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ORIGINAL ARTICLE

A prospective observational study of impact of body mass index on early postoperative complications following abdominal surgeries

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Abstract

Aims & Objectives: To determine the effect of higher BMI on early postoperative complications following abdominal surgeries and to assess whether the higher BMI has **positive / neutral / negative effect** on early (30 days)post-operative complications following abdominal surgeries.

Materials and methods: A prospective, single-centre, observational study conducted on 86 patients who underwent abdominal surgeries both open and laparoscopic, in emergency or elective procedure over a period of 1 year. Patients were categorised into 2 groups (body mass index (BMI) >25 kg/m2-overweight and patients with BMI < 25 kg/m2 - normal weight). Patients were followed till 30 days post-surgery.

Results: Most common post-surgery complication is observed to be seroma formation, which was more common in higher BMI patients.(12.19%).Other complications common in higher BMI were wound infection (4.44% in normal weight and 4.8 % in higher BMI),intestinal obstruction (2.22% in normal weight and 4.8% in higher BMI).Pulmonary complications(4.44%), re-exploration(4.44%),readmission, fever(2.22%), mortality and AKI (2.22%) were found to be more common in normal weight individuals.

Conclusion: There was no significant difference found in early post-operative complications following abdominal surgeries of patients in normal weight and higher BMI category. Higher BMI had effect only on the wound related complications.

Keywords: Body mass index (BMI -kg/m2), early (30 days) post-operative complications, abdominal surgeries, obesity.

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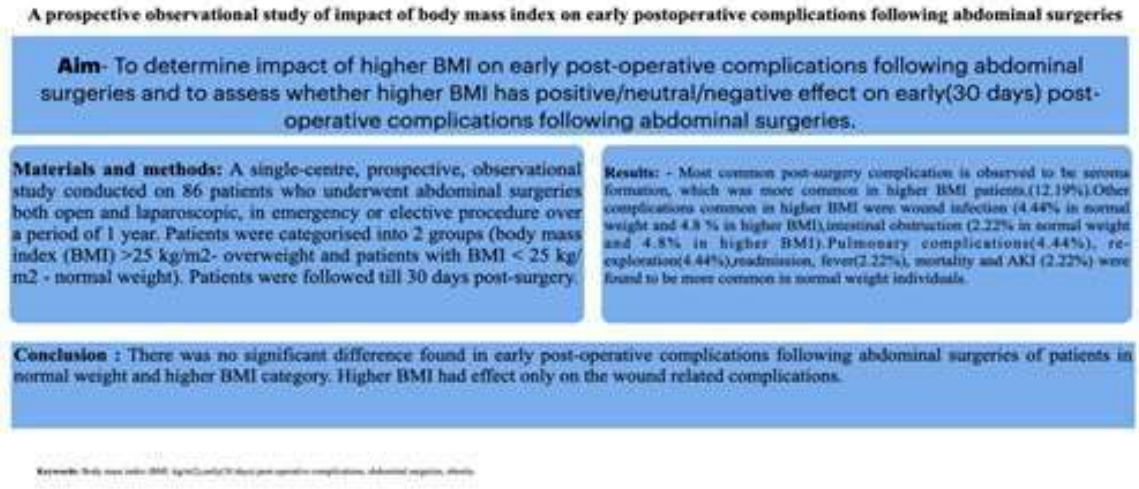
Graphical Abstract



Introduction

We are dealing with weight problems epidemic. An international estimate of 39% of adults are obese, and 13% are overweight in 2016. There's an extensive variation in occurrence rates of obesity and central obesity in India in line with ICMR-INDIAB study in 2015, and these rates vary from 11.8% to 31.3% and 16.9%–36.3%, respectively [1].

A higher BMI is considered one of the leading reasons for morbidity and mortality within the US [2]. A study expected that morbidity and complications related to higher BMI value $11 billion each year [3]. As our population has come to be more overweight, this value has expanded. Specialists foresee that by 2030 about half of the overall population is going to be obese, with 11% qualifying as morbidly obese [4].

Obesity is defined as an abnormal accumulation of fat such that fitness is impaired (WHO). Commonly, it's far assessed using the body mass index (BMI). Common techniques to determine the amount of adiposity include body mass index (BMI), waist circumference, skin folds, bioelectrical impedance evaluation, dual-strength x-ray absorptiometry (DEXA), computed tomography (CT), and magnetic resonance imaging (MRI) [5]. Historically, obese or obese status has been evaluated through an anthropometric weight-for-height measurement. It's recognized that weight problems are associated with various diseases like diabetes, cardiovascular sicknesses, and cancers like colon most cancers [6]. There are various factors that affect the result of surgery and its postoperative complications like related comorbidities, immunocompromised popularity, and infections. Higher BMI patients have an elevated occurrence of a respiratory disorder, type-2 diabetes, and oesophageal reflux. In addition, they have a difficult airway, more postoperative complications, and tough local anaesthesia [7,8]. For this reason, medical professionals and anaesthesiologists want to understand the perioperative implications of those serious problems in higher BMI sufferers. Weight problems end in excessive expenses due to postoperative complications related to excess weight. These complications call for similar interventions and longer medical institution stays. Higher rates of wound infection and surgical site infections (SSIS), hospital stays,

and readmissions may be attributed to obesity [9-13].

By understanding the postoperative complications which are related to obesity we are able to recommend and search for options to enhance their recovery and decrease complications they may experience. Moreover, within the era of recent healthcare reform, knowledge of which complications are more likely within the overweight or morbidly obese patient is of interest, giving us plans to switch rates for services on the concept of health centre-acquired complications [14].

With the upward push in minimally invasive surgical procedures and advances in medical and surgical control, perioperative complications and loss of life are rarer. But, whilst complications occur, they will delay adjuvant therapy (if any are required), create enormous tension, and generate extra expenses. This study is ambitious to analyse the affiliation of body mass index (BMI) with 30-day morbidity and mortality following abdominal surgeries.

Material and methodology

A single-centre, prospective, observational study conducted on 86 patients who underwent abdominal surgeries both open and laparoscopic and in emergency or elective procedure over a period of 1 year.

Inclusion criteria:

1) Patients of age >18 years
2) Patients undergoing emergency and elective abdominal surgery(both open or laparoscopic) within the study period
3) Patients giving consent for surgery.

Exclusion criteria

1) Patients primarily for gynaecological or urology operations or polytrauma patients
2) Patients undergoing open inguinal hernia surgery.
3) Patients who are undergoing day care surgeries under local anaesthesia
4) Patients in whom height or weight is not available and/or cannot be measured due to the disease condition of the patient.
5) Patients with immunocompromised status such as HIV, primary or secondary immunodeficiency disorders, patients who are on steroids(oral or systemic)for more than 7 days or immunosuppressant drugs, post organ transplant patient who are receiving immunosuppressant drugs.
6) Patients lost to 30 days post-operative follow up.

Baseline characteristics of patients were noted on a predefined proforma on admission. Patients were categorised into 2 groups (body mass index (BMI) >25 kg/m2- overweight and patients with BMI < 25 kg/m2 - normal weight).Both groups underwent surgery by an experienced surgeon. All the patients were followed up for 30 days for post op complications.

Information was gathered about the patient's medical history such as pulmonary, cardiac or cerebrovascular disease, diabetes, hypertension, any malignancy, and height and bodyweight The Body Mass Index (BMI; kg/m2) was recorded. At discharge, the patients were given an information sheet to assess post-operative complications within 30 days of discharge. Patient were asked to fill up the sheet at 30 days post- operative and share it's copy on email or phone. Contact details were mentioned in the sheet along with the date on which the sheet has to be shared and consent for the same will be taken during primary consent. After data collection the findings were noted as per outcome table. Reminder phone call was given twice for the investigation sheet to be submitted back.

Statistical Analysis

Data were analysed using SPSS (Statistical Package for Social Sciences, Version 15.0) package. Data were given as Mean, SD and N for continuous data and Number and Percentage for categorical data. Fisher Exact Probability tests were applied to compare percentages for categorical data between 2 groups. Chi square test was applied to compare percentages of more than 2 groups.

All statistical tests will be two tailed. Alpha (α) Level of Significance was taken as $p<0.05$. S=Significant, NS=Not Significant, DF=Degrees of Freedom and P=Probability value.

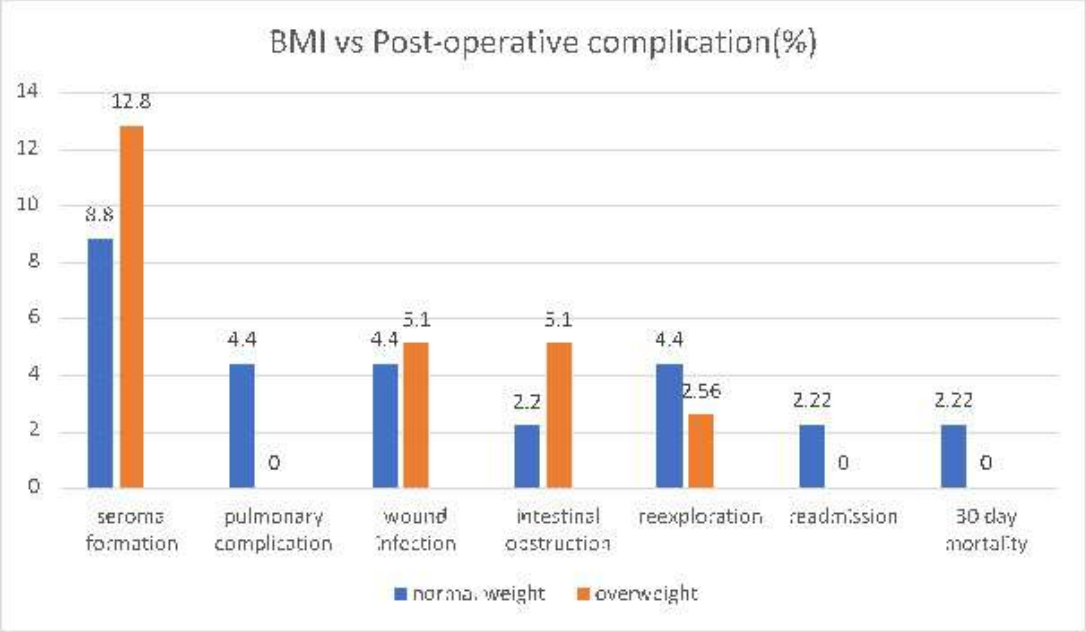
Results and analysis

Table 1. Demographics

	Normal weight (BMI<25 KG/M2)	Higher BMI (BMI>30 kg/m2)	P value
Age years (mean+/-SD)	57.02	57.4	P=0.7
BMI (mean =/-SD)	24.77	25	
Male[n(%)]	25(55.5%)	25(62.50%)	P=0.6
Female[n(%)]	20(44.4%)	16(39.02%)	
No comorbidities	5(11.11%)	7(17.7%)	
Diabetes	22(48.8%)	18(43.9%)	P=0.5
Hypertension	24(53.3%)	17(41.46%)	P=0.4
Heart disease	13(28.9%)	10(24.3%)	P=0.8
Pulmonary disease	9(20%)	6(14.6%)	P=0.8
Malignancy	21(46.7%)	21(51.2%)	P=0.7
Emergency surgery	7(15.5%)	8(19.5%)	P =0.6
Elective surgery	38(84.4%)	33(80.48%)	
Open surgery	32(71.11%)	27(69.23%)	P =0.5
Laparoscopic surgery	13(28.88%)	14(34.14%)	
Smoker	6(13.3%)	8(19.5%)	P =0.4
Non-smoker	39(86.6%)	33(80.48%)	

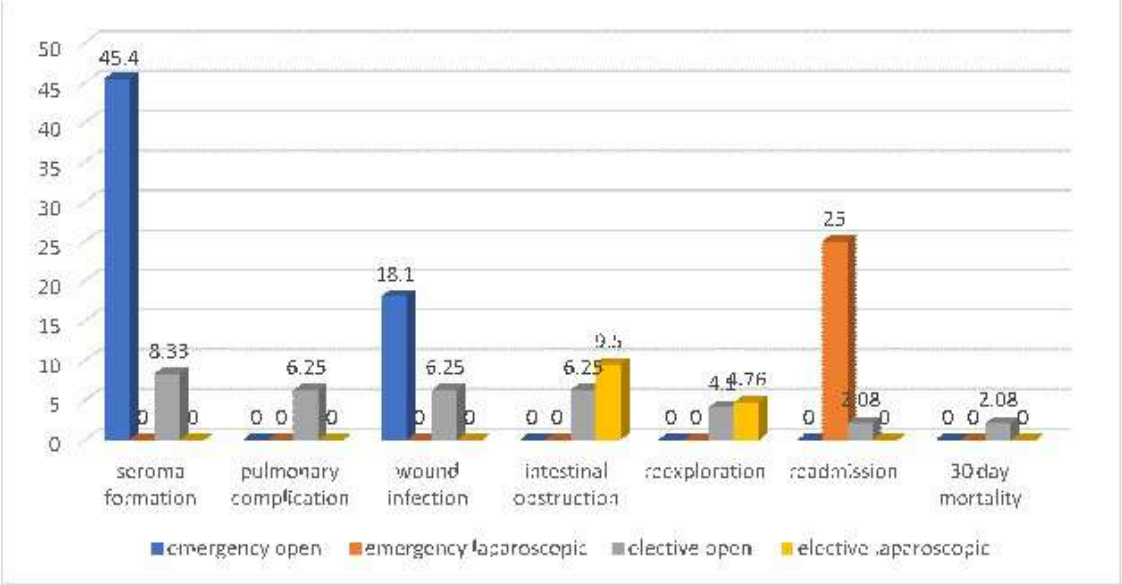
The p value of the above data calculated using chi square test and Fischer's exact probability test as statistical tests were found to have values that were not significant.

Figure 1. Bar diagram depicting association of BMI with post-operative complications



Complications were observed more frequently in patients undergoing emergency open surgeries and the most common complication being seroma formation (45.4%). Readmission rates were observed to be higher in emergency laparoscopic surgeries (25%). Seroma formation and wound infection was more commonly observed in patients undergoing emergency open surgeries.

Figure 2- Bar diagram representing association of post- operative complication with the urgency and type of surgery

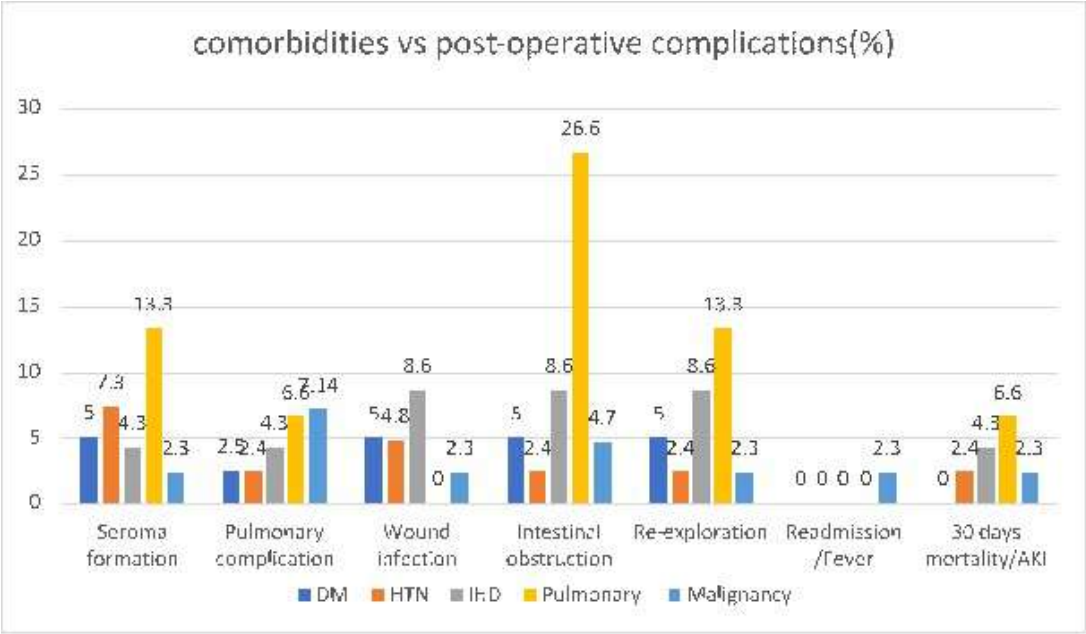


Patients having DM were found to have wound related complications more like seroma formation (5%), wound infection (5%), intestinal obstruction and re-exploration (5%). Patients having malignancy suffers more from pulmonary complications (7.14%). Intestinal obstruction was more common in patients with pulmonary complications (26.6%).

Table 2. Depicting association of post-operative complications with comorbidities

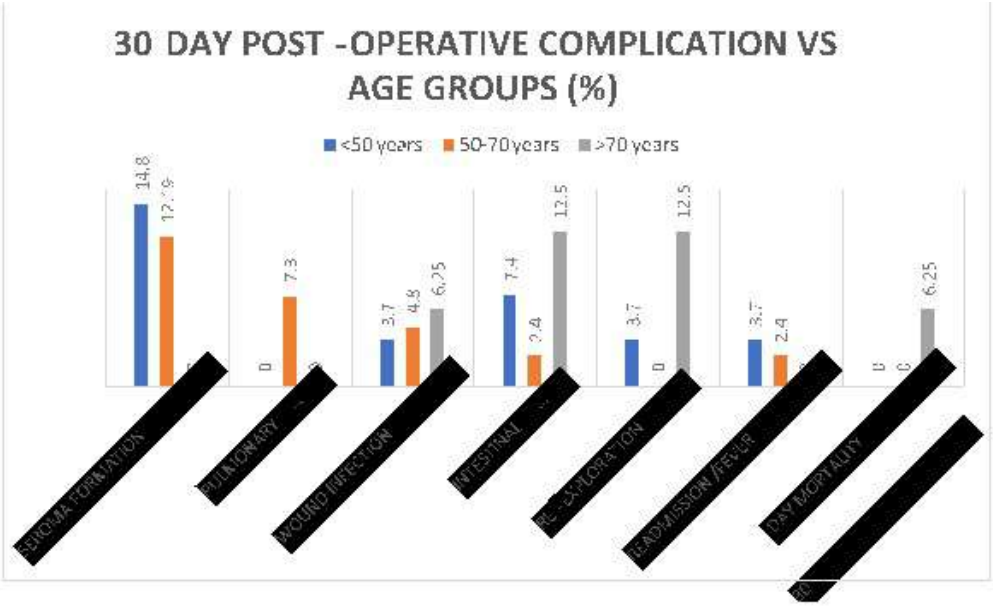
	DM(n=40)	HTN(n=41)	IHD(n=23)	Pulmonary (n=15)	Malignancy (n=42)
Seroma formation n (%)	2(5%)	3(7.3 %)	1(4.3 %)	2(13.3 %)	1(2.3%)
Pulmonary complicatio n	1(2.5 %)	1(2.4 %)	1(4.3 %)	1(6.6%)	3(7.14 %)
Wound infection	2(5%)	2(4.8 %)	2(8.6 %)	0	1(2.3%)
Intestinal obstruction	2(5%)	1(2.4 %)	2(8.6 %)	4(26.6 %)	2(4.7%)
Reexploration	2(5%)	1(2.4 %)	2(8.6 %)	2(13.3 %)	1(2.3%)
Readmission /Fever	0	0	0	0	1(2.3%)
30 days mortality/A KI	0	1(2.4 %)	1(4.3 %)	1(6.6%)	1(2.3%)

Figure 3. Bar diagram representing the correlation of comorbidities with post- operative complications



Post-operative complications were more commonly observed in age group of >70 years like wound infections (6.25%), intestinal obstruction (most common) (12.5%). Re-exploration rates and mortality was also high in patients >70 years age.

Figure 4. Bar diagram representing association of age groups with post-operative complications



It was observed that males developed more post- operative complications as compared to females. Intestinal obstruction was more common in males (8.16%). Females had more propensity to develop wound infections. 30-day mortality was seen in female.

Figure 5. Bar diagram representing correlation between gender and post-operative complications

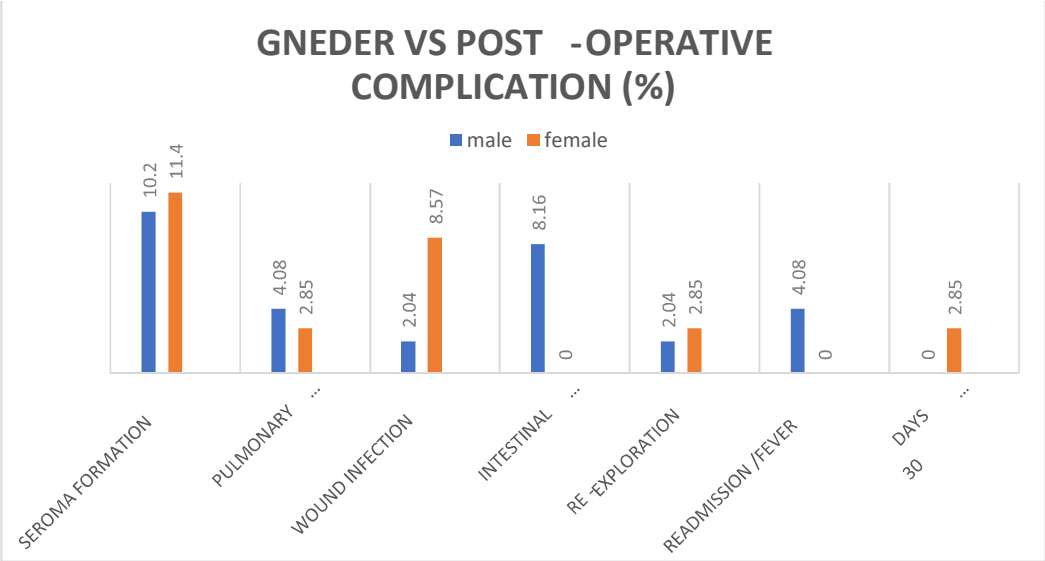


Figure 6. Wound dehiscence along with wound infection in a post- operative patient

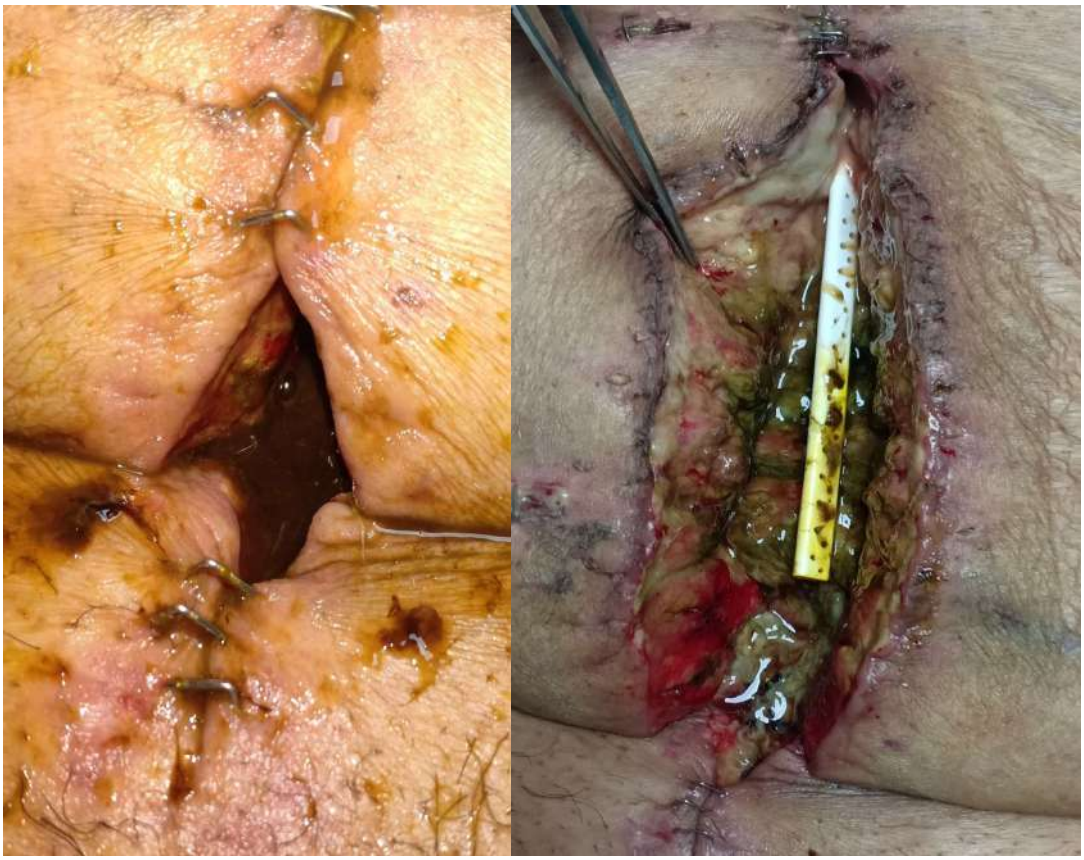


Figure 7. Wound dehiscence post open radical cholecystectomy

Discussion

Obesity is believed to be the risk factor for post-operative complications following surgeries. Although obesity is known to cause medical hazards, recent literature shows conflicting evidences to support this hypothesis. Also, there is an existence of a paradox between body mass index and survival found. This study is designed to determine the impact of higher BMI on early post-operative complications following abdominal surgeries.

This is a prospective cohort study conducted over a period of 1 year.

A total of 86 patients undergoing abdominal surgeries both open and laparoscopic and in emergency or elective procedure during the study period was included in this study. The mean age group in this study is 57.2 years, including 35 females and 49 males. Sex ratio being 1:5(male: female) with a mean BMI of 24.7 kg/m2.

Out of these, around 53.6% patients were found to have normal weight (BMI< 25 kg/m2) and 46.4% patients were found to have higher BMI (BMI>25 kg/m2). When compared to age, median age group studied in this study is 57.2 years. Out of which the mean age belonging to normal weight category is 57.02 years and that belonging to higher BMI category is 57.4 years. There was not significant difference in age and BMI of the patient (p=0.7).

There were many other studies conducted on larger populations and longer duration as follows:

In a retrospective study conducted by Haider Mahdi et al(15) over a period of 6 years from 2005-2011 on a larger population of 3947 found that after surgery for endometrial cancer, 50% of the patients were in the normal weight category and 49% were in the higher BMI category, with a median age of 64.7 years in the normal weight category and 63.1 years in the higher BMI category. Age groups and BMI categories did not differ significantly. Stevens et al. [16] in his study conducted to see association of higher BMI and mortality observed that the association is age- dependent. Mortality was increased in obese adults up to the age of 74, whereas this effect declined in older age. Calle et al. [17] conducted a similar study to see association of higher BMI with age group found that the risk of death from all causes increases throughout the range of moderate and severe obese . He found an U-shaped association between higher BMI and age groups, with an increased risk in the lowest and highest percentiles of the distribution. Landi et al. [18] studied 18,316 patients to identify the relationship between age, BMI, and mortality. They found that death rates increased at the lowest and highest BMI rankings in younger patients. Galanos et al. [19] studied critical care patients to find similar association between higher BMI and age group nut could not reproduce the U shaped curve. His study suggested a protective effect with BMI>30 kg/m2 probably due to the increased nutritional reserve which the higher BMI patients had. However, this study was performed on patients with medical conditions, not surgical.

In the present study, there are 55.5% of male belonging to normal weight category and 64.10% males belonging to overweight category. On the other hand, among females, 44.4% are normal weight and 35.8% are overweight in this study (p value=0.5).

When BMI was compared to comorbidities, HTN was more common among normal weight individuals i.e., 53.3% whereas malignancy was more common among higher BMI patients i.e., 53.8%. Although other comorbidities had no significant difference in normal weight and higher BMI patients. Their p values were as follows-

DM (p value= 0.5), HTN (p value=0.4), IHD (p value=0.8), pulmonary condition (p value=0.8), malignancy (p value= 0.7)

The comorbidities in the present study are more common in age group of 50-70 years, DM being the commonest 6.5%

Al Muhim et al. [20], in 2014 conducted a review of literature on obesity disease and surgery.

In that he states effect of various general disease associated with obesity as follows-

Diabetes mellitus- Obesity is highly associated with development of type 2 DM among all ages. This may be because of the common association between obesity and metabolic syndrome, impaired fasting glucose, and impaired glucose tolerance.

Hypertension - Generalized and central obesity increase the risk of arterial hypertension. As high blood pressure and impaired glucose tolerance are associated with obesity, it has been suggested that hyperinsulinemia could represent one of the pathogenic connection between obesity and

arterial hypertension. Age, race, and sex may alter the frequency of hypertension in obese patients.

Heart Diseases-Obesity is considered a risk factor for coronary artery disease, heart failure, and atrial fibrillation. It is more prevalent in females as compared to males. Obesity has a strange association with heart failure that is called obesity paradox (as well as other diseases). It can result in systolic and diastolic dysfunction, on the other hand, obese patients with heart failure have better clinical outcomes in comparison to patients with normal BMI. Obesity has also higher risk for atrial fibrillation incidence, recurrence, and poor prognosis.

Respiratory Diseases-Obesity is a risk factor for several respiratory diseases like obstructive sleep apnoea and bronchial asthma. Obesity also has a significant impact on bronchial asthma risk, severity, and control.

Malignancies-Obesity is associated with higher cancer incidence, recurrence, progression, and death. It can be responsible for the following cancer types:

(1) gastrointestinal system
(2) hepatobiliary system
(3) breast malignancy
(4) endometrial , ovarian, cervical malignancy
(5) lung malignancy
(6) skin malignancy
(7) multiple myeloma
(8) leukaemia

The increased risk of cancer mortality associated with an elevated BMI is significant at levels above 30 kg/m2.

In this study, maximum overweight patients underwent emergency surgeries (20.5%) whereas normal weight patients underwent elective surgeries more (84.4%). Also, open abdominal surgeries were preferred for both normal weight (62.2%) and overweight patients (51.28%) in cases of elective surgeries. Overall, in case of emergency laparoscopic approach was preferred irrespective of BMI status.

Open approach is also popular in elective surgeries in both normal weight and higher BMI individuals in cases of elective surgeries depending on the complexity of the procedures to be performed.

In this study, the mean length of hospital stay was 9.4 days for normal weight patients and 8.7 days for higher BMI patients. The length of hospital stays as observed in this study was more in patients undergoing open surgeries as compared to patient undergoing laparoscopic surgeries. Patients undergoing laparoscopic surgeries had faster recovery and less hospital stay.

In other studies, findings related to length of hospital stay was as follows:

In a study conducted by Klassen et al. [21] the mean length of hospital stay post- surgery was 17.7 days in normal weight individuals and 21.2 days in higher BMI patients.

Similarly, in study of Haider Mahdi et al. [15] (3.4 days in normal weight and 6.5 days in higher BMI individuals) and J T Mullen et al. [22,23] (13.5 days in normal weight and 10.3 days in higher BMI individuals), the mean length of hospital stay was more in higher BMI patients.

In the study conducted by Tjeertes et al(24), the mean length of hospital stay was more in normal weight patients i.e., 10 days in normal weight individuals and 4 days in higher BMI patients.

Postoperative complications-

In present study, most common complication that occurred post-surgery is observed to be seroma formation that is more common in higher BMI patients. (12.8%) (p value=0.6)

Other complications like, wound infection (no significant difference found) 4.44% in normal weight and 5.1 % in higher BMI. Intestinal obstruction is found to be more common in higher BMI individuals (2.22% in normal weight and 5.1% in higher BMI). Pulmonary complications (4.44%), re-exploration (4.44%), readmission and fever (2.22%), mortality and AKI (2.22%) were found to be more common in normal weight individuals as compared to higher BMI individuals.

In a retrospective study conducted by Haider Mahdi et al. [15] in 2005-2011 to study impact of obesity on 30-day morbidity and mortality after surgery for endometrial cancer had following findings related to post-operative complications: Morbidly obese patients were at significantly higher risk of surgical site

infection (8.8% vs 3.3%; p = 0.001) and wound disruption (2.4% vs 0.6%; p= 0.001) than were normal weight patients. However, no difference was found between obese and normal weight patients for risk of SSI (4.6% vs 3.3%) or wound disruption (0.6% vs 0.6%). No difference between groups was found in the rate of septic shock [normal weight (0.3%); obese (0.3%); morbidly obese (0.4%)], or pneumonia [normal weight (0.7%); obese (0.9%); morbidly obese (1.1%)]. The risk of sepsis was significantly lower in obese patients compared with those of normal weight (0.7% vs 1.7%; p = .02), with no difference between normal weight and morbidly obese patients (1.7% vs 2%; p = .59). They concluded that morbidly obese females experienced more SSI and wound disruption. There was no difference between BMI groups in relation to hospital stay, surgical re-exploration, 30-day mortality.

Tjeertes et al. [24] conducted a single center prospective studies in 4293 patients over a period of 6.3 years and analyzed impact of bodyweight on postoperative morbidity and mortality using multivariate and univariate regression models. Obese patients required a longer operation time ($p < 0.001$), was associated with more intraoperative blood loss ($p < 0.001$) and higher rates of surgical site infection ($p < 0.001$). Underweight patients also had higher rates of complications than normal weight patients. Complication grades were different between groups, with more non self-limiting (>grade 1) complications in the underweight (25 %), overweight (16.9 %) and the obese (20.7 %), com- pared to (14.2 %)in normal weight patients (overall p-value $p < 0.001$).

They concluded that underweight patients have higher complication rates as compared to normal weight patients. Obesity is a significant risk factor for surgical site infection, more surgical blood loss and longer operation time. They found that incidence of surgical site infection increases with an increase in BMI.

John T Mullen [22,23], in 2008 conducted a similar study to study impact of body mass index on perioperative outcomes in patients undergoing major intra-abdominal cancer surgery on 2258 patients over a period of 4 years. It was a prospective, multi-institutional, risk adjusted cohort study on patient undergoing major intra-abdominal cancer surgery. Their findings regarding post-operative complications were as follows:

The mean total length of hospital stay was 13.5 for underweight group and 10.3 for higher BMI group but this difference was not statistically significant (p=0.95). The rate of return to operating room and major complications also had no significant difference. There was no significant difference in rates of systemic infection like respiratory, urinary tract, central nervous system, cardiovascular amongst BMI classes.

In their study they concluded that obesity can be considered as risk factor for wound infections only. Other complications were more frequently observed in underweight group of patients. Rate of reoperation was also more in underweight patients. Mortality rates were also increased among underweight as compared to higher BMI patients.

In a study conducted by Bamgbade et al. [25], to study postoperative complications in obese and nonobese patients in 2006 also concluded that, obese patients have higher risk of myocardial infarction, wound infection, nerve injury and urinary tract infection. Obesity is an independent risk factor for perioperative morbidity.

In this study, the effect of other factors like type of surgery (emergency or elective), age, sex, comorbidities on post-operative complications are also studied to rule out confounding factors. The results were as follows:

The complication of seroma formation was more common in open surgical approach (45.4%). There is no significant difference in other complications like pulmonary complication, readmissions. Overall, most complications are common in open surgical approach rather than laparoscopic. Wound infections were also common in open surgical approach. Complication was intestinal obstruction was more common in laparoscopic approach.

Patients having DM were found to have wound related complications more like seroma formation (5%), wound infection (5%), intestinal obstruction and re-exploration (5%). Patients having malignancy suffers more from pulmonary complications (7.14%). Intestinal obstruction was more common in patients with pulmonary complications (26.6%). Post -

operative complications were more commonly observed in age group of >70 years like wound infections (6.25%), intestinal obstruction (most common) (12.5%). Reexploration rates and mortality was also high in patients >70 years age .When compared to sex of patient, it was observed that males were more frequently associated with postoperative complications. Females had more tendency to develop wound infections (75%). Male had intestinal obstruction as most common complication.

Conclusion

The present examination is an observational potential cohort taking a look at concerning 86 sufferers who underwent abdominal surgical procedures both open and laparoscopic and in emergency or optionally available manner conducted over a length of 1 year. Based on facts and consequences acquired in the present observation, the subsequent conclusions are obtained:

- there has been no full-size difference found in early post-operative complications following abdominal surgical procedures of sufferers in normal weight and higher BMI categories.
- overweight patients have been more common in age group of 50-70 years.
- whilst categorized as in keeping with BMI, normal weight patients had greater comorbidities consisting of dm, htn, ihd, pulmonary circumstance except for malignancy which was common in higher BMI group.
- most comorbidities had been determined in age organization of 50-70 years, out of which dm is most common. Malignancy is more commonly found in age group of <50 years.
- Maximum higher BMI patients underwent emergency surgeries whereas normal weight patients underwent elective surgeries more.
- Open abdominal surgeries were preferred for both normal weight and higher BMI patients in cases of elective surgeries . Overall, in case of emergency laparoscopic approach was preferred irrespective of BMI status.
- Maximum time spent in the hospital was within the range of 5-10 days.

BMI of the patient did not affect the length of hospital stay.

- When compared to type of surgery, patients who underwent open surgeries had maximum length of hospital stay as compared to laparoscopy. Patients undergoing laparoscopic surgeries had faster recovery and less length of hospital stay.
- Seroma formation was the most common complication observed in both normal weight and overweight patients. Seroma formation was mostly seen in higher BMI patients followed by wound infection and intestinal obstruction.
- Complications were observed more frequently in patients undergoing emergency open surgeries and the most common complication being seroma formation. Readmission rates were observed to be higher in emergency laparoscopic surgeries. Seroma formation and wound infection were more commonly observed in patients undergoing emergency open surgeries.
- Patients having DM were found to have wound-related complications more like seroma formation, wound infection, intestinal obstruction and re-exploration. Patients having malignancy suffer more from pulmonary complications. Intestinal obstruction was more common in patients with pulmonary complications.
- Post-operative complications were more commonly observed in age group of >70 years like wound infections, intestinal obstruction (most common). Re-exploration and mortality became additionally excessive in sufferers >70 years age
- it is found that males developed more post-operative complications then females.
- intestinal obstruction turned to be more common in men. Females had extra propensity to develop wound infections. 30-day mortality was seen in females.

Conflicts of interest

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

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