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Guest Editors: Liselotte Mettler, Harry Reich, Limin Feng, Shailesh Puntambekar, Adolf Gallinat, and Michael Stark

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Editorial Board

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Editorial

Hysterectomy: Current Methods and Alternatives

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Hysterectomies performed in the field of obstetrics and gynaecology until the 19th century always had a lethal end. In the 20th century they were performed quite successful concerning survival but perhaps too frequently, whereas the 21st century has witnessed a steep decline in hysterectomy numbers. It is, therefore, an opportune time to review the indications for hysterectomies and hysterectomy techniques as well as the present and future status of this surgical procedure.

There is a widespread consensus that hysterectomies are primarily to be performed in cancer cases and obstetrical chaos situations even though minimal invasive surgical (MIS) technologies have made the procedure more patient friendly than the classical abdominal opening. Today, minimally invasive hysterectomies are performed as frequently as vaginal hysterectomies, and the vaginal approach is still the first choice if the correct indications are given. It is rarely necessary to open the abdomen; this procedure has been replaced by laparoscopic surgery with multiple- and single-port entries. Laparoscopic and robotic-assisted laparoscopic surgery can also be indicated for hysterectomies in selected patients with gynaecological cancers.

For women of reproductive age, laparoscopic myomectomies and numerous other uterine-preserving techniques are applied in a first treatment step of meno-metrorrhagia, uterine adenomyosis, and submucous myoma. These interventions are only followed by a hysterectomy if the pathology prevails.

We have selected six papers to reflect the present status of hysterectomies and alternate techniques preserving the uterus. In the time of organ preserving minimal invasive surgery in splendid cooperation with imaging technologies and early recognition of the disease, the number of hysterectomies definitely decreases and will hopefully one day be only used in cases of malignancy. Even malignancy treatment, of course, totally depends on early recognition and possibly can also be treated by different modalities than resection in the future.

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Review Article

Hysterectomy—Current Methods and Alternatives for Benign Indications

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Hysterectomy is the commonest gynecologic operation performed not only for malignant disease but also for many benign conditions such as fibroids, endometrial hyperplasia, adenomyosis, uterine prolapse, dysfunctional uterine bleeding, and cervical intraepithelial neoplasia. There are many approaches to hysterectomy for benign disease: abdominal hysterectomy, vaginal hysterectomy, laparoscopic assisted vaginal hysterectomy (LAVH) where a vaginal hysterectomy is assisted by laparoscopic procedures that do not include uterine artery ligation, total laparoscopic hysterectomy (TLH) where the laparoscopic procedures include uterine artery ligation, and subtotal laparoscopic hysterectomy (STLH) where there is no vaginal component and the uterine body is removed using a morcelator. In the last decades, many new techniques, alternative to hysterectomy with conservation of the uterus have been developed. They use modern technologies and their results are promising and in many cases comparable with hysterectomy. This paper is a review of all the existing hysterectomy techniques and the alternative methods for benign indications.

1. Introduction

The term hysterectomy originates from two Greek words: "hystero" which means uterus and "ectomy" which means resection removal from the human body. This surgical procedure is indicated in several common gynecologic problems. Hysterectomy is either total or subtotal, with or without the adnexae and depended on the way performed: abdominal, vaginal and laparoscopic or laparoscopic assisted vaginal hysterectomy. Historically the first vaginal hysterectomy was performed by Conrad Langenbeck in 1813, the first subtotal abdominal hysterectomy by Walter Burnham in 1853, the first elective abdominal hysterectomy by Clay and Koeberle in 1863, and the first laparoscopic hysterectomy by Harry Reich in 1988.

2. Material and Methods

There are several indications for hysterectomy or the alternative procedures with preservation of the uterus which will be analyzed in detail. In this paper, only benign conditions will be reviewed.

2.1. Fibroid Uterus. Fibroids (myomas) originate from the uterine smooth muscle wall. The percentage of malignant transformation to sarcoma is 0,1–0,8% according to various references. Fibroids, depending on size and location can cause menorrhagia or symptoms from pressure to adjacent organs, for example, ureters, bladder, or intestine. Before proceeding to hysterectomy for a fibroid uterus, reproductive activity of the patient must be completed.

2.1.1. Surgical Approach

(I) Abdominal Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(II) Laparoscopic Hysterectomy:

(a) *Total*: (+/− initially laparoscopic myomectomy for reduction of the uterine volume): with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(III) Laparoscopic Assisted (Total) Vaginal Hysterectomy (LAVH). (+/− initially laparoscopic myomectomy for reduction of the uterine volume): with or without bilateral salpingoophorectomy.

(IV) Vaginal (Total) Hysterectomy: with or without bilateral salpingoophorectomy.

2.1.2. Alternative Methods

(I) Myomectomy:

(a) via laparotomy,
(b) via laparoscopy.

(II) Uterine artery embolism (UAE).

(III) Transvaginal Temporary Uterine Artery Occlusion.

(IV) MRI-Guided Focused Ultrasound (MRgFUS).

(V) Medical treatment (progesterone mifepristone and asoprisnil under investigation).

2.2. Endometrial Hyperplasia. Endometrial hyperplasia with atypia associated with a high risk for malignant transformation, is an absolute indication for hysterectomy. In endometrial hyperplasia without atypia, hysterectomy is indicated only if pharmacological agents cannot control menorrhagia.

There are four categories of endometrial hyperplasia:

(a) simple hyperplasia without atypia,

(b) complex hyperplasia without atypia,

(c) simple hyperplasia with atypia,

(d) complex hyperplasia with atypia.

2.2.1. Surgical Approach

(I) Abdominal Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(II) Laparoscopic Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(III) Laparoscopically Assisted (Total) Vaginal Hysterectomy (LAVH): with or without bilateral salpingoophorectomy.

(IV) Vaginal (Total) Hysterectomy: with or without bilateral salpingoophorectomy.

2.2.2. Alternative Methods

Operative hysteroscopy and resection of the endometrium (endometrectomy) using a resectoscope in case of hyperplasia without atypia (Trans Cervical Resection of the Endometrium—TCRE),

Operative hysteroscopy and cauterization of the endometrium using a resectoscope in case of hyperplasia without atypia (Rollerball),

Thermal uterine balloon therapy system for endometrial ablation in case of hyperplasia without atypia,

Medical treatment (pharmacological agents such as progesterone) in case of hyperplasia without atypia,

Insertion of levonorgestrel hormone releasing intrauterine device (LNG-IUD) in case of hyperplasia without atypia.

2.3. Adenomyosis. A benign condition of the uterus which can cause menorrhagia characterized by diffuse spread of ectopic endometrium in the myometrium. Hysterectomy is indicated when other therapeutic approaches have failed to control symptoms.

2.3.1. Surgical Approach

(I) Abdominal Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(II) Laparoscopic Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(III) Laparoscopic Assisted (Total) Vaginal Hysterectomy (LAVH): with or without bilateral salpingoophorectomy.

(IV) Vaginal (Total) Hysterectomy: with or without bilateral salpingoophorectomy.

2.3.2. Alternative Methods

Adenomyomatectomy via laparotomy or laparoscopy.

Combination of hysteroscopic resection of the endometrium (Trans Cervical Resection of the Endometrium—TCRE) and hysteroscopic cauterization to the endometrium with the Rollerball device.

2.4. Uterine Prolapse. It is not an absolute indication for hysterectomy. In case of absence of other uterine pathology (such as sarcoma, carcinoma of the endometrium, carcinoma of the cervix) the translocation of the uterus in its natural position and the surgical fixation of the uterus in the pelvis have better results than hysterectomy in the anatomy of the pelvic floor.

2.4.1. Surgical Approach

(I) Total Hysterectomy:

(a) *Abdominal Total*: with or without bilateral salpingoophorectomy.

(b) *Vaginal Total*: with or without bilateral salpingoophorectomy.

(c) *Laparoscopic Total*: with or without bilateral salpingoophorectomy and sacrocolpopexy or lateral fixation of the vaginal vault using the J.B. Dubuisson method (using a polypropylene mesh). Laparoscopic approach is accompanied with a "Burch" or a "free Tension Vaginal Tape" procedure.

(d) *Laparoscopic assisted total vaginal hysterectomy*: with or without bilateral salpingoophorectomy.

(II) Subtotal Hysterectomy: Only in Cases That Cervical Pathology, for Example, CIN or Cervical Carcinoma Has Been Excluded

(a) via laparotomy + cervicosacropexy,

(b) via laparoscopy + cervicosacropexy or lateral fixation of the cervical stump using the J.B. Dubuison method (using a polypropylene mesh).

2.4.2. Alternative Methods.

Conservation of the Uterus: When Other Uterine Pathology Has Been Excluded and the Only Problem Is the Prolapse.

(a) Fixation of the uterine ligaments by laparotomy or laparoscopy.

(b) Fothergill isthmical uteropexy (Manchester repair) in case of simple elongation of the cervix.

(c) Isthmical sacropexy (sacrocolpopexy) by laparotomy or laparoscopy.

(d) Kapandji procedure.

(e) Colpoclisis.

2.5. Dysfunctional Uterine Bleeding (DUB). This common cause of abnormal uterine bleeding pattern is diagnosed when anatomical causes have been excluded. The problem is a hormonal imbalance in the hypothalamus-hypophysis-gonads axis.

2.5.1. Surgical Approach

(I) Abdominal Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(II) Laparoscopic Hysterectomy:

(a) *Total*: with or without bilateral salpingoophorectomy.

(b) *Subtotal*: with or without bilateral salpingoophorectomy.

(III) Laparoscopic Assisted (Total) Vaginal Hysterectomy (LAVH): with or without bilateral salpingoophorectomy.

(IV) Vaginal (Total) Hysterectomy: with or without bilateral salpingoophorectomy.

2.5.2. Alternative Methods

(a) Insertion of levonorgestrel hormone-releasing intrauterine device (LNG-IUD).

(b) Rollerball electrocoagulation (RBE).

(c) Nd:YAG laser ablation.

(d) Transcervical resection of endometrium (TCRE).

(e) Thermal uterine balloon therapy system for endometrial ablation.

(f) Global 3D Bipolar Ablation Method.

(g) Punctual Vaporizing Method.

(h) Endometrial Ablation by Intrauterine Instillation of Hot Saline.

(i) Diode Laser Method.

(j) Photodynamic Therapy.

(k) Microwave Method.

(l) Radiofrequency Method.

(m) Cryotherapy Method.

2.6. High Grade Cervical Intraepithelial Neoplasia (CIN III). In younger patients who have not completed their family an excision of the transformation zone using electrocautery (LLETZ) or a classical conisation of the cervix using scalpel or laser is indicated. In older patients who have completed their family, trachelectomy or even an abdominal hysterectomy with or without the ovaries is indicated.

A review of all the existing and especially the new techniques of hysterectomy and its alternatives follows.

(1) Total laparoscopic hysterectomy (TLH) with or without salpingoophorectomy.

(2) Subtotal laparoscopic hysterectomy (STLH) with or without salpingoophorectomy.

(3) Laparoscopic assisted vaginal hysterectomy (LAVH) with or without salpingoophorectomy.

(4) Laparoscopic adenomyomectomy in case of focal adenomyosis.

(5) Isthmical sacropexy (sacrocolpopexy with conservation of the uterus).

(6) Cervicosacropexy after laparoscopic subtotal hysterectomy.

(7) Lateral fixation of the cervical stump or the vaginal vault (J.B. Dubuisson method).

(8) Uterine artery embolism (UAE) in case of uterine fibroids.

(9) Ttansvaginal temporary uterine artery occlusion.

(10) MRI guided focused ultrasound (MRgFUS).

(11) Hysteroscopic (transcervical) resection of the endometrium (endometrectomy) with resectoscope (TCRE).

(12) Hysteroscopic cautery to the endometrium with resectoscope (Rollerball).

(13) Nd-YAG Laser Ablation.

(14) Thermal uterine balloon therapy system for endometrial ablation.

(15) Global 3D Bipolar Ablation Method.

(16) Punctual Vaporizing Method.

2.6.1. Total Laparoscopic Hysterectomy (TLH)

Position

The patient is placed in the supine position with both hands on her sides using extension tubes for intravenous access. Her knees slightly bended to avoid pressure. Calves slightly turned laterally. Rumps 10 cm outside the operation table edges. The height of the operation table 30 cm lower than in classical laparotomy. Upper limbs insulated from the operating table.

proceduree

There are placement of the uterine manipulator device. Small incision vertical or round on the lower edge of the umbilicus 10 mm in length. Insertion of the Veress needle. Security test using a syringe. Inflation of the peritoneal cavity through the veress needle with CO_2. The pressure limit is 14–18 mmHg. Insertion of the main trocard 10 mm wide and through that insertion of the laparoscope and inspection of the whole peritoneal cavity. There are placement of the patient in trendelenbourg position and insertion of the lateral trocards (5 mm width) trying to avoid the epigastric vessels (superficial and deep) and umbilical arteries. Placement of the middle operating trocard (5 mm width) above the pubis symphysis. The left round ligament is grasped and uterus is turned onto the other side in order to put tension on it. The round ligament is coagulated using bipolar diathermy and cut using scissors. The parametrium is opened and the frontal sheath is cut to the uterine-urinary bladder peritoneal fold. A "window" is opened on the posterior sheath of the broad ligament. The same procedure on the right side. Ovarian ligaments or suspensor ligaments (depending on the indication) are grasped, coagulated and cut. The uterine-urinary bladder peritoneal fold is grasped, divided and cut to the lateral edge. The frontal vaginal vault then appears. The ascending and descending branches of the uterine arteries are found in the parametrium, coagulated with bipolar diathermy and cut. Uterosacral ligaments are grasped and cut where they conjoint. Vaginal vault is presented using the manipulator and a circular incision is performed and uterus can now be removed through the vagina. Uterus is placed in the vagina so that inflation of the abdomen is not disturbed. Vaginal vault is coagulated only mildly in bleeding spots to avoid tissue necrosis. Suturing of the vaginal vault edges and uterosacral ligaments (2 stitches in the ankles). Checking of the haemostasis. Removal of the instruments and the pneumoperitoneum. Suturing of the wounds where trocards were placed.

2.6.2. Subtotal Laparoscopic Hysterectomy (STLH). The differences between this procedure and Laparoscopic total hysterectomy are listed below. (1) When parametrium is divided we stop at the isthmus where uterine artery is divided in her ascending and descending branches. Thermal ligation is performed only for the ascending branches. (2) Circular incision is performed round the isthmus and not around the vaginal vault. (3) Uterine body is removed using a morcelator through the middle operative trocard and not through the vagina as in total hysterectomy. (4) Ovaries are placed in a laparoscopic bag when removed. (5) Uterosacral ligaments are not incised. (6) Suturing of the cervical stump and not of the vaginal vault is performed.

2.6.3. Laparoscopic Assisted Vaginal Hysterectomy (LAVH). In this procedure, laparoscopic approach is used only for the ligation and incision of the round ligaments and the suspensory or ovarian ligaments whether ovaries are going to be removed or not. Ligation and incision of the uterine arteries and the rest of the procedure is performed through the vaginal route.

2.6.4. Laparoscopic Adenomyomectomy (Focal Adenomyosis). Excision of adenomyomas can be performed using the laparoscopic approach but is completely different when compared to the laparoscopic myomectomy. Surgical procedure is certainly more difficult because adenomyomas have no clear margins from the normal uterine smooth muscle wall. In certain occasions the surgeon is obliged to perform a tumor reduction operation and remove only part of the mass. Another difference comparing with myomectomy is the tissue deficit that the surgeon has to deal with when adenomyoma is removed and the deficit has to be sutured. There are very few references in the international literature but the results of this operation seem promising even when it is performed as a mass-reduction operation.

2.6.5. Laparoscopic Isthmical Sacropexy (Sacrocolpopexy with Conservation of the Uterus). There are two different techniques. The first is described as lateral fixation only of the right side due to the presence of rectum and sigmoid colon on the left side. The second referred as "Scali" technique is described as bilateral fixation using a "V" shaped mesh. This technique is described below.

There Are Three Basic Principles. (a) Suspension of the uterus in its normal position and fixation of the pelvic floor below the urinary bladder. (b) Treatment of the stress incontinence even if the patient is asymptomatic. The reason is that suspension of the uterus will reveal or worsen the stress incontinence. (c) Surgical reconstruction of the rectovaginal diaphragm.

Surgical Procedure. There is incision on the peritoneum 1 cm below the urinary bladder—uterine peritoneal fold. The space between the bladder and uterus is exposed and the bladder is pulled downwards. These space's lateral margins (pillars) are joined inferiorly in the height of the posterior

Table 1: Alternative to hysterectomy methods for benign disease.

Laparoscopic adenomyomectomy in case of focal adenomyosis
Isthmical sacropexy (sacrocolpopexy with conservation of the uterus)
Cervicosacropexy after laparoscopic subtotal hysterectomy
Lateral fixation of the cervical stump or the vaginal vault (J.B. Dubuisson method)
Uterine artery embolism (UAE) in case of uterine fibroids
Ttansvaginal temporary uterine artery occlusion
MRI guided focused ultrasound (MRgFUS)
Hysteroscopic (transcervical) resection of the endometrium (endometrectomy) with resectoscope (TCRE)
Hysteroscopic cautery to the endometrium with resectoscope (Rollerball)
Nd-YAG Laser Ablation
Thermal uterine balloon therapy system for endometrial ablation
Global 3D Bipolar Ablation Method
Punctual Vaporizing Method

urethra. The vaginal wall is exposed and the broad ligament is opened at the isthmus far away from the uterine arteries. A wide window is opened in the posterior fold of the broad ligament. The peritoneum between the uterosacral ligaments is opened to 1 cm above the point the two uterosacral ligaments joint together ("Λ" point). The sacral promontory (L5-S1 space), the iliac veins and the ureters are recognized. The peritoneum covering the sacrum is opened and anterior elongated ligament and middle sacral vessels are recognized. The latest are coagulated only if they cannot be removed from the points that stitches are to be placed. Opening of the peritoneum continues to the point that uterosacral ligaments joint. A "V" shaped mesh is inserted through the middle operating trocard (10–12 mm). The wide part of the mess is placed in the space in front of the urinary bladder and the sides are placed through the windows in the broad ligaments. The sides of the mess are barried behind the uterus at the isthmus. The two pararectal spaces are opened, suspensory muscles of the rectum are recognized and the sides of the mesh are fixed in this space and the Cardinal ligaments. The mesh is sutured on the vaginal wall using 2/0 nonabsorbable stitches with a 23 mm needle (6–8 stitches). Restoration of the peritoneum only in the rectovaginal space follows. Then sacropexy is performed. The two sides of the mesh are fixed on the anterior longitudinal ligament of the spine with two stitches using no1 nonabsorbable stitches with a 30 mm needle. Special attention is needed to avoid injury of the intervertebral disk. Restoration of the peritoneum is completed in order to cover the mesh in the retroperitoneal space.

After completion of the procedure, a Burch colposuspension or a tension-free vaginal tape application is performed for the reasons already mentioned. In case stress incontinence is due to sphincter failure Burch colposuspension is not indicated and a tension-free vaginal tape has to be applied. At the end a typical posterior repair is performed.

Complications:

(a) When opening the space in front of the urinary bladder, injuries to the bladder are common. Injuries to the ureters are more uncommon.

(b) When opening the broad ligaments, the sigmoid colon can be injured.

(c) When opening the recto-uterine space, the rectum can be injured.

(d) When the anterior longitudinal ligament is prepared, bowel, ureters, middle sacral artery, and left iliac vein can be injured.

(e) Infection of the mesh.

2.6.6. Cervicosacropexy after Laparoscopic Subtotal Hysterectomy. During the time of uterus removal from peritoneal cavity, the mesh that is going to be used (polypropylene Type 1) is drawn and cut out. It is inserted through the medial operating trocard and detained on the cervical stump with staplers and four sutures using nonabsorbent stitch 1, with 23 mm needle.

Opening of the peritoneum in front of the anterior elongated ligament and opening of a "channel" between this and the cervical stump. The mesh inserted within the channel and fixation on the anterior elongated ligament with staplers and two sutures using nonabsorbent stitch. Restoration of the peritoneum follows.

After completion of the operation, Burch colposuspension or insertion of a tension-free vaginal tape is needed. In cases that urine incontinence is due to sphincter deficiency, Burch procedure has no place and the placement of a tension-free vaginal tape would be preferable. Finally, a typical posterior repair is performed.

2.6.7. Laparoscopic Lateral Fixation with the Use of Synthetic Mesh (J.B. Dubuisson Method)

(A) Of Cervical Stump (After Laparoscopic Subtotal Hysterectomy). During the time of uterus removal from the peritoneal cavity, the mesh that is going to be used (polypropylene Type 1) is drawn and cut out in two elongated parts. These two parts are inserted in the peritoneal cavity through the suprapubic operative trocard and are expanded on the cervical stump. Fixation on the cervical

stump using stapler and four nonabsorbent stitches 1, with 23 mm needle follows. A needle holder is inserted over the iliac promontory on the left, two to three centimeters outside the side trocard. Forward this up to the parietal peritoneum. Forward outside the peritoneum until meeting the one side of the mesh. The side of the mesh is grasped and pulled up to the skin and finally fixed with a small grasper. The same surgical procedure to the other side. Restoration of the peritoneum over the cervical stump. Pulling of the sides of the plexus- fixing on the sheath of the external oblique abdominal muscle with nonabsorbent stitches.

Similarly to the classical sacropexy, a Burch colposuspension or insertion of a tension-free vaginal tape is needed afterwards. If incontinence is due to sphincter deficiency, Burch operation has no use and the placement of a tension-free tape would be preferable. Finally, a typical posterior repair suture is performed.

(B) Of Vaginal Stump (After Laparoscopic Total Hysterectomy). It is the same surgical technique. The only difference is that the mesh is fixed on the vaginal and not on the cervical stump.

2.6.8. Uterine Artery Embolization (UAE). It is a transcutaneous, X-Ray guided technique, performed by specialists in intervention-radiography [1]. An angiography catheter is inserted in the uterine arteries through one of the two common femoral arteries. Infusion of the embolic agents (polyvinyl alcohol particles or tris-acryl gelatin microspheres) follows in the two uterine arteries until their blood flow decelerates [1–7].

The mechanism of UAE is the irreversible ischemic necrosis of the fibromyomas caused by the crucial decrease of the blood flow, having as a result their necrosis, while the rest of the normal myometrium is capable of surviving [8, 9]. The whole procedure takes place under intravenous anesthesia and lasts approximately one hour.

The recovery is brief and relatively mild, with 4-5 days of recurrent uterine cramping and constitutional symptoms (nausea malaise, fatigue and low-grade fever). Patients can usually return to normal activities within 8–14 days [6, 10–13].

UAE technique was first described in 1995 [2]. Several studies show a 50–60% decrease in fibroids dimensions and also a decrease in menorrhagia and the rest of the symptoms related to them in a percentage that reaches 85–95% in short- and middle-term follow-up [3, 5–7, 10, 14–20].These studies also report 87–97% patient satisfaction after the procedure. With concern to the mild complications, according the perspective study FIBROID registry, a percentage of 2,7% (90 out of 3041 patients) in the immediate postoperative period and 26% (710 out of 2729 patients) after the hospital exit are reported. The percentages of the severe complications are 0,6% and 4,1%, respectively, [13].

A common complication of UAE is the infracted fibroid to become endocavitary and "aborted" through the vagina (approximately in 10% of the cases) [6, 21]. According to Fred Burbank [22], this is not a complication, if the patient is well informed and ready to consider this as part of the procedure. In any case, this is usually reported after UAE for submucosal fibroids or fibroids lying within the uterine wall and protruding inside the uterine cavity. According to the literature the "abortion" of such fibroids can take place within 6 months and 4 years [23]. Most of the times the "abortion" is spontaneous while in some cases cervical dilation or even hysteroscopic removal is needed when the fibroid remains connected to the uterus.

The most serious complication of UAE is endometritis (less than 1%) [3, 6, 10, 11, 13, 24], which if left without antimicrobial prophylaxis could lead to sepsis, or even death (~0,05/1000) [25].

Concerning the failure rate of the procedure, according to the FIBROID registry study after three years of follow-up there was a need for hysterectomy, myomectomy or a repeat UAE procedure in 9,8%, 2,8% and 1,8%, respectively, [26]. The need for a repeat operation is not only due to new fibroids but also due to incomplete infarction of the old ones [27]. The successful embolization of only one uterine artery is considered as a technical failure of the procedure, since in most of the cases the blood flow to the fibroids derives from both the uterine arteries [28]. There is also dispute among several studies whether the size or the number of fibroids are predictive factors of possible failure [29].

Uterine artery embolization (UAE) for fibroids has been extensively investigated. Since 1995 when was first introduced and particularly in the last 5 years, several high-quality studies reported on its outcome have been completed. These studies have demonstrated that when successful, UAE can provide symptom control similar to surgery. Although hysterectomy remains more effective in symptom control and durability, many women are seeking uterine-sparing alternatives. UAE has emerged as the leading minimally invasive treatment for fibroids: Morbidity is low and recovery rapid; serious complications are quite rare. With a few anatomical exceptions, UAE is appropriate for most patients with symptomatic fibroids who have completed childbearing [30]. Although pregnancy is certainly possible after embolization [30–32] existing data suggest better reproductive outcomes for myomectomy in the first 2 years after treatment. The current recommendation is for myomectomy as a first choice for patients seeking to become pregnant.

2.6.9. Transvaginal Temporary Uterine Artery Occlusion. It is an alternative method targeting to decrease the blood flow in the uterine arteries in order to treat fibroids. The theory supporting this technique is that a fibroid necrosis can take place after temporary occlusion of uterine arteries and temporary uterine ischemia that follows [33, 34]. It demands special equipment and the duration of the procedure is 6 hours. Immediately after the procedure the fibroids and the uterine volume decreases 40-50%. In 6 months follow-up, the symptoms improved 80–90%.

Comparing transvaginal temporary uterine artery occlusion with uterine artery embolization, in this technique there is no exposure to radiation and the patients has much less postoperative pain. Although the short-term results seem to be similar to UAE, the long-term results are insufficient since the ischemia is much weaker compared to embolization [29].

2.6.10. MRI Guided Focused Ultrasound (MRgFUS). It is a new, minimal interventional method of thermal destruction of fibroids, approved by the US Food and Drug Administration (FDA) since 2004. High frequency ultrasound waves penetrate the anterior abdominal wall and focus in a specific target inside the fibroid increasing the temperature up to 55–90°C, which leads to necrosis (coagulative necrosis) within a few seconds. The simultaneous use of MRI allows the exact focus on the target and real-time temperature feedback [35–37]. The technique demands special equipment, has to be performed by an expertised specialist and under intravenous anesthesia [29].

The method is based on cconsecutive exposures to focused sonications (ultrasound energy), lasting 20 seconds each and resulting in a small (0.5 cm^3) bean-shaped ablated volume. There is a pause of 90 s to elapse for the tissue to return to its baseline temperature, between sonications. Multiple sonications are required to cover the entire target volume, which is typically limited to a maximum of 150 cm^3 of tissue, and total procedure time is usually over 3 hours. During the procedure short-term lower abdominal pain, leg pain and buttock pain are common. Patients are usually discharged home 1 hour after the procedure and return to usual activities, on average, within 48 hours [35].

After taking into account that the total number of patients treated with MRgFUS is very small worldwide, its assessment and comparison with other techniques are unsafe. Although compared to UAE there is no exposure to radiation and the postoperative pain is less, in MRgFUS there are constrictions concerning the volume and the number of fibroids. There is a relation between time and total volume of fibroids. This technique also has minor results concerning the decrease of the uterus and fibroid volume [29]. The existence of some special characteristics, like fibroids neighboring blood vessels and nerves or sensitive organs like bowel or urinary bladder, diminishes the number of candidates for the method [36]. Preservation of fertility after MRgFUS is not well documented. It is interesting that the procedure is more successful when a three months treatment with GnRH-agonists precedes, so as for the fibroid blood flow to be decreased [38].

2.6.11. Hysteroscopic (Transcervical) Resection of the Endometrium (Endometrectomy) with Resectoscope (Transcervical Resection of the Endometrium-TCRE). In about 20–25% of hysterectomies the indication is menorrhagia without any obvious pathology. TCRE was first described in 1983 from DeCherney and Polan [39], and is still considered as the gold standard alternative method since it combines histological diagnosis and effective treatment. Its target is the resection of the whole endometrium, including basic layer. It is suitable for patients who do not respond to medical treatment, do not want hysterectomy and are not in reproductive age. Before the procedure, malignant disease and atypia in cases of endometrial hyperplasia should be excluded. TCRE is combined with the use of rollerball for the destruction of the endometrium in special spots like fundus and areas around tubal ostia. Preoperative treatment with GnRH-agonists or danazol is not necessary. Postoperatively, the placement of levonorgestrel hormone-releasing intrauterine device (LNG-IUD) has been proposed. Especially in adenomyosis cases this combination increases the success rate of the procedure. In a brief description, endometrium resection starts from the fundus to the isthmus of the uterus clockwise. The resection ends to the isthmus because of the risk of subsequent haematometra. As already mentioned the fundus is coagulated using rollerball along with the tubal ostia and the whole area of endometrial resection [40].

2.6.12. Hysteroscopic Cauterization of the Endometrium with Resectoscope (Rollerball)

First Generation Endometrial Ablation Method. The technique was first described by Vancaille in 1989 [41] and as TCRE, is among the most effective first generation methods, done under hysteroscopic guidance. It is important that the endometrium should be as thin as possible, when applied. That is why follicular phase of the menstrual cycle is preferred. The results are even better if GnRH- agonists or danazole are administered for one or two cycles before the operation [42]. The success rate (amenorrhea) after the procedure reaches 100% against 75% without any previous pharmaceutical treatment, the operative time is less because of better visibility, the patients safety and the surgeons effortlessness much greater. It is suitable for these patients who do not respond to pharmaceutical treatment, do not want hysterectomy and are not in reproductive age. Before the procedure malignancy and atypia should be excluded. The technique uses monopolar energy at 60–80 Watt in order to destroy the endometrium through coagulation or at 160 watt to destroy it through vaporization. The percentage of the remnant functional endometrium rates at 70% [43]. So it would be favorable for the patient to administer a combination of estrogen-progesterone or to place a levonorgestrel hormone-releasing intrauterine device (LNG-IUD).

It seems that the combination of the two methods (TCRE-ROLLERBALL) is the gold standard when concerning the endometrium destruction and the avoidance of hysterectomy [40]. Mistletoe study which included 16087 patients in the United Kingdom, showed less complications with the usage of rollerball in difficult to reach with the loop spots, like fundus and the tubal ostia. The same study showed that 75–85% of the patients were very satisfied [44, 45].

2.6.13. Nd-YAG Laser Ablation

First Generation Endometrial Ablation Method. It was introduced in 1981 by Goldrath et al. [46]. It requires preoperative hormonal treatment to assure that the endometrium is thin and atrophic. During the procedure there is no use of electric energy and Normal Saline or Dextrose 5% in 50% Saline or Ringer's Lactate Solution is used to dilate the endometrial cavity. There are three techniques: dragging or touching (touch technique), blanching (nontouch technique) and dragging and blanching in combination (combination technique). There is no bleeding because the treatment is strictly by coagulation. In order to avoid meeting the same areas

twice there is need for strict charting of the endometrial cavity. The most common technique used is the combination technique; nontouch technique is used in the cornea areas and touch technique in the rest of the endometrial cavity. The disadvantage of Nd-YAG Laser ablation is that it is expensive because of the need for single-use optical fibers [40].

2.6.14. Thermal Uterine Balloon Therapy System for Endometrial Ablation

Second Generation Endometrial Ablation Method. There are many companies manufacturing such systems of thermal endometrial destruction. The technique uses the successful heating of some dilative liquid within the balloon that is placed inside the endometrial cavity. The procedure lasts about 8 to 15 minutes depending on the manufacturing company and the success rate of endometrial destruction varies in different studies. The temperature of the liquid inside the balloon ranges from 75–80°C to 87 + 5°C depending again on the manufacturer. Although the procedure takes place without hysteroscopic guidance and is characterized as "blind", this second generation technique is safe because the strict observation of all the crucial parameters for the patient's safety. Before the procedure the existence of endometrial polyps or fibroids, congenital anomalies of the uterus, pregnancy, pelvis inflammation, endometrium hyperplasia with atypia and malignancies of the endometrium or the cervix should be excluded. This method should take place during the follicular phase of the menstrual cycle [40].

2.6.15. Global 3D Bipolar Ablation Method

Second Generation Endometrial Ablation Method. In this technique a three-dimension double polar device is used. The device is connected to a RF generator and causes ablation by coagulation of the endometrium and the superjacent myometrium in a certain set depth. The diameter of the device is 6,5 mm. The power of the generator is fixed to 180 W. It is completed in about one minute and does not demand previous hormonal treatment. The success rate (amenorrhea) is about 80% [40].

2.6.16. Punctual Vaporizing Method

Second Generation Endometrial Ablation Method. This technique uses vaporization and not coagulation of the endometrium. Two different devices are manufactured by two different companies. The first uses monopolar energy, the second bipolar. These devices can perform desiccation, vaporization or blended cut depending on the generator adjustment. Their use is not only restricted to endometrial destruction, but can be used in the treatment of submucosal fibroids, polyps and adhesiolysis. The advantage of the bipolar device is the use of Normal Saline for dilatation which makes it safer even in the procedure lasts longer [40].

Other Second-Generation Endometrial Ablation Methods are: Endometrial Ablation by Intrauterine Instillation of Hot Saline, Diode Laser Method, Photodynamic Therapy, Microwave Method, Radiofrequency Method, and Cryotherapy Method.

3. Discussion

Independently the technique used, hysterectomy is one of the most common gynecological procedures. There are certain differences comparing various techniques related to indications, advantages and disadvantages. Abdominal hysterectomy, the most well established method, permits the surgeon to deal with any kind of pathology malignancy included, and has the benefit of the direct touch on the tissues. It also offers the benefit of the direct three-dimension visualization of the surgical field and additionally does not warrant expensive special instruments. On the other hand, laparoscopic approach is not indicated for malignant disease due to the hazard of spreading malignant cells by the gas (CO2) used to inflate the abdominal cavity, there is no direct touch on the tissues and warrants specialized surgeons and expensive instruments and equipments. Visualization is in two dimensions which require familiarization with the technique. Despite the disadvantages, laparoscopic approach offers better view of the whole abdominal cavity, magnification, enhanced ability to perform delicate manipulation of the tissues, blood loss is minimal and recovery of the patient is quicker with thrombotic complications occurring less often. In addition post laparoscopic procedure adhesions are rare compared to laparotomy procedures, pain is less, restoration of the gastrointestinal tract function is quicker, scarring much less and duration of in-hospital stay shorter. Another advantage of laparoscopy is the ability to record the procedure.

There are certain differences comparing total laparoscopic hysterectomy and laparoscopic assisted vaginal hysterectomy. In the first, vaginal removal of the uterus follows complete laparoscopic ligation and excision of all the pedicles. In the second, ligation and excision of the uterine arteries and the rest of the pedicles is performed using the vaginal route. In more details, in total laparoscopic hysterectomy thermal ligation and excision of the upper and the lower brands of the uterine arteries is performed, in subtotal laparoscopic hysterectomy thermal ligation and excision only of the upper brands of the uterine arteries and in laparoscopic assisted vaginal hysterectomy ligation and excision of the main uterine arteries. Vaginal hysterectomy on the other hand when indicated is a procedure with excellent results.

The alternative to hysterectomy techniques, which became available recently and most of them used advanced technology have also very good results when compared to hysterectomy. Most of them are indicated in case of menorrhagia and are based on endometrial ablation. Even if the control of blood loss is not 100% as it is in hysterectomy, it is satisfactory. In cases of menorrhagia due to fibroids the alternative methods are based in the shrinkage of them by tissue necrosis or disturbance to their blood supply. The results in this case are less satisfactory when compared to hysterectomy or myomectomy. Finally when uterine

prolapse is the indication for hysterectomy, the results of the alternative techniques are comparable and even better than hysterectomy. The surgical removal of a uterus that has otherwise no other pathology is an amputating operation that offers no extra benefits when compared to fixing the uterus in its proper position and repairing the pelvic floor system.

4. Conclusion

Hysterectomy, whatever the approach used (abdominal, vaginal, laparoscopic), remains the gold standard in the treatment of many uterine benign pathological conditions but we have to encourage the new techniques which use modern technologies and their results are promising and in many cases comparable with hysterectomy.

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Clinical Study

Long-Term Outcomes Following Laparoscopic and Abdominal Supracervical Hysterectomies

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Long-term outcomes, in terms of cervical stump symptoms and overall patient satisfaction, were studied in women both after abdominal (SAH) and laparosocopic (LSH) supracervical hysterectomies. Altogether, 134 women had SAH and 315 women LSH during 2004 and 2005 at our department. The response rate of this retrospective study was 79%. Persistent vaginal bleeding after the surgery was reported by 17% in the SAH group and 24% in the LSH group. Regular bleeding was reported by only 8% in both study groups, and the women rarely found the bleeding bothersome. The women reported a significant pain reduction after the surgery, but women having a hysterectomy because of pain and/or endometriosis should be informed about the possibility of persistent symptoms. The overall patient satisfaction after both procedures was high, but the patients should have proper preoperative information about the possibility of cervical stump symptoms after any supracervical hysterectomy.

1. Introduction

Hysterectomy is the ultimate treatment for women suffering from symptomatic fibroids, abnormal uterine bleeding and uterine malignancy and is one of the most frequent performed surgical procedures [1, 2]. There is no universal agreement about the optimal method of hysterectomy—abdominal, laparoscopic, or vaginal—and there is a question whether the cervix should be removed as a routine part of the hysterectomy.

The world's first successful supracervical abdominal hysterectomy (SAH) was performed in 1853 by Gilman Kimball in USA. Since then, the advantages and disadvantages of supracervical versus total hysterectomy technique have been discussed, with variable enthusiasm in different time periods and between countries. More recently, there has been a swing back to supracervical, with marked geographic variations [3–6]. In Scandinavia, the ratio of supracervical to total hysterectomy is traditionally high. At our department in Oslo, Norway, supracervical hysterectomy is the recommended procedure for women with benign conditions requiring hysterectomy and with no previous history of cervical dysplasia. Although laparoscopic supracervical hysterectomy (LSH) has gradually replaced abdominal hysterectomy, SAH is still performed in women where laparoscopic or vaginal approach is not feasible, mainly due to significant enlarged uterus [7].

Opponents of supracervical hysterectomy, either it is performed open or by a laparoscopic approach, often seem to be concerned with the risk of cervical stump symptoms such as vaginal bleeding and pelvic pain following the hysterectomy, causing patient distress and eventually repeated surgery. In a previous publication reporting long-term outcomes after LSH, we found that although vaginal bleeding and pelvic pain are frequently observed following LSH, the patient satisfaction following the procedure was high [8].

In this study, we wanted to evaluate whether the occurrence of vaginal bleeding and persistent pelvic pain are consequences of the cervix-sparing technique, or related to the surgical approach. Here we present the long-term outcomes in terms of cervical stump symptoms, women acceptability of such symptoms, and overall patient satisfaction after both abdominal and laparoscopic supracervical hysterectomies performed during the same time period.

2. Material and Methods

Following ethical approval, all women who were treated by LSH and SAH on the basis of a benign condition during 2004 and 2005 at the Department of Gynaecology, Oslo University Hospital Ullevål, Oslo, Norway, were sent a questionnaire. Nonresponders were sent a reminder letter four weeks following the original mail out. Firstly, the LSH-treated group were contacted between 12 and 36 months after surgery, while the SAH-treated group were contacted somewhat later, between 17 and 41 months after surgery.

The questionnaire was divided into two sections. The first section contained questions about reasons for having the hysterectomy, as well as menstrual pain and bleeding prior to the hysterectomy. In the second section, questions about experiences of menstrual bleeding and pain following the hysterectomy, any further treatments for such symptoms, any new symptoms related to the hysterectomy and overall satisfaction with the surgery were included. Standard 10-point visual analogue scales (VAS) were used to measure pain intensity and the extent to which bleeding was bothersome. The remaining questions were either dichotomous yes or no responses, or they provided women with either four or five categories of responses to choose from.

Data were analysed using SPSS for Windows (SPSS 14.0, SPSS, Inc, Chicago, IL, USA). Normally distributed continuous data from two groups of women were analysed using a two-sided Independent Samples Student t-test and when paired, the Paired Samples t-test. Categorical data were analysed using Pearson Chi-Square. Forward stepwise logistic regression analysis was used to calculate the adjusted odds ratios for continued menstrual/cyclical pain, continued vaginal bleeding, and patient satisfaction.

3. Results

Altogether, 134 women were identified as having had an SAH and 315 women an LSH during 2004 and 2005 and were therefore sent a questionnaire. Twelve women could not be contacted (five women in SAH group and seven women in LSH group); nine had moved to unknown addresses, and three had died from nongynecological conditions. The response rate in the two groups of women was 82% (SAH group : 106/129) and 78% (LSH group : 240/308), respectively.

Out of all 449 procedures, 228 (51%) were performed in 2004 and 221 (49%) in 2005. The total response rates for 2004 and 2005 were 75% and 81%, respectively. Mean age of the responders was 48 years (SD 7) in the SAH group and 45 years (SD 6) in the LSH group. There were no significant differences between responders and nonresponders in terms of age and incidence of repeated surgery in either of the two groups of women.

3.1. Reasons for Having the Hysterectomy. Most women in both treatment groups (59% in SAH group, 70% in LSH group) stated two or more reasons for having the hysterectomy, the dominating reasons being fibroids (86% versus 68%) and/or heavy bleeding (50% versus 67%). Among women having SAH, 22% stated pain and 4% endometriosis as a reason for the hysterectomy. Respectively, in the LSH group, 46% of women stated pain and 16% endometriosis as a reason for the hysterectomy.

3.2. Menstrual Bleeding. Nineteen women (5%) had reached the menopause before the hysterectomy, and three women had medically induced amenorrhoea. Self-reported preoperative menstrual data were available for 96 women in the SAH group and 220 women in the LSH group. The majority in both treatment groups reported their preoperative periodic bleedings to be very heavy (38% in SAH group versus 43% in LSH group) or heavy (18% versus 25%). The remaining women reported their preoperative periodic bleedings as moderately heavy (21% versus 18%), normal (19% versus 11%), or minimal (5% versus 3%).

Out of the responders, 19 women (17%) in the SAH group and 57 women (24%) in the LSH group reported experiencing vaginal bleedings after the hysterectomy. When comparing the occurrence of vaginal bleeding in the two treatment groups, the difference was not statistically significant ($P > .05$). Among women who underwent SAH, ten women (9%) reported to experience regular periodic bleedings, and nine (8%) experienced irregular vaginal bleedings. In the LSH group, 16 women (7%) experienced regular periodic bleedings, 25 women (10%) irregular bleeding patterns, seven women (3%) bleedings in relation to sexual activity, and the remaining nine women (4%) a combination of regular and irregular bleedings which also were related to sexual activity. In the SAH group, no significant age-related differences were found (OR 0.95, 95% CI: 0.87, 1.05), and reason for hysterectomy appeared not to influence the occurrence of persistent vaginal bleeding (Table 1). Adjusted odds ratios (OR) revealed that older women who had been treated by LSH were less likely to experience persistent vaginal bleeding (OR 0.89, 95% CI: 0.83, 0.95). Furthermore, vaginal bleedings after the procedure were less likely to be reported by women who had LSH because of pain (OR 0.41, 95% CI: 0.20, 0.85) or fibroids (OR 0.47, 95% CI: 0.23, 0.93), but more likely to be reported in women with heavy periods prior to surgery (OR 4.07, 95% CI: 1.32, 12.57) (Table 1).

All women who experienced persistent vaginal bleedings reported the amount of bleeding to be minimal (88% in SAH group, 90% in LSH group), or less than their normal preoperative periodic bleeding (12% versus 10%). The mean degree of bother caused by vaginal bleedings after the hysterectomy, scored on a 10-point VAS, was 1.7 (SD 2.7) in the SAH group and 1.1 (SD 2.0) in the LSH group, respectively.

3.3. Pain. Out of the responders, 60 women (55%) in the SAH group and 178 women (74%) in the LSH group suffered from menstrual pain before the hysterectomy. The preoperative mean pain score measured by a 10-point VAS was 5.3 (SD 2.5) in the SAH group and 6.8 (SD 2.1) in the LSH group, respectively. Twenty-three women (21%) in the SAH group and 89 women (37%) in the LSH group reported continued menstrual/periodic pain following their

Table 1: Adjusted risk estimates for experiencing persistent vaginal bleeding following abdominal and laparoscopic supracervical hysterectomy.

	Reason for hysterectomy		Number of women with vaginal bleeding	Odds ratio (95% CI)
Supracervical abdominal hysterectomy	Fibroids	Yes	16	0.66 (0.16, 2.71)*
		No	3	
	Heavy bleeding	Yes	11	1.28 (0.49, 3.35)*
		No	8	
	Pain and/or endometriosis	Yes	5	1.37 (0.43, 4.32)*
		No	14	
Supracervical laparoscopic hysterectomy	Fibroids	Yes	33	0.47 (0.23, 0.93)*
		No	24	
	Heavy bleeding	Yes	41	4.07 (1.32, 12.57)*
		No	16	
	Pain and/or endometriosis	Yes	23	0.41 (0.20, 0.85)*
		No	34	

* Forward stepwise logistic regression analysis.

hysterectomy. The mean pain score after hysterectomy was significantly less than before surgery after both procedures (SAH: mean pain score 2.3, SD 1.9, mean pain reduction 2.5, 95% CI: 1.3, 3.7, $P < .01$; LSH: mean pain score 3.5, SD 2.2, mean pain reduction 3.3, 95% CI: 2.7, 3.9, $P < .01$).

Whilst all women reported a significant decrease of pain intensity experienced after the hysterectomy, women having a hysterectomy because of pain and/or endometriosis reported significant higher levels of remaining menstrual/cyclical pain after both procedures (SAH: mean pain score 3.4, SD 2.1; LSH: mean pain score 3.5, SD 2.9), compared with women who did not report endometriosis and/or pain as a reason for the hysterectomy (SAH: mean pain score 1.9, SD 1.7; LSH: mean pain score = 0.9, SD 1.7), $P = .05$ and $P < .001$, respectively (Table 2). The adjusted odds ratios (OR) revealed that increased intensity of preoperative pain resulted in a greater chance of experiencing pain after both procedures (SAH: OR 3.9, 95% CI: 2.0, 5.7; LSH: OR 1.1, 95% CI: 1.0, 1.3).

3.4. Repeated Surgery. In total, 30 out of 449 women (7%) had a further related surgery after the hysterectomy (6% after SAH, 7% after LSH), the most common procedures being performed because of postoperative bleeding, hematomas with secondary infection and adhesions (Table 3). Three of the seven women who went on to have their cervix removed had their original hysterectomy because of endometriosis. Out of the women who reported experiencing continued menstrual bleeding after the hysterectomy, 11% and 7% underwent repeated surgery after SAH and LSH, respectively.

3.5. New Symptoms Following Hysterectomy. Out of the responders, 81 women (26% in SAH group, 22% in LSH group) reported experiencing new symptoms following their hysterectomy. Although some women reported to suffer from different forms of pain (pelvic pain, dyspareunia, pain related to the scar) after the hysterectomy, the majority of symptoms reported by the women appeared to be related to the menopause (vasomotoric symptoms, vaginal dryness, reduced libido, gained weight) (Table 4).

3.5.1. Satisfaction with Surgery. Almost all women reported being satisfied (SAH: 28%, LSH: 20%) or very satisfied (SAH: 58%, LSH: 70%) with the hysterectomy. After both procedures, women who reported being satisfied with the preoperative information were more likely to report being very satisfied with the hysterectomy (SAH: OR 5.5, 95% CI: 2.4, 13.0; LSH: OR 3.3, 95% CI: 1.8, 6.2). No significant difference regarding degree of total satisfaction was found comparing women who experienced persistent vaginal bleeding and women who had no vaginal bleeding after the hysterectomy. In both groups, women who reported having a new symptom following their hysterectomy, were less likely to report being very satisfied (SAH: OR 0.2, 95% CI: 0.1, 0.6; LSH: OR 0.2, 95% CI: 0.1, 0.4). No significant difference regarding degree of total satisfaction was found comparing women who had repeated surgery following SAH or not, whereas women who had repeated surgery following LSH were less likely to report being very satisfied (OR 0.1, 95% CI: 0.1, 0.5).

4. Discussion

This study reports the occurrence of long-term outcomes following both LSH and SAH in women with benign conditions, as well as the impact these outcomes have on the women's experiences. The relatively large sample size and an excellent response rate represent strengths of the study. Although all procedures were performed at the same department during the same time period, comparisons between the outcomes after the two supracervical procedures should be interpreted with care, as the women were selected and not randomised to the treatment groups. As the benefits of a laparoscopic compared with an abdominal approach are

Table 2: Pain intensity prior to and after surgery by reasons for hysterectomy.

	Reason for hysterectomy	*N*	Mean pain score prior to surgery* (SD)	Mean pain score after surgery (SD)	Mean diff. in pain scores (SD) [95% CI]	*P*-value
Supracervical abdominal hysterectomy	Fibroids	91	5.4 (2.5)	2.3 (1.9)	2.6 (2.8) [1.4, 3.8]	<.01**
	Heavy bleeding	52	5.6 (2.6)	2.3 (2.0)	2.5 (3.2) [0.7, 4.3]	<.01**
	Endometriosis/pain	27	6.7 (1.9)	3.4 (2.1)	3.0 (3.1) [0.1, 5.9]	.04**
Supracervical laparoscopic hysterectomy	Fibroids	151	4.8 (3.4)	1.1 (1.9)	3.7 (3.3) [3.2, 4.2]	<.001**
	Heavy bleeding	151	5.6 (3.2)	1.3 (2.0)	4.4 (3.4) [3.2, 4.9]	<.001**
	Endometriosis	37	7.5 (2.5)	3.5 (2.9)	4.0 (4.0) [2.7, 5.3]	<.001**
	Pain	104	7.1 (2.6)	1.9 (2.5)	5.3 (3.5) [4.6, 6.0]	<.001*

* 10-point VAS,** Paired Samples *t*-test.

Table 3: Surgical procedures performed after the hysterectomy.

Surgical procedures after hysterectomy	Supracervical abdominal hysterectomy *N**	Supracervical laparoscopic hysterectomy *N***
Resurgery within 24 hours due to bleeding	3	—
Laparoscopic adhesiolysis	—	6
Laparoscopic extirpation of cervix uteri	—	7
Drainage of postoperative hematoma/abscess	2	1
Bowel resection due to postoperative peritonitis	1	1
BSOE and removal of cervix uteri (sarcoma uteri)	—	1
Scar correction	1	3
Umbilical hernia repair	—	1
Tension-free vaginal tape procedure (TVT)	—	2
Cystoscopy	1	—
Total	**8 (6%)**	**22 (7%)**

* Total number of women having supracervical abdominal hysterectomy: 134.
** Total number of women having supracervical laparoscopic hysterectomy: 315.

Table 4: New symptoms reported following the hysterectomy.

New symptoms	Supracervical abdominal hysterectomy *N* (%)	Supracervical laparoscopic hysterectomy *N* (%)
Changes related to urination and/or defecation	4 (3.8)	9 (3.8)
Vasomotor symptoms	—	5 (2.1)
Vaginal discharge	—	5 (2.1)
Vaginal dryness and/or dyspareunia	3 (2.8)	5 (2.1)
Pelvic pain	3 (2.8)	5 (2.1)
Problems related to the scar (pain and/or cosmetics)	6 (5.7)	—
Other (depression, gained weight, reduced libido, cystitis, candida infection, fear of cervical cancer)	12 (9.0)	24 (10.0)

well documented, it would be unethical to randomise women to LSH or SAH [9]. Given these limitations, our study enables a comparison of long-term outcomes after cervix-sparing surgery with both laparoscopic and abdominal techniques. Other limitations of the study are that the data were collected retrospectively and that the questionnaires were sent to the SAH group after the results of the LSH group were known. Furthermore, we were unable to compare the results of supracervical hysterectomy to those of total hysterectomy irrespective of surgical approach.

The results of our study demonstrate that although cervical stump symptoms are relatively common following the two surgical procedures, the overall patient satisfaction is high. The occurrence of vaginal bleedings after SAH is in previous studies reported to be 7%–20% [10–12]. Similarly, the occurrence of persistent vaginal bleedings following LSH is reported in the wide range of 0%–25% [13–17]. The occurrence of vaginal bleedings after both procedures in our study (18% after SAH and 24% after LSH) were relatively high compared to these previous reports. This may partly be explained by different definition of vaginal bleeding in the different studies. We included both regular and irregular bleedings as well as bleeding related to sexual activity, whereas some previous reports have only reported the occurrence of vaginal bleeding on a regular monthly basis. When we included only regular bleedings in our analyses, the proportion decreased to 8% in both study groups. In spite of the high number of women with continued vaginal bleedings, the women rarely found the bleeding to be bothersome, and it did not affect their overall satisfaction.

Insufficient surgical experience and skill, resulting in amputation above the level of the internal cervical ostium, have been suggested as possible causes of the high occurrence of vaginal bleedings following supracervical hysterectomy [13]. Whether other mechanisms, like more meticulous destruction of any remaining endometrium in the spared cervix, could reduce the occurrence of persistent vaginal bleedings after surgery remains to be demonstrated.

The proportion of women who reported suffering from preoperative menstrual pain in our study was relatively high, 74% in the LSH group and 57% in the SAH group. The pain score after hysterectomy was significantly less than before surgery after both procedures, with less pain in the LSH group, possibly related to less adhesion formation after surgery. Although the pelvic pain was reduced after the procedure, a relatively large proportion of women reported continued pain. Some may argue that women with endometriosis and/or pelvic pain would have a more favourable outcome after total hysterectomy compared with a supracervical procedure. However, to our knowledge, no evidence from randomised control trials suggests that total hysterectomy in women with preoperative pain results in greater pain reduction. Furthermore, an eventual effect of a subsequent removal of the cervix following a supracervical procedure due to pain does not appear to have been reported.

The results indicate that women are overall satisfied regarding the outcome following both supracervical procedures. However, as cervical stump symptoms appear to be relatively common, it is important to inform women preoperatively regarding the risk of persistent menstrual bleedings and/or pain. In our study, women who were not satisfied regarding information, reported a significantly lower degree of total patient satisfaction, which illustrates the importance of proper and adequate preoperative information.

5. Conclusion

Persistent vaginal bleedings are relatively common following supracervical hysterectomy. The bleedings are, however, reported by women as minimal and rarely bothersome, and the patient satisfaction following both supracervical procedures is high. All women should have proper preoperative information. Women with pelvic pain and/or endometriosis should in addition be informed of the possibility of persistent pelvic pain and the increased risk of repeated surgery following supracervical hysterectomy.

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Review Article

Ovariohysterectomy in the Bitch

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Ovariohysterectomy is a surgical procedure widely employed in practice by vets. It is indicated in cases of pyometra, uterine tumours, or other pathologies. This procedure should only be undertaken if the bitch is in a fit state to withstand general anaesthesia. However, the procedure is contradicated if the bitch presents a generalised condition with hypothermia, dehydration, and mydriasis. Ovariohysterectomy is generally performed via the linea alba. Per-vaginal hysterectomy can also be performed in the event of uterine prolapse, if the latter cannot be reduced or if has been traumatised to such an extent that it cannot be replaced safely. Specific and nonspecific complictions can occur as hemorrhage, adherences, urinary incontinence, return to oestrus including repeat surgery. After an ovariectomy, bitches tend to put on weight, it is therefore important to inform the owner and to reduce the daily ration by 10%.

1. Introduction

Ovariohysterectomy in the bitch is a surgical procedure consisting of laparotomy with ablation of both ovaries and the uterus.

This procedure is indicated for the following [1].

(i) Uterine tumours.

(ii) Serious uterine lesions, whether traumatic or infectious in origin; the most common cause being dystocia during parturition.

(iii) Other pathologies that justify an ovariohysterectomy include metorrhagia, pyometria, glandular-cystic uterine hyperplasia with secondary infection leading to chronic metritis; the latter usually occurs postoestrus ("postoestrus metritis") and is initially treated medically, as with acute postpartum metritis, surgery becomes a necessity once the disease becomes chronic and recurrent [2–5].

These alterations in the uterine mucosa are the result of ovarian hormonal imbalances.

Metritic pathologies have become increasingly common since the introduction and growing popularity of synthetic progesterone treatments such as medroxyprogesterone acetate, which are used to prevent or eliminate heats where the onset of metritis is common especially if they are used after the 3rd day of pro-oestrus [6].

This procedure should only be undertaken if the bitch is in a fit state to withstand general anaesthesia. She will reabsorb the toxins produced in the uterus, or lick any pus that accumulates at the lower commissure of the vulva, leading to gastroenteritis and hepatonephritis and subsequently diarrhoea, vomiting, and raised urea (normal value around 0.6 g/L), and creatinine (normal value around 10 mg/L).

However, if the ureamia is greater than 0.6 g/L, we advise the administration of Lespedeza capitata LESPEDEZIA N.D.v, 0.7–1 mL/kg morning and evening for 2 days via IM or SC injection, without exceeding 20 mL/injection/animal. The latter is a mild diuretic, hypoazotemic agent that acts via renal vasodilatation and stimulates the activity of the renal parenchyma. These injections should be combined with intravenous fluid therapy with isotonic NaCl solution at 0.9% and the urea levels checked 2 days later. Antibiotic

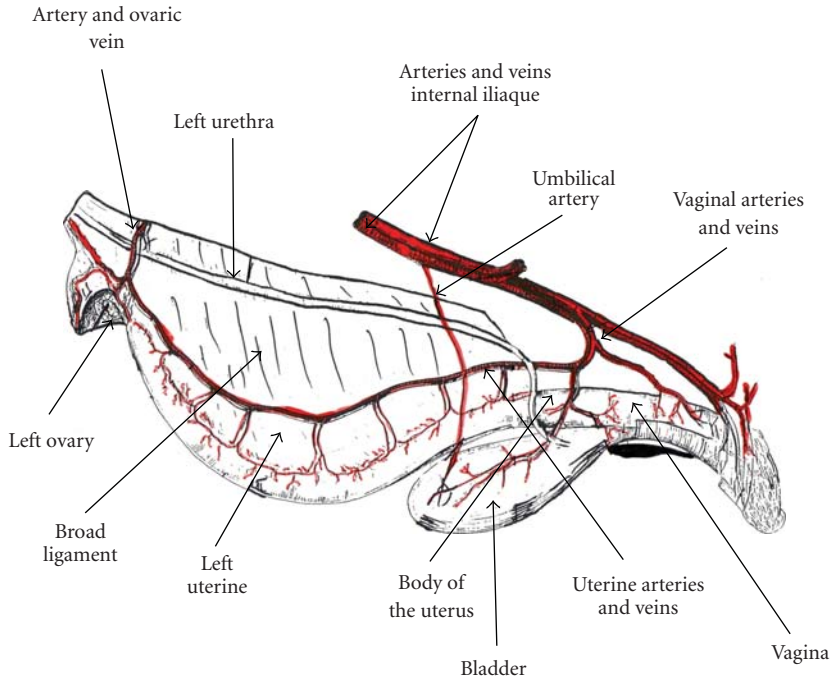

Figure 1: Arteries and veins of the genital apparatus of the bitch (Seen side left).

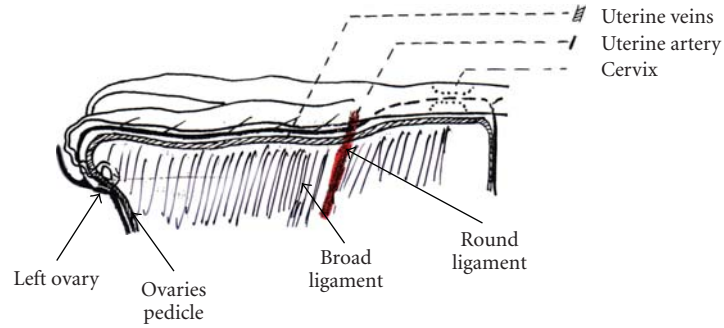

Figure 2: Uterine irrigation.

prophylaxis with Cefalexin RILEXINE N.D.v, at a dose of 20 mg/kg every 12 hours during 3 days, is also advisable to prevent bacteraemia.

(i) Another indication is that of convenience, that is, sterilisation, as many owners complain of the manifestations of heat with vulvular discharge, as well as the problems associated with repeated matings.

(ii) Finally, and with the owner's consent, ovariohysterectomy can be proposed as a radical alternative to medical abortion following an unwanted pregnancy, as it also involves definitive sterilisation [1].

However, there are certain contraindications to the procedure, such as if the bitch presents with a generalised condition with hypothermia, dehydration, and mydriasis. Similarly, animals presenting with hepatorenal insufficiency should not undergo general anaesthesia if the urea levels are greater than 0.6 g/L and the creatinine is greater than 10 mg/L, such animals are associated with poor peri- and postoperative survival. It is therefore essential to perform a complete, detailed preoperative clinical examination, with blood tests for serum biochemistry.

2. Materials and Method

2.1. Anatomy. The genital apparatus of the bitch is primarily located in the abdominal cavity, with the exception of the vagina, which lies in the pelvis [6, 7] (Figures 1 and 2).

The neck of the uterus is relatively short, it measures 1-2 cm long, and lies a few centimetres in front of the anterior border of the pubis; it is followed by the body of the uterus, which measures 3–5 cm in length in the intrabdominal position, and which starts from the anterior straight of the pelvis then divides after a few centimetres into two divergent horns, which lie on the floor of the abdomen on either side of the linea alba, then travel back up towards the ovaries;

the latter are situated in the costolumbar angle, one or two centimetres from the bisection and buried in a fatty ovarian sac, which opens medially [7, 8].

The uterus receives its blood supply from the right and left uterine arteries (Figures 1 and 2). The body of the uterus that lies closest to the oviduct is irrigated by the uterine branch of the ovarian artery, whilst the neck and remainder of the body are supplied by the uterine branch of the vaginal artery.

The uterine artery provides the majority of the organ's blood supply and serves no other organs; it originates from the internal iliac artery along with the umbilical artery.

2.2. Surgical Approaches. Easy access to the genital apparatus is gained via the linea alba; the incision starts at the umbilicus and ends 2 to 3 cm cranial to the anterior border of the pubis. This approach provides direct access to the uterine horns and facilitates prehension of the ovaries.

2.3. Surgical Technique

2.3.1. Surgical Equipment

(a) Preparation of the Animal. Ensure that the bitch has been fasted since the previous day especially in the context of elective surgery: however, in an emergency situation, after induction of anaesthesia rapid intubation with a cuffed endotracheal tube should prevent aspiration of stomach contents due to gastric reflux.

In the event of pyometria or metritis, the bitch's organism has to eliminate the toxins produced during the infection, it is therefore essential for the success of the procedure to choose anaesthetic agents with minimal toxicity. Various protocols are available, these include: IV premedication with valium and morphine at 0.25 mg/kg and 0.1 mg/kg, respectively, followed by induction of anaesthesia with propofol at a dose of 5 mg/kg, the volume is increased slowly until the animal is sufficiently well anaesthetised to enable intubation. Isoflurane gas is then used to maintain anaesthesia; a flow rate of 2% is normally sufficient to maintain a good level of anaesthesia until the end of the procedure. To control perioperative pain, morphine can be administered at the same dose as for premedication, to a maximum of 10 injections/hour to avoid exceeding the threshold of toxicity.

Once anaesthetised, the bitch is positioned in dorsal recumbency with her front legs pulled forward and tied to the table, and the back legs tied back; the bitch is then put on a drip with previously warmed normal saline (0.9%) with glucose.

(b) Preparation of the Surgeon. The surgeon should wear a clean and sterile gown, scrub their hands thoroughly using surgical scrub solution, and wear sterile gloves.

(c) Preparation of the Material. In addition to the standard laparotomy kit, the surgeon requires the following instruments:

(i) 2 babcock forceps,

(ii) 4 artery forceps,

(iii) 4 doyen bowel clamps,

(iv) resorbable multifilament suture material, VICRYL, dec. 3.

And finally material for the septic phase of the surgery: scalpel, mayo scissors, and resorbable VICRYL Dec 3.5 or 4 for closure of the abdominal wall.

2.3.2. Surgery. The surgical zone should be carefully scrubbed using the same type of surgical scrub solution as used by the surgeon, and disinfected using alcohol and surgical antiseptic solution several times over.

(a) Principal Phases

Laparotomy. The skin is incised along the linea alba, that is, the sheath of the rectus abdominus, starting from the umbilicus and ending a few centimetres in front of the pubis.

Using a pair of scissors, the subcutaneous connective tissue, which may contain a substantial amount of fatty tissue, is bluntly dissected to visualise the linea alba.

Haemostasis is performed before opening the abdominal cavity. If simple swabbing proves insufficient, any bleeders should be ligated or twisted to obtain a very clean surgical field.

Using rat-tooth forceps, the linea alba is grasped in the middle and tented up before being incised with a pair of scissors. The peritoneum is then punctured using a cannula that is slid towards the umbilicus to enable incision of the linea alba without damaging the abdominal contents, with the cutting edge of the blade turned uppermost. The same procedure is then performed in the opposite direction towards the pubis.

If the uterine horns are voluminous they will be seen in the bottom of the surgical field following incision of the peritoneum; normal-sized horns will not be visible, for example, following recovery from postoestral metritis or during routine spaying.

To find the uterine horns easily, the operating table is tilted so that the animal's head is below its feet, to move the abdominal organs towards the diaphragm; this is known as the TRENDELENBURG position.

To locate the genital apparatus with ease, the bladder is retracted laterally; cranial to the bladder, the body of the uterus and bifurcation of the horns are easily locatable. One of the horns is then followed cranially up to the ovary, which is hidden in the fat-filled ovarian bursa. The ovary is not visible but can be felt through this ovarian bursa. It is a 1-2 cm long mass, which is exposed after incision of the bursa.

Sectioning the Ovarian Pedicle and Broad Ligament

– *Ovarian Pedicle.* The ovary is grasped and babcock forceps placed. The latter are handed to an assistant who holds the ovarian pedicle taught out of the abdomen to facilitate placement of a ligature as close

as possible to the root of the pedicle to ensure haemostasis of the ovarian artery.

The broad ligament is then punctured with a clamp to grasp the suture material and a ligature is placed in the ovarian pedicle as close as possible to the lumbar wall. Once this ligature has been placed, the ends of the threads are kept long so that the ovarian pedicle can be found with ease in the event of haemorrhage.

A clamp is then placed between this ligature and the ovary, and the pedicle is sectioned between the two. The ovarian pedicle is held throughout this procedure with a clamp. The quality of the haemostasis is checked; the long ends of the suture material on the ovarian pedicle are then cut.

In some cases, such as in the event of hypertrophy of the vascular bundle, it may be advisable to place two ligatures, one around the artery and one around the ovarian vein. Never hold the ligature itself with the clamp, as it might slip off the pedicle when being released back into the abdomen.

– *Broad Ligament*. If the broad ligament is seen to contain large vessels, they should be ligated prior to be being cut.

However, if the vessels are invisible and buried under fat, the ligament can simply be torn in the middle above the uterine artery by exerting traction between two swabs with the fingers to tear it from front to back to the level of the cervix, and as close as possible to the lumbar wall. A point of resistance will be encountered within the round ligament; this corresponds to the vaginal process (which corresponds to the scrotum in the male) which explains the risk of inguinal herniation of the uterus in bitches following relaxation of the latter.

Another technique for sectioning the broad ligament involves the placement of a row of overlapping mattress sutures along the length of the ligament before making the section with a scalpel or a pair of scissors.

Once the ovarian pedicle has been sectioned, the second horn is located and the corresponding ovarian bursa grasped with Babcock forceps.

The ovarian pedicle and broad ligament are sectioned as described previously.

Finally, the two uterine horns are replaced back onto pelvis.

Suturing the Anterior Portion of the Laparotomy Incision. The prolapse of intestinal loops through the incision can cause significant heat and fluid loss, which can have very serious consequences, especially if the bitch is already suffering from deterioration in general status due to severe pyometria, for example. It is therefore advisable to suture the anterior portion of the laparotomy wound before continuing the surgery.

However, if the haemostasis of the ovarian pedicles or broad ligaments is a source of concern, the placement of a few forceps should suffice to provide temporary closure of the anterior portion of the laparotomy wound.

Sectioning the Cervix [9]

– *Ligating the Uterine Arteries and Veins (Figure 3)*. Once both uterine horns have been flipped back onto the pelvis, the uterine cervix is sectioned, following ligation of the uterine arteries and veins.

The veins can be visualised passing on either side of the cervix. The arteries run under the veins in the musculosa of the cervix, which is why the haemostatic sutures should transfix the lateral walls of the cervix. However, if the uterine artery is perforated during ligation, a wider transfixion is needed, more caudal to the previous attempt.

– *Forcep Placement (Figure 3)*. Once both of the ligatures have been placed, the cervix is crushed at their level with an intestinal clamp. Another clamp is then placed just above the first and the contents of the uterus are pushed back towards the horns; two other clamps are placed in the same way above the 2nd clamp. The 2nd and 3rd clamps are removed, thus leaving a secretion-free zone.

– *Sectioning the Cervix (Figure 3)*. Once both intestinal clamps have been placed, the anterior section of the cervix is performed; the cervix may be normal or pathological.

Normal Cervix. The cervix is simply sectioned with a scalpel between the two clamps.

Pathological Cervix. For pathological cervixes, the serosa is dissected just caudal to the clamp that is placed on the uterus; the serosa is then retracted caudally.

The musculosa is then sectioned cranial to the intestinal clamp placed on the cervix; if the clamps have been placed correctly, no fluid should leak from the cut ends.

Dealing with the Stump (Figure 3)

– *Small, Normal Cervix*. The stump is simply replaced in the abdominal cavity. It is however advisable to suture it or bury it in a fold of omentum.

– *Pathological Cervix*. The cut section of the musculosa, mucosa, is cauterised with an iodine-based solution, and then sutured in two phases:

Septic Phase. For the septic phase, a simple continuous suture is made in the musculosa with VICRYL N.D dec. 3.

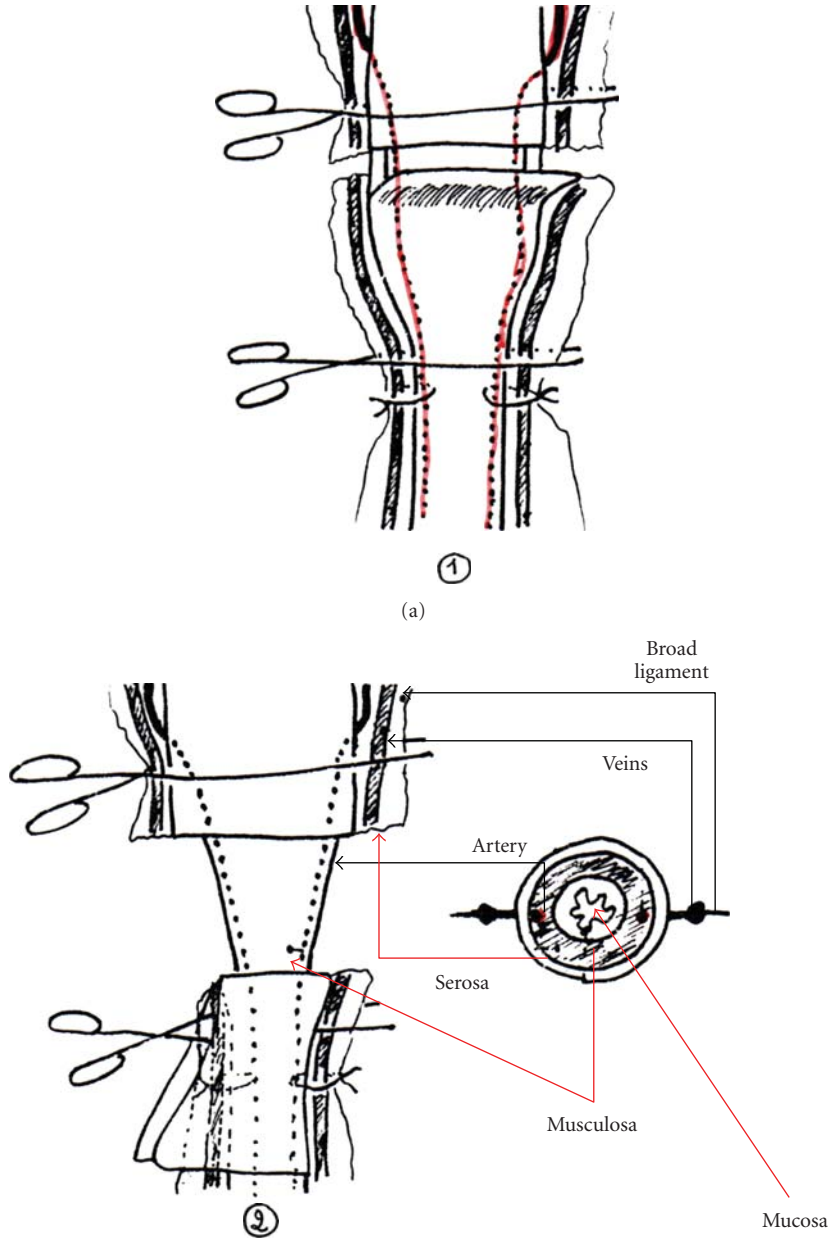

Figure 3: Section of the pathological cervix.

Aseptic Phase. The needle is changed and either a buried simple continuous suture is made with the serosa (sero-serous continuous suture), or the stump is enfolded in one of the broad ligaments, which is fixated with a suture in the bursa. The ligament will weld itself to the stump. Finally, the stump can be invaginated by burying it in the vagina, then placing a ligature a few centimetres behind the original section. However, invagination is practically impossible to perform in small dogs due to the small size of their genital tract.

These suture procedures eliminate the risk of peritoneal infection, since the pathological secretions drain into the vagina.

Suturing the Abdominal Wall. The sutured stump is returned to the abdominal cavity and the abdominal wall is closed using "X"-shaped interrupted sutures with VICRYL N.D. Dec.4.

If the subcutaneous connective tissue is very abundant, a simple continuous subcutaneous suture is performed using VICRYL N.D. Dec.3.

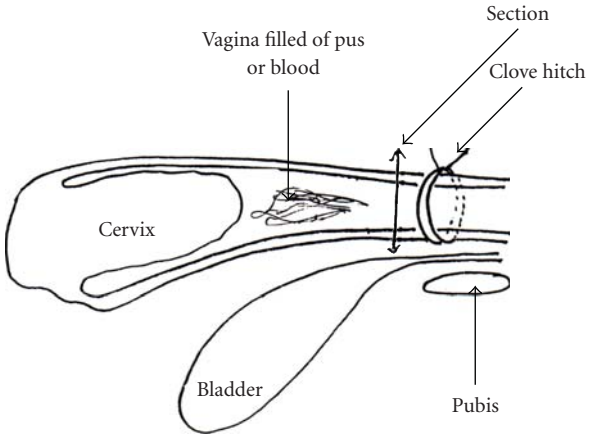

Figure 4: Complication: Pathological cervix amputation.

Finally, the skin is sutured using simple interrupted sutures or mattress sutures with non-resorbable filament such as MONOSIN N.D. Dec.3. The wound is then disinfected with antiseptic solution and protected with a few swabs and an adhesive dressing.

3. Results

3.1. Surgical Variation. Hysterectomy in the bitch via the linea alba is not very difficult. Nevertheless, it is sometimes necessary to perform the surgery via a vaginal approach rather than via the linea alba.

3.1.1. Hysterectomy via the Vaginal Approach. Per-vaginal hysterectomy is performed in the event of uterine prolapse, if the latter cannot be reduced or if has been traumatised to such an extent that it cannot be replaced safely.

The elective site for amputation is between the cervix and urinary meatus, in which case there are two different possible techniques, either with an elastic ligature, or by suturing.

(a) Elastic Ligature. An elastic band is placed between the cervix and the urinary meatus, the exeresis is then performed and the stump sutured by joining the internal and external segments with a perforating simple continuous suture.

(b) Suture. Firstly, an intestinal clamp is placed between the cervix and the urinary meatus to crush the pedicle, then, either a transfixing suture or overlapping mattress suture is placed. Once the sutures have been placed, the vagina is excised.

The stump will be expelled within 15 days.

3.2. Postoperative Care. Firstly, advise perioperative oxygenation if the surgical shock is very great.

The animal is warmed, especially if the female was in poor condition prior to the procedure, she must be rolled in a blanket and placed in a heated kennel.

Intravenous fluid therapy is administered with isotonic saline along with an injection of Vitamin C and corticosteroids.

The bitch is then placed under antibiotic therapy for at least 5 days.

The sutures are removed after 10 days.

Any stagnant uterine secretions in the cervix and vagina will be eliminated in the days following and then cease completely.

3.3. Complications. These can be classified as general or specific.

3.3.1. General.

(i) Evisceration.

(ii) Abdominal herniation.

(iii) Suppuration from the cutaneous wound.

(iv) Peritonitis.

3.3.2. Specific. Haemorrhage: occurring during the intervention and continuing in the hours following. The latter represents one of the most common causes of the death of the animal. They can be situated at the level of the following.

(i) *Ovarian pedicle*: this is why it is not advisable to operate during oestrus, where the uterine arteries and veins are hypertrophied.

(ii) *Broad ligament*: always check that there is no significant haemorrhage after rupture.

(iii) *Uterine cervix*: treatment involves a blood transfusion and repeat surgery to ligate the bleeding vessel.

(iv) *Abscess*: These form especially at the level of the anterior straight of the pelvis and lumbar, when the cervix is not correctly treated, resulting in pain during defecation, vomiting, and finally an occlusive syndrome. The diagnosis is established via an exploratory laparotomy. Treatment is surgical, and may even necessitate nephrectomy or enterectomy.

(v) *Abdominal adherences*: these result from a localised peritonitis and cause an occlusive syndrome.

(vi) *Urinary incontinence*: around 20% of spayed bitches are affected, especially large breeds.

(vii) *Recurrence of metritis*: occurs in the month or years following the intervention, and a serous, purulent, or haemorrhagic vulvular discharge may occur. This complication occurs in bitches who have undergone hysterectomy alone, and which did not resolve the problem given that part of the genital apparatus remains in place: vagina, cervix, and occasionally a short section of uterus in front of the cervix, and when the oestrus cycle is abnormal, the uterine mucosa is not the only organ to suffer the consequences, the cervix and to a lesser extent the vagina also react. There are two possible solutions.

(a) *Ablation of the cervix*: repeat surgery with placement of a clove hitch as far as possible from the cervix on the vagina. Then make a cut a few millimetres from the ligature. The stump is then disinfected with an iodine solution and sutured with a perforating simple continuous suture with VICRYL Dec. 3, and returned to the pelvic cavity. The disadvantage of this method is that the ovaries remain in place and the posterior portion of the vaginal mucosa may therefore continue to secrete abnormally for a few months, or even for up to a year later, which can result in the emission of drops of pus at the lower commissure of the vulva. This is why an ovariectomy is preferable and necessary (Figure 4).

(b) *Return to oestrus*: the differential diagnosis should include cystitis, vaginitis, cervicitis, and inflammation or infection of the anal glands, which may be mistaken for signs of oestrus by the owners, which can be detected using a vaginal swab, and/or serum progesterone assay. If the bitch is confirmed as being in oestrus, there are two possible explanations: a residual fragment of the ovary, which was overlooked at the time of the ovariohysterectomy, or the secretion of oestrogens from the corticoadrenal glands due to hypophyseal dysfunction. Repeat surgery is therefore advisable, if the latter fails or if the surgeon is confident that no ovarian fragments have been overlooked then hormonal treatment can be started [6].

(viii) Bitches who have undergone surgery for pyometria may present with thrombocytopenia: in the days following the procedure, the bitch presents with a marked tendency to haemorrhage. The mucosae are pale, the pulse weak, the bitch is hypothermic (36°C), and petechiae appear on the gingival and labial mucosae. Subcutaneous oozing is seen at the abdominal incision, and an angry red patch covering the entire caudo-ventral abdominal zone. Occasionally, a large quantity of blood clots is discharged from the vulva. Haematology reveals a significant reduction in circulating platelets, to the order of 3,500 rather than 300,000–450,000/mm^3. The red blood cell count is also markedly reduced to around 120,000 instead of 6,000,000/mm^3. The tendency to haemorrhage increases over time and the edges of the wound disunite within 3-4 days, the animal is very pale, comatose, and death follows.

4. Discussion

The current success rate is close to 95%, whilst several decades ago failures were to the order of 50%.

5. Conclusion

Ovariohysterectomy is the only effective treatment for pyometria and it is a radical treatment for postoestrus metritis when it recurs following failure of medical treatment. For the procedure to have the best chances of success, it is important to perform it on a bitch in good general condition.

It is also important to remember that after an ovariectomy bitches tend to put on weight, 1 kg for every 10 kg after 90 days; the metabolism of the bitch falls from 37 to 33 Kcal/day, it is therefore important to reduce the daily ration by 10%.

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Review Article

Radical Hysterectomy with Pelvic Lymphadenectomy: Indications, Technique, and Complications

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Radical hysterectomy with pelvic lymphadenectomy remains the treatment of choice for women with Stages IA_2 and IB_1 carcinoma of the cervix, and selected patients with Stage II endometrial cancer. Improvement in surgical techniqe, administration of prophylactic antibiotics, thromboemolic prophylaxis, and advances in critical care medicine have resulted in lower operative morbidity associated with this procedure. Major urinary tract complications such as ureteral injury or vesico-vaginal fistula are now extremely rare (<1%). Five-year survival rates following this procedure vary according to a number of clinical and histologic variables, and may be as high as 90% in women without lymph node metastases.

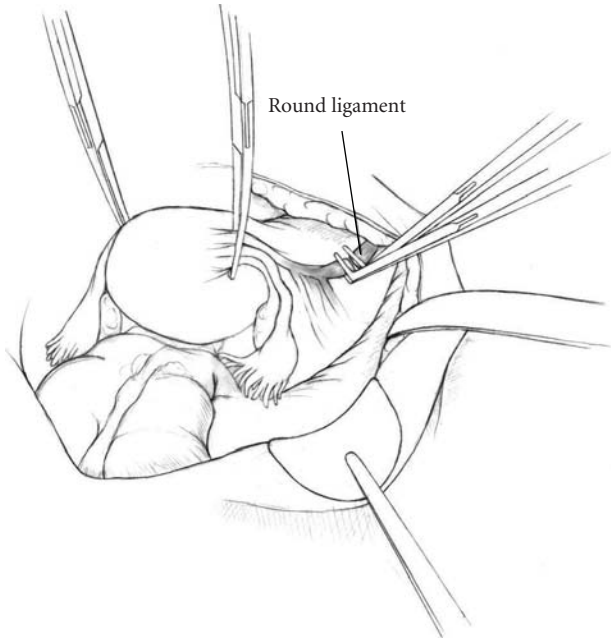
1. Introduction

The number of patients with early stage cervical cancer has steadily increased with the widespread use of the Papanicolaou test for screening. In 2009, it is estimated that there will be 11,070 new cases of cervical cancer in the United States and nearly 500,000 new cases worldwide. Approximately 85% of newly diagnosed cervical cancer in industrialized countries are expected to have localized or regional disease [1, 2]. With the trend toward early detection, more patients with invasive cervical cancer are diagnosed with early stage disease and are candidates for primary surgical treatment with radical hysterectomy and pelvic lymphadenectomy.

In 1898, Ernst Wertheim of Vienna described the operation of radical hysterectomy including removal of the parametrium and pelvic lymph nodes. In 1905, Wertheim reported outcomes of the first 270 patients treated by radical hysterectomy, which included an operative mortality rate of 18% and a major morbidity rate of 31%. Since that time, radical hysterectomy with pelvic lymphadenectomy has been performed with modifications in surgical technique as the major surgical treatment for early stage invasive cervical cancer [3, 4]. The use of prophylactic antibiotics, thromboembolic prophylaxis, administration of blood products, and advances in postoperative and critical care medicine all have lowered operative morbidity, and increased the survival rate of cervical cancer patients treated with this operation.

2. Indications

The primary indication for radical hysterectomy with pelvic lymphadenectomy is Stage I invasive cervical cancer. Early invasive cervical cancer is divided by the International Federation of Gynecology and Obstetrics (FIGO) Staging System into Stage IA_1, which includes lesions invading the cervical stroma to a depth of 3 mm, or less and a maximum horizontal spread of 7 mm, and Stage IA_2, which includes lesions with stromal invasion of 3–5 mm and a maximum horizontal spread of 7 mm [5]. These diagnoses can be made only after careful histologic evaluation of a conization specimen using an ocular micrometer to establish the depth of stromal invasion. Patients with Stage IB_1 cervical cancer have microscopic evidence of stromal invasion >5 mm, horizontal spread >7 mm or a clinically visible cervical lesion ≤4.0 cm diameter. In patients with FIGO Stage IA_1 cervical cancer and no evidence of lymph vascular space invasion (LVSI), conservative therapy with cervical conization or simple



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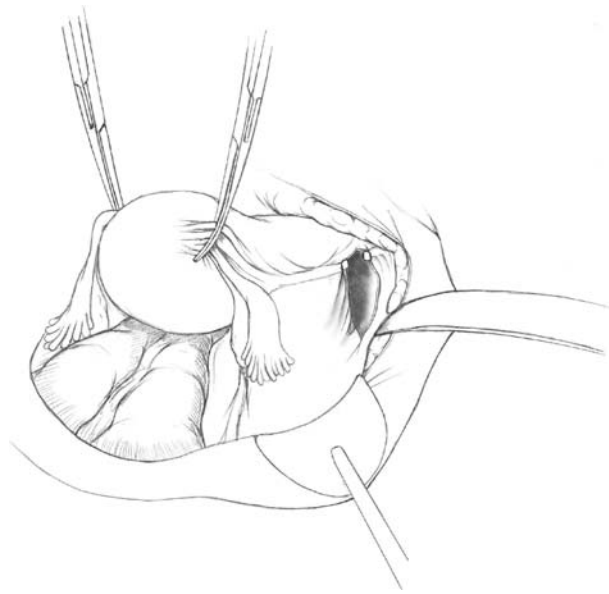

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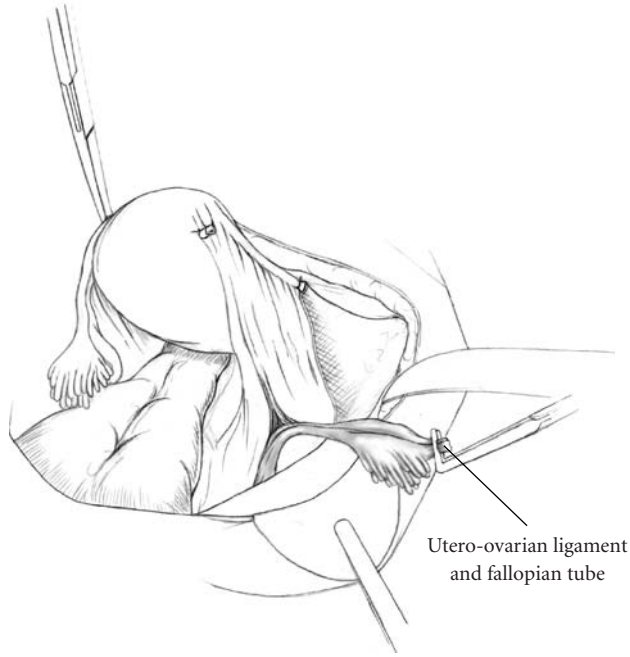


Figure 3

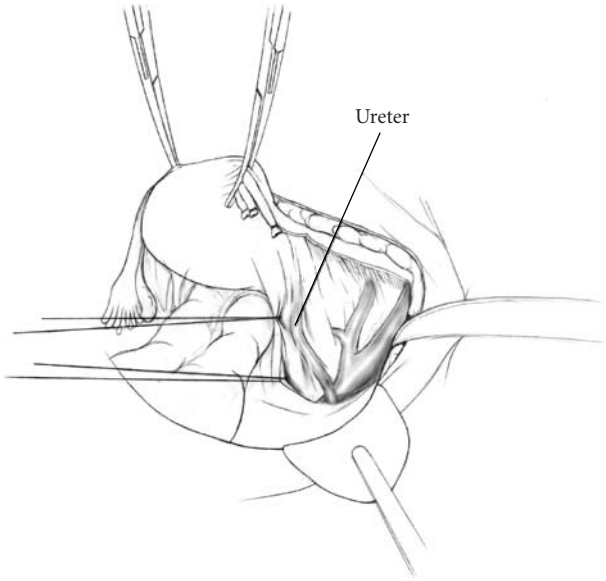
hysterectomy is appropriate [6–11]. However, patients with Stage IA_2 or Stage IB_1 cervical cancer have a significant risk of lymph nodal spread and should be treated by radical hysterectomy and pelvic lymphadenectomy. Patients with Stage IB_2 or Stage IIA cervical cancer are treated with chemoradiation or combined therapy in many institutions. However, selected patients with Stage IB_2 or IIA cervical cancer may be treated with radical hysterectomy and pelvic lymphadenectomy [12–14].

Radical hysterectomy may also be considered in the treatment recurrent cervical cancer. This procedure is appropriate only in patients with small central recurrences, following primary radiation of early stage disease. Maneo and colleagues, for example reported that radical hysterectomy is a safe alternative to pelvic exenteration in patients with Stage IB/IIA cervical cancer treated by primary radiation therapy, who have a recurrence <4 cm in diameter without evidence of ureteral obstruction or parametrial involvement [15].

Finally, radical hysterectomy with pelvic lymphadenectomy is indicated in patients with endometrial cancer and endocervical involvement (FIGO Stage II disease). Boente reviewed the clinical, surgical, and histopathologic data from 202 patients with endometrial adenocarcinoma and cervical involvement, and reported a survival advantage for patients treated by radical hysterectomy with pelvic lymphadenectomy when compared to total abdominal hysterectomy. This advantage was most notable in patients with multiple high-risk factors [16]. Radical hysterectomy with pelvic lymphadenectomy alone can be therapeutic in selected patients with Stage II endometrial cancer, thereby avoiding the morbidity associated with combination therapy [17].

3. Preoperative Evaluation

Prior to undergoing radical hysterectomy, patients should have a thorough evaluation to insure that there are no major medical contraindications to surgery. The anesthesiologist should be aware of the potential for blood loss in patients undergoing this procedure and should make preparation for central venous access as well as the availability of properly typed and cross-matched blood. A prophylactic antibiotic, usually a first generation cephalosporin, is given within 30 minutes of skin incision [18]. Heparin 5000 units is given



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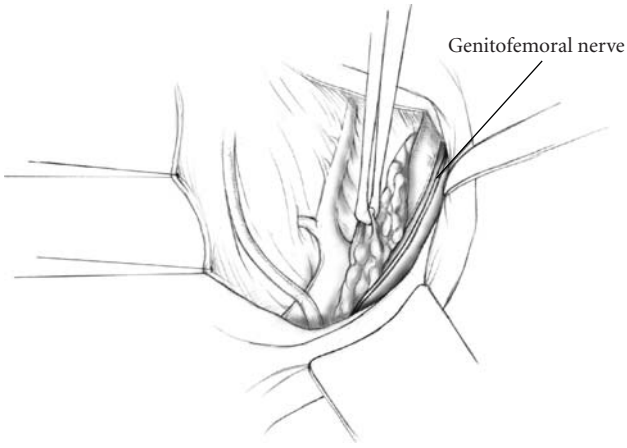

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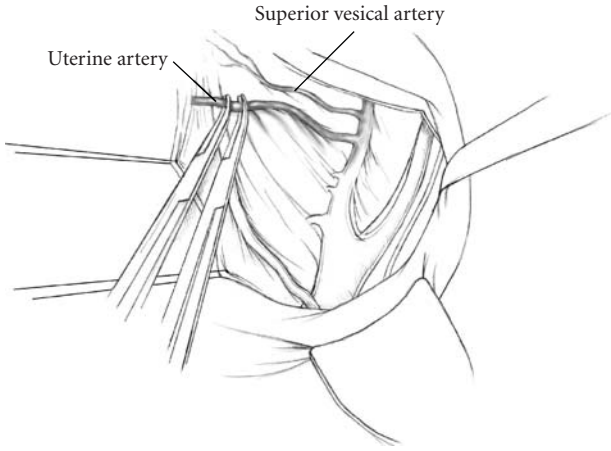

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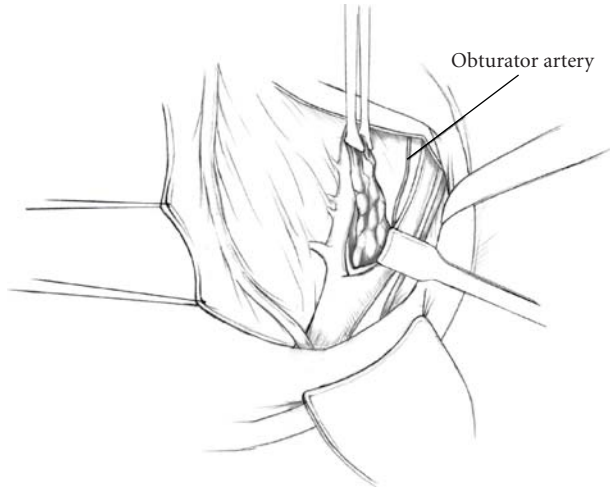

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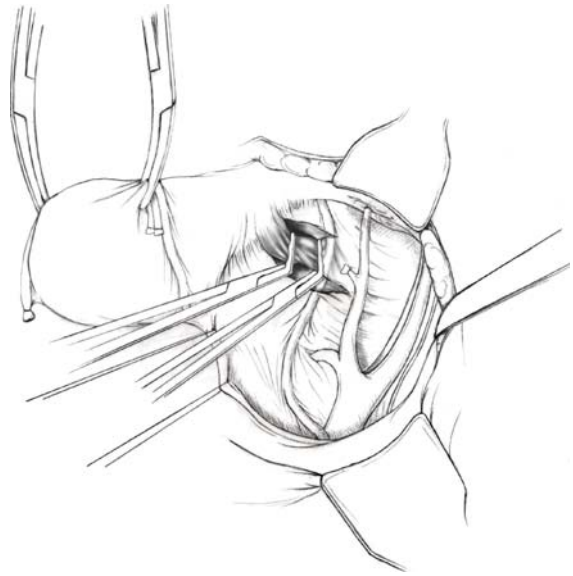


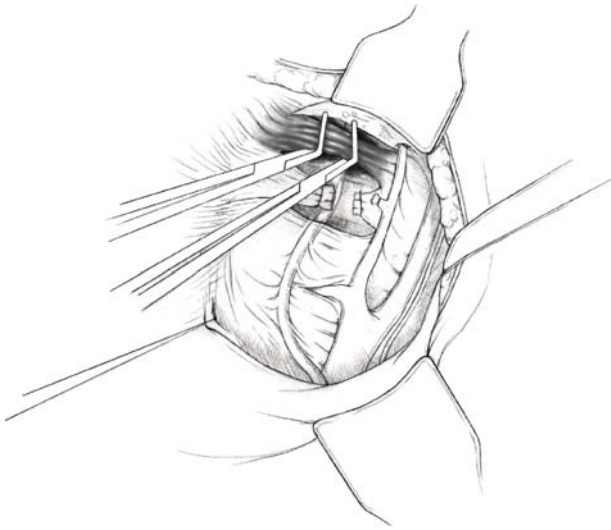
Figure 8

subcutaneously prior to surgery and three times daily in the postoperative period for thromboembolic prophylaxis. In addition, sequential compression devices (SCDs) are placed on both lower extremities immediately prior to surgery, and are left in place until the patient is ambulating [19].

4. Surgical Technique

(1) The patient is placed in supine position and the abdomen and vagina are prepped. A foley catheter is placed in the patient's bladder, and SCD's are placed on both lower extremities.

(2) A vertical midline incision is made 3 cm above the umbilicus and is extended inferiorly to the pubic symphysis. A Bookwalter retractor is placed, and



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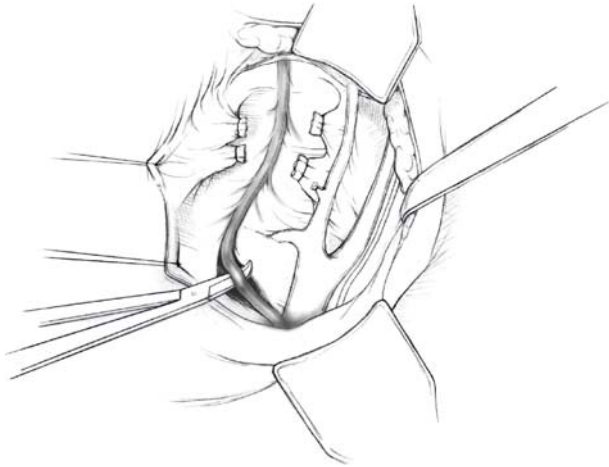


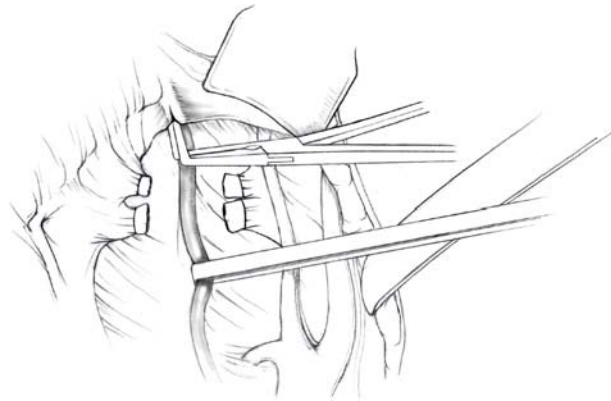
Figure 10

right-angle or body wall retractors are used to retract the pelvic sidewalls.

(3) Prior to initiating the pelvic procedure, the entire abdominal cavity is evaluated for evidence of metastatic disease. This includes all surfaces of the liver and diaphragm, the celiac plexus, omentum, small, and large bowel surfaces as well as the mesentery. Pelvic and para-aortic lymph nodes are palpated, and any enlarged or suspicious nodes are excised and sent for histologic evaluation.

(4) The bowel is packed into the upper abdomen using warm, moist laparotomy sponges. Two 8-inch Kelly Clamps are placed on the uterine cornua for retraction.

(5) The right round ligament is clamped, cut, and ligated at the right lateral pelvic wall (Figure 1). The anterior leaf of the right broad ligament is incised inferiorly along the lateral pelvic wall for a distance of approximately 3 cm.



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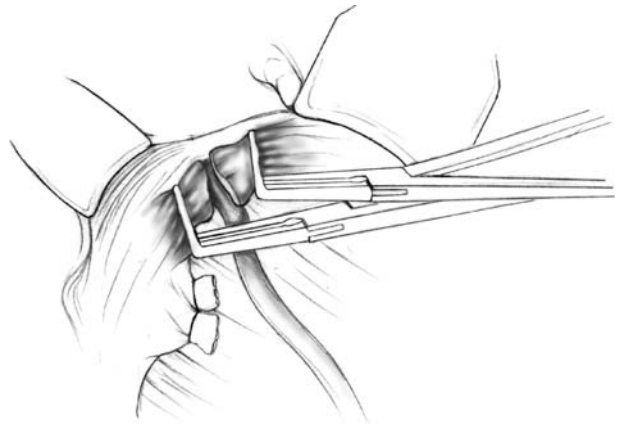


Figure 12

(6) The posterior leaf of the right broad ligament is incised superiorly along the lateral pelvic wall to the level of the infundibulopelvic ligament (Figure 2).

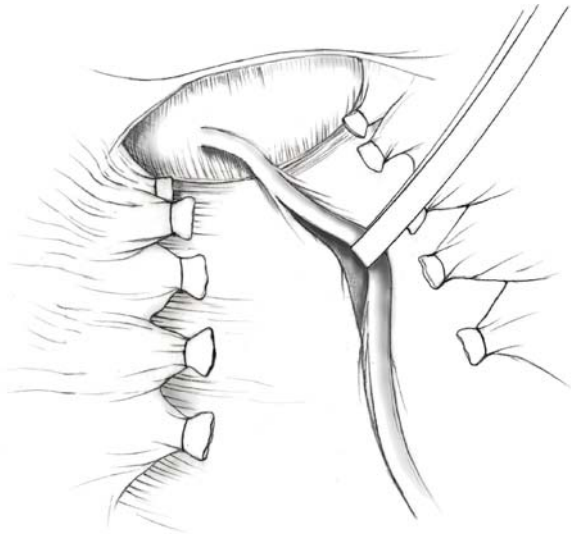
(7) If the right ovary is to be preserved, the posterior leaf of the right broad ligament is further incised parallel and inferior to the infundibulopelvic and utero-ovarian ligaments. The right utero-ovarian ligament is then clamped, cut, and ligated, and the ovary is placed in the right iliac fossa (Figure 3).

(8) If the right ovary is to be excised, the right infundibulopelvic ligament is clamped, cut, and doubly ligated at the lateral pelvic wall. The right utero-ovarian ligament is then clamped, cut, and suture ligated, and the right tube and ovary are removed.

(9) Steps (5)–(8) are then repeated on the left side.

(10) The right retroperitoneal space is entered along the lateral pelvic wall, thereby exposing the common iliac, external iliac, and internal iliac arteries and associated lymph nodal tissue.

(11) The ureter is identified, and two silk sutures are placed in the adjacent medial peritoneum, thereby pulling the ureter medially away from the iliac vessels (Figure 4).



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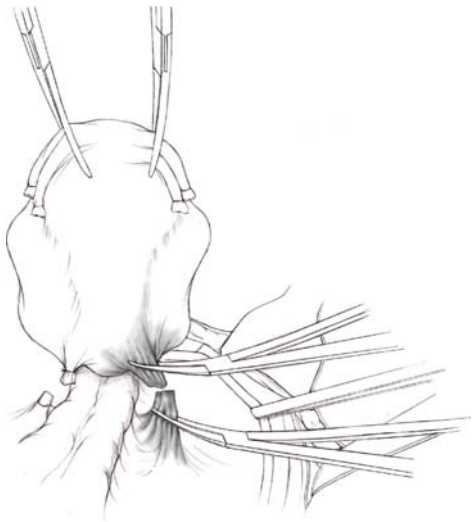

Figure 14

(12) The lymph node dissection is begun by sharply excising all lymph nodal tissue surrounding the right common iliac, external iliac, and internal iliac arteries. The lateral extent of the pelvic lymph node dissection is defined by the genitofemoral nerve (Figure 5). The external iliac and common iliac arteries are retracted laterally, and lymph nodal tissue surrounding the common iliac, external iliac, and internal iliac veins is removed by sharp dissection. Lymph nodal tissue from each of the major anatomic sites (i.e., common iliac, external iliac, internal iliac) is placed in separate containers and submitted for histologic analysis.

(13) The anterior division of the internal iliac artery is identified, and the uterine artery is isolated, ligated with 2-0 silk ties, and transected. The superior vesical artery is preserved (Figure 6).

(14) A vein retractor is placed on the medial aspect of the external iliac artery and vein, and the obturator nerve is identified. All lymph nodal tissue is removed from the obturator fossa by sharp dissection (Figure 7), placed in a separate container and submitted for histologic analysis.

(15) Steps (10)–(14) are repeated on the left side.

(16) The right pararectal space and paravesical spaces are defined by blunt dissection, and the lateral aspect of the cardinal ligament containing the vascular web is clamped, cut, and ligated with 2-0 silk ties (Figures 8 and 9). Ligation of the left vascular web is completed in the same fashion.

(17) The right ureter is dissected from the medial peritoneum at the level of the uterosacral ligament (Figure 10), and a 3/8 inch Penrose drain is placed around the ureter (Figure 11). The ureter is dissected laterally from the parametrial tunnel using right angle clamps (Figure 12). The parametrial vasculature is ligated, and the ureter is rolled laterally out of the tunnel. The right ureter is dissected free from surrounding tissue until its entrance into the bladder (Figure 13). The left ureter is then dissected free from the left parametrium in the same fashion.

(18) The bladder is sharply dissected from the anterior vagina, and the peritoneum between the uterus and the rectum is incised. The anterior rectal wall is reflected away from the posterior vagina.

(19) The uterus is elevated and the uterosacral ligaments are clamped, cut, and tied (Figure 14). The anterior, posterior, and lateral attachments of the uterus and parametria have now been ligated. The paravaginal tissue at the inferior margin of the dissection is clamped, cut, and tied using curved Lainz clamps (Figure 15).

(20) The vagina is transected approximately 3 cm below the cervix and isolated bleeding sites on the vaginal cuff are ligated using 2-0 vicryl suture. The vagina is closed using a continuous interlocking 0 vicryl suture (Figure 16).

(21) Closed suction drains may be placed in both retroperitoneal spaces at the discretion of the surgeon. These drains are brought out through the anterior abdominal wall in each lower quadrant and are sutured to the skin using 2-0 silk suture.

(22) If the ovaries are retained, they are suspended to the lateral pelvic wall with 2-0 prolene, and titanium clips are placed on the suture site for future identification.

(23) The abdomen is then closed in layers, using continuous 0 looped PDS in a modified Smead-Jones technique.

Table 1: Complications of Radical Hysterectomy.

Author	# of Pts	Wound Infection (%)	Ureteral Injury (%)	Bladder Injury (%)	Blood Vessel Injury (%)	Urinary Tract Fistula (%)	Bladder Dysfunction (%)	Pulmonary Embolism or DVT (%)	Lympho-cysts (%)	Intestinal Obstruction (%)
Cai et al. 2009 [20]	480	0.63	0.83	0.83	0.21	1.0	12.9	—	5.8	—
Manchana et al. 2009 [21]	290	—	—	—	—	—	14.5	—	9.3	—
Likic et al. 2008 [22]	529	—	1.32	—	—	—	—	—	—	—
Pikaart et al. 2007 [23]	201	4.0	1.5	—	—	0.5	7.5	1.5	1.0	—
Wu et al. 2006 [24]	219	—	—	—	—	9.5	19.9	—	7.8	—
Landoni et al. 2001 [13]	109	—	0.92	—	—	0.92	14.7	2.8	11.9	—
Zorlu et al. 1998 [25]	115	10.4	0.87	2.6	8.7	—	—	—	—	—
Abrão et al. 1997 [26]	302	—	—	—	—	2.9	9.2	—	—	—
Finan et al. 1996 [27]	229	—	—	—	—	—	—	4.4	—	—
Magrina et al. 1995 [28]	375	—	—	—	—	0.3	—	0.8	0.8	1.3
Benedetti-Panici et al. 1993 [29]	84	—	—	—	—	7.1	—	4.8	21.4	—
Ayhan et al. 1991 [30]	270	—	—	—	—	—	16.2	—	6.4	—

Table 2: Five-year survival following radical hysterectomy for cervical cancer.

Author	# of Pts	Stage	Size of Lesion (cm)	Depth of Stromal Invasion	Lymphvascular Space Invasion	Lymph Node Status	5-Year Survival (%)	*P* value
Sartori et al. 2007 [31]	454	IB-IIA	—	—	—	All	80	<.01
						Negative	88	
						Positive	57	
Ho et al. 2004 [32]	197	IB-II	—	All	—	—	82	
				Inner 2/3	—	—	88.8	.003
				Outer 1/3	—	—	73.8	
					Negative	—	89.5	<.001
					Positive	—	68.4	
						Negative	87.3	<.001
						Positive	67.2	
Ayhan et al. 2004 [33]	393	IB	All	—	—	—	91	
			≤4	—	—	—	91.0	.012
			>4	—	—	—	85.9	
				—	Negative	—	93.7	.009
				—	Positive	—	86.0	
Landoni et al. 2001 [13]	238	IB-IIA	All	—	—	—	79	
Tsai et al. 1999 [12]	222	IB-IIA	All	—	—	—	76	
			≤4	—	—	—	88	.0003
			>4	—	—	—	67	
						Negative	87	.0011
						Positive	71	
Lai et al. 1999 [34]	827	IB-II	<2	—	—	—	90.6	.0001
			2–4	—	—	—	82.7	
			>4	—	—	—	69.1	
				Inner 2/3	—	—	90.3	.0001
				Outer 1/3	—	—	74.9	
					Negative	—	86.3	.0002
					Positive	—	76.5	
						Negative	87.3	.0001
						Positive	68.2	

5. Complications

Complications of radical hysterectomy with pelvic lymphadenectomy are summarized in Table 1. Bladder dysfunction and lymphocyst formation are among the most common complications of radical hysterectomy and occur in 5%–15% of cases in recent reports. Bladder dysfunction results from extensive dissection of the ureters at the bladder base and transection of the uterosacral ligaments, which interrupts autonomic nerve supply to the bladder. In general, more radical dissection results in a higher frequency of bladder dysfunction. However, preservation of the superior vesical artery and blood supply to the distal ureter has resulted in a marked decrease in the frequency of vesicovaginal and ureterovaginal fistula following radical hysterectomy.

Lymphocyst formation after radical hysterectomy and lymphadenectomy is due to interruption of efferent pelvic lymphatics and can result in lymphedema, pelvic discomfort, and infection as well as an increase in the frequency of deep venous thrombosis and pulmonary embolism. Variation in the incidence of lymphocyst formation depends on the extent of lymphadenectomy, retroperitoneal drain

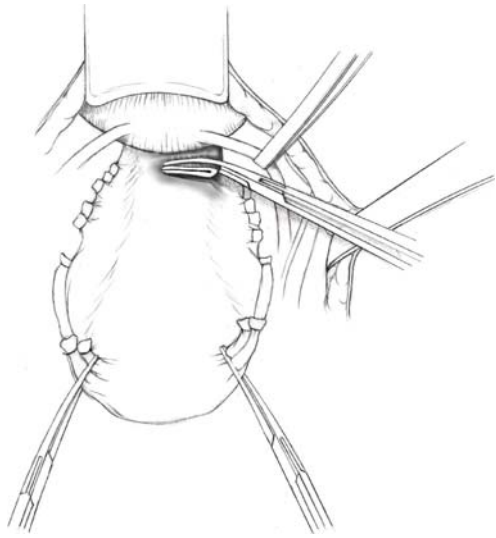

Figure 15

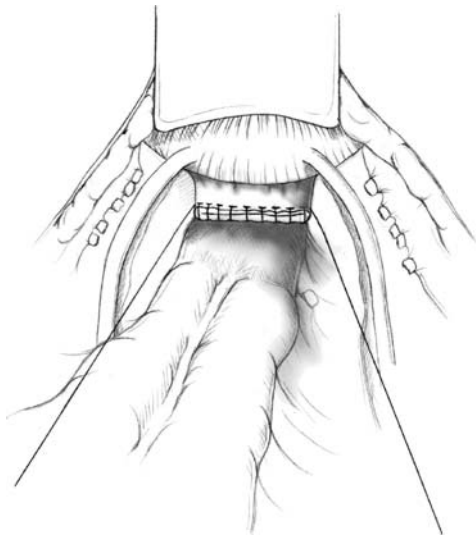

Figure 16

placement, and differences in the surgical technique used for ligating lymphatic channels. Lymphocysts can be managed with guided-percutaneous drainage or laparoscopic surgical resection [35, 36].

The incidence of thromboembolic disease after radical hysterectomy has decreased over time, as a result of widespread implementation of thromboprophylaxis with preoperative and postoperative Heparin and lower extremity sequential compression devices. Nevertheless, it remains the leading cause of mortality in the immediate postoperative period. Multiple clinical trials have provided irrefutable evidence that thromboprophylaxis decreases the risk of deep venous thrombosis and pulmonary embolus. Pulmonary embolus has been cited as the most common cause of preventable hospital death, therefore making thromboprophylaxis the number one strategy to improve safety for patients undergoing major pelvic surgery [19].

6. Survival

The 5-year survival in patients with early stage cervical cancer treated with radical hysterectomy and pelvic lymphadenectomy varies between 80% and 95% according to a number of clinical and histologic findings, and is summarized in Table 2. Patients with low-risk early-stage disease, undergoing radical surgical treatment have a survival of nearly 100% [20]. However, patients with more advanced disease have lower reported outcomes. Several risk factors related to poor prognosis include large tumor volume, deep stromal invasion, presence of lymph vascular space invasion, and lymph node metastases [31–33]. A thorough analysis of these factors is helpful in determining which patients may benefit from postoperative therapy following radical hysterectomy.

7. Summary

Radical hysterectomy with pelvic lymphadenectomy is the treatment of choice for healthy women with stage IA_2-IB_1 cervical carcinoma. Women with nonbulky IB_2 and IIA cervical carcinoma, centrally recurrent disease, and endometrial carcinoma with cervical involvement may also be considered for surgical treatment by radical hysterectomy. Improvements in surgical technique, prophylactic antibiotics, thromboembolic prophylaxis, administration of blood products, and advances in postoperative and critical care medicine all have lowered operative morbidity from this procedure. Five-year survival rates in excess of 90% can be achieved when this procedure is performed for the proper indications.

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Case Report

Contrast-Enhanced Dynamic MR Imaging of Uterine Fibroids as a Potential Predictor of Patient Eligibility for MR Guided Focused Ultrasound (MRgFUS) Treatment for Symptomatic Uterine Fibroids

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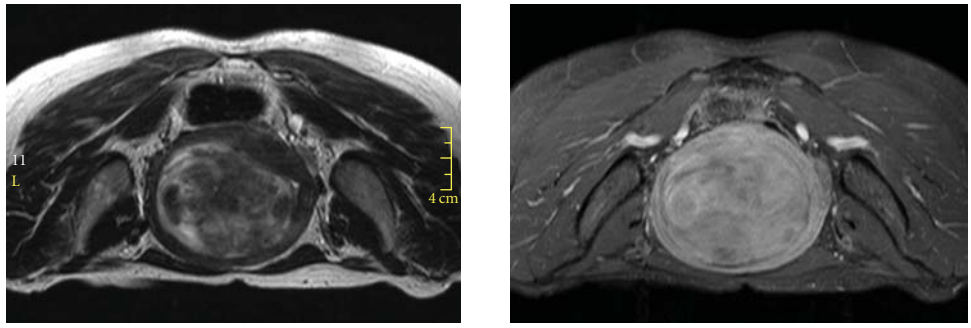
Magnetic resonance-guided focused ultrasound surgery (MRgFUS) is a non-invasive treatment approach for symptomatic uterine fibroids. One imaging characteristic considered in selecting patients who may benefit from MRgFUS of their uterine fibroids is the signal intensity of the fibroid compared with surrounding myometrium on T2-weighted MR images. Previous reports suggest that hyper-intense fibroids are less amenable to MRgFUS compared with iso- or hypo-intense fibroids. In this case study, we utilized contrast-enhanced dynamic MR imaging to further characterize the vascularity of a hyper-intense fibroid. Based on the results of dynamic T1-weighted contrast-enhanced images, we assumed that the hyper-intense appearance resulted from high fluid content rather than high vascularity and predicted that the fibroid would respond to MRgFUS. The patient underwent the MRgFUS without complication and reported significant decrease in fibroid symptoms at 3 and 12 months post-treatment. This case suggests that pre-treatment dynamic contrast-enhanced imaging used in conjunction with T2-weighted imaging may improve the criteria for selecting uterine fibroids amenable to treatment with MRgFUS, potentially leading to improved patient outcomes.

1. Introduction

Uterine fibroids are the most common tumors of the female reproductive tract. Fibroids have been identified clinically in at least 25% of women [1], and pathological analyses suggest that the prevalence of fibroids may be as high as 77% [2]. Although most fibroids are asymptomatic, approximately 25% are associated with symptoms that can have a significant impact on patient's quality of life, including prolonged or excessive menstrual bleeding, pelvic pain or bulkiness, dyspareunia, increased urinary frequency, and infertility [3].

Several options, each with varying degrees of invasiveness, are available for treatment of symptomatic uterine fibroids. These include among others, hysterectomy, myomectomy (abdominal or laparoscopic), uterine artery embolization, MR-guided Focused Ultrasound (MRgFUS), and hormonal therapy [4], which also is sometimes provided as an adjuvant to other therapies. Each of the treatments has its own benefits and disadvantages. For example, the benefit of hysterectomy is that the removal of the uterus is 100% effective in alleviating fibroid-related symptoms [5]. However, the procedure is invasive, requires general or epidural anesthesia, and typically involves several weeks of postoperative recovery time during which patients may be limited from engaging in daily activities, including work.

MRgFUS is a non-invasive treatment for uterine fibroids. It utilizes precisely focused ultrasound waves to generate and maintain high temperatures within the targeted fibroid, resulting in protein denaturation and coagulative necrosis [3]. MRgFUS is integrated with magnetic resonance imaging visualization to plan and guide treatment and to monitor treatment outcomes in real time. This allows precise thermal



(a) (b)

Figure 1: Patient screening MR images. (a) Axial T2-weighted image showing a heterogeneous fibroid, hyper intense relative to the uterine wall. (b) Contrast enhanced Axial T1-weighted screening MR image, showing enhancement of the fibroid.

ablation of the treated fibroid while preserving surrounding normal structures.

While clinical studies demonstrate that MRgFUS is a safe and effective treatment for symptomatic uterine fibroids [6–8], not all patients are considered to be equally suitable candidates for the procedure [9]. Potential candidates are screened with pelvic MRI to determine if they meet patient selection guidelines. Factors considered for MRgFUS patient selection include the imaging characteristics and location of the fibroid within the pelvis, the number and size of fibroids, presence of structures obstructing the energy beam pathway, and the vicinity of the fibroid relative to vulnerable structures [10].

One imaging characteristic considered in the patient selection process is the fibroid's capacity to absorb heat, as the effects of MRgFUS result from the thermal ablation of the fibroid tissue. This is often assessed based on the signal intensity of the fibroid compared with the surrounding myometrium on T2-weighted MR images (T2WIs). Previous reports suggest that the average nonperfused volume (NPV), as measured by posttreatment contrast-enhanced image, obtained with MRgFUS in the treatment of hyper-intense fibroids, is lower than that achieved in iso- or hypointense fibroids [9, 11].

The following case report demonstrates successful treatment of a fibroid that is hyper-intense on T2WIs and suggests that contrast-enhanced dynamic MR imaging may be used to select a subpopulation of uterine fibroid patients suitable for MRgFUS despite hyper-intense results on T2WIs.

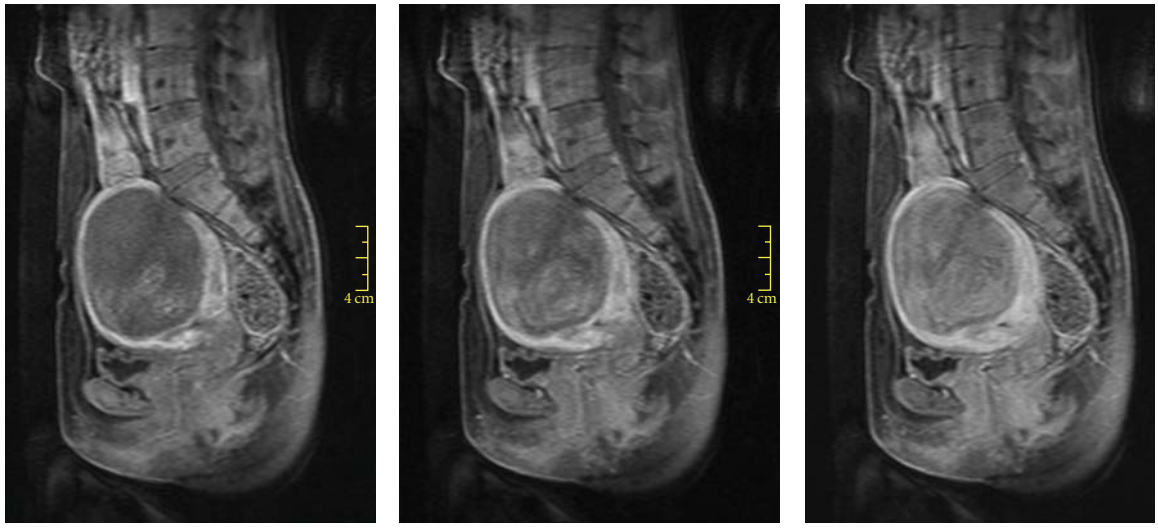
2. Case Report

A 47-year old premenopausal Asian female, with BMI of 20, was referred to our clinic by her gynecologist due to severe menorrhagia. Her Symptom Severity Score (on the 0 to 100 Scale of the UFS-QoL questionnaire [12]) was 56 points. This scale refers to patients with 21 points or more as symptomatic patients. The patient was referred for MRI screening to evaluate her suitability for the MRgFUS treatment. MRI showed a single intramural fibroid of 560 cc. Intensity of the fibroid relative to the uterine wall was hyperintense on T2WIs, and its texture was very heterogeneous (Figure 1).

To evaluate the fibroid's viability more fully, and as part of our screening routine for MRgFUS, T1-weighted MR images (T1WIs) with contrast were acquired. The contrast agent used was Optimark (Covidien Imaging Solutions, Missouri, U.S.). Dynamic T1-weighted gradient echo sagittal images were acquired every 15 seconds from the moment of injection until 180 seconds after the injection (TR 4.81 ms, TE 2.3 ms, matrix 256×115, thickness 3 mm, spacing 0.6 mm, FOV 30 cm) (Figure 2). T1-weighted axial fat-saturation images were taken 240 seconds after the injection (TR 594 ms, TE 11 ms, matrix 256×144, thickness 5 mm, spacing 1 mm, FOV 30 cm) (Figure 1). The images show low enhancement in the fibroid during the 120 seconds after the injection, despite high enhancement on the 240-second delayed scan. Based on the delayed enhancement, we assumed that the hyper-intense appearance of this fibroid resulted from the high fluid content rather than the high vascularity, and we decided to recommend MRgFUS to the patient.

After consulting with the patient about the potential benefits and risks involved in treating her specific fibroid, she chose to undergo MRgFUS, knowing that results might be less than satisfactory due to the hyper-intense appearance of her fibroid. Treatment was performed using the ExAblate 2000 system (InSightec, Haifa, Israel) and SIGNA HDx MRI (GE Healthcare, Milwaukee, U.S.). T2WIs were acquired for treatment planning. The procedure required 128 focal ablations (sonications) with average energy of 3300 Joules. Treatment duration was 3.5 hours from first to last sonication. Average temperature achieved was 75°C. Contrast-enhanced T1WIs were acquired posttreatment, showing that 335 cc (60%) of the fibroid was nonenhancing (Figure 3).

The treatment was concluded without complications. During her followup phone call the next day, she reported returning to work and feeling well with no adverse events. The patient provided a similar report in a phone call 7 days posttreatment. At the 3-month followup, the patient's symptoms significantly improved, and her SSS score was reduced to 28 points. At that time, the patient returned for MR imaging, which showed 38% fibroid shrinkage. At 1-year followup, which included a clinical visit to evaluate patient's symptoms, her SSS was reduced to 13 points, which is considered as nonsymptomatic.



(a) (b) (c)

Figure 2: Contrast-enhanced sagittal T1-weighted screening MR dynamic images acquired at 30, 60, and 90 seconds post contrast injection (from left to right). Fibroid shows lower enhancement than the myometrium in the first 2 minutes postinjection.

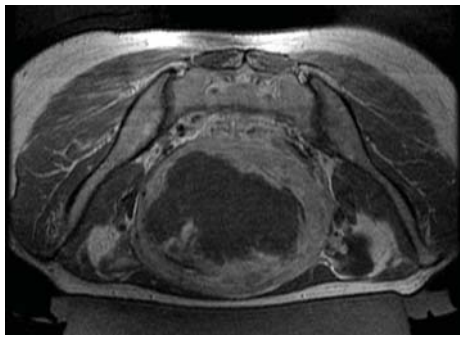


Figure 3: Contrast-enhanced axial T1-weighted MR image after treatment, showing nonperfused volume of 60%.

3. Discussion

In MRgFUS for symptomatic uterine fibroid, the nonperfused volume (NPV) of uterine fibroids has been found to correlate with treatment-related symptom relief, and to be inversely related with the need for repeated treatment (either MRgFUS or other therapeutic modalities) [8]. The success and durability of MRgFUS in relieving symptoms of uterine fibroids depend on appropriate selection of those patients in whom higher posttreatment NPV can be obtained. Therefore, patient eligibility is an important factor in achieving high NPV and significant symptom relief [10].

Based on previous experience, MRgFUS treatment of hyperintense fibroids usually results in relatively poor NPVs, and subsequent treatment failures [3]. The hyper-intensity of these fibroids on T2WIs is assumed to result either from high concentrations of fluids or from high vascularity. We assume that either scenario makes it difficult to achieve temperatures sufficient for thermal ablation of fibroid tissue, which are critical to the efficacy of MRgFUS. In case of high concentrations of fluids, the energy absorption by the tissue is low, resulting in low temperatures in the focus. In case of high vascularity the blood flow disperses the heat from the treated region. Consequently, the potential for low NPV on post-treatment imaging, subsequent insufficiency of symptom relief, and overall treatment failure in this patient were considered.

This case report shows that hyper-intense fibroids can be successfully treated with MRgFUS, however, the fibroids should be subcategorized based on their potential for successful treatment. T2WIs contribute to important patient-selection information regarding the location and structure of the fibroid(s) and coexisting pathologies. T1WIs with contrast examine the viability of the fibroid and, when performed dynamically, provide additional information on the rate of fibroid enhancement. Delayed enhancement may indicate that the fibroid has low vascularity and will absorb sufficient ultrasound energy to result in successful MRgFUS, even if the fibroid appears hyper-intense on the T2WIs.

We suggest that dynamic contrast enhancement imaging, in addition to fibroid intensity in T2WI, may provide important information whether or not a fibroid is suitable for MRgFUS. Although in this case report, other factors could have contributed to the treatment success, we assume that the dynamic contrast imaging during screening helped in patient selection. Additional studies are needed to verify this theory and establish a correlation between the pretreatment dynamic contrast enhancement imaging characteristics of a given fibroid and patient outcomes following MRgFUS.

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Case Report

Successful Magnetic Resonance Imaging-Guided Focused Ultrasound Surgery for Recurrent Uterine Fibroid Previously Treated with Uterine Artery Embolization

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A 45-year-old premenopausal woman was referred to our clinic due to recurring symptoms of uterine fibroids, nine years after a uterine artery embolization (UAE). At the time of screening, the patient presented with bilateral impairment and narrowing of the uterine arteries, which increased the risk of arterial perforation during repeated UAE procedures. The patient was subsequently referred for magnetic resonance imaging-guided focused ultrasound surgery (MRgFUS) treatment. Following the treatment, the patient experienced a significant improvement in symptoms (symptom severity score was reduced from 47 to 12 by 1 year post-treatment). MR images at 3 months showed a 49% decrease in fibroid volume. There were no adverse events during the treatment or the follow-up period. This case suggests that MRgFUS can be an effective treatment option for patients with recurrent fibroids following previous UAE treatment.

1. Introduction

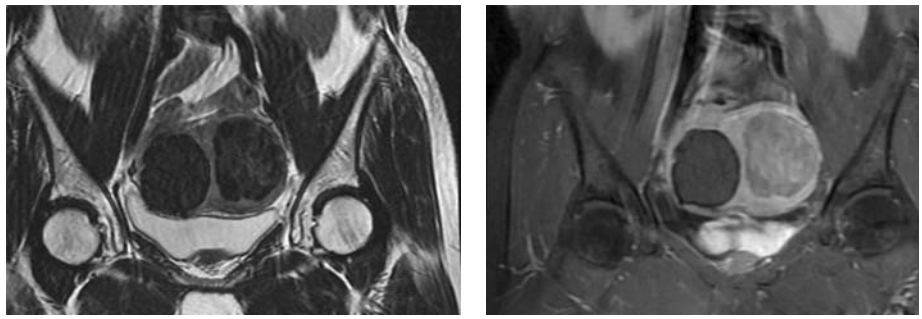
Uterine leiomyoma (fibroid) is the most common reproductive tract tumor in women of reproductive age. Fibroids have been clinically identified in at least 25% of women [1], and pathological analysis suggests that the prevalence of fibroids may be as high as 77% [2]. Symptomatic fibroids can significantly affect quality of life (QOL) and can result in heavy and prolonged menstrual flow, urinary frequency, pelvic pain, abdominal pressure, infertility, and dyspareunia [3–5].

Surgical treatments for uterine fibroids include hysterectomy and myomectomy [6]. Minimally invasive or noninvasive treatments include uterine artery embolization (UAE), magnetic resonance imaging-guided focused ultrasound surgery (MRgFUS), and hormonal therapy [6–9]. Each of these treatment options, which require minimal or no hospitalization, enables women to preserve their uteri [10] and usually minimize complications, recovery time, and treatment costs [11, 12].

UAE is a minimally invasive, image-guided therapy, in which the blood supply to the uterine fibroid is blocked by catheterization, and the ischemic necrosis of the fibroids is induced by the insertion of embolic particles [13]. The embolic particles are usually composed of polyvinyl alcohol, tris-acryl, or gelatin sponge material.

MRgFUS is a noninvasive treatment in which ultrasound energy, focused on the fibroid in multiple focal spots, raises the temperature of tissue within the focal zone and causes coagulative necrosis. MRI guides and monitors the procedure, thereby providing closed loop anatomical and thermal feedback [9].

Several measures are used to assess the efficacy of these minimally invasive or noninvasive treatments, including a Uterine Fibroids Symptoms Quality Of Life (UFS-QOL) assessment questionnaire [14], fibroid shrinkage, and patient



(a) (b)

Figure 1: Screening MR images: (a) coronal T2-weighted image showing two fibroids, (b) coronal T1-weighted contrast-enhanced image—the right fibroid is already nonenhancing, whereas the left one is still viable.

satisfaction. As with any fibroid treatment, besides hysterectomy, symptoms can recur following the less invasive approaches. Consequently, referral to an alternative treatment, after a particular modality has been pursued, is also a measure of the treatment efficacy.

Different patient selection criteria are established for UAE and MRgFUS treatments. For UAE, submucosal and pedunculated fibroids may be considered as relative contraindications, as is a previous internal iliac or uterine artery occlusion, or a recent GnRH analogue administration. In addition, there is insufficient data to advocate UAE as a means of preserving fertility [15, 16]. For MRgFUS, hyperintense fibroids and multiple fibroids may be considered relative contraindications, as they are difficult to treat. In addition, in cases where the ultrasound beam is interrupted by anatomical structures, such as bowels, bones, or nerves, MRgFUS treatment may be impossible without successful mitigation techniques [17].

This is the first case report of MRgFUS treatment in a patient with recurring fibroid symptoms following UAE.

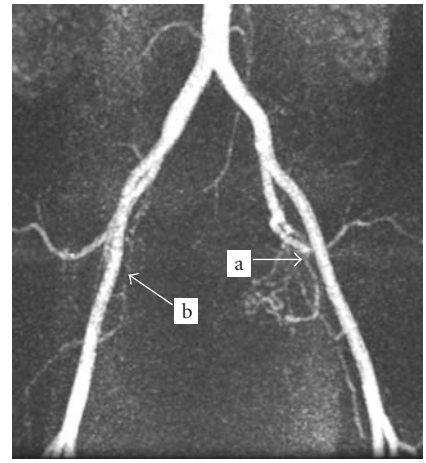


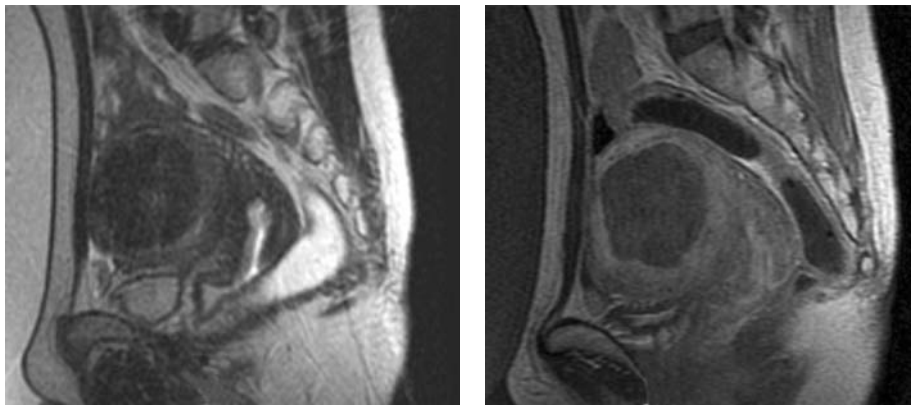
Figure 2: MR angiography. The reason for UAE unsuitability: (a) narrow left uterine artery, (b) no obvious right uterine artery.

2. Case Report

A 45-year-old premenopausal woman, with a BMI of 22.1 and 2 previous pregnancies, complained of menorrhagia in 1998. Clinical examination showed two intramural fibroids with volumes of approximately 115 cc and 15 cc. In November 1998, the patient underwent a UAE, and both her fibroids were treated. Approximately nine years later, in 2008, the patient reported the recurrence of symptoms, including severe menorrhagia and irregular menstrual periods (symptom severity score of 47). A pelvic MRI including MR angiography was performed in order to determine her fibroid status and suitability for an additional UAE. Two intramural fibroids were observed (Figure 1). The first was an 81 cc fibroid on the right side of the uterus, which was nonenhancing on contrast-enhanced T1-weighted images (probably due to necrosis following the previous UAE procedure). The second fibroid, which was located on the left side of the uterus, was 90 cc and was enhancing on T1-weighted images. An MR angiography revealed that the right fibroid lacked a blood supply, with an almost invisible right uterine artery. The left fibroid was supplied only by the narrow left uterine artery (Figure 2). The left fibroid was likely a recurring or new fibroid that had not been treated by the previous UAE. It was recommended that the patient not undergo an additional UAE, due to the difficulty in approaching the fibroid bilaterally and the increased risk of arterial perforation during repeated UAE procedures. Since the patient insisted on a noninvasive treatment for her symptoms, she was referred to our unit for MRgFUS treatment.

Following a negative endometrial biopsy result, the left fibroid was deemed suitable for MRgFUS treatment.

The MRgFUS procedure was performed using the Exablate 2000 system (InSightec Ltd., Haifa, Israel) and the 1.5T HDx MRI (GE Healthcare, Milwaukee, U.S.). Patient preparation included shaving and cleaning of the abdomen, insertion of a urinary catheter, and administration of conscious sedation (Fentanyl, one ampoule). The patient was then placed on the ExAblate treatment table with her abdomen positioned over the ultrasound transducer bath.



(a) (b)

Figure 3: Treatment images: (a) Sagittal T2-weighted planning image, (b) Sagittal contrast-enhanced T1-weighted posttreatment image showing 90% of nonenhancing volume on the left fibroid.

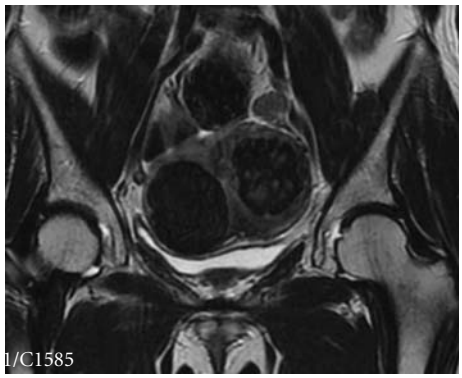


Figure 4: Coronal T2-weighted image three months post-treatment, showing 49% volume shrinkage of the treated fibroid.

Pretreatment T2-weighted MR images were obtained for procedure planning and for targeting the left fibroid. For the duration of the treatment, 35 sonications were delivered over approximately 1 hour, and thermal responses consistent with effective ablation were observed on the real-time temperature maps. T1-weighted contrast-enhanced images that were obtained immediately following the procedure showed a nonperfused volume (NPV) of 81 cc, which constitutes approximately 90% of the fibroid volume (Figure 3).

The patient was discharged approximately 30 minutes after completion of the procedure and reported a return to normal activity and a regular work schedule after one day. The patient did not report any pain and was very satisfied with her rapid recovery compared to her previous UAE. There were no adverse events during or after the treatment.

Three months after the treatment, the patient reported significant symptom improvement. Contrast-enhanced T1-weighted and T2-weighted MR images, obtained at that time, revealed shrinkage of the treated fibroid by 49% (Figure 4). The patient's SSS was 22, reflecting a 25-point decrease from the base-line score before the MRgFUS treatment. At the one-year follow-up assessment, her symptom severity score was further decreased to 12.

3. Discussion

We are currently noticing an increase in the number of uterine fibroid patients who seek minimally invasive or non-invasive treatment options. These options include laparoscopic surgeries, UAE, MRgFUS, and other modalities.

Patients should be made aware of all the treatment options available for uterine fibroids, including invasive, minimally invasive or noninvasive procedures. The most clinically suitable treatment option should be recommended for each individual patient, according to her medical condition and personal needs.

UAE treatment may pose an increased risk in cases where the uterine artery is absent in the area of the fibroid, or when a highly tortuous uterine artery or ectopic arterial branches feed the fibroid [18]. Therefore, patients who present with one of these anatomical features, who have recurring symptoms and are seeking a minimally invasive or noninvasive treatment, may be referred for MRgFUS or hormonal therapy.

This paper demonstrates how patients can potentially benefit from alternative minimally invasive or noninvasive treatment options for symptomatic uterine fibroids. Specifically, MRgFUS treatment can be a good option for patients who were previously treated with UAE. Additional studies of the safety and efficacy of MRgFUS following UAE should be conducted.

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