Myomectomy Techniques

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Contents

Abstract

Uterine fibroids are common, and if symptomatic and the uterus is to be conserved for child-bearing, myomectomy is the traditional surgical solution. Myomectomy can be done by a variety of techniques, including by laparotomy (open surgery), laparoscopy, hysteroscopy and via the vagina. Each has its indication, and advantages and disadvantages. Open myomectomy is suitable for all cases and remains the only choice when the fibroids are numerous and/or large. Laparoscopic myomectomy is most suited to small to medium sized subserous fibroids but can also be used if the fibroid is intramural. Recently, robotically assisted laparoscopic myomectomy has been introduced into clinical practice, but whether it is cost effective remains to be seen. Hysteroscopic myomectomy is indicated for small intra-cavitary and submucous fibroids. Finally, vaginal myomectomy, widely practised in the nineteenth century, is undergoing a revival as an alternative to laparoscopic and hysteroscopic surgery.

1 Introduction

Due to their high prevalence and association with abnormal menstruation, subfertility, an abdominal mass and pressure symptoms, the management of uterine fibroids has traditionally represented a considerable workload for gynaecologists. While at least half the women with uterine fibroids remain asymptomatic, typically those with small leiomyomas, the absence of medical treatment which is both effective and suitable for long-term therapy coupled to the natural tendency of fibroids to enlarge during the reproductive years has meant that many women do ultimately require more invasive treatment. For the gynaecologist, this has essentially meant either conservative surgery (myomectomy) if fertility is to be preserved, or radical surgery (hysterectomy), when future childbearing was no longer an issue. However, it is increasingly the case that even women

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who do not desire pregnancy wish to retain the uterus and refuse hysterectomy. In such cases, myomectomy is the traditional surgical solution.

2 Preparation for Myomectomy

Adequate assessment prior to myomectomy is essential to ensure that the appropriate surgery is done and the surgery is made as safe as possible. Estimation of uterine size is the starting point, and this is easily achieved by abdominal and bimanual palpation, most gynaecologists describing the size of the uterus in terms or pregnancy equivalent. If vaginal myomectomy is a possibility, adequate vaginal access and good uterine mobility on vaginal examination should be sought. Although not a common finding, vaginal examination may reveal a cervical or prolapsed vaginal fibroid.

As it is rarely possible to conclude from palpation, how many fibroids there are and their precise position, something which may influence the route of surgery, clinical examination should be supplemented by appropriate imaging. In our practice, this typically involves ultrasound scanning as a cheap alternative to MRI, the aim being to document the number of fibroids, their position and size.

If the fibroids are relatively small and shown to be submucous on imaging, it is the practice of the authors to carry out an office (out-patient) hysteroscopy to confirm that the fibroid is suitable for hysteroscopic excision.

In view of the risk of intra-operative bleeding, it is important to diagnose and correct any pre-existing anaemia before surgery, so a full blood count is standard practice. This may simply involve treating with iron supplements, but could mean the use of GnRH analogues to stop menstruation, or more recently, ulipristal acetate. Hormone pretreatment can also be used to shrink fibroids to facilitate surgery, but this is not routine practice in our clinic for the reasons outlined in Sect. 4.

If imaging shows ureteric dilatation secondary to pressure from the fibroids, renal function tests are also done. Other investigations are only ordered if clinically indicated.

3 Techniques of Myomectomy

To many gynaecologists as well as patients, myomectomy equates with the excision of fibroids by laparotomy, laparoscopy or hysteroscopy (Mukhopadhaya et al. 2008). This ignores the fact that the earliest myomectomies were not done by any of these routes of surgery but via the vagina (for fibroids which were sited in the cervix or had prolapsed into the vagina). There are, therefore, four routes of surgery to remove uterine fibroids as summarised in Table 1.

Table 1 Different types of myomectomy and our operative criteria

Route of surgery	Uterine/fibroid size	Number	Position
Abdominal	Any	Any	Any
Laparoscopic	≤15 cm total fibroid diameter	≤3	Subserous/intramural
Hysteroscopic	≤5 diameter	1 to a few	Intracavitary/ submucous
Vaginal	≤14 weeks uterine size	1 to several	Vaginal/ intracavitary/ intramural/subserous

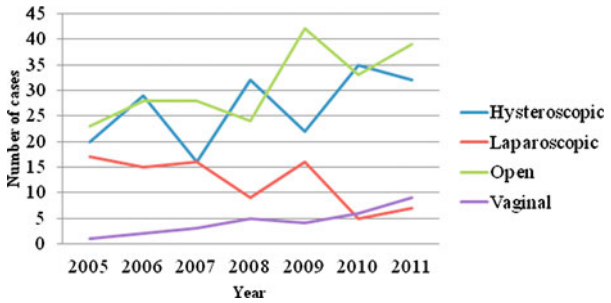

Fig. 1 Myomectomies carried out under the care of the senior author (2005–2011)

The choice of which type of myomectomy to carry out is obvious in some cases, while in others it is a matter of the experience and preference of the gynaecologist. At one end of the spectrum, women with gross uterine enlargement secondary to multiple large fibroids have little option but to undergo open myomectomy. At the other extreme, there would be few who would disagree that hysteroscopic myomectomy for one or two small submucous fibroids is the best and most elegant technique in such cases, while laparoscopic myomectomy is most suited to women who have a few small to medium-sized subserous/intramural fibroids.

As is typical of all surgical procedures, individual surgical practice is not quite as clear cut. For instance, there are a handful of enthusiasts who carry out laparoscopic myomectomy in cases where, because of the size and number of fibroids to be removed, the majority of gynaecologists would not even consider it (Sinha et al. 2008). Another example is vaginal myomectomy, a technique which has been all but forgotten by the majority of gynaecologists; we consider that this technique has several important advantages over the other route of surgery, so offer it to suitable patients as a matter of routine as demonstrated in Fig. 1 (Thomas and Magos 2011).

4 Open Myomectomy

Open myomectomy is the traditional conservative procedure when the uterus is significantly enlarged by multiple, large fibroids (Breech and Rock 2008). While the advent of pelvic ultrasound scanning has meant that women are diagnosed with relatively small fibroids at an earlier age than previously, and indeed in many cases uterine fibroids are an incidental finding when imaging is done for some other reason, it is still the case that a significant proportion of patients who present to gynaecologists with a diagnosis of uterine fibroids and symptoms have an easily palpable pelvic mass in the abdomen. In the majority of such cases, open myomectomy is both the most appropriate and most thorough treatment if uterine function is to be preserved. About 40,000 open myomectomies are done each year in the USA, and 2,000 or so in England.

Having decided to carry out an open myomectomy, the next decision is whether or not to delay surgery and pre-treat with a GnRH analogue. Pre-treatment for 3 months is certainly popular for a number of reasons: there is a good chance that therapy will inhibit menstruation which may well have been abnormally heavy previously; amenorrhoea should lead to improved haemoglobin with correction any pre-existing anaemia, particularly if combined with iron therapy; it should reduce fibroid and uterine size, thereby allowing for a smaller laparotomy incision and possibly the use of a cosmetically and functionally superior low transverse laparotomy incision rather than a vertical one.

There are, however, disadvantages to GnRH pre-treatment. Quite apart from the need to delay surgery for the analogues to take effect, treatment is expensive and associated with menopausal side-effects such as hot flushes and night sweats (although this can be counteracted by concurrent oestrogen add-back therapy). Dissecting the fibroids from the myometrium tends to be more difficult as the tissue planes are often less distinct. There may be little or no benefit in terms of operative blood loss. Perhaps most importantly, there is good evidence that there is a higher fibroid recurrence rate in patients who have been pre-treated for the simple fact that small fibroids become so small with therapy that they are missed during surgery (Vercellini et al. 2003).

In consideration of the above, our protocol is to only prescribe GnRH analogue pre-treatment as an adjunct to correcting anaemia due to menorrhagia, and if shrinking the uterus will avoid the need for a vertical laparotomy incision. It may be that the recently introduced orally active selective progesterone receptor modulator, ulipristal acetate, may prove to be a more acceptable option to stop menstruation and shrink fibroids prior to surgery.

4.1 Patient Selection

Any patient is suitable for open myomectomy, but in reality, women who are offered this type of intervention are the ones who are judged to be unsuitable for the other approaches. This usually means that the typical woman who undergoes open myomectomy has multiple large fibroids, often extending to or above the umbilicus. Occasionally, open myomectomy is done on patients with relatively small or few fibroids when it tends to be a matter of patient preference. It is certainly true that, for instance, open myomectomy has more of a chance of removing all the fibroids with a stronger uterine repair for subsequent childbearing than laparoscopic myomectomy, and for some this is an important consideration.

4.2 Surgical Technique

The default incision for open myomectomy is a low transverse (Pfannenstiel) laparotomy. In some cases this is inappropriate because of the size of the fibroids, the presence of a previous midline incision or concern about adhesions, when a vertical laparotomy may be preferred. Quite apart from the cosmetic disadvantage of a vertical laparotomy, this incision has a considerably greater risk of breakdown and post-operative herniation. At the other end of the scale when there are relatively few, small fibroids to remove, surgery can be done via a mini-laparotomy (incision $\leq$7 cm) and even ultraminilaparotomy (incision $\leq$4 cm) as an alternative to laparoscopic myomectomy.

The aim of surgery is to remove as many of the fibroids as possible, ideally all of them, no matter how small. Rather than incising the uterus over each and every fibroid, the recommended technique is (a) to remove the fibroids through as few incisions as possible, and (b) to avoid posterior uterine incisions to reduce the chance of post-operative adhesions involving the fallopian tubes and ovaries risking subfertility (Breech and Rock 2008). It is for this reason that most procedures start with a single vertical anterior midline incision, and if a posterior incision is required, we prefer a "hood incision", originally described by Victor Bonney, arguably the most important figure in popularising open myomectomy in the UK (Chamberlain 2003).

Whatever the approach, we prefer to only open the endometrial cavity if this is unavoidable because of the presence of intracavitary or submucous fibroids. There are those, however, who advocate removing even posterior fibroids through an anterior uterine incision by cutting through the uterine cavity. Traditionally, if the uterine cavity has been opened at open myomectomy, any subsequent deliveries are done by elective Caesarean section.

Table 2 Techniques which have been tried to reduce intra-operative blood loss at open myomectomy

Pre-operative techniques
GnRHa
Uterine artery embolisation
Intra-operative techniques
Hypotensive anaesthesia
Single midline uterine incision
Enucleation of coagulation cascade (e.g. tranexamic acid, aprotinin, aminocaproic acid, recombinant factor VIIa, gelatin-thrombin sealant)
Dissection techniques (e.g. laser electrosurgery chemical dissection with sodium-2-mercaptoethane sulfonate [MESNA])
Uterotonics (e.g. ergometrine, oxytocin, misoprostol, sulprostone)
Hormonal tourniquet (e.g. vasopressin, terlipressin, epinephrine, bupivacaine + adrenaline)
Mechanical tourniquet (e.g. clamps, clips, electrocoagulation, single tourniquet, triple tourniquets)

The major risk of open myomectomy is haemorrhage, which if severe may necessitate the greatest fear not only for the patient but the gynaecologist, namely hysterectomy. Various strategies, both pre- and intra-operative, have been advocated to reduce this risk (Table 2). Radiologists, of course, know the history of uterine artery embolisation (UAE) and are aware that UAE was originally introduced not as a definitive management, but as a precursor to open myomectomy to reduce the risk of intra-operative haemorrhage (Ravina et al. 1994).

Despite the long history of the operation, only a few of these strategies have been proven to be effective under controlled conditions. Table 3 summarises the results of randomized trials of various intra-operative techniques which have been studied, showing that the most effective strategy is the use of triple tourniquets to occlude uterine perfusion during surgery (Kongnyuy and Wiysonge 2011). The classic technique is to place tourniquets around the cervix and each infundibulopelvic ligament to occlude the uterine and ovarian arteries thereby rendering the uterus totally avascular during surgery (Breech and Rock 2008). Concern about prolonged ovarian hypoxia has meant that some gynaecologists release the ovarian tourniquets every 20 min or so, but this of course adds to the blood loss. To circumvent this problem, we have designed a special clamp (Ovarian Artery Clamp) which can be applied medial to the ovaries to occlude the ovarian blood supply to the uterus without crushing the fallopian tubes as would be the case with a standard clamp (Fig. 2a, b) (Magos et al. 2011). Preliminary results from our Institution show that this technique is as effective as conventional triple tourniquets.

As a further refinement of the technique, and a reflection of the fact that it can be difficult to apply an effective tourniquet around the cervix, we have reported the use of sterilised cable ties as an alternative to catheters and sutures (Al-Shabibi et al. 2010). Interestingly, the use of cable ties at surgery can be traced back to the 1970s!

Table 3 Efficacy of various intra-operative techniques to reduce bleeding at open myomectomy

12 randomized studies 674 women
Not effective Intravenous *oxytocin* Myoma enucleation by *morcellation*
Effective Intramyometrial *bupivacaine + adrenaline* (MD-69 ml) Intravaginal *misoprostol* (MD-149 ml) *Single tourniquet* (MD-241 ml) Intravenous *tranexamic acid* (MD-243 ml) Intramyometrial *vasopressin* (MD-299 ml) *Gelatin-thrombin matrix* (MD-545 ml) *Triple tourniquets* (MD-1870 ml)

MD Mean difference blood loss

On completion of the myomectomy, it is generally recommended that steps should be taken to reduce the risk of post-operative adhesions. A variety of anti-adhesive agents can be used for this, although in reality, their efficacy remains largely unproven (Ahmad et al. 2008). It is our usual practice to leave a drain in the pelvis both to monitor any oozing from the uterus and reduce the chance of a clinically significant post-operative haematoma. We also give prophylactic antibiotics during and after the surgery. Prophylactic anticoagulants are not given pre-operatively for fear that this will increase the risk of intra-operative haemorrhage, and instead we rely on anti-embolism compression stockings and pneumatic calf pumps during surgery to reduce the chance of deep vein thrombosis.

Drains and bladder catheters are usually removed after 2 days, and although variable, most patients are discharged from hospital after 5–6 days.

4.3 Operative Complications

Intra- and to some extent post-operative haemorrhage is the main risk of surgery. As noted above, triple tourniquets are a very effective technique for reducing bleeding complications, but even then around 10 % of our patients require a peri-operative blood transfusion (Taylor et al. 2005b; Al-Shabibi et al. 2009). Some may feel this rate of transfusion is unduly high, but the need for blood products very much depends on the size and number of fibroids removed. On average, we excise 15–20 fibroids per patient, a figure which is considerably more than reported in most published series (Hanstede et al. 2008).

Despite the extent of the surgery, we have never had to resort to hysterectomy because of intra- or post-operative bleeding. For instance, during the period 2005–2012, we only had to carry out two hysterectomies out of over 250 procedures, the indications for both being severe uterine

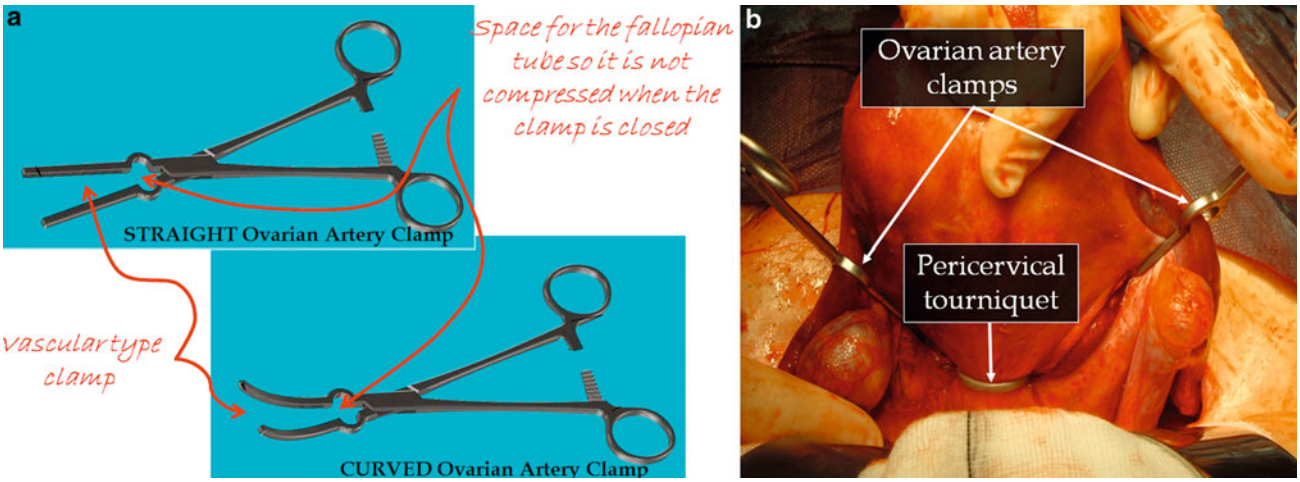

Fig. 2 **a** Straight and curved ovarian artery clamps for use at open myomectomy. **b** Pericervical tourniquet and ovarian artery clamps in position at the start of open myomectomy

sepsis following repeat open myomectomy; in one case, over 100 fibroids were removed at surgery. This compares with rates of hysterectomy because of bleeding of 4 % in other published series (Olufowobi et al. 2004).

The other typical complications (e.g. wound, urinary tract and chest infections, venous thrombosis), occur as with any other open pelvic surgery. All patients are counseled regarding the theoretical risk of injury to bowel and bladder, but in reality, this rarely happens unless there are extensive adhesions around the uterus. We advise all our patients undergoing open myomectomy to delay trying for a pregnancy for at least 6 months to give time for the uterus to heal.

5 Hysteroscopic Myomectomy

To a gynaecologist, hysteroscopic myomectomy is the total opposite to open myomectomy. Whereas open myomectomy clearly represents major surgery with all its associated risks including haemorrhage, hysteroscopic myomectomy is an elegant and above all, relatively quick and atraumatic treatment for intracavitary and submucous fibroids. Bleeding is rarely an issue.

First described by the American Robert Neuwirth in 1976, when he used hysteroscopic scissors to cut the stalk of pedunculated intra-cavitary fibroids, two years later he introduced what arguably remains one of the most important development in modern gynaecology, the use of the resectoscope for excising submucous fibroids which are partially embedded in the myometrium (Neuwirth and Amin 1976; Neuwirth 1978). This includes most submucous myomas.

The instrumentation and techniques for hysteroscopic myomectomy have been developed further in the ensuing years with the introduction of the Versapoint device and more recently the intra-uterine morcellator (Di Spiezio et al. 2008). However, few would argue that the resectoscope remains the instrument par excellence for hysteroscopic myomectomy. It is both the most efficient instrument and the only one which can be used to remove fibroids which extend deep into the myometrium. The introduction of the miniresectoscope, a paediatric instrument which has been lengthened to make it suitable for use in adults, has meant that the benefits of resectoscopic surgery is now available in the outpatient/office setting (Papalampros et al. 2009).

5.1 Patient Selection

Whatever the instrumentation, patient selection is of paramount importance (Table 1). Hysteroscopic myomectomy should only be offered to women who have one or two relatively small ($\leq$5 cm for most gynaecologists) submucous fibroids (Fig. 3). Multiple submucous fibroids are rarely suitable for fear of inducing a surgical Asherman's syndrome with scarring and agglutination of the raw surfaces following surgery. Large fibroids are unsuitable as surgery is likely to be prolonged with a risk of fluid overload (see below). Subserous or transmural fibroids, even if they have an intra-cavitary component, are unsuitable as surgery will inevitably result in uterine perforation. Despite these restrictions, hysteroscopic myomectomy remains second only to open myomectomy at our Institution as surgical treatment for uterine fibroids, a situation no doubt explained by early diagnosis by ultrasound (Fig. 1).

5.2 Surgical Technique

The precise technique of hysteroscopic myomectomy depends on the instrumentation being used, but all share

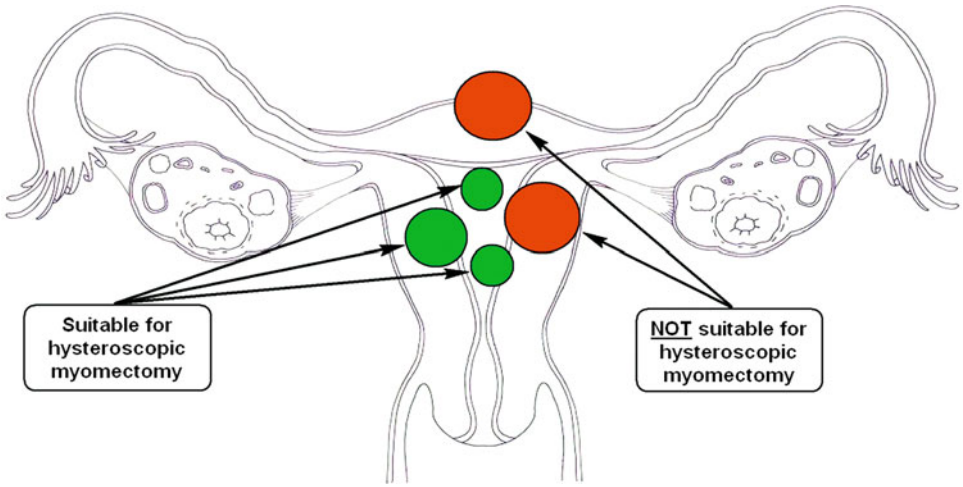

Fig. 3 Not all fibroids are suitable for hysteroscopic myomectomy

some common principles. The cervix may have to be dilated to allow insertion of the operative hysteroscope; if this is necessary in the outpatient clinic, it is sometimes necessary to inject local anaesthetic into the cervix or paracervix. The uterine cavity has to be distended with a sterile low-viscosity irrigant at a relatively high pressure (100–150 mm Hg) to allow adequate separation of the uterine walls and visualisation of the fibroid(s). The choice of irrigant depends on the type of instrument being used, traditional fluids including 1.5 % glycine solution (for monopolar surgery) and normal saline (for mechanical or bipolar instruments).

Unless very small, the fibroid is then cut into pieces to aid removal, a process which is technically much easier with a resectoscope than the Versapoint because of the design and angle of the active electrode. Care has to be taken when resecting the intramural portion of any fibroid to avoid cutting too deeply and thereby perforating the uterus, and it is for this reason that fibroids which are <5 mm from the serosa are probably best not managed hysteroscopically. When there is a deep intramural component, we use a technique described by Mazzon (Italy) which involves dissecting out the fibroid using various cold knife (non-electrosurgical) electrodes (Casadio et al. 2011). Using this technique, performing partial myomectomy and leaving the deep part of the fibroid in situ can no longer be justified.

At the end of the surgery, most of the resected fibroid pieces are removed and sent for histological analysis. This is important as sarcomatous change is always a possibility, albeit a rare one.

5.3 Operative Complications

The major risks of operative hysteroscopy are listed in Table 4, of which uterine perforation and fluid overload are the classic complications (Aydeniz et al. 2002). In reality, all the complications listed are uncommon and largely avoidable by good technique.

Uterine perforation is arguably the major fear as it can result not only in uterine haemorrhage but injury to adjacent structures (e.g. bowel, bladder, major blood vessels). Perforation is avoided by ensuring that resection is not carried too deeply into the myometrium. If the uterus is perforated during myomectomy, the surgery must stop and a laparoscopy or laparotomy done both to control any uterine bleeding and to check for collateral damage.

Fluid overload and associated electrolyte derangement, which in extreme cases can be fatal and similar to the TURP syndrome seen in men, is avoided by continuous and careful monitoring of fluid balance throughout the procedure and stopping surgery if fluid balance reaches a pre-determined limit. We take the additional precaution in such cases of checking blood biochemistry, giving a small dose of furosemide (20–40 mg i.v.), and catheterising the bladder to monitor urine output with the expectation that there will be full metabolic return to normal within 12–24 h. The risk of serious sequelae has, anyway, been greatly reduced by the change from mono- to bi-polar electrosurgery and the use of more physiological electrolyte-containing uterine distension media.

Of the other risks, bleeding during surgery is uncommon for the simple fact that the intra-uterine distension pressure is usually above the mean arterial pressure. On occasions, heavy bleeding can occur at the end of the procedure when the uterus is deflated, particularly if a particularly large, deep fibroid has been excised, but this is usually simply managed by tamponade with an intra-uterine balloon for a few hours. Infection is generally very uncommon after hysteroscopy, but we do give prophylactic antibiotics during surgery. The authors have never seen gas embolism in their clinical practice.

Table 4 Complications of operative hysteroscopy

Uterine perforation
Fluid overload
Haemorrhage
Gas embolism
Infection
Cervical trauma
Electrosurgical burn

6 Laparoscopic Myomectomy

Laparoscopic myomectomy was first described towards the latter part of the 1970s at around the same time as hysteroscopic myomectomy. Kurt Semm, Professor of Obstetrics and Gynaecology in Kiel in Germany, considered by many to be the father of modern laparoscopic surgery, developed the instruments and techniques which made laparoscopic myomectomy as well as a long list of other procedures formerly done by laparotomy possible (Semm 1979). He introduced laparoscopic suturing techniques, large (10 mm) laparoscopic forceps, the Aqua-Purator for suction/irrigation, and relevant to myomectomy, a manual tissue morcellator to allow removal of the fibroid through a laparoscopic port. Although it took some time for his ideas to be widely accepted, laparoscopic myomectomy has become a standard gynaecological procedure, although one which is only undertaken by a minority of gynaecologists because of the need for an ability to suture laparoscopically to repair the uterus at the end of the procedure (Taylor et al. 2005a).

Technological advances since Semm's first description have meant the availability of larger and more efficient morcellators, morcellation always being relatively time consuming and greatly adding to the overall operating time. While Semm was looking directly through the laparoscope during surgery, which meant that his assistants were largely blind to the procedure and therefore of limited help, all laparoscopic surgery is now done under video monitoring, so the entire surgical team can play a role to make the procedure efficient and safe (Magos et al. 2011).

The earlier comments about pre-treatment with GnRH analogues apply equally to laparoscopic myomectomy as well, with the similar advantages and disadvantages.

6.1 Patient Selection

Laparoscopic myomectomy is principally indicated for patients who have a few small to medium-sized subserous and/or intramural fibroids associated with modest overall uterine enlargement (Table 1). Pedunculated subserous fibroids are particularly suited to a laparoscopic approach, whereas deep intramural fibroids are technically the most difficult to operate on. However, it would not be unfair to claim that no two gynaecologists have the same criteria for the procedure, and the upper limit for laparoscopic myomectomy in terms of number and size of fibroids to be removed is often a matter of personal preference. There is no doubt that the larger and more numerous the fibroids, the more difficult and time-consuming the procedure, and it is debatable whether spending over 7 h to remove a handful of myomas laparoscopically rather than taking 1–2 h by laparotomy can be justified (Hasson et al. 1992).

6.2 Surgical Technique

Many aspects of laparoscopic myomectomy are the same as for any laparoscopic procedure. It is not uncommon to use more ports than usual (say 4 instead of 3), to use larger ports (12–15 mm instead of 5 mm), and to place them higher in the anterior abdominal wall than usual so as not to be too close to the uterus. As noted above, for anything other than pedunculated subserous fibroids, uterine repair will be necessary so the gynaecologist must be able to suture laparoscopically.

Modifications of the classic laparoscopic procedure originally described by Semm have been developed to make the surgery easier. Hand-assisted laparoscopic myomectomy and laparoscopically assisted ultraminilaparotomy are two examples but have yet to be widely practised (Wen et al. 2010).

Intra-operative bleeding remains the major risk of surgery, just as with open myomectomy. As by definition only a few fibroids are to be removed, many gynaecologists use local dilute vasopressin infiltration to reduce blood loss during surgery. Great care has to be taken to ensure that the vasopressin is not injected directly into a blood vessel as this risks cardiovascular complications, and even death; it is for this reason that the use of vasopressin for this indication is banned in some countries (Hobo et al. 2009).

An arguably safer approach is to occlude the uterine vessels temporarily or permanently at the start of surgery using electrosurgery, sutures or clips (Dubuisson 2007). Again, care has to be taken to avoid inadvertently occluding the ureters which lie close. Our favoured technique is an adaptation of the triple tourniquets, we use at laparotomy which has the advantages that (a) blood flow from the ovarian vessels are also halted to provide total rather than partial haemostasis, and (b) there is less risk of injuring the ureter as there is no need for any pelvic side wall dissection (Taylor et al. 2005c).

Following excision of the fibroids, it is important to repair the uterus in layers. Not only does this provide haemostasis,

but importantly from the point of view of obstetric performance, reduces the risk of dehiscence in subsequent pregnancies.

On completion of the myomectomy, most gynaecologists use powered morcellators to remove the fibroid(s) through one of the ports, although fibroids can also be removed via a posterior colpotomy.

While the operating time tends to be considerably longer than with laparotomy, intra-operative blood loss, minor complications and patient recovery in terms of post-operative analgesia requirements, duration of hospitalisation and time taken for return to full activities are superior to open myomectomy (Jin et al. 2009).

6.3 Operative Complications

All the complications of open myomectomy apply to laparoscopic myomectomy but, as the fibroids which are removed tend to be smaller, the problems tend to be less frequent than with conventional surgery. Conversely, laparoscopic myomectomy has its own unique risks related to the surgical approach (Makai and Isaacson 2009). In essence, these can be summarised as (a) complications which occur at the time of laparoscopic entry (e.g. bowel or vascular injury), and (b) many injuries are not recognised at the time. While uncommon, undiagnosed injuries can have severe consequences quite apart from the need for reparative surgery, which tends to be by laparotomy and in the case of bowel injury, may involve a colostomy (usually temporary). It is important that patients contemplating laparoscopic myomectomy understand this and are also warned that the procedure may have to be converted to laparotomy should the need arise.

7 Robotic Myomectomy

Robotic surgery is a development of laparoscopic surgery which is becoming increasingly available. Rather than the surgeon directly holding and operating the instruments, the instruments are operated by the arms of a robot which in turn is controlled by the surgeon some distance away via a control panel. Currently, the only robot in clinical use is the da Vinci surgical system, and there have been a few favourable reports of its use for laparoscopic myomectomy (Chen and Falcone 2009).

The advantages claimed for robotic surgery over standard laparoscopic surgery include the availability of a three- rather than two-dimensional vision resulting in enhanced visualisation, wristed instrumentation which provides greater dexterity and control than hand-held devices, elimination of the fulcrum effect integral to conventional laparoscopy which means that the surgeon no longer moves their hand in the opposite direction to the intended path of the instrument, and not least for what is often a prolonged procedure, far greater comfort for the surgeon who, rather than having to strain over the patient sits comfortably at the robot console (Schreuder and Verheijen 2009).

On the negative side, the da Vinci system is very expensive in terms of capital and running costs. The setting-up time is considerably longer than with conventional laparoscopy. Due to its size, the operating room has to be relatively large. As a result, few units in the UK have a da Vinci surgical system. No doubt, their use will increase but whether robotic surgery ever becomes cost effective or even of benefit compared with conventional surgery remains to be seen (Liu et al. 2012).

8 Vaginal Myomectomy

Cost is certainly not an issue with vaginal myomectomy, which in contrast to hysteroscopic myomectomy, is a non-endoscopic method of removing fibroids via the vagina. Vaginal myomectomy for submucous fibroids which had prolapsed into the cervix and vagina was in fact the first myomectomy, practised in the 1840s by pioneers of gynaecological surgery such as Amussat in France and Atlee in the US. By the end of the nineteenth century, the technique had been expanded to include not only the removal of prolapsed fibroids, but submucous, intramural and even subserous fibroids. These techniques are well documented in textbooks, usually with beautiful drawings, such as “Operative Gynecology” by Harry Sturgeon Crossen published in 1917 (several of these books are available free for download from www.archives.org).

Today, apart from myomectomy for a fibroid which has prolapsed through to the cervix or vagina, vaginal myomectomy has largely been forgotten by most gynaecologists, and the technique is not even mentioned in some current textbooks. This is a pity as it is a very useful alternative to hysteroscopic and laparoscopic myomectomy in suitable cases. Compared with hysteroscopic myomectomy, this technique is suitable for fibroids larger than 5 cm in diameter, and there is no risk of uterine perforation, fluid overload or gas embolism to list but three risks. Compared with laparoscopic myomectomy, the surgery is considerably faster and the uterine repair stronger as conventional suturing can be used.

8.1 Patient Selection

As is evident from the above, a vaginal approach to myomectomy can be considered irrespective of the position of the fibroid, the sole exception being a dominant fundal

Table 5 Proposed classification of vaginal myomectomy

Type	
1	Avulsion of prolapsed pedunculated submucous fibroid
2	Non-incisional access to intracervical or intracavitary fibroid
3a	Incisional access to intracavitary fibroid (Dührssen cervical incision)
3b	Incisional access to intracavitary fibroid (incision continued as hysterotomy)
4	Colpotomy access to intramural and subserous fibroids

fibroid which is better approached laparoscopically unless too large. Instead, the important considerations are, as in all vaginal procedures, adequate vaginal access and uterine mobility. Vaginal access is rarely an issue unless the patient is a virgo intacta, but obviously, surgery is easier in multiparous women who have delivered vaginally. Similarly, uterine mobility is not usually a problem unless the uterus is fixed by adhesions secondary to conditions such as severe endometriosis; it should be noted that adequate uterine mobility is not synonymous with utero-vaginal prolapse.

The main issue, then, is uterine and fibroid size. In the view of the authors, vaginal myomectomy for anything other than a prolapsed vaginal or cervical fibroid would be unduly difficult if the overall uterine size is ≥14–16 weeks gestation equivalent.

8.2 Surgical Technique

The various techniques of vaginal myomectomy are summarised in Table 5. The easiest technique is the Type 1 procedure, the one which Atlee described in 1845, and merely involves avulsing a fibroid which has prolapsed from the uterine cavity into the vagina. If the fibroid is lying in the cervix, removal may be aided by cutting the cervix longitudinally, the so-called Dührssen incision (Type 3a procedure). The incision can be extended into the uterus for the removal of fibroids which are in the uterine cavity or myometrium (Type 3b procedure). Finally, subserous fibroids can be accessed via an anterior or posterior colpotomy (Type 4 procedure) (Fig. 4).

If the cervix or uterus is to be incised, we inject vasoconstrictors into the cervix. It is in fact remarkable how relatively avascular the surgery is in most cases, probably explained by the fact that maneuvering.

Readers may be interested to learn that the original use for Dührssen incisions was to carry out vaginal Caesarean section. Yes, even a Caesarean section can be carried out vaginally!

Providing patient selection is appropriate, and vaginal myomectomy is not attempted in cases where the fibroids are obviously too large, our experience with all the various types of vaginal myomectomies is very positive. After a hiatus of 100 years or so, there is now particular interest in the Type 4 procedure not only in the West but as far afield as China (Yu et al. 2011). The technique has been favourable compared with laparoscopic myomectomy in randomised trials (Yi et al. 2011).

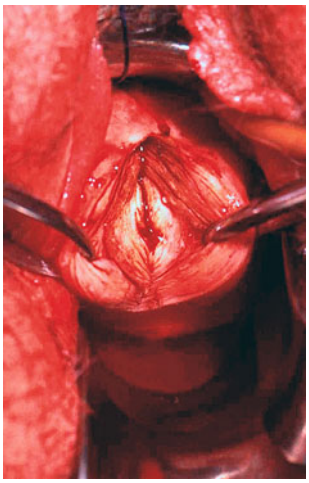

Fig. 4 Type 4 vaginal myomectomy where an anterior intramural fibroid is being removed through an anterior colpotomy (an incision between the vagina and the peritoneal cavity)

8.3 Operative Complications

As with laparoscopic myomectomy, patients undergoing vaginal myomectomy should be warned about the risk of bleeding which may require blood transfusion, conversion to laparotomy, and hysterectomy. In reality, these complications are uncommon if patient selection correct. Despite operating though the vagina, infection is also infrequent in our experience, but we do give prophylactic antibiotics during surgery.

Perhaps, the commonest risk complication after the Type 4 procedure is formation of a pelvic haematoma, and it is for this reason that we sometimes leave a drain in the colpotomy incision (Davies et al. 1999).

9 Conclusion

Despite the passage of time, myomectomy remains an important treatment for uterine fibroids when uterine conservation is required. Myomectomy can be done in many ways, and many women can now avoid major open surgery. To what extent robotic surgery will change clinical practice remains to be seen, but we are encouraged by the renewed interest in the vaginal approach to myomectomy.

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