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Total laparoscopic hysterectomy versus total abdominal hysterectomy: an assessment of the learning curve in a prospective randomized study

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The present randomized study was undertaken in order to compare the short-term results between total laparoscopic hysterectomy and abdominal hysterectomy in a centre with experience in laparoscopic surgery. From January 1997 to September 1998 inclusive, 102 women aged 44–71 years were randomly assigned to either total laparoscopic hysterectomy (n = 51 patients) or abdominal hysterectomy (n = 51 patients). The patients' demographic characteristics were similar in both groups. Average intra-operative blood loss was lower in laparoscopic hysterectomy than in abdominal hysterectomy ($P \leq 0.001$). The average time employed for laparoscopic hysterectomy was 104.1 ± 26.98 min; according to the learning curve experienced in this study, the range was 72–163 min and the results after the plateau was reached showed no statistical difference between laparoscopic and abdominal operating times. The mean length of hospital stay was 2.38 ± 0.30 days in the laparoscopic hysterectomy group versus 6.23 ± 1.85 days in the abdominal hysterectomy group ($P \leq 0.001$). In conclusion, this study shows that total laparoscopic hysterectomy can be effectively performed within reasonable time limits, provided that operators are experienced surgeons in operative laparoscopy and that operating times are comparable with those of abdominal hysterectomy.

Key words: hysterectomy/laparoscopy/laparotomy/total laparoscopic hysterectomy

Introduction

The use of laparoscopic hysterectomy has recently been reported as an alternative to traditional abdominal hysterectomy and the utilization of a mini-endoscopic technique has also been recorded (Wattiez *et al.*, 1999).

Nevertheless, it has been found in the UK that >80% of hysterectomies are still performed using the classical abdominal route (Garry and Hercz, 1995; Hall *et al.*, 1998). Moreover, even in those countries with general experience in vaginal hysterectomy, the majority of hysterectomies, especially if adnexectomy is associated, are also performed abdominally (Vessey *et al.*, 1992; Olsson *et al.*, 1996).

The first laparoscopic hysterectomy was performed and published in 1989 (Reich *et al.*, 1989), but it was only from 1991 onwards that this surgical method of removing the uterus began to be used (Nezhat *et al.*, 1992; Phipps *et al.*, 1993; Chapron *et al.*, 1996).

In this prospective randomized study, laparoscopic hysterectomy was compared to traditional AH.

Materials and methods

The Ethics Committee of the University approved the study protocol. Patients were enrolled in this study from 1 January 1997 to 30 September 1998 at the Gynaecologic University Hospital (University of Palermo, Italy); they included 51 cases of laparoscopic hysterectomy and 57 cases of abdominal hysterectomy.

The criteria for choosing laparoscopic hysterectomy were generally based on uterus volume, which did not exceed that of 16 weeks' pregnancy (i.e. 700 g). In this prospective, randomized study, the indications for hysterectomy (which were the same for laparoscopic hysterectomy and abdominal hysterectomy) included abnormal uterine bleeding or menorrhagia in 30 patients, enlarged uterus with myomata in 20 patients, pelvic pain in seven patients, abnormalities in the pelvic floor in five patients and adnexal mass in four patients.

Patients had given their informed consent to undergo either laparoscopic hysterectomy or abdominal hysterectomy. Instruments used in laparoscopic hysterectomy included bipolar forceps, two endoscopic graspers, two needle holders and a uterine manipulator (the Clermont-Ferrand uterine manipulator; Storz GMBH, Tuttlingen, Germany).

All the laparoscopic hysterectomies were performed by the same team of three laparoscopic surgeons (A.P., G.C., R.V.), each with individual experience of more than 100 major and advanced laparoscopic procedures (major adhesiolysis, adnexectomy, myomectomy and supracervical hysterectomy).

Surgical techniques

The patient was placed in the lithotomy position with her legs open at 60°, under general anaesthesia with endotracheal intubation; a Foley urinary catheter ensured the bladder was emptied during the operation.

After a CO_2 pneumoperitoneum was created, a 10 mm trocar was placed in the umbilical site to introduce the laparoscope and the camera. Three ancillary 5 mm trocars were also placed suprapubically.

After an accurate abdominal pelvic inspection, lysis of any adhesions was performed. The uterus was then mobilized, making the various anatomical planes more accessible. Particular attention was given to the course of the ureter in its pelvic zone. After bipolar coagulation, the round ligament was sectioned at ~3 cm from the uterus, in order to prevent bleeding from the superior uterine vessels. The areolar tissue of the broad ligament was then dissected and its posterior fold fenestrated at an avascular area above the uterine vessels (Figure 1). This manoeuvre permitted a better mobilization and identification of the infundibulo-pelvic ligament, whose vessels

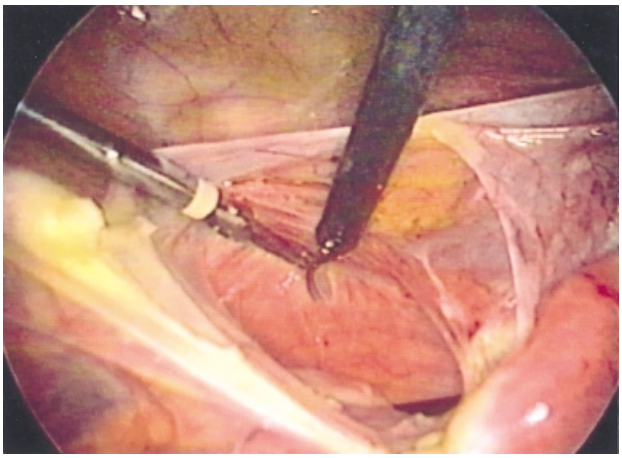

Figure 1. The posterior fold of the broad ligament has been opened at an avascular area above the uterine vessels, so making easier the mobilization and dissection of the infundibulo-pelvic ligament.

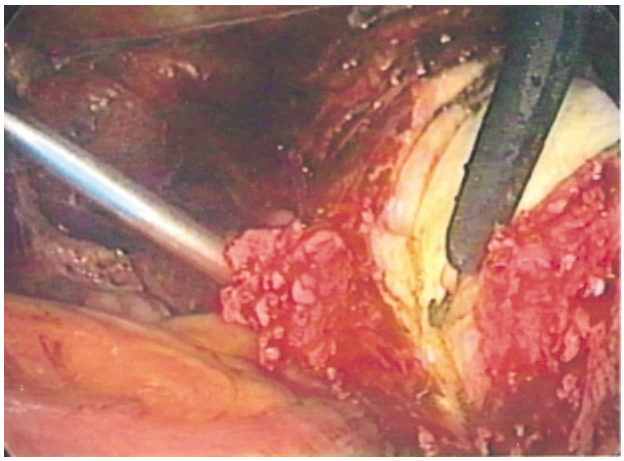

Figure 2. Final circular colpotomy: the use of the Clermont-Ferrand manipulator in our experience has proved to be effective in facilitating this surgical manoeuvre and, at the same time, in avoiding CO_2 leakage through the vagina.

were coagulated and cut using bipolar forceps and scissors under direct visualization of the pelvic ureter.

Once the uterine ligaments were sectioned, the operation continued centrally in a downward direction. If, however, the adnexae were not to be removed, the utero-ovarian ligament was coagulated and sectioned proximal to the ovaries.

Thereafter, the vesico–uterine peritoneal fold was opened by scissors and a bladder dissection from the low uterine segment down to the upper part of the vagina was performed; during this step, the location of the right cleavage plane was crucial to avoid any bladder injury. The utero-sacral ligaments were then coagulated and sectioned, thus favouring lateralization of the ureter from the uterus. At this point, the uterine artery was carefully skeletonized and, by exerting the right pressure on the uterine manipulator, it became more evident at the level of the ascendant branches and was then coagulated with bipolar forceps and cut with scissors. This step was critical because most ureteral injuries during laparoscopic hysterectomy are known to occur at this time during surgery (Liu, 1997).

The operation continued with the coagulation and incision of the cardinal ligaments in order to expose the vaginal fornices, separated from the stump of the uterine artery. Circular colpotomy was then performed and the uterus was removed through the vagina, and it was immediately weighed before being sent for histological examination.

At this stage, the Storz manipulator was extremely effective in completely exposing the fornices and at the same time in avoiding CO_2 leakage from the pneumoperitoneum, thus making colpotomy easier (Figure 2). In cases of very large uteri, or limited vaginal access, wedge morcellation was also performed. Finally, the vaginal vault was sutured laparoscopically or vaginally (only in one case), and the pelvis was then checked in order to ensure haemostasis and to perform pelvic irrigation, thus removing blood clots. Intra-operative cystoscopic examinations were performed to rule out bladder injuries in only four procedures in which an extensive bipolar electrosurgery was utilized owing to brisk bleeding during bladder dissection.

Abdominal hysterectomy was performed according to the technique described for benign disease (Mattingly and Thompson, 1985).

The beginning of the operation was calculated as the moment of the umbilical incision and introduction of the Verres needle for laparoscopic hysterectomy and as the moment of cutaneous incision for the abdominal technique. Cutaneous suture was considered the end of the operation in both cases. Any time spent on other surgical procedures was deducted from the overall duration of both surgical techniques.

Blood loss during laparoscopic hysterectomy was calculated as the difference between the volume of liquid introduced into the pelvic cavity for irrigation purposes and the volume of liquid aspirated during the operation. Blood loss during abdominal hysterectomy was assessed by measuring the amount of blood contained in the aspirator at the end of the operation: sponges were not used for this study.

Postoperative pain was assessed in the 3 days after surgery using the visual analogue scale (VAS): from 0 = no pain to 10 = maximum pain. An analgesic, Ketorolac, was given the day after surgery for postoperative pain. A temperature $\geqslant$38°C starting from the second postoperative day was considered as postoperative fever.

The following parameters were also evaluated: postoperative decrease in haemoglobin (Hb), complications and duration of post-operative stay.

A statistical analysis of the data was performed using Student's *t*-test (for parametric continuous variables), Wilcoxon rank sum test (for non-parametric continuous variables), the χ^2 test or the Fisher's exact test (for categorical variables). A P-value < 0.05 was considered statistically significant.

Results

In 30 of the laparoscopic hysterectomy cases (59%), laparoscopic hysterectomy alone was performed. In the other 21 patients (41%), other laparoscopic procedures were associated: colposuspension with Burch's method in 13 cases, Douglasectomy using McCall's method ($n = 6$), appendectomy ($n = 2$).

The average time employed for laparoscopic hysterectomy was 104.1 $\pm$ 27.0 min (excluding the time for the associated surgical procedures). According to our learning curve for this kind of laparoscopic surgery, the range in operating time was 72–163 min (Figure 3). Indeed, the results after the plateau was reached showed a marked reduction in the operating time, with an average time of 93.6 $\pm$ 21.4 versus 129.2 $\pm$ 22.3 min in the first 15 laparoscopic procedures (Table I).

Average intra-operative blood loss was significantly lower in laparoscopic hysterectomy as opposed to abdominal hysterectomy, with lower first postoperative day haemoglobin drop in the patients who underwent laparoscopic hysterectomy

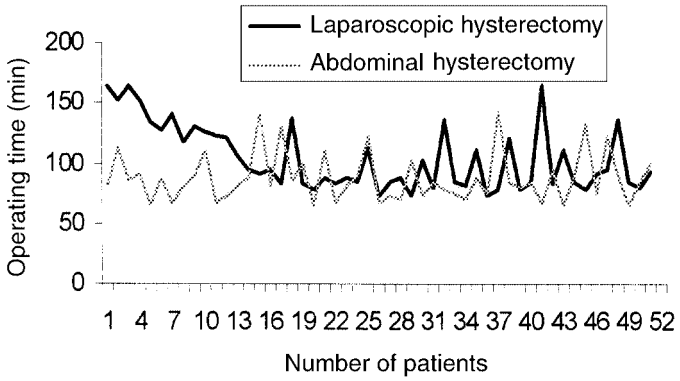

Figure 3. Learning curve for laparoscopic hysterectomy compared to abdominal hysterectomy operating times.

Table I. Comparison of operating times (min) for laparoscopic and abdominal hysterectomies

No. of patients	Laparoscopic hysterectomy	Abdominal hysterectomy	*P*-value
51	104.1 ± 27.0	87.8 ± 20.4	<0.001
First 15	129.2 ± 22.3	87.9 ± 20.3	<0.001
Last 36	93.6 ± 21.4	87.8 ± 20.7	NS

Data are presented as mean ± SD, NS = not significant.

Table II. Comparison of postoperative results of laparoscopic and abdominal operations

Parameters	Laparoscopic hysterectomy (n = 51)	Abdominal hysterectomy (n = 51)	*P*-value[a]
Age (years)	47.8 ± 7.42	47.6 ± 7.4	NS
Parity	2.3 ± 1.48	2.4 ± 1.4	NS
Uterine weight (g)	368.0 ± 125.3	389.0 ± 143.9	NS
Blood losses (ml)	140.0 ± 41.5	406.0 ± 103.9	<0.001
Postoperative day 1 Hb drop (g/100 ml)	0.4 ± 0.2	1.6 ± 0.4	<0.001
Postoperative stay	2.4 ± 0.30	6.2 ± 1.9	<0.001

Data are presented as mean ± SD.
NS = not significant, Hb = haemoglobin.
[a]Student's *t*-test.

Table III. The comparison of postoperative pain assessed by VAS for laparoscopic and abdominal hysterectomy

	Laparoscopic hysterectomy	Abdominal hysterectomy
Day 1*	4.1 ± 1.2	6.9 ± 1.8
Day 2*	2.3 ± 1.6	5.4 ± 1.3
Day 3*	1.0 ± 0.7	3.1 ± 0.9

Data are presented as mean ± SD.
VAS = visual analogue scale 0–10.
*$P < 0.001$.

(Table II). In this study, it was never necessary to convert laparoscopic hysterectomy to abdominal surgery.

Patients who underwent laparoscopic hysterectomy had less intense postoperative pain (assessed with the VAS method) than patients in the abdominal hysterectomy group (Table III). No major intra-operative complications were recorded during laparoscopic hysterectomy. Postoperative complications in the laparoscopic hysterectomy group were fever after surgery in one patient and a uretero-vaginal fistula diagnosed 10 days after surgery in one patient, for which it was necessary to introduce a ureteral splint.

There were no intra-operative complications in the abdominal hysterectomy group, but the postoperative complications were: two cases of haematoma of the vaginal cuff (blood transfusion was required in one case), and four cases of postoperative fever.

Discussion

The potential benefits and risks of laparoscopic hysterectomy have been widely reported since the first paper on total laparoscopic hysterectomy was published (Reich *et al.*, 1989). In some randomized controlled studies comparing laparoscopic hysterectomy with abdominal hysterectomy, it was concluded that the duration of laparoscopic hysterectomy was significantly longer than that of abdominal hysterectomy, although after laparoscopic surgery patients had less pain, a shorter hospital stay and a quicker resumption of their normal activities (Nezhat *et al.*, 1992; Phipps *et al.*, 1993; Raju *et al.*, 1994).

Subsequently, in a randomized prospective trial on 143 patients comparing laparoscopically assisted vaginal hysterectomy (LAVH) and abdominal hysterectomy (Olsson *et al.*, 1996), it was found that LAVH took significantly longer than abdominal hysterectomy, but duration of hospitalization and convalescence were shorter. This study demonstrated that the level of postoperative complications in the two groups was similar, although one LAVH patient had a vesico–vaginal fistula.

According to one report (Garry, 1998), the difference in duration of surgery for the two techniques is due to the fact that most of these studies were carried out 'during the world learning curve for laparoscopic hysterectomy'. Technical ability and competence in the new surgical procedures should be acquired and procedures standardized before comparative studies are undertaken.

In one of the first case series of 100 LAVH (Garry and Hercz, 1995), it was reported that a depressing 20% complications occurred, including 13 cases with haematoma of the vaginal cuff, two cases of ureteral damage and one case of lesion of the epigastric artery. The good postoperative recovery in 80% of the patients with no intra-operative complications was encouraging (Garry and Hercz, 1995).

Previously published papers reported an incidence of serious complications of 3.5–5 per 1000 for advanced laparoscopic procedures (Querleu *et al.*, 1993; Chapron *et al.*, 1998). However, these results, obtained by experts in centres with considerable experience, are not representative of the general situation. In fact, various authors have recently reported series of major complications which occurred both during the set-up stage and during the laparoscopic surgery (Chapron *et al.*, 1997; Nezhat *et al.*, 1997).

It was reported in 1993 that the percentage of major complications found in a multicentre study (Pierre *et al.*, 1993), which consisted of 2528 advanced laparoscopic procedures

carried out in 84 hospitals, was 17.4 per 1000. This was three times that reported by referral hospitals. Three years later, a multicentre study carried out by the French association for endoscopic gynaecology recorded a percentage of 12.5 per 1000 for complications in major surgical procedures (Pierre *et al.*, 1998).

A recently published random study (Marana *et al.*, 1999) comparing LAVH and abdominal hysterectomy demonstrated that surgery for LAVH can take the same time as for abdominal hysterectomy. It also confirmed that blood loss and postoperative pain were significantly less in the patients who underwent LAVH. Furthermore, the percentage of complications in the two groups was acceptably low and there was no statistically significant difference between the two groups. This study has unequivocally established the importance of the experience of surgeons in the length of time required to perform LAVH.

The current study reports the first series of 51 laparoscopic hysterectomies performed in a university centre with significant experience in endoscopic gynaecological surgery. In order to assess the laparoscopic hysterectomy learning curve, the following parameters were examined: duration of surgery, percentage of intra- and postoperative complications and percentage of conversions to abdominal hysterectomy.

In a previous study (Siren and Sjoberg, 1995), 100 successive laparoscopic hysterectomies performed by a senior gynaecologist were assessed in order to evaluate the learning curve. It was found that the duration of surgery decreased from an average of 180 min for the first 10 operations, to an average of 75 min for the last 20. This study also found a direct correlation between duration of surgery, patient weight and the weight of the uterus. On the contrary, no relationship of this kind was found in our study.

Interestingly, we noted that in eight patients who had previously undergone hysterectomies (Caesarean section or myomectomy), the duration of laparoscopic surgery decreased over the period of this study when compared to the operating times of the other cases, thus confirming the importance of the learning curve.

It has been shown (Chapron *et al.*, 1996) that laparoscopic surgery could actually reduce the number of laparotomies for patients with no previous vaginal delivery and for whom a hysterectomy was necessary; in their opinion, when vaginal access is poor even the laparoscopic assistance cannot make vaginal hysterectomy easier. In these cases the only way to avoid laparotomy is to perform total hysterectomy by laparoscopy.

In conclusion, our study shows that total laparoscopic hysterectomy can be effectively performed within reasonable time limits in a hospital where operators are experienced in endoscopic surgery. The study also shows that the operating times eventually achieved are comparable to those of abdominal hysterectomy.

This prospective randomized study has demonstrated that after laparoscopic hysterectomy, patients recovered more quickly and had less pain, and the incidence of complications was also low. One serious complication after laparoscopic hysterectomy in this first series of patients was found, but in our opinion it is possible to avoid major complications by paying particular attention to the surgical details.

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