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Research Article

Rates, Causes and Predictor Factors of 30-Day Readmission After Bariatric and Metabolic Surgery

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Abstract

Introduction: *Bariatric and metabolic surgeries have improved significantly. However, a serious complication occurred in 4.1% of all patients within the first 30 days after surgery which indicated readmission. Hospital readmission is a burden for patients and the health care system.*

Objectives: *This study aims to highlight rates, causes, and predictors of 30-day readmission after bariatric and metabolic surgery.*

Subjects and methods: *A retrospective case-control study was adopted for this study. We collected data from the clinical records of all patients who were admitted to the bariatric surgery unit at the selected hospital during the period between 2015 to 2019. Univariate analysis followed by logistic regression analysis was adopted.*

Results: *The final analysis included 1088 cases. The majority of patients underwent sleeve gastrectomy (SG) (712) (65.4%), followed by mini gastric bypass (MGB) (241) (22.2%), single anastomosis sleeve-ileal bipartition (SASI) (84) (7.7%), and Roux-en-Y gastric bypass (RYGB) (51) (4.7%).*

Forty-two patients were readmitted within 30 days after surgery with an overall readmission rate of 3.9%, varying between 2.07% and 9.52%. Patients who underwent SASI had the highest readmission rate (9.52%), followed by patients who underwent RYGB (5.88%), SG (3.65%), and MGB (2.07%)

Serious complications were the main causes of readmission as bleeding (35.7%), leakage (9.5%), as well as abdominal pain (33.3%), and vomiting (11.9%).

Logistic regression analysis revealed that patients with a length of stay greater than 2 days, patients with postoperative complications, and those who underwent RYGB or SASI or revisional operation were at higher risk of readmission.

Conclusion: *The overall readmission rate after bariatric and metabolic surgery was 3.86%. Readmission was mostly due to bleeding, abdominal pain, and vomiting. Patients with a length of stay greater than 2 days, patients with postoperative complications, and those who underwent RYGB or SASI or revisional operation were at higher risk of readmission.*

Key words: *Bariatric surgery; metabolic surgery; readmission, rate; predictors*

Introduction

Worldwide, there are more than one billion obese persons. This number is still increasing. (WHO, 2022) Non-surgical efforts such as increased physical activity, dietary regimen, and behavioral interventions failed to achieve the required weight loss in severely obese subjects. (Goldstein, 1992) Even medical treatment failed to achieve sustained weight loss among persons with severe obesity. (Sutherland et al., 2004; Ludwig et al., 2010)

At present, bariatric and metabolic surgery (BMS) is the only effective way for patients with obesity to achieve significant long-term weight loss. It is associated with substantial improvement in obesity-related comorbidities. (Sjöström, 2013; Arterburn et al., 2015; Doumouras et al., 2017a) The benefits of BMS for weight loss in persons with severe or morbid obesity are uncertain. However, these benefits should be considered regarding surgical complications. (Wolfe et al., 2016) Bariatric and metabolic surgeries have improved significantly. Currently, the laparoscopic approach is the method of choice, with only a small percentage of all procedures performed from an open access. (Nguyen et al., 2013) The most commonly performed surgeries nowadays are sleeve gastrectomy (SG), Mini gastric bypass (MGB), and Roux-en-Y gastric bypass (RYGB). (Małczak et al., 2017) However, these BMSs are associated with serious complications in 4.1% of all patients. (Smith et al., 2011) Although many studies have demonstrated that bariatric procedures are safe, a small proportion of patients experience at least 1 major adverse event within the first 30 days after surgery that indicates readmission. (Dang et al., 2020)

Readmission rates have ranged between 0.6% and 11.3% depending on the procedure type in different populations of patients undergoing bariatric and metabolic surgery. (Doumouras et al., 2016; Doumouras et al., 2017a; Doumouras et al., 2017b; Berger et l, 2018) Hospital readmissions increase the average cost of a bariatric operation. (Dormn et al., 2012) There has been recent attention to readmission as an indicator of the quality and cost of health care. (Abraham et al., 2015) Studying patient and surgical factors that predict readmission is a potential strategy for patient care and cost-effectiveness for payers and patients.

Patients and Methods:

Setting:

This study was carried out in Al Qassimi Hospital. It is the largest governmental hospital in the North Emirates (Sharjah) that is under the Emirates Health Services. It was established by the Ministry of Health

and Prevention in the UAE.

Patients were included in the bariatric program if their BMI was □ 40 kg/m2, or □ 35 kg/m2 with a comorbidity related to obesity. Also, patients with uncontrolled diabetes mellitus were included if they had BMI ≥ 30 kg/m2.

Revisional bariatric surgery was performed at lower BMI levels, considering the regain of weight as a comorbidity. Patients with complications, e.g., persistent symptomatic gastroesophageal reflux disease (GERD), hiatal hernia, deranged liver functions etc. were operated upon regardless of the presence or absence of obesity.

Excluded patients were obese patients with ages above 65 years or below 13 years old, pregnant ladies, addicts, and people with mental illness that prevents the proper cooperation to achieve the goals of surgery. Also, obese patients with active malignancy or those on chemotherapy were excluded.

Bariatric and metabolic surgery:

The types of primary BMS that are conducted in Al Qassimi Hospital are SG, MGB, SASI, and RYGB. Bariatric patients followed a strict protocol regarding inclusion and exclusion criteria, patient education, nutritional and psychiatric assessment, preoperative preparation, choosing the optimum operation, venous thromboembolism prophylaxis, postoperative care, and follow-up. All bariatric operations were done by or under the supervision of a consultant surgeon. They were performed laparoscopically under general anesthesia.

After surgery, patients were encouraged for early ambulation and respiratory exercises. Patients were discharged home when they fulfilled the discharge criteria (stable vital signs, no nausea, and vomiting, can drink satisfactory fluids, and having minimal abdominal pain). Postoperative follow-up with the multidisciplinary team was arranged after two weeks, one month, three months, six months, and 12 months after surgery.

Study design

A retrospective case-control study was adopted for this study. We collected data from the clinical records of all patients who were admitted to the BMS unit at the selected hospital during the period between January 1, 2015 to December 31, 2019.

Data collection tool included personal characteristics such as age, gender, BMI, and nationality; associated co-morbid conditions such as diabetes, hypertension, cardiac diseases, sleep apnea, and thyroid diseases; and operative factors as type of procedure, length of stay, and complications. Postoperative complications included leakage, bleeding, and infection. Causes of readmission were also recorded.

Statistical analysis:

Patients were divided into two groups according to readmission within 30 days after the surgery: readmitted (case group) and not readmitted (control group).

Continuous variables were presented as means with standard deviations (SD) or medians with interquartile ranges (IQR). Categorical variables were presented as frequency and percentage and compared using the Pearson Chi-square (X2) test or Fisher' Exact test.

Logistic regression analysis was used to calculate the OR with 95% confidence interval (CI). For identification of independent variables associated with readmission within 30 days after BMS. Statistical significance was set to $P < 0.05$.

All the explanatory variables included in the logistic model were categorized into two or more levels (R = reference category): gender: male^{R}, female; age (years): < 20R, 20 – 29, 30 – 39, 40 – 49, > 50; nationality: citizenR, non-citizen; hypertension: no^{R}, yes; diabetes mellitus (DM): no^{R}, yes; sleep apnea: no^{R}, yes; depression/anxiety: no^{R}, yes; gastro-esophageal reflux disease (GERD): no^{R}, yes; dyslipidemia: no^{R}, yes; asthma: no^{R}, yes; cardiac disease: no^{R}, yes; musclo-skeletal disorder: no^{R}, yes; procedure of BMS: SGR, MGB, SASI, RYGB; operation: primary^{R}, revisional; length of stay (LOS): 1-2R, 3-4, > 4; complications: no^{R}, yes; initial BMI: 30 – 39R, 40-49, ≥ 50. All statistical analyses were performed using SPSS - 22.

Ethical aspects

Patients gave their informed consent to the processing of their data. The study was approved by the local Ethics Committee and was in accordance with the Declaration of Helsinki principles.

Results

All 1104 records of patients who were operated upon in the BMS unit in the selected hospital from 2015 till the end of 2019 were reviewed. Sixteen records were excluded as they were operated for surgeries other than bariatric problems. The final analysis included 1088 cases. The majority of patients underwent SG (712) (65.4%), followed by MGB (241) (22.2%), SASI (84) (7.7%), and RYGB (51) (4.7%).

Among the studied cases, 42 patients were readmitted within 30 days after surgery with an overall readmission rate of 3.9%, varying between 2.07% and 9.52%. Patients who underwent SASI had the highest readmission rate (9.52%), followed by patients who underwent RYGB (5.88%), SG (3.65%) and MGB (2.07%). (Table 1).

Surgical procedures	**No.**	**30-day readmission**	
		No.	**%**
Sleeve gastrectomy (SG)	712	26	3.65
Mini gastric by-pass (MGB)	241	5	2.07
Single anastomosis sleeve–ileal bipartition (SASI)	84	8	9.52
Roux-en-Y gastric by-pass (RYGB)	51	3	5.88
Total	**1088**	**42**	**3.86**

Table 1: Number of bariatric surgeries, by type of operation and 30-day readmission

The causes of readmission are presented in table 2. Serious complications were the causes of readmission as bleeding (35.7%), leakage (9.5%), acute kidney injury (one case), and acute pancreatitis (one case). Other symptomatic causes were recorded as abdominal pain (33.3%), vomiting (11.9%), and fever (4.8%).

Causes of readmission	**No.**	**%**
Bleeding	15	35.7
Abdominal pain	14	33.3
Leakage	4	9.5
Fever	2	4.8
Vomiting	5	11.9
Acute kidney injury	1	2.4
Acute pancreatitis	1	2.4
Total	**42**	**100.0**

Table 2: Causes of 30-day readmission after bariatric surgery

Table 3 describes the general characteristics of the studied cases. Females represented 69.4 % of patients and 87.6% were citizens. The mean age was 33.4 ± 9.9 ranging from 13 to 64 years. Diabetes mellitus (22.1%), hypertension (15.5%), gastro-esophageal reflux (13.1%), and dyslipidemia (8.2%) were the most commonly associated co-morbidities. Most of the cases were operated upon as primary surgery (89.8%) while 10.2% were revisional operations. The length of stay after surgery ranged from 1 to 40 days with a median equal to 3 (IQR = 1.0)). Complications (1.7%) and re-admission within 30 days (4.2%) after surgery, were very rare. Preoperative body weight ranged from 69 Kg to 250 Kg with a mean equal to 125 ± 26.8 Kg. The preoperative BMI ranged from 30 Kg/m2 to 82 Kg/m2 with a mean equal to 44.8 ± 8.5 Kg/m2.

Variable	**No. (1088)**	**%**
Gender:		
Male	333	30.6
Female	755	69.4
Age		
< 20	110	10.1
20-29	315	29.0
30-39	404	37.1
40-49	183	16.8
≥40	76	7.0
Min – max	13 – 64	
Mean (Standard deviation)	33.0 ±9.9	
Nationality:		
Citizen	953	87.6
Non-citizen	135	12.4
Co-morbid diseases		
Diabetes	240	22.1
Hypertension	179	15.5
Sleep apnea	20	1.8
Depression/anxiety	16	1.5
Gastroesophageal reflux disease	142	13.1
Dyslipidemia	89	8.2
Asthma	42	3.9
Cardiac disease	8	0.7

Thyroid disease	47	4.3
Musculoskeletal disease	65	6.0
Surgical procedure:		
Sleeve gastrectomy (SG)	712	65.4
Mini gastric by-pass (MGB)	241	22.2
Single anastomosis sleeve–ileal bypass (SASI)	84	7.7
Roux-en-Y gastric by-pass (RYGB)	51	4.7
Operation		
Primary	977	89.8
Revisional	111	10.2
Length of stay		
1-2	281	25.8
3-4	751	69.0
>4	56	5.1
Min – max	1 - 40	
Median (Interquartile range)	3.0 (1.0)	
Complication		
No	1069	98.3
Yes	19	1.7
Pre-operative body weight		
Min – max	69 – 250	
Mean (Standard deviation)	125 ± 26.8	
Pre-operative BMI		
30-39	310	28.5
40 - 49	502	46.1
≥ 50	276	25.4
Min – max	30 – 82	
Mean (Standard deviation)	44.8 ± 8.5	

Table 3: General characteristics of the study population

Table 4 presents the distribution of BMS patients according to personal, clinical, and surgical characteristics and readmission within 30 days after surgery and, the results of univariate analyses. The percentage of

women in the readmission group (71.4%) was insignificantly higher than in the control group (69.3%). No significant difference between the two groups regarding age and associated comorbidities except for thyroid disease whereas the proportion was significantly higher in the readmission group than the control one (11.9% versus 4.0%, p = 0.03).

Regarding surgical procedures, SASI and RYGB were significantly more encountered in the readmission group than in the control group (19.0% versus 7.3% and 7.1% versus 4.6%, p = 0.03).

The proportion of revisional surgery was significantly higher in the readmission group than the control one (21.4% versus 9.8%, p = 0.01). Also, the mean LOS was significantly longer in the readmission group compared to the control group (4.8 versus 1.02 days, p<0.001), with a higher proportion of patients who stayed > 4 days in the readmission group. Surgical complications were very rare in the control group whereas the proportion of complications was 42.9% in the readmission group, p < 0.001.

Characteristics	**Readmission**				**Test of significance (p)**
	No (n=1046)		**Yes (n=42)**		
	No.	**%**	**No.**	**%**	
Gender					
Male	321	30.7	12	28.6	Fisher's Exact (p=0.87)
Female	725	69.3	30	71.4	
Nationality:					
Citizen	914	87.4	39	92.9	Fisher's Exact (p=0.47)
Non-citizen	132	12.6	3	7.1	
Age (years)					
<20	104	9.9	6	14.3	χ^2=1.40 (p=0.85)
20-29.9	303	29.0	12	28.6	
30-39.9	388	37.1	16	38.1	
40-49.9	178	17.0	5	11.9	
≥50	73	7.0	3	7.1	
Min - Max	13 - 64		14 – 55		
Mean ± SD	33.2 ± 9.9		31.9±10.3		
Comorbidity					
Diabetes	230	22.0	10	23.8	χ^2=0.09 (p=0.78)
Hypertension	174	16.6	5	11.9	χ^2=0.66 (p=0.42)
Sleep apnea	19	1.8	1	2.4	Fisher's Exact (p=0.55)
Depression/anxiety	16	1.5	0	0.0	Fisher's Exact (p=1.00)

Gastro-esophageal reflux	136	13.0	6	14.3	X^2=0.06 (p=0.82)
Dyslipidemia	86	8.2	3	7.1	Fisher's Exact (p=0.55)
Asthma	42	4.0	0	0.0	Fisher's Exact (p=0.40)
Cardiac disease	8	0.8	0	0.0	Fisher's Exact (p=1.00)
Thyroid disease	42	4.0	5	11.9	Fisher's Exact (p=0.03)
Musculoskeletal disorder	63	6.0	2	4.8	Fisher's Exact (p=1.00)
Surgical procedure:					
Sleeve gastrectomy	686	65.6	26	61.9	X^2=9.98 (p=0.03)
Mini gastric by-pass	236	22.6	5	11.9	
Single anastomosis sleeve–ileal bipartition	76	7.3	8	19.0	
Roux-en-Y gastric bypass	48	4.6	3	7.1	
Operation:					
Primary	944	90.2	33	78.6	X^2=6.01 (p=0.01)
Revisional	102	9.8	9	21.4	
Length of stay:					
1-2	278	26.6	3	7.1	X^2=35.47 (p<0.001)
3-4	722	69.0	29	69.0	
>4	46	4.4	10	23.8	
Min – max	1 - 13		1 - 40		
Mean (Standard deviation)	3.02 ± 1.01		4.8 ± 5.95		
Complications:					
No	1045	99.9	24	57.1	Fisher's Exact (p<0.001)
Yes	1	0.1	18	42.9	
Pre-operative body weight in kg					
Min – max	69 - 250		85 - 185		*t* = 1.40 (p = 0.16)
Mean (Standard deviation)	129.7 ± 26.2		126.6 ± 27.2		
Pre-operative BMI in kg/m^2					
≥ 30	295	28.2	15	35.7	X^2=1.17 (p=0.56)
≥ 40	484	46.3	18	42.9	
≥ 50	247	25.5	9	21.4	
Min – max	30.0 – 82.0		30.0 – 67.2		
Mean (Standard deviation)	44.8 ± 8.5		43.9 ± 8.4		

Table 4: Distribution of bariatric and metabolic surgery patients according to personal, clinical, and surgical characteristics and readmission within 30 days after bariatric surgery.

After adjustment for the confounding effects between variables, table 5 illustrates variables that were retained as significant determinants for the outcome of interest (30-day readmission after BMS).

As compared to SG, SASI had double the risk of readmission (OR = 1.92, CIs: 1.11 – 5.16) and RYGB had 3.54 folds the risk of readmission (OR = 1.51, CIs: 1.09 – 6.23). Patients who were operated upon as revisional operation had a 3.54-fold risk of readmission (OR = 3.54, CIs: 1.17 – 7.12).

Patients who stayed 3- 4 days or > 4 days after surgery were more liable to be readmitted within 30 days after surgery (OR = 2.10, CIs: 1.12 – 10.4) and (OR = 18.11, CIs: 4.99 – 60.82) respectively.

Lastly, the occurrence of postoperative complications was accompanied by a high risk of readmission (OR = 51.12, CIs: 22.09 – 73.45).

Variables	**Odds Ratio**	**95% CIs**
Procedure		
Sleeve gastrectomy [R]	1	
Mini gastric bypass	0.41	(0.19 – 1.64)
Single anastomosis sleeve-ileal bipartition	1.92	(1.11 – 5.16)
Roux-en-Y gastric bypass	1.51	(1.09 – 6.23)
Type of operation		
Primary [R]	1	
Revisional	3.54	(1.17 – 7.12)
Length of stay (days):		
1 - 2 [R]	1	
3 - 4	2.10	(1.12 – 10.41)
> 4	18.11	(4.99 – 60.82)
Complications		
No [R]	1	
Yes	51.12	(22.09 – 73.45)

[R] = Reference category, OR = Odds ratio, CIs = Confidence interval

Table (5): Factors associated with readmission within 30 days after bariatric and metabolic surgery, results of logistic regression analysis.

Discussion

In 2011, Annually, 10% of healthcare expenditures in the USA were spent on the treatment of obesity, and BMSs and their medical complications. (Dumon et al., 2011). These expenditures have been going to increase substantially till now. Most of the previous studies that looked for outcomes after BMSs have emphasized factors associated with risk for readmission, reoperation, morbidity, and mortality.

BMS is safe with a 0.15% to 0.5% 30-day mortality rate. (Zellmer et al., 2014; Zhou et al, 2021; Stenberg et al., 2022); however, an appreciable proportion of patients suffer at least one considerable adverse event within the first 30 days following BMS that results in hospital readmission. (Kleipool et al., 2023)

Rates of 30-day readmission:

In the present study, we reported an overall 30-day readmission rate of 3.9% after BMS in the selected hospital. The rate was higher after SASI (9.5%), followed by RYGB (5.9%), SG (6.7%), and the least after MGB (2.1%). Variant rates of 30-day readmission were reported in previous studies. A higher rate (7.5%) was reported in a study that was conducted in a Canadian center, (Dang et al., 2020) This rate went with some other studies reported for various bariatric cohorts across the US and Canada. (Berger et al., 2014; Khorgami et al., 2016; Garg et al., 2016; Celio et al., 2017) In a study that was conducted by Major et al. (2018), the overall readmission rate was 5.89%. In another previous larger study, the overall readmission rate was 5.7%. after BMS (Lois et al., 2015). Sippy et al., (2016) reported an overall 30-day readmission rate of 2.1% after SG or RYGB. Readmission rates ranged from 1.87 to 14.16% after BMS were reported by other authors. (Dallal et al., 2012; Chen et al., 2015; Abraham et al., 2015; Doumouras et al., 2016; Aman et al., 2016) Previously reported hospital readmission rates for bariatric surgery vary widely in the literature. (Saunders et al., 2008; Kellogg et al., 2009; Birkmeyer et al., 2010) Possible explanations for these differences may be due to differences in the patient populations, the definition of hospital readmission, the type of procedure performed, or surgeon experience. (Dorman et al., 2012).

Causes of 30-day readmission:

Regarding hospital readmission, causes can be non-surgical as vomiting, anemia, dehydration, chronic pain, and malnutrition, (Zellmer et al., 2014; Ahmed et al., 2020) or surgical causes as type of surgery and direct/indirect complications of the primary surgery or revisional surgery. (Zellmer et al., 2015) In the

present study, the most common causes of readmission were bleeding (35.7%) and abdominal pain (33.3%) followed by vomiting (11.9%) and postoperative complications (9.5%). This goes with other previous studies. Aman and his colleagues reported that the most common reason for readmission was nausea/vomiting (12.95 %), followed by abdominal pain (11.75 %) and dehydration (10.54 %). (Aman et al., 2016) Dorman, et al. (2012) reported that the most prevalent reasons for readmission are nausea, and vomiting, which may be related to a slow return of bowel function and dehydration. Since pain was a common reason for readmission after BMS in our study as well as in previous studies. Pain management should be considered among postoperative priorities to reduce readmissions. Poor pain control can prolong the initial LOS as well as the probability of readmission. There may be potential to reduce readmissions by instituting very early outpatient assessments to decrease the probability of occurrence of pain, nausea, and infection. (Dang et al., 2020)

Predictors of 30-day readmission:

To reduce the burden of avoidable readmissions on healthcare systems, many studies have looked at factors affecting readmission or perioperative complications associated with bariatric and metabolic surgery. The factors reported by these studies are variable, and it can be difficult to compare results because of the lack of standardized reporting of readmission diagnoses and heterogeneity between centers and surgeon practices. (Dang et al., 2020) Many patients and surgical factors could be associated with 30-day readmission after BMSs. On multivariable analysis, in the present study, factors that were significantly associated with readmission were surgical procedure type (SASI and RYGB as compared with SG), revisional operations, length of stay, and postoperative complications.

The rates of 30-day readmissions were significantly higher after RYGB, compared to SG. This suggests that RYGB is independently associated with increased readmission rates, while patients undergoing SG are less likely to be readmitted. This finding is consistent with many previous studies. Current unanimity suggests that readmission rates are 1.1 to 9.0% for RYGB and 0.7–5.4% for SG. (Dorman et al., 2012; Hong et al., 2012; Young et al., 2015; Sippey et al., 2016) These results are consistent with those reported by Spaniolas et al., who showed a significantly higher prevalence of diabetes among RYGB patients, compared to SG (56.6% versus 43.2%) (Spaniolas K, et al., 2014) Another study of New York statewide data showed a significantly higher readmission rate of 6.14% after RYGB, compared to 4.33% after SG. (Patterson et al., 2015) Berger et al. (2018) found that the highest readmission and complication rates were associated with

RYGB and more than half of the patients in their study underwent this procedure. Khorgami et al., (2016) found that RYGB had a 60% higher risk for 30-day readmission compared to SG. However, contrary to this, other studies did not observe a similar relationship. (Doumouras et al., 2016 and Dang et al., 2020) Although readmission was more common after RYGB compared with SG as reported in many previous studies (Chen et al., 2015; Sippy et al., 2016; Aman et al., 2016; Khorgami et al., 2016), one study reported higher rates of readmission after SG. (Lois et al., 2015) In a study by Sippey et al. (2016), readmission was more common after RYGB compared with SG, and nausea, vomiting, pain, bleeding, and dehydration were more commonly a reason for readmission after SG than RYGB. (Aminian et al., 2018) Despite that RYGB and SG may have the same long-term effects on excess body weight, and comorbid conditions, SG is a safer procedure than RYGB. Some authors reported that the higher rate of readmission after RYGB may be due to the prolonged surgical time compared to SG. (Ahmed et al., 2023) In spite of the low incidence of postoperative complications following both RYGB and SG surgery, SG is safer than RYGB in the first 30 days following surgery. (El Chaar et al., 2017)

Also, the 30-day readmission rate was significantly higher after SASI than SG. A finding that went with other previous studies. (Emil et al., 2017; Emil et al., 2021; Mahdy et al., 2021) The complication rate of the SASI was approximately 10%, slightly higher than the mean overall complication rate after SG (8.7%). Emile et al., (2021) attributed the higher rate of readmission after SASI to longer operation time than SG and that complications are more frequently encountered in SASI.

In the present study, the length of hospital stay during BMS was found to be independently associated with readmission, which is consistent with other studies. (Doumouras et al., 2016) In a larger previous study, it was found that a 30-day readmission rate of 5.8% for RYGB and 1.2% for laparoscopic adjustable gastric banding (LAGB) was associated with prolonged LOS as a risk factor for readmission for both procedures. (Dorman et al., 2014) Prolonged LOS following surgery was one of the only factors that significantly predicted readmissions in both surgical populations in multivariate analysis. (Dorman et al., 2012) Longer LOS may be due to pain, nausea, vomiting, and fluid and electrolyte depletion. These patients are at higher risk for readmission, as these symptoms may persist after discharge. (Dang et al., 2020) Some patients stay for a longer period of stay after surgery though they are adherent to the operation protocol. (Kaboli et al., 2012; Carey et al., 2014; Carey et al., 2015) Some factors may be associated with readmission rates indirectly through prolonging LOS as age, higher preoperative BMI, gender, comorbid conditions especially diabetes, and operative time. (Dallal et al., 2012; Jensen-Otsu et al., 2015; Carter et al., 2015; Garg et al.,

2016)

The high rate of weight regain following bariatric and metabolic surgery is consistent with the reported increase in revisional bariatric procedures in recent literature. (Ahmed et al., 2020 and Ahmed et al., 2021) Revisional BS is often recommended for those with inadequate weight loss or significant weight regain, as well as persistent comorbid conditions following primary bariatric surgery. (Fobi, 2004; Flegal et al., 2012) While some small cohorts and meta-analyses have reported no difference in complication rates between primary and revisional bariatric cases (Meijer et al., 2011; Postel et al., 2014; Guerrier et al., 2018), others have reported that complication rates are higher in revisional bariatric surgery. (Lawson et al., 2013; Zellmer et al., 2014; Spaniolas et al., 2014) We found that revisional operations were significantly associated with higher readmission rates. The current literature suggests that revisional bariatric surgery is associated with higher rates of mortality and morbidity and outcomes may be related to the primary and revisional operation performed. This may be attributed to the serious morbidities usually associated with the revisional operation, because it usually takes longer time with more serious complications. (Ahmed et al., 2023) In a previous study comparing primary and revisional RYGB, the revisional cohort was found to have a significantly longer LOS, conversion to laparotomy and higher rates of 30-day morbidity that in turn required hospital readmission. (Dumon et al., 2011)

We found that postoperative complications were significantly associated with 50 times higher rates of readmissions after BMS. Postoperative complications that were encountered were bleeding (15 cases), leakage (4 cases), and one case for each of acute kidney injury and acute pancreatitis. This goes with other studies that found that the most common complication that predicted readmission was bleeding. (Abraham et al., 2015) Postoperative complications were found to be associated with a significant increase in readmissions in studies by many researchers. (Khorgami et al., 2016; (Kassin et al., 2012; Lawson et al., 2014; Doumouras et al., 2016) We recognize that postoperative complications are considered as the main cause of readmission after BMS rather than such a significant association.

In many previous studies, patient-related factors and comorbidities were significantly associated with 30-day readmission rates. (Jensen-Otsu et al., 2015; Reyes-Perez et al., 2016; Sippet et al., 2016; Khorgami et al., 2016; Garg et al., 2016; Sun et al., 2016) These variables were not associated with readmission rates in our study. In particular, initial BMI was determined as a significant predictor of readmission after BMS by many previous studies. (Jencks et al., 2009 and Celop et al., 2017) However, as in other studies, BMI could not be proved as a significant predictor of readmission rate in our study. (Dorman et al., 2010; Telem et al.,

2015 Khorgami et al., 2016)

Whatever the reason for readmission, it accounts for greater costs for the healthcare settings and the patients. So, it is important to know the main causes, frequency, and therapeutic options, to develop strategies that enable improved care and lower the readmission rate. A program focusing on the components of patient education, discharge planning, and postoperative care and follow-up is mandatory to lower the rate of readmission after BMS and consequently reduce the cost of medical care. In our center, we implement a strict protocol to reduce the readmission rate. We implement rigorous preoperative planning and education (medical-psychological-nutritional). After the surgery, we maintain a close channel of communication between the patients and the multidisciplinary team, with follow-up appointments.

Our study has some limitations. Although we captured all admissions in the selected hospital, it is possible that some patients may have been admitted to other hospitals, leading to an underestimate of true readmission rates. The study patients come from a single hospital, which may make the results less liable for generalization. However, this hospital is considered one of the largest hospitals in UAE which accepts many cases for BMS. Furthermore, readmissions beyond the 30 days were not evaluated in this study. This may have had a significant impact as many BMS complications may occur after 30 days of discharge. Another limitation due to the record study nature of the study is the non-inclusion of some variables such as preoperative preparations of patients, operation time, surgeon experience, and postoperative fluids and pain-relieving medication.

Conclusions

The overall 30-day readmission rate after BMS in our study was 3.86%. Readmission was mostly caused by bleeding, abdominal pain, and vomiting. On multivariate analysis, patients with a length of stay greater than 2 days, patients with postoperative complications, and those who underwent RYGB or SASI or revisional operation were at higher risk of readmission.

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