

Risk of Pneumoperitoneum in Obese: Old Myths and New Realities

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ABSTRACT

Objective: To provide an overview of difficulties encountered during laparoscopic entries in obese patients and the contemporary methods used to establish the safest possible laparoscopic entry in obese.

Methods: Twenty-six articles related to laparoscopy procedures, in general, and associated difficulties in obese patient, in particular, were examined.

Results: Obesity imposes a challenge for the minimal access surgery procedures; particularly those related to the primary access of peritoneal cavity. However, closed and open peritoneal entry using blunt or optical instruments, through different sites, have been used to prevent entry failures or possible complications if difficulties are encountered whenever the surgeon cannot safely use his/her preferred entry procedure.

Conclusion: Induction of pneumoperitoneum can be a difficult, time-consuming and occasionally hazardous task in a morbidly obese patient. Different alternatives are possible according to differences in the method of entry, the site or the instruments used. The risk-benefit and the alternative options must be examined individually by the healthcare provider.

Keywords: Laparoscopic entry, Obesity, Complications, Gynecological laparoscopic surgery, Pneumoperitoneum, Veress needle.

INTRODUCTION

Overweight and obesity are both labels for ranges of weight that are greater than what is generally considered healthy for a given height. The weight and height are used to calculate the body mass index (BMI), which correlates with the amount of the body fat.¹

Obesity is an ever-increasing problem. It is now considered an epidemic in the United States. According to a study from the Center for Disease Control and Prevention, 30.5% of Americans are considered obese with a body mass index (BMI) greater than 30 kg/m², and 4.7% of Americans are considered morbidly obese (BMI 40).² Prevalence of obesity in India is up to 50% in women in the upper strata of the society. In Delhi, the prevalence of obesity stands at 33.4 % in women.³

The prevalence of obesity in USA and throughout the industrialized world is such that the practicing surgeon cannot reasonably expect to avert its many implications for patient care.⁴

Laparoscopic surgery has developed rapidly over the last few years, and many surgical procedures formerly carried out through large abdominal incisions are now performed laparoscopically. Laparoscopic techniques have revolutionized the field of surgery with benefits that include decreased postoperative pain, earlier return to normal activities following surgery and fewer postoperative complications (e.g. wound infection, hernia).⁵

Reduction of the trauma of access by avoidance of large wounds has been the driving force for such development.⁶ However, the insertion of needles and trocars necessary for the pneumoperitoneum and the performance of the procedure are

not without risk.⁷ The technical modifications imposed by surgical laparoscopy are obvious (e.g. number and size of trocars, location of insertion sites, specimen retrieval), and therefore morbidity may be substantially modified. Complications such as retroperitoneal vascular injury, intestinal perforation, wound herniation, wound infection, abdominal wall hematoma, and trocar site metastasis have been reported.⁸

Laparoscopic surgery may be of particular benefit to obese patients for prevention of postlaparotomy complications.⁹ Nevertheless, in women who are overweight, and even more so in those who are obese, every aspect of laparoscopy becomes more difficult and potentially more risky. Placement of laparoscopic instruments becomes much more difficult and often requires special techniques. Bleeding from abdominal wall vessels may become more common since these vessels become difficult to locate. Many intra-abdominal procedures become increasingly difficult because of a restricted operative field secondary to retroperitoneal fat deposits in the pelvic sidewalls and increased bowel excursion into the operative field. This second problem probably is related to increased volume of bowel, decreased elevation of a heavier anterior abdominal wall by the pneumoperitoneum, and the inability to place many obese patients in steep trendelenburg because of ventilation considerations.¹⁰ Unique complications are associated with gaining access to the abdomen for laparoscopic surgery, resulting in an inadvertent injury to the internal organs.⁵

Generally, laparoscopic surgery has a complication rate of 5.7 per 1000; about one-half of these complications are associated with initial entry into the peritoneal cavity and this happens within the first few minutes of the laparoscopic

procedure.¹¹ The frequency of entry complications reported in the international literature is very low (1-3%). The most serious complications may be life-threatening, but are very rare with the incidence of major vascular perforation reported as being 0.9 per 1000 procedures and the incidence of bowel perforation reported as being 1.8 per 1000 procedures.¹² Even if the reported prevalence is very low, the mortality rate arising from these lesions reportedly ranges between 8 and 17%.¹³

Challenges with the Laparoscopic Entry Techniques in Obese

Although abdominal thickness correlates with patient weight, short stature or truncal obesity may increase abdominal wall thickness out of proportion to patient weight. Routine evaluation of the abdominal wall prior to laparoscopy is important because the success of trocar insertion may depend on altering the technique based on abdominal wall thickness.⁷

Standard gynecologic laparoscopic entry is through the umbilicus. Blindly passing a sharp Veress needle, insufflating, and then blindly passing a sharp trocar is the traditional technique for laparoscopic entry. Although it has been suggested that the angle of Veress needle entry should vary between 45° and 90° according to the BMI of the patient, it is reasonable to state that, for obese, a controlled 90° angle entry of the Veress needle with insertion of not more than 2 cm of the needle tip with selective umbilical stabilization or elevation of the abdominal wall is the safest route of Veress needle insertion for the vast majority of cases.¹² The angle of insertion is more critical as the adipose layer limits free rotational movement of working ports. Patients who are grossly obese are at a significantly greater risk of complications when undergoing laparoscopic surgery. In most women, the aortic bifurcation rests between the 4th and 5th lumbar vertebrae, or within 1.25 cm above or below a line drawn between the iliac crests. Nevertheless, due to anatomic variation it may be located either above or below these disk spaces. The umbilicus is most commonly located between the 3rd and 4th lumbar vertebrae. However, this relationship is quite variable. The position of the umbilicus relative to the aortic bifurcation is negatively correlated with body mass; it more commonly rests caudal to the bifurcation in overweight and very obese women.¹⁴ If a Veress needle approach is used in the patient who is morbidly obese, an ultralong Veress needle may assist, also it is important to make the vertical incision as deep as possible in the base of the umbilicus, since this is the area where skin, deep fascia and parietal peritoneum of the anterior abdominal wall will meet. In this area, there is little opportunity for the parietal peritoneum to tent away from the Veress needle and allow preperitoneal insufflation and surgical emphysema. If the needle is inserted vertically, the mean distance from the lower margin of the umbilicus to the peritoneum is 6 cm (± 3 cm). This allows placement of a standard length needle even in extremely obese

women. Insertion at 45°, even from within the umbilicus, means that the needle has to traverse distances of 11 to 16 cm, which is too long for a standard Veress needle.⁷ Using MRI and CAT scans (on unanesthetized women in the supine position) to measure the thickness of the abdominal wall and critical distances to the great vessels. Hurd et al reported that the position of the umbilicus was found, on average, 0.4, 2.4 and 2.9 cm caudally to the aortic bifurcation in normal weight (BMI < 25 kg/m²), overweight (BMI 25-30 kg/m²) and obese (BMI > 30 kg/m²) women respectively (Fig. 1). In all cases, the umbilicus was cephalad toward the left common.

Iliac vein crossed the midline at the sacral promontory. Preperitoneal placement and vascular injury with a standard Veress needle (11.5 cm in length) is least likely using the standard approach in nonobese women. In the overweight patient, however, similar outcomes require modifying the point of needle insertion to the base of the umbilicus. Preperitoneal insufflation is least likely to occur in very obese women only if the needle is placed through the base of the umbilicus at a 90° angle. The fact that the umbilicus is usually caudal to the bifurcation in this weight group helps support the relative safety of this modified approach.^{14,15}

Moreover, the saline drop test should be used to confirm intraperitoneal Veress needle placement. Entry related complications may be reduced by filling the peritoneal cavity with carbon dioxide (CO₂) to a predetermined pressure level rather than to a preset volume. Trocars may be placed angled towards the operation site to avoid torquing the instruments. They can be sutured in place to prevent slippage and longer cannulas should be used. Finally, long instruments and extra ports along with routine bowel preparation will improve bowel manipulation, decrease bowel excursion into the operative field and ultimately better visualization.¹⁶

Alternative methods of entry for insufflation may be required when faced with the very obese patient or when conventional methods are contraindicated or fail to produce an adequate pneumoperitoneum. Accordingly, the initial entry can also be performed through other sites in the abdominal wall, as 9th or 10th intercostal space or upper-left quadrant insertion site

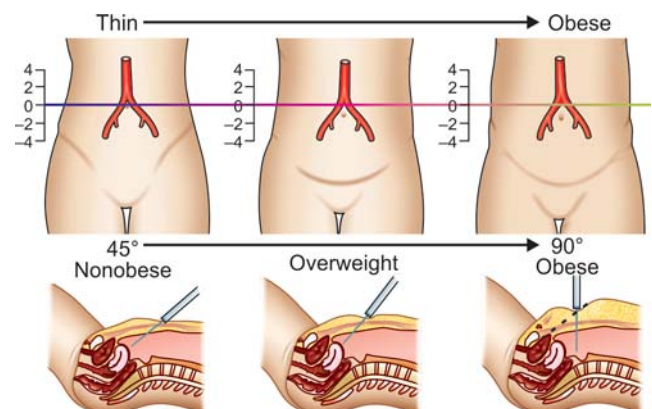


Fig.1: Effect of obesity on location of great vessels

(Palmer's point). Percutaneous induction of a pneumoperitoneum with the Veress needle in the left upper quadrant is a safe and effective technique in morbidly obese patients.¹⁷

Other approaches have been advocated as suprapubic entry, and access through the natural orifices as uterus or posterior vaginal fornix (cul-de-sac) by using a long Veress needle (17 cm).^{11,15} The technique of vaginal approach should not be used in the presence of a cul-de-sac mass, severe rectovaginal endometriosis, fixed uterine retroversion, or whenever vaginal vault surgery has been performed. Regarding uterine approach, it has been found that the safety is maximized by directing this step with the aid of intraoperative sonography. This technique should not be used in the presence of leiomyomata, possible pelvic infection or pregnancy, and whenever there is a risk of adhesions between the bowel and fundus of the uterus (e.g. prior myomectomy or hysterotomy).¹⁴

On the other hand, it is generally recommended that an open (Hasson) technique should be performed for primary entry in patients who are morbidly obese, although even this technique may be difficult.⁷

Optical access trocars have been first introduced in 1994, and developed as an alternative method of peritoneal entry to decrease the risk of injury to intra-abdominal organs. The theoretical advantage of these trocars is that each layer can be identified prior to transection.^{7, 18}

Obesity had generally been thought to increase the risk of laparoscopic surgery.⁴ Primary prevention of entry complications is beneficial to the patient, the treating physician and the society, given the negative health implications, the fear and costs of litigation and the negative economic impact on the health care budget.¹²

METHODOLOGY

The study was carried out through a literature search from the electronic library using the following search engines: Google, Springer online, PubMed and other linked references. Publications used were searched by using relevant combinations of medical subject headings (laparoscopy; obesity; gynecological surgical procedures; intraoperative complications; postoperative complications) and free text words. The literatures were critically appraised according to a standardized grading scheme used by the RCOG.

Findings

Technical obstacles associated with open pelvic surgery in the obese are primarily those related to exposure of the operative field and access to deep pelvic structures. These obstacles present similar challenges when laparoscopy is attempted, as have been previously described.^{19,20} Loffer and Pent discussed at length the additional, unique difficulty of establishing pneumoperitoneum in obese patients. Together, all of these limitations place the obese patient undergoing laparoscopy at

an inherently increased risk of conversion to laparotomy, as confirmed by several authors. In a subsequent review of 2,530 attempted gynecologic laparoscopic surgeries, Sokol et al determined that a BMI greater than 30 kg/m² placed patients at a more than two-fold risk of unintended laparotomy. Eltabbakh et al noted similar findings in a review of 47 obese patients who underwent operative gynecologic laparoscopies.

Despite these challenges, a laparoscopic approach is well suited to the obese patient, who is inherently less mobile and, therefore, more susceptible to thromboembolic events and suboptimal wound healing following laparotomy. One randomized, prospective trial comparing outcomes of laparoscopic with abdominal hysterectomy found less operative blood loss, less postoperative pain, and shorter hospital and convalescence times for patients undergoing laparoscopic hysterectomy. These same authors concluded that total laparoscopic hysterectomy may afford significant benefit to society in the form of indirect costs related to recovery time, when compared with abdominal hysterectomy.⁴

Jansen et al in a study on 25,764 patients found that 83 of 145 complications were related to primary access.²¹ Similarly, Champault et al in a French survey of 1,03,852 laparoscopic operations found that 83% of vascular injury, 75% of bowel injury and 50% of local hemorrhage were caused during primary trocar insertion.²² The impact of Veress needle injury has been highlighted in another big literature review. Thirty-eight selected articles included 6,96,502 laparoscopies with 1,575 injuries (0.23%), 126 (8%) of which involved blood vessels or hollow viscera (0.018% of all laparoscopies). Of the 98 vascular injuries, 8 (8.1%) were injuries to major retroperitoneal vessels. There were 34 other reported retroperitoneal injuries, but the authors were not specific as to which vessel was injured. Of the 28 injuries to hollow viscera, 17 were considered major injuries, i.e. 60.7% (0.0024% of the total cases assessed).¹³

In an attempt to facilitate access to peritoneal cavity in obese patient which can help in decreasing the entry complications; Phillips et al²³ reported a peritoneal hyperdistention to 25 mm Hg as against 12 to 15 mm Hg, noting that a downward force of 3 kg umbilically with an intra-abdominal distension pressure of 10 mm Hg resulted in a distance of only 0.6 cm between the trocar and abdominal contents. However, this distance increased to 5.6 cm with insufflation pressure of 25 mm Hg. Reich et al reported no specific or vascular complications in 3,041 cases using this technique. Tsaltas et al, in 1150 consecutive operative laparoscopies using the 25 mm Hg hyperdistention technique, similarly reported no entry complications or adverse clinical events.

Prediction of laparoscopy outcome in obese patient had been made by Lamvu et al through a Tilt Test, which involves placing the patient in steep trendelenburg for 2 to 5 minutes following intubation and positioning, observing the patient's cardiac and respiratory indices. Patients who remain

normotensive and maintain respiratory pressures at 30 to 40 mm Hg during the Tilt test before and after insufflation are very likely to have a positive clinical result.¹⁶

The role of alternative peritoneal access has been evaluated by a retrospective review of 918 insufflations through the 9th intercostal space which found one entry into the stomach and one into the pleural space (causing a pneumothorax) by the Veress needle.

Transuterine Veress CO₂ insufflation using a long Veress needle for pneumoperitoneum has been found to be especially helpful in obese women. In one study of 138 women weighing 250 to 400 lbs, failure to establish pneumoperitoneum occurred in 13.8% (5/36) through the umbilicus, in 3.6% (3/83) through the uterus, in 8.3% (1/12) subcostally and in 28.6% (2/7) through the open (Hasson) technique. A prospective randomized study compared the conventional infraumbilical route with a transuterine route in 100 overweight and obese women (BMI > 25 kg/m²) in establishing pneumoperitoneum. In the infraumbilical group, pneumoperitoneum was achieved at a ratio (punctures/pneumoperitoneum) of 56/49 (1.14) with one failure, but in the transuterine group the ratio was 53/51 (1.04).¹⁵ Similar results were obtained by Wolfe et al. A Veress needle was inserted through the uterine fundus to establish a pneumoperitoneum in 100 women undergoing laparoscopy for sterilization or diagnostic purposes. The transuterine approach was chosen for 86 women because of obesity and for 14 because a previous abdominal insertion had been unsuccessful. There were no complications associated with the transuterine Veress needle placement.²⁴

Several studies on the benefits and complications of the various laparoscopic entry techniques have been published. Hasson reviewed 17 publications of open laparoscopy by general surgeons (9 publications, 7,205 laparoscopies) and gynecologists (8 publications, 13,486 laparoscopies) and compared them with closed laparoscopy performed by general surgeons (7 publications, 90,152 patients) and gynecologists (12 publications, 5,79,510 patients). Hasson reported that for open laparoscopy the rate of umbilical infection was 0.4%, bowel injury 0.1% and vascular injury 0%. Hasson advocated the open technique as the preferred method of access for laparoscopic surgery. Further analysis of Hasson's review suggests that the prospective studies and surveys indicate that general surgeons experience higher complication rates than gynecologists with the closed technique, but experience similar complication rates with the open technique. Using the closed technique, the visceral and vascular complication rates were 0.22 and 0.04% for general surgeons, and 0.10 and 0.03% for gynecologists. In a published record of his own 29-year experience with laparoscopy in 5,284 patients, Hasson reports only one bowel injury within the first 50 cases.

The open entry technique may be utilized as an alternative to the Veress needle technique, although the majority of gynecologists prefer the Veress entry. There is no evidence

that the open entry technique is superior to or inferior to the other entry techniques currently available.

The visual entry cannula system may represent an advantage over traditional trocars, as it allows a clear optical entry, but this advantage has not been fully explored. The visual entry cannula trocars have the advantage of minimizing the size of the entry wound and reducing the force necessary for insertion. Visual entry trocars are nonsuperior to other trocars since they do not avoid visceral and vascular injury.¹⁵

To identify which of the various laparoscopic entry techniques is the safest and/or most effective in the obese woman undergoing gynecological laparoscopic surgery, Sarah and Josette (2008) reviewed seven individual studies (Fig 2), with a total target population of 461 obese women, BMI across selected studies ranging between 28 and 44 (Fig. 3), who underwent five different laparoscopic methods of entry

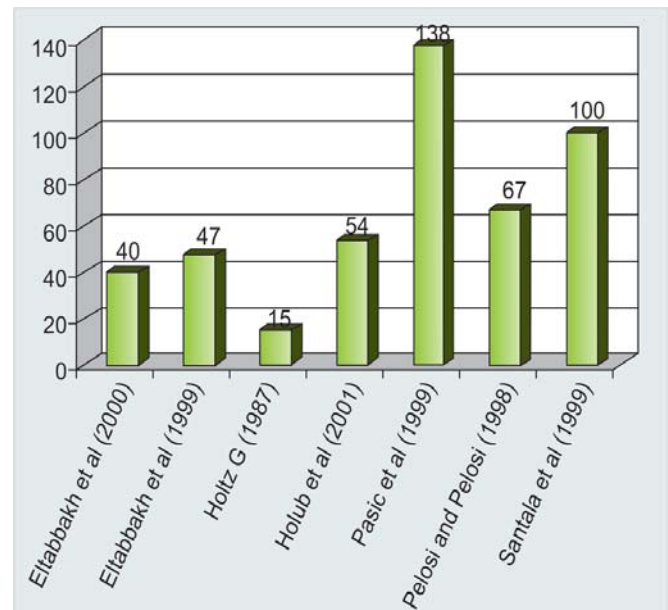


Fig. 2: Number of obese women in selected studies (n = 461)

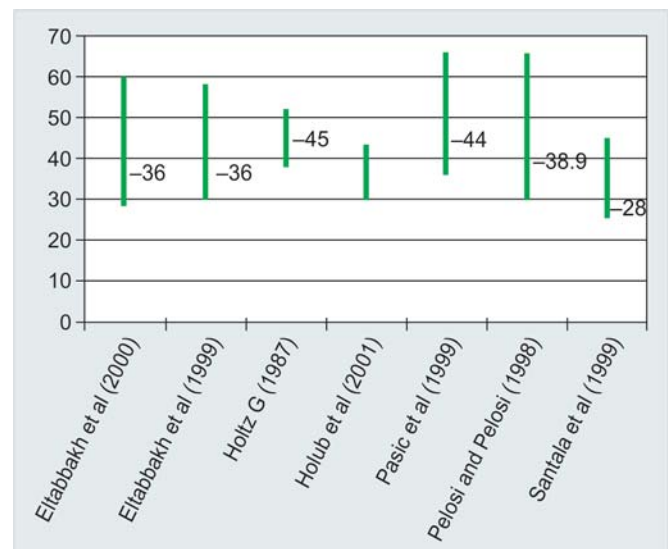


Fig. 3: Range of BMI across selected studies (with mean where possible)

(Fig. 4); they found that the subcostal approach carried the minimal failure rate in comparison to the closed/intraumbilical access (Fig. 5). Failed laparoscopy due to unsuccessful pneumoperitoneum or secondary to it was noticed to be higher with the infraumbilical route (Fig. 6). The major findings of this review were not conclusive in providing decisive evidence that could influence a change in practice from one method of entry to another in the obese woman.²⁵

It has been argued that it is not only the method of entry that matters, proper selection of patients, site of entry, previous abdominal surgery, obesity, expertise of the surgeon are the factors which determine the increased or decreased primary access related complications in laparoscopic surgery. So, it has been concluded that no method of primary access is superior to the other in terms of primary access related complications and the closed primary access is as safe as open access and it is recommended that surgeons must continue with the primary access technique in which they are expert.²⁶

CONCLUSIONS

Laparoscopic surgery in obese patients presents a variety of challenges and potential complications. The traditional view suggested that this approach was unsafe and should be avoided

in such patients. However, as laparoscopic surgery and skills have progressed in recent years, it has become apparent that this approach is safe and effective in many obese patients and indeed has potential advantages over traditional open surgery. Obese patients will continue to present an increasing challenge to laparoscopic surgeons. It is imperative that we understand the dynamics of this condition and develop techniques to deal effectively and safely with such patients.

Gaining safe and accurate access is the first and most important step in achieving a safe and efficient laparoscopic surgery.

Minor technical difficulties are more common among obese women during diagnostic and operative laparoscopy.

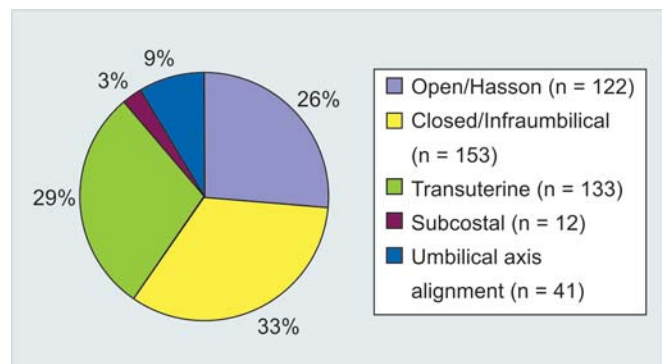


Fig. 4: Percentage of different entry techniques in review from selected papers (n = 461)

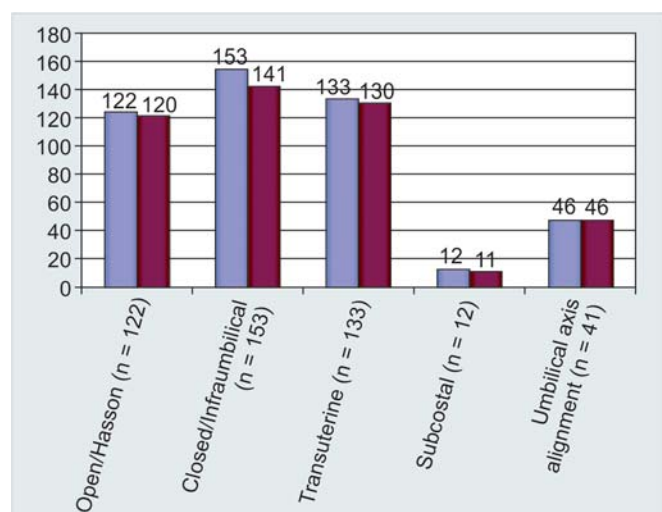


Fig. 5: Number of failed laparoscopies by entry technique

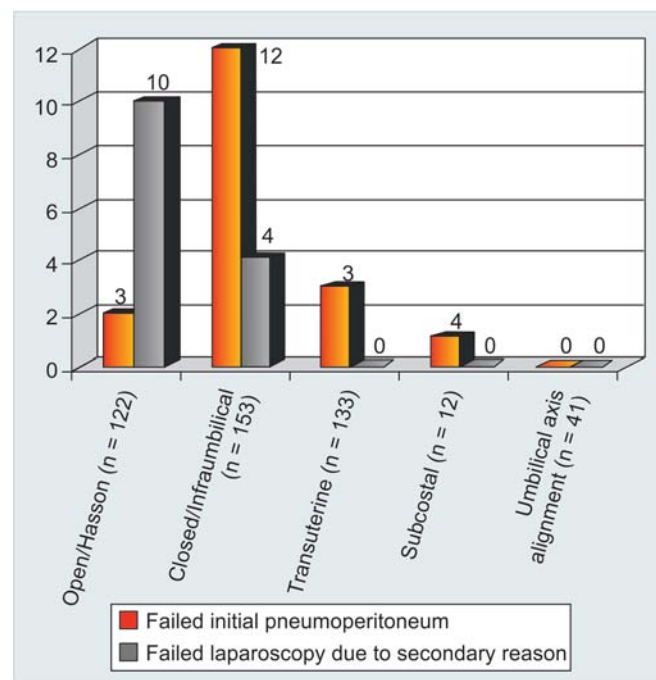


Fig. 6: Failed laparoscopy due to unsuccessful pneumoperitoneum and reasons secondary to pneumoperitoneum

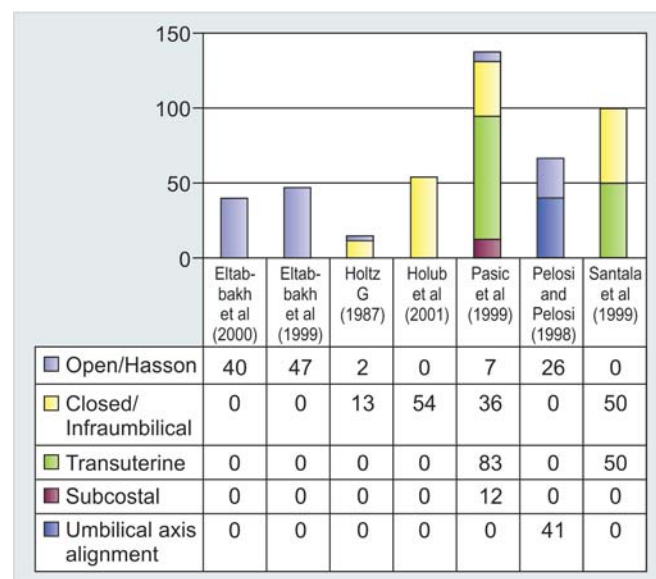


Fig. 7: Number of entry techniques within selected papers

While obesity was considered a relative contraindication to laparoscopy, it should no longer be considered a contraindication to laparoscopic surgery.

RECOMMENDATIONS FOR PRACTICE

On the basis of the available evidence, there appears to be no benefit in terms of safety of one technique over another. No definitive conclusions can be drawn to confirm the relative safety of any particular technique.

In everyday clinical practice, the individual laparoscopic may continue his preferred entry technique. Furthermore, it is recommended that every laparoscopic surgeon requires additional skills in the practice of at least one alternative entry method, site or instrument as a backup in case the preferred method, site or instrument cannot establish an uneventful entry in the abdominal cavity.

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