Obesity Surgery, **14**, 124-128

Case Report

Intra-operative Pneumothorax Complicating Laparoscopic Roux-en-Y Gastric Bypass

Amir Mehran, MD[1*]; Oscar Brasesco, MD[1]; Eric De Velasco, MD[2]; Samuel Szomstein, MD[1]; Raul Rosenthal, MD[1]

Division of [1]General and Minimally Invasive Surgery and [2]Anesthesiology, Cleveland Clinic Florida, Weston, FL, USA

**Currently affiliated with Department of Surgery, University of California at Los Angeles*

Background: Intra-operative pneumothorax (PTX) is an infrequent complication of laparoscopic surgery. Most cases are attributed to CO_2 diffusion across congenital diaphragmatic defects and resolve spontaneously. We report a case of PTX during a laparoscopic Roux-en-Y gastric bypass (LRYGBP). When applied to this specific patient population, the current literature recommendations for the management of intra-operative PTX are questioned.

Material and Methods: A retrospective chart review of 400 consecutive LRYGBP procedures performed over a 30-month period revealed 1 case of PTX (0.025%).

Results: A bulging left diaphragm, hypotension, bradycardia, decreased pO_2, and elevated $EtCO_2$ and airway pressures, were noted early in the case. She initially responded to conservative management but required multiple subsequent hospital admissions for pulmonary complications.

Conclusions: Pneumoperitoneum-induced PTX during laparoscopic bariatric surgery is a rare complication. Its treatment must be based on the potential underlying cause, with consideration of these patients' often delicate pulmonary status. In stable patients, where the PTX is attributed to diaphragmatic or hiatal dissection, expectant treatment is appropriate. In all other situations, however, we believe that tube thoracostomy is indicated. An algorithm for treatment of PTX in laparoscopic bariatric surgery is proposed. It follows the dictum of maintaining extreme vigilance and a low threshold for aggressive intervention in this group of patients.

Key Words: Morbid obesity, bariatric surgery, gastric bypass, laparoscopy, pneumothorax

Reprint requests to: Raul Rosenthal, MD, Director, The Bariatric Institute, Cleveland Clinic Florida, 2950 Cleveland Clinic Blvd., Weston, FL 33331, USA. Fax: (954) 659-5256;
e-mail: rosentr@ccf.org

Introduction

Intra-operative pneumothorax (PTX) is an infrequent complication of laparoscopic surgery. Most cases are attributed to CO_2 diffusion across congenital diaphragmatic defects and resolve spontaneously. We report a patient with PTX during a laparoscopic Roux-en-Y gastric bypass (LRYGBP). In the absence of diaphragmatic trauma, this occurrence during laparoscopic bariatric surgery is the first such case that we could find in the English language literature. A retrospective chart review of 400 consecutive LRYGBP procedures at the Cleveland Clinic Florida revealed only this one case of PTX (0.025%). The case is presented, and an algorithm for treatment of PTX in laparoscopic bariatric surgery is proposed.

Case Report

A 25-year old woman with BMI 51 kg/m^2 was referred for bariatric surgery following many unsuccessful conservative attempts at weight loss. Her comorbidities included hypertension, diabetes and obstructive sleep apnea. She had no history of prior tobacco use and preoperative chest x-ray (CXR) was normal. After a thorough work-up, including pulmonary consultation, she underwent a LRYGBP. A right jugular central line had been placed preoperatively without any left-sided attempts. During the creation of the lesser sac window, hypotension, bradycardia, rising peak airway pressures, and a

bulging left diaphragm were noted. Table 1 summarizes the anesthetic and cardiopulmonary events at the time. Suspecting a PTX, the pneumoperitoneum (set at 15 mmHg) was immediately evacuated, the FiO_2 was increased to 100%, and nitrous oxide was discontinued. Immediate fiberoptic bronchoscopy was performed, and revealed no endotracheal tube dislodgement or mucus plugs. As she remained stable, a CXR was performed (Figure 1) before any aggressive intervention. It confirmed the presence of a left PTX. Once her vital signs and airway pressures improved, the procedure was resumed and completed laparoscopically with lower intra-abdominal pressures. Post-procedure CXR in the operating-room showed complete resolution of the PTX (Figure 2). Subsequent daily CXRs remained unremarkable. The patient made a rapid recovery and was discharged home on the 7th postoperative day.

Within 48 hours of discharge, she presented to an outside emergency-room for shortness of breath and pleuritic chest pain. As part of the investigation, a chest CT angiogram was performed and was read as a large left pleural effusion with a filling defect in the left pulmonary artery. Suspecting a pulmonary embolus, heparinization was begun and she was transferred to our facility without copies of her x-rays. Physical examination revealed mild tachypnea with diminished left breath sounds, no lower extremity tenderness, and a 100% oxygen saturation on 2 liters of oxygen. Gastrografin® upper GI series (UGI) ruled out a leak as a cause of the effusion. A limited repeat chest CT (Figure 3) performed the next day, confirmed the effusion. The left pulmonary artery filling defect, however, was not seen. Bilateral lower extremity duplex scans were negative for deep venous thromboses. Elevated D-dimers, however, were present on the admission laboratory tests. She was admitted to the intensive care unit and a pulmonary consultation was obtained. Upon reviewing all available data, the pulmonologists attributed the initial PTX and the gradual development of the pleural effusion, to a significant perioperative pulmonary event (possible embolus) and a subsequent parenchymal infarct. Systemic anticoagulation, therefore, was continued. A diag-

Table 1. Anesthetic and cardiopulmonary parameters at the time of pneumothorax

Gases & meds: O_2, N_2O, Forane, Atracurium, Fentanyl
Vent. settings: 60% O_2, PEEP 5, rate 10
$\Delta EtCO_2$: 27 → 36 mmHg
ΔAirway pressures: 26 → 31 mmHg
ΔBlood pressure: 110/65 → 80/60 mmHg
ΔPulse rate: 90 → 45 beats/minute
O_2 sat.: unchanged @ 100%
ABG: (100% FIO_2): $p0_2$ 113 & pCO_2 39 mmHg

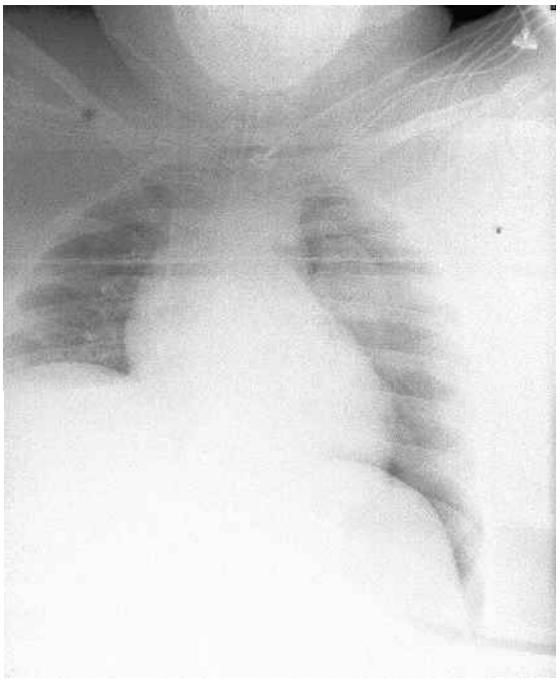

Figure 1. Intra-operative chest x-ray demonstrating large left pneumothorax.

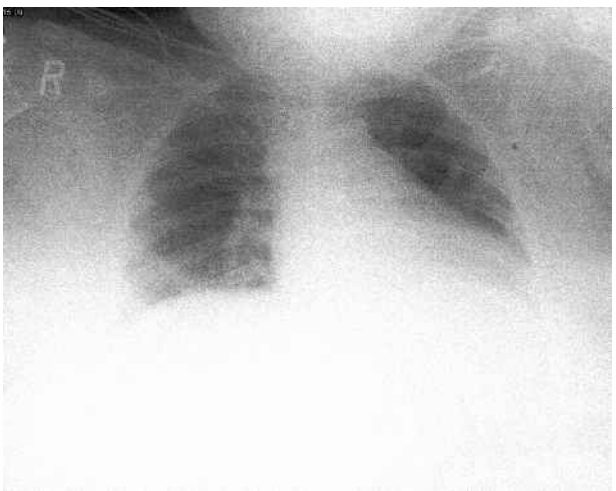

Figure 2. Postoperative chest x-ray showing resolution of the pneumothorax.

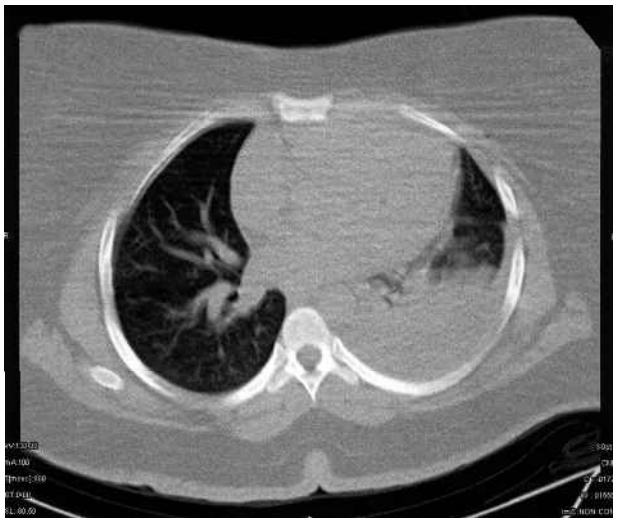

Figure 3. Chest CT showing large left pleural effusion.

nostic thoracentesis was performed, revealing sanguinous fluid with elevated white cells, LDH and total protein, but no organisms. The patient was discharged home on the 9th postoperative day, asymptomatic and oxygen-independent, with plans for an outpatient therapeutic thoracentesis.

On the 13th postoperative day, she was readmitted with fever, shortness of breath and increasing left chest pain. Repeat UGI and abdominal CT ruled out leak or other intra-abdominal processes as the source of the fever. A chest CT demonstrated a larger effusion with air-bronchograms in the left lower lobe. A therapeutic thoracentesis (360 cc) was performed with similar findings as the last time. The patient was treated with antibiotics for a presumed pneumonia and was discharged home on the 16th postoperative day.

At 1-year follow-up, she has remained asymptomatic with resolution of the effusion on subsequent CXRs. Recent pulmonary function tests were normal. Her current BMI is 34, and the preoperative comorbidities (hypertension, diabetes, sleep apnea) have resolved. She is now pregnant with twins.

Discussion

Pneumoperitoneum-induced pneumothorax during laparoscopic surgery is a well known complication, with reports dating back to the 1970s. PTX has been described in a variety of laparoscopic procedures including herniorrhaphies, cholecystectomies, fundoplication or other hiatal procedures, as well as in gynecologic and urologic operations. It may be bilateral or even a late event occurring several days after the surgery.[1-19]

Intra-operative PTX occurs in up to 1.9% of laparoscopic cases,[7] with higher rates quoted for fundoplications or other hiatal dissections.[3,6] It usually affects elderly patients with pre-existing cardiopulmonary co-morbidities. Prolonged procedures (>200 min) and higher abdominal insufflation pressures (>15 mmHg) have been reported as well.[3,7,10,12] As outlined in Table 2, the exact mechanisms are unknown and probably differ for each case. The most popular explanation is CO_2 leakage, either by direct trans-diaphragmatic diffusion or via congenital defects such as pericaval or aortic spaces. Iatrogenic causes include central venous line attempts, hiatal dissections causing pleural or esophageal tears, and rupture of emphysematous bullae secondary to barotrauma.

As outlined in Table 3, the PTX results in significant cardiopulmonary and systemic impairments. An intraoperative spontaneous PTX typically presents with a sudden exacerbation of these clinical findings, as well as a bulging diaphragm (Table 4). In fact, some patients are completely asymptomatic, with the latter sign as the only evidence of a PTX.[3] Furthermore, mainstem bronchus intubation, a mucus bronchial plug, patient position or equipment failure can also cause hypoxemia, absent breath

Table 2. Potential causes of intraoperative pneumothorax

simple diffusion ?
congenital defects:
• para-aortic or paracaval spaces
• other congenital patent diaphragmatic foramen
• inguinal space (via retroperitoneum)
iatrogenic:
• hiatal dissection with pleural or esophageal tears
• barotrauma with bullae or emphysematous bleb rupture
• diaphragmatic tear/trauma
• central line placement
• trocar sites (via subcutaneous tissue)
• equipment failure/misconnections
• pulmonary infarct

Table 3. Adverse effects of pneumoperitoneum

↓ functional reserve capacity
↓ pulmonary compliance
↓ venous return
↓ blood pressure
↓ cardiac output
↓ renal blood flow
↓ splanchnic circulation
↑ airway pressures
↑ hypercarbia
↑ intracranial pressure (secondary to ↑ CO_2)

Table 4. Signs of intraoperative pneumothorax

↑ end-tidal CO_2
↑ airway pressures
hypoxia
jugular venous distention (tension PTX)
hypotension
absent breath sounds
bulging diaphragm
expanding subcutaneous emphysema

sounds, and respiratory compromise. Therefore, the presence of a vigilant anesthesiologist is of utmost importance in these situations.

In the majority of cases, the PTX spontaneously resolves without any further sequelae, either during the surgery or shortly afterwards. Upon diagnosis, the pneumoperitoneum must be immediately evacuated. As in our case, once the patient is stabilized, the procedure can usually be resumed at lower insufflation pressures (10 mmHg). If respiratory compromise persists, however, a temporary thoracic vent such as a Veress needle can be placed on the affected side. The failure of this maneuver necessitates chest tube placement, open conversion, or even stopping the procedure altogether.[3] PEEP therapy has also been used to treat intraoperative PTX. Theoretically, it reduces the pressure gradient between the abdomen and the chest during both inspiration and expiration, thus inflating the lung and resolving the PTX.[14] PEEP will, however, exacerbate barotrauma-induced PTX and must be used with caution.

Do these recommendations apply to morbidly obese patients undergoing laparoscopic bariatric surgery? Obesity-related pulmonary co-morbidities, such as decreased respiratory capacity and obstructive sleep apnea, place these patients at a greater risk for most surgical procedures. Furthermore, deep venous thrombosis and pulmonary embolus are major causes of postoperative mortality in this population. Hence, most bariatric patients lack adequate pulmonary reserves to deal with an acute respiratory insult. Therefore, in contrast to other cases of laparoscopy-induced PTX, a more aggressive approach is warranted in morbidly obese patients undergoing bariatric surgery. In the absence of hiatal dissection, potentially fatal causes of PTX must be considered prior to the simple transdiaphragmatic diffusion of CO_2. Tube thoracostomy under general anesthesia is an easy and safe option and must be considered in these situations. Therefore, we propose a potential algorithm for the management of intraoperative PTX in bariatric surgery cases (Figure 4). It follows the same aggressive dictum as for the detection and treatment of anastomotic leaks. Had this approach been applied to our patient, she would have had a quicker recovery and probably avoided multiple readmissions to the hospital.

In conclusion, pneumoperitoneum-induced pneumothorax during laparoscopic bariatric surgery is a rare complication. Its treatment must be based on the potential underlying cause and with consideration of these patients' often delicate pulmonary status. In stable patients, where the PTX is attributed to diaphragmatic or hiatal dissection, expectant treatment is appropriate. In all other situations, however, we believe tube thoracostomy is indicated. This case further highlights the need for extreme vigilance and a low threshold for aggressive intervention in bariatric surgery patients.

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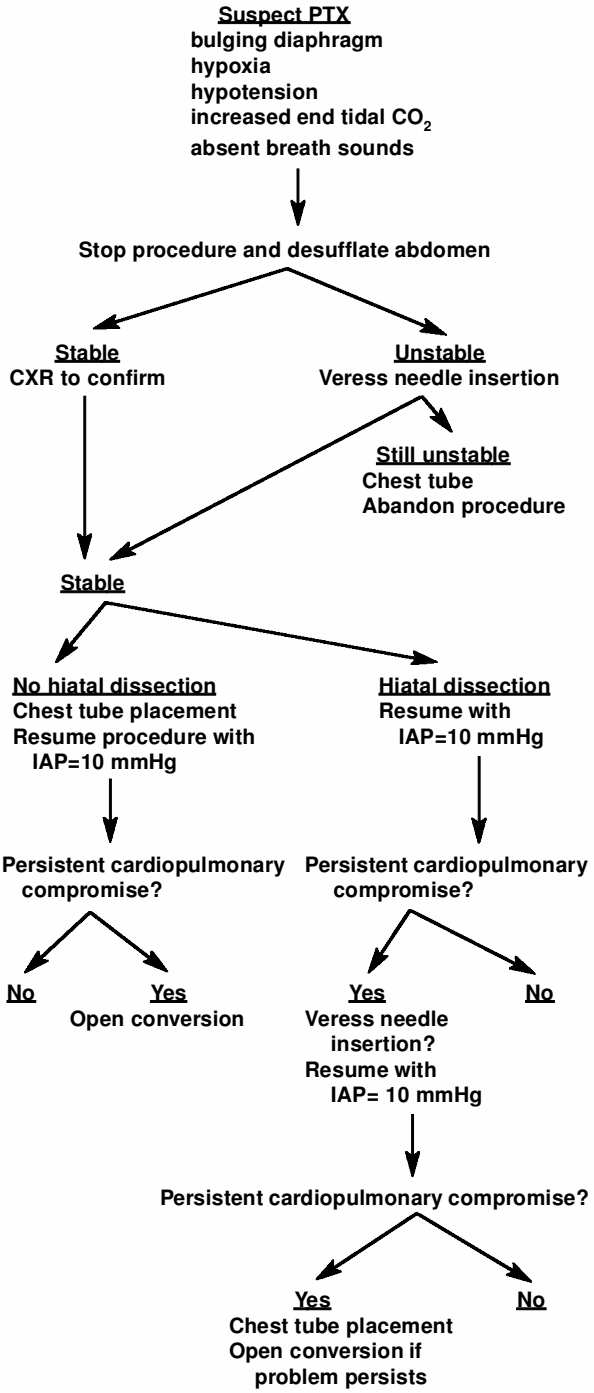

Figure 4. Algorithm for treatment of intraoperative pneumothorax (PTX) in laparoscopic bariatric surgery. CXR = chest x-ray IAP = intra-abdominal pressure.

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(Received June 9, 2003; accepted August 8, 2003)