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Research Paper

Variation in intra abdominal pressure between obese and non obese patients with umbilical hernias and patients with no abdominal pathologies

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Structured Abstract

Introduction: *Umbilical hernia repair, despite its perceived simplicity, is associated with recurrence between 2.7 and 27%, in mesh repair and non mesh repair respectively.*
Our hypothesis is that raised intra abdominal pressures (IAP) is a significant causative factor for the occurrence of umbilical hernias.

Objectives: *To study the correlation of IAP with BMI and occurrence of umbilical hernia*

Methods: *Patients who consented to the study had multiple measurements of pre operative IAP taken using a manometer via the bladder after instilling 50 ml of normal saline. Other details were taken via a questionnaire and data was analyzed.*

Results: *Variation of IAP at Valsalva between obese and non obese patients (BMI more than 30) in the hernia group was found to be significant with a p value of <0.001 (Mean ± SD = 17.3 ± 1.6)*
Difference in IAP on Valsalva between patients with umbilical hernia and no abdominal pathologies was significant. A ROC curve with a cutoff of 14 was obtained with a sensitivity of 72% and a specificity of 81%.

Conclusion: *Our study showed a significant difference in IAP between patients with umbilical hernia and patients with no demonstrable hernias. Rise in IAP is caused by multiple factors. In our investigation, elevated IAP remained a risk factor for umbilical hernias even though BMI did not. Furthers studies must be done to find the etiology of increased IAP in patients with hernias so that we may aim to actively correct the etiology.*

Keywords: *Intra abdominal pressure, obesity, umbilical hernia, Valsalva manoeuvre.*

Introduction

Umbilical hernias account for approximately 6% to 14% of all abdominal wall hernias in adults, and almost 90% of adult umbilical hernias are acquired.(1)

A significant number of patients have recurrence of the same post surgical repair for the primary hernia. This increases the morbidity and total hospital costs of the patient.

The costs of umbilical hernia surgery in India vary based on the centre and state. On an average, open umbilical hernia repair costs between 30000 to 70000 INR, averaging around 55000 rupees. On the other hand, laparoscopic surgery costs between 40000 to 1 lakh rupees.

If the rates of recurrence can be decreased, it will significantly decrease the costs incurred by the patient and improve quality of life.

The rationale behind the study is to identify a possible causative factor for the disease and address the need for not just a surgical correction, but also a physiological correction for the disease.

Existing literature about the disease lists patient related factors such as ascites, liver disease, diabetes and obesity as predisposing causes of the development of an umbilical hernia.[2] All of these factors indirectly have a correlation with high intra abdominal pressures.

Raised intra abdominal pressures (IAP) is a significant causative factor for the occurrence of umbilical hernias.[3] However, knowledge of the baseline IAP in people with ventral hernias compared to the general population is not clearly defined.

We aimed to remove known causes of raised intra abdominal pressure and then measure intra abdominal pressures in that subset of the study population to assess whether they have a high IAP even in the absence of known risk factors.

Materials and Methods

An observational study was conducted on the patients admitted in the Department of General Surgery in our institute to find the difference between intra abdominal pressures between people with umbilical hernia and people with no abdominal pathologies. Ethical approval was obtained from the institutional review board (IRB number – 143/2022). Individuals aged 18 to 75 years, who were clinically diagnosed with reducible umbilical hernia, were included in the umbilical hernia group. Individuals with complicated umbilical hernia, chronic liver disease, ascites, chronic kidney disease, gastrointestinal malignancies, peritonitis, and previous history of minor and major abdominal surgeries were excluded.

In the group without umbilical hernia, individuals aged 18 to 75 years, who were undergoing evaluation of elective breast and thyroid surgeries, without any abdominal pathology were included. Individuals with any hernia, chronic liver disease, ascites, chronic kidney disease, gastrointestinal malignancies, peritonitis, previous history of minor and major abdominal surgeries were excluded.

Informed written consent was obtained from all participants. Sample size was calculated to be 24, based on study measuring IAP values at rest and on Valsalva in patients with ventral hernias. [4]

Data was collected using a questionnaire. The variables measured were patient height, weight, body mass index (BMI), hip and waist circumference, intra abdominal pressure (IAP) at rest and on doing valsalva. BMI was categorized using the WHO standards. Waist to hip ratio value of 0.9 and below was considered normal for males and a value of 0.8 and below was considered normal for females.

The IAP was measured using a manometer via the bladder, after instilling 50 ml of normal saline. IAP was measured in the supine position after ensuring that abdominal muscle contractions were absent. Transducer was zeroed at the level where the midaxillary line crossed the iliac crest. IAP at resting (IAP resting) was measured at end expiration. IAP during valsalva (IAP valsalva) was measured after the patient performed valsalva manoeuvre. Three measurements of IAP resting and IAP valsalva were taken with 5 minutes interval and the average measurement was taken. Percentage change in IAP on valsalva was calculated as (IAPvalsalva – IAP resting) / IAP resting * 100.

Data was anonymized to maintain confidentiality. Statistical analyses were carried out by using SPSS, version 21.0. Categorical and quantitative

variables were expressed as frequency (percentage) and mean ± SD respectively. Independent t test was used to compare quantitative parameters between categories. Receiver Operating Characteristic (ROC) graphs was plotted and the area under the curve was calculated to assess diagnostic accuracy of IAP in detecting hernia and to assess the optimal cutoff scores. Sensitivity, Specificity, positive predictive value (PPV), and negative predictive value (NPV) and accuracy were calculated for the diagnostic accuracy of IAP in prediction of hernia. For all statistical interpretations, $p<0.05$ was considered the threshold for statistical significance.

Results

From January 2023 to December 2023, 90 patients - 46 males (51.1%) and 44 females (48.9%) - who met inclusion and exclusion criteria were included in the study. Among the 90 patients included, 47 patients had an uncomplicated umbilical hernia. Rest 43 patients were those who underwent evaluation for non abdomen related surgery (25 for thyroid illness and 18 for breast illness).

The mean age of the population in years was 55.89 ± 9.36 (37 -75). Among the population, 7.8% were semi-skilled workers, 38.9% were skilled workers, 43.3% were clerical workers, shop owners or farmers and 10% were semi-professionals. Educational status was high school level in 43.3%, intermediate level in 44.4% and graduate or postgraduate in 12.2%. 4.4% belonged to upper, 37.8% to upper middle, 47.8% to lower middle and 10% to upper lower socioeconomic status.

The mean BMI was 26.39 ± 4.07 kg/m^2 in the population (19.47 – 34.62). 37% of patients had BMI between 25 and 30 kg/m^2. 22% patients had BMI >30 kg/m^2. 52 percent of people had normal waist to hip circumference while 48 percent had high waist to hip circumference. There was a significant positive correlation between waist-to-hip ratio and BMI, $\rho(90)=0.61$, $p<0.001$. (Figure I)

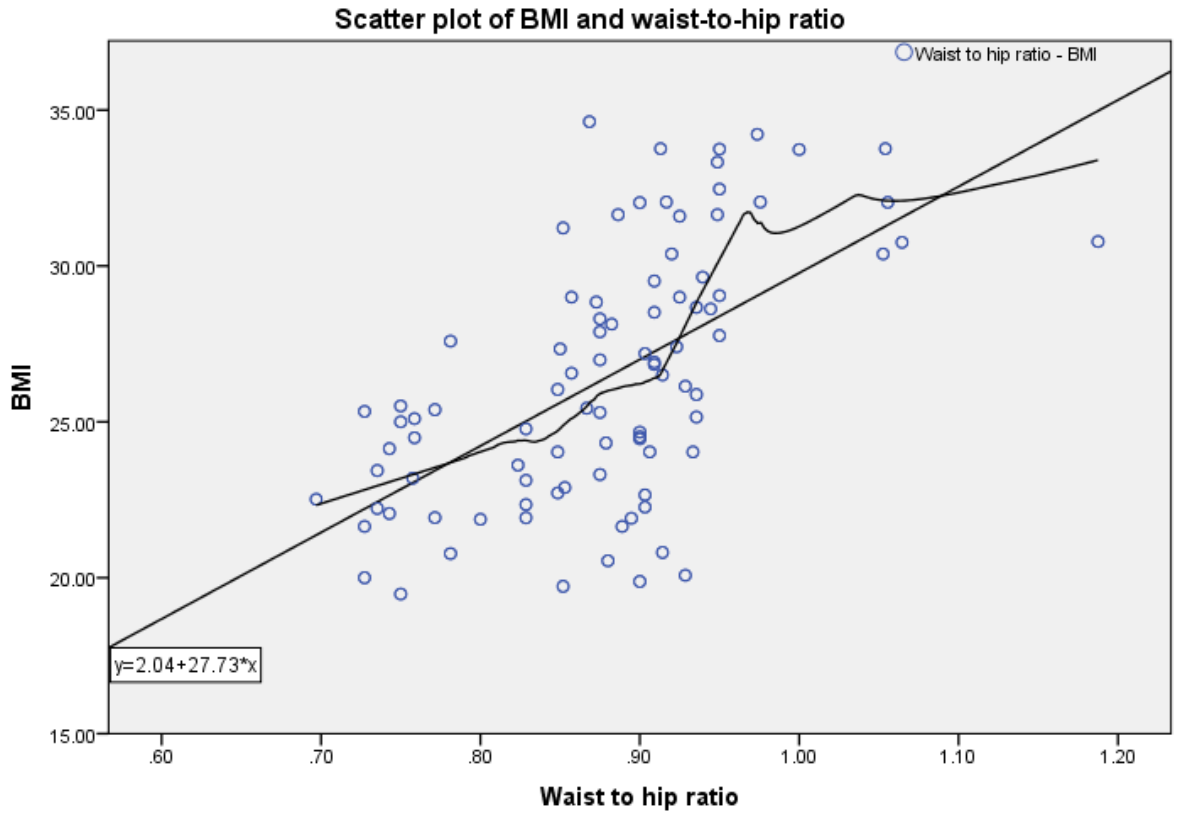

Figure I: Scatter plot demonstrating the relationship between the BMI (kg/m2) and waist-to-hip ratio.

Patients with umbilical hernia (group1, n=47) and patients without umbilical hernia (group2, n=43), were comparable with regard to their demographic and clinical parameters. There was no statistically significant difference in age, gender, occupation, educational status, socioeconomic status, smoking status, alcohol consumption status, diabetes and hypertension between the two groups. On comparing the anthropometric parameters (BMI and waist-to-hip ratio), there was no statistically significant difference between patients with umbilical hernia and patients without umbilical hernia. (Table 1).

Table I: Demographic, clinical and anthropometric parameters of patients with umbilical hernia (group 1) and patients without umbilical hernia (group 2).

		Group 1 (n=47)	Group 2 (n = 43)	P
Age		54.36 ± 9.28	57.56 ± 9.28	0.11
Gender	Male	28	18	0.09
	Female	19	15	
Occupation	Semi skilled	4	3	0.79
	Skilled	18	17	
	Clerical/shopowner/farmer	19	20	
	Semi-profession	6	3	
Educational status	High school	19	20	0.66
	Intermediate	23	17	
	Graduate/PG	5	6	
Socioeconomic status	Upper	2	2	0.58
	Upper middle	1	17	
	Lower middle	25	18	
	Upper lower	3	6	
Smoking		19	15	0.58
Alcohol		23	15	0.17
Diabetes mellitus		27	20	0.30
Hypertension		25	18	0.28
BMI		26.83 ± 4.04	25.91 ± 4.10	0.29
Waist to hip ratio		.88 ± .08	.88 ± .10	0.86

Variation of IAP at rest between obese and non obese patients (BMI more than 25) in the hernia group was found to be significant with a p value of <0.025 (Mean ± SD = 10.9 ± 1.9). Variation of IAP at rest between obese and non obese patients (BMI more than 30) in the hernia group was found to be significant with a p value of <0.01 (Mean ± SD = 12 ± 1.8)

Variation of IAP at Valsalva between obese and non obese patients (BMI more than 25) in the hernia group was found to be significant with a p value of <0.01 (Mean ± SD = 16.1 ± 1.78). Variation of IAP at Valsalva between obese and non obese patients (BMI more than 30) in the hernia group was found to be significant with a p value of <0.001 (Mean ± SD = 17.3 ± 1.6)

On comparing the Intra-abdominal pressure at rest between patients with umbilical hernia (group 1) and patients without umbilical hernia (group 2), it was seen that there was no statistically significant difference between the two groups. The mean intra-abdominal pressure at rest in patients with umbilical hernia was 10.47 ± 1.82 mm Hg as compared to 10.07 ± 1.77 mm Hg in patients without umbilical hernia (p = 0.30). However, on comparing the Intra-abdominal pressure on valsalva manoeuvre between patients with umbilical hernia (group 1) and patients without umbilical hernia (group 2), it was seen that there was a statistically significant difference between the two groups. The mean intra-abdominal pressure on valsalva manoeuvre in patients with

umbilical hernia was 15.24 ± 2.48 mm Hg as compared to 12.06 ± 2.43 mm Hg in patients without umbilical hernia (p = <0.001). The percentage change in IAP on valsalva was compared between patients with umbilical hernia and patients without umbilical hernia. There was a statistically significant difference, with patients with umbilical hernia having a higher percentage increase in IAP as compared to those without umbilical hernia, 47.52 ± 24.55 vs 19.99 ± 15.08, p = <0.001 (Table 2)

Table II: Mean Intra-abdominal pressure at rest, mean intra-abdominal pressure on valsalva manoeuvre and percentage change in IAP on valsalva manoeuvre between patients with umbilical hernia (group 1) and patients without umbilical hernia (group 2).

	Group 1 (n =47)	Group 2 (n= 43)	P
IAP Rest	10.47 ± 1.82	10.07 ± 1.77	0.30
IAP Valsalva	15.24 ± 2.48	12.06 ± 2.43	<0.001
IAP percentage change on valsalva	47.52 ± 24.55	19.99 ± 15.08	<0.001

There was a significant positive correlation between BMI and IAP at rest, ρ(90)=0.53, p <0.001. Similarly, there was a significant positive correlation between BMI and IAP on valsalva, ρ(90)=0.532, p <0.001. The correlation was seen even within the subgroups (patients with umbilical hernia, and patients without umbilical hernia). However, there was no significant correlation between BMI and percentage change in IAP on valsalva, ρ(90)=0.175, p =0.098. There was no correlation within the subgroups also.

ROC curve was plotted comparing the IAP on valsalva values between people with umbilical hernias and people without umbilical hernia. The area under the curve was 0.81. A cutoff of 14 mm Hg was obtained with intra abdominal pressure on Valsalva maneouvre which predisposes to occurrence of umbilical hernia with a sensitivity of 72% and a specificity of 81% (PPV – 81 and NPV – 72.9) (Figure II).

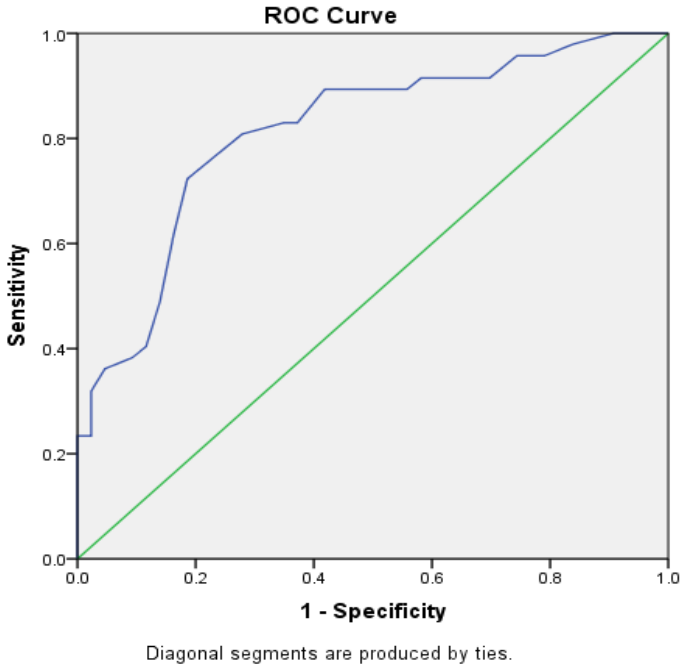

Figure II – ROC curve for IAP on Valsalva (area under curve – 0.81)

ROC curve was plotted comparing the percentage change in IAP on valsalva values between people with umbilical hernias and people without umbilical hernia. The area under the curve was 0.839. A cutoff of 31.5% was obtained with percentage change in IAP on valsalva maneouvre which predisposes to occurrence of umbilical hernia with a sensitivity of 78.7% and a specificity of 81.4% (PPV – 82.2 and NPV – 77.7) (Figure III).

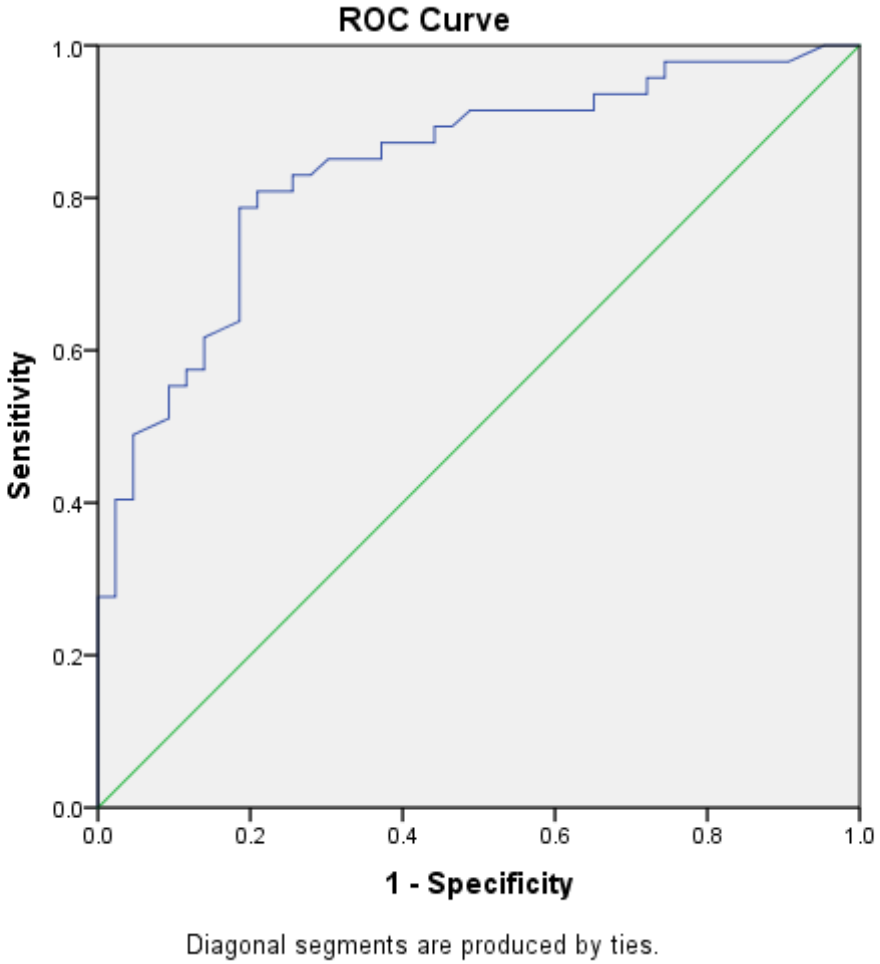

Figure III: ROC curve of percentage change in IAP on valsalva (area under curve - 0.839)

Discussion

Body mass index was a precarious variable to measure in the Asian population as there are significant differences in body composition between the Asian and Western population.

World Health Organization (WHO) guidelines state that alternative measures that reflect abdominal obesity such as Waist circumference, Wasit to hip ration (WHR), and waist-to-height ratio (WHtR) have been found to be superior to BMI.[6]

"According to Ahmad et al, Waist cicumference is the best indicator as compared with WHR for abdominal obesity for Malaysian adults."[7]

In our study, comparing BMI with waist to hip circumference, it was found that people with a BMI of less than 30 could have normal or abnormal waist to hip circumferences, indicating that if we considered waist to hip circumference as a measure of obesity, people in the normal BMI range could still fall under the category of obese.

Obesity is a known predisposing factor for rise in intra abdominal pressure. As Indians are prone to have a pear shaped body composition it appears

that people who have a normal BMI by WHO standards could still have an increased waist to hip circumference, thus increasing the risk factors for having a high IAP.

"According to Divya et al [5] in a study published in 2017, obesity and ascites were associated with significantly increased odds ratios of recurrence of 3.3 (95% CI, 1.0-10.1) and 8.0 (95% CI, 1.8-34.4), respectively."

Multiple logistic regression was carried out to ascertain independent risk factors for umbilical hernia. It was seen that intra abdominal pressure on Valsalva manoeuvre was an independent risk factor for umbilical hernia with a significant P value. It was also seen that increased BMI was not a predisposing factor for umbilical hernia in the population.(Figure IV)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	BMI	-.054	.191	.079	1	.779	.948	.652	1.377
	BMI_25(1)	-1.294	1.196	1.170	1	.279	.274	.026	2.859
	BMI_30(1)	-.935	1.348	.481	1	.488	.392	.028	5.515
	IAP	.583	.266	4.779	1	.029	1.791	1.062	3.019
	VAL_IAP	-.924	.196	22.141	1	.000	.397	.270	.583
	Constant	9.166	7.060	1.686	1	.194	9565.502		

a. Variable(s) entered on step 1: BMI, BMI_25, BMI_30, IAP, VAL_IAP.

Figure IV – Logistic Regression analysis

This was consistent with the findings of "*Jie et al that stated that recurrence rates among obese and nonobese patients were not significantly different (3.7% vs 4.6%, P = .72)."* [8]

However other studies such as "*Venclauskas L et al state that higher patient's body mass index and hernia size of >2 cm could be the risk factors for umbilical hernia recurrence."*[10]

In other words it is not enough to treat the anatomical cause of hernia alone, but we must try to find and correct the physiological cause as well.

The limitations of my study were primarily an interviewer bias, as there is no blinding in the study and the data is collected by the principal investigator and measurement bias for IAP readings.

Another limitation of the study was that the time period of the study was less and hence recurrence could not be studied. Also all IAP measurements were done pre operatively and any variation in IAP between different types of surgery (whether laparoscopic or open) was not studied. Differences between IAP according to the variation in placement of mesh or primary repair was also not studied.

Conclusion

Patients with umbilical hernia seem to have a higher intra abdominal pressure despite ruling out other possible causes of high IAPs. Although people with higher BMIs were found to have a higher intra abdominal pressure, it was not found to be a significant risk factor for primary umbilical hernias in our population. Finding the cause of this rise should be of prime importance in future studies as targeting the cause of raised IAP can decrease recurrence rates and hence costs and morbidity for the patient.

Also recurrent surgeries for umbilical hernias will be technically challenging for the surgeon and hence addressing the risk factors will be a rewarding exercise for surgeons alike.

Support - Nil
Conflicts of Interest - Nil
Permissions - Nil

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