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ORIGINAL CONTRIBUTIONS

Thoracic Complications of Bariatric Surgeries: Overlooked Entities

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Abstract

Introduction Bariatric surgeries are increasingly performed to treat obesity worldwide. The currently available literature on these surgeries mainly focuses on their abdominal complications, giving less attention to their thoracic ones. Hence, the present work aimed to highlight the thoracic complications associated with bariatric surgeries.

Methods A retrospective descriptive study was performed and involved the review of the medical charts of 390 patients who underwent different bariatric surgeries between January 2014 and January 2017 in our hospital or who were referred to us from other centers after their specific operations. The data of patients who developed thoracic complications and who required further intervention were identified and categorized by the modality of diagnosis, outcome, duration of hospital and ICU stays, and management. Patients with a history of a preexisting pulmonary disease were excluded.

Results Twenty-six patients were observed to have thoracic complications secondary to their bariatric surgeries. Twenty-two patients (84.6%) received post-laparoscopic sleeve gastrectomy (LASG). Nine patients (34.6%) required ICU stays. Twenty patients (76.9) had incidences of pleural effusion in the postoperative period. The mean duration of hospital and ICU stays were 4.4 ± 11.67 days and 15 ± 19.36 days, respectively. Other reported thoracic complications included esophageal perforations, thoracic empyema, septic pericardial effusion, and pancreaticopleural fistula.

Conclusion Bariatric surgeries are safe procedures in selected patients. There is a significant amount of literature describing abdominal, nutritional, neurological, and even ophthalmic complications after bariatric surgeries. Being that they are relatively rare, thoracic complications are underreported in the literature. The management of thoracic complications after bariatric surgery requires awareness and a high index of suspicion to prevent further morbidities and mortalities.

Keywords Bariatric surgery · Esophageal perforation · Empyema · Pleural effusion · Thoracic complication · Obesity

Introduction

Obesity is emerging as a leading epidemic condition worldwide [1]. Saudi Arabia has witnessed an alarming increase in the prevalence of this condition [2]. It has been associated with an increase in medical and financial burdens. The WHO has documented that obesity is a significant contributor to ill-health, disability, and mortality in many regions of the world [3]. Various modalities have been mentioned in the literature for the management of obesity. Bariatric surgeries have gained global acceptance for their clinical efficacy, as they provide better results concerning weight loss and low-associated comorbidities compared with other nonsurgical interventions [4]. There are a wide variety of bariatric procedures being globally performed. Laparoscopic sleeve gastrectomy is the most frequently performed procedure in American and Asian nations [5]. Bariatric surgery has excellent outcomes; however, there are several known complications that can develop as a result of this surgery, such as nutritional, gastrointestinal, and neurological complications [6]. The current literature mainly focuses on the abdominal complications that may result after bariatric surgery, thus providing less attention to other clinical effects [6]. Thoracic complications are relatively rare; hence, they are underreported in the literature. Nevertheless, these complications sometimes require further investigations and definitive management. The present work aimed to

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highlight the thoracic complications associated with different bariatric procedures currently performed.

Materials and Methods

We conducted a retrospective, descriptive study based on the review of the medical charts of 390 patients between January 2014 and January 2017. These patients underwent different bariatric procedures that were either performed in our institution (373 patients) or that involved patients who were referred to us from other hospitals (17 patients). Twenty-six patients had thoracic complications after different bariatric procedures. The bariatric procedures performed included laparoscopic sleeve gastrectomy (LASG), laparoscopic adjustable gastric banding (LAGB), laparoscopic Roux-en-Y gastric bypass (LRYGB), and laparoscopic biliopancreatic diversion (LBPD). One patient underwent an intragastric balloon insertion (IGB). The demographic data of the study population were collected. The data of patients with thoracic complications who required further interventions were identified and analyzed. Patients with a history of preexisting pulmonary diseases were excluded. Thoracic complications that occurred in the postoperative period were identified and individually categorized by their modality of diagnosis, outcome, length of ICU and hospital stays, and management that was offered to those patients.

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

Results

Out of the 390 patients who underwent bariatric procedures during the study period, 26 patients were observed to have thoracic complications and met the inclusion criteria. Nine patients (34.5%) underwent bariatric procedures in our hospital (group I), while 17 patients (65.5%) were referred from other hospitals with different thoracic complications (group II). The data of those 26 patients were subjected to further analysis. The demographic characteristics of the study population are summarized in Table 1.

In our population of patients, LASG was the most common bariatric procedure to be followed by thoracic complications (22 patients—84.6%) and pleural effusion was observed to be the most common thoracic complication (20 patients—76.9%). Three patients (9.1%) underwent revisions of bariatric procedures. Only two patients underwent LAGB (7.6%) and one of these patients underwent a revision to Roux-en-Y esophagojejunostomy after gastric band migration and the erosion of the stomach and the abdominal esophagus. Moreover, one patient (3.8%) underwent LBPD and one patient (3.8%) underwent IGB insertion.

Nine patients (34.6%) required intensive care unit (ICU) admissions due to their thoracic complications. The mean duration of ICU and hospital stays were 4.4 ± 11.67 days and 15 ± 19.36 days, respectively. All of the thoracic complications and their specific management methods are summarized in Table 2.

Pleural Effusion

Twenty patients (76.9%) developed pleural effusion postoperatively. In 18 patients (69.2%), pleural effusion occurred after LASG, with one patient (3.8%) developing pleural effusion

Table 1 Demographic characteristics of the study population ($n = 26$)

	Group I (9 patients)	Group II (17 patients)
Age (years)*	38.6 ± 3.67	32.3 ± 2.32
Gender		
Male	4	12
Female	5	9
Total number of complications (%)	9 (34.6%)	17 (65.4%)
Primary complications		
Pleural effusion	9	10
Esophageal perforation	0	6
Empyema and septic pericarditis	0	1
Secondary complications		
Pleural effusion	0	1
Empyema	0	4
Duration of pleural effusion (days)*	5.9 ± 3–1	20.8 ± 6.79
ICU stay (days)*	0.1 ± 0.11	6.7 ± 3.40
Hospital stay (days)*	9.3 ± 1.92	17.9 ± 5.64

*mean ± SD

Table 2 Thoracic complications after bariatric surgery

Initial thoracic complications [no.]	Bariatric procedure [no.]	Secondary thoracic complications [no.]	Management [no.]	Outcome [no.]	ICU admission [no.]
Thoracic esophageal perforation [5]	LASG [2]	Empyema [3]	Stent, drainage, and decortication [3]	Resolved [3]	Yes [5]
	LASG [1]*				
	LAGB [1]	Empyema [1]	Drainage [1]	Died [1]	
	IGB [1]	None [1]	Thoracotomy and primary repair [1]	Resolved [1]	
Abdominal esophageal perforation [1]	LAGB [1]**	Pleural effusion [1]	Percutaneous drain + thoracostomy tube [1]	Resolved [1]	Yes [1]
Empyema+ septic pericarditis [1]	LASG [1]*	None [1]	Decortication and pericardial window	Resolved [1]	Yes [1]
Pancreaticopleural fistula [1]	LBPD [1]	Pleural effusion [1]	Thoracostomy tube [1]	Resolved [1]	Yes [1]
Pleural effusion [18]	LASG [18]	None [18]	Thoracostomy tube [5]	Resolved [5]	Yes [1]
					No [4]
			CT guided drainage [1]	Resolved [1]	No [1]
			Conservative [12]	Resolved [12]	No [12]

No., number of patients

*LASG was revised to LRYGB

**LAGB was revised to Roux-en-Y esophagojejunostomy

after LRYGB and one patient (3.8%) developing pleural effusion after LBPD. The latter patient developed right pleural effusion due to a pancreaticopleural fistula (PPF). Twelve patients were conservatively managed (Fig. 1a, b). The other eight patients required a drainage procedure, in the form of a thoracostomy tube, in six patients, whereas CT-guided drainage was utilized for one patient and a thoracostomy tube and a percutaneous drain were utilized for another patient (Table 3). The duration of pleural effusion drainage ranged from 1 to 95 days (mean 15.7 ± 24.13 days).

Esophageal Perforation

Five patients (19.2%) developed a thoracic esophageal perforation (TEP) and one patient (3.8%) experienced gastric and abdominal esophageal erosions (AEP) from the migrated gastric band (Table 2). In four patients, an esophageal perforation occurred due to bougie advancement. In one patient, an esophageal perforation occurred due to band migration and erosion into the walls of the stomach and abdominal esophagus. In another patient, TEP occurred due to the inflation of IGB within the thoracic esophagus. The balloon migrated into the thoracic cavity.

Patients presented with symptoms of respiratory distress and high-grade fever. Radiological images included a chest X-ray and a chest computed tomography (CT) scan, which showed a pneumomediastinum; if empyema developed, loculated fluid in the pleural cavity and thickening of the pleura were detected. CT scans also showed the migrated balloon in the patient who underwent IGB (Fig. 2a, b). Contrast swallows confirmed the esophageal leakage.

Three patients were managed by the use of endoscopic stents and drainage of the empyema, after which a thoracotomy and decortication were performed. One of the patients received another endoscopy and reinsertion of another stent due to stent migration. One patient was solely managed by the use of drainage and died before any surgical intervention. Bariatric surgeries were revised in two patients: one patient initially received LASG and then received LRYGB, and the other patient initially received LAGB and then received a Roux-en-Y esophagojejunostomy. The patient with TEP after receiving a thoracic balloon inflation underwent a left thoracotomy, an extraction of the migrated balloon, and a primary repair of the esophagus (Table 2).

Empyema

Empyema was confirmed in four patients (15.4%) by the use of a CT scan due to the presence of loculated pleural effusion, pleural thickening, and pleural enhancement (with or without internal foci of air) (Fig. 3). Empyema was secondary to iatrogenic TEP and leakage in the pleural space. One patient was treated with a thoracostomy tube drainage, while the other

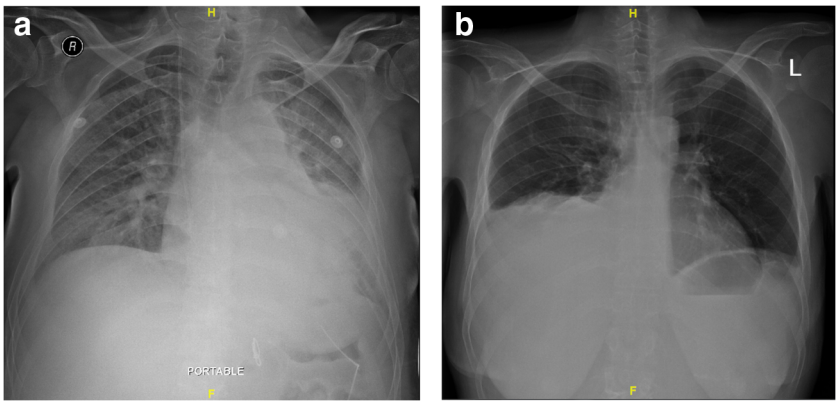

Fig. 1 **a** Chest X-ray showing a pleural effusion post-LSG. **b** Chest X-ray showing a pleural effusion post LBPD

three patients initially underwent thoracostomy tube drainage and were subsequently treated with a thoracotomy and decortication (Table 2).

Septic Pericardial Effusion

One patient (3.8%) developed septic pericardial effusion (Table 2). This patient initially underwent LASG, which was then revised to LRYGB due to staple line leakage. The patient developed an anastomotic leak and peritoneal collection, which then resulted in a left-sided thoracic empyema. At a later time, the patient became hemodynamically unstable and developed sepsis. The patient was admitted to the ICU and required inotropic support. Echocardiography showed a moderate pericardial effusion. The patient underwent decortication for the empyema, during which aspiration of the pericardial effusion revealed pus collection. The pericardium was drained and the pericardial window was created. The thoracostomy tube was left to drain the pericardium. The culture of the pericardial fluid revealed the presence of *Escherichia coli*, which was managed via antibiotics.

Pancreaticopleural Fistula

One patient underwent LBPD 8 years before her current presentation. Two months before her current presentation, the patient underwent an open partial revision of the BPD, with an elongation of the alimentary limb by 50 cm and an open cholecystectomy due to severe malabsorption. The patient was referred to our institution with a history of shortness of breath and right-sided chest pain. CT scans of the chest and upper abdomen showed right moderate pleural effusion, a heterogeneous cystic lesion in the posterior mediastinum, which was in continuity with multiple, loculated retropancreatic fluid collections, and pancreatic pseudocysts. A right thoracostomy tube was inserted. The pleural fluid was observed to have high amylase and lipase levels (3567 IU/L and 10,342 IU/L, respectively). Pancreaticopleural fistula (PPF) was suspected and conservative measures were initiated in the form of total parenteral nutrition (TPN), intravenous broad-spectrum antibiotics, and subcutaneous octreotide administration. After 4 weeks, the thoracostomy tube was removed and the patient was started on a low-fat diet. The patient was discharged after 6 weeks and demonstrated no evidence of recurrence during the 1-year follow-up period.

Discussion

Despite the improvement in the performance of bariatric surgical procedures, complications are not uncommon [7]. Thoracic complications following bariatric surgery, although

Table 3 Pleural effusion with respect to management, size, laterality and duration of drainage

Management (no.)	Size			Laterality		Duration of drainage[#] [days]
	Small	Moderate	Large	Left	Bilateral	
Conservative* (12)	12			11	1	None
Thoracostomy tube (6)	1	2	3	3	3	15.7 ± 24.13
CT-guided aspiration (1)			1	1		
Thoracostomy tube and percutaneous drainage (1)		1		1		

No., number of patients

*Early mobilization, incentive spirometry, hydration, and antibiotics accordingly

[#] Mean ± standard deviation

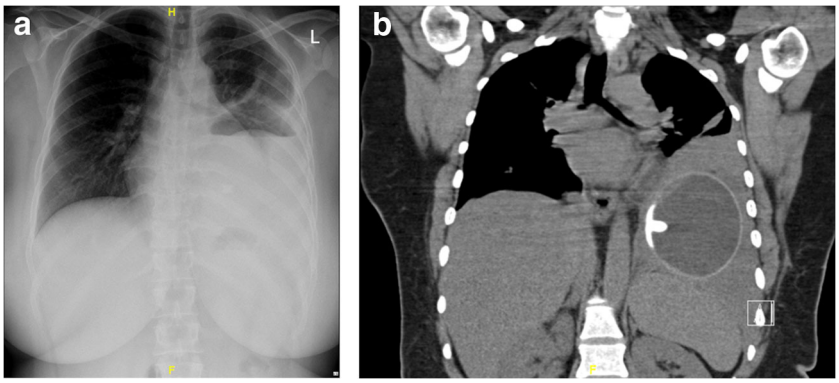

Fig. 2 **a** Chest X-ray and **b** Chest Computed Tomography (CT) scan showing pneumomediastinum, free fluid in pleural cavity, and migrated balloon in the patient who underwent IGB

rare, remain to be important components of the postoperative evaluation [8].

Pleural effusions may occur after different types of abdominal surgeries, with a higher rate of prevalence after upper abdominal operations, as reported by Light and George [9]. They stated that the pleural effusion may be due to intraoperative hypervolemia, the manipulation of pancreases, pulmonary embolisms, pulmonary atelectasis, subphrenic abscesses, and irritation of the diaphragm. Postoperative pleural effusion may also be secondary to thoracic and/or abdominal complications, e.g., esophageal perforations and/or peritoneal fluid collections from gastric or anastomotic leaks [10].

In our study, 12 patients with postoperative pleural effusion matched these criteria. Pleural effusions were conservatively managed if the effusion was presented early within the first 48 h, if the patient was asymptomatic, if the effusion was a left-sided effusion, if the effusion did not exceed 500 ml (with only an obliteration of the costophrenic angle), and if the effusion did not increase in size in the follow-up chest X-ray. In eight patients, pleural effusions occurred in situations of abdominal leakage and contamination. A large amount of effusions observed in the chest X-ray, the rapid accumulation and reaccumulation of effusions, and the presence of bilateral effusions in three patients, were indications for drainage, either via a thoracostomy tube or CT-guided pigtail drainage.

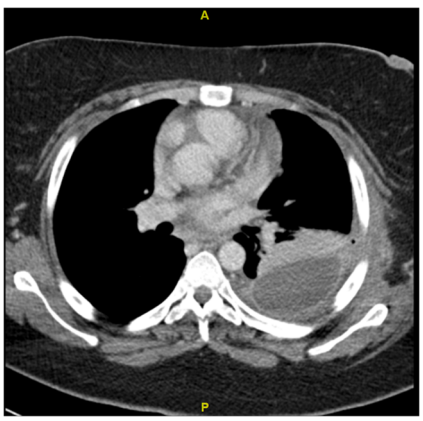

Fig. 3 (CT) scan showing a loculated pleural effusion with pleural thickening and enhancement with internal foci of air

Nelsen et al. reported that 89 patients who underwent upper abdominal surgery developed pleural effusions. They stated that the incidence of postoperative pleural effusion was the same, regardless of how extensive the surgery was [11]. In our study, 18 patients developed pleural effusions after LASG. This may raise the point that pleural effusions may be due to the type of surgery or the organ involved, rather than due to how extensive the surgery was.

Esophageal perforations following bariatric surgeries are life-threatening complications as they cause infectious and inflammatory responses that disseminate to the nearby vital organs [12]. Many case reports have described different mechanisms of iatrogenic esophageal perforations following different types of bariatric procedures. Esophageal perforations following IGB have been observed to occur due to the inflation of the balloon in the thoracic esophagus during insertion, as well as during the extraction of the balloon [13, 14]. Perforations of the middle or lower thoracic esophagus following both LAGB and LASG have been described in many case reports. The leading cause of perforations in these reports was esophageal instrumentation by a bougie or a calibrating balloon. [15, 16].

In our study, six patients had esophageal perforations after bariatric procedures. Three patients had thoracic esophageal perforations post LASG. In two patients, esophageal perforations occurred after LAGB: a thoracic perforation occurred in one patient and abdominal perforations occurred due to band migration and the erosion of the abdominal esophagus that is located just above the esophagogastric junction in the other patient. In one patient, TEP occurred after inflation of IGB in the esophagus.

In a systematic review that included almost 5000 patients who underwent different bariatric surgeries, it was observed that 79% of the anastomotic leaks were postoperatively detected after more than 10 days. For this reason, it is essential to maintain a high index of suspension if a patient presents with pleural effusion in the postoperative period of bariatric surgery, even if leaks or perforations were excluded by the use

of routine contrast imaging that is postoperatively performed within the first 48 h [17].

The primary management of contained esophageal perforations involves nonoperative care in the form of stent insertions, drainages of any collocation, antibiotics, and nutritional support [18]. Surgical interventions, such as debridement, aggressive drainages, establishment of esophageal continuity, and enterostomies for enteral feeding, would be more appropriate if the perforation was severe and was associated with sepsis [19]. Three of our patients were conservatively managed with endoscopic esophageal stent placements. One patient required an emergent thoracotomy and laparotomy for the removal of the intrathoracic gastric balloon and for the primary repair of the esophagus.

The revisions of bariatric procedures are not uncommon, especially after failed or complicated LASG and LAGB. Multiple recent reports have demonstrated the safety of a revision to a Roux-en-Y gastric bypass [20]. In our study, two patients with esophageal perforations after bariatric surgeries underwent revisions of the bariatric procedures. In one patient who was administered TEP after LASG, the patient underwent a stent placement of the esophagus and a revision to RYGB. The second patient experienced gastric and abdominal esophageal erosions that occurred after LAGB. This patient underwent a revisional Roux-en-Y esophagojejunostomy.

Empyema is an uncommon complication of bariatric surgeries. Krassas and his colleagues described a case of thoracic empyema due to a diaphragmatic perforation by LAGB [21]. Avriel et al. reported an increased risk for major respiratory complications after LAGB in the long-term period [22]. In their series, empyema occurred in 2 out of 30 patients in conjunction with other respiratory complications, including aspiration pneumonia, exacerbation of asthma, lung abscesses, and hemoptysis. In our study, four out of 26 patients had empyema that was secondary to TEP and leakages into the pleural space. Three cases were managed by the use of drainage and antibiotics, followed by a thoracotomy and decortication. In one patient, drainage and antibiotics were successful in controlling the infection in the pleural space.

In the literature, there were only a few reported cases of late pericardial involvement as a thoracic complication of bariatric surgery. Pericardial effusion was due to the presence of a gastro-pericardial fistula after LAGB and a Roux-en-Y gastric bypass surgery [23]. In our study, there was one case of empyema and pericardial sepsis. Septic pericarditis may be developed due to the spread of the infection from the empyema space to the pericardium.

A pancreaticopleural fistula (PPE) is a rare complication, with a reported incidence of less than 1% in acute pancreatitis and 0.4–4.5% in chronic pancreatitis. A leaking pancreatic duct or a pseudocyst can access the pleural cavity through a diaphragmatic or aortic hiatus, or can trans-diaphragmatically access the pleural cavity directly [24]. The effusion is typically an exudate with a high amylase level compared to the serum level [25]. Endoscopic retrograde cholangiopancreatography (ERCP) is a useful diagnostic and therapeutic tool in such cases [26]. However, in patients who have undergone LBPD, ERCP cannot be utilized due to the alerted gastrointestinal anatomy. There are no clear guidelines for PPF management because it is a rare entity. It has been reported that 50% of PPF cases will close with conservative measures, with the subsequent resolution of effusion [24].

In our study, one patient presented with PPF after LBPD. The diagnosis was suspected by the CT images and the analysis of the pleural fluid, with high levels of amylase and lipase being observed. Conservative management, in the form of drainage by the use of a thoracostomy tube, TPN, antibiotics, and octreotide, was successful in controlling the patient's symptoms.

There are reports of increasing rates of morbidities and mortalities that are related to bariatric surgeries in the Kingdom of Saudi Arabia [27]. The Saudi Ministry of Health has issued new regulations for the practice of medicine in private health institutions in February 2018 [28]. These regulations elaborate the standards and guidelines for accreditation and reaccreditation regarding bariatric surgery centers throughout Saudi Arabia.

Conclusion

Our study demonstrated several thoracic complications of bariatric surgeries. These complications are underreported and overlooked in many cases. It is time to develop a high index of suspicion based on the sound knowledge of such complications and to approach them promptly to reduce morbidity and mortality in such an increasingly used type of surgery.

Compliance with Ethical Standards

This study has been approved by the ethical committee of The Institutional Review Board (IRB-2018-01-250)

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Does not apply.

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