

Original Research Article

A comparative study of open versus closed method of establishment of pneumoperitoneum in laparoscopic surgery

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Received: 17 July 2019

Revised: 20 August 2019

Accepted: 20 August 2019

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ABSTRACT

Background: Laparoscopy has overtaken open surgery as the choice of procedure wherever feasible. More than 50% of complications in laparoscopy occur during creation of pneumoperitoneum. In this study, we are comparing open or Hasson's method and closed or Veress method of creation of pneumoperitoneum.

Methods: This is a prospective comparative parallel randomised control trial conducted at the Department of Surgery, Baroda Medical College and SSG Hospital from November, 2017 to November, 2018. We divided the patients (n=100) into two groups i.e., open method (group O) (n1=50) and closed method (group C) (n2=50) groups using the envelope method of randomisation. We compared the two techniques in terms of time required to complete the procedures and complications (major and minor) associated with creation of pneumoperitoneum.

Results: All the patients that participated in this study belonged to the age group of 10-69 years out of which majority were 15-50 years old. In our study, the mean time required to create pneumoperitoneum by closed method (group C) was 9.3 seconds while by open method (group O), it was 7.84 seconds with p value <0.001. There were 15 cases of gas leak from the port side, all recorded in the open method of establishment of pneumoperitoneum.

Conclusions: Even though the open method takes less time to create pneumoperitoneum, both methods are similar in terms of time taken to complete the operation and major and minor complications because there was no statistically significant difference in the frequency of these parameters between the two techniques.

Keywords: Pneumoperitoneum, Veress needle, Hasson's method, Laparoscopy

INTRODUCTION

Laparoscopy is the type of surgical procedure that allows a surgeon to access the inside of the abdomen and pelvis without having to make a large incision on the skin, hence is known as key-hole surgery.¹ It is derived from the Greek word *laparo* meaning abdomen and *skopein* meaning to see. Laparoscopy is preferred to laparotomy wherever feasible because of its advantages like decreased postoperative hospitalisation, less postoperative pain, faster improvements in quality of life, better cosmetic results, and smaller scars.² This procedure consists of creating a pneumoperitoneum therefore

distending the abdominal cavity, primary and secondary port placements, and different port closure techniques. There are five basic ways available at present to create pneumoperitoneum - blind Veress needle insertion, direct trocar insertion, optical trocar insertion, open method, and modified open method, out of which direct Veress needle insertion is the most commonly used.³ The most significant risks for laparoscopy consist of trocar injuries during insertion into the abdominal cavity, port site complications like port site infection, port site oedema, port site haematoma, and port site pain, and a greater risk of hypothermia and peritoneal trauma due to increased exposure to cold and dry gases during insufflation.⁴ The

risk of such injuries, especially those during trocar entry, is increased in patients who have low body mass index or have a history of prior abdominal surgery.^{5,6} However, the overall incidence of complications in laparoscopic surgery is still less compared to open surgery. Past studies indicate that the open method is better than closed method in terms of duration of the surgery and frequency and severity of complications, especially in patients with low BMI, scars of previous surgery, abdominal tuberculosis, and pelvic inflammatory disease.⁷⁻¹⁰

In our study, the main objective was to understand how open and closed methods of creating pneumoperitoneum affect the duration of surgery and compare the incidence of major and minor complications that occurred after creation of pneumoperitoneum via both techniques.

METHODS

This was a prospective comparative parallel randomised control trial with an allocation ratio of 1:1. The study was conducted at the Department of Surgery, Baroda Medical College and SSG Hospital from November, 2017 to November, 2018 and included all the patients (n=100) who were undergoing laparoscopic surgery in this time period at our department. Exclusion criteria consisted of conditions not allowing induction of general anaesthesia, presence of anterior abdominal wall infection, presence adhesions from previous surgeries, mechanical bowel obstruction, liver cirrhosis or portal hypertension, and patients not giving a consent for laparoscopic surgery. We divided the patients into two groups i.e. open or Hasson's method (group O) (n1=50) and closed or Veress method (group C) (n2=50) groups using the envelope method of randomisation. After obtaining a written informed consent, we obtained the following data on a printed pro-forma such as history: name, age, gender, religion, education, occupation, residential address, chief complaints, past history, family history, diet, bowel and bladder habits, addiction, etc., detailed clinical examination: general, per abdominal, and per rectal examination, routine investigations: haemoglobin, total count, urine albumin, urine sugar, blood sugar, blood grouping, X-ray chest, and ultrasonography (abdomen and pelvis) and specific investigations: serum creatinine, electrolytes, bilirubin, bleeding and clotting time, computed tomography (abdomen), etc.

Before the operation, shaving and cleaning of local parts, antibiotic prophylaxis, and catheterisation was carried out. The laparoscopic procedure was conducted under general anaesthesia in sterile conditions. In closed technique (Veress technique), we created a sub-umbilical longitudinal skin incision of 2-3 mm through which Verres needle was inserted in the midline in sagittal plane at a 45 degree angle to the spine to avoid injury to major vessels especially in thin and lean patients. Confirmation of the entry of Verres needle into the peritoneum was done by saline drop test and initial intra- peritoneal pressure of less than 10mm Hg in order to prevent extra-

peritoneal insufflation. In case of open technique (Hasson technique), we created a small longitudinal sub-umbilical transverse skin incision of 1.3-1.5 cm which was followed by opening of the rectus sheath with a triangular knife (size 11) in the same direction and separating it and the rectus muscle with straight artery forceps both transversely and longitudinally. The peritoneum was picked with artery forceps and a nick was made with a triangular knife to open the peritoneal cavity. After opening the peritoneal cavity, we inserted the cannula or laparoscopic sheath without the trocar followed by CO₂ insufflation maintained at a flow rate of 2 l/min and at 12 mm Hg pressure. The abdominal cavity was thoroughly inspected after creation of the pneumoperitoneum for complications before the intended procedure and complications were divided into major (emphysema extending up to the neck causing dyspnoea, bowel perforation, bladder perforation, and mesenteric vascular injury) and minor (abdominal bruise, localised emphysema, small haematoma, omental injury, bowel serosa injury, and gas leak) depending upon the nature and severity of injuries. The operative procedure was carried out and excised organs were removed from the umbilical port. All patients were given Injection Cefosulbactam (1.5 gm IV 12 hourly) for a period of 3 days with the first dose given 3 hours prior to induction. Inj diclofenac (50 mg diluted in 100 ml normal saline IV 12 hourly) for 3 days followed by tablet diclofenac (50 mg BD) for post-op pain. Patients were kept nil-by-mouth till bowel sounds were heard. Their dressing was done on alternate days and sutures were removed on the 12th post-operative day. Post-operative local examination done to check for signs of infection by looking for tenderness over suture line, colour change and discharge while the presence of haematoma was checked by the presence of swelling over suture line. A detailed systemic examination to assess the abdomen, respiratory, cardiovascular, and central nervous systems was carried out.

This study used descriptive and inferential statistical analysis with results on continuous measurements presented on Mean±SD (Min-Max) and categorical measurements presented in number (%). Significance was assessed at 5% level of significance assuming normal distribution of dependent variables and randomisation of independent samples. We used Student t- test (two tailed, independent) to find the significance of study parameters on continuous scale between two groups (Inter group analysis). The statistical software namely, MedCalc Software Version 12.5.0 was used for the analysis of the data and Microsoft Word and Excel have been used for data entry.

RESULTS

All the 100 patients that participated in this study belonged to the age group of 10-69 years out of which majority were 15-50 years old which is the period of maximum physical activity (Table 1). There were 62%

male and 38% females in the current study. More number of men corresponded to hernia repair and appendectomy being the most commonly performed laparoscopies (54%) at our set up during the study period followed by laparoscopic cholecystectomy (46%). In our study, the distribution of surgery was 20% laparoscopic appendectomy, 20% laparoscopic inguinal hernia repair, 46% laparoscopic cholecystectomy, 6% laparoscopic incisional hernia repair, and 8% diagnostic laparoscopy. The mean time required to create pneumoperitoneum by closed method (group C) was 9.3 seconds while by open method (group O), it was 7.84 seconds with p value <0.001 which is significant (Table 2). An average of 53.84 seconds was taken to complete the operations when pneumoperitoneum was created by closed method while in open method, it took 53.94 to finish the same procedures. Out of 50 cases of open method of establishment of pneumoperitoneum, there were 7 (14%) cases of abdominal wall bruising of which 5 cases were in laparoscopic cholecystectomy and 2 in laparoscopic appendectomy. On the other hand, out of 50 cases of closed method of establishment of pneumoperitoneum, there were 3 (6%) cases of abdominal wall bruising of which 2 cases in laparoscopic cholecystectomy and 1 case in laparoscopic incisional hernia repair were reported. All the cases recovered with conservative

management. There were 6 (12%) cases of localised emphysema noted in our study equally divided into groups O and C. In group O, 1 case occurred during laparoscopic cholecystectomy and 2 in laparoscopic inguinal hernia repair while in group C, 1 case occurred in laparoscopic cholecystectomy, 1 from laparoscopic appendectomy and 1 from diagnostic laparoscopy. None of the cases needed surgical intervention and recovered with conservative management. There were 4 (8%) cases of small haematoma in group C and 5 (10%) in group O and in both the groups, maximum occurrence of this minor complication was present in laparoscopic cholecystectomy. Of the 5 cases of omental injuries that were witnessed during the study, 3 took place in group C and 2 in group O (Figure 1) (Table 3). There were 15 cases of gas leak from the port side recorded in our study. All of these cases were observed in the open method of establishment of pneumoperitoneum- 4 cases reported in laparoscopic appendectomy, 2 cases in laparoscopic inguinal hernia repair, 7 cases in laparoscopic cholecystectomy, 1 case each in laparoscopic incisional hernia repair and diagnostic laparoscopy. We did not record any case of extensive emphysema (extending up to the neck), bowel perforation, bladder perforation, vascular injury, serosal injury, and port site wound infection.

Table 1: Distribution of patients according to age.

Age in years	Number of patients	Percentage (%)
10-19	12	12
20-29	26	26
30-39	33	33
40-49	16	16
50-59	8	8
60-69	5	5
Total	100	100

Table 2: Time required to create pneumoperitoneum.

Operation	Closed method (minutes)	Open method (minutes)	P value
Lap appendectomy (n=20)	7.6 (n1=10)	5.4 (n2=10)	<0.0001
Lap inguinal hernia repair (n=20)	10.2 (n1=10)	7.4 (n2=10)	<0.0001
Lap cholecystectomy (n=46)	8.3 (n1=23)	8.0 (n2=23)	<0.0015
Lap incisional hernia repair (n=8)	12.6 (n1=4)	12.2 (n2=4)	0.3
Diagnostic laparoscopy (n=6)	7.8 (n1=3)	6.2 (n2=3)	0.0028
Average (n=100)	9.3 (n1=50)	7.84 (n2=50)	<0.001

Table 3: Incidence of omental injury.

	Closed method		Open method		P value
	Number	%	Number	%	
Lap appendectomy (n=20)	0 (n1=10)	0	1 (n2=10)	10	0.3306
Lap inguinal hernia repair (n=20)	0 (n1=10)	0	0 (n2=10)	0	-
Lap cholecystectomy (n=46)	0 (n1=23)	0	0 (n2=23)	0	-
Lap incisional hernia repair (n=8)	2 (n1=4)	50	1 (n2=4)	25	0.5370
Diagnostic laparoscopy (n=6)	1 (n1=3)	33.33	0 (n2=3)	0	0.3739

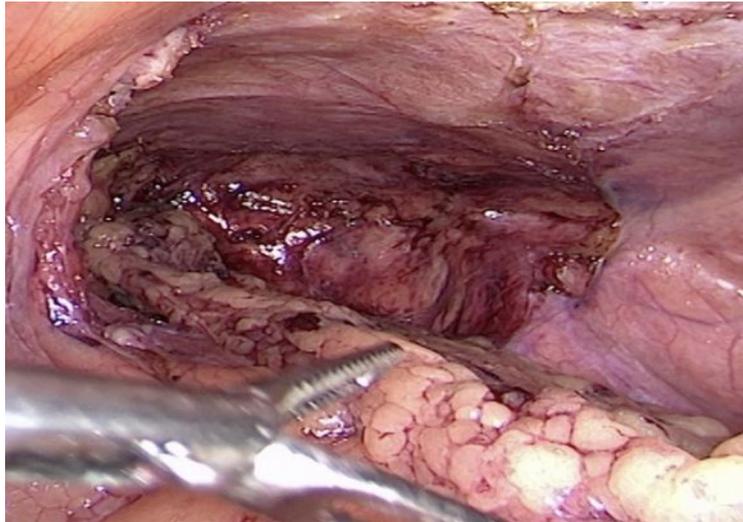


Figure 1: Omental injury. Laparoscopic view of omentum with diffuse oozing of blood due to which no specific point of bleed can be seen. Laparoscopic grasper in the lower left corner.

Table 4: Comparison between previous studies and our study.

Reference year	No. of patients	Procedure	Access time (min)	Complications	Results
Borgatta et al¹³	212	Laparoscopic tubal sterilization	Needle, 9.6 Open, 7.5	Needle, 7/110 Open, 4/102	Open technique is safer and faster
Nezhat et al¹⁶	200	Diagnostic and operative laparoscopy	Not mentioned	Needle, 22/100 Open, 3/100	Open technique has fewer complications
Byron et al¹⁷	252	Diagnostic and operative laparoscopy	Needle, 5.9 Open, 2.2	Needle, 19/141 Open, 4/111	Open technique is safer and faster
Peitgen et al¹⁴	50	Diagnostic and operative laparoscopy	Needle, 3.8 Open, 1.8	Needle, 0/25 Open, 0/25	Open technique is faster
Cogliandolo et al¹⁵	150	Laparoscopic cholecystectomy	Needle, 4.5 Open, 3.2	Needle, 5/75 Open, 5/75	Open technique is faster
Gulla` et al¹⁸	262	Diagnostic and operative laparoscopy	Not mentioned	Needle, 11/101 Open, 0/161	Open technique is safer
Our study	100	Various laparoscopic surgeries	Closed, 9.3 Open, 7.8	Closed, 13/50 Open, 32/50	Open technique is faster

Studies in the past collectively demonstrate the superiority of open technique over closed method in terms of speed and safety of the procedures.

DISCUSSION

Among the various techniques for achieving a pneumoperitoneum and introducing the first trocar, two common methods are usually performed. Closed technique requires the Veress needle, which is inserted into the abdominal cavity for CO₂ insufflation followed by blind introduction of the first trocar. On the other hand, the open technique which was first described by Hasson begins with a small incision at the umbilical site and subsequently all layers of the abdominal wall are incised. The first trocar is then inserted under direct vision followed by gas insufflation. More than 50% of complications arising from a laparoscopic procedure occur before the commencement of the actual operation i.e. during the creation of pneumoperitoneum and trocar entry.^{4, 11} The morbidity associated with the establishment

of the pneumoperitoneum and the insertion of the first trocar is estimated to be less than 1%, but the true incidence of visceral and vascular injury for both techniques is unknown. Several randomised control trials found that the open technique on an average causes less complication and is cheaper and faster than the Veress needle technique. Veress needle technique is more commonly associated with bowel injury, especially in previously operated patients, preperitoneal insufflation, especially in obese patients, and vascular injury in thin and lean patients.^{11, 12} Our study shows similar findings when compared to the Borgatta et al study in terms of the time required to create pneumoperitoneum.¹³ The Peitgen et al and the Cogliandolo et al studies show that the open technique is faster as compared to the closed technique with similar frequency of complications. This correlates with the findings of this study where the open method took 7.84 mins and the closed method took 9.3 mins on

an average with similar rates of major and minor complications (Table 4).^{14,15} Less time required to induce pneumoperitoneum in open method in our study is due to exploitation of umbilical stalk. This method relies on the anatomy of the anterior abdominal wall at the umbilicus. Umbilical cord in foetal life is attached to the anterior abdominal wall by a ring of thickened fascia. This ring persists in adult life and has no intraperitoneal attachments to it. An opening made superior or inferior to umbilicus can be used as entry point for insertion of cannula and trocar. This method is being used by many surgeons. By adopting this new technique, open method may become the gold standard. Veress needle technique takes more time to create pneumoperitoneum because of the routine use of confirmation of entry tests like saline drop test, initial intra- peritoneal pressure test, etc. The time taken to complete surgery after creation of pneumoperitoneum in both the open and closed method had no significant difference even after the fact that creation of pneumoperitoneum was faster in the open method. This might be attributed to the phenomenon of “gas leak” in some cases. This was resolved by tightening the anchorage of the cut fascia to the trocar. This consumes time and causes a disturbance in the middle of the procedure. Some minor complications like gas leak from port site, abdominal wall bruise, and small haematoma were more common in the open technique while omental injury was more common in the closed technique. Formation of a small emphysema was seen with an equal frequency in both groups. There were no major complications like extensive emphysema, bowel perforation, bladder perforation, vascular injury, serosal injury, and port site wound infection to be reported in this study. The small sample size of this study is its main limitation and a larger sample size is required to study the parameters more comprehensively. This is a single-centre study and hence, its results cannot be generalised. Also, the operative procedures taken into account for this study are performed by multiple doctors with varied abilities due to which it is difficult to control the confounding variables.

CONCLUSION

The open technique or Hasson's technique is almost equal to closed technique or Veress' technique in terms of the time taken to complete the operation and major and minor complications because there was no statistically significant difference in the frequency of these parameters between the two techniques. The open method takes less time to create pneumoperitoneum while leads to statistically significant more gas leaks as compared to the closed method. Hence, multi-centric studies with a large sample size, systematic reviews, and meta analysis on this topic are required for more conclusive data.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Jain AP, Shah SC, Shah PC, Patel KR. A comparative study of open versus closed method of establishment of pneumoperitoneum in laparoscopic surgery. *Int Surg J* 2019;6:3335-40.