Shoulder Tip Pain Following Laparoscopic Cholecystectomy— a Randomized Control Study to Determine the Cause

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Abstract The aim of this study was to determine the effect of low-pressure pneumoperitoneum and duration of surgery in laparoscopic cholecystectomy on postoperative shoulder tip pain. A total of 100 patients were assigned into two groups depending on the intraperitoneal pressure during laparoscopic cholecystectomy. Group A included patients in whom the intraperitoneal pressure was 13–15 mm of Hg and group B included patients who underwent surgery at 10–12 mmHg. Each group was then subdivided into two subgroups depending on the duration of surgery. In the first subgroup, the duration of surgery was less than 1 h and the next subgroup included patients who took more than 1 h. Presence or absence of shoulder tip pain was recorded within 4 h, at 24 h, and at 48 h. Total number of patients having shoulder tip pain in the lower pneumoperitoneal group was more than the higher pneumoperitoneal group in both subgroups, P values >0.05 . More patients in the <1 h subgroup had shoulder tip pain as compared to the >1 h group at both pneumoperitoneal groups, P values >0.05 . Shoulder tip pain was most at 24 h and gradually decreased thereafter. In our study, intra-abdominal pressures and shorter duration of surgery were factors unrelated to incidence of shoulder tip pain after laparoscopic cholecystectomy.

Keywords Shoulder pain · Laparoscopic cholecystectomy · Pneumoperitoneal pressure

Introduction

Although laparoscopic cholecystectomy has emerged as the gold standard in gallbladder surgery with its advantages, including less postoperative pain and earlier ambulation with return of normal activities, it is not without its undesirable side effects, of which shoulder tip pain is a troublesome symptom [1, 2]. Reasons proposed as causes of shoulder pain is stimulation of the sympathetic nervous system by hypercarbia [3], the residual pneumoperitoneum after the surgery, and rapid distention of the abdomen by carbon dioxide [2]. Although there are many studies studying the effect of intra-abdominal instillation of local anesthetics, low-pressure pneumoperitoneum, and slow insufflation to reduce shoulder tip pain, none have studied the effect of duration of surgery as an important factor in shoulder tip pain. The aim of the present study is to prove or disprove the effect of duration of surgery and the pressure of pneumoperitoneum on the effect on shoulder tip pain.

Materials and Methods

The study was conducted as a prospective double blind randomized controlled trial. Patients admitted in the Department of General Surgery, Sir Ganga Ram Hospital for laparoscopic cholecystectomy between 18 and 60 years were eligible for the study. The outcome measure studied was presence or absence of shoulder tip pain at 4, 24, and 48 h. Of the 109 subjects who were screened, 100 patients met the inclusion criteria and were randomized. There were no conversions to open surgery and no patients were lost to follow-up. Patients falling under the exclusion criteria mentioned in

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The manuscript has never been presented in any meeting or published in any written form whatsoever.

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Table 1 were excluded. Written informed consent was taken from all the enrolled patients.

Randomization was done by a computer-generated sequence, with the help of the software www.randomization.com, and stored in sealed opaque envelopes. An equal number of subjects were chosen for the two groups undergoing laparoscopic cholecystectomy repair, at different pneumoperitoneal pressures. Demographic variables of the two groups are shown in Table 2. The patients received a similar standardized anesthetic and postoperative analgesic treatment. The outcome measure studied was postoperative shoulder tip pain at 4, 24, and 48 h. Information on convalescence was recorded through direct questioning and over the telephone, if the patient was discharged early.

All patients were operated under general anesthesia in the reverse Trendelenburg with right side up position by the four-port technique. Pneumoperitoneum was created using Veress needle at maximum flow rate till 15 mm of Hg, followed by insertion of the first trocar (5 mm) for the laparoscope at the umbilicus. We routinely make the epigastric port as 10 mm and use it later to extract the gallbladder. The remaining surgery was carried out with intra-abdominal gas pressure maintained between 10 and 12, and 13 and 15 mmHg in the two arms, respectively. Because three patients in group A could not tolerate pneumoperitoneum at 15 mm of Hg and had pneumoperitoneum-induced bradycardia, they had to undergo surgery at 10–12 mm of Hg and included in group B. The duration of surgery was carefully recorded using the wall-mounted OT timers. After removal of the gallbladder, 10 ml of 0.5 % bupivacaine solution was infiltrated into the port sites. In patients with an acute cholecystitis, empyema, or gangrenous gallbladder, a silicone Jackson-Pratt drain was inserted through the lateral most port and placed in the subhepatic space. In all the cases, residual carbon dioxide was completely evacuated at the end of the procedure. The time of arrival in the postoperative ward was defined as 0 h postoperatively. Presence of shoulder pain was measured at 4, 24, and 48 h, respectively. The visceral or local pain at the port sites was specifically asked for and excluded from the questionnaire after proper explanation to the patients. In cases where the patient has been discharged, the shoulder tip pain was asked over the telephone.

A total of 100 patients were included in the study. Group A included patients in whom the intraoperative pressure was kept at 13–15 mm of Hg. Group B included patients in whom the intraoperative pressure was kept at 10–12 mm

Table 1 Exclusion criteria for the study

Failure to obtain consent	3
Patients with endocrine, renal, hepatic, or immunological disease and pregnant patients	5
ASA grade III or IV	1

Table 2 Demographic variables of subjects in the two study groups

	Group A (<i>n</i> =47)	Pressure B (<i>n</i> =53)	<i>P</i> values
Age	46.84±10.78	43.02±13.12	0.115
Sex (M/F)	15/35	16/34	0.829
Body mass index	29.05 (22–52.9)	26.75 (21.2–56.0)	0.057
Time of surgery	72.5 (30–150)	60 (13–240)	0.124
Postoperative drain	16 (32 %)	23 (46 %)	0.151

of Hg. The two groups were further divided into two subgroups depending on the duration of surgery. The first subgroup included patients in whom the duration was less than 1 h and the second subgroup included patients in whom it took more than 1 h. Results of the study of the two groups and subgroups are shown in Table 3. Table 4 shows the same patients regrouped according to the duration of surgery and subgrouped according to the pneumoperitoneal pressures. This was done to find out whether the duration of surgery is also a factor in the causation of shoulder tip pain. *P* values were also determined for the new subgroups.

Results

Demographic variables of both the groups with regard to age, sex, and BMI were comparable. Categorical variables are expressed as frequencies. Mann–Whitney *U* test was used for comparison of continuous variables between the two groups. Differences between groups were assessed with Chi-square or Fisher's exact test for categorical variables as appropriate. The comparison of age between the groups was performed using Student's *t* test. Results are expressed as mean ± SD, median (range), or numbers and percentages. *P* value of <0.05 was taken as significant. Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0

The mean age of the subjects in the study was 47 and 43 years in the two groups. There were no significant intraoperative or postoperative complications in either group. The operating surgeons had noted that there was little difference in the exposure or working space at 10–12 mmHg when compared with that at 13–15 mmHg. Three patients in group A could not tolerate pneumoperitoneum at 15 mm of Hg and had pneumoperitoneum-induced bradycardia; they had to undergo surgery at 10–12 mm of Hg and were included in group B.

The total number of patients who underwent surgery at low-pressure pneumoperitoneum did not have significant difference in incidence of shoulder tip pain as compared with those who underwent surgery at standard-pressure pneumoperitoneum (*P* value >0.05 in all the subgroups) (Table 3). In patients in whom the surgery took less than 1 h, four patients in the 13–15 mm of Hg group had pain at 24 h compared with

Table 3 Group distribution and average shoulder tip pain in the groups with difference in the pressure of pneumoperitoneum

Subgroups	Group A (13–15 mmHg) <i>n</i> =47			Group B (10–12 mmHg) <i>n</i> =53		
	Al (<1 h) <i>n</i> =45	Am (>1 h) <i>n</i> =2	<i>P</i> value	Bl (<1 h) <i>n</i> =42	Bm (>1 h) <i>n</i> =11	<i>P</i> value
Shoulder tip pain—4 h	0 (0 %)	0 (0 %)		2 (4.8 %)	1 (9.1 %)	0.580
Shoulder tip pain—24 h	4 (8.9 %)	0 (0 %)	0.659	6 (14.3 %)	3 (27.3 %)	0.307
Shoulder tip pain—48 h	3 (6.7 %)	0 (0 %)	0.706	5 (11.9 %)	3 (27.3 %)	0.205

six patients in the 10–12 mm of Hg group. This decreased to three and five patients, respectively at 48 h (Table 4). None of the patients at >1 h group who underwent surgery at 13–15 mm of Hg had shoulder tip pain, suggesting that there is no correlation between the duration of surgery and shoulder tip pain (*P* values—0, 0.659, 0.706).

More patients in the low pneumoperitoneal pressure group had shoulder tip pain as compared with the high pressure group (20 vs 7). Shoulder tip pain was most at 24 h and gradually decreased thereafter in both the groups.

Discussion

The incidence of shoulder tip pain was almost unheard of in open cholecystectomy era and was first reported after laparoscopic gynecological procedures [4]. Early pain after laparoscopic cholecystectomy is multifactorial, due to surgical trauma to the abdominal wall at the port sites, local effect of carbon dioxide on the peritoneum, and distention of the abdominal wall and the diaphragm [5]. The pain pattern after laparoscopic cholecystectomy is therefore multimodal in nature. It is a combination of three separate components: incisional pain (somatic pain), visceral pain (deep intra-abdominal pain), and shoulder pain (referred somatic pain). Visceral pain accounts for most of the discomfort experienced in the early postoperative period and is distinctly different from shoulder tip pain [6]. Shoulder pain mostly becomes apparent on the day after surgery when the visceral pain component has decreased. There are also great individual differences in pain perception after abdominal surgery [7].

Incidence of shoulder tip pain after laparoscopic cholecystectomy varies greatly with some studies reporting incidences as high as 30–50 % [8]. The type of pain, intensity, and

duration of pain varies between different patients and is largely unpredictable. The prevention and treatment of such pain, therefore, is also controversial. A number of studies have looked at methods to reduce the incidence and severity of shoulder pain following laparoscopic surgery.

A number of clinical trials have shown variable analgesic effects with a variety of methods including periportal infiltration of local anesthetics, intraperitoneal spraying above the gallbladder, and instillation into the subdiaphragmatic and subhepatic space covering the area of the hepatoduodenal ligament [7]. Bupivacaine administered in the subdiaphragmatic area is presumed to block noniceptive input generated from the inflamed diaphragmatic peritoneum [9]. In all our patients, we routinely instill 20 cc of 0.25 % bupivacaine in the subdiaphragmatic space. Some other studies have contradicted this finding [6, 10]. They have stated that neither the intensity nor the time course of the different pain components is affected by the intraperitoneal instillation of bupivacaine. In the light of this routine, use of intraperitoneal local anesthetics however cannot be recommended because of the low study quality in many trials and conflicting results. The volume of gases used has also been studied as a cause of pain [11], although because of intraoperative change of gas ports and leakage from trocars, such data cannot be accurately substantiated.

Other methods investigated to reduce shoulder tip pain include surgery with low-pressure insufflation, prewarmed gas, preemptive anti-inflammatory medication, preemptive diaphragmatic local anesthetic irrigation, postoperative drains, and subdiaphragmatic suction. Unfortunately, studies have often found quite varied and sometimes conflicting results regarding the effectiveness of these interventions [5]. Some studies have also shown that the shoulder tip pain is minimal if the initial insufflation rate is kept suboptimal, although this needs to be substantiated.

Table 4 Group distribution and average shoulder tip pain in the groups with difference in duration of surgery

Subgroups	Time <1 h Pressure 10–12 mmHg, (<i>n</i> =45)	Time >1 h Pressure 13–15 mmHg, (<i>n</i> =42)	<i>P</i> value	Pressure 10–12 mmHg, (<i>n</i> =2)	Pressure 13–15 mmHg, (<i>n</i> =11)	<i>P</i> value
Shoulder tip pain—4 h	0 (0 %)	2 (4.8 %)	0.139	0 (0 %)	1 (9.1 %)	0.657
Shoulder tip pain—24 h	4 (8.9 %)	6 (14.3 %)	0.430	0 (0 %)	3 (27.3 %)	0.400
Shoulder tip pain—48 h	3 (6.7 %)	5 (11.9 %)	0.398	0 (0 %)	3 (27.3 %)	0.400

Some studies have shown that the incidence and intensity of postoperative shoulder tip pain was significantly less in the low-pressure pneumoperitoneum group when compared with standard-pressure pneumoperitoneum groups [8, 11–16]. Our study, however, shows that the incidence of shoulder pain has no statistical difference between groups undergoing laparoscopic surgery at different pneumoperitoneal pressures.

Our study also shows that the duration of surgery also has no significant impact on the incidence of postoperative shoulder pain (P value >0.05 in all subgroups). This varies with opinions of a few groups that say shoulder tip pain can be kept to a minimum if the operative times are reduced [11].

Again, a few studies have shown that the incidence of shoulder tip pain is more after Nissen's fundoplication and other crural surgeries than after laparoscopic cholecystectomy [1]. Injury to the crura and bleeding during the procedure lead to a higher risk of shoulder pain [5]. In such hiatal surgeries including LAGB and in few gynecological surgeries, pain occurs preferentially on the left shoulder. This difference suggests that the region of surgery and position of the patient have an important influence on the site of pain. The cause is that in laparoscopic cholecystectomy the liver is separated from the undersurface of the diaphragm because of the reverse Trendelenburg with a right side up position of the patient. This leads to stretching of the right hemidiaphragm and the gas to be potentially trapped below the right diaphragm. Reverse is true for hiatal surgeries.

It has also been noted that after laparoscopic cholecystectomy, shoulder tip pain is less in the immediate postoperative period as compared with visceral pain and may be ignored initially by the patients. Our study also agrees with the above observation. As the visceral pain component gradually weans off on the following day, the shoulder tip pain may become more apparent and necessitate remedy. It has therefore been suggested that instillation of intraperitoneal bupivacaine would not result in reduction of the pain at a time when it is most needed in the patient. Innovative and ancillary treatment regimens, for example, collateral meridian acupressure (shiatsu) therapy, have also been suggested for reduction of such type of pain [17]. Further studies are needed to find an effective solution to postoperative shoulder pain.

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