

# Trocar Configuration in Laparoscopic Hysterectomy for Benign Indications

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## Abstract

Hysterectomy is the most common gynecological surgical procedure worldwide. In recent years, there has been a significant increase in the proportion of hysterectomies performed laparoscopically. Despite attempts to standardize the procedure, there are various approaches available to the surgeon, in terms of number and position of laparoscopic trocars. We have conducted an electronic search on PubMed and, in this article, we present different laparoscopic trocar configurations in order to perform a laparoscopic hysterectomy

**Keywords:** Configuration, hysterectomy, laparoscopy, port, trocar

## INTRODUCTION

Hysterectomy is the most common gynecological surgical procedure with approximately 600,000 hysterectomies being performed annually in the United States.<sup>[1]</sup> In recent years, there has been a significant increase in the proportion of laparoscopic hysterectomies.<sup>[2]</sup> Laparoscopic hysterectomy is associated with quicker return to normal activities compared to abdominal hysterectomy.<sup>[3,4]</sup>

In this article, we present different trocar configuration approaches in order to perform a laparoscopic hysterectomy for benign indications.

## METHODS

We conducted an electronic search on PubMed looking at trocar configuration in laparoscopic hysterectomy for benign indications. The following keywords were used: “hysterectomy,” “trocar,” “port,” “configuration,” and “benign.” Relevant articles were checked for quality and to ensure that they were relevant to the topic. Twenty-four

articles were finally included. We do acknowledge that this list of articles does not include all relevant publications and this can be viewed as a limitation of our paper.

## FIVE-PORT LAPAROSCOPY

Shahid *et al.* described their surgical technique for performing laparoscopic subtotal hysterectomy in patients with a uterine size of 12 weeks of gestation or more, weighing more than 300 g.<sup>[5]</sup> They used a 5-mm port inserted at the Palmer’s point, 2 cm below the costal margin at the left mid-clavicular line, a 0°/5-mm laparoscope, a second 5-mm port placed on the contralateral side, in the right hypochondrium and two other ancillary (5-mm) ports were inserted laterally at the level of the umbilicus depending upon the size of the uterus, above the level of the ovarian ligaments lateral to the epigastric vessels and a 10-mm suprapubic port was placed 4 cm above the pubic symphysis in the midline [Figure 1]. The right side of the procedure was carried out with the laparoscope in the right subcostal

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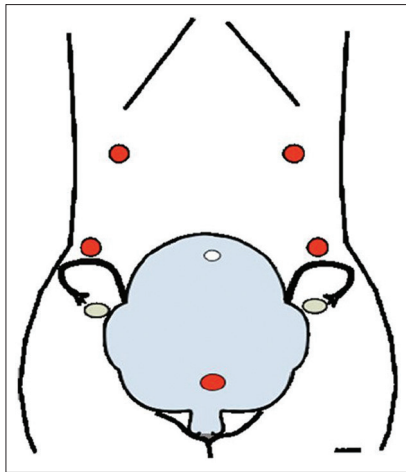
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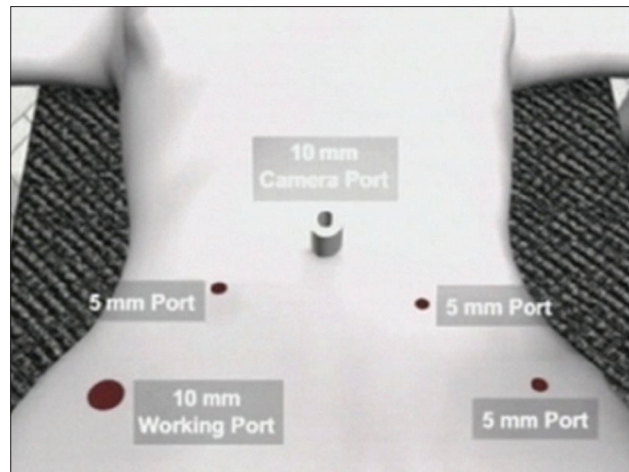
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**Figure 1:** Modified 5-port technique<sup>[5]</sup>

port and the left side was carried out with the laparoscope in the left subcostal port: in 29 patients with median uterine size of 18 weeks gestation, average blood loss was 200 ml, operation time was significantly longer for uteri weighing more than 500 g, no patient needed blood transfusion, there were no cases of conversion to laparotomy, one patient had bladder injury that was repaired laparoscopically, and the mean hospital stay was  $2 \pm 1$  days.

An alternative approach using five ports for laparoscopic hysterectomy was described by Puntambekar *et al.*:<sup>[6]</sup> a 10-mm port was inserted at the umbilicus for the laparoscope (a), a 10-mm port at the right McBurney's point for the surgeon's operating port (b), a 5-mm port at the right mid-clavicular line at the level of the umbilicus for the surgeon's manipulating port (c), a 5-mm port as a mirror image of port (b) for the myoma screw (d) and a 5-mm port as a mirror image of port (c) for manipulation of bladder and bowel (e) [Figure 2]. The primary surgeon stood on the patient's right, the first assistant and person holding the camera stood on the patient's left and the scrub nurse to the right of the primary surgeon. The operators did not use a vaginal manipulator. Instead, a gauze in the vagina was used to prevent gas leakage. In case of large uteri, morcellation was performed via the 10-mm right port. Laparoscopic suturing of the vault was completed either using the ipsilateral or contralateral technique. 140 patients with benign gynecological pathologies had laparoscopic hysterectomy using the above approach; average surgical time was  $88.75 \pm 52.72$  min, average blood loss was  $53.80 \pm 35.94$  ml, two patients had cystotomy that was repaired laparoscopically at the time of initial surgery, two cases of vaginal tears during delivery of the specimen that was repaired immediately and one case of sigmoid perforation that was repaired intra-operatively, 119 (of 140) patients were discharged within 48-h from surgery.

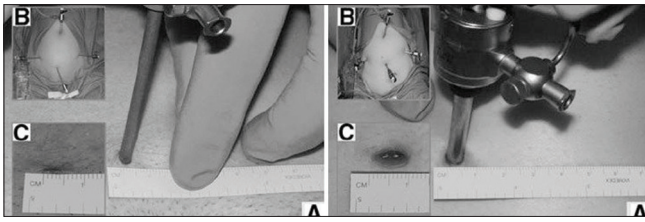


**Figure 2:** Trocar configuration (5 ports) in the technique described by Puntambekar *et al.*<sup>[6]</sup>

#### FOUR-PORT LAPAROSCOPY

This is one of the most common approaches when performing a laparoscopic hysterectomy. One option is to position a 10-mm primary trocar at the umbilical base followed by three, 5-mm, ancillary trocars, one suprapubic and two laterally to the epigastric arteries, in the left and right lower abdominal quadrants, respectively. Ng *et al.* described their 5-year clinical experience with using the above approach for laparoscopic hysterectomy;<sup>[7]</sup> in 512 patients, total laparoscopic hysterectomy was performed successfully in 98.2% of cases. Mean operating time was 133 min, mean blood loss was 309 ml (50–1500) with 20 patients (4%) requiring blood transfusion, mean hospital stay was 2.7 days (1–10), 18 patients (3.6%) were re-admitted and 23 women (4.5%) encountered major complications.

With the same port configuration, one can, alternatively, use a 3-mm or 5-mm umbilical trocar and three, 3-mm ancillary trocars (a technique called needlescopic, or mini-laparoscopic, hysterectomy) [Figure 3]. Ghezzi *et al.* used the above approach to 32 consecutive cases and compared the outcomes with a control group of 54 women who had laparoscopic hysterectomy using 10-mm and 5-mm trocars and the same trocar layout and surgical technique.<sup>[8]</sup> Surgical times and estimated blood loss were similar in both groups, no major complication occurred in either of the groups and only one case of conversion from needlescopic to conventional laparoscopic hysterectomy was needed due to bleeding from the uterine artery. Mini-laparoscopic hysterectomy was first described by Wattiez *et al.* who used a 4-mm trocar directly infra-umbilically, two 3.5-mm trocars in the right and left lower quadrant and one 5-mm port in the median lower abdomen.<sup>[9]</sup> An alternative is the ipsilateral port placement: this involves placement of the primary trocar



**Figure 3:** 4-port configuration for mini-laparoscopic (needlescopic) hysterectomy<sup>[8]</sup>

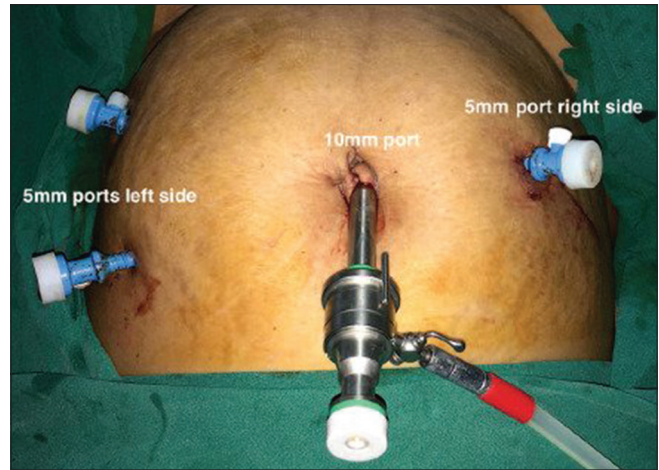
through the umbilicus, two ancillary trocars at the right and left lower quadrant (2 cm above and 2 cm medial to the anterior superior iliac spine) and a fourth trocar placed 8 cm above and parallel to the left lower trocar (in most cases, nearly parallel to the umbilical trocar).<sup>[10]</sup> In case of large uteri, the primary trocar can be placed at the Lee-Huang point, which is between the umbilicus and the xiphoid process,<sup>[11]</sup> and the ancillary trocars can be moved cephalad to facilitate the surgical procedure<sup>[12]</sup> [Figure 4].

### THREE-PORT LAPAROSCOPY

Laparoscopic hysterectomy can be performed with the use of three trocars; this can include a 10-mm umbilical trocar and 25-mm ancillary trocars on the right and left lower quadrant. Zeng *et al.* described their three-port technique for laparoscopic hysterectomy in case of uterine size of 16 weeks gestation or more and weighing more than 800 g:<sup>[13]</sup> this includes positioning of a 10-mm trocar at the umbilical point or upper umbilicus, use of 30° scope, a 10-mm trocar placed 2 cm above the left utero-ovarian ligament after elevating the uterus and a 5-mm trocar placed on the right side following the same rule. They used the above approach in 18 patients who underwent laparoscopic hysterectomy for benign gynecological indications and reported average surgical time of 107 min, no intra-operative complications, no cases needing blood transfusion and no cases of conversion to laparotomy. A randomized-control trial comparing three-port laparoscopic hysterectomy (11-mm camera port at the umbilicus and a 5-mm port at both the left and right lower quadrants) with single-port laparoscopic hysterectomy showed that the three-port approach was associated with shorter operative time and less analgesia requirements in order to achieve the same postoperative pain control.<sup>[14]</sup>

### TWO-PORT LAPAROSCOPY

Tyan *et al.* described their technique of performing laparoscopic hysterectomy for benign indications using 25-mm ports (without the use of any multi-channel ports).<sup>[15]</sup> A direct entry of a 5-mm trocar at the umbilical base was followed by entry of a 5-mm suprapubic port under direct visualisation. A uterine manipulator was used, and the

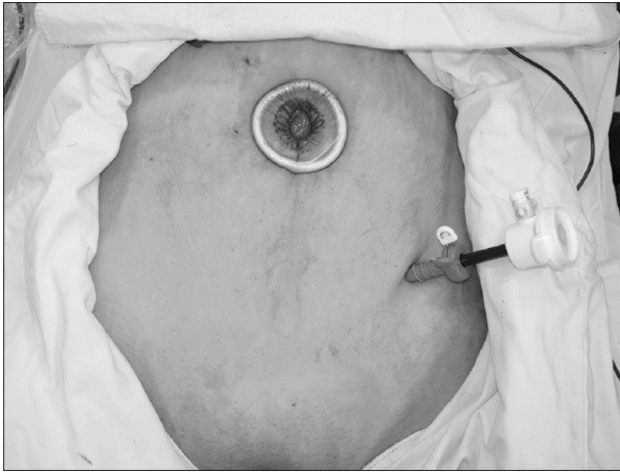


**Figure 4:** Trocar configuration (4 ports) in case of large uterus<sup>[12]</sup>

vaginal cuff closed vaginally. They compared this approach with conventional four-port laparoscopic hysterectomy in a retrospective study (excluding supracervical hysterectomies in both groups) and found no significant difference in terms of estimated blood loss, operative time, complications or length of hospital stay. They concluded that this approach is a safe alternative in case of patients with small uteri and no significant surgical risk factors who require no other intervention at the time of hysterectomy. Yi *et al.* described their technique for performing a two-port laparoscopic hysterectomy using a multi-channel port with an Alexis® wound retractor XS (Applied Medical, Rancho Santa Margarita, CA):<sup>[16]</sup> Pneumoperitoneum was created via a Veress Needle at the umbilical base, a 10-mm trocar was inserted supra-umbilically and the abdomen and pelvis inspected via a 0° laparoscope. A 5-mm trocar was inserted at the left iliac fossa region under vision, the umbilical trocar removed, and skin incision extended by 1.5 cm and the retractor inserted through the extended incision. The wrist portion of a size-6<sup>1/2</sup> rubber glove covered the wound retractor, and two trocars were inserted into the fingers of the glove and ligated with rubber bands. A 10-mm laparoscope and atraumatic forceps were inserted through the umbilical port [Figure 5]. The 5-mm trocar at the left iliac fossa was used as the main port for the procedures. In their series of ten patients, they reported no complications, mean operative time of 135.5 min, estimated blood loss of 350 ml and postoperative stay of 4.3 days. They described the possible limitations of the technique in case of huge uteri and extreme obesity.

### SINGLE-PORT LAPAROSCOPY

Wheless described the first case of single-site laparoscopic sterilization in 1972.<sup>[17]</sup> The first single-site laparoscopic hysterectomy was described by Pelosi *et al.* in 1991.<sup>[18]</sup> The



**Figure 5:** Two-port laparoscopy with use of Alexis® wound retractor XS at the umbilicus<sup>[16]</sup>

procedure involves placement of a multi-channel trocar at the umbilical base by use of an open technique via a 1.5–2 cm skin incision.<sup>[19]</sup> A 5-mm, 0° telescope with a flexible tip or a 5-mm 30° telescope can be used, followed by 25-mm working instruments in the remaining two channels. It is widely believed that single-port laparoscopic hysterectomy is technically more difficult than conventional laparoscopic hysterectomy. Regarding the learning curve, Paek *et al.* found that proficiency is achieved after 40 cases.<sup>[20]</sup> The main technical challenge of this approach (other than lack of triangulation) is proximity of the instruments, leading to clashing between the instruments and the surgeon's hands; This difficulty can potentially be overcome by use of a 33-cm long instrument and a 43-cm long straight instrument or, alternatively, use of a double-bended and a straight instrument.<sup>[21]</sup> Data regarding the outcomes of this approach for laparoscopic hysterectomy are slightly conflicting. This, together with the technical challenges inherent to the single-port access, may be the reasons behind the not so widespread use of this approach. Yim *et al.* performed a retrospective study comparing 52 cases of single-port laparoscopic hysterectomy with conventional four-port laparoscopic hysterectomy and reported that single-port hysterectomy was associated with less intra-operative blood loss, no difference in peri-operative complications, shorter hospital stay and less immediate postoperative pain.<sup>[22]</sup> In a systematic review and meta-analysis of 23 studies comparing single-port versus conventional laparoscopic hysterectomy for benign clinical indications, Sandberg *et al.* found that there were no significant differences in terms of complications, conversion to laparotomy or clinically significant postoperative pain, however, the single-port approach was associated with longer operative time (mean difference of 11 min) and need for an additional port in 3.5% of cases.<sup>[23]</sup> In another systematic review and meta-analysis

of 18 studies comparing single-port versus conventional laparoscopic hysterectomy, Yang *et al.* identified that single-port laparoscopic hysterectomy was associated with longer operative time, higher risk of failure of the procedure (3.59% versus 0.36% for conventional laparoscopic hysterectomy, of which 69% was due to additional ports and 31% due to conversion to laparotomy), and shorter hospital stay.<sup>[24]</sup> There was no significant differences in terms of postoperative pain, perioperative complications or estimated blood loss.

## HAND-ASSISTED LAPAROSCOPY

This approach is mostly used in cases of very large uteri where conventional laparoscopic hysterectomy might not be feasible. The surgeon inserts his/her hand into the abdominal cavity through an air-sealed incision to facilitate manipulation of the enlarged uterus.<sup>[25]</sup> This approach for hysterectomy was first described by Pelosi MA *et al.* who performed laparoscopic subtotal hysterectomy in a 45-year-old patient with fibroid uterus extending up to the umbilicus on preoperative magnetic-resonance imaging (uterine weight = 3050 g) and vaginal obliteration.<sup>[26]</sup> They used open laparoscopic entry via the umbilicus and a 7, 5 cm transverse lower abdominal incision through which an air-sealing hand access system was mounted. The specimen was morcellated via the suprapubic incision. The operative time was 150 min, blood loss of 220 ml and discharged home on the second postoperative day without complications. Hand-assisted laparoscopic hysterectomy has been described successfully in a case of a fibroid uterus weighing 5020 g without complications;<sup>[27]</sup> The authors used a 5-mm left upper quadrant trocar, a 10-mm trocar below the xiphoid in the midline, two further 5-mm trocars (one in the left and one in the right upper quadrant) and a 7-cm vertical midline laparotomy (2 cm above the pubic symphysis), through which a GelPort® Laparoscopic System (Applied Medical, Rancho Santa Margarita, CA) was inserted. They used a 45° laparoscope, the operation lasted 315 min and blood loss was 120 ml. In a retrospective cohort study comparing hand-assisted versus conventional open hysterectomy for large uteri (>1 kg), hand-assisted laparoscopic hysterectomy was associated with longer operative time, shorter hospital stay and similar, low rate of complications.<sup>[28]</sup>

## DISCUSSION

The laparoscopic gynecological surgeon has a number of different approaches in his armamentarium, when it comes to choosing the trocar configuration in order to perform a laparoscopic hysterectomy for benign gynecological disease. Various approaches were described in the previous section of our article. Before deciding on the surgical approach,

the surgeon needs to ensure that he/she has a thorough knowledge of the abdominal wall anatomy in order to prevent laparoscopic entry-related complications. As a rule of thumb, the trocars should be inserted at a 90° angle to the abdominal wall. There are 2 superficial vessels that need to be spared during auxiliary trocar insertion; the superficial epigastric artery and the circumflex iliac superficial artery. They can be demarcated, in the majority of patients, by diaphanoscopy. Deeper to this, the inferior epigastric artery originates at the inguinal ligament of the external iliac artery. It can be visualized through the laparoscope and should be spared as injury to this artery during trocar insertion can lead to hemorrhage and need for conversion to laparotomy. Other than vessels, nerves can also be injured during auxiliary trocar insertion. In particular, the iliohypogastric and ilioinguinal nerves are at risk for injury with laterally placed trocars through direct trauma or nerve entrapment. These nerves emerge from the T12 to L1 and L1 to L2 regions, respectively, and course through the muscles of the anterior abdominal wall.

It is important for the reader to appreciate that the surgical outcomes described in the studies cannot be directly attributed to the trocar configuration approach used. A number of direct as well as confounding factors (e.g., surgeon's experience, clinical details, equipment used) exist, which are all likely to have an impact on the reported outcomes.

We acknowledge the fact that the list of the articles included in our paper is not exhaustive. After careful consideration of the available evidence, an agreement was reached between the two authors (GG and AM) that the included list of papers was appropriate in order to inform the reader of the various trocar configurations approaches. This can be viewed as a deficiency of our paper. Another potential weakness of our paper is the fact that we have not included comments on merits and demerits of each surgical approach.

## CONCLUSION

There are various approaches available in terms of number, size and position of laparoscopic trocars in order to perform a safe laparoscopic hysterectomy for benign indications. The aim of our article was to present those approaches to the reader rather than suggest that any approach is superior to the others in terms of surgical outcomes. Certain approaches (e.g., Single-port laparoscopy) have been demonstrated to have longer learning curve and may be considered technically more challenging. Careful consideration of each clinical case, equipment available and expertise of the operating surgeon and the surgical team need to be taken into consideration when deciding which approach to utilize.

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## Conflicts of interest

There are no conflicts of interest.

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