COMPARISON OF CLOSED AND OPEN METHODS OF PNEUMOPERITONIUM IN LAPAROSCOPIC CHOLECYSTECTOMY

Mohammad Akbar, Ishtiaq Ali Khan, Danish Naveed, Irfanuddin Khattak, Arshad Zafar, Muhammad Salim Wazir*, Asif Nawaz Khan, Zia-ur-Rehman

Department of Surgery, *Department of Community Medicine, Ayub Medical College Abbottabad

Background: Pneumoperitonium is the first step in laparoscopic surgery including cholecystectomy. Two commonly used methods to create pneumoperitonium are closed and open technique. Both have advantages and disadvantages. The current study was designed to compare these two techniques in terms of safety and time required to complete the procedure. **Methods**: This was a randomized controlled prospective study conducted at Department of Surgery, Ayub Hospital Complex Abbottabad, from 1st June 2007 to 31st May 2008. Randomization was done into two groups randomly using sealed envelopes containing the questionnaire. Seventy envelopes were kept in the cupboard, containing 35 proformas for group A and 35 for group B. An envelope was randomly fetched and opened upon selection of the patient after taking the informed consent. Pneumoperitonium was created by closed technique in group A, and by open technique in group B. Time required for successful pneumoperitonium was calculated in each group. Failure to induce pneumoperitonium was determined for each technique. Time required to close the wounds at completion, total operating time and injuries sustained during induction of pneumoperitonium were compared in both techniques. **Result**: Out of the total 70 patients included in study, 35 were in group A and 35 in group B. Mean time required for successful pneumoperitonium was 9.17 minutes in group A and 8.11 minutes in group B. Total operating time ranged from 55 minutes to 130 minutes in group A and from 45 minutes to 110 minutes in group B. Mean of total operating time was 78.34 and 67 minutes in group A and B respectively. Mean time needed to close the wound was 9.88 minutes in group A and 4.97 minutes in group B. Failure of technique was noted in three patients in group A while no failure was experienced in group B. In two cases in group A minor complications during creation of pneumoperitonium were observed while in group B no complication occurred. No patient died in the study. **Conclusions:** We concluded from this study that open technique of pneumoperitonium was, less time consuming and safer than the closed technique.

Keywords: Pneumoperitonium**,** Laparoscopic cholecystectomy, Open and close methods

INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard for treatment of benign gallbladder disease.[1] The creation of pneumoperitonium is a prerequisite to carry out the procedure.[2] Pneumoperitonium is traditionally induced by blind veress needle insertion at umbilicus followed by blind trocar entry at the same site.[3] This blind primary access is the main challenge in the procedure. Indeed, most of the complications in laparoscopic cholecystectomy occur before actual dissection is started and are related to this primary entry.[4–6] In order to avoid these complications, other techniques of primary access were introduced.[7] Open technique described by Harrith Hasson in 1971 was the first alternative to the classical closed technique.[8] Both the techniques had been used by different workers and advantages and disadvantages related to each method described.[9,10] The current study was planned to evaluate both technique in terms of time required to create pneumoperitonium, failure/success of the technique, complications of primary access, time spent on closing the wounds, total operating time, and hospital stay in our setup. The haemodynamic effects of pneumoperitonium and physiologic effects of absorbed carbon dioxide has important anaesthetic implications.[11] However this was not the purpose of our study. We concluded that open method of pneumoperitonium is safer and less time consuming.

MATERIALS AND METHODS

This was a randomized controlled study conducted at Department of General Surgery, Ayub Teaching Hospital Abbottabad from 1st June 2007 to 31st May 2008. Seventy patients admitted with symptomatic gall stones with normal common bile duct scheduled for laparoscopic cholecystectomy were included in the study. Patients with paraumbilical hernia, history of upper abdominal surgery, and uncontrolled systemic illness were excluded from study. Selected patients were randomized into group A and B using sealed envelopes containing questionarre. Seventy proformae, 35 for each group were prepared and sealed in blank envelopes. Each envelope contained one out of these seventy proformae. After informed consent, an envelope was randomly fetched and opened. In some of selected patients laparoscopic procedure had to be converted to open operation for indications not related to induction of

pneumoperitonium. These patients were excluded from study subsequently and their serial no. was given to next patient by adding a new envelope of the same group. All the patients were operated upon under general anaesthesia by the same anaesthesia team. The surgical team consisted of a surgeon (principal author), two assistants and one scrub nurse. Patients were operated in reverse trendelenburg position with right side elevated approximately 30 degree. The equipment used in all cases was from KARL STORZ Company. Single Monitor was used and assembled near the right shoulder of the patient. Surgeon and one assistant stood on the left side of the patient. While the second assistant stood on the right side. All the trocars except the blunt one used for open pneumoperitonium were reusable and the same for all patients. The insufflator had the maximum flow capacity of 10 litres per minute. The light source was 300 watt fan cooled Xenon lamp and camera was single chip. Laparoscope used was 0 degree in all cases. Graspers, dissectors, scissors and clip applicators were all reusable from KARL STORZ and the same. Four trocars were used in all patients. Ten mm umbilical port was for laparoscope. Ten mm port in epigastrium and 5 mm port in right hypochondrium were for surgeon's right and left hands. The 4^{th} 5 mm port for assistant was placed in midaxillary line in right iliac fossa.

Pneumoperitonium was created by closed method in group A and open method in group B. In some group A patients closed method of pneumoperitonium failed. Pneumoperitonium in these patients was created by open method like group B, but they were still retained in group A. This was taken as failure of the closed method.

In group A an infraumblical transverse 1 cm incision was made through the skin to the subcutaneous tissue. Abdominal wall was lifted by two towel clips applied to the skin 5 cm from either side of incision. Surgeon then held the Veress needle in right hand like a dart and advanced it at right angle to fascia until a change in resistance was felt or a click was heard. Aspiration test performed and if no blood or enteric content came on aspiration, we proceeded to saline test. If the flow of saline through the needle was not free, the needle was withdrawn, and reintroduced repeating the same process. Three consecutive failures in saline test were taken as 'Failed technique', and case was converted to open method of pneumoperitonium. Free flow of saline through the needle was taken as successful placement, Veress needle was then attached to the insufflator, CO_2 insufflation started at a rate of 1 litre per minute and initial insufflation pressure recorded. This pressure was termed first veress intraperitoneal pressure (VIP). If first VIP was 10 mmHg or more and flow of gas seemed inhibited, veress needle again withdrawn, reinserted and same process repeated. Again 3 consecutive failures were taken as 'Failed procedure' and pneumoperitonium was created by open method. If the first VIP was low and flow of gas seemed uninhibited, insufflator was switched to high flow rate until the preadjusted intra-abdominal pressure reached to 14 mm Hg. Veress needle was then removed and a 10 mm sharp trocar with oversleeve introduced in the same opening while keeping the abdominal wall elevated. Trocar-sleeve assembly was held like a cork screw with the valved end in the palm of the right hand. It was advanced in steadily rotating manner until a hissing sound from the outer end of canula was heard or change in resistance was felt. Trocar was removed and laparoscope inserted into the canula. Insufflator was attached to canula and thorough inspection of peritoneal cavity was made. Any injury inflicted during blind insertion of needle and trocar was noted. Time from incision to laparoscope insertion was calculated and recorded. Three more trocars were inserted under vision and operation completed. Facial closure of umbilical and epigastric port sites was performed with vicryl No. 1, while skin in all sites was closed with silk 3/0. Total operating time from first incision to last skin stitch was recorded. Time spent on closure of wounds was measured from removal of last trocar to the final skin stitch. Number of patients in whom this method failed to create pneumoperitonium was recorded. Total operating time was calculated from first incision to last stitch and recorded for each patient

In group B patients, 3 cm curved supraumbilical incision was made. In patients in whom closed method was not successful, infraumblical incision was extended up on both sides of umbilicus in U-shaped manner. In both the cases, umbilical stalk identified, dissected all around, held in strong Kocker's forceps, lifted upward and cut at its origin from anterior abdominal wall. This resulted in a rounded defect in the peritoneal cavity. A closed haemostat was introduced into this defect to ensure free peritoneal entry. Margins were lifted by two strong Kocker's forceps and stay sutures with vicryl 1 were placed on both sides of the defect. Assistant on right side held and lifted the stay sutures while the surgeon introduced the 10 mm disposable canula with blunt obturator inside through the defect. The canula had sliding olive shaped sleeve to which stay sutures were attached. Upon successful entry into abdomen, obturator was removed and canula connected to insufflator. High flow at 4 litres/minute started straightaway. Laparoscope was inserted when the pressure was 14 mm Hg. Thorough inspection of the peritoneal cavity performed and any injury inflicted during creation of pneumoperitonium was recorded. Time taken from incision to the insertion of laparoscope was calculated and recorded. Remaining part of operation was the same except the closure of the umbilical wound, which was more quickly performed by simply tying of the stay sutures together. Total

operating time was calculated from first incision to last skin stitch and was recorded. Wound closure time was measured for each patient from removal of last trocar to the final skin stitch.

In both groups hospital stay was determined and recorded. Patients were monitored closely during hospitalization for any complication. All patients were given one week appointment in OPD at the time of discharge. Total follow up was one month from the date of operation.

The data were processed using SPSS 16.0. Fully informed, understood and voluntary consent of the patients was obtained and the ethical committee of the Institution approved the study.

RESULTS

Seventy patients were inducted for this randomized study. Sixty patients were females making the male/female ratio 1:7. Age ranged from 17 to 68 years with mean age 42 years. Time required creating pneumoperitonium ranged from 6 to 17 minutes in group A and 6 to 10 minutes in group B. Mean time of induction of pneumoperitonium was 9.17 minutes in group A and 8.11 minutes in group B. No patient in group B suffered injury during creation of pneumoperitonium while in group A two patients sustained injuries, one had extra peritoneal insufflation, and other had injury to small bowel mesentery. No major vascular or visceral injury occurred in any patient. In 4 patients from group A pneumoperitonium could not be successfully created by closed method and open method of pneumoperitonium was adapted. This was taken as failure of technique. Total operating time ranged from 55 to 130 minutes with mean of 78.34 minutes in group A. In group B the total operating time ranged from 45 to 110 minutes and mean was 67 minutes. Time spent on wounds closure ranged from 6 to 13 minutes in group A and 4 to 6 minutes in group B. Mean wound closure time was 9.88 minutes in group A and 4.97 minutes in group B. The hospital stay in group A ranged from 36 to 72 hours in group A and 36 to 56 hours in group B. The mean hospital stay was 49.71 hours in group A and 45.1 hours in group B. One patient in group A and two patients in group B developed port site infection but no patient developed systemic or intraabdominal sepsis. Table-1 and 2 show the overall comparison of the two groups. The sample size was not calculated, therefore, the statistical power was calculated which was 33%.

DISCUSSION

Laparoscopic Cholecystectomy has become the method of choice for treatment of symptomatic and uncomplicated gallbladder stones. One of the key steps in the procedure is induction of pneumoperitonium, which is not physiological and has adverse haemodynamic and respiratory effects.[12,13] These effects can be minimized with appropriate dedicated anaesthetic management.[14] Iatrogenic injuries in laparoscopic surgery, however, are still a problem confronted by the surgeon.[15] Traditional closed method of pneumoperitonium involves initial blind entry into abdomen and more than half of such injuries are related to this primary blind access and occur before the start of actual anatomic dissection.[16] It is because of these complications that laparoscopic surgery faced a lot of criticism by the surgical community in the beginning.[17] To prevent these complications other methods were introduced in practice like open technique as devised by Harrith Hasson, direct trocar insertion, optical trocars, radically expending trocars and use of disposable shielded trocars.[18–21] However, the veress needle technique and Hasson's technique with their different modifications are the two widely used methods today.[22] We compared these methods in terms of time required to induce pneumoperitonium, time needed to close the wounds, total operating time and complications associated with each method.

Table-1: Time analysis in two groups (n=70)

Variable	Group A (n=35)		Group B (n=35)		*p*-value
	Range	Mean±SD	Range	Mean±SD	
Time required to Induce pneumoperitonium (minutes)	6–17	9.17±2.86	6–10	8.11±1.02	*0.044
Time required to close the wounds (minutes)	6–13	9.88±1.98	4–6	4.97±0.7	*0.000
Total Operating time (in hours)	55–130	78.34±21.59	45–110	67±15.10	*0.013
Hospital Stay (hours)	36–72	49.71±8.30	36–56	45.1±6.76	*0.014

*Statistically significant

Table-2: Complications in two groups (n=70)

Variable	Group A (n=35)		Group B (n=35)		*p*-value
	No. of cases	Percentage	No. of cases	Percentage	
Injury During Induction	2	5.7%	0	0%	*0.151
Failure of technique	4	11.4%	0	0%	*0.039
Port Site Infection	1	2.9%	2	5.7%	0.555

*Statistically significant

The open method of pneumoperitonium was described by Harrith Hasson in 1974.[23] The complications associated with blind entry were eliminated but method did not gain wide acceptance because it was reported to be time consuming and associated with significant gas leak. The method was specifically recommended for patients with history of surgery in the upper abdomen.[22] However, we excluded such patients from our study and applied the two methods randomly in homogenous patient population, making the comparison more reliable.

The time required from incision to the introduction of laparoscope in our study was less in open method. This is in accordance with some other workers.[5,24] However some workers have reported more time consumption in open method.[21,25,26] Less time required in open method in our study might be due to our special modification of umbilical stalk technique. This method exploits the anatomy of the anterior abdominal wall at the umbilicus. Umbilical cord in foetal life was attached to the anterior abdominal wall through a ring of fascial thickening. This ring persists in adult life and when elevated, tents out as hollow stalk. Normally no intraperitonial structure is attached at this level. If this stalk is divided, a circular hole is created with clear thick margins. A blunt obturator can be introduced through this opening to confirm free peritoneal entry. This method has not been described in literature but is being used by many surgeons. Our experience with this technique was encouraging. Only two instances of air leakage were recorded. Closure time was also reduced as simple tying the stay sutures resulted in effective closure of umbilical wound. By adopting this new technique, open method may become the gold standard.[21] Moreover the new insufflators with CO_2 flow of 20 litres or more per minute can overcome the minor leaks.

More time consumption in our blind technique might be due to routine performance of veress needle entry tests like aspiration test, saline test and first veress intraperitonial pressure (VIP) test. Some authors do not recommend routine use of these tests and even omit lifting of the abdominal wall.[20,21] Our extra time may also be due to some cases in which the veress needle was withdrawn and reinserted and verification tests performed again. In four such patients three repeated manoeuvres did not achieve successful entry and the method had to be abandoned in favour of open technique.

The most important advantage of open technique is avoidance of complications associated with primary access. We did not encounter any complication of access with this method. A number of significant complications like major vessel injury or bowel laceration have been reported by different authors in closed technique.[25] We did not find any such complication in our blind entry technique. This might be because of the routine lifting of the abdominal wall and performing the veress needle test. However in two patients in closed technique group minor complications occurred. In one patient extra peritoneal insufflation was noted. In another patient small bowel mesentery was injured but patient did well post operatively.

The total operating time in our study was also less in closed technique group. This was mainly due to less time consumed on creation of pneumoperitonium at the start and closure of wounds at completion because rest of the procedure was technically same in both groups. Our finding is in consistence with many workers.[5,25]

Time required to close the wounds in group A was significantly more than group B. this is because the umbilical wound was more difficult to close in group A as the facial margins were difficult to be grasped and stitched in the depth through a small opening. In group B the stay sutures applied to the facial margins in the start needed only to tie together at the end.

The incidence of wound infection was more in open group but this was not found significant statistically. This might be due to more dissection and tissue trauma in these patients. This finding is similar to that reported by other authors. Total hospital stay was slightly more in group A. Two patients who sustained injuries during primary access were retained for one more day and account for this extra stay.

CONCLUSION

Open method for induction of pneumoperitonium is safer than the closed method. Contrary to common belief it is less time consuming. Air leaks are infrequent with umbilical stalk modification of open technique. We recommend routine use of this method to create pneumoperitonium for laparoscopic cholecystectomy.

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Address for Correspondence:

Dr. Mohammad Akbar, House No. 4, Al-Fateh Avenue, Opp. Muqaddas Tower, Mansehra Road, Abbottabad. Tel: +92-992-381156.
Email: Mohammadakbar55@yahoo.com