

Closed vs. open method of pneumoperitonium at infra-umbilical site in laparoscopic surgery — A comparative study

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Abstract

Objective: To assess the safety profile of closed and open method of pneumoperitonium by comparing access and closure time during laparoscopic surgery and complications.

Methods: This quasi-experimental study was conducted at Bahawal Victoria Hospital, Bahawalpur, Pakistan, from September 15, 2013, to September 15, 2016, and comprised patients who were block-randomised into two equal groups. The first half constituted Group A where pneumoperitonium was created by closed method, while the latter half was designated as Group B where the open method was employed. The two groups were compared for access, closure time and complications. SPSS 23 was used for data analysis.

Results: There were 850 patients, with 425(50%) in each of the two groups. The overall mean age was 38.78±5.41 years, and 667(78%) were females. The mean access time in Group A was 6.58±1.78min and in Group B it was 5.49±1.82 min. The mean closure time was 7.60±2.12min in Group A and 6.91±1.40min in Group B (p<0.00). Access problem in Group A was significantly high (p=0.001). Abdominal wall complications were 13(3.05%) in Group A and 24(5.64%) in Group B (p=0.064). Visceral injury happened in 5(1.17%) patients in Group A and 1(0.23%) in Group B (p=0.101).

Conclusion: Open method of pneumoperitoneum was found to be safe and less time-consuming compared to the closed method.

Keywords: Laparoscopic cholecystectomy, Pneumoperitonium, Veress needle, Hasson's cannula, Open method, Closed method. (JPMA 68: 1478; 2018)

Introduction

Laparoscopic abdominal surgery requires the implementation of successful pneumoperitoneum.¹ In vast majority of patients, more than half of all complications happen at the time of entry and a great majority of these occur during the insertion of the primary umbilical trocar.²

To address this issue, various techniques have evolved to gain access to the peritoneal cavity. These include closed (Veress), open (Hasson), direct trocar insertion, the use of disposable shielded trocars, radially expanding trocars and visual entry systems along with their various modifications.³ The closed method is the traditional one, while the open method is a more recent one.⁴ The closed technique involves the blind insertion of the Veress needle into the peritoneal cavity.⁵ The open method involves making an incision and then dissecting the fascia to the peritoneal cavity to introduce the cannula under direct vision.

Both techniques are being used at different centres and a few studies have been published comparing their

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advantages and disadvantages but no technique has been shown to be superior to the other.⁶ The open technique is considered safer.⁷ The open technique reduces the number of "blind steps" from 3 with the Veress needle (insertion, insufflations, and first trocar introduction), to just one; the trocar introduction.²

There have been many studies comparing the efficacy and safety of the numerous access techniques although meta-reviews of these have turned out to be inconclusive. Given this uncertainty, the choice of method is usually left to the surgeon's preference. In view of the mentioned confusions and the paucity of literature, the current study was planned to compare the two techniques.

Patients and Methods

The quasi-experimental study was conducted at the Surgical Department of Bahawal Victoria Hospital, Bahawalpur, Pakistan, from September 15, 2013, to September 15, 2016. Non-probability consecutive sampling was used to raise the study sample. The subjects were block-randomised in blocks of 2,4,6 at each week of admission. Randomisation was done at the time of admission into two equal groups. The first half constituted Group A where pneumoperitonium was created by closed method, while the latter half was designated as Group B where the open method was

employed.

Those included were aged 30-50 years with symptomatic gall stones and normal common bile duct confirmed by ultrasound who had been scheduled for laparoscopic surgery i.e., cholecystectomy. Those with para-umbilical hernia, upper abdominal surgery, co-morbidity (diabetes, hypertension, renal failure, chronic liver disease), obesity i.e. body mass index (BMI) above 30 were excluded. Approval was obtained from the institutional ethics review committee, and informed written consent was obtained from all the participants.

The surgical team consisted of a consultant surgeon with at least 5 years of experience. All patients were operated upon under general anaesthesia. The same equipment, including the same monitor, insufflators, light source and camera, were used for all cases. In all the patients, reusable blunt trocars were used.

In Group A, blind insertion of Veress needle and trocar was done at an infra-umbilical transverse 1cm incision. Abdominal wall was lifted by two towel clips applied to the skin on either side of the incision. The surgeon then held the Veress needle in the 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 and saline tests were performed. Three consecutive failures in saline test were taken as 'Failed technique', and the case was converted to open method of pneumoperitoneum. Free flow of saline through the needle was taken as successful placement. Veress needle was then attached to the insufflator, and carbon dioxide (CO₂) insufflation was started at a rate of 1 litre per minute and initial insufflation pressure was recorded as first Veress intraperitoneal pressure (VIP). If first VIP was 10mmHg or more and flow of gas seemed inhibited, Veress needle was withdrawn, reinserted and the same process was repeated. Again, 3 consecutive failures were taken as 'Failed procedure' and the pneumoperitoneum was created by open method. If the first VIP was low, and flow of gas seemed uninhibited, the insufflator was switched to high flow rate until the pre-adjusted intra-abdominal pressure reached 14mmHg. Veress needle was then removed and a 10mm sharp

trocar with over-sleeve was introduced. Trocar was removed and laparoscope was inserted into the cannula. Insufflator was attached to cannula and a thorough inspection of the peritoneal cavity was made. Any injury inflicted during the blind insertion of needle and trocar was noted. Time from incision to laparoscope insertion was calculated and recorded. Facial closure of port sites was performed with vicryl No. 1, while skin in all sites was closed with Prolene 3/0.

In Group B, infra-umbilical incision 3cm was given and insufflation cannula was inserted under direct vision. Umbilical stalk was identified, dissected all around, held in strong Kocker's forceps, was lifted upward and cut at its origin from the 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. The assistant held the stay sutures, while the surgeon introduced the 10mm disposable cannula with blunt obturator inside through the defect. The cannula had sliding olive shaped sleeve to which stay sutures were attached. Upon successful entry into the abdomen, the obturator was removed and cannula was connected to the insufflator. Remaining part of operation was the same as for the closed method except for the closure of the umbilical wound, which was performed by simply tying of the stay sutures together. Access, closure time and complications described by the surgeon were noted.

SPSS 23 was used to analyse data. Comparison of injuries was done using Chi Square test. Comparisons of access and closure time between the two groups were made using Student t Test. $P < 0.05$ was considered statistically significant.

Results

There were 850 patients, with 425 (50%) in each of the two groups. The overall mean age was 38.78 ± 5.41 years, and 667 (78%) were females and 187 (22%) males. The mean access time in Group A was 6.58 ± 1.78 min (range: 4.2-11.2 min) and in Group B it was 5.49 ± 1.82 min (range: 2.90-

Table-1: Comparison of access time closed method (Veress needle) vs Open method (Hasson cannula) groups.

Group	Minimum	Maximum	Mean	SD	SEM	P value
Closed method	4.20	11.20	6.58	1.78	0.086	<0.0005
Open method	2.90	9.80	5.49	1.82	0.088	

*Calculated using student's t test

SD: Standard deviation

SEM; Standard error mean.

Table-2: Comparison of closure time closed method (Veress needle) vs Open method (Hasson's cannula) groups.

Group	Minimum	Maximum	Mean	SD	SEM	P value
Closed method	4.9	13.7	7.60	2.12	0.102	<0.0005
Open method	5.6	11.2	6.91	1.40	0.068	

* Calculated using students t test

SD: Standard deviation

SEM; Standard error mean.

Table-3: Comparison of complications closed method (Veress needle) vs. Open method (Hasson's cannula) groups.

No	Complications	Closed Method (n=425)	Open Method (n=425)	(P Value)*
A	Access Problem	10(2.35%)	00	(0.001)
1	Difficulty in entry	7(1.6%)	00	(0.008)
2	Failure to Pneumoperitonium	3(0.70%)	00	(0.083)
B	Abdominal wall related complication	13(3.05%)	24(5.64%)	(0.064)
1	Leakage of Gas	4(0.94%)	8(1.88%)	(0.245)
2	Localised Emphysema	4(0.94%)	5(1.17%)	(0.738)
1	Bruise at port site	1(0.23%)	4(0.94%)	(0.178)
2	Haematoma	1(0.23%)	3(0.70%)	(0.316)
3	Port site infection	2(0.47)	2(0.47%)	(1.000)
4	Port site Hernia	1(0.23%)	2(0.47%)	(0.563)
C	Intra-abdominal complications	5(1.17%)	1(0.23%)	(0.101)
1	Omental injury	1(0.23%)	0	(0.317)
2	Bowel serosal Tear	2(0.47%)	1(0.23%)	(0.563)
3	Bowel Perforation	1(0.23%)	0	(0.317)
4	Mesenteric vascular injury	1(0.23%)	0	(0.317)
D	Mortality	0	0	-

*Chie Sq. test used.

9.80min) ($p=0.001$) (Table-1).

The mean closure time was 7.60 ± 2.12 min (range: 4.9-13.7min) in Group A and 6.91 ± 1.40 min (range: 5.6-11.2min) in Group B ($p<0.001$) (Table-2). Access problem in Group A was significantly higher than Group B ($p=0.001$). Abdominal wall complications were 13(3.05%) in Group A and 24(5.64%) in Group B ($p=0.064$). Visceral injury happened in 5(1.17%) patients in Group A and 1(0.23%) in Group B ($p=0.101$) (Table-3).

Discussion

There have been many studies comparing the efficacy and safety of the numerous access techniques.⁸ The choice of method is usually left to the surgeon's preference. The current study compared the Veress needle (Group A) method against Hasson's cannula (Group B) method for pneumoperitonium in laparoscopic surgery.

The mean access and closure times in Group A were higher than Group B. Similar results have been reported earlier.^{4,7,9} European Association for Endoscopic Surgery stated open

approach faster, but did not favour the use of either technique over the other.¹⁰ Petigen et al. found that the open technique took half the time required by the closed technique and recommended its use on that basis.¹¹ It is evident that open technique is less time-consuming.

Access problem to create pneumoperitonium are faced in closed method. In our study difficulty in primary entry happened in 7(1.64%), failure to create pneumoperitoneum in 3(0.70%) in the closed method, while none in the open approach. In literature failure of technique was noted in 4(11.4%) out of 35 patients in closed group while no failure was experienced in open group.⁹ Taye MK et al. reported difficulty in primary entry in 26 (1.73%), failure to create pneumoperitonium in 20(1.33%) in closed and none and 2(0.13%) in the open method out of 1500 patients.¹²

Regarding abdominal wall complications, in our study gas leak was found in 4 (0.94%) versus 8(1.88%), localised emphysema 4(0.94%) vs. 5(1.17%), haematoma 1 (0.23%) vs. 3 (0.70%), wound infection 2 (0.47%) vs. 2 (0.47%), hernia 1(0.23%) vs. 20 (.47%) in closed to open. Channa et

al. noted gas leakage 15(4%), port-site haematoma 1(1.66%) and wound infections in 2 (3.33%) in the Hassan group. No such complications happened in the Veress needle group. Port-site hernia did not occur in either arm. Sigman et al. reported gas leak 1 (25%) out of 4 cases, resolved by tightening the anchorage of the cut fascia to the trocar.¹³ Bathla V et al. concluded port-site haematoma (0.5% and 2%) and emphysema (0.5% and 5%) in open and closed method in 200 cases in each group.¹⁴ Gas leak consumes time and causes a disturbance in the middle of the procedure. The open group suffered more abdominal wall complications compared to the closed group.

Regarding intra-abdominal complications, bowel and vascular injuries are taken as major complications and need special address. In our study, bowel perforation happened in 1(0.25%) vs. 00, mesenteric vascular injury 1 (0.25%) vs. 00, bowel serosal tear 2 (0.47%)vs. 1 (0.23%), Omental injury 1 (0.23%)vs. 00, overall 5 (1.17%) vs. 1 (.25%) in closed to open. Jansen et al. noted complication rate 0.07% and 0.17% for the closed and open techniques respectively.¹⁵ Catarci reported highest with optical trocars (0.27%), the second highest with the closed technique (0.18%, used 82% of the time), and the lowest with the open technique (0.09%) in an analysis of a multicentre questionnaire survey of general surgeons (57% responding).¹⁶ Bonjer et al. in their comparison between open and closed techniques found that the rates of visceral and vascular injury were respectively 0.08% and 0.07% after closed laparoscopy, and 0.05% and 0% after open laparoscopy ($p=0.002$).¹⁷ Chapron, on the other hand, reported that the bowel and major vessel injury rates were 0.04% and 0.01% in the closed technique ($n = 8324$) and 0.19% and 0% in the open technique ($n = 1562$), respectively. They concluded that open laparoscopy does not reduce the risk of major complications during laparoscopic access.¹⁸ The rate of visceral injury with closed technique varied from 0.03% to 0.15% with prevalence of injury to the gastrointestinal tract (80%) greater than that for urinary tract (20%). With the open technique, the same figure varied from 0% to 0.12%.¹⁶ Most studies indicate less visceral and bowel injuries in open group. Vascular injuries may be disastrous if they happen. Until 1997, reported vascular injuries were nil for Hassan cannula compared to 0.02%, 0.24% in closed group 16.

Studies reflect effect of experience of surgeon on vascular injuries. Major vascular injuries caused by the insertion of the Veress needle into the abdominal midline occur even in the hands of experienced surgeons. Schäfer analysed 26 major vascular injuries and reported that only four of them (15%) had been caused by inexperienced surgeons

(surgeons who had performed fewer than 50 laparoscopic procedures). The other 22 (85%) injuries had been caused either by experienced surgeons (those who had performed 51 to 100 procedures) or very experienced surgeons (over 100 procedures performed).¹⁹

In our study, overall complications were 4.23% vs. 5.88% in closed vs. open group. Taye MK noted 6.66% vs. 4.13% and Akbar et al. found 8.57% vs. 5.71% in closed and open groups respectively.^{12,9} It includes minor complications in the abdominal wall that settles in no time and was not a problem for patients.

Number of attempts to push Veress needle increases chances of injuries. Noted injuries with one attempt are 0.8-16.3%, two attempts 16.31-37.5%, three attempts 44.4-64%, and more than three attempts 84.6-100%. The complications were extra-peritoneal in sufflation, Omental and bowel injuries, and failed laparoscopy.²⁰

Studies indicate that elevated intra-abdominal pressure prevents injuries. Reich et al.²¹ noted no vascular injury under intra-peritoneal pressure of 25-30mmHg, investigating 3,041 patients submitted to blind insertion of the first trocar through a midline incision at the umbilicus, indicating that elevated intra-peritoneal pressure protected the intra-abdominal structures from injury caused by the first trocar. All injuries to the great vessels caused by the Veress needle reported in the literature resulted from midline puncture in the umbilical region.²² Expected complication rate is also discussed in literature. A systematic review¹¹ of prospective, non-randomised studies of open versus closed (needle/trocar) access indicated a trend during open access towards a reduced risk of major complications with relative risk.

Bonger reported no significant difference in the mortality rates.¹⁷ High rates of mortality related to major injury (10-50%) actually were reported in gynaecologic series, associated mainly with delayed diagnosis and treatment.¹⁷ Schafer et al.¹⁹ also noted no mortality in either of the two study arms.

We studied a large sample size to have meaningful, reliable results. Verres needle was being used due to simplicity of use, but open method was the safer one. Hasson, who was the pioneer of open technique, concluded that there was no evidence to support abandoning the closed entry technique in laparoscopy.¹⁵ Literature, as cited above, does not favour one procedure. Future trends are awaited.

Conclusion

Open method of pneumoperitoneum was found to be

safer and less time-consuming compared to the closed method.

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Conflict of Interest: None.

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