Laparoscopic entry Techniques complications and recommendations for prevention of laparoscopic injury

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Abstract

Objective: To review different laparoscopic techniques and their associated complications and to provide clinical direction to the best practice based on the best available evidence.

Method; Medline, Pubmed, and Cochrane Databases were searched for English language articles published before June 2007.

Keywords: Primary access, Pneumoperionium, open access (Hasson) direct trocar, shielded trocar, laparoscopic complications, visual entry.

Conclusion: It is an evidence-based fact that minimal access surgery is superior to conventional open surgery. It is beneficial to patient, healthcare system and community. Over the past 50 years different techniques, technologies and evidence-based guidelines have been introduced to eliminate the risk associated with laparoscopic entry. No single technique or instrument has been proved to eliminate laparoscopic entry associated injury. Proper evaluation of the patient, supported by good surgical skills and reasonably good knowledge of the technology of the instruments remain to be the cornerstone for safe access and success in minimal access surgery .

Introduction

The word laparoscopy originated from the Greek word (Lapro-abdomen, scorpion-to examine). Laparoscopy is the art of examining the abdominal cavity and its content. This is achieved by sufficiently distending the abdominal cavity (pneumoperitonium) and visualizing the abdominal contents using illuminated telescope. Over the past 50 years rapid advancement in technology in terms of electronics , optical equipments and other ancillary instruments, combined with improved surgical proficiency and expertise, laparoscopic surgery rapidly advanced from a gynaecological procedure for tuba sterilization to one used in performing most of the surgical procedures in all surgical and gynaecological discipline for a variety of indications.

Initially laparoscopic surgery was termed a minimally invasive surgery , but this term was changed to minimal access surgery as laparoscopic surgery is an invasive procedure associated with similar risks of major complications as compared with the conventional open surgery. The major difference between laparoscopic surgery and conventional open surgery is the minimal access to the abdominal cavity ,as the abdominal incision(and its associated complications) is replaced by very small incisions only sufficient to introduce trocar of 5-10mm in diameter. This minimal traumatic insult to the patient, if achieved safely and efficiently the patient postoperative recovery will be shorter with less pain and return to full activity and work in shorter time. This has many advantages to patients , healthcare system and society at large.

It is an evidence based fact that laparoscopic surgery is superior to conventional open surgery in almost most of the surgical pathology that needs surgical intervention.
In meta-analysis of 27 randomized controlled trials comparing laparotomy and laparoscopic access for benign gynaecological procedures, the minor complications rate was 40% lower in laparoscopic surgery than with laparotomy. However the risks for major complications are similar. The efficacy of both procedures was equal [40].

The main challenge facing the laparoscopic surgery is the primary abdominal access , as it is a blind procedure associated with vascular and visceral injuries. It has been proved from studies that 50% of laparoscopic surgery major complications occur prior to the commencement of the surgery[3,8].If there is delay in diagnosis of visceral injuries or delay in reporting by patient the morbidity will increase and may lead to mortality.[9].

Over the past 30 years primary access complications rate has not decreased significantly inspite of the improvement in technology and surgical skills. The Royal College of Obstetricians and gynaecologists –London, conducted a survey in 1978 evaluating the laparoscopic surgery complications. The rate of laparoscopic entry related complications was 3 per 1000[41].In a recent literature review ,the risk of primary access complications in advanced laparoscopic tertiary centre was 1.0 per 1000[42].This indicate that in spite of the improvement in the technology and experience, primary access was decreased but not completely eliminated.

Several techniques and technologies have been introduced over the past 50 years to minimize laparoscopic related injuries. These will be analysed and discussed in this literature review. These include closed technique(Veress needle pneumopertonium ,trocar/cannula system).Open (Hasson) technique. Direct trocar insertion without prior pneumoperitonium. The use of shielded disposable trocars.Optical Veress needle and optical trocar. Radically expanding trocar and the trocarless, reusable visual access cannula.

Incidence of laparoscopic entry complications

In Finland after 70,607 laparoscopic procedure performed, 256 complications were reported to the national patient insurance association. The overall rate of major complications was 1.4 per1000 procedures. This includes 0.6 per 1000 intestinal injury, 0.3 per 1000 urological injuries and 0.1 per 1000 vascular injuries.[41].

In Netherland a multicentre prospective study from 72 hospitals, the overall incidence of cases of intestinal injuries of major complications was 5.7 per 1000 procedure. 70% of these were related to the primary port entry[42].

The overall incidence of laparoscopic entry injuries in the Dutch study was 3.3 per 1000 . There were 29 cases of gastro-intestinal damage. (13 per 1000). 27 cases of abdominal vessels injuries (1.05 per 1000)[41].

In United Kingdom there has not been a recent study reviewing the incidence of all laparoscopic surgery complications .The result of a prospective observational study of all gynaecological laparoscopic procedures performed by all grade of staff in a teaching hospital over a period of twelve months showed an incidence of 3 per 1000 laparoscopic entry related injuries[43]

A prospective study of 1265 cases underwent major pelvic surgery performed in advanced gynaecological surgery centre in Australia ,the overall incidence of complications was 6 per 1000. 50 % of complications were related to Laparoscopic entry [44].

In the united states a review of 51 publications including 21,547 open technique,16,739 direct entry technique and 134,917 Veress/ trocar reported entry related bowel injury).11%(open),o,o5% (direct entry) and0.04% (Veress/trocar). Corresponding vascular injury rate were 0.01%, 0 .0 % and 0.04% respectively[36].

Laparoscopic entry techniques

Closed entry (classic) laparoscopy

This technique involves incising the skin at the base of the umbilicus either vertically or transversely. This is followed by insertion of Veress needle and insufflations of C02 into the peritoneum cavity(pneumopertonium). A sharp trocar / cannula system is introduced into the abdomen through the umbilical incison.The sharp trocar is removed and illuminated telescope is introduced through the cannula. This allows the abdominal cavity to visualized and examined. The first laparoscopy was performed by Jacobeus of Sweden in 1925[7].

Veress needle and pneumoperitonium

Veress needle was first popularized by Roal Palmer of France 1947[5]. The creation of pneumoperitonium remains an essential step of successful laparoscopic surgery. Being a blind procedure it is associated with injury to the vascular and visceral contents of the peritoneal cavity .It is the most popular technique used by most of the laparoscopic surgeons worldwide to achieve pneumoperitoneum.
There are many sites for insertion for Veress needle to achieve peumoperitonium. In the usual circumstances in a patient with an average BMI and no history of previous or suspected intra-pertoneal adhesions , the Veress needle is inserted through an incision at the base of the umbilicus.
In obese patient with BMI >30 or patient with history of previous midline incision, or failed pneumopertonium after three attempts alternative site for Veress needle insertion may be thought.
The second common site for insertion of Veress needle is the Palmer's point.Palmer`s point lies 3 cm below the left costal border in the mid-clavicular line[5].This technique is recommended for obese or very thin patient, patient with history of previous midline surgery or suspected intraperitoneal adhesions, or failure to achieve pneumoperitonium after three attempts. It is essential to decompress the stomach using nasogastric tube suction. This technique should be avoided in patient known to have hepato-splenomegally, history of previous gastric or splenic surgery or palapable gastro-pancreatic mass[12].
A 5-millimeter telescope can be introduced at the same site of Veress needle visualize the peri-umblical adhesions ,then a 10 mm trocar can be introduced under direct vision , followed by additional trocar/cannula system inserted under direct vision as required .

Other sites that have been used for pneumopertoneum include trans-uterine and trans-cul-de-sac. These techniques had been used in the past by gynaecologists to achieve pneumoperitoneum in obese patients[17,18].These two sites are not recommended as they carry the risk of sepsis and the risk of perforation of the rectum in the presence of pelvic inflammatory disease(PID) or severe endometriosis.[19,20].

For optimal and safe pneumoperitoneum initially the patient should be lying flat. The abdomen should be palpated for palpable masses. The sacral promontory should be palpated as the aortic bifurcation is very close to the sacral promontory, this is especially important in very thin patient with android pelvis.
The angle of insertion of the Veress needle in relation to the skin varies according to the patient BMI. An study to localize the position of the umbilicus in relation to the bifurcation of the aorta using computerized axial tomography(CT), the location of the umbilicus varied from 0.4cm ,2.4 cm and 2.9 cm in average, overweight and obese patient respectively[11].Based on these results the Veress needle should be introduced perpendicular to the skin of the umbilicus in obese patient and at 45 degrees toward the hollow of the sacrum in thin patient.
It is recommended not to the Veress needle after entry into the peritoneum cavity as this will enlarge a puncture to a vessel or bowel from 1.6mm to 1cm in diameter.

Veress needle safety tests

Several tests have been recommended to ascertain correct placement of Veress needle in the peritoneal cavity. These include The double click sound of the Veress needle test, the aspiration test ,the hanging drop of saline test, and the syringe test[10].
A recent retrospective study evaluating these four tests reported that non of four tests proved confirmatory for the intraperitoneal placement of the Veress needle and concluded that the most valuable test is to observe actual insufflation pressure (intra-peritoneal) to be 8 mm Hg or less, and the gas is flowing freely[23].

There is an existing controversy regarding the optimal or sufficient pneumoperitoneum to be achieved prior to the insertion of the of the primary trocar. Traditionally it has been defined as achieving volume of 1-4 litres depending on the BMI of the patient and the parity in case of female patient, this is usually achieved by an intra-peritoneal pressure of 10 -15 mm Hg[24]. It has been shown that achieving high intra-peritoneal pressure entry(HIP entry) ranging from 20 - 25 mm hg will increase the gas bubble and produce greater splinting of the anterior abdominal wall and increase the distance between the umbilicus and bifurcation of the aorta from 0.6cm (at pressure of 12 mm Hg) to 5.9 cm. this will allow easy entry of the primary trocar and minimize the risk of vascular injury[24].
The high pressure entry technique is recommended by Royal college of Obstetricians and gynaecologists-London (RCOG) and Canadian Society of Obsetricians and Gynaecologists(SOGC)[10,33].

New modifications to the Veress needle have been introduced to minimize Veress needle associated injury. These include pressure sensor equipped Veress needle, optical Veress needle. However none of these new modifications has been proved to be superior to the classic Veress needle and eliminated Veress needle related injury. Controlled randomized trials are recommended to ascertain their safety and justify their extra cost [15].

Hasson (open) entry technique

This technique was first described by Harrith Hasson in 1971.When first reported his technique Hasson claimed that his technique avoids Veress needle pnemoperitoneum and it is associated complications (gas embolism and vascular injury)[34]. This technique involves incising the fascial layer and holding its edges by two lateral stay sutures, these will be used to stabilize the cannula. This will seal the abdominal wall incision to the coned- shape sleeve. The telescope is introduced and insufflation. commenced after visualising omentum and bowel

Long standing controversy remains about the optimal primary access technique. Some authorities believe that Hasson open technique is superior to the classic closed entry technique defending their views in that it is faster, eliminate the risk of gas embolism ,and significantly reduces the vascular and bowel injuries related to primary access. However there is conflicting evidence between different studies and there is no unified opinion regarding this issue.

Hasson reviewed 19 publications in which closed entry technique was used by surgeons and gynaecologists. The total number of laparoscopic operations performed was 660,110. These were compared with 17 publications where the open technique was used . The total number of operations performed was 579,510. The incidence of complications in the open laparoscopy group were as follows: umbilical infection 0.4 %,bowel injury 0.1% ,and vascular injury 0.0%. The corresponding complications rate for closed laparoscopy were 0.2%, 0.1% and 0.2% respectively[25].-

A meta-analysis of 760,890 closed laparoscopy and 22,465 open laparoscopy reported the incidence of vascular injury rate in closed laparoscopy was 0.44% compared with 0% in open laparoscopy. The incidence of bowel injury 0.7% compared with 0.5% respectively. The authors concluded that the open (Hasson) technique eliminate the risk of vascular injury and gas embolism and reduces the risk of bowel injury and recommend the open technique to be adopted for primary laparoscopic entry[44].

Direct trocar entry technique

This technique was introduced by Dingerfield in 1978. In his first publication he suggested the advantages of his technique which eliminates Veress needle complications ,these include failed pneumoperitoneum ,preperitoneal insufflation and gas embolism. It is fast as it is a one step pneumoperitoneum. However being a blind procedure it does not eliminate the risk of bowel and vascular injuries .[45,46,47].

Several studies were published stressing on safety of this method and recommending it is use for primary access. Most of these studies were retrospective, only few studies were prospective. A retrospective review of 51 publications comparing the entry related complications with the closed(Veress /trocar technique, open and direct trocar technique. Entry related bowel injury rate were 0.04% (Veress/trocar), 0.11% (open) ,and 0.05% (direct). The corresponding vascular injury rate were 0.04%, 0.01% and 0% respectively[36].

From the above studies there is no clear evidence as to the optimal form of laparoscopy entry in low risk patient and it depend on the surgeon preference and experience with the individual technique.

Disposable shielded trocar

Disposable shielded " safety" trocar when first introduced to the market in 1984, the manufacturer claimed that this trocar system works in a way that the sharp tip is and only becomes active and gets exposed when it encounter resistance through the abdominal wall. As it enters the abdominal cavity the sharp edge retract and the shield springs forward and cover the sharp tip of the trocar and the manufacturer wrote in the commercial label "safety" trocars.These trocars were intended to avoid contact of the end of the trocar with the intra-abdominal content. However it must be pointed out that even when this trocar was introduced correctly according to the recommended specification ,there will be a moment when this trocar enter the peritoneal

cavity and before its retraction ,it will be in contact with abdominal content. This brief moment is sufficient to produce injury especially with its very sharp end. Disposable trocars require half the force required to introduce the classic reusable trocars.
A retrospective study of 103852 laparoscopy entry used the disposable shielded trocars and classic trocars showed the ,shielded trocars were responsible for 30% of serious injuries caused by laparoscopic entry, and two deaths out of seven deaths caused by laparoscopic entry injury[31].

Many studies were done and all disputed the complete safety of these trocars. As it is very popular in the united states , most of these studies were published in the United States, this led the FDA to directly write to the manufacturers of shielded laparoscopic trocars requested that in the absence of clinical data showing reduced incidence of injuries, manufacturers and distributors voluntary eliminate safety claims from the label of shielded trocars[32].

Visual entry systems

This include the disposable optic trocars and the endo TIP visual cannula. These new technology aims to optimize the laparoscopic entry by facilitating entry under direct vision. Controlled randomized trials are required to assess their safety and proof their superiority to the traditional Veress needle and trocar /cannula system in order to justify their expensive cost.

Recommendations

Assessment, counselling and consent

Patient must be properly evaluated ,this include full clinical history and thorough clinical examination and relevant investigations. The patient must be informed of the associated risks and potential complications associated with laparoscopic surgery and the possibility of conversion to laparoscopy if the clinical circumstances dictate that.

The surgeon must have adequate training and experience in laparoscopic surgery before intending to perform any procedure independently. He should be familiar with the equipment ,instrument and energy source he intend to use.

There is no safe technique that reduces laparoscopic surgical complications associated with laparoscopic entry in low risk patients. The surgeon should select the technique he feels he is performing safely, however it is recommended to use the pressure entry (20-25mm Hg) to optimize insertion of the primary trocar and cannula.

The open (Hasson) technique and Palmer's point pneumopertonium should be considered in obese patient and patient with suspected peri-umbilical adhesions .

The different Veress needle safety tests provide are not sensitive indicators to the correct placement of the Veress needle. The most confirmatory test is to observe the actual intra-peritoneal pressure to be below 8 mmHg and the gas flowing freely. Excessive movement of the needle should be avoided as this will convert a tiny puncture to vessel or bowel from 1.6mm to 1.0 cm in diameter.

The distension pressure should be reduced to12 -14 mm Hg , once the insertion of the trocar is complete. This avoids cardio-pulmonary complications, the most serious is gas embolism.

Once the laparoscopy has been introduced into the abdominal cavity ,the bowel should be inspected for obvious injury and to check for any adherent bowel around the umbilicus.

Conclusion

It is an evidence-based fact that minimal access surgery is superior to conventional open surgery. It is beneficial to patient, healthcare system and community. Over the past 50 years different techniques ,technologies and evidence-based guidelines have been introduced to eliminate the risks associated with laparoscopic entry. No single technique or instrument has been proved to eliminate laparoscopic entry associated injury. Proper evaluation of the patient, supported by good surgical skills and reasonably good knowledge of the technology of the instruments remain to be the cornerstone for safe access and success in minimal access surgery.

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