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Anesthesia for Laparoscopic Cholecystectomy: Experience with 5000 Cases.

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ABSTRACT

Background: Since the introduction of laparoscopic cholecystectomy in 1987 by Philips Mouret its popularity has increased tremendously and very rapidly because of its several advantages. But reports of randomized large control series are not yet available so we plan to report our experience of 5000 cases of single incision laparoscopic cholecystectomies and their anesthetic management. Objective: The purpose of this retrospective study was to evaluate the general anesthetic technique for laparoscopic cholecystectomy keeping in mind the pathophysiological effect of laparoscopy, head up position and pneumoperitoneum. **Methods:** A retrospective study of 5000 cases of symptomatic gall bladder disease that underwent laparoscopic cholecystectomy at Nobel Medical College Teaching Hospital, Nepal from Jan 2010-Dec 2015 was done. Detail pre-anesthetic check up, investigation, preparation and anesthetic techniques were carried out as per hospital protocol. Strict vigil was made to maintain the vital parameters within normal limit particularly ETCO2 below 35 mmHg. All efforts were made to keep ETCO2 below 35mHg. At the end of surgery residual neuromuscular blockade was reversed with neostigmine and glycopyrrolate, before they were transferred to PACU. **Results:** The mean age of the patients was 48 years with a male:female of 1:2.26. 28.64 % of patients belonged to ASA III. More than 95 % patients maintained SPO2 between 98-100% and 91% maintained their ETCO2 below or around 35 mmHg. Intra-operative surgical and anesthetic complications were controlled with proper therapies. There was no intra-operative death. **Conclusion:** Single incision laparoscopic Cholecystectomy (SILC) is a safe, cost effective ideal for day care surgery and general anesthesia with controlled mechanical ventilation with oxygen, air, fentanyl, isoflurane, midazolam and vecuronium/atracurium is good choice.

Keywords: General Anesthesia, Laparoscopic Cholecystectomy, Mechanical Ventilation.

INTRODUCTION

"Progress is simply a comparative of which we have not yet settled the superlative" G. K Chesterton (1874-1936), these words of Chesterton fits very well with the gradual progress of the operative treatment of symptomatic gall bladder diseases, since the time archeological excavation demonstrated the presence of gall stones in the mommy of a young Egyptian women about 2000 years ago.[1] The first successful cholecystectomy was performed by the noted general surgeon Karl Langerbuch on July 15th 18882.[2].

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This was the start of a successful management of a disease which still puzzles mankind and continues to be a national and international problem. After this historic event for about 100 years open cholecystectomy, by a big laparotomy incision, had remained the gold standard for the definitive management of patients with symptomatic gall bladder diseases.

Rapid Development of science enabled Jacobeus in 1911 to visualize the abdominal cavity for the first time and termed it as Lapraroscopy. "Lap" is a greek word meaning to look into the flanks achieved through the abdominal wall after creation of peumoperitoneum.[3] After another 75 years, in March 1987 Phillipse Mouret in France performed the first laparoscopic cholecystectomy in human.[4] This revolutionized the management of patients with gall bladder diseases and emerged as the gold standard for the surgical treatment of symptomatic gall bladder diseases and is now available in most parts of the world. It has many benefits over the

conventional and mini-lap cholecystectomies like diminished post operative pain and wound infection, more rapid recovery of pulmonary function, shorter hospital stay, reduced cost, more rapid returns to full activity and superior cosmetic results and reduced intra operative and post operative complications. But it needs highly trained, skilled anesthesiologists with a thorough knowledge of the physiological changes of pneumoperitonium with CO_2 insufflation and head up tilt with their effects on intra-operative ventilation, hemodynamic, metabolic, blood gas changes. To sum up, both mechanical and neuro-humoral factors affects the cardiovascular and respiratory systems adversely. In spite of all these, laparoscopic cholecystectomy is the most common upper abdominal operation though the optimal surgical and anesthetic management of gall bladder diseases is still evolving because till date there remain numerous challenging unanswered questions with both the surgical and anesthetic technique of laparoscopic cholecystectomy. There are several techniques to anesthetize patients for laparoscopic cholecystectomy like "Balanced Anesthesia" with controlled ventilation with O_2, N_2O, relaxants and analgesics with or without opioids and inhalational agents like isoflurane, sevoflurane, desflurane and central neuraxial blockage like spinal, epidural or combined spinal epidural with or without profound sedation and analgesics.

Nobel Medical College Teaching Hospital Pvt. Ltd. (NMCTH) is a tertiary care hospital in the eastern region of Nepal. It is very popular for laparoscopic cholecystectomy. So a large number of patients not only from Nepal but also from the adjoining states of India come to our hospital for removal of their gall bladder by laparoscopic route. To cope up the rush two exclusive surgical and anesthetic teams works in two exclusive operation theatres from 9 AM to 5 PM. In the light of such a huge number of laparoscopic cholecystectomies a desire has been expressed by many of our fellow colleagues during the last national meet of anesthesiologists of Nepal to report our anesthetic experience for such a huge number of laparoscopic cholecystectomies.

MATERIALS AND METHODS

Nobel Medical College Teaching Hospital Pvt. Ltd. (NMCTH) is a tertiary care hospital in the eastern part of Nepal, where a large number of patients report for laparoscopic cholecystectomies from the eastern part of Nepal and adjoining states of India. In the absence of a proper hospitalized organization and management (O & M) department, to keep all the hospital records, the hospital computerized surgical database were used and 5000 patients between the age 12-78 years and belonging to ASA I, II,III were picked up who had laparoscopic cholecystectomies for their symptomatic gall bladder disease. It was observed that the patients with symptomatic gall bladder with CBD pathology, impaired mental state, neurological dysfunctions, renal dysfunctions, features of raised ICP, obesity, sepsis, peritonitis and bleeding disorders were excluded. For each patient the detailed required information was recorded for further analysis. It was observed that on arrival at the hospital all the patients were thoroughly investigated and examined at PAC and again on the day before surgery. All routine investigations as per protocol for gall bladder surgery like complete blood count, serologies, liver function test, renal function test, chest x-ray, ECG, and ultrasound were done. Echocardiography was done for those who had some positive ECG findings or complained of some cardiac symptoms. Once the patients were declared fit, they were admitted on the previous evening of surgery and received oral lorazepam 1mg and ranitidine 150 mg. Clear fluid were allowed up to midnight. On arrival at the operation theatre all patients were put on monitors to record HR, NIBP, SPO2, ECG which served as the baseline control reading for that particular patient and intravenous infusion with dextrose saline at the rate of 5ml/kg/hr were started except for diabetic patients in whom ringer lactate or normal saline was administered. After this, injection ranitidine 50 mg and injection midazolam 0.03mg/kg was administered. Ten minutes after, the patients were put on the operation table and the monitor was connected to check the parameters as already mentioned. All the patients were then pre-oxygenated for 3-5 minutes. Simultaneously injection glycopyrrolate 0.2 mg and injection fentanyl 1.5mcg/kg was administered as premedicant. Anesthesia was then induced with injection propofol 1.5 mg/kg slowly at the rate of 4 ml per 10 seconds. Trachea was then intubated 90 seconds after giving injection succinylcholine at a dose of 1.5mg/kg body weight. A second dose of 30 mcg of fentanyl was administered one minute prior to intubation to attenuate the stress response. The correct position of endotracheal tube was confirmed before fixing the tube. Then a 14 F orogastric tube was put. Thereafter, anesthesia was maintained with oxygen and air (2:1), isoflurane (up to 2%) along with injection vecuronium 0.1mg/kg or injection atracurium 0.5mg/kg) with controlled mechanical ventilation. All 5000 cases were anesthetized with a penlon anesthesia workstation with monitor and ventilator (AV-S) supplied with the machine (Model: Prima Sp2). The ventilator was set for controlled mechanical ventilation with a tidal volume of 8-10 ml/kg, I: E ratio 1:2, rate 12-15/ minute. CO_2 was then insufflated to raise the intra-abdominal pressure up to 12 mmHg. A head up tilt of 25 degree was made and surgeon completed the operation with SILC technique. Throughout the surgery every attempt was made to maintain the ETCO2 below 35 mmHg. If the ETCO2 went more than 35 mmHg then it was brought down by

increasing the minute ventilation, deepening the depth of anesthesia and bringing down the airway pressure. Incremental doses of vecuronium 1mg or atracurium 5mg and fentanyl 20 mcg were given when the patient became light or movement started. Through-out the surgery strict vigil was kept on all the parameters and any abnormality noticed was treated immediately with proper medications. 15 minutes before closure ranitidine 50 mg and ondansetron 4 mg were given intravenously to reduce post operative nausea and vomiting (PONV). Paracetamol 1 gm intravenously were administered slowly over 20 minutes before reversal for post operative analgesia. At the end of surgery the residual neuromuscular effects of relaxants were reversed by injection neostigmine (0.05-0.07 mg/kg) and glycopyrrolate 0.4 mg. Extubation was done after satisfactory clinical signs of reversal like obeying command, adequate respiration and good hand grip. Patients were transferred to the PACU after 5 minutes of oxygen administration when the patient could raise his head and hold it for 5 seconds. On transfer to the PACU, the patients were administered injection ketorolac 30 mg. and oxygen by mask for 30 minutes. Patients with respiratory diseases received oxygen for a longer period of time. Once the patients were stable, they were transferred to phase II recovery ward.

RESULTS

Five thousand laparoscopic cholecystectomies were performed for symptomatic gall bladder diseases from January 2010 to December 2015 at NMCTH. The mean age of all 5000 cases was 48 years with a range of 12-78 years. The majority of patients (58%) were in the age group 30-50 years. The number of females predominated in the study (69.36%), yielding a male: female ratio of 1:2.26.

Quite a substantial number of patients i.e. 1432 (28.64%) belonged to ASA III whereas 1682 (33.64%) belonged to ASA II and rest belonged to ASA I.

The mean operative time for all cases was 52.07± 14.03.

The baseline readings of all the parameters studied acted as control for that particular patient. After removal of gall bladder all cases demonstrated cholelithiasis except 416 the number of patients who had symptomatic gall bladder disease without cholelithiasis viz.- chronic cholecystitis (254) hypoplastic polyps (25), gall bladder dyskinesia (62) and cholangitis(75)

Out of 5000 patients 4783 (95.66%) maintained their SPO2 between 98-100% throughout the surgery. The fall in SPO2 between 85-90 % in 217 (4.34%) patients were easily corrected to more than 92% by adjusting ventilation (tidal volume or rate), FiO_2, bronchodilator, deepening the depth of anesthesia and muscle relaxants.

In the present study, 3162 (63.24%) out of 5000 cases maintained their ETCO2 between 30-35 mmHg. ETCO2 between 40-45 mmHg was observed in (411) 8.22% patients who were suffering from COPD or other respiratory diseases. Lowering of airway pressure, bronchodilators, increase in respiratory rate, increase in the concentration of isoflurane, intermittent nebulization during surgery brought down the ETCO2 below 35mmHg but ETCO2 of 54 patients who were suffering from moderate to severe COPD or respiratory disease remained around 40 mmHg till the end of the surgery, which settled at the baseline after exsufflation. In rest 1427 (28.54%) patients ETCO2 went up to 40 mmHg after head up position and pneumoperitonium which settled below 35 mmHg with time, deepening of anesthesia, an increase in the tidal volume and transient exsufflation.

Table 1: Intra-operative complications and Early (0-6 hours) PONV.

Variables		Number of Patients	Percentage%
Bradycardia (less than 50/min)		121	2.42
Tachycardia (more than 90/min)		653	13.06
Hypotension (less than 90 mmHg)		414	8.28
Hypertension (more than 20% from baseline)		716	14.32
Arrhythmia	VPC's	90	1.8
	Ist degree heart block	8	0.16
	Non specific ST depression	6	0.12
PONV Early (0-6 hours)		416	8.32

All the intra-operative complications were recognized and immediate steps were taken to correct these. IV Atropine was used for combating bradycardia; analgesics; propofol; esmolol and isoflurane were used to treat a tachycardia. 50% of patients (45) who had intra-operative hypertension needed 5-10mg sublingual nifedipine to control their blood pressure. In rest 50% BP was controlled with injection fentanyl, propofol and increasing the isoflurane up to 2.5 MAC for a short while. Hypotension was treated with IV infusion (crystalloid/colloid), calcium gluconate and steroid. Eighty- eight patients also needed IV mephenteramine in increments of 6 mg up to a total of 18 mg to correct their hypotension. Hypotension in all the patients responded very well when the patients were made supine from their head up position. Non specific ST depression disappeared by

increasing FiO_2 and administration of analgesics. Arrhythmias were controlled by increasing the FiO_2, temporarily stopping the isoflurane, administering muscle relaxants and midazolam except in 40 cases of VPCs who needed injection xylocard for proper control.

Propped up position, nil per oral, and injection ondansetron and H2 receptor antagonist controlled early PONV (0-6 hours) for all cases except 20 patients who needed injection dexamethasone 8mg also. One thousand Eighty Nine (21.18%) patients needed supplementary analgesics (injection Ketorolac 30 mg iv) as they complain of pain in the early post operative period.

Table 2: Intra-operative complications.

Complications	Number of Patients	Percentage %
Injury to liver bed	25	0.5
Injury to CBD	5	0.1
Injury to omentum	10	0.2
Oozing from liver bed	20	0.4
Injury to Cystic duct & hepatic duct)	8	0.16
Bleeding from port entry point	10	0.2

All the intra-operative complications were successfully managed with intravenous infusions (crystalloids and colloids), blood transfusions, IV injection tranexemic acid 1gm, injection vitamin C 500 mg, calcium gluconate 10cc of 10 %, intravenous vitamin K. The mean operative time for all cases was 58.07± 14.03 minutes.

The conversion rate in the present study was 1.36% (68 patients). Out of 65 patients who had an injury to liver, omentum, gut and oozing from liver bed 58 patients who were converted to open method rest 7 patients along with 13 others who had minor injuries to the CBD and cystic duct were tackled laparoscopically only.

Table 3: Hospital Stay.

Post Operative Day	Number of Patients	Percentage %
O day	None	None
1st day	114	2.28%
2nd day	3750	75%
3rd day	761	15.22%
4th -7th day	293	5.86%
>7th day	82	1.64%

Out of the 82 patients, who had to stay in the hospital for more than seven days, 8 patients underwent laparotomy by open method to repair the injury/ fistula. Anyway all were discharged uneventfully by 22nd day.

DISCUSSION

The introduction of laparoscopy in the field of surgery in the mid 1950s revolutionized surgical techniques. With the passage of time and advanced research, particularly in the field of anesthesia and improved surgical skill, availability of better equipments, the process of laparoscopic surgery further improved. All these advancements resulted in reduction of overall medical costs, reduced bleeding, less post operative surgical and pulmonary complications, early recovery and return to normal work and increase in the number of day care surgery. A survey in 2007 showed that in the United States 80% of surgeries are performed as day care surgery. [5] In our institution laparoscopic cholecystectomies have almost replaced open cholecystectomies as a procedure of choice for the treatment of symptomatic gall bladder diseases. Better surgical and anesthetics skill have contributed a great deal to it. To our knowledge, this is the longest comprehensive report for the anesthetics experience of laparoscopic cholecystectomy from Nepal. Even Pubmed and Google search also didn't reveal such a large series for anesthetics management of laparoscopic cholecystectomy, may be due to the fact that this procedure has now been adopted all over the world so rapidly that large randomized controlled series are not being reported.

Laparoscopic cholecystectomy needs head up positions, pneumo-peritoneum to increase IAP, preferably below 15 mmHg. CO_2 is mostly used for this purpose as it does-not support combustion, highly soluble in blood so cleared much early than other gases. But the drawbacks of CO_2 are that it produces gaseous embolism, an increase in arterial CO_2 pressure (PCO_2), changes in arterial blood pressure and heart rate. The patho-physiologic effects of all these on cardiac, respiratory, neurologic and other systems are unique for laparoscopic surgeries which had been nicely enumerated by several workers. [6,7]

With an IAP of less than 12 mmHg, the most relevant hemodynamic changes are: increase in central venous pressure (CVP), heart rate, systemic and pulmonary resistance and mean arterial pressure. But if the IAP is more than 15 mm Hg with head up tilt the vena caval compression and raised intra-thoracic pressure, due to elevation of the diaphragm, will reduce cardiac output and may cause hypotension. All these are more pronounced if the IAP exceeds more than 20 mmHg. Arrhythmias and bradycardia may appear in non atropinized patients due to vagal stimulations. [8] Pneumo-peritoneum and elevation of the diaphragm due to head up positions induces several changes in pulmonary

functions like reduced lung volumes, decreased pulmonary compliance, increase in peak and mean airway pressure, basal atelectasis, reduced diaphragmatic excursion leads to increased pulmonary shunting , preferential ventilation leads to V/Q mismatch and early closure of the smaller airways. All leads to reduced functional residual capacity (FRC). Incidence of CO_2 subcutaneous emphysema, pneumothorax, pneumo-mediastinum, pneumo-pericardium and downward pulling of endo-tracheal tube may lead to endo-bronchial intubation leading to hypercapnia and respiratory acidosis. Hypercapnia may also lead to increase intracranial pressure and reduced cerebral perfusion.

Increase in intra-abdominal pressure (IAP), peritoneal insufflations of CO_2 and head up position may also lead to a reduction of glomerular filtration rate (GFR), urine output and creatinine clearance due to reduction of renal cortical and medullary blood flow. Pressure on the inferior vena cava and iliac veins reduces femoral and portal venous flow leading to more chances of deep vein thrombosis (DVT) and transient elevations of liver enzymes. C-reactive protein and interleukin 6 levels are less elevated after laparoscopy compared to open surgery, suggesting an attenuation of surgical inflammatory response. Head up position also increases the risk of regurgitation, silent aspiration and peripheral nerve injuries. [9-15]

All these patho-physiological changes of laparoscopic procedures complicate the anesthetic management. So, the anesthesiologists must have a thorough understanding of these changes so that he is always prepared to prevent, detect and treat the possible alterations that can occur during the surgical procedures. Several anesthesia techniques can be used for laparoscopic cholecystectomy like general anesthesia, regional anesthesia viz. central neuraxial block, local infiltration with intra-peritoneal spray and deep intravenous sedation as cited in Miller's Anesthesia 2005.[16] The ideal anesthetic techniques for laparoscopic surgery to give emphasis on shorter and more favorable techniques. It should provide rapid induction as well as rapid, smooth post operative recovery, should maintain stable cardiovascular and respiratory function, lead to minimize post operative nausea and vomiting (PONV) and provide good post operative pain relief with early mobility. [16] As a matter of fact an ideal anesthetic technique for laparoscopic cholecystectomy is still a debatable issue and evolving. Presently, most of the researchers in this field recommend general anesthesia using "balanced anesthesia" technique with intravenous short acting anesthetics and adjuvant drugs, muscle relaxants, and inhalational agents with endo-tracheal intubation and control ventilation as the favored technique. The advent of newer short acting inducing agents like propofol and etomidate, newer potent short acting analgesics like remifentanil, fentanyl, and short acting muscle relaxants like vecuronium, atracurium etc further augmented the use of general anesthesia for laparoscopic surgery.[16-20] In the present study also balanced general anesthesia as advocated by previous workers was used. Propofol was used for induction after proper atropinization and anesthesia was maintained with oxygen, air, isoflurane (1.5%), fentanyl and controlled ventilation with vecuronium or atracurium.

In the present study more than 95% patients maintained their SPO2 at normal level, similar was the findings of other previous workers like Jeon-yean Hong et al [21], Maha S. A Adbel Hadi et al[22] and Harris MNE et al[23]. In 4.34% of patients the SpO2 dropped temporarily and got corrected immediately with a proper measure. These sorts of observation were also previously reported by Kubota et all [24], Maha S. A Adbel Hadi et al [22].

Mild increase of ETCO2 (35-40mmHg) and moderate increase of ETCO2 40-45 mmHg were observed in 28.54% and 8.22% respectively after insufflations of CO_2. Similar or almost similar finding were also observed previously by Kamolpornwijit W et al [25] & G. Chopra et al [26], Fox LG et al [27] Kelman GR [28]. Anyway, in all the above studies, including the present one ETCO2 drop to baseline level after ex-sufflation.

In the present study, 8.28% patients had tachycardia, 14.32% had mild hypertension, 2.08% patients had arrhythmias. Tachycardia, hypertension and arrhythmias were also observed previously by Scott DB, et al [29], Myles PS [30], Critcheley LA et al [31], E.R. Loureiro et al [32], T.K Biswas e al [33], B. Gautam [34] Every researcher like Wahba RWM et all [35] felt that the original cause of these hemodynamic disorders is due to hypercarbia which induced release of catecholamines. IAP induces decrease in venous return which also may induce tachycardia. Lighter plane of anesthesia might play a part.

Bradycardia and hypotension occurred in the present study in 2.42% and 8.28% cases respectively. This is mainly due to vagally mediated reflex initiated by stretching of the peritoneum or inadequate ventilation and hypoxia. This sort bradycardia and hypotension were observed by most of the authors like E. O'Leary et al [36] & Joris JL [37].

IAP of all the patients in the present study was maintained at 12 mmHg. Ming-Xin Pan et al [38], Maria F, et al [7] and many others also used IAP of either 12 mmHg or 13 mm Hg

Conversion rate of present study is 1.36%. From time to time, various authors have reported various conversion rate viz. Miller reports a conversion rate of 1-3 per thousand and Similarly, Shea JA, et al [39], Singh K, et al [40] and Capizzi FM et al [41] reported more or less similar conversion rates. This is because the conversion rate depends on experience and expertise of the surgeon which varies from center to center.

There is a wide variation in the mortality rate in cases of laparoscopic cholecystectomy like Miller reported 0.01%-0.1% where as Loureiro ER et al [32] reported 0.3% mortality. Anyway, in the present series, there was no intra-operative death. This wide variation might be due to variations in time of death.

In the present study incidence of intra-operative complications [Table 2] were less. The similar less incidence of intra-operative complications were also reported before by Mall BR, et al [42], Shea JA, et al [39], Singh K et al [40].

In the present study more than 92.5% patients were discharged by midday of postoperative day 3. Almost similar incidences have also been reported by Robert W et al [43], Ganey GB et al [44].

CONCLUSION

Our retrospective study of 5000 cases, of laparoscopic cholecystectomy at NMCTH conforms the view of many other workers that laparoscopic cholecystectomies by SILC is safer, cost effective, less hospital stay, less intra-operative complications, less PONV, less need for postoperative analgesics. In our institution, today, laparoscopic cholecystectomy has replaced open cholecystectomy and balanced general anesthesia with midazolam, glycopyrrolate, fentanyl as premedicant, propofol, incremental doses of fentanyl, endotracheal intubation with succinylcholine followed by controlled mechanical ventilation with muscle relaxants viz. vecuronium or atracurium is the technique of choice. Further study on anesthetics management of laparoscopic cholecystectomy will further substantiate our study.

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