

# Open access for pneumoperitoneum during laparoscopic cholecystectomy (transumbilical vs. conventional)

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## Background

The gold standard technique in the management of symptomatic gall bladder stones is laparoscopic cholecystectomy; it provides minimal postoperative pain, less hospital stay, and good cosmetic outcome. The placement of the umbilical trocar remains the most critical step. There are two common techniques, which are open and closed methods. Transumbilical technique is preferred as it includes a natural opening and is a fast and safe technique.

## Objective

In this study, the authors compared transumbilical and the conventional supraumbilical and infraumbilical open methods access for pneumoperitoneum during laparoscopic cholecystectomy regarding the time for port site entry, the time for port site closure, postoperative pain, and intraoperative and postoperative complications.

## Patients and methods

This prospective comparative study was conducted on 160 cases, candidates for laparoscopic cholecystectomy, divided into two groups, that is, group A (transumbilical technique) and group B (supraumbilical and infraumbilical technique), starting from October 2017 to January 2019, in the Theodor Bilharz Research Institute.

## Results

The mean±SD time for port site entry in transumbilical technique (group A) was 40.3 ±1.2s compared with 131.9±5.5s in the conventional infraumbilical and supraumbilical open techniques (group B), with significant difference between the groups, in favor of the transumbilical technique (group A) ( $P<0.0001$ ).

## Conclusion

Transumbilical access for establishing pneumoperitoneum in laparoscopic cholecystectomy is considered as a fast, safe, effective, and simple technique with mild postoperative pain and less morbidity.

## Keywords:

conventional infraumbilical and supraumbilical open techniques, laparoscopic cholecystectomy, pneumoperitoneum, transumbilical

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## Introduction

The gold standard technique in the management of symptomatic gall bladder stones is laparoscopic cholecystectomy; it provides minimal postoperative pain, less hospital stay, and good cosmetic outcome [1].

Placement of the umbilical trocar remains the most critical step in laparoscopic cholecystectomy, and therefore, there are several techniques to decrease complications associated with the placement of this first trocar such as vascular and intestinal injuries [2].

There are two methods: the open technique (supraumbilical or infraumbilical) and the closed technique [Veress needle, which is inserted blindly in the abdominal cavity for carbon dioxide (CO<sub>2</sub>) insufflations] [3].

Supraumbilical open technique begins with a small c-shaped incision above the umbilicus, and infraumbilical open technique begins with a small c-shaped incision below the umbilicus, and subsequently, all layers of the abdominal wall are incised; the first trocar is inserted under direct vision followed by gas insufflation [4].

Some prefer transumbilical technique because they feel that it gives better visual control, through the natural opening, which is simple, easy, feasible, and safe, with excellent functional and cosmetic results [5]. This is ended by scarless laparoscopic cholecystectomy [6].

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## Aim

Our objective was to compare the transumbilical technique with the conventional open techniques access for pneumoperitoneum during laparoscopic cholecystectomy regarding the timing for port site entry, timing for port site closure, postoperative pain, and intraoperative and postoperative complications.

## Patients and methods

### Patients

Our study was conducted on 160 cases, candidates for laparoscopic cholecystectomy in the period from October 2017 to January 2019 in the Theodor Bilharz Research Institute. The exclusion criteria were patients with midline laparotomy with distortion of the anatomy of the umbilicus, patients with a history of an operation through a transverse umbilical incision, and patients with umbilical and paraumbilical hernia.

All patients were randomly divided by the statistician (randomized blinded study) into two main groups. Both groups are open techniques:

- (1) Patients who were operated upon laparoscopic cholecystectomy with transumbilical technique for creating pneumoperitoneum (group A).
- (2) Patients who were operated upon laparoscopic cholecystectomy with supraumbilical or infraumbilical open techniques for creating pneumoperitoneum (group B).

### Methods

*Preoperative preparation were as follows:*

- (1) Laboratory investigations [complete blood count, liver functions (alanine aminotransferase (ALT), aspartate aminotransferase, total bilirubin, direct bilirubin, alkaline phosphatase,  $\gamma$ -glutamyl transferase, albumin (ALB)), renal functions, and coagulation profile].
- (2) Radiological (abdominal ultrasonography and radiography of chest).
- (3) Anesthetic consultation.
- (4) Consent (Approved by the Ethical Committee of our institute).
- (5) Preparation (Fasting 8–10 h, shaving, and intravenous antibiotic on induction).

### *Operative procedures*

- (1) Transumbilical technique for pneumoperitoneum in laparoscopic cholecystectomy (group A)

### Patient positioning

The patient lied supine, and the surgeon was positioned on the patient's left side (North American positioning). The camera operator stood on the patient's left and to the left of the surgeon, whereas the assistant stood on the patient's right. The video monitor was positioned on the patient's right above the level of the costal margin. The table was rotated with the patients' right side up, which tilted the patient in the reverse Trendelenburg position to improve the exposure. Gravity pulled the duodenum, the colon, and the omentum away from the gall bladder, thereby the working space available in the upper abdomen increased.

### Technique

Traction to the umbilical scar with two toothed forceps was applied to evert the umbilicus. Thereafter, a vertical transumbilical incision of 10 mm was performed with scalpel followed by blunt dissection by inserting Kelly clamp through the defect and the fascia till reaching the intraperitoneal cavity. Then a 10-mm blunt trocar (Storz) was introduced. At the end of the procedure, just one High Dermal Absorbable PDS 2/0 stitch was made to close the umbilical opening without skin suturing:

- (1) Supraumbilical and infraumbilical open techniques for pneumoperitoneum in laparoscopic cholecystectomy (group B).

### Patient positioning

The patient lied supine, and the surgeon was positioned on the patient's left side (North American positioning). The camera operator stood on the patient's left and to the left of the surgeon, whereas the assistant stood on the patient's right. The video monitor was positioned on the patient's right above the level of the costal margin. The table was rotated with the patients' right side up, which tilted the patient in the reverse Trendelenburg position to improve the exposure. Gravity pulled the duodenum, the colon, and the omentum away from the gall bladder, thereby the working space available in the upper abdomen increased.

### Technique

C-shaped supraumbilical or infraumbilical incision of 10 mm was performed with scalpel, followed by blunt dissection till identify the sheath. Traction was applied by two Kelly forceps and cut with scissor, and then the peritoneum was reached. Traction was applied by a Kelly clamp, then opened with scissor, and maintained an upward pull, and then a blunt trocar was introduced

under direct vision. At the end of the procedure, the sheath was closed with prolene 1 stitch, and then the skin closed with prolene 3/zero two stitches.

In both groups, a 30° telescope was then inserted through the umbilical port, and an examination of the peritoneal cavity was performed. A 10-mm operating port was placed subxiphoid, and two additional 5-mm trocars were positioned subcostal in the right upper quadrant in the midclavicular and anterior axillary lines.

The two 5-mm ports were used for grasping the gall bladder and exposing the gall bladder and cystic duct. The infundibulum was retracted laterally to further expose the triangle of Calot.

Dissection was continued until the triangle of Calot was cleared of all fatty and lymphatic tissue. Visualization was done of this critical view of safety (cystic artery and cystic duct).

The next step was a clipping of the cystic duct by one clip proximally and two clips distally and then divided in between. The artery was usually encountered running parallel to and behind the cystic duct. Once identified and isolated, clips were placed proximally and distally, and the artery was divided.

The gall bladder was then dissected off the liver and was usually removed through the subxiphoid port. The fascial defect and skin incision might need to be enlarged to remove the gall bladder and contained gall stones.

Both techniques were compared regarding demographic data (age, sex, and BMI), presenting symptoms and signs [right upper quadrant pain (RUQP), nausea, vomiting, abdominal distension, history of jaundice, history of acute attack, history of pancreatitis, and history of cholangitis], investigations performed (laboratory and imaging, such as total leukocyte count, alkaline phosphatase, total bilirubin, ALT, abdominal ultrasound, and endoscopic

retrograde cholangiopancreatography), operative parameters (timing for port entry in seconds, port site leakage, timing for closure of wound in seconds, visceral injury, and major vascular injuries), and postoperative parameters (home pain score, home analgesia score, wound infection, seroma, and incisional hernia) within 6-month follow-up.

## Results

Both techniques were compared regarding demographic data (age, sex, and BMI) and presenting symptoms and signs (RUQP, nausea, vomiting, abdominal distension, history of jaundice, history of the acute attack, history of pancreatitis, and history of cholangitis), as shown in Tables 1 and 2.

Group A included patients who were operated upon laparoscopic cholecystectomy with transumbilical technique for creating pneumoperitoneum.

Steps of transumbilical technique for creating pneumoperitoneum are shown Fig. 1.

Group B included patients who were operated upon laparoscopic cholecystectomy with infraumbilical open technique for creating pneumoperitoneum, as shown in Fig. 2.

Patients who were operated upon laparoscopic cholecystectomy with supraumbilical open technique for creating pneumoperitoneum are shown in Fig. 3.

Laboratory investigations were done for all cases of chronic calculous cholecystitis (total leukocyte count, alkaline phosphatase, total bilirubin, and ALT), as well as imaging (abdominal ultrasound) (Table 3).

The mean±SD operative timing for umbilical port site entry in seconds in transumbilical technique (group A) was 40.3±1.2 compared with 131.9±5.5 in infraumbilical and supraumbilical open techniques (group B), with significant difference, in favor of transumbilical technique (group A) ( $P<0.0001$ ).

**Table 1 Mean±SD age, sex, and BMI in group A and group B**

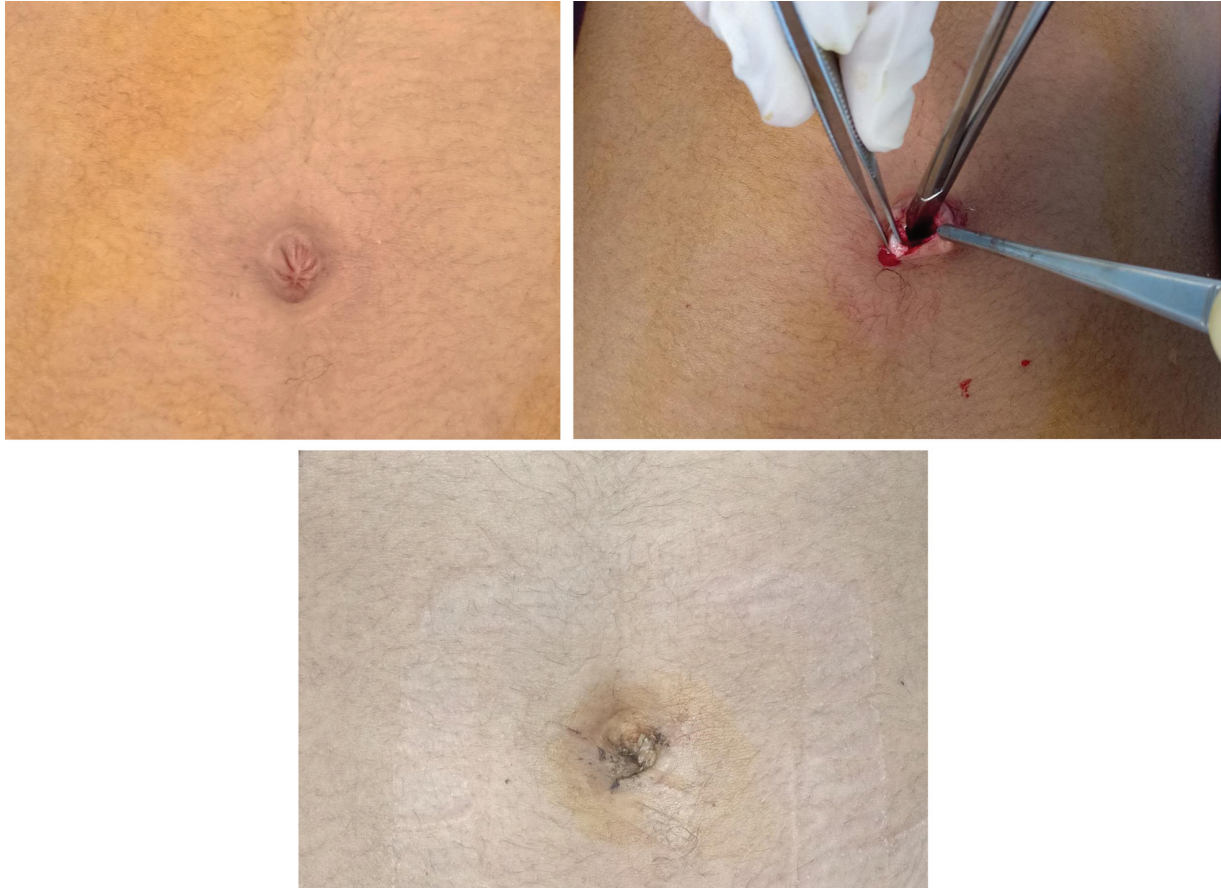
	Group A	Group B	P value
Age (mean ±SD)	38.2±1.6	40.6±1.7	0.32
Sex	58 female – 22 male	62 female – 18 male	0.79
BMI (mean ±SD)	29.3±0.7	29.1±0.7	0.84

**Table 2 Presenting symptoms in group A and group B**

Number of patients	Group A	Group B	P value
RUQP	68	64	0.76
Nausea and vomiting	6	8	1
Abdominal distension	16	26	0.30
History of jaundice	22	18	0.79
History of acute attack	12	4	0.26
History of pancreatitis	2	4	1
History of cholangitis	8	6	1

RUQP, right upper quadrant pain.

Figure 1



Steps for transumbilical technique for port site entry.

The mean $\pm$ SD operative timing for closure of umbilical port site wound in seconds in transumbilical technique (group A) was  $47.0\pm 3.02$  compared with  $136.0\pm 2.14$  in infraumbilical and supraumbilical open techniques (group B), with significant difference, in favor of transumbilical technique (group A) ( $P<0.0001$ ).

Mean $\pm$ SD postoperative home analgesia score in transumbilical technique (group A) was  $1.2\pm 0.16$  compared with  $1.9\pm 0.20$  in infraumbilical and supraumbilical open techniques (group B), with no significant difference ( $P=0.0187$ ).

In transumbilical technique (group A), only one patient had incisional hernia (which was early in third day postoperatively in a 57-year-old female patient with BMI 34, diabetic, asthmatic on inhaler with postoperative cough) compared with two patients in the supraumbilical and infraumbilical open techniques (group B) (on second and fifth month postoperative) discovered on regular follow-up, with no significant difference ( $P=0.0085$ ) (Fig. 4).

In transumbilical technique (group A), only two patients had infected umbilical port compared with

four patients in supraumbilical and infraumbilical open techniques (group B), who were discovered on regular follow-up, with no significant difference ( $P=0.0085$ ) (Table 4).

## Discussion

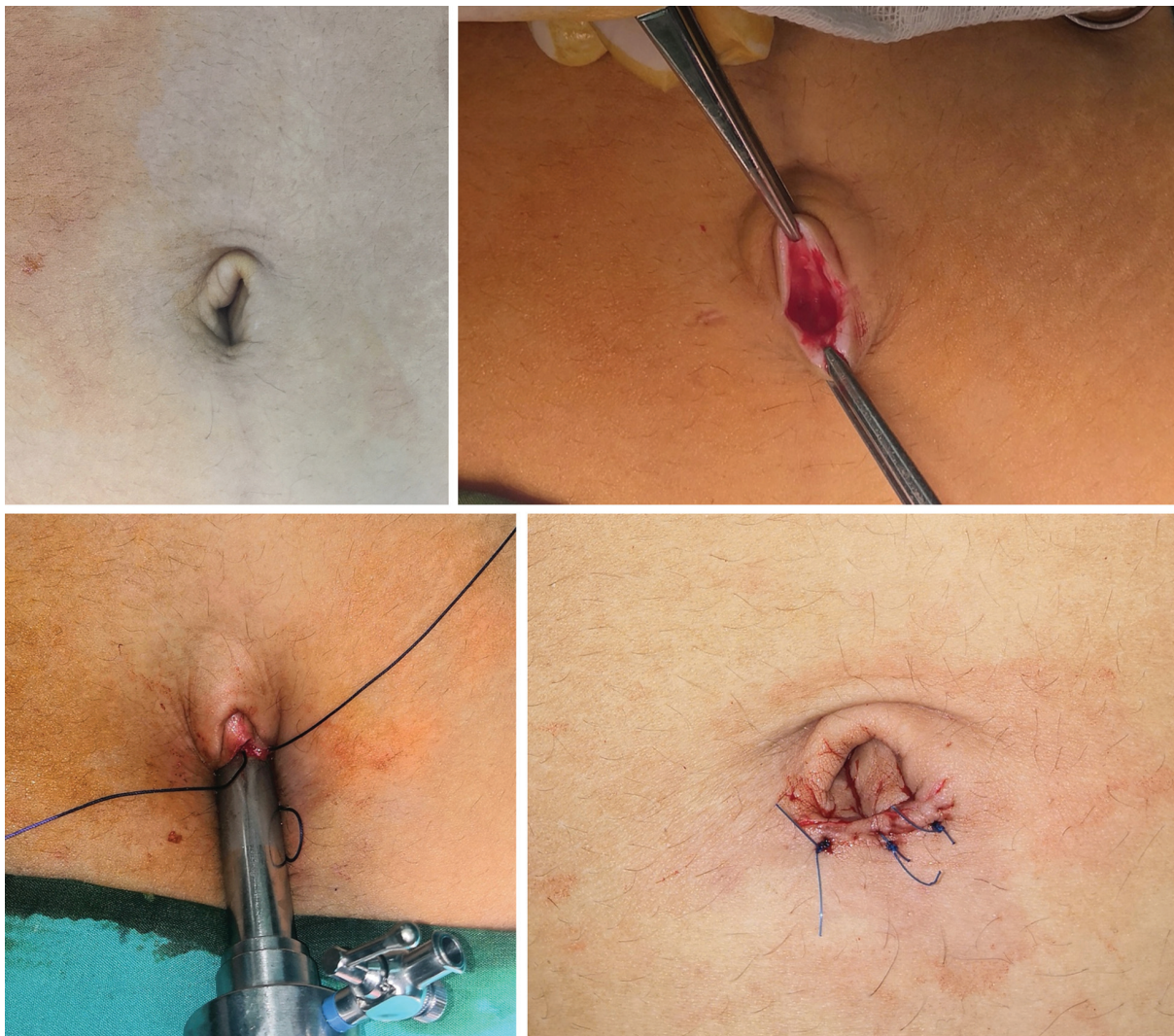
Laparoscopic cholecystectomy has become one of the most commonly performed surgery around the world [7].

Azevedo in a cohort of 696 502 patients who underwent a laparoscopic procedure by using the closed technique (Veress needle) has reported an incidence rate of vascular and visceral injuries of 0.018 and of 0.0024%, respectively [8].

Nowadays, the closed method is the preferred method among most laparoscopic surgeons in spite of the associated hazards. This is owing to gas leakage through the incision and some technical difficulties such as increased time to access the peritoneal cavity [9].

This study was carried out in the Department of General surgery, Theodor Bilharz Research Institute,

Figure 2



Steps for infraumbilical open technique for port site entry.

in the period from September 2018 to February 2019. The aim of this study was to compare transumbilical vs infraumbilical and supraumbilical open techniques access for pneumoperitoneum in laparoscopic cholecystectomy regarding timing, cosmetics, pain control, and complications and to find out which technique is preferred.

The total number of the patients in this study was 160 (80 in group A and 80 group B). There were 58 females and 22 males, with mean $\pm$ SD age of 38.2 $\pm$ 1.6 years old (range: 22–58 years old) in group A (transumbilical), with mean  $\pm$ SD BMI of 29.3 $\pm$ 0.7 (range: 22–38). However, in group B (open infraumbilical and supraumbilical), there were 62 females and 18 males, with mean $\pm$ SD age of 40.6 $\pm$ 1.7 years old (range: 19–59 years old), and had mean $\pm$ SD BMI of 29.1 $\pm$ 0.7 (range: 21–39).

The sex distribution in this study revealed that cholelithiasis was more common in females

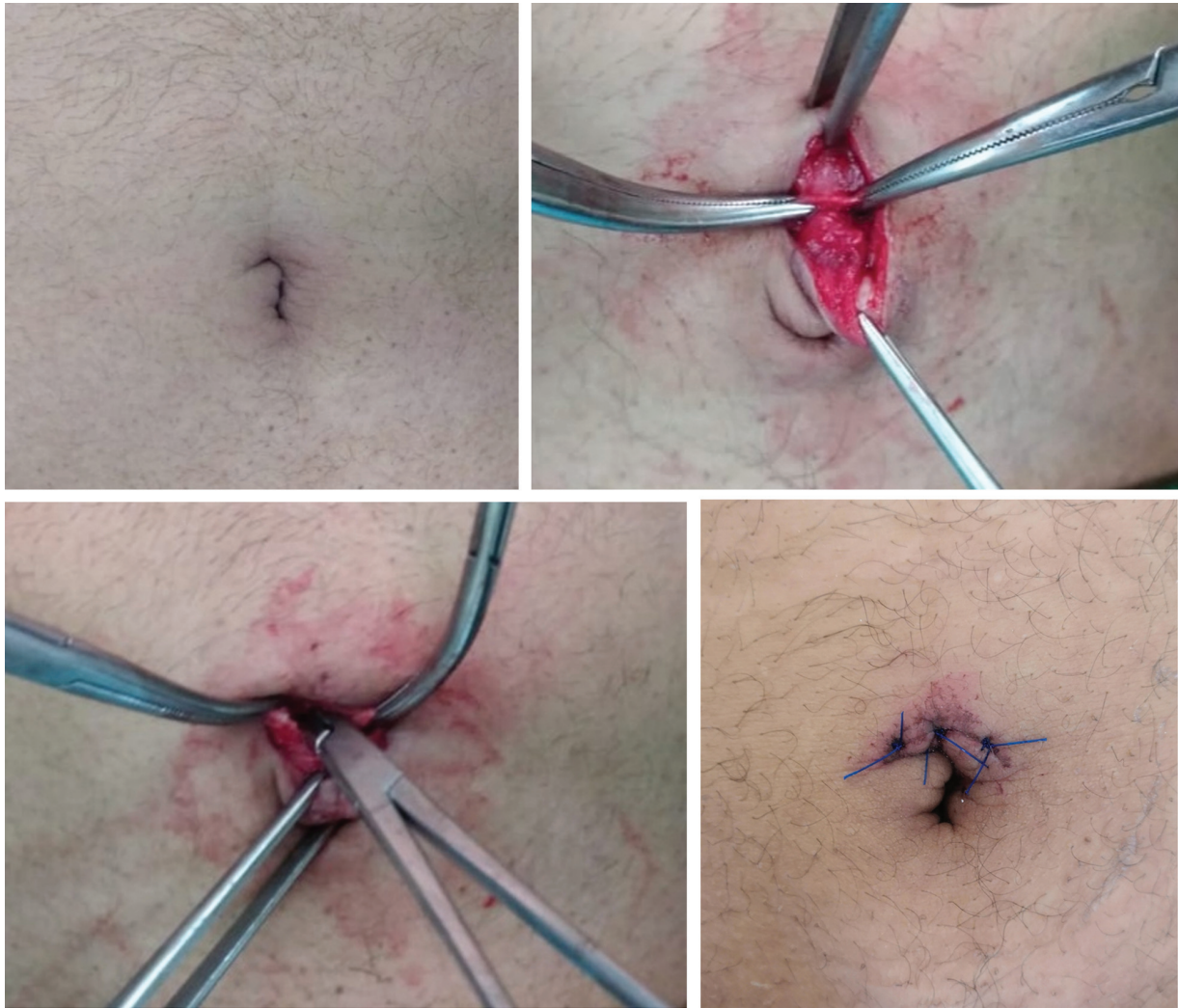
with a female to male ratio of 58:22 in group A and 62:18 in group B. This was in agreement with many studies which found that the gall stones were more common in females [10].

The most common decades of life for the development of cholelithiasis in this study were the fourth and fifth decades (50%) of our patients. This was in some agreement with several studies that found that the gall stones were more common in the fourth to the fifth decade of life [11].

The most common complaint in these patients was RUQP. These findings were in some agreement with several studies which reported that the most common complaints were RUQP, epigastric pain, nausea and jaundice came as the sixth most common complaint [11].

In this study, the operative time for umbilical port site entry in seconds in transumbilical technique (group A)

Figure 3



Steps for supraumbilical open technique for port site entry.

**Table 3 Investigations (laboratory and imaging)**

	Group A (mean±SD)	Group B (mean±SD)	<i>P</i> value
TLC	7.7±0.23	7.18±0.2	0.75
Alkaline phosphatase	99.1±9.7	82.6±6.5	0.01
Total bilirubin	0.8±0.07	0.7±0.04	0.009
ALT	46.7±3.5	43.8±3.8	0.67
Abdominal ultrasound	56 multiple stones	62 multiple stones	0.61
Number of gall bladder stones	24 single stone	18 single stone	

ALT, alanine aminotransferase; TLC, total leukocyte count.

mean±SD was 40.3±1.2 compared with 131.9±5.5 in infraumbilical open technique (group B), with significant value of importance for transumbilical technique (group A) ( $P<0.0001$ ).

Mean±SD operative timing for closure of umbilical port site wound in seconds in transumbilical technique (group A) was 47.0±3.02 compared with 136.0±2.14 in infraumbilical and supraumbilical open techniques (group B), with significant value of importance for

transumbilical technique (group A) ( $P<0.0001$ ). This is similar to several studies which reported that transumbilical technique is simple to learn, perform, and once mastered, it can be done promptly without delaying the operation [12].

In this study, operative umbilical port site gas leakage in transumbilical technique (group A) was reported in 10 cases compared with 28 cases in infraumbilical and supraumbilical open techniques

Figure 4



Early third day postoperative incisional hernia in transumbilical technique (group A).

**Table 4** Timing for umbilical port site entry in seconds, operative timing for the closure of umbilical port site wound in seconds, home analgesia score, postoperative umbilical port incisional hernia, and umbilical port infection

	Group A (mean ±SD)	Group B (mean ±SD)	P value
Timing for umbilical port site entry in seconds	40.3±1.2	131.9 ±5.5	<0.0001
Timing for the closure of umbilical port site wound in seconds	47.0 ±3.02	136.0 ±2.14	<0.0001
Home analgesia score	1.2±0.16	1.9±0.20	0.0187
Umbilical port incisional hernia	1	2	0.0085
Umbilical port infection	2	4	0.0085

(group B), with no significant value of importance ( $P=0.2101$ ).

In our study, there was no visceral and vascular injury in both groups A and B. In a meta-analysis by Bonjer *et al.* [13], by using closed technique, there were vascular injuries in 0.083% of cases and 0.075% of cases by using open one, whereas visceral injuries occurred in 0.048% of patients using the closed technique and in 0.0% using the open technique.

The open technique was described by Hasson in 1971 and was recommended in patients with a previous laparotomy in whom they expected to find adhesions [14–16].

A recent analysis of 3000 patients with open and closed entry techniques showed that the open

technique has better outcomes in terms of major complications, which included emphysema extending up to the neck causing dyspnea, bowel perforation, bladder perforation, and mesenteric vascular injury (open vs closed: 1.33 vs 0.13%,  $P<0.001$ ). Roger Pozzo describes a modification to the open technique with a transumbilical incision, which provides a fast, secure, and effective way of entering abdominal cavity under direct vision.

In this study, mean±SD postoperative 24 h pain score in transumbilical technique (group A) was  $4.8\pm0.23$  compared with  $5.7\pm0.35$  in infraumbilical and supraumbilical open techniques (group B), with no significant value of importance ( $P=0.0344$ ).

However, mean±SD postoperative 24-h analgesia score in transumbilical technique (group A) was  $1.2\pm0.16$  compared with  $1.9\pm0.20$  in infraumbilical and supraumbilical open techniques (group B), with no significant value of importance ( $P=0.0187$ ).

In this study, postoperative wound infection in transumbilical technique (group A) was reported in two patients compared with four patients in infraumbilical and supraumbilical open technique (group B), with no significant value of importance ( $P=1$ ). In a study done by Roger [17], the surgical site infection rate was similar (0.84%) to that reported in the literature (0.6%).

Postoperative seroma in transumbilical technique (group A) was reported in two patients compared with six patients in infraumbilical and supraumbilical open technique (group B), with no significant value of importance ( $P=0.6153$ ).

Postoperative incisional hernia in transumbilical technique (group A) was seen in only one patient (which was early in third day postoperative in a 57-year-old female patient with BMI 34, diabetic, asthmatic on nebulizer with postoperative cough) compared with two patients (on second and fifth month postoperative) in infraumbilical and supraumbilical open techniques (group B), which were discovered on regular follow up with no significant value of importance.

Lastly, through the use of the open technique, vascular and visceral injuries can be virtually eliminated, significantly improving patient safety [18,19].

## Conclusion

From this study, the following conclusions can be made:

- (1) Transumbilical technique access for establishing pneumoperitoneum in laparoscopic cholecystectomy is quick for port entry and port closure, safe, reliable, simple, easy to learn, minimal postoperative pain and is associated with minimal morbidity. So, it provides the surgeons with an effective and safe means to insert the first trocar.
- (2) It is recommended to use this technique as a routine procedure to access the peritoneal cavity for abdominal laparoscopic surgery.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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