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# BENIGN UTERINE PATHOLOGY - MINIMALLY INVASIVE SURGICAL TECHNIQUES VERSUS OPEN SURGERY

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***Abstract:*** *The use of laparoscopic procedures has shown a continuous growth since 1990's, while the abdominal and vaginal approaches decreased. The aim of this study is to evaluate and to compare each type of surgical approach (abdominal, vaginal, laparoscopic) used for performing a hysterectomy. A systematic review of literature was performed. After analyzing the 22 studies included in this review, it was observed that laparoscopic hysterectomy compared to abdominal hysterectomy has a shorter hospital stay, allows the patient to return quicker to daily activities, but is associated with longer procedure time and has higher incidence of major complications compared to vaginal and abdominal approach. The alternative of laparoscopically approach is represented by robotic assisted surgery which is high current. The advantages of the assisted robotic surgery promise to open a new window for minimally invasive surgery in gynecology.*

***Key words:*** *Abdominal hysterectomy, laparoscopical hysterectomy, vaginal hysterectomy.*

## 1. Introduction

The introduction of the laparoscopic surgery for the treatment of gynecological pathologies has modified the way in which hysterectomies are performed worldwide. The use of this minimally invasive surgery for hysterectomies has grown in the last two decades from 0.3% (during the year 1990) to approximatively 12% (in 2003) [58]. Once the laparoscopic technology was available, the laparoscopic hysterectomy became much more convenient. The procedure though, has its limits: limited range of motion at the surgical site, resulting in loss of dexterity, poor depth perception, high costs and a long learning curve which makes it a difficult skill to acquire for surgeons. These drawbacks have restrained practitioners from using the laparoscopic technique to perform hysterectomies, especially in the cases of patients with obesity or surgical antecedents. The increased usage of the laparoscopic surgical technique in benign diseases has lowered the rate of classical abdominal hysterectomies from 74% to 60% and of vaginal hysterectomies from 24% to 22% [37].

Currently, several techniques are being used to perform hysterectomies: abdominal hysterectomy, vaginal hysterectomy,

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laparoscopic hysterectomy and robotic assisted laparoscopic hysterectomy [1]. In the past, the only ways to perform a hysterectomy were abdominally or vaginally, the latter being considered minimally invasive.

Recently introduced, robotic assisted surgery offers a three-dimensional image and helps in rising the precision and dexterity of the practitioner during the procedure. Laparoscopic and robotic assisted surgery are the newest methods available in the surgery of benign uterine affiliations. These two methods, according to the international guides, should not replace vaginal hysterectomy, but rather be considered a worthy alternative to abdominal hysterectomy in the cases where vaginal hysterectomy cannot be performed [18]. In April 2005, FDA approved the use of the Da Vinci robot during gynecological surgery. One of the first papers published on this subject was the one written by *Reynolds and Advincula* [47], which tackles the idea of using robots during surgeries for benign pathologies. The results of their study revealed that 16 patients with no major complications were subjected to robotic assisted laparoscopic surgery and did not require conversion to laparotomy, with a mean operating time of 242 minutes and average uterus weight of 131 grams.

Other studies have been published in the following years, the most recent one being written by *Boggress* et al [7] who concludes that during 152 cases of robotic assisted laparoscopic hysterectomies, none of which converted to laparotomies, the mean operating time was 122.9 minutes and the average uterus weight was 347 grams. The technical advantages include three-dimensional view and articulated robotic arms that can be controlled with the aid of a console, reducing the surgeons fatigue, frustration and strain, thus providing more comfort during the procedure [30]. Nowadays a considerable amount of studies indicate that robotic assisted surgery does not have significant advantages over traditional laparoscopy performed in the cases of benign diseases. Nonetheless, robotics offers an advantage in complex surgeries. The introduction of robotics in gynecological surgery and the introduction of the Da Vinci robot in particular is one of the most important steps toward the future of surgery [7], [24]. The benefits of minimally invasive hysterectomy are well documented, and include less post-operatory pain, smaller incisions, reduced hemorrhage, faster recovery time and less hospital stay [40].

## 2. Objective of the study

The aim of this study is to evaluate the advantages and disadvantages of each type of surgical approach used in the treatment of benign gynecological diseases. The three types of surgeries that will be compared are the following: abdominal hysterectomy (AH), vaginal hysterectomy (VH) and laparoscopic hysterectomy (LH).

## 3. Material and methods

The study is comprised of material extracted from various databases (PubMed, Medline, Cochrane Menstrual Disorders and Subfertility Group Trials Register, Embase) during the year 2015 and contains data regarding perioperative outcomes of a group that underwent an AH, VH or LH. Primary outcome data abstracted includes perioperative data such as operating time, length of hospital stay, any intraoperative or postoperative complications and post-surgical recovery time. Relevant articles were identified using the keywords MeSH: „abdominal hysterectomy", „laparoscopic hysterectomy" and „vaginal hysterectomy", without restrictions of language and date.

The studies were selected using the following eligibility criteria: women with benign gynecological pathology, surgical procedures that included the comparison of at least two of the above mentioned procedures for hysterectomy, studies that reported long-term clinical data such as major postoperative complications, convalescence and secondary results such as operating time, length of hospital stay, immediate and short term complications. Studies that contain data on oncologic gynecological pathology were excluded.

## 4. Results

There are numerous comparative studies between the types of hysterectomies that can be performed. Out of the studies that have been published, the ones written by *Summit* [54], *Otossen* [42] concluded that the laparoscopic procedures lasted longer, but were associated with a significant drop in postoperative pain, shorter hospital stay and shorter convalescence [9].

Mean operating time in the case of vaginal hysterectomies was approximatively 60 minutes, whereas in the case of laparoscopic hysterectomies was 105 minutes. This showed a significant difference from abdominal hysterectomies, but in opposite directions. It has been shown that abdominal hysterectomies were performed much faster that laparoscopic hysterectomies. The same applies to vaginal hysterectomies, which were also performed faster. The most important variables that can influence the operating time are the experience of the surgeon, the weight of the uterus and other patient related pathologies such as intra-abdominal adhesions or obesity.

The mean hospital stay has been significantly shorter for women that underwent vaginal hysterectomies (~ 3 days), compared to an average of 6 days for the abdominal hysterectomies. Women who underwent laparoscopic surgery had a mean hospital stay of 4 days, with a small difference from the ones who had vaginal hysterectomy.

Convalescence after vaginal hyste-rectomy and laparoscopic hysterectomy was shorter than after abdominal hysterectomy. There was no significant difference identified between the convalescence required after vaginal or laparoscopic hysterectomy.

As per the rate of postoperative complications, laparoscopic hysterectomy has been shown to have a higher rate of complications than abdominal hysterectomy (OR 2.61, 95% CI 1.22–5.60) [22, 23].

Laparoscopic surgery has multiple advantages, yet complications should not be ignored. The most frequent intra and post operatory complications are the following:

**Vascular injury:** may implicate blood vessels of the abdominal wall or large retroperitoneal blood vessels. *Vessels of the abdominal wall:* Accidents that imply the inferior epigastric vessel (the most frequent type of vascular complication) occur with a rate of 3% [11]. *Large retroperitoneal vessels:* the aorta, vena cava and iliac vessels. In most cases, the injury was observed during the insertion of the Veress needle or the primary trocar. The incidence of major vascular injury in the Royal College of Obstetricians and Gynecologists (RCOG) study was 9/10000 laparoscopies [11]. *Baadsgaard et al* [4] have reported 47 such lesions of large vessels during laparoscopy, concluding that most of these lesions have been inflicted by the insertion of the Veress needle. *Nezhat* [35] reported on eight cases of major retroperitoneal vascular injury during laparoscopic surgery not related to trocar or Veress needle injury and emphasized the need for proper understanding of the anatomy and safe use of diathermy.

Table 1

*Summary of studies comparing the hysterectomy procedures (LH, AH,VH)*

| Authors | Number of cases | | | Procedure time (minutes) | | | Hospital stay | | | Recovery time | | | Complications (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LH | AH | VH | LH | AH | VH | LH | AH | VH | LH | AH | VH | LH | AH | VH |
| **Summitt [52]** | 34 | 31 | 23 | 179.8 | 146 | 65 | 2.1 | 4.1 | 3.3 | 4 | 38 | | 6 | 10 | 8 |
| **Lumsden [29]** | 95 | 95 | - | 81+/-30 | 47+/-16 | - | 4 | 6 | - | No difference | | | 8 | 14 | - |
| **Perino [43]** | 51 | 51 | - | 104+/-27 | 87+/-20 | - | 2.3 | 6 | - | - | - | - | 4 | 12 | - |
| **Falcone [16]** | 24 | 24 | - | 180 | 130 | - | 1.5 | 2.5 | - | 14 | 19 | - | - | - | - |
| **Marana [31]** | 58 | 58 | - | 91.1 | 91.8 | - | 4 | 6 | - | - | - | - | 3 | 8 | - |
| **Olsson [39]** | 71 | 72 | | 148 | 85 | - | 2 | 4 | - | 16 | 35 | - | 27 | 33 | - |
| **Nezhat [34]** | 10 | 10 | | 160 | 102 | - | 2 | 5 | - | 3 | 5 | - | 10 | 50 | - |
| **Phipps [44]** | 24 | 29 | | 65 | 30 | - | 2 | 6 | - | 2 | 6 | - | - | - | - |
| **Raju [46]** | 40 | 40 | | 100 | 57 | - | 4 | 6 | - | 3 | 6 | | - | - | - |
| **Langebrekke [27]** | 46 | 54 | | 100 | 61 | - | 2 | 5 | - | 19 | 36 | - | 10 | 14 | - |
| **Arbogast [3]** | 61 | 65 | | 137 | 66 | - | 1 | 4 | | - | - | | 38 | 68 | - |
| **Howard [19]** | 15 | 15 | | 169 | 119 | - | 3 | 5 | | - | - | | 13 | 40 | |
| **Soriano [51]** | 40 | - | 40 | 160+/50 | - | 108 +/-35 | 5.7 | - | 5.3 | - | - | - | 32.5 | - | 15 |
| **Richardson [49]** | 29 | - | 24 | 131 | - | 37 | 3.2 | - | 3.3 | 6.4 | - | 5.7 | 36 | - | 30 |
| **Ottosen [42]** | 40 | 40 | 40 | 102 | 68 | 81 | 3.1 | 3.7 | 2.8 | 19.7 | 28.1 | 21.3 | 2.5 | 2.5 | 7.5 |
| **Casey [10]** | 115 | 194 | 220 | 112 | 116 | 90 | 2.3 | 4.7 | 3.4 | - | - | - | 0 | 8.8 | 4 |
| ***Bharatnur[5]*** | - | 25 | 25 | - | 101 | 65 | - | 5 | 8 | - | - | - | - | 2 | 6 |
| **Boike [8]** | 50 | 50 | 50 | 240 | 163 | 176 | 2.5 | 8 | 3.8 | - | - | - | 12 | 26 | 6 |

LH=Laparoscopical hysterectomy; AH=Abdominal hysterectomy; VH=Vaginal hysterectomy

**Bowel injury:** is one of the most important complications of laparoscopic surgery because it is potentially life threatening, especially if the injury is not recognized at the time of operation. In the RCOG survey [11], the incidence of bowel injury was 1.8:1000. More recently, *Zaki et al*. reported two cases of bowel injury among 1508 patients (incidence 1.3:1000).[60]

**Gas embolism:** is a very rare but potentially life-threatening complication. Carbon dioxide may be introduced into a large vein via the Veress needle and trapped in the right ventricle, causing right outflow obstruction from the right ventricle into the pulmonary artery.

Indicative features include sudden circulatory collapse, cyanosis, raised jugular venous pressure, a high arterial $pCO_2$ and a drop-in end tidal carbon dioxide concentration. If carbon dioxide insufflation is still ongoing via the Veress needle, it should be stopped immediately and the tubing disconnected.

**Pneumothorax:** may occur if there is a congenital defect in the diaphragm. It may rapidly evolve and it is manifested through cyanosis, engorgement of neck veins, increase in airway pressure and classical signs of pneumothorax. This will be exacerbated by the use of nitrous oxide, which will expand the pneumothorax.

**Subcutaneaous and pre-peritoneal emphysema.** Subcutaneous emphysema is usually benign and resolves on its own. No specific treatment is needed other than massaging the swollen anterior abdominal wall towards the nearest trocar site to express the trapped gas.Pre-peritoneal emphysema is a common complication which may result from inserting the Veress needle at too shallow an angle from the horizontal and frequently occurs at obese patients. To avoid pre-peritoneal emphysema during closed laparoscopy in obese patients, the Veress needle and the primary trocar can be inserted at a 90° angle [11].

**Cardiac arrhythmia: b**radycardia may occasionally follow the pneumoperitoneum. There is a reflex vagal response to peritoneal distension [28]. This response may become more noticeable with the introduction of muscle relaxants, lacking any inhibitory vagal action. This is often successfully managed by stopping the in-flow of gas to the peritoneal cavity and administering an anticholinergic agent. Occasionally the arrhythmia may persist or it can cause significant concern, in which case the laparoscopy should be abandoned.

**Nerve injury:** transient nerve injury may occur during any procedure if the positioning of the anaesthetized patient is incorrect. *Schwartz* [50] has reported two transient nerve injuries amongst 45 consecutive patients undergoing laparoscopic hysterectomy. One of the lesions involved the femoral nerve and the other the peroneal nerve. The correct positioning of the patient, especially when undergoing prolonged laparoscopic surgery, is necessary to avoid nerve compression injury.

**Venous thrombosis**: even if venous thrombosis is a relatively uncommon complication following laparoscopic surgery due to fast convalescence, venous thrombosis and pulmonary embolism do occur after laparoscopic pelvic surgery. 6 cases of pulmonary embolism have been identified out of 3189 cases of laparoscopic hysterectomy [50]. Apart from the use of subcutaneous heparin for prophylaxis in those having major laparoscopic surgery, the filling pressure of carbon dioxide should be set at ≤13 mm. If the filling pressure rise significantly >15mm, it would impede venous return from the vena cava and consequently cause venous stasis predisposing to deep vein thrombosis.

**Avoiding complications arising from the use of electrical energy.** The principles of electro surgery have been systematized and reviewed by *Vancaillie* [55]. Complications of electro surgery during a laparoscopy can result from three situations: accidental burns, capacitive coupling and direct coupling.

Table 2

*The incidence of common complications in surgical approaches of hysterectomy for benign gynecological pathology*

| | ABDOMINAL HYSTERECTOMY **(N = 292)** | LAPAROSCOPICAL HYSTERETOMY A **(N = 584)** | VAGINAL HYSTERECTOMY **(N = 168)** | LAPAROSCOPICAL ASSISTED VAGINAL HYSTERETOMY **(N = 336)** |
|---|---|---|---|---|
| **Major hemorrhage** | 7 (2.4) | 27 (4.6) | 5 (2.9) | 17 (5.1) |
| **Bowel injury** | 3 (1) | 1 (0.2) | 0 | 0 |
| **Ureteral injury** | 0 | 5 (0.9) | 0 | 1 (0.3) |
| **Vesical injury** | 3 (1) | 12* (2.1) | 2 (1.2) | 3 (0.9) |
| **Pulmonary embolism** | 2 (0.7) | 1 (0.2) | 0 | 2 (0.6) |
| **Conversion** | 1 (0.3) | 23 (3.9) | 7 (4.2) | 9 (2.7) |
| **Wound dehiscence** | 1 (0.3) | 1 (0.2) | 0 | 1 (0.3) |
| **Hematoma** | 2 (0.7) | 4 (0.7) | 2 (1.2) | 7 (2.1) |
| **Other** | 0 | 0 (0) | 1 (0.6) | 0 (0) |
| **Major complications** | 18 (6.2) | 65 (11.1) | 16 (9.5) | 33 (9.8) |

Table 3

*Complications of laparoscopy in gynecological benign pathology*

| **Author** | **Number of cases** | **Vascular injuries** | **Bowel injuries** | **Genito urinary injuries** | **Incisional hernia** | **Gas embolism** |
|---|---|---|---|---|---|---|
| **Worley M.J.[57]** | 3560 | 17 | 273 | 18 | 21 | 15 |
| **Chapron C. [12]** | 29966 | 45 | 48 | 38 | - | - |
| **Cordick C. [13]** | 743 | 1 | 3 | 1 | 1 | - |
| **Querleu D. [45]** | 17521 | 17 | 40 | 7 | | |
| **Ostrzenski [41]** | 2491 | - | - | 70 | - | - |
| **Jansen F.W.[21]** | 25764 | 65 | 29 | 7 | 2 | - |
| **Bhoyrul S [6]** | 629 | 408 | 182 | - | - | - |
| **P-H Wang [56]** | 6451 | 3 | 11 | 28 | - | - |
| **Cosson M [14]** | 1604 | 45 | - | 16 | - | - |

## 5. Discussions

In the case of laparoscopic techniques, the greatest concern is towards the risk of injury of the urinary tract, especially the injury of the ureters. A meta-analysis has demonstrated that statistically there is a higher rate of urinary tract lesions in the case of laparoscopic hysterectomy than the abdominal hysterectomy. The differences are though negligible when the comparison is made between laparoscopic hysterectomy and vaginal hysterectomy [48]. According to several studies, laparoscopic surgery is associated with a double risk for major complications. A significant increase of the incidence of urinary tract lesions has been identified

when comparing laparoscopic hysterectomy to abdominal hysterectomy, whereas no difference has been identified when comparing laparoscopic hysterectomy to vaginal hysterectomy.

Regarding the long-term complications, there have been little significant differences in case of fistulae, in developing urinary or sexual dysfunction and in general patient satisfaction between the three types of surgical approaches. It is worth mentioning that for most of these cases, there are few studies to detect notable differences. The intensity of pain and the amount of medication needed to treat it are lower in the case of laparoscopic hysterectomy [20], due to the fact that the trauma inflicted upon the abdominal wall is less significant. The majority of studies have not reported long term complications such as chronic pelvic or abdominal pain or bowl dysfunction.

When comparing the rate of unspecified infections and febrile episodes, it has been found to be much lower in the cases of vaginal hysterectomy than in the cases of abdominal hysterectomy. There were no significant differences between the surgical approaches from the point of view of the necessity of blood transfusions, though it has been found that laparoscopic hysterectomy is associated with a lower rate of blood loss that abdominal hysterectomy (average difference of 45.3 ml) and a lower drop in hemoglobin level (0.55g/l) [25]. Another recent meta-analysis concluded that unlike women who underwent abdominal hysterectomy, the ones that had a laparoscopic hysterectomy lost less blood during the surgery (123.4 vs 308.5 mL), a lower rate of infected wounds and a faster convalescence, but had more lesions of the urinary tract [2].

In order to evaluate the superiority of one of the three surgical techniques, depth studies have been made that tackle even the molecular response in case of laparoscopic and abdominal hysterectomies. Blood serum concentration of IL-1β, IL-6, IL-8, TNF-α, and IL-10 were measured by commercially available ELISA assays before and 4 h, 24 h, and 48 h after the operation. Concentrations of IL-6 were significantly increased in both groups at 4 h, 24 h, and 48 h after the surgery; levels of IL-10 showed a significant increase 4 h and 24 h after the operation. An increase in IL-1β levels was observed only after laparotomy; no significant variations were observed in serum levels of IL-8. The postoperative increase of IL-1β, IL-6, and IL-10 levels was more pronounced in patients undergoing laparotomy than in those treated laparoscopically. Systemic cytokine response after interventions for benign adnexal masses depends on the degree of the surgical trauma and is less pronounced in patients undergoing laparoscopy [54].

In the year 2011, a meta-analysis compared the abdominal, vaginal and laparoscopic hysterectomy. The authors concluded that the vaginal approach should be used as often as possible, but that the laparoscopic approach is a worthy rival for abdominal hysterectomy, especially when the vaginal approach is not possible [59]. Currently, in Europe, the advantages of minimally invasive surgery are well known, and the majority of hysterectomies are done laparoscopically [38].

The American Association of Laparoscopic Gynecology recommends that most of the hysterectomies performed for benign diseases should be performed either through the vaginal or laparoscopic approach [58]. Despite the standardization of the minimally invasive hysterectomy techniques, they are not currently performed and accepted on a wide scale in the field of gynecological surgery. This is due to the long learning curve and technical difficulties that surgeons encounter.

A thorough evaluation of changes in direct costs (hospital costs) and indirect costs (loss of production value) when performing a laparoscopic hysterectomy instead of an abdominal hysterectomy has been performed. The direct costs were 1.7% higher and the indirect costs 50.3% lower for patients undergoing laparoscopic surgery. The total costs were 23.1% lower after laparoscopic hysterectomy [15]. When the laparoscopic approach is used, the higher cost of the intervention itself is compensated by a decrease in hospital costs, as the hospital stay is significantly shortened. Thus, laparoscopic hysterectomy, being a procedure in which reusable equipment is involved and performed by well-trained surgeons is a viable alternative from a financial standpoint for the classical abdominal hysterectomy.

A study by *Nezhat et al* [33] shows that the mean cost of performing a laparoscopic-assisted vaginal hysterectomy ($7,161.66) is significantly larger than the cost for a vaginal hysterectomy ($4,868.06) or an abdominal hysterectomy ($4,926.80). *Korolija et al* [26] also claimed that the higher cost of laparoscopic hysterectomy is acceptable, as long as the hospital stay and convalescence are shorter.

For many patients, laparoscopic hysterectomy is a safer and less invasive procedure than abdominal hysterectomy, also proving the requirement of far less hospital stay and faster convalescence [53]. Even though the main reason for performing a laparoscopic surgery instead of an abdominal one is the increase of the quality of life, few studies have been made to asses this particular aspect. The available data suggest that laparoscopic surgery has results that are at least the equal, if not better regarding the quality of postoperative life [17].

The results of some studies have shown that laparoscopic-assisted vaginal surgery has longer operating times, a lower loss of blood, shorter hospital stay, lower decrease of hemoglobin levels, less postoperative pain, less postoperative complications and quicker convalescence [32]. The quality of life represents the key result sought in different hysterectomy approaches, but this aspect requires further investigation.

Only two studies have used the quality of life as a main result, whereas others have mentioned it as a secondary result. The conclusion was that up to 12 weeks after the intervention, the quality of life was improved after laparoscopic hysterectomy compared to abdominal hysterectomy. Studies have proven that even after four years, laparoscopic hysterectomy offers advantages over the abdominal hysterectomy, the quality of life being significantly improved [36].

## 6. Conclusions

Due to the fact that the hysterectomy is one of the most common gynecological procedure for women, efforts are being made constantly to make it as simple and as easy for women. The general tendency is to perform as many minimally invasive hysterectomies, either by vaginal approach or laparoscopic approach. These procedures have better functional results, both regarding the much lower postoperative morbidity and faster convalescence. Nonetheless, laparoscopic hysterectomy has been proven to have a higher rate of major complications than vaginal hysterectomy, and the operating time is longer. On the other side, laparoscopic hysterectomy requires a shorter hospital stay, has much lower levels of postoperative pain, delivers a higher quality of life and allows the patient to return quicker to daily activities.

Minimally invasive surgery has the goal of obtaining clinical results that are at least equal to classic surgical techniques, but with a quicker convalescence. In the case of laparoscopic hysterectomy, the results indicate better postoperative recovery when compared to abdominal hysterectomy. This is why women with benign gynecological diseases who require a hysterectomy and are eligible for the laparoscopic approach, should have the chance to opt for it.

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