

Laparoscopic Entry Using Direct First Trocar Insertion without a Prior Pneumoperitoneum: A Prospective Cohort Study

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ABSTRACT

Purpose: This study aimed to assess safety, feasibility, complications, and time of direct first trocar insertion (DFTI) with carbon dioxide (CO₂) insufflation and operating time in laparoscopic surgery.

Materials and methods: This study was a prospective cohort study (clinical original) performed at AL-Karama Teaching Hospital/College of Medicine, Wasit University, Iraq, from April 2011 to December 2017. The study enrolled 687 patients prepared for different laparoscopic procedures using direct first trocar insertion techniques for laparoscopic entry. Conversion of laparoscopic entry to Veress needle (VN) or open technique was performed when direct first trocar insertion technique failed. Recorded data were age, sex, indications for laparoscopic surgery, time of direct first trocar insertion with CO₂-insufflation, operating time, and direct first trocar insertion-related complications.

Results: Direct first trocar insertion technique was successful in 684 (99.57%) patients and failed in 3 patients when trocar entry was converted to Veress needle technique. These three patients were excluded from the statistical analysis of the study data. Demographic distribution of the patients was as follows: 90 (13.2%) males and 594 (86.8%) females. This study had no major complications, while minor complication rate was 1.31%. Mean \pm standard deviation (SD) of direct first trocar insertion with CO₂-insufflation time for males, females, and total patients was 2.32 \pm 0.57 minute (m), 1.89 \pm 0.53 m, and 1.95 \pm 0.56 m, respectively. *p* value was 0.03 and was statistically significant. This study had no mortality.

Conclusion and clinical significance: Direct first trocar insertion is a safe and cost-effective laparoscopic entry technique. It has a high feasibility rate, low complication rate, fast laparoscopic entry, and fast creation of pneumoperitoneum.

Keywords: Direct first trocar insertion, Gallstones, Laparoscopy, Pneumoperitoneum.

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INTRODUCTION

Insertion of the primary trocar and successful creation of a pneumoperitoneum are essential steps in laparoscopic surgery, as more than 50% of complications during laparoscopic surgery occur at the time of Veress needle (VN) or the first trocar entry, independent of the complexity of surgery.¹⁻³

Bateman et al.⁴ reviewed data on 2,324 laparoscopic procedures that were performed by the same surgical team and reported that more complications occurred during VN and trocar insertion than during the operative procedures that were performed. Therefore, optimizing the entry technique is essential. Techniques that are currently used for laparoscopic entry are VN, open laparoscopy (Hasson's technique), optical trocar, threaded or radially expanding devices, and direct first trocar insertion (DFTI) without a prior pneumoperitoneum.⁵ The existence of many laparoscopic entry techniques indicates that none has completely been established as standard or complication-free⁶ or they are equally highly effective.

Laparoscopic entry and creation of a pneumoperitoneum with a VN may be associated with complications such as extraperitoneal insufflation, which increase the difficulty and time of the procedure.⁷ A meta-analysis performed by Jiang et al.⁷ reported that the VN technique was associated with a significantly increased risk of minor complications. Additionally, the possibility of multiple insertion attempts and entry failure were significantly higher in the VN technique than in other techniques.⁸ Despite being considered safe by some laparoscopic surgeons, the VN technique may cause

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serious vascular and visceral abdominal injuries, usually in obese patients and those with intra-abdominal adhesions.⁹

Hasson's open laparoscopic technique reduces vascular injuries but does not reduce bowel injuries.¹⁰ This may reflect a selection bias because Hasson's technique may be used in high-risk patients for visceral and vascular injuries.¹⁰ The DFTI technique was reported to be associated with low complication rates and is preferred by some laparoscopic surgeons.¹¹

The DFTI technique without a prior pneumoperitoneum for laparoscopic entry was first reported by Dingfelder in 1978.¹² The reported benefits of this technique are its short laparoscopic entry, short insufflations and operative times, ability to immediately recognize vascular and visceral injuries, minimal entry failure, and low carbon dioxide (CO₂) embolism.^{1,13}

Jansen et al.⁶ found that 57% of complications occurred during the insertion of the first trocar, and 43% of these complications were related to surgical experience. Failure to create and maintain a pneumoperitoneum may influence these complications.

Günenç et al.¹¹ reported that VN and DFTI are blind techniques and can result in severe visceral and vascular injuries. To avoid such injuries, laparoscopic surgeons and gynecologists seek safe and effective laparoscopic access techniques. DFTI without a prior pneumoperitoneum was reported to be a safe alternative to the VN technique.¹⁴

Direct first trocar insertion is not contraindicated in thin or obese patients in non-emergency situations.¹⁵ Although it is a blind technique, DFTI decreases the number of blind steps from three steps with VN (insertion, insufflation, and trocar insertion) to one. The most important advantage of the DFTI technique is that it can be used to prevent complications associated with the use of a VN, such as failure of the pneumoperitoneum, extraperitoneal insufflation, bowel insufflation, and CO₂ embolism.¹⁶ The experience of the surgeon determines whether laparoscopic access can successfully be achieved, not CO₂ pneumoperitoneum or trocars.¹⁷ A controllable, easy-to-follow technique and the surgeon's experience are more reliable factors than any design of the surgical instrument.

The DFTI technique is faster than other techniques for laparoscopic entry;¹⁸ however, it is the least-used technique in laparoscopic surgery today.¹⁹ The insufflation-related complications of DFTI technique are low and should be evaluated further.²⁰

This study reported the 6.5-year experience of one consultant laparoscopic surgeon who routinely uses the DFTI technique without a prior pneumoperitoneum for laparoscopic entry. In particular, the safety, feasibility, complications, DFTI with CO₂ insufflation time, and operative time during laparoscopic surgery were assessed.

MATERIALS AND METHODS

Ethical Considerations

This study was approved by the ethics committee of the Medical College of Wasit University, Iraq, in March 2011. All enrolled patients were informed of the procedure and its potential complications and provided written informed consent prior to inclusion in the study.

Study Design, Setting, and Participants

This prospective cohort study enrolled 687 patients who underwent different laparoscopic procedures using the DFTI technique. Patients with an umbilical hernia, pregnant women, those with previous laparotomy incisions other than a gridiron incision for appendectomy, and those with a Pfannenstiel incision for obstetric and gynecologic pathologies were excluded. Three patients underwent conversion to the VN technique due to failure of the DFTI technique and were excluded from the analysis.

This study was performed at the Al-Karama Teaching Hospital, College of Medicine, Wasit University, Iraq, from April 2011 to December 2017. Routine investigations, including abdominal ultrasonography, chest radiography, electrocardiography, complete blood count, blood type, fasting blood sugar level, blood urea, Hepatitis B, and Hepatitis C, were performed. Antithrombotic measures such as subcutaneous heparin (the prophylactic dose was administered according to the patient's body mass index) and elastic stockings were used in obese and high-risk patients. All 687 operations were laparoscopically performed by one

consultant laparoscopic surgeon using DFTI without a prior pneumoperitoneum. Data on age, sex, indications for laparoscopic surgery, DFTI-related complications, complications that were unrelated to DFTI, DFTI-CO₂ insufflation time, and operative time were recorded.

Direct First Trocar Insertion Technique

Each patient was placed in the supine position. After anesthesia was induced, he or she was then prepared and draped. A transverse 1-centimeter infraumbilical incision was made using a scalpel gauge 11 (Demotek manufactured by Demophorius Healthcare Ltd, Cambridge, United Kingdom). In obese patients prepared for laparoscopic cholecystectomy (LC), the incision was made 3–4 cm above the umbilicus. The operating surgeon and his well-trained assistant elevated the anterior abdominal wall by pulling it up with their left hands. While elevating the anterior abdominal wall away from the underlying viscera, the surgeon held a 10-mm trocar, with his right index finger positioned 3 cm away from the trocar tip to guard against sudden uncontrolled entry of the trocar into the abdomen. The trocar was inserted at a 45° angle in non-obese patients and at a 90° angle in obese patients. Then, the trocar was advanced in a controlled fashion into the peritoneal cavity with a twisting, semicircular motion. In contrast to the insertion of a VN, during which the surgeon can feel penetration through the fascia and peritoneum separately, during DFTI, a distinct single "pop" signified that the trocar had pierced the fascia and peritoneum. Then, a laparoscope was introduced, proper intraperitoneal placement was ascertained, and a pneumoperitoneum was created with high-flow insufflation. Then, the patient was tilted into the reverse Trendelenburg's position. Intraperitoneal placement of the first trocar was determined by observing the initial gas flow pressure rates. The intraperitoneal structures were carefully inspected for any injury or incidental pathology. Other trocars were inserted under direct vision.^{2,7,9,15}

Statistical Analysis

This study's data were statistically analyzed using IBM SPSS Statistics V22.0 (IBM Corp., Armonk, N.Y., USA.). A *p* value < 0.05 was considered statistically significant.

RESULTS

A total of 684 patients (age range: 16–77 years; mean: mean ± standard deviation: 39.21 ± 12.04 years; 95% confidence interval: 38.31–40.12 years) had successful DFTI entry. A total of 594 (86.8%) women and 90 (13.2%) men underwent different laparoscopic procedures. There were no major complications or deaths (Table 1). The pathologic distribution of the laparoscopic procedure is presented in Table 2.

DFTI-related complications occurred in nine (1.31%) patients, including seven (1.02%) patients with extraperitoneal CO₂ insufflation. These patients were all women, possibly due to the fact that Camper's fascia is thicker in women than in men. Two patients (0.3%; one man, one woman) had bleeding at the infraumbilical port site. The bleeding stopped spontaneously in both patients.

Regarding complications unrelated to DFTI, one woman developed a hernia; 10 patients (1.46%) (three men and seven women) developed intraoperative bleeding at Calot's triangle unrelated to DFTI, which spontaneously stopped; and 14 patients (2.04%) (2 men and 12 women) developed port-site infections that were conservatively treated (Table 3).

Table 1: Patient demographics

Sex	No.	%	Age at statistical analysis/Year				p value
			Mean \pm SD	95% confidence interval		Range	
				Lower boundary	Upper boundary		
Male	90	13.2	46.01 \pm 12.62	43.37	48.65	20–77	0.00
Female	594	86.8	38.18 \pm 11.62	37.25	39.12	16.75	
Total	684	100.0	39.21 \pm 12.04	38.31	40.12	16.77	

SD, standard deviation

Table 2: Pathologic distribution of the study patients

Pathology	Sex		Total	%
	Male	Female		
Chronic calculous cholecystitis	43	509	552	80.7
Acute calculous cholecystitis	14	25	39	5.7
Chronic acalculous cholecystitis	4	7	11	1.6
Empyema of the gallbladder	10	15	25	3.64
Mucocele I of the gallbladder	12	18	30	4.40
Acute appendicitis	4	7	11	1.6
Ovarian pathology	0	4	4	0.6
Abdominal trauma	3	4	7	1.03
Others*	0	5	5	0.73
Total	90	594	684	100

*Two women, migrating intrauterine device; three patients, acute mesenteric lymphadenopathy

Table 3: Perioperative complications during the study period

Complications		Sex		Total	%	p value
		Male	Female			
DFTI-related complications	Extraperitoneal insufflation	0	7	7	1.02	0.179
	Port-site bleeding	1	1	2	0.3	
	Vascular injury	0	0	0	0	
	Visceral injury	0	0	0	0	
Total		1	8	9	1.31	
DFTI non-related complications	Hernia	0	1	1	0.15	0.442
	DFTI-unrelated intraoperative bleeding	3	7	10	1.46	
	Port-site infection	2	12	14	2.04	
Total		5	20	25	3.65	

Table 4: Direct first trocar insertion (DFTI)-CO₂ insufflations time and intraperitoneal operative time

Time (minute)		No	Mean \pm SD	95% confidence interval for mean		Minimum	Maximum	p value
				Lower boundary	Upper boundary			
DFTI-CO ₂ insufflations time	Male	90	2.32 \pm 0.57	2.20	2.40	1.00	4.00	0.03
	Female	594	1.89 \pm 0.53	1.85	1.93	1.00	5.00	
	Total	684	1.95 \pm 0.56	1.90	1.99	1.00	5.00	
Operative time	Male	90	35.92 \pm 9.73	33.88	37.96	18.00	70.00	0.03
	Female	594	30.82 \pm 7.60	30.21	31.43	18.00	70.00	
	Total	684	31.49 \pm 8.09	30.88	32.10	18.00	70.00	

The mean \pm standard deviation of the DFTI-CO₂ insufflation times were 2.32 \pm 0.57 m, 1.89 \pm 0.53 m, and 1.95 \pm 0.56 m for men, women, and all patients, respectively. The 95% confidence intervals were 2.20–2.40, 1.85–1.93, and 1.90–1.99 for men, women, and all patients, respectively. The mean \pm standard deviation

operative time was 35.92 \pm 9.73 m, 30.82 \pm 7.60 m, and 31.49 \pm 8.09 m for men, women, and all patients, respectively. The 95% confidence intervals were 33.88–37.96, 30.21–31.43, and 30.88–32.10 for men, women, and all patients, respectively (all p value = 0.03; Table 4).

DISCUSSION

The aim of this study was to evaluate the safety, feasibility, complications, and time of performing the DFTI technique. DFTI has a very high feasibility rate, low complication rates, and less need for instrumentation, and a pneumoperitoneum can be created quickly. The DFTI technique is a safe alternative to the insertion of a VN and other laparoscopic entry techniques. However, performing the DFTI technique requires good experience.

Insertion of the first trocar and creation of a pneumoperitoneum are the most critical steps in laparoscopic surgery. Subcutaneous emphysema, port-site bleeding, and vascular and visceral intraperitoneal injuries are serious complications that may occur during laparoscopic entry and creation of a pneumoperitoneum. Four basic techniques are used for laparoscopic entry and to establish a pneumoperitoneum: blind VN, DFTI, insertion of an optical trocar, and open laparoscopy.² The DFTI technique was first described by Dingfelder in 1978¹³ and later reported by Copeland et al. in 1983.²¹ The latter reported that adequate abdominal wall relaxation, a proper skin incision, and the use of a sharp trocar are essential for successfully performing DFTI; other authors advised elevating the rectus sheath for a successful outcome.¹⁵ Innovations in shielded trocars have encouraged use of DFTI, but no experimental or clinical study has established the superiority of the shielded trocar to the non-shielded trocar.^{1,21,22}

The rationale for using the DFTI technique before the creation of a pneumoperitoneum is based on the fact that many complications that occur during laparoscopic surgery are directly related to the insertion of a VN.^{22,23} It was reported that the DFTI technique was a safe alternative to the VN technique.^{20,24} Additionally, the DFTI technique was associated with minimal insufflation-related complications such as gas embolism and was faster than most other laparoscopic entry techniques.²⁰

Theodoropoulou et al.¹ reported that the DFTI feasibility rate was 99.5%, which was compatible with the feasibility rate that was found in this study. In a randomized, prospective study that enrolled 84 patients, Prieto-Diaz-Chavez et al.²⁵ reported that the complication rates for DFTI and VN insertion were 2.3% and 23.8%, respectively. Yerdel et al.²⁴ enrolled 1,567 patients in their study and reported that the complication rates after DFTI and VN insertion were 0.9% and 14.4%, respectively. In a study that included 698 thin and very obese patients, Agresta et al.²⁶ found that DFTI was safe, with a slightly higher feasibility rate than the VN technique, and was related to minimal minor complication rates, but they reported that there were no differences in the rates of major complications. DFTI may be a safe technique in thin patients.^{26,27} The DFTI technique did not lead to major complications in this study. There were minor rates of DFTI-related and DFTI non-related complications. The total minor complication rate was significantly lower than that of VN as reported in previous studies.^{20,24,26}

Byron et al.¹⁸ reported DFTI and VN insertion times of 2.2 m and 5.9 m, respectively. Zakherah et al.²⁸ reported DFTI and VN insertion times of 2.2 ± 0.7 m and 8.2 ± 1.4 m, respectively. Thus, in this study, the DFTI-CO₂ insufflation time was comparable with the DFTI time of these studies,^{18,27} but a pure DFTI time without a CO₂ insufflations time was significantly shorter than that of the DFTI and VN insertion times.

Agresta et al.²⁶ study showed that DFTI was feasible in 100% of cases, and conversion to open laparoscopy was not necessary.

Although the open trocar technique with Hasson's cannula is considered a safe alternative, it is not complication free and

is a time-consuming entry technique; thus, many laparoscopic surgeons use it very selectively.^{16,26} Past studies^{16,22,26} revealed that none of the available techniques create a pneumoperitoneum during laparoscopic entry and is free of complications. Each was associated with different advantages and limitations when performed by experienced surgeons for appropriate indications.²⁹ This study has some limitations that were:

- Unavailability of some laparoscopic instruments that can shorten the operative time such as multifire reusable clip applier and those instruments that can reduce the entry-related injuries such as the optical trocars.
- Poor quality of some laparoscopic instruments such as electrocautery hooks and graspers.

CONCLUSION AND CLINICAL SIGNIFICANCE

When performed by an experienced laparoscopic surgeon, DFTI is a safe, fast, and cost-effective technique for laparoscopic entry and pneumoperitoneum creation. Additionally, it has a very high feasibility rate, low complications, few instrumentation, and fast creation of pneumoperitoneum. Thus, DFTI technique is a safe alternative to VN insertion and other laparoscopic entry techniques. This study findings suggest that successful DFTI requires a good surgical experience. I recommend large-scale combined studies by the colleges of obstetricians and gynecologists and surgeons to assess laparoscopic entry, CO₂-insufflation and operative times, and complication rates of the different laparoscopic entry techniques.

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