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Evaluating the Impact of Preoperative CT scans in Revisional Bariatric Metabolic Surgery: A Single-Institute Experience.

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ABSTRACT:

Background: Radiology can play an essential role in planning and assessment, with the techniques of virtual gastroscopy (VG) or abdominopelvic computerized tomography (APCT) scans.

Method This retrospective study aimed to determine the outcomes of APCT imaging and VG in revisional surgery that impact the decisions for BMS procedures. Group 1 did not affect the surgical plan, and Group 2 directly impacted it, either postponing, modifying it into concomitant/staged surgery, or changing the BMS procedure.

Results: A total of 277 revisional BMS patients underwent a preoperative APCT scan. The incidence of a finding on the APCT was 24.2%, with a direct impact observed in 25.4%. In group 2, 5.4% of the plans were altered (p=0.001), specifically from one anastomosis gastric bypass (OAGB) to laparoscopic sleeve gastrectomy (LSG) due to suspected Crohn's disease. Additionally, 57.9% of surgeries included concomitant procedures. One hundred sixty patients with larger stomach volumes (634±95.3 ml), 63.6% had hiatal hernias with reflux Los Angeles (LA) class B, prompting shifts to roux-en-y-gastric bypass (RYGB) or OAGB from re-LSG procedures. For patients with previous vertical banded gastroplasty (VBG), 10.0% had their surgery plan changed from RYGB to LSG after detecting disrupted staple lines.

Conclusion This study underscores the vital impact of APCT and VG imaging on refining surgical plans in revisional BMS, revealing their key role in detecting critical conditions that necessitate changes in surgical strategy. It emphasizes the importance of collaborative decision-making between radiologists and surgeons to enhance patient outcomes and safety.

Keywords: CT scan, abdominopelvic computerized tomography, revisional surgery, bariatric surgery, postponing, Virtual gastroscopy

Key points:

1. APCT and VG imaging directly impact surgical plans in revisional BMS by identifying conditions requiring changes in the surgical approach.
2. Diagnoses from preoperative scans prompt significant adjustments, including surgical method modifications or delays.
3. The study emphasizes the need for close cooperation between radiologists and surgeons to optimize patient care and safety in revisional BMS procedures

INTRODUCTION

Radiological assessment techniques, including ultrasound (US) and abdominopelvic computerized tomography (APCT) scans, are crucial in enhancing preoperative planning and assessment. By identifying new preoperative findings, these methods allow for necessary adjustments to surgical plans, thereby improving surgical preparedness. Without such preoperative radiological evaluations, surgeons may encounter unexpected intraoperative findings, increasing the risk of surgery termination, complications, or other adverse outcomes due to insufficient preparation. A study by Joo et al. found that intraoperative findings occurred in 29.3% of cases. The operative plan was changed by 0.9%, and surgery interruption was by 1.2%, but no increased morbidities or extra length of stay were noticed (Joo et al., 2019). Furthermore, radiology also has the critical role of adjusting the bariatric metabolic surgery (BMS) plan during workup because concomitant procedures are possible after the radiologist's finding, like—cholecystectomy or treating hernia defects, whereby no association with increased morbidity, mortality, or postoperative complications were noted

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(de Lucena et al., 2022; Doulamis et al., 2019; Mahawar et al., 2015; Shada et al., 2018). A potential drawback of employing radiology and APCT scans during the preoperative phase is the significant resource consumption.

A study by Lesourd et al. tested preoperative APCT scans for malignancy in patients undergoing BMS. An abdominal APCT scan could not be advocated to seek cancer before bariatric surgery since it was only found in 0.6% of malignancies (Lesourd et al., 2021). Furthermore, Virtual gastroscopy (VG) has emerged as a valuable diagnostic tool in the preoperative work-up of patients undergoing BMS (El-Sayes et al., 2021). It provides essential information and guidance for surgeons in selecting the most suitable surgical procedure, leading to improved outcomes and reduced risks (El-Sayes et al., 2021). This study aimed to determine the outcomes of APCT imaging and VG findings that impact the decisions for revisional BMS procedures.

Methods

This retrospective cohort study analyzed medical records from a Medical Research Institute, Alexandria University, Alexandria, Egypt, between March 2017 and Jan 2022 before revisional BMS. The study was approved by the appropriate ethics committee and performed in accordance with the ethical standards of the 1964 Declaration of Helsinki. All patients provided informed consent for the data to be published for research.

All patients received ultrasound examination and laboratory testing. Furthermore, every patient was assessed by a multidisciplinary team (MDT) consisting of a surgeon, internist, dietician, and psychiatrist.

Inclusion of APCT scan and virtual gastroscopy

All patients selected for revisional BMS as a preoperative assessment got a virtual gastroscopy and APCT to assess potential anatomical alterations.

Decision and strategy definitions

Group 1: This did not affect the revisional surgical plan but needed to inform the patient to follow up and/or further investigations after revisional surgery and recovery.

Group 2: Directly impacted the revisional surgical plan, either postponing, modifying it into concomitant/staged surgery, or changing the revisional BMS procedure.

APCT examination and technique

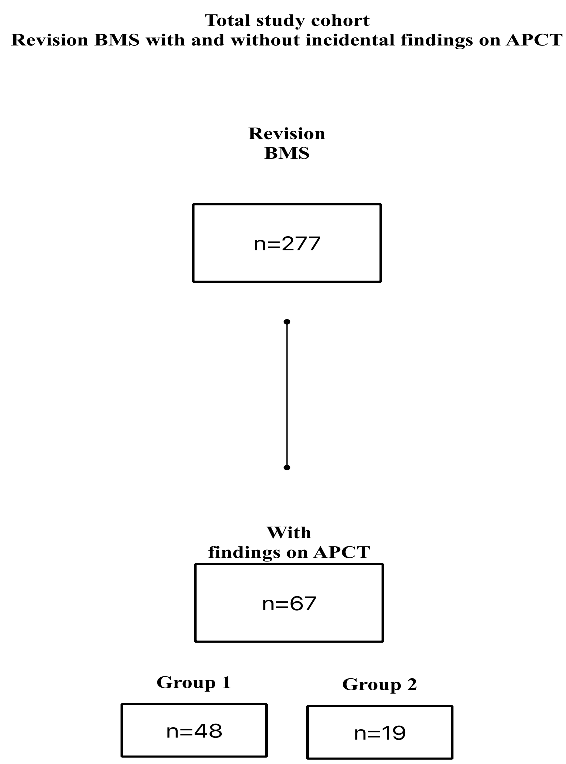
A multi-detector computed tomography MDCT virtual gastroscopy and 3D reconstruction were performed. Image acquisition was performed in the supine position and limited to the stomach, which is adequately inflated with gas on the topo gram (El-Sayes et al., 2021). A full description of the techniques, including triphasic CT of the liver, the CT pancreatic protocol, and the four-phase technique, is in Appendix 1

Statistical analysis

Descriptive and inferential statistics were used for the analyses. All data were tested for normality using the Kolmogorov-Smirnov, Q-Q plot, and Levene’s tests. Categorical variables are expressed as numbers and percentages. Normally and non-normally distributed continuous variables are presented as means, standard deviations (SDs), medians, and interquartile ranges. When appropriate, categorical variables were tested using Pearson’s chi-square test or Fisher’s exact test. A post-hoc analysis was performed with a chi-square test with Bonferroni correction. *P*-values < 0.05 were considered statistically significant. Statistical analyses were performed using R-studio (version 4.0.4).

Results

A total of 277 patients were identified from the hospital records for revision surgery. From this cohort, 67 (24.2%) had a finding on the APCT scan (Flow chart figure 1)



Baseline demographics

Of the 67 patients, females were present in groups 1 and 2, 48.6% and 51.4% of the time. Age was mean±sd 37.6±7.9, and BMI 50.4±6.6. Both groups' baseline demographics were insignificant (p=0.775, 0.324, 0.539) (Table 1).

For the associated medical problems, hypertension, and fatty liver significantly differed between the groups but did not correlate with group 2, which directly impacted the surgical plan (Table 1, 2).

Indication for revision surgery

In total, weight regain (WR) contributed at 54.9%, followed by WR with acid reflux at 38.0%, bile reflux at 2.8%, WR combined with bile reflux at 2.8%, and malnutrition at 1.5% of cases.

Table 1 Demographics with findings on APCT scan

n=67	Group 1 (n=48)	Group 2 (n=19)	P value
Gender Female	23 (48.6%)	10 (51.4%)	0.775
Age	35.8±8.4	39.4±7.4	0.324
BMI	49.0±8.7	51.8±4.5	0.539
Smoking	12 (24.3%)	4 (23.1%)	0.986
ASA score 1	12 (24.3%)	8 (40.5%)	0.158
2	17 (35.1%)	5 (29.7%)	-
3	9 (18.9%)	4 (21.6%)	-
4	10 (21.6%)	2 (8.2%)	-
Associated medical problems Present n (%)			
Hypertension	15 (31.1%)	0 (0.0%)	0.005
DM	12 (24.3%)	2 (7.7%)	0.139
Dyslipidemia	4 (8.1%)	0 (0.0%)	0.095
Fatty liver	36 (75.7%)	12 (61.5%)	0.002

APCT= abdominopelvic computerized tomography, BMI=Body mass index, ASA=American society of anesthesiologist classification, DM=Diabetes mellitus

Table 2: Decision before and after APCT

Index surgery	Group 1 N=48	Group 2 N=19	P value
Gastric band	21 (35.1%)	7 (35.1%)	0.002
OAGB	6 (13.5%)	3 (16.2%)	
RYGB	2 (4.1%)	1 (5.4%)	
LSG	13 (27.0%)	4 (21.6%)	
VBG	6 (13.5%)	4 (21.6%)	
Decision before CT			P=0.004
OAGB	8 (17.6%)	3 (16.2%)	
RYGB	14 (28.4%)	5 (24.3%)	
LSG	26 (54.0%)	11 (59.5%)	
Final surgery procedure after diagnoses			Between decision before and final surgery. P value 0.0023
OAGB	8 (17.6%)	2 (10.8 %)	
RYGB	14 (28.4%)	5 (24.3%)	
LSG	26 (54.0%)	12 (64.9%)	

OAGB= one anastomosis gastric bypass, RYGB= to roux-en-y-gastric bypass, LSG= laparoscopic sleeve gastrectomy, VBG= vertical banded gastroplasty

APCT scans outcomes

The radiology identified 38 different findings or diagnoses on the APCT scan (p=0.0023). In some instances, extra diagnostics testing or treatments before surgery were necessary by US-guided aspiration, Magnetic resonance imaging (MRI), magnetic resonance cholangiopancreatography (MRCP), Endoscopic retrograde cholangiopancreatography (ERCP), laboratory testing, biopsy, embolization, or surgical excision (Table 3 and 4).

Decision and strategy outcomes

Group 2 had 19 patients. There were 11 APCT findings/diagnoses and six final diagnoses (Table 4).

Impact on the surgical decision and strategy after APCT

Postponed

Among the 19 patients, stratification analysis revealed that the procedure was postponed for 31.5% (6 patients) due to various conditions (Bosniak III, non-Hodgkin lymphoma, Hydatid cyst, Early Intraductal papillary-mucinous tumor (IPMT).

Change surgical approach

A significant change in surgical approach was necessary for two patients (10.5%) undergoing revision surgery, specifically from OAGB to LSG, after Crohn's disease was confirmed through endoscopic and percutaneous tissue biopsy.

Concomitant surgeries

Additionally, concomitant surgeries were conducted alongside revisional BMS for 57.9% (11 patients). These procedures addressed various conditions, including ovarian tumors, large hiatal hernia, and Chocolate cysts, without necessitating a change in the revisional BMS approach (Table 4).

Table 3: Decisions and Strategies Group 1

APCT findings	Extra diagnostics testing before surgery /decision	Final diagnoses	Revision N= 48
Pancreatic tail lesion	MRI of the pancreas	Ectopic splenule	n=1
Abdominal wall nodule	MRI	Endometrioma	n =1
Distal Common bile duct stone	Preoperative Endoscopic retrograde cholangiopancreatography	-	n = 2
Hepatic focal lesion	Ultrasound-guided biopsy	Atypical focal steatotic nodule, Adenoma, Hemangioma,	n = 3
Mesenteric cyst	Preoperative US-guided aspiration	Lymphatic cyst	n = 2
Pancreatic cyst	MRI of the pancreas and follow up	Simple cyst	n = 2
Renal angiomyolipoma	Imaging and planned embolization	-	n = 1
Solid renal mass	Radiological guided biopsy	Oncocytoma	n = 1
Adrenal nodule/ Adenoma	n.a.	Follow-up	n = 5
Chronic Portal Vein thrombosis	n.a.	Follow-up	n = 1
Colonic diverticulosis	n.a.	Follow-up	n = 1
Diaphragmatic mesothelial cyst	n.a.	Follow up	n = 1
Diverticulosis	n.a.	Follow-up	n = 2
Hepatic focal lesion/ Haemangioma	n.a.	Follow up	n = 1
Hypoplastic hepatic segment	n.a.	Follow up	n = 2
Large pelvic varicosities/ Pelvic congestion syndrome	n.a.	Follow up	n = 1
Uterine fibroid	n.a.	Follow up	n = 4
Median arcuate ligament syndrome	n.a.	Follow up	n = 1
Mesenteric panniculitis	n.a.	Follow up	n = 4
Mild splenomegaly/ Non-specific mostly post-infection	n.a.	Follow up	n = 3
pelvic inflammatory disease (PID)	n.a.	Follow up	n = 1
Splenic infarct	n.a.	Follow up	n = 2
Splenosis	n.a.	Follow up	n = 1
Tailgut cyst	n.a.	Follow up	n = 1
Splenic focal lesion/ Haemangioma	n.a.	Follow up	n = 2
Multiple hepatic cysts	n.a.	Follow up	n = 2

Table 4: Decisions and Strategies Group 2

APCT findings	Extra diagnostics testing/	final diagnoses	Decision	Revision N= 19
Complex renal cyst	Ultrasound-guided aspiration	Renal cyst Bosniak III	Postponed	n= 3
Ileitis	Colonoscopy and biopsy	Suspected Crohn’s disease	Change of BMS surgery	n = 1
Ileitis-appendicitis	Colonoscopy and biopsy	Suspected Crohn's disease	Change of BMS surgery	n = 1
Large abdominal lymph node	Ultrasound-guided biopsy Non-hodgkin's lymphoma	NHL (retro pancreatic node)	Postponed	n = 1
Large hepatic cyst	Laboratory testing	Hydatid cyst	Postponed	n = 1
Pancreatic cyst	MRI of the pancreas	Early Intraductal papillary-mucinous tumor (IPMT)	Postponed	n = 1
Ovarian dermoid cyst	Surgical excision	(-)	Concomitant surgery with BMS	n = 2
Large ovarian cyst	MRI of the pelvis	Chocolate cyst	Concomitant surgery with BMS	n =2
Large hiatal hernia	Endoscopy	(-)	Concomitant surgery with BMS	n =3
Ovarian dermoid cyst	Surgical excision	(-)	Concomitant surgery with BMS	n = 2
Large uterine fibroid	MRI of the pelvis and myomectomy	(-)	Concomitant surgery with BMS	n = 2

MRI=Magnetic Resonance Imaging

Virtual gastroscopy outcomes

In total, 277 patients in the revision surgery group outcomes of the virtual gastroscopy (VG) revealed diverse stomach volumes across different BMS procedures: vertical banded gastroplasty (VBG) patients had an average volume of 1900 ml (range 1600-2200 ml), LSG patients had 310 ml (range 175-1200 ml), gastric band patients had 1850 ml (range 1600-2100 ml), one anastomosis gastric bypass (OAGB) patients had 190 ml (range 170-240 ml), and Plication patients had 1475 ml (range 1000-1950 ml). VG findings informed the revision surgery planning for 210 patients, identifying an average stomach volume of 409±70.2 ml with no reflux in 31 (14.8%) patients. Re-LSG was decided to perform. In a subgroup of 160 patients with larger stomach volumes (634±95.3 ml), 63.6% (102 patients) had hiatal hernias with reflux LA class B, necessitating revisions to roux-en-y-gastric bypass (RYGB) or OAGB as re-LSG was deemed unsuitable by the multidisciplinary team (MDT) (Table 4).

Anatomical evaluations in the VBG subgroup revealed that 80.0% had intact staple lines, 10.0% experienced staple line disruptions, and 10.0% had minor disruptions (Table 5)

Table 5: The volume of the stomach in revision surgery previous operations

	In ML median (min-max)
VBG	1900 (1600-2200)
LSG	310 (175-1200)
Gastric Band	1850 (1600-2100)
OAGB	190 (170-240)
Plication	1475 (1000-1950)

OAGB= one anastomosis gastric bypass, RYGB= to roux-en-y-gastric bypass, LSG= laparoscopic sleeve gastrectomy, VBG= vertical banded gastroplasty

Vertical banded gastroplasty

Moreover, for patients previously treated with VBG, 10.0% had their initial RYGB surgery plan changed to LSG due to disrupted staple lines identified via VG, a statistically significant decision on the forehand (Table 6)

Table 6: Anatomical changes in the vertical banded gastroplasty group

VBG n=10	
Staple line	
Intact n (%)	8 (80.0%)
Disruption n (%)	1 (10.0%)
Minor Disruption n (%)	1 (10.0%)
Volume above mesh (ml)Median (min-max)	50 (30-180)

VBG= vertical banded gastroplasty

Discussion

This retrospective cohort study analyzed medical records from a bariatric metabolic surgical clinic before revisional BMS. The incidence of patients with an APCT finding was 24.2%. Radiology identified 38 different findings or diagnoses on the APCT scan. Among the patients in group 2, three different surgical decisions were applied: postponing surgery, BMS change, and concomitant surgery with revisional BMS.

A study by Lesourd et al. (Lesourd et al., 2021) and our study investigated the usefulness of preoperative APCT scans in BMS. Lesourd et al. found cancer in 0.6% of cases, while our study focused on patients with specific complaints, pain, a family history of malignancy, or chronic granulomatous/autoimmune disease. Lesourd et al. reported a higher incidence of APCT findings (75.2%) than our study (24.0%). The difference can be attributed to different inclusion criteria and a higher false positive rate in Lesourd et al.'s study. Our study showed that a proportion of 11.9% of findings directly impacted surgical decisions.

Role of virtual gastroscopy in revisional surgery

Although VG is not commonly used in BMS, its effectiveness has been demonstrated in weight loss assessment and laparoscopic gastroscopy for gastric cancer (Hany, Torensma, Zidan, et al., 2022; Hayashi et al., 2016; Takiguchi et al., 2015).

At our clinic, patients seeking revisional surgery often prefer laparoscopic sleeve gastrectomy (LSG) due to insufficient weight loss or weight regain accompanied by an enlarged stomach volume. In such cases, VG plays a crucial role in decision-making by detecting GERD absence through endoscopy and informing optimal surgical strategies. Furthermore, VG can identify larger sleeve volumes and confirm GERD presence, prompting consideration of alternative revision surgeries such as Roux-en-Y gastric bypass (RYGB) or one-anastomosis gastric bypass (OAGB) instead of re-performing LSG (Hany, Zidan, et al., 2022). Consistent with our findings, 63.6% (102 patients) had hiatal hernias with reflux LA class B, necessitating revisions to RYGB or OAGB as re-LSG was unsuitable.

It is important to note that RYGB is generally preferred for GERD treatment and is known for its high rates of GERD resolution (Felsenreich et al., 2022; Parmar & Mahawar, 2018). However, OAGB is not recommended for patients with GERD due to concerns about bile reflux, although its efficacy and safety have been reported in some studies (Eskandaros, 2021; Parmar & Mahawar, 2018). In the case of vertical banded gastroplasty (VBG), VG outcomes guide surgical decision-making. A longer pouch above the mesh suggests OAGB, while a shorter pouch indicates RYGB as the appropriate choice (Department of Surgery, Medical Research Institute, Alexandria University, Egypt. & Ibrahim, 2019; Hany, Torensma, Ibrahim, et al., 2022). If the stapler line is disrupted, conversion to LSG can be considered a safe and accessible option without mesh removal or endoscopic intervention (Benlice et al., 2018).

Our CT findings highlight the crucial role of early diagnosis in facilitating prompt treatment. In our study, 31.5% of postponed surgical cases were attributable to diagnoses needing subsequent therapy. Notably, large abdominal lymph nodes, subsequently diagnosed as non-Hodgkin lymphoma (retro pancreatic node) and sarcoidosis, were found in 29.7% of cases, warranting treatment delay. Similarly, in 10.8% of cases, US-guided aspiration detected complex renal cysts with a Bosniak III designation, revealing the importance of BMI as a risk factor for malignancy (Goenka et al., 2013). Hence, early detection offers substantial patient benefits. In our study, more than half of the patients (57.9%) underwent concomitant surgery (CS) with revisional BMS based on APCT or virtual gastroscopy findings. CS included procedures such as gynecological surgery on the ovaries, general surgery for hiatal hernia, gastric gastrointestinal stromal tumor (GIST), and urology surgery for large uterine fibroids.

A systematic review (SR) on CS in BMS demonstrated comparable mortality rates between CS and BMS groups, with a slightly higher complication rate in the CS group (OR 1.2, 95% CI 1.1-1.3) (Xia et al., 2021). In group 2 of our study, 21.6% of cases had a hiatal hernia (HH) [29]. HH repair during BMS conversion surgeries varied, with rates reported at 24.1% for LSG to RYGB conversions and 20.2% for adjustable gastric band to LSG conversions [29]. Another study highlighted the benefits and safety of concomitant HH repair (incidence of HH in 30.4% of patients) during LSG procedures (Hider et al., 2022).

Gastrointestinal stromal tumors (GIST) were found at a low incidence during BMS (1.97%). Radical surgical resection of GIST during LSG can help prevent missed diagnoses and optimize patient outcomes (Hallak et al., 2022).

Limitations

Our study, a retrospective cohort analysis on a select patient group, comes with certain limitations. Firstly, missing data could have introduced potential bias or confounding factors. Incomplete pathological reports for some excised lesions or organs further contribute to the limitations. Pain patterns weren't characterized, limiting our understanding of different abdominal pain types and their impact on surgical decisions.

The study also needs to fully explore the challenges of interdisciplinary collaboration, especially regarding referral responsibilities and diagnosing and treatment initiation roles. Finally, we did not examine the ultrasound results since this study focused only on the CT scan.

The study's single-center focus should also be considered, as the results may only apply to some populations or healthcare settings, particularly outside academic medical centers.

Conclusion

This study clarifies the selective but pivotal role of APCT scans and VG in revisional BMS surgical planning, challenging the assumption of their use. Our data reveal that APCT scans can decisively alter surgical decisions or delay surgery for specific indications, advocating for a targeted approach. It emphasizes the importance of collaborative decision-making between radiologists and surgeons to enhance patient outcomes and safety.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical approval

All procedures involving human participants were performed in accordance with the ethical standards of the institutional and/or national research committee and the guidelines of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants in the study

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