ORIGINAL ARTICLE

Incidence and severity of adverse events in laparoscopic Nissen fundoplication; an anesthesiologist's perspective

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ABSTRACT

Introduction: Laparoscopic fundoplication is surgical treatment of choice for gastroesophageal reflux disease. The primary objective of our study was to determine the incidence and severity of intraoperative and postoperative (up to 48 hours after surgery) complications in laparoscopic Nissen fundoplication.

Methodology: We retrospectively analyzed case files and anesthesia charts of patients operated for this surgery from 2005 to 2011 and recorded the incidence and severity of intraoperative and postoperative (up to 48 hours after surgery) complications.

Results: 63 patients undergoing laparoscopic surgery for either a sliding (76%) or paraesophageal hiatus hernia (24%) were included in the study. Mean age was 41.6 ± 13.3 years and mean surgical duration was 4.5 ± 1.5 hours. Hypertension (28.5%), bradycardia (22.2%), high mean airway pressures (17.4%), desaturation (17.4%), arrhythmia (15.8%), bronchospasm (9.5%), pleural injury (6.3%) and subcutaneous emphysema (4.7%) were the main intraoperative complications. Abdominal pain (79%), radiological evidence of atelectasis (31.7%), breathlessness (22%), nausea and vomiting (20.6%), chest pain (9.5%) and pneumothorax (3%) were reported in early postoperative period. Pleural effusion (19%), pneumonia (3%), abdominal fluid collection (3%) and bed sore (1.5%) were seen in late postoperative period (after 24 hrs). There was no mortality and the incidence of mild (grade 1), moderate (grade 2; grade 3) and severe complications (grade 4) was 31.5, 62.3 and 5.26% respectively. Injury to splenic artery, injury to stomach and difficult dissection due to adhesions was the reason for conversion to open surgery in three patients.

Conclusion: Hypertension, bradycardia, high mean airway pressures and desaturation are the commonest intraoperative complications. Pneumothorax is common but clinically asymptomatic. Monitoring of airway pressure, EtCO2, SpO2 and intermittent chest auscultations is needed to detect it. Multimodal analgesia is needed for abdominal pain. Lung recruitment manoeuvers, chest physiotherapy and early mobilization are needed to prevent atelectasis, pleural effusion and pneumonia in the postoperative period.

Key words: Gastroesophageal reflux disease; Laparoscopic Nissen's fundoplication; Pneumoperitoneum; Outcomes; Perioperative complications

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INTRODUCTION

Nissen fundoplication is surgery of choice in patients with gastroesophageal reflux disease (GERD) and in adults and children with endoscopic findings of hiatus hernia.[1] Complications secondary to pneumoperitoneum, insertion of the needle and trocar, patient positioning and insertion and manipulation of the instruments during laparoscopic surgeries have been highlighted in various studies.[2] Surgical dissection around the esophagus and diaphragmatic hiatus in Nissen fundoplication increase chances of pleural injury and subcutaneous emphysema and thus complicate the anesthetic management.[3] Numerous studies have been conducted to highlight the complications associated with this surgery. Majority of these studies only discuss the surgeons' perspective; there is no information on the anesthetic management.[3-7] Joris et al[8] has discussed the

incidence, diagnosis and intraoperative management of pneumothorax from an anesthesiologist's perspective.

The primary objective of our study was to determine the incidence and severity of intraoperative and postoperative (up to 48 hours after surgery) complications in laparoscopic Nissen fundoplication. We also describe the demographic characteristics, anesthetic management, duration of surgery, duration of hospital stay and clinical outcome of patients operated in our hospital using this technique.

METHODOLOGY

After obtaining the ethics committee approval, we retrospectively reviewed case files and anesthesia charts of patients operated for laparoscopic fundoplication from January 2005 to July 2011. Patients aged 18-60 years and classified as ASA I/II and operated by surgeons with average surgical skills for this procedure were included. Based on results of learning curve for laparoscopic fundoplication, a surgeon is rated as average after a minimum of 20 independent laparoscopic fundoplications.[9] Exclusion criteria included age <18 or >60 years, BMI>30 kg/m^2 , history of coronary artery disease, COPD or asthma.

Uniformity in anesthetic technique was present as all the cases included in the study were conducted under the supervision of a single consultant anesthesiologist. As an institutional protocol all patients are fasted for 8 hours and are administered proton pump inhibitors (tablet ranitidine; 150 mg HS and 6 AM), pro-kinetic agent (tablet metoclopramide; 10 mg HS and 6 AM) and an anxiolytic (tablet alprazolam 0.5mg HS) prior to laparoscopic fundoplication. General anesthesia is administered using thiopentone (dose range from 4-6 mg/kg; loss of eyelash reflex); fentanyl (2 μg/kg), midazolam (0.04 mg/kg), vecuronium (0.1 mg/kg). Maintenance is done with O_2/N_2O/isoflurane; pneumatic compression stockings are used; warm ringer lactate is infused based on 4:2:1 formula. Electrocardiogram (ECG), non invasive blood pressure (NIBP), pulse oximeter (SPO_2) and capnometer are used for monitoring. Neuromuscular blockade is antagonized with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg at end of surgery and trachea is extubated on establishment of regular spontaneous breathing pattern. Ondansetron (0.1 mg/kg) is administered to all for antiemesis and diclofenac is used for postoperative analgesia. To prevent hypercapnia the tidal volume is set between 4-10 ml/kg in volume controlled mode of mechanical ventilator. Necessary changes are made by the anesthesiologist in tidal volume, respiratory rate, I:E ratio and total flows to maintain $EtCO_2$ less than 40 mmHg and limit airway pressures to 35 cmH_2O.

Demographic data, e.g. age, sex, weight, chief complaints, clinical diagnosis and co-morbidities, were recorded for all of the patients. Note was made of the pre-anesthetic check up, premedication, induction and maintenance of anesthesia, ventilatory parameters (tidal volumes, mean airway pressures, respiratory rates) intraoperative anesthetic and surgical complications from the case files. The hemodynamic monitoring, $EtCO_2$ and SpO_2 levels were studied to detect any deviations. Hypertension and tachycardia were defined as a rise in mean arterial pressure (MAP) and heart rate (HR) by > 20% of the baseline values.

Postoperative complaints (early: up to 24 hours after surgery, late: after 24hours), duration of surgery and hospital stay were recorded. Duration of surgery was counted from introduction of Verees needle to skin closure of puncture wounds. Postoperative chest x-ray films were studied to detect any area of atelectasis or pneumothorax.

All intraoperative and postoperative complications were graded in order of increasing severity from 1-5 based on criteria mentioned below.

Grade 1: Complications managed by change of depth of anesthesia or by drugs (antipyretics, antiemetics, analgesics, diuretics, electrolytes), intravascular fluids, physiotherapy and suctioning.

Grade 2: Intraoperative blood product administration and pharmacological therapy with drugs other than those mentioned in Grade 1 (e.g. use of antiarrythmics, inotropes, vasodilators)

Grade 3: Management requiring surgical, endoscopic and radiological interventions (e.g. simple pneumothorax, pleural effusion)

Grade 4: Life threatening complication requiring postoperative mechanical ventilation and ICU admission (e.g. tension pneumothorax)

Grade 5: Death

In our hospital diagnosis of GERD and hiatus hernia is based on clinical symptomatology, physical examination, laboratory testing, upper gastro-intestinal (GI) endoscopy and barium swallow. Preoperative esophageal manometry is omitted in patients with typical symptoms of GERD. Indications for surgery include failure to respond to medical treatment with proton pump inhibitors (PPI) and pro-kinetic agents, presence of extra-esophageal manifestations (asthma, hoarseness, cough, chest pain, aspiration) and complications of GERD (e.g., Barrett's esophagus, peptic stricture).

RESULTS

Total number of patients operated by surgeons with average skills and managed by the same anesthesiologist during the entire time span was 77. Conversion to standard

open fundoplication was done in 3 cases due to adhesions, injury to splenic artery and injury to stomach and they were thus excluded from the study. Surgical duration was prolonged (>7 hours) and they were shifted to intensive care unit at end of surgery. Sleeve gastrectomy was done in 4 patients and 7 underwent cholecystectomy along with the laparoscopic Nissen fundoplication. Demographic characteristics from 63 patients included in the study are summarized in Table 1.

Table 1: Demographic characteristics (All values are numbers (n) or mean ± SD)

Parameter	Value
Age (years)	41.6 ± 13.3
Weight (kg)	56.2±11.9
ASA status (I/II)	10/53
Gender M/F	21:42
Type of hiatus hernia	
a. Sliding	48
b. Paraesophageal	15
Duration of surgery (hours)	4.5 ± 1.5
Mallampati (I/II/III/IV)	48/11/4/0
Clinical features of GERD	**n**
a. Heartburn	39
b. Regurgitation	17
c. Dysphagia	4
d. Chest pain	2
e. Hematemesis	2
Co-morbid conditions	**n**
a. Past history of tuberculosis	18
b. Hypertension	13
c. Diabetes	5
d. Coronary artery disease	5
e. Anemia	4
f. Obesity	4
g. ECG with LBBB	3
h. Chronic liver disease	1

M: Male; F: Female; GERD: Gastroesophageal reflux disease

All patients were premedicated and fasted as per institutional protocol. Induction and maintenance of anesthesia was also as per protocol. Electrocardiogram (ECG) changes in the form of premature ventricular contractions were reported in 10 patients (1.5 mg/kg Xylocard was administered IV) and episodes of bradycardia managed with injection atropine (0.3 mg-0.6 mg) were reported in 14 patients. The intra-abdominal pressure was maintained between 14-18 mmHg by a CO_2 insufflator and surgery was performed with patients in 10º -20º head-up position.

The incidence and severity of perioperative complications is detailed in Table 2. Positive pressure ventilation was given using volume controlled mode. In the preinsufflation phase $EtCO_2$ ranged between 35 and 40 mmHg in all patients. All patients developed hypercarbia after CO_2 insufflation which was managed by either an increase in tidal volume or respiratory rate. In 10 patients (15.8%) minute ventilation had to be increased 50% above baseline. Majority could maintain normocarbia with 15%-40% increase of minute ventilation.

Table 2: Perioperative complications.

Intraoperative complications	Value n (%)	Grade of severity
a. **Desaturation^**		-
i. Endobronchial intubation		1
ii. Endotracheal mucus plug /	11 (17.4)	1
secretions	8 (12.7)	3
a. Subcutaneous emphysema	3 (4.7)	3
b. Pleural tear/chest tube insertion	3 (4.7)	2
c. Bronchospasm	4 (6.3)	2
d. Hypertension	6 (9.5)	2
e. High minute ventilation#	18 (28.5)	2
f. High mean airway pressures ¯	10 (15.8)	4
g. Conversion from laparoscopic to	11 (17.4)	2
open	3 (3.8)	2
h. Bradycardia	14 (22.2)	
i. Arrhythmia	10 (15.8)	
Early postoperative complications (< 24 hours)		
a. Abdominal pain		1
b. Breathlessness	50 (79)	1
c. Postoperative nausea and vomiting	14 (22)	1
d. Chest pain	13 (20)	1
e. Radiological evidence of atelectasis	6 (9)	1
f. Radiological detection of pneumotho-	20 (31.7)	3
rax	2 (3)	3
g. Hypothermia	63 (100)	
Delayed postoperative complications (> 24 hours)		
a. Pleural effusion	12 (19)	3
b. Pneumonia	2 (3)	3
c. Abdominal fluid collection	2 (3)	3
d. Bed sore	1 (1.5)	2

^ SPO2< 92% with FiO_2 of 0.5%. # 50% above baseline . ¯ Mean airway pressure above 30 cm H_20 but less than 40 in all cases

An increase in MAP and HR was managed by supplemental dose of fentanyl (0.5 μg/kg) in 20 patients and by increasing depth of anesthesia (up to 1.5 MAC of isoflurane) in further 15 patients. Persistent high MAP was recorded in 18 patients and was managed by nitroglycerin (NTG) infusion (0.1-0.5 μg/kg/min). Tachycardia developed in 12 of these and was managed either by inj. metoprolol (incremental bolus doses of 1 mg; 3 mg was the most frequently administered dose). Drop in SpO_2) after start of NTG infusion varied from 2-4%. No patient developed

hypotension; blood loss was within recommended range; average hourly urine output varied between 50-75 ml/hr. Hypothermia (core temperature <36 ºC) was universal at end of surgery (range 34.8-36º C). The occurrence of pleural injury was recognised by surgeons; it did not lead to any hemodynamic or ventilatory compromise in any of our patients. All patients with subcutaneous emphysema had an underlying pneumothorax. Subcutaneous emphysema was minimal and localised over the upper chest wall only; there was no compromise of the airway. It appeared towards the end of surgery. All patients who developed a pleural injury were managed intraoperatively with 100% oxygen, positive end expiratory pressure (PEEP) of 5 cm H_2O, low insufflation pressures of 8-10 mmHg and chest tube insertion.

Postoperative complications are summarized in Table 2. Rescue antiemetics included metoclopramide and dexamethasone and rescue analgesics administered included intravenous morphine (3-4.5 mg), fentanyl (30-50 μg) and tramadol (50 mg). All patients who complained of breathlessness or chest pain were already receiving oxygen via ventimask (FiO_2 0.4) in the postoperative ward. They were investigated using chest x-ray, ECG, cardiac enzyme levels and arterial blood gas analyses. Symptom of breathlessness was present in all patients with radiological findings of pleural effusion. The effusion was transudate, mild to moderate in quantity and was thus managed conservatively. The average hospital stay of patients after the surgery was 8.3 ± 3.5 days.

DISCUSSION

General anesthesia with endotracheal intubation and controlled ventilation is recommended for laparoscopic Nissen fundoplication. Delayed gastric emptying is identified in about 40% of the patients necessitating administration of H_2 blockers/ proton pump inhibitors or prokinetics prior to induction of anesthesia to minimize the effect of aspiration from possible gastroesophageal reflux. Surgery is done in reverse Trendelenburg position which promotes venous stasis but is favourable for diaphragmatic function and respiratory mechanics. Tension pneumothorax, surgical emphysema, cardiovascular collapse, hypoxia, and hypercarbia are some of the intraoperative complications secondary to carbon dioxide insufflations.[2,8] Increased intra-abdominal pressure and pneumoperitoneum are responsible for various hemodynamic, metabolic and ventilatory changes observed in laparoscopic surgeries.

None of the patients in our study developed any life threatening complication. Hypertension (28.5%), bradycardia (22.2%) and high mean airway pressures (17.4%) were the three most common intraoperative complications. All cases of intraoperative pneumothorax (6.3%) were secondary to breach of left parietal pleura during surgical dissection near hiatus. This is consistent with previous study of Joris et al[8] in which the author detected pneumothorax in 15.2% of patients undergoing laparoscopic Nissen fundoplication on basis of increased airway pressures, decreased total lung thorax compliance and increased CO_2 absorption. Meticulous monitoring of $PaCO_2$, P_{ETCO2}, PV loops, F-V loops, oxygen uptake, CO_2 elimination, arterial blood gas analysis was done and intraoperative fluoroscopy and bronchoscopy were also used to detect pneumothorax. This accounts for the higher incidence reported by them. None of the patients developed any drop in SpO_2. They used PEEP to manage all cases of pneumothorax; chest tube insertion was avoided in their study.

Paraesophageal hernias are technically difficult to resect; colon, small bowel, spleen, pancreas etc. can be present in the large hernia sac. High peak airway pressures (>50 cmH_2O), hypercarbia (>70 mmHg), respiratory acidosis have been reported secondary to pneumomediastinum leading to collapse of mainstem bronchus during laparoscopic repair of paraesophageal hernia.[11] Similar findings were reported in a patient who developed subcutaneous emphysema and pneumothorax during repair of a giant paraesophageal hernia.[11] Incidence of intraoperative [pneumothorax (3), splenic injury (2), and crural tear (1)] and early postoperative [esophageal leak (2), severe bloating (2), small bowel obstruction (1)] complications was 16.2% and 13.5% respectively during laparoscopic repair of 35 patients with large paraesophageal hiatal hernias. They reported mortality of 5.4% (within 30 days) and thus emphasized the need for further refinement of the operative technique and careful postoperative follow up.[12]

One anesthesia related death, one case of pneumothorax and one case of iatrogenic liver laceration were reported from a study of 74 cases operated for fundoplication at a community centre hospital.[5] Mortality and morbidity figures of 0% and 25.7% respectively have been reported by Bittner et al[4] after short-term follow-up of 35 patients after laparoscopic Nissen fundoplication. Mean length of hospital stay (2.8 ± 0.21 days)[5] and surgical duration (1.78 ± 0.58 hrs)[4] was shorter in previous studies. Safety of laparoscopic fundoplication has been established for pediatric patients with chronic respiratory or gastroenterological symptoms when the intra-abdominal pressure is maintained below 10 mmHg.[13\]

Surgical complications during laparoscopic fundoplication like splenic bleeding necessitating a splenectomy are rare. Division of the hepatic branch of the vagus (predisposes to cholelithiasis) or accessory left hepatic artery (causes hepatic necrosis) can occur during dissection.[5] The surgeon must rule out gastric perforation before proceeding with fundoplication and maintain close communication with the anesthetist during insertion of bougie dilator (54-60F) as esophageal perforations have been reported at the

GE junction. Delayed diagnosis of postoperative gastric perforation and postoperative pancreatitis have also been reported.[6] Wrap-migration can present acutely as a life threatening complication or as post-operative reflux or retro-sternal pain. Wound infection, port-site herniation, wrap-ischemia and postoperative dysphagia lead to increased morbidity in postoperative period.[3]

Prevalence of abdominal pain was high (79%) highlighting the fact that multimodal analgesia is required even for patients undergoing laparoscopic surgeries. Postoperative dyspnea was reported by 22% of the patients. Pulse oximetry, chest x-ray, arterial blood gas analysis was used to differentiate nonhypoxic (secondary to surgical pain, anxiety) from hypoxic (secondary to pulmonary dysfunction, atelectasis, pneumothorax, pulmonary edema etc.). Radiological (chest x-ray) evidence of atelectasis and pneumothorax was 31.7% and 3% respectively. Atelectasis had resolved by the second postoperative day in all but those who later developed a pleural effusion or consolidation. Incidence of nausea and vomiting (20.6%) in our study was lower when compared to reported incidence after laparoscopic cholecystectomy (40-70%).[14] Pneumoperitoneum created during the operation and residual gas after the operation are two main factors in causation of postoperative pain and nausea vomiting. Decreasing pressure and rate of CO_2 insufflation, gasless laparoscopy, and use of warmed gas, pre-emptive anti-inflammatory medication, pre-emptive diaphragmatic local anesthetic irrigation, pulmonary recruitment manoeuvres and instillation of 2 to 3 L of Ringer's lactate into the abdomen to evacuate CO_2 at the end of the surgery decrease postoperative pain and vomiting.[15] Active peritoneal suctioning evacuates residual CO_2 and minimises post-laparoscopic shoulder pain.[15]

Pleural effusion (19%) seen in late postoperative period (after 24 hrs) was minimal and managed conservatively. This has not been documented in previous studies. Delayed postoperative mobilisation of patients, longer surgical duration and hospital stay may account for this difference.

Limitations of our study include its retrospective design. Prospective studies need to be conducted with more number of cases to compare perioperative complication rate for paraesophageal and sliding varieties of hiatus hernia. Mean age and weight of patients in our study was 41.6 $\pm$ 13 years and 56.2 $\pm$11 kg respectively; perioperative complications are expected to be higher in the elderly and obese and thus future studies should focus on this subset of the population. Past history of tuberculosis was present in 29% of the population which is expected in any study from a developing country where tuberculosis is endemic.

When computing perioperative complication rate for any surgical procedure or comparing results from different randomised controlled trials it is important to take into account the operating skills of the surgeon and the experience of the anesthesiologist.[9] Thus in our study we have included only those cases in which surgery was performed by a surgeon with average clinical skills. Complications are maximum when surgeon is novice for the specific procedure (i.e. on extreme left of learning curve) and minimum when he is expert (extreme right of the curve).

There has been an absolute increase in the incidence of GERD in the last 20-30 years and number of antireflux surgeries are thus increasing. Laparoscopic Nissen fundoplication has some specific and unique complications, e.g. pneumothorax and subcutaneous emphysema. In majority of patients pneumothorax is asymptomatic and does not compromise the patients hemodynamic and ventilatory status. High index of suspicion, close clinical observation of airway pressure and $EtCO_2$, periodic auscultations of chest and communication with the surgeon is needed to detect tension pneumothorax which is rare in incidence but is potentially life threatening and needs prompt management. Needle thoracocentesis followed by chest tube insertion is management of tension pneumothorax. Non-tension CO_2 pneumothorax may be symptomatic or asymptomatic and is thus managed accordingly. Intercostal drains lead to loss of pneumoperitoneum. Lower intra abdominal pressures and high rates of CO_2 insufflation are then used to complete the surgery. Use of PEEP in clinically stable patients has helped in resolution of pneumothorax and averted the need of a chest drain in a study by Joris et al[8] and should be considered by anesthesiologists when managing such cases. Passage of CO_2 into the pleura after injury is facilitated due to the existence of a pressure gradient; intra-abdominal pressure > intrapleural end-expiratory pressure. Application of PEEP decreases or reverses the gradient which prevents further CO_2 build up. Being highly diffusible the existing CO_2 in the pleura is rapidly removed by the circulating blood. Also, re-expansion of the lung with PEEP mechanically seals the surgically induced tear in the parietal pleura.

Most commonly reported intraoperative problems like hypertension, bradycardia, high mean airway pressures and desaturation are of mild and moderate severity and potentially reversible at the end of surgery. They are due to pneumoperitoneum and common for all laparoscopic surgeries. Postoperative incidence of abdominal pain is high and multimodal analgesia should be used. Mild hypothermia was present in all the patients. Low temperature of CO_2 is the most likely cause and warming the gas prior to insufflation can help prevent it. Intraoperative use of lung recruitment manoeuvres, postoperative early patient mobilisation, active chest physiotherapy and deep breathing exercises may decrease incidence of atelectasis, pleural

effusion and pneumonia. Day-case laparoscopic Nissen fundoplication has been documented as a feasible and safe option in young and middle aged patients belonging to ASA I/ II class.[16] Careful patient selection and thorough vigilance in intraoperative and immediate postoperative period will be needed for day case laparoscopic Nissen fundoplication.

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