomyomas generally present as asymptomatic painless scrotal mass. But the presentation of a painful mass is very rare. This tumor has no age specific characteristics. There is a probability of this tumor being malignant. Hence surgical exploration and histopathological confirmation is needed.

Case Presentation

A 40 year old gentleman with no comorbidities presented with occasionally painful left-hemiscrotal mass since 9 years. On examination, the patient is conscious, alert and moderately built. On examination of the groin a non-tender mass in the left hemiscrotum, which was soft in consistency. No cough impulse was present and we could get above the swelling. Right testis was found to be normal. There was no regional lymphadenopathy.

A scrotal Doppler was done which showed omental herniation into the left inguinal region reaching till the base of the scrotum and vascularity was seen. After pre anesthetic evaluation the patient underwent diagnostic laparoscopy. intraoperatively all the hernia orifices were found to be normal and there was no defect seen. Hence we proceeded with an open groin exploration in view of the possible scrotal mass (Figures 1 and 2).

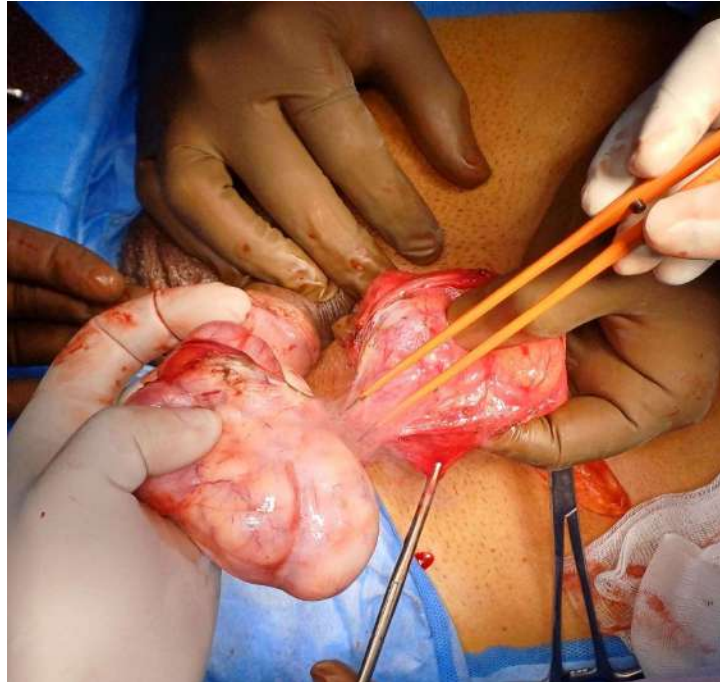Figure 1. Scrotal doppler showing the left epididymis

Figure 2. Intraoperative Image of the Left Testis and the Paratesticular Mass

There was a 7*5cm well encapsulated scrotal swelling near to Left testicle was normal and separate from the mass. On cut section the mass was fleshy and greyish white. The mass was sent for histopathological evaluation [1].

He tolerated the procedure well. After the surgery patient has no complaints. Hence he was discharged the next day after surgery. Histopathological report came out to be leiomyoma with cystic degeneration and no capsular invasion present.

Discussion

Epididymis, tunica albuginea, tunica vaginalis and vestigial remnants comprise the paratesticular region [4]. Paratesticular leiomyomas are most commonly present in middle-aged and elderly males, with average age at diagnosis being 50 years as per review of reported cases. The most uncommon tumor of the male genital tract is leiomyoma. It accounts for 7% of all intrascrotal tumors.

It is a slow growing tumor and mostly asymptomatic. Here leiomyoma was an incidental finding in the testicular exploration via the laparoscopic approach in view of inguinal hernia. Leiomyomas originate from subcutaneous smooth muscles and tunica dartos. Under the microscope, the tumor consists of smooth muscle cells admixed in interlacing bundles; sometimes it contains hyalinized connective tissue component [4]. As in our case it can appear as swelling that has been isolated in the paratesticular region,

Leiomyomas are difficult to diagnose using ultrasonography. These kind of tumors do not require a radical surgery and mere excision of the same would suffice for complete cure. Radical orchidectomy is performed only in patients suspicious of malignancy or the swelling is inseparable from the testicle.

Conclusion

leiomyoma is a rare benign pathology, which is difficult to diagnose but surgical excision provides complete treatment [5].

Conflicts of interest

The authors declares that they do not have conflict of interest.

Funding

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REFERENCES:

1. Irsayanto D, Azmi YA, Rahman IA, Soebadi DM. Paratesticular leiomyoma mimicking an inguinal hernia: A rare case report and literature review. Int J Surg Case Rep. 2022 Sep;98:107580. doi: 10.1016/j.ijscr.2022.107580.

2. Ekenci BY, Kokurcan A, Durak HM, Doğan AE, Sarı H, Yalçınkaya F. Paratesticular Leiomyoma; A Rare Case Report. Bulletin of Urooncology. 2022 Dec 1;21(4).

3. Fernandez A, Krishnamoorthy S, Muralitharan S, Johnson T, Ramanan V. Bilateral Synchronous Paratesticular Leiomyoma - A Rare Entity. J Clin Diagn Res. 2017 Apr;11(4):PD05-PD06. doi: 10.7860/JCDR/2017/25109.9518.

4. Akbar SA, Sayyed TA, Jafri SZ, Hasteh F, Neill JS. Multimodality imaging of paratesticular neoplasms and their rare mimics. Radiographics. 2003 Nov;23(6):1461-76.

5. Egharevba PA, Omoseebi O, Okunlola AI, Omisanjo OA. Scrotal leiomyoma: a rare cause of scrotal swelling. African Journal of Urology. 2020 Dec;26(1):1-4