Direct Trocar Insertion for the Establishment of Pneumoperitoneum in Laparoscopic Procedures. A review of the Literature.

Koroye F. Oyintonbra,[1] Olatoregun B.O. Frank,[1] Alagoa J. Paingha[1]

[1]Department of Surgery, Niger Delta University Teaching Hospital,
Okolobiri, Bayelsa State, Nigeria
Correspondence to O. F. Koroye,
oyintonbrak1@gmail.com, +2348037087725

Abstract

Background: *the creation of pneumoperitoneum is a sine qua non for the performance of laparoscopic procedures. There are several methods of establishing pneumoperitoneum and they include Veress needle insertion, open (Hasson) technique, optical trocars, self expanding shielded trocars and direct trocar insertion. The aim of this review is to highlight direct trocar insertion as a technique of initial entry and insufflation and also compare it to other well known techniques in terms of technical difficulty, success rate, time for insertion and complication rate.*

Methods: *A literature search was conducted with the Google search engine. The Pubmed and Google scholar databases were searched. Studies were classified into 4 categories, those that addressed insufflation and entry techniques in general (A), those that dealt with complications of various entry techniques (B), those that showed the authors' experiences with direct trocar insertion (C) and those comparing direct trocar insertion with other entry techniques (D). Data on the success rate, complication rate and time taken to achieve insufflation were taken and analysed.*

Results: *A total of 26 relevant articles were reviewed. Eight articles were in category A, four each in categories B and C and 12 in category D. The success rates ranged from 99.5% to 100%. There was also a significant difference in favour of direct trocar insertion in the time taken to achieve pneumoperitoneum.*

Conclusions: *Direct trocar insertion is easy to perform, safe, has high success rate and low complication rate. It is a worthy alternative for other well established techniques.*

Keywords; insufflation techniques, laparoscopic entry, direct trocar insertion, pneumoperitoneum, review article.

Introduction

Establishment of pneumoperitoneum is a sine qua non for the performance of laparoscopy and laparoscopic procedures.

There are various methods of creating pneumoperitoneum and they include Veress needle insertion, open (Hasson's) technique, direct trocar insertion (DTI), visual entry system (optical trocars) and radially expanding shielded trocars.[1,2,3,4,5,6]

There is however no clearly defined advantage of one method over another.[1,2]

The usual sites for insufflation are the umbilicus (infra, trans or supra umbilical) and the Palmer's point (3cm below the left costal margin, mid clavicular line) and carbon dioxide remains the most widely used gas. Less common sites used for insufflation include transforniceal (vagina) and transuterine routes.

The aim of this study is to highlight direct trocar insertion (DTI) as a technique of initial entry and insufflation. The specific objectives are to compare direct trocar insertion with other insufflations techniques in terms of the success rate, time taken for insertion as well as complication rates

Materials and Methods.

A literature search was carried out for articles in English using the Google search engine of the Pubmed and Google scholar databases using the key words, insufflation techniques, laparoscopic entry, direct trocar insertion and pneumoperitoneum. Articles selected for review were divided into 4 categories; those that addressed insufflation/ entry techniques in general (A), those that dealt with complications of entry techniques (B), those that showed authors' experience with direct trocar insertion (C) and those that compared direct trocar insertion with other established entry techniques especially the Verses needle technique (D). Data on the success and complication rates and the time to achieve insufflation were taken and analysed.

Results

A total of 26 articles were reviewed. Six articles addressed insufflation and entry techniques generally. Four articles were more specific and were categorized under articles that dealt with complications of entry techniques while there were four articles showing the authors experience with direct trocar insertion. Twelve papers were categorized under those that compared direct trocar insertion to other entry/insufflation techniques. The success rates ranged from 99.5% to 100% with complication rates ranging from 0 to 2%.

Table 1 showing success and complication rates of DTI in various studies

S/N	AUTHOR	YEAR	SAMPLE SIZE	SUCCESS RATE	COMPLICATION RATE
1	Dingfelder	1978	301	100%	1%
2	Agresta et al	2012	2091	100%	0
3	Theodoropolou et al	2008	196	99.5%	2%
4	Rahman and Mamun	2003	1375	100%	0.22%

Two studies comparing DTI and Veress needle (VN) insertion showed a higher complication rate and this was statistically significant in one of them, 2.3% (DTI) and 23.8% for VN ($p=0.009$). The time taken to achieve pneumoperitoneum was also significantly lower in the DTI group compared to the VN group in two studies which analysed this variable; 1.5 minutes (DTI) versus 3 minutes (VN), $p<0.001$ and 1 minute (DTI) versus 3.8 minutes (VN), $p<0.05$.

Discussion

Initial entry and creation of pneumoperitoneum in laparoscopy and laparoscopic surgical procedures could be open or closed. Open methods include the Hasson's technique where anterior abdominal wall dissection is carried down to the fascia and peritoneum which is also opened and the trocar inserted under direct vision. Closed methods include Veress needle insertion and direct trocar insertion (DTI).

Pasic et al in a study of 3086 patients to assess the safety and efficacy of the various insufflation techniques concluded that body mass index and previous abdominal surgery were key factors in the selection of the most successful insufflation technique based on the surgeon's experience.[3]

Proponents of particular methods of initial access have published favorable data on the efficacy and safety of their preferred techniques.[4,5,6]

Milat in his work in 2005 advocated that open pneumoperitoneum be adopted as the standard practice for safety reasons. He asked the question; "when it comes to guaranteeing patient safety, shouldn't the demonstration that a technique reduces risk be considered as adequate level of proof if there is no demonstrated benefit to the more dangerous approach□" [4]

However in a Cochrane review, open entry was associated with a significant reduction in one minor complication (failed entry) with no significant difference in the incidence of major life threatening complications like vascular and visceral injuries. The authors were quick to warn that the results should be interpreted with caution as the low rate of reported complications of laparoscopic procedures makes it difficult to show any significant differences between techniques.[1]

The various methods of establishing pneumoperitoneum are not without complications.
These have been widely reported in the literature and they include bowel injury, minor and major vascular injury, bladder injuries, omental injury, preperitoneal insufflation, bowel insufflation, omental insufflation, subcutaneous emphysema as well as failed entry.[7,8,9.] A large retroperitoneal haematoma has also been reported from towel clip injury which was to elevate the anterior abdominal wall to aid entry.[10]

Direct trocar insertion refers to insertion of the primary trocar without prior insufflation. The umbilicus is the entry point commonly used. A small smiling infra-umbilical incision is made and carried down to the rectus sheath. The trocar is then inserted and with the typical twisting supination-pronation movements, the fascia and peritoneum are breached to enter the peritoneal cavity. Gas, carbon dioxide is then connected to the trocar for insufflation. Next the camera is inserted after which the other trocars are then inserted under direct vision.

The DTI method is the fastest method of entry and the least used in clinical practice.[7] It is used more commonly among gynaecologists and not surprisingly, they have done most of the work on this subject. [2,3,6,7,8,11,12]

The first study on direct trocar insertion without prior insufflation in the literature was by Dingfelder in 1978.[11] A few years later Copeland et al in a series of over 2000 patients reproduced the efficacy and safety of this method. [12] He stressed the key points of adequate muscle relaxation, adequate skin incision and elevation of the anterior abdominal wall as imperative for successful entry.[12]

Elevation of the abdominal wall can be achieved by various means. Surgeons performing DTI have reported elevation by hand[13], use of towel clips, use of skin and subcutaneous sutures [14], and use of rectus stiches.[15]

Authors also differ in the elected site of entry. Some routinely use the transumbilical route unless there are contraindications like adhesions from previous surgery while some authors routinely use palmers point even when use of the umbilical route is not contraindicated. [13] The type of surgery, whether upper or lower abdominal procedures, also influences the entry site used. [13]The palmers

point is preferred for upper abdominal surgeries e.g. fundoplication and the umbilical route for others.

Whatever the point of insertion or the method of elevation of anterior abdominal wall, several studies have shown encouraging results with direct trocar insertion.

In a study published in 2012, Agresta el al in Italy achieved a 100% success rate in DTI performed on 2091 patients undergoing various procedures including emergencies. They reported no minor or major complications.[13]

Theodoropolou et al working in London explained that with the DTI technique, what would ordinarily have been a 3 step process (Veress needle insertion, insufflation and then trocar insertion) is converted to a one step procedure . [14] They reported a success rate in DTI of 195 in 196 patients (99.5%) with no major complications. Minor complications encountered included one case of wound infection, and three subcutaneous haematomas. In the long term three stitch granulomas and one port site hernia were observed.[14]

Borgatta et al in one of the earliest studies in the literature comparing DTI with the veress needle for insufflation in over 2000 patients undergoing laparoscopy for tubal ligation, reported a significantly lower operating time (p=0.001) and a lower volume of carbon dioxide used for insufflation (p=0.001).[16] in favor of the DTI group. There were also fewer instrument insertions (21.8% vs 7.8%) in the DTI group. A total of 11 minor omental injuries occurred, seven in the Veress needle group and four in the DTI group. [16]

The following year in 1991, Nezhat el al published their work comparing the Verses needle (VN), direct reusable conventional trocar (DTI) and direct disposable shielded trocar insertion with complication rates of 22%, 6%, and 0% respectively.[17] The overall complication rate (28%) in the study is high and this may be attributed to the fact that laparoscopic surgery was still in its early developmental stages at that time.

Laparoscopic cholecystectomy is one of the most frequent laparoscopic procedures performed by the general surgeon and arguably in laparoscopic surgery in general. It is therefore a veritable base for the study of DTI compared to other entry techniques especially the more renowned Veress needle technique. The literature contains several studies which have made this comparison. [18,19,20,21.] In a study comparing DTI with Veress needle insufflation in 1500 patients who had laparoscopic cholecystectomy, 1357 had direct trocar insertion performed, 106 had Veress needle insertion and 19 had the open (Hasson's) technique for initial access and insufflation.[18] Six major complications occurred, four bowel lacerations and two omental herniations. Three of the four small bowel injuries occurred in the DTI group with one in the open technique group. [18] The two patients who had omental herniation belonged to the open technique group. They concluded that DTI was expedient and safe. [18] Even though the sample size in the study was large, the skewed and non randomized allocation of the patients across the three groups in favour of DTI may be a pointer that DTI is the commonly used and preferred technique of the authors.

In a prospective, non randomized study comparing DTI with Veress needle, Altun el al reported three major complications and more frequent minor complications in the Veress needle group. There was however no statistically significant difference in the occurrence of complications between both techniques, [19] A total of 283 patients were studied.

Conducting a similar study in patients undergoing laparoscopic cholecystectomy, Pietro- Diaz el al found a significant difference in favor of (DTI) in terms of complication rate, (DTI 2.3%,VN 23.8%, P=0.009), duration of surgery and laparoscope insertion time .[20] It is worth noting though that the sample size in the study was small, 84 (42 in each group).

Inan et al in 2005 assessed the complication rate while performing DTI compared to Veress needle showed a lower rate in the DTI group.[21]
In a meta analysis of randomized clinical trials comparing DTI to VN consisting 2940 women, a significantly higher incidence of minor complications was seen in the VN group as well as an increased risk of repeated multiple insertions. No statistically significant difference was demonstrated with respect to the occurrence of major complications.[22]

Agresta et al in an earlier study comparing DTI with VN in 598 non obese (thin) subjects showed a 100% success rate in the DTI group compared to 98.7% in the VN group.[23] No minor complications occurred in the DTI patient group as against a rate of 5.9% (subcutaneous emphysema and extra peritoneal insufflations in the VN group.[23] Two cases of hepatic injury (0.6%), ileal perforation (0.3%) and mesentenic laceration (0.3%) which were all classified as major complications occurred in the VN group.[23] This was however not statistically significant.[23] These findings perhaps encouraged the authors to carry out a larger study on DTI in all kinds of patients and even in emergencies , with similar results.[13]

Direct trocar insertion has also been shown to be efficacious in obese patients.[24] Working on morbidly obese patient, n=155 with an average BMI of 45kg/m^2 who had laparoscopic bariatric surgery, Altun et al in 2010 reported minor complications including extra-peritoneal insufflations (five patients), gastric serosal laceration (one patient) and left liver lobe laceration (one Patient).[24] They concluded that DTI was quick and safe for initial access to the peritoneal cavity in bariatric patients.[24]

Some other studies have suggested that the open technique is superior to DTI and VN as less major complications were recorded.[25][26]

Whatever the access technique chosen, it is imperative that it is performed by a skilled and experienced laparoscopic surgeon working in a dedicated and motivated team. The value of continuing education cannot be over emphasized. It is also important that the surgeon is acquainted with the instruments and technologies involved in the various access techniques, of which DTI is a very plausible option as one technique may become indicated where another is contraindicated.

Conclusions

There are various access techniques in laparoscopic surgery including DTI.

Direct trocar insertion is easy to perform, fast, has a high success rate and a low rate of complications. It is at least as good as, and is a very good alternative to other standard entry/insufflations techniques.

It should be made clear that no technique has been scientifically proven to be superior to another and we will need more studies especially randomized controlled trials and meta analyses to prove what is factual for now, wrong in the future

Clinical Significance

The significance of this study is that surgeons, especially general surgeons should be aware and familiar with the technique of DTI as well as its benefits so that it can become a tool in the armamentarium of the surgeon.

References

1. Ahmad G, O'Flynn H, Duffy JM, Phillips K, Watson A. Laparoscopic entry techniques. Cochrance Database Syst Rev. 2012; 15; (2)

2. Viols GA, Ternamian A, Dempster J, Laberge PY. Society of Obstetricians and Gynaecologists of Canada. Laparoscopic entry: a review of techniques, technologies, and complications. *J Obstet Gynaecol Can*. 2007; **29**(5):433-65

3. Pasic RP, Kantardzic M, Templeman C, Levine RL. Insufflation techniques in gynecologic laparoscopy. *Surg Laparosc Endosc Percutan Tech.* 2006; **16**(1):18-23.

4. Milat B. Open Pneumoperitoneum for the sake of Quality Assurance. *J Chir (Paris).* 2005; **142**(6):344-7.

5. Cakir T, Tuney D, Esmaeilzadem S, Aktan AO. Safe Veress needle insertion. *J Hepatabiliary Pancreat Surg.* 2006; **13**(3):225-7.

6. Tinelli A, Malvasi A, Mynbaev OA. Bladeless Direct Optical Trocar Insertion in Laparospic Procedures on the Obese Patient. JSLS: *Journal of the Society of Laparoendoscopic Surgeons.* 2013; *17*(4):521-528.

7. Krishnakumar S, Tambe P. Entry Complications in Laparoscopic Surgery. *Journal of Gynecological Endoscopy and Surgery*. 2009;**1**(1):4-11

8. Deffieux X, Ballester M, Collinet P, Fauconnier A, Pierre F. Risks association with laparoscopic entry: guidelines for clinical practice from the French College of Gynaecologists and Obstetricans. *Eur J Obstet Gynecol Reprod Biol.* 2011; **158**(2):159-66. Epub 2011 May 31.

9. Usal H, Sayad P, Hayek N. Major vascular injuries during Laparoscopic cholecystectomy. An institutional review of experience with 2589 procedures and literature review. *Surg Endosc.* 1998 ; **12**(7):960-2.

10. Christensen JG, Achiam MP. Retroperitoneal haematoma as a complication at the beginning of a Laparoscopic operation. *Ugeskr Laeger.* 2015 ; **177**(2A):98-9.

11. Dingfelder JR. Direct Laporoscope trocar insertion without prior pneumoperitoneum. *J Reprod Med.* 1978; **21**(1):45-7

12. Copeland C, Wing R, Huka JF. Direct trocar insertion at Laparoscopy: an evaluation. *Obstet Gynecol.* 1983; **62**:665-66.

13. Agresta F, Mazzarolo G, Bedin N. Direct Trocar Insertion at Laparoscopy. *Journal of the Society of laparoenendoscopic Surgeons.* 2012; **16**(2):255-259.

14. Theoderopoulou K, Lethaby DR, Bradpiece HA, Lo TL, Parihar A. Direct Trocar Insertion Techniques: an alternative for creation of pneumoperitoneum. JSLS: *Journal of the society of laparoendoscopic surgeons.* 2008; **12**(2):156-158.