

Intra-operative change of gastric pH during laparotomic cholecystectomy under general anaesthesia: A prospective case-control study

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ABSTRACT

Background: Gastric decompression by suctioning often shows greenish/greenish-yellow-coloured gastric aspirates following cholecystectomy under general anaesthesia (GA). Possible intraoperative regurgitation of duodenal contents into stomach because of surgical manipulation may be the reason for such alteration in colour of the gastric secretions. **Aim:** We conducted this study to determine whether there were any pH changes of gastric secretions during laparotomic cholecystectomy operation to confirm our hypothesis of regurgitation of duodenal contents into the stomach. **Settings and Designs:** Prospective observational controlled study in the Department of Anaesthesiology and Critical Care in a tertiary care university teaching hospital. **Methods:** Fifty adult ASA I and II patients scheduled for open cholecystectomy operation under GA were included in the study group and another 50 non-abdominal surgical patients without any gall bladder disease were taken as controls. Three to five milliliters of gastric secretions were aspirated just after intubation and also before reversal of residual neuromuscular blockade for analysis of pH. **Statistical Analysis:** Analysis of variance test and Chi-square test with Fisher's exact correction were used for statistical analysis. Differences were significant when the *P* value was <0.05. **Results:** Post-operative values of pH in the study group were significantly higher than their pre-operative values (2.40 ± 1.10 vs. 4.04 ± 1.6 , $P \leq 0.001$). Forty-nine patients (98%) in the study group had altered coloured post-operative gastric aspirations, while no patient in the control group had such changes ($P < 0.001$). **Conclusions:** A significant change in gastric pH takes place during laparotomic cholecystectomy due to reflux of duodenal content into the stomach.

Key words: Anaesthesia, cholecystectomy, gastric pH, post operative nausea and vomiting

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INTRODUCTION

Oro/naso-gastric suctioning following open cholecystectomy operation often shows a large amount of yellowish or greenish-yellow-coloured fluids. As normal gastric secretion is usually colourless, we presumed that such altered gastric aspirates were because of intraoperative regurgitation of duodenal

contents into the stomach. Duodenal contents, being alkaline in nature, may alter the pH of the gastric contents following its regurgitation into the stomach. In this prospective, controlled observational study, we investigated the pre- and post-operative pH values of gastric secretions to find any change so as to correlate the role of possible duodenal reflux in relation to the change of colour of gastric secretions during cholecystectomy.

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METHODS

After obtaining Institutional Ethical Committee approval and informed consent, 50 adult ASA class I and II patients of either sex undergoing open cholecystectomy under general anaesthesia (GA) were selected as the study group and another 50 patients undergoing non-abdominal surgeries under GA (viz. orthopaedics, ENT and general surgery patients excluding those procedures where blood/other external fluids can enter into the stomach during the operation) were selected as the control group. Patients on antacids, H2 blockers or on proton pump inhibitors were excluded from the study.

Patients were premedicated with tablet diazepam 0.1 mg/kg (rounded to 5 or 10 mg) on the night before and on the morning of the day of surgery. Perioperative monitoring included electrocardiography, non-invasive blood pressure, pulse oximetry and end tidal capnography.

GA was induced with i.v. propofol (2 mg/kg), fentanyl (1.5 µg/kg) and tracheal intubation was facilitated with i.v. vecuronium (0.1 mg/kg). Anaesthesia was maintained with air-oxygen mixture along with isoflurane as well as top-up doses of fentanyl and vecuronium as per requirement. After institution of GA, a naso/orogastric tube was inserted up to the 50-cm mark and 3–5 mL of gastric aspirates were withdrawn and sent to the laboratory for estimation of the gastric pH. The second sample of gastric aspirates was taken through the naso/orogastric tube immediately before reversal of the residual neuromuscular block and was also analyzed in a similar way. Investigators analyzing the pH were unaware about the types of operation as well as the pre- and post-operative status of the samples. All patients in the control group were managed in a similar way and gastric aspirates were also analyzed in a similar fashion. Patients from whom adequate amount of gastric aspirates could not be obtained were excluded from the data analysis. Patients had standard post-operative care after extubation following reversal of residual neuromuscular blockade.

Statistical analysis

This is the first study to assess the intraoperative change of gastric pH during open cholecystectomy. Based on average open cholecystectomy load over the last 2 years (125/year) in our hospital, we took 20% of the total cases ($n=50$) to complete this study over a period of 2 years. Equal numbers of patients from other

disciplines were enrolled as the control group. Data was analyzed using the statistical package for social science (SPSS) (Version 10.0). Statistical difference of means between the groups was calculated using the analysis of variance test, while the Chi-square test with Fisher's exact correction was used for discrete variables. Differences were considered significant when the P value was <0.05 .

RESULTS

Control group patients were from ENT, orthopaedics and surgery departments [Table 1]. Three patients in the control group were excluded as we could not aspirate the desired amount of gastric secretion. In their place, we included three more patients. Age and sex distribution of patients varied significantly between the two groups. Further, duration of anaesthesia was also significantly longer in the control group ($P<0.05$) [Table 2].

The pre-operative pH value of gastric fluid in the cholecystectomy and non-cholecystectomy groups was 2.40 ± 1.10 and 2.18 ± 0.80 , respectively ($P=0.25$). In the control group (non-cholecystectomy patients), there was no significant difference between the values of pre- and post-operative pH (2.18 ± 0.80 vs. 2.12 ± 0.7 , $P=0.60$). However, among patients who underwent cholecystectomy, the mean post-operative pH was significantly higher than their pre-operative values (2.40 ± 1.10 vs. 4.04 ± 1.6 , $P<0.001$). Accordingly, the post-operative values of pH in the cholecystectomy patients were found to be significantly higher than that of the non-cholecystectomy patients (4.04 ± 1.6 and 2.12 ± 0.7 , $P<0.001$) [Table 3].

Table 1: Surgical procedures performed in the non-cholecystectomy group (control group)

Types of surgery	Number of patients
Mastoid exploration	25
Hemithyroidectomy	6
Dynamic hip screw fixation	7
Plate implantation upper limb fracture	4
Carcinoma breast with axillary node dissection	8

Table 2: Demographic parameters of patients and duration of general anaesthesia

Parameters	Cholecystectomy group ($n=50$)	Non-cholecystectomy group ($n=50$)	P value
Age (years) (mean±SD)	40.90 ± 13.84	28.10 ± 10.81	<0.001
Sex (M:F)	6:44	22:28	<0.001
Duration (min) (mean±SD)	82 ± 25.93	160.10 ± 61.88	<0.001

Table 3: Gastric fluid pH obtained both before and after surgery

Parameters	Cholecystectomy group (n=50)	Non-cholecystectomy group (n=50)	P value#
Pre-op pH (mean±SD)	2.40±1.10	2.18±0.80	0.25
Post-op pH (mean±SD)	4.04±1.6	2.12±0.7	<0.001
P value [§]	<0.001	0.605	

[§]P value when compared within the same group; #P value when compared between the two groups

Of 50 patients in the cholecystectomy group, colour of the pre-operative gastric fluid was white in 21 (42%) patients and yellowish-green in 29 (58%) patients. Mean pH of the pre-operative and post-operative gastric aspirates of these 29 patients was 2.73 ± 0.9 and 4.39 ± 0.03 , respectively. However, 49 patients (98%) in this group had a greenish-yellow aspirate in the post-operative period. In the control group, all 50 patients (100%) had a white-coloured gastric aspirate both in the pre- and in the post-operative period ($P < 0.001$).

DISCUSSION

Performing gastric emptying before the tracheal extubation following cholecystectomy often shows yellow or greenish-yellow-coloured aspirations. Gastric secretions normally are colourless. In the presence of overnight fasting, such change of colour may be because of mixing with other secretions like those from duodenum with bile content. In our study, we found that a significant change in pH of the gastric secretion takes place during the procedure of cholecystectomy. Findings from the control group of patients also suggest that mere prolonged duration of surgery and GA exclusively do not produce such changes in the pH of the gastric secretion. Change of colour and a significant alkaline alteration of pH of gastric secretions indicate that regurgitations of duodenal contents into the stomach take place during the cholecystectomy operation.

There was a significant difference among the parameters of age, sex and duration of anaesthesia between the two groups of patients. We believe that these differences were because of randomization of patient as well of different types of surgical procedures in the control group taking a longer duration than cholecystectomy. Differences in the distribution of sex can be attributed to the higher incidence of gall stone diseases among the female population. Despite longer duration of anaesthesia, change

in gastric pH among the control group of patients was not significant. This highlights that mere duration of anaesthesia has an insignificant effect on gastric pH.

The colour of the gastric aspirates before the operation was altered in 58% of the patients who underwent cholecystectomy. As many as 80% gall stone disease patients often have abnormal duodenogastric reflux (DGR) and antroduodenal motility in both pre- and post-operative periods.^[1-3] In our study, patients in the cholecystectomy group had a tendency to have higher pre-operative gastric pH than the control group. Chronic DGR and relatively higher values of pre-operative pH indicate that the altered colour of the pre-operative gastric aspirates might have been because of this pre-existing DGR-mediated slow reflux of duodenal contents into the stomach. However, this pre-operative reflux was not severe enough to bring significant changes in gastric pH. Estimation of bile components could have solved this issue of non-significant higher values of pH in the background of altered coloured aspirates.

Colour of the post-operative gastric aspirates in patients who underwent cholecystectomy was greenish-yellow in all but one patient. Surgical procedures for cholecystectomy often require manipulation of duodenum, common bile duct and gall bladder itself.^[4] We presume that in the background of abnormal DGR with altered antroduodenal motility, presence of local manipulations and pressure have facilitated significant amount of reflux of the duodenal contents through an anaesthesia-induced relaxed pylorus leading to a significant change of colour and pH of gastric secretions.

We could find an explanation for what is otherwise a common observation in day-to-day anaesthesia practice. Previous studies measuring gastric pH continuously over a period of 24 h following cholecystectomy have demonstrated an alkaline shift of gastric pH because of the exaggerated effect of DGR.^[5,6] No studies have estimated intraoperative change of gastric pH during laparotomic cholecystectomy. We feel that these findings might have further clinical importance in the perioperative management of these patients. Gastric secretion has an acidic pH that protects against ingestion of unsuitable material.^[7] One of the natural ways of protection is vomiting to expel out the abnormal/unaccustomed contents from the stomach. Studies have revealed that

duodenal contents have noxious effects when present in abnormal sites or when they have accumulated in large amounts.^[8,9] This changed internal milieu because of duodenal reflux may lead to the increased tendency of nausea and vomiting following upper abdominal, specifically cholecystectomy, operation.^[10] Patients having acute as well as chronic cholecystitis often suffer from various degrees of nausea and/or vomiting. Besides various other causes specific to gall bladder, abnormal DGR-mediated ongoing gastric reflux of irritant bile may be one of the causes of bilious vomiting and development of nausea in patients suffering from gall bladder diseases. Because of adaptation, many of them continue to have these symptoms, although with a lesser degree of severity.^[11] However, the immediate post-operative period is an acute stage where possibility of adaptation is minimal. Irrespective of the use of narcotics, gastric motility is deranged under GA, more so after open cholecystectomy.^[12,13] This bradygastria and large-volume reflux of noxious bilious duodenal contents can both increase the gastric volume as well as irritability leading to increased incidence of post-operative nausea and vomiting. Further studies estimating the incidence of post operative nausea and vomiting following cholecystectomy and finding out its correlation with gastric pH changes are required to establish this assumption.

CONCLUSION

In conclusion, significant alteration of the gastric pH takes place during the cholecystectomy operation. Greenish-yellow changes in the colour of gastric secretion as well as alkaline shift of its pH strongly indicate reflux of duodenal contents into the stomach.

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