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Routine low-pressure pneumoperitoneum during laparoscopic cholecystectomy

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Abstract
Background: Pneumoperitoneum at 15 mmHg results in dangerous hemodynamic disturbances in some patients. The use of low-pressure insufflation may make laparoscopic surgery safer.
Methods: Data were collected prospectively from a consecutive series of patients who had undergone an elective laparoscopic cholecystectomy (LC) by the same surgeon, during the years 1993–94 (group 1, 77 patients) and 1996 (group 2, 50 patients). The groups were similar with respect to age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) grade, existence of abdominal scars due to previous surgery, and severity of gallbladder disease. Patients underwent LC with a mean intraabdominal pressure of 10.56 mmHg in group 1 and 7 mmHg in group 2, respectively.
Results: The mean operative time was 75 min and 78 min in groups 1 and 2, respectively (NS). Insertion of an additional cannula was required more frequently (24% versus 14%; NS) in group 2. There were no conversions in either group. The morbidity rate and the postoperative hospital stay were similar for both groups.
Conclusions: LC can be performed routinely at low intraabdominal pressure, which may contribute to the safety and comfort of the procedure.

Key words: Pneumoperitoneum — Low pressure — Laparoscopic cholecystectomy

Since the introduction of laparoscopic cholecystectomy (LC), pneumoperitoneum at 15 mmHg has been commonly used for all laparoscopic procedures. Despite its widespread use, this pressure is not without its problems and disadvantages. It has been shown that an intraabdominal pressure of 15 mmHg during LC may reduce cardiac output by as much as 30%; it may also increase blood and central venous pressure [11, 15]. Additionally, other hemodynamic changes—such as increase of heart rate, increase of systemic vascular resistance, and reduction of stroke volume—have been demonstrated [4, 6, 16]. Physiological changes of the respiratory system—such as decrease in functional residual capacity, tidal volume, and increase in peak airway pressures—have all been associated with high-pressure pneumoperitoneum [2, 16]. Serious and potentially lethal complications, including deep venous thrombosis, myocardial infarction [10], atelectasis, and pneumonia [5], especially in elderly or high-risk patients, have been attributed to the physiological effects of pneumoperitoneum at 15 mmHg.

We have demonstrated previously that a lower-pressure pneumoperitoneum during laparoscopic cholecystectomy reduces the adverse hemodynamic effects [3]. In this study, we evaluate the feasibility, efficacy, and safety of the routine use of an insufflation pressure of 7 mmHg during LC.

Patients and methods

We prospectively collected and analyzed the data from a consecutive series of patients who underwent elective laparoscopic cholecystectomy in our department, by the same consultant surgeon, during the years 1993–1994 (group 1) and during 1996 (group 2). In 1995, an insufflator that was able to maintain the space at lower pressures was introduced, enabling a routine pressure of 7 mmHg to be chosen even for difficult cases. The patients in group 1 had the operation with high-pressure pneumoperitoneum (>10 mmHg), whereas the patients in group 2 had the one with low pressure. There were 77 patients (M/F, 18:59) in the high-pressure group and 50 patients (M/F,10:40) in the low-pressure group. The mean working pressure in group 1 was 10.56 mmHg, and it was 7 mmHg in group 2. Twenty patients from group 1 and 14 from group 2 had undergone previous abdominal surgery. Sixteen patients in the first group and 11 in the second group (20.7% versus 22.0%) had a body mass index (BMI) >30 kg/m^2. Six patients in the high-pressure group had heart disease and 11 had chronic pulmonary disease; in the low-pressure group, 11 had cardiac disease and three had chronic pulmonary disease. The details of the patients are shown in Table 1.

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Table 1. Patient data

	High-pressure group (n = 77)				Low-pressure group (n = 50)			
Sex (m/f)	18/59				10/40			
Age (mean yr)	51.6				55.2			
BMI (mean kg/m^2)	26.63				27.72			
ASA grade	I	II	III	IV	I	II	III	IV
ASA pts.	43	23	11	0	28	12	7	3

ASA, American Society of Anesthesiologists

Table 2. Severity of the disease

		Gallbladder adhesions				Gallbladder wall			
		None	Light	Moderate	Dense	Thin	Slightly thickened	Thickened & fibrous	Acutely inflamed
High-pressure group	pts.	44	12	12	9	30	30	17	0
Low-pressure group	pts.	22	16	8	4	25	16	7	2

The operative technique, which has been described previously [7], was similar for all patients. A reverse Trendenleburg position was not used in both groups. The patients were in the flat position. A liver retractor facilitated the elevation of the liver edge; therefore, either retrograde or antegrade dissection was feasible. The initial insufflation was at 15 mmHg to allow safe insertion of the secondary trocars. Subsequently, it was reduced to 7 mmHg in the low-pressure group, whereas in the high-pressure groups, it was reduced to 10–12 mmHg. In both groups, the intraabdominal pressure was maintained with an automatic insufflator. In group 1, a 9-lt insufflator was used (Stryker UK, Berkshire, England); in group 2, we used a 16-lt insufflator. This instrument is still in use in our department (NuMo, Surgical Innovations Ltd., Leeds, England). The intraoperative findings are shown in Table 2.

Results

The operation was completed successfully in all patients. There were no conversions to open cholecystectomy or intraoperative complications in either group. The insertion of an additional cannula to improve exposure was required in 11 patients in the high-pressure group and in 12 in the low-pressure group (14% versus 24%, $p > 0.1$). The additional port was used significantly more frequently in the obese patients (BMI >30 kg/m^2) of group 2 (63.6%). The mean operative time in group 1 was 75 min; it was 78 min in group 2 ($p > 0.1$). There was no mortality in either group, and the morbidity rate was 3.9% versus 4.0%. Two patients from group 1 and three from group 2 developed wound infections. The median postoperative hospital stay was 1 day for both groups.

Discussion

"The higher the pressure, the better the view" used to be the axiom invoked by surgeons who needed adequate exposure for laparoscopic procedures. However, it is probable that intraabdominal pressures >12 mmHg hardly lead to an effective enlargement of the gas-filled abdominal cavity, even in obese patients [13]. In addition, pneumoperitoneum at high pressure (≥15 mmHg) reduces cardiac output and stroke volume and also causes venous distention in the lower limbs and stasis [6]. High intraabdominal pressure also splints the diaphragm, resulting in reduced functional capacity of the lungs, the need for increased ventilation pressures, and a higher probability of pulmonary complications [2].

Since the introduction of laparoscopic surgery, efforts have been made to reduce the adverse hemodynamic and cardiopulmonary effects of pneumoperitoneum without compromising the efficacy, feasibility, and safety of the operation [1, 12]. There is a need to maintain good exposure, while reducing the pressure of insufflation as much as possible, especially in high-risk patients. Those considerations have led to the introduction of two alternatives to the standard pneumoperitoneum. First, an abdominal wall-lifting device can be used to enable the operation to be carried out without insufflation [9] or at a reduced pressure [1]. Second, the pressure of the pneumoperitoneum can be reduced if a high-flow insufflator is available, since the insufflator will trigger promptly when used at low pressures.

We have been performing LC at low-pressure pneumoperitoneum (7 mmHg) since 1995. It was obvious from the beginning that a sensitive, high-flow insufflator was required to maintain intraabdominal pressure, especially when a suction-irrigation device was needed. Our technique is similar to that one, which was employed at 15 mmHg [7, 8]. The use of a liver retractor instead of cephalad traction of the fundus of the gallbladder enables us to counteract the potentially inadequate exposure due to the low-pressure pneumoperitoneum, especially in obese patients. An additional retractor was used whenever we felt that the exposure was inadequate in order to retract the duodenum, transverse colon, and omentum downward to expose the lower part of Calot's triangle. The duodenal retractor was needed more frequently in obese patients.

In our series, we did not have to convert to open cholecystectomy in any patient, and there were no intraoperative complications in either group. Operative times were similar for both groups. There were no deaths or major postoperative complications (myocardial infarction, stroke, deep venous thrombosis). Two patients in the high-pressure group and three in the low-pressure group developed a wound infection, which resolved with conservative treat-

ment. The postoperative hospital stay was the same for both groups.

A recent study [14] has demonstrated that patients who underwent LC at low-pressure pneumoperitoneums (7.5 mmHg) had less postoperative pain, better pulmonary function, and more rapid discharge from hospital than patients who underwent LC at 15 mmHg. Our results suggest that low-pressure pneumoperitoneum (7 mmHg) without the need of the reverse Trendelenburg is feasible and safe, and that it potentially reduces the risks of perturbed cardiac functions and venous stasis in the legs. Therefore, it can be used routinely during LC.

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