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Is simultaneous resection of Meckel's diverticulum beneficial or harmful in bariatric and metabolic surgery?

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Abstract

Aim: To investigate whether complications are different with respect to resection or non-resection of Meckel's diverticulum (MD) detected incidentally during two bariatric and metabolic surgery (BMS) procedures, open sleeve gastrectomy with transit bipartition (SG-TB) with resection of MD (MDR) and open one-anastomosis gastric bypass (OAGB) without MDR.

Materials and Methods: This case-control study included patients who received treatment between December 2015 and January 2022. A total of 24 obese patients with type 2 diabetes mellitus diagnosed with MD during open SG-TB surgery (and underwent concurrent MDR) were defined as the MDR positive (MDR-P) group. Ten obese patients without type 2 diabetes mellitus who were found to have MD during open OAGB surgery but did not undergo MDR were defined as the MDR negative (MDR-N) group.

Results: The mean age of the MDR-P group was 54.42 ± 10.83, while the MDR-N group had a mean age of 39.50 ± 9.77 years ($p = 0.001$). 66.7% of the MDR-P group was male, 100.0% of the MDR-N group was female ($p < 0.001$). Median follow-up time was 24 (IQR = 24 - 36) months for both groups. None of the patients developed intraoperative or postoperative complications related to diverticulectomy (for the MDR-P group) or related to MD (for the MDR-N group).

Conclusion: Resection of incidental MD during SG-TB and non-intervention in OAGB did not cause any complications in short and mid-term follow-up. We still think that patients should be informed about the risks of all possibilities and the intervention for MD should be determined according to the patient's decision.

Introduction

Bariatric and metabolic surgery (BMS) is an increasingly widely used and constantly evolving field that has proven itself as the most effective treatment option for obesity and obesity-related comorbidities [1]. BMS, which includes many different procedures, can cause important morbidities such as malabsorption and micronutrient deficiency, weight regain and inadequate weight loss when the length of the optimal segment to be by-passed is not balanced, especially in surgeries involving the small bowel [2]. Considering that the total small bowel length (TSBL) can vary in a range of 2.5–13 meters [2], intraoperative measurement of TSBL is important. During this measurement, it is also possible to detect additional gastrointestinal system (GIS) pathologies. Meckel's diverticulum (or Meckel's diverticula, MD) is the most common congenital abnormality of the GIS, which is caused by the incomplete closure of the omphalomesenteric duct during intrauterine life [3,4]. Diagnosis is often dependent upon symptomatic presentation which is rare; however, some cases are detected incidentally during abdominal surgery or imaging. Although MD prevalence is reported between 0.3%-2.9% in the general population, this rate is suggested to be an underestimation because most cases are asymptomatic throughout life [3,5]. Symptoms usually emerge when complications occur, including intestinal obstruction, gastrointestinal bleeding or diverticulitis, which often present early in life [4]. Although there is a consensus that MD resection (MDR) should be performed in cases with complications, performing MDR for incidentally-detected cases is controversial [3,6-9]. To our knowledge, the conflict regarding resection of incidentally-detected cases does not exclude BMS procedures; however, evidence concerning such patients is vanishingly rare. Although the frequency of incidental MD in obese patients is largely unknown, a study examining pathological specimens of 427 Roux-en-Y gastric bypass (RYGB) surgeries reported a frequency of 1.2%

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[10]. In the literature, there are several studies that have described data concerning patients with primary BMS history (RYGB) who required MDR due to MD-related complications [11-13].

In this study, we aimed to investigate whether the resection or non-resection of incidentally-detected MD during BMS is advantageous, by evaluating the intra- and postoperative results of two well-known BMS procedures, open sleeve gastrectomy with transit bipartition (SG-TB) with MDR versus open one-anastomosis gastric bypass (OAGB) without MDR.

Materials and Methods

Study design and ethical issues

Ethical approval of this case-control study was acquired from the Ethics Committee of Near East University Faculty of Medicine (date:28.04.2022, no:1514). The study included patients who received treatment in our bariatric surgery Center of Excellence between December 2015 and January 2022. All steps of the study were carried out with respect to the ethical standards stated in the Declaration of Helsinki and its amendments.

Participants and data collection

A total of 24 obese patients undergoing open SG-TB surgery and 10 obese patients undergoing open OAGB surgery were included in the study. Patients younger than 18 years of age or older than 65 years, patients undergoing revision surgery, cases with additional non-MD pathology identified during TSBL measurement, and those who could not be followed up due to death or other reasons were excluded from the study. All demographic, clinical, anthropometric, operational and follow-up data about participants had been recorded in a digital database, and these data were retrospectively reviewed.

Operative and Meckel's diverticula related features

All patients were evaluated by an endocrinologist before the operation. BMS was accepted to be necessary in patients who did not respond positively to diet therapy for at least 6 months and met the following criteria: Having a BMI of $\geq$40 without obesity-related comorbidity or having a BMI of $\geq$35 in the presence of obesity-related comorbidity [14].

In patients with BMS indication, the SG-TB procedure was applied to patients with type 2 diabetes mellitus (T2DM) and the OAGB procedure to patients without T2DM, under general anesthesia and with routine surgical procedures. TSBL was measured routinely during both BMS procedures in order to plan the respective surgeries according to inter-individual differences [2]. We created the common channel at a distance of 150 cm from the ileocecal valve in patients who underwent SG-TB. In patients who underwent OAGB, anastomosis was performed between the small bowel and the gastric pouch, approximately 200 cm away from the ligament of Treitz (although it varies according to TSBL from the beginning of the small intestine).

None of the patients had reported any complaints that could be associated with MD before the primary operation. MD was not detected in any of the patients with routine ultrasonography imaging performed before BMS and in the abdominal computed tomography imaging performed when necessary. All MDs were detected incidentally during the measurement of TSBL in both BMS procedures.

When intraoperative MD was encountered in patients who underwent SG-TB operation, MDR was performed. Because these patients have T2DM and they may have a higher risk of complications associated with MD [15]. Another reason is that MD complications that may occur after surgery may endanger the common canal created closer to the iliocecal valve due to the nature of the operation. The group of these patients was named MDR positive (MDR-P). Concurrent MDR was performed by using a linear stapler (Endo-GIATM Universal Stapling System [60 × 2.5 mm], Covidien, USA) with care taken to avoid narrowing the intestinal lumen.

Since the OAGB operation was performed on patients without T2DM and the anastomosis between gastric pouch and small intestine was far from the MD site, MDR was not performed during the primary operation considering that this group had a low risk of MD-related complications. The group of these patients was named MDR negative (MDR-N).

Follow-up

After BMS, the patients were called for controls at 1 week, 1 month, 3 months, 6 months, 1 year, and then annually. In addition to routine post-BMS follow-up evaluations, patients were also evaluated for complications associated with MD or MDR.

Statistical analysis

All analyses were subject to a statistical significance threshold of $p < 0.05$ and were performed on SPSS for Windows, v25.0 (IBM, Armonk, NY, USA). The Shapiro-Wilk test was used to determine normality of distribution in continuous variables. Data are summarized as mean ± standard deviation or median (minimum - maximum) for continuous variables according to normality of distribution, while absolute and relative frequencies (n, percentage) are used for categorical variables. Continuous variable comparisons were performed with the independent samples t-test or the Mann-Whitney U test depending on normality of distribution. Categorical variables were analyzed with the Fisher's exact test or the Fisher-Freeman-Halton test.

Results

The overall mean age was 50.03 ± 12.47 years (54.42 ± 10.83 in MDR-P and 39.50 ± 9.77 in MDR-N). There was a significant age difference between the groups ($p = 0.001$). 66.7% of the MDR-P group were males, 100.0% of MDR-N group were females, and there was a significant difference in sex distribution between the groups ($p < 0.001$). The MDR-P group had significantly higher mean weight ($p < 0.001$) and BMI ($p < 0.001$). All clinical, demographic, anthropometric and follow-up data of the groups are summarized and compared in Table 1 and Figure 1-4.

Table 1. Summary of patient characteristics with regard to diverticulectomy.

	Total (n=34)	MDR-P (n=24)	MDR-N (n=10)	p
Age	50.03 ± 12.47	54.42 ± 10.83	39.50 ± 9.77	0.001
Sex				
Female	18 (52.9%)	8 (33.3%)	10 (100.0%)	<0.001
Male	16 (47.1%)	16 (66.7%)	0 (0.0%)	
Height, cm	165.59 ± 7.95	165.67 ± 8.96	165.40 ± 5.17	0.931
Weight, kg	106.31 ± 18.95	99.01 ± 14.91	123.84 ± 16.28	<0.001
Body mass index, kg/m^2	37.84 (28.03 - 60.89)	36.02 (28.03 - 52.07)	43.24 (40.25 - 60.89)	<0.001
Total small bowel length, meters	5.0 (4.0 – 6.0)	4.7 (4.0 – 6.0)	5.65 (5.3 – 6.0)	<0.001
Drug use				
None	10 (29.4%)	0 (0.0%)	10 (100.0%)	<0.001
Oral antidiabetics	5 (14.7%)	5 (20.8%)	0 (0.0%)	
Insulin	10 (29.4%)	10 (41.7%)	0 (0.0%)	
Oral antidiabetics + Insulin	9 (26.5%)	9 (37.5%)	0 (0.0%)	
Operation				
Sleeve gastrectomy with transit bipartition	24 (70.6%)	24 (100.0%)	0 (0.0%)	<0.001
One anastomosis gastric bypass	10 (29.4%)	0 (0.0%)	10 (100.0%)	
Duration of surgery, minutes	139.3 ± 19.5	149.5 ± 3.3	114.9 ± 20.8	<0.001
Length of hospital stay, days	4.0 (3.0 – 5.0)	4.0 (4.0 – 5.0)	3.0 (3.0 – 4.0)	<0.001
Follow-up time, months	24 (24 – 36)	24 (24 – 36)	24 (24 – 36)	0.809

Data are summarized as mean ± standard deviation or median (minimum - maximum) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables.
Abbreviations; MDR-N: Meckel's diverticulum resection negative patients, MDR-P: Meckel's diverticulum resection positive patients.

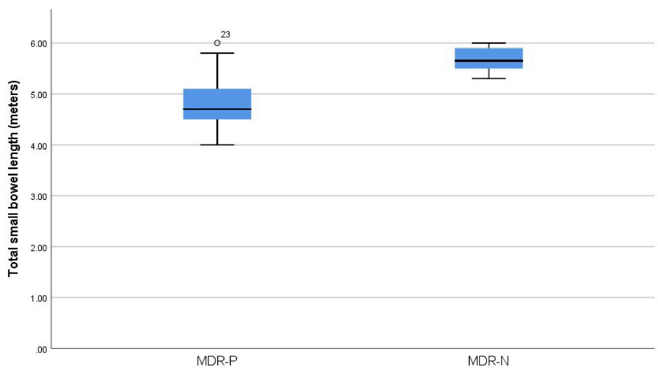

Figure 1. Total small bowel length with regard to the diverticulectomy.

During the study period, open sleeve gastrectomy with transit bipartition (SG-TB) operation was performed in a total of 1510 patients, and MD was found in 24 (1.6%) of them. In the same period, 455 patients underwent open one-anastomosis gastric bypass (OAGB) operation and MD was found in 10 (2.1%) of them. Overall incidence was found to be 1.7%. Median SG-TB operative time including MDR was 135 minutes (IQR: 120-150) and the median duration of this additional MDR procedure was 15 minutes (IQR: 10-20). Median OAGB operative time was 105 minutes (IQR: 90-120). The detected MDs were located at a median distance of 80 cm (IQR: 70-90) from the ileocecal valve. None of the patients developed intraoperative or postoperative complications related to diverticulectomy (for the MDR-P group) or related to MD (for the MDR-N group).

Discussion

To our knowledge, this is the first study to compare the outcome of resection or non-resection of incidental MD detected during BMS. In the present study, no early or late postoperative complications were seen patients in the

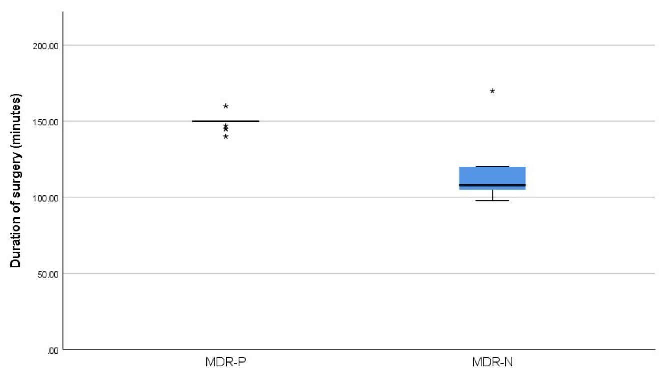

Figure 2. Duration of surgery with regard to the diverticulectomy.

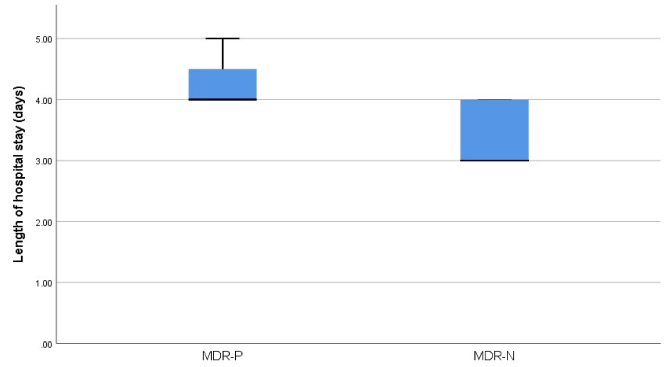

Figure 3. Length of hospital stay with regard to the diverticulectomy.

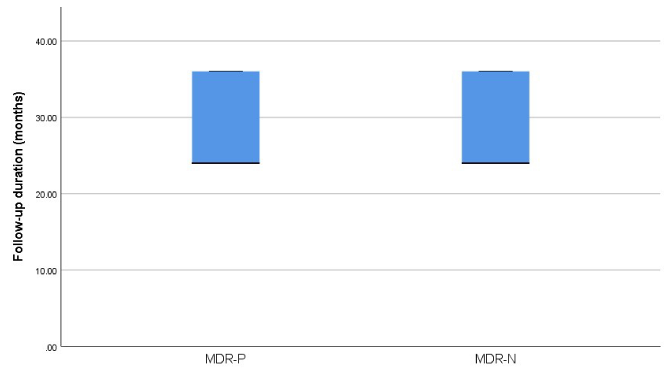

Figure 4. Follow-up duration with regard to the diverticulectomy.

MDR-P or the MDR-N groups.

The OAGB surgery can be thought of as a modification of RYGB. Because OAGB bypasses a relatively greater proportion of the small bowel, there may be a higher likelihood of needing micronutrient supplementation compared to RYGB [16]. Transit bipartition is designed to increase the metabolic effects of conventional SG in addition to bariatric effects. After SG is performed, a gastroileal anastomosis is created in the antrum and an additional side-to-side (lateral) enteroanastomosis is created 80-120 cm proximal to the cecum [17]. Because TSBL can vary between 2.5-13 meters [2], in some BMS procedures it is recommended to measure the TSBL to determine the optimal length of the portions to be bypassed [18]. However, when MD is encountered during TSBL measurement, the approach to the BMS procedure and whether MDR should be performed are unknown.

MD is the most common anomaly of the GIS and typically located within 100 cm proximal to the ileocecal valve [13]. MD-related complications have been reported as the basis for additional interventions after BMS, albeit rarely [3,19]. Although MDs are mostly asymptomatic and they are often diagnosed incidentally [3], considering the potential effects on BMS surgery we aimed to investigate whether resection or non-resection of MD were associated with BMS outcome. Therefore, due to the proximity of the distal enteroanastomosis of SG-TB to the MD, and because our patients had T2DM, we resected any MD that was detected during SG-TB surgery. Close follow-up was carried out to assess possible adverse outcomes of MDR. OAGB, due to the distance of the anastomosis from the MD, resection was not performed, since we considered that the risk of MD complications in these patients was the same as in any abdominal surgery. After surgery, we followed the patients for possible MD-related complications. No complications were recorded in the two groups. In patients undergoing SG-TB, we believe this approach protected the patient from possible anastomosis-related complications that may have developed in relation with the proximity of MD. In patients undergoing OAGB, resection of incidentally detected MDs does not seem to be necessary. Because no MD-related complications were found in the follow-ups.

In the literature, there are no studies which have specifically assessed MD and MDR in patients who underwent BMS. However, research that has provided additional information about MD exist. Sohn et al. reported the rate of incidental MD as 1.2% in 427 patients who underwent open RYGB with routine extirpation of the gallbladder and appendix [10]. In a patient with a history of RYGB, small bowel intussusception due to MD developed years after the primary operation and the patient had to be operated again. Abelson et al., who presented this case, concluded that if MD had been resected during primary surgery despite the postoperative risks, the patient would not have required a second surgery [13]. In a prospective study ($n = 400$), unanticipated findings during open RYGB were investigated, and a large MD was reported in a single patient [19]. Peterli et al. reported that 16 of 110 patients who underwent RYGB required reoperation for various reasons, and only 1 of them was reported to be due to MD [11]. In another study, only 2 of the 104 patients requiring complementary surgery after 301 laparoscopic RYGB had undergone further intervention due to MD-related complications [12]. In these last two studies, none of the reoperations after laparoscopic sleeve gastrectomy (SG) were caused by MD [11,12]. In another study, 1 of 73 patients who underwent laparoscopic SG required reoperation for lysis of adhesion & MDR after 30 months for intermittent abdominal pain [20].

Only 4% of patients with MD experience symptoms throughout their lifetime, and more than 50% of symptomatic patients are under 10 years of age [4,6,21]. Non-resected MD may bleed, become infected, cause intestinal intussusception and obstruction, or even become a focus of cancer [3,13,18]. Kruljac et al. reported a case of MD that was resected during biliopancreatic diversion and histopathological examination confirmed a carcinoid tumor [18]. Complicated MD can result in serious conditions such as perforation and subsequent peritonitis [4]. On the other hand, MD resection also carries the risk of additional complications. In one study, 202 patients with T2DM with a BMI below 35 underwent laparoscopic ileal interposition (associated with SG) and it was found that 2 of these patients also underwent MDR after incidental detection. Unfortunately, one of these patients died in the early postoperative period due to dehiscence from diverticulectomy-induced abdominal sepsis [22]. In another study, 1 of 170 patients who underwent biliopancreatic diversion died in the early postoperative period due to hemorrhage at the level of the resection of an incidentally-detected MD [23]. Some researchers argue that intraoperative incidental MD should be resected [7,8], others argue that it should not undergo resection, considering that most of the MD complications are encountered in the early stages of life and prophylactic MD removal may cause life-threatening complications [6,9]. We did not encounter any complications from MD or MDR in the present study.

There is no disagreement regarding the resection of all complicated MD [3,4]. For cases other than these, some risk factors associated with increased risk of complications have been described. The most investigated criteria for the surgical necessity of incidental MD are based on the detection / assessment of the following: presence or absence of ectopic tissue, palpation of MD thickening, and the width of the diverticulum base [3,24,25]. On the other hand, a study reporting experience from 1476 patients with MD reported that $<$50 years of age, male sex, diverticulum length greater than 2 cm, and the presence of histologically abnormal tissue within a diverticulum were all associated with symptomatic MD. However, they did not find width and length-width ratio to be associated with the risk of complications. They also stated that, if one, two, three or four of these factors were present, the risk of complications was estimated to be 17%, 25%, 42% and 70%, respectively. As a conclusion, they recommended prophylactic MDR in the presence of any of these four factors [26]. There is no data in the literature on the results of MD or MDR in patients undergoing SG-TB or OAGB. Although we did not find any complications in any of the patients with and without MDR in the present study, it is difficult to make a definitive recommendation. More clear recommendations can be developed in randomized controlled studies with long-term follow-up and more cases, including control groups with SG-TB but not MDR, and OAGB and MDR. The management of incidental MD encountered during BMS can also be carried out by considering above mentioned risk factors in other studies.

Conclusion

Resection of incidental MD during SG-TB and non-intervention of incidental MD during OAGB did not cause any complications in short and mid-term follow-up. We still think that patients should be informed about the risks of all possibilities and the intervention should be determined according to the patient's decision. However, to reach a definitive conclusion regarding the management of MD encountered during these two (and possibly other BMS procedures), comprehensive studies with a larger number of participants and diversified control groups are necessary, especially with investigation of other risk factors.

Limitations

This study has some limitations. Since it is a single-center study the generalizability of its results is limited. Since incidental MD is relatively rare and the patient population consists of only patients with BMS, the number of people in our study was also limited. As it is a retrospective study, new data could not be included and the follow-up period was limited. Due to the short/mid-term follow-up period in the study, future complications related to MDR or non-resected MD may not have been detected. In particular, the fact that the surgical procedures and T2DM presence were the main differences that distinguish the groups may be considered as important confounding factors. Inclusion of patients who underwent SG-TB but did not undergo MDR, and patients who underwent OAGB & MDR would have provided more objective data. Results are limited to these two surgical procedures only and do not cover all bariatric patients. Lastly, as there is no study investigating the relationship between MD and these two BMS procedures, the results of the study cannot be directly compared to literature outcomes due to novelty.

Ethics approval

Ethical approval of this case-control study was acquired from the Ethics Committee of Near East University Faculty of Medicine (date:28.04.2022, no:1514).

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