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## Embolisation of uterine arteries or laparoscopic uterine artery ligation as possible treatment of uterine leiomyoma

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**Abstract** *Background:* Many women with symptomatic uterine leiomyomata wish to preserve their uterus. Novel organ- and fertility-preserving treatment options such as embolisation of uterine arteries or laparoscopic uterine artery ligation have frequently been discussed as viable alternatives to myomectomy. This article strives to bring together the conclusions of major studies on novel organ-preserving treatment alternatives for uterine myoma. *Methods:* Minimally invasive organ-preserving laparoscopic myomectomy remains the best treatment option for patients with symptomatic fibroids who wish to retain their uterus. However, in certain cases other options such as embolisation or laparoscopic ligation of uterine arteries can serve as viable alternatives. *Results:* A failure rate of up to 39% and complications such as reduced fertility because of ovarian failure after transcatheter embolisation of uterine arteries might restrict the use of this method. *Conclusions:* For postmenopausal women, transcatheter embolisation of uterine arteries is a possible treatment alternative. Laparoscopic ligation of uterine arteries and anastomotic sites of uterine arteries with ovarian arteries might also be viable for young women who desire to preserve future fertility. Further data and studies on the long-term follow-up after ligation are yet to come.

### Introduction

A great number of leiomyomata can already be detected in women of childbearing age. Since the use of ultrasound has been established, the rate of detection has risen, and at the moment leiomyoma can be found in around 20 to 40% of women of childbearing age. It has been generally agreed upon that myoma in pre- and postmenopausal women should only be treated if they are symptomatic or fast growing. It has to be addressed on a case-by-case basis whether young women with myoma who desire to become pregnant will benefit from surgery before trying to conceive [4, 5]. When deciding if surgical myomectomy is necessary, symptoms such as recurring miscarriages as well as other myoma related complications in pregnancies should be taken into account. This article will concentrate on the advantages and disadvantages of the present minimally invasive organ-preserving treatment options for pre- and postmenopausal women with symptomatic fibroids.

### Surgical treatment of uterine myoma

There is general consensus on how to approach submucous, intramural and subserous fibroids surgically. Figure 1 shows general criteria for choosing suitable treatment options for different types of myoma [6, 5, 19, 21, 47, 43, 46, 44, 15] (see also Fig. 2).

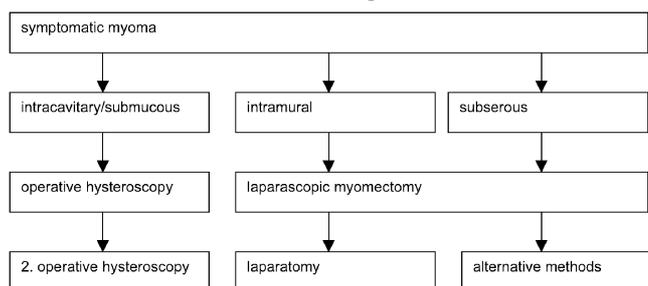
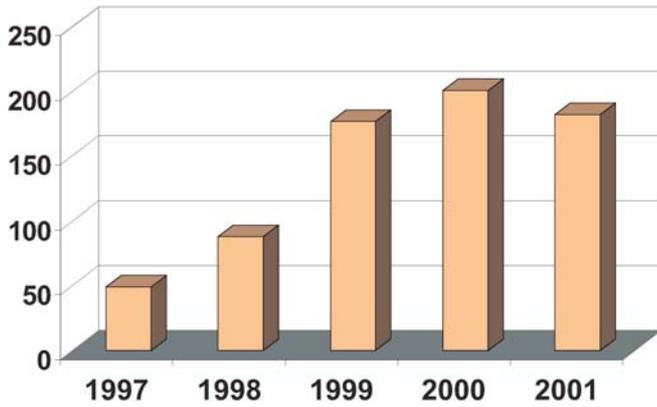


Fig. 1 Organ-preserving surgical treatment options

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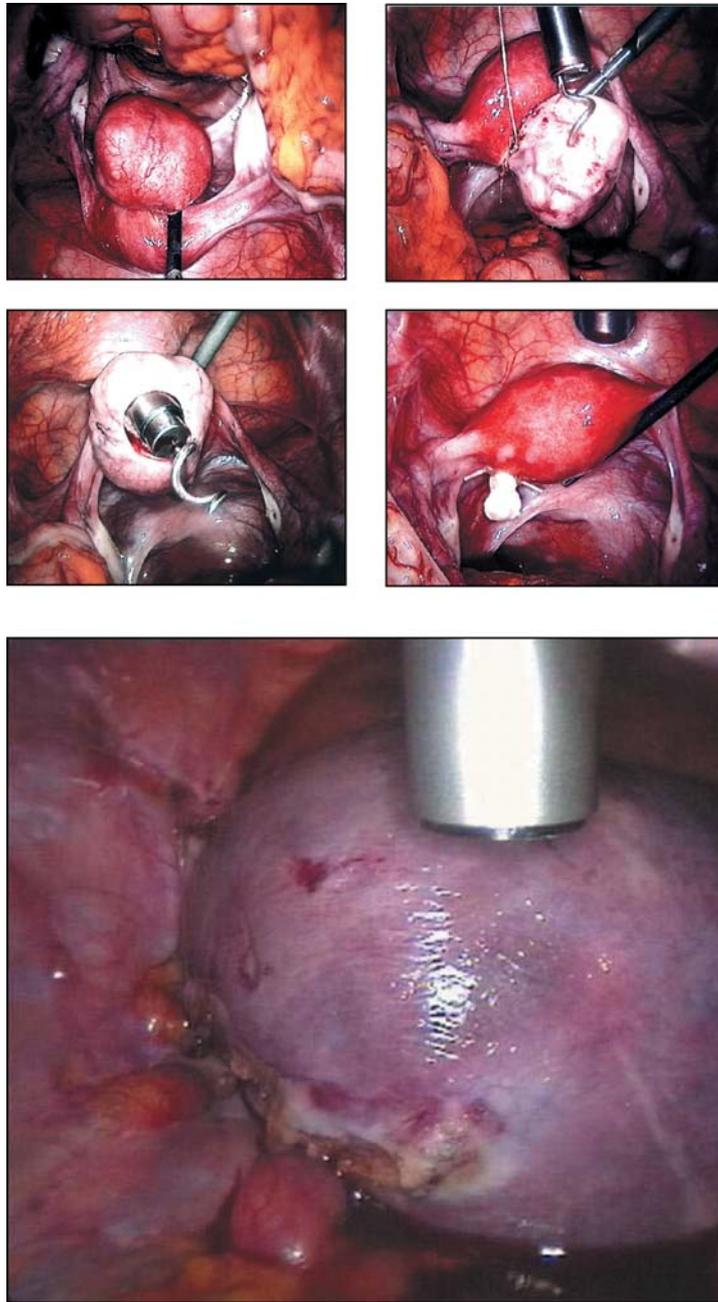
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**Fig. 2** Rates of organ-preserving myomectomy at the University Hospital of Tübingen

**Fig. 3** Laparoscopic myomectomy



Intracavitary and submucosal fibroids accessible by hysteroscopy should be dissected by operative hysteroscopy [7, 8, 19, 42, 44]. Laparoscopic myomectomy as a minimally invasive method is generally considered to be the treatment of choice for other types of myoma (Fig. 3). Subserous fibroids today are always easily dissected by laparoscopy without carrying a high risk of complications [6]. In either of these cases, no increase in risks for following pregnancies can be found, even in the course of vaginal delivery.

In the case of intra- or transmural myoma, however, treatment is clearly more demanding. Here, it is the size of the myoma that determines the treatment option. If myoma are small and solitary, they are normally asymptomatic and dissection therefore may not be necessary.

Patients with bigger myoma should undergo surgery for two reasons. First, whilst myoma are benign for the major part, in rare cases rapidly growing myoma are malignant [20]. Second, even solitary myoma can cause symptoms such as menorrhagia, hyper- or dysmenorrhoea or pelvic pain, once they have reached a certain size. Depending on the degree of experience of the surgeon, laparoscopic organ-preserving myomectomy is a viable option for many women with solitary leiomyoma.

Nonetheless, in cases of multiple myoma, where preservation of the uterus is the aim, in general, laparotomy is necessary. When choosing organ-preserving myomectomy, patients should be counselled as to possible risks, such as the possibility that clinically occult/not visible myoma at the point of surgery might require future surgical intervention. In addition, due to transmural opening of the uterus, which is frequently necessary, uterine dehiscence might be a serious complication during a following pregnancy. Therefore, after transmural myomectomy, patients should be informed that future births will require primary caesarean section.

In postmenopausal patients or patients who do not desire future fecundity, hysterectomy may be offered as the definitive treatment for symptomatic fibroids [21]. In most cases, minimally invasive surgery by laparoscopically assisted hysterectomy is also possible.

However, for various reasons many women wish to avoid hysterectomy and ask for alternative solutions. In this article we have attempted to answer the question about which organ-preserving treatment options are available to these patients.

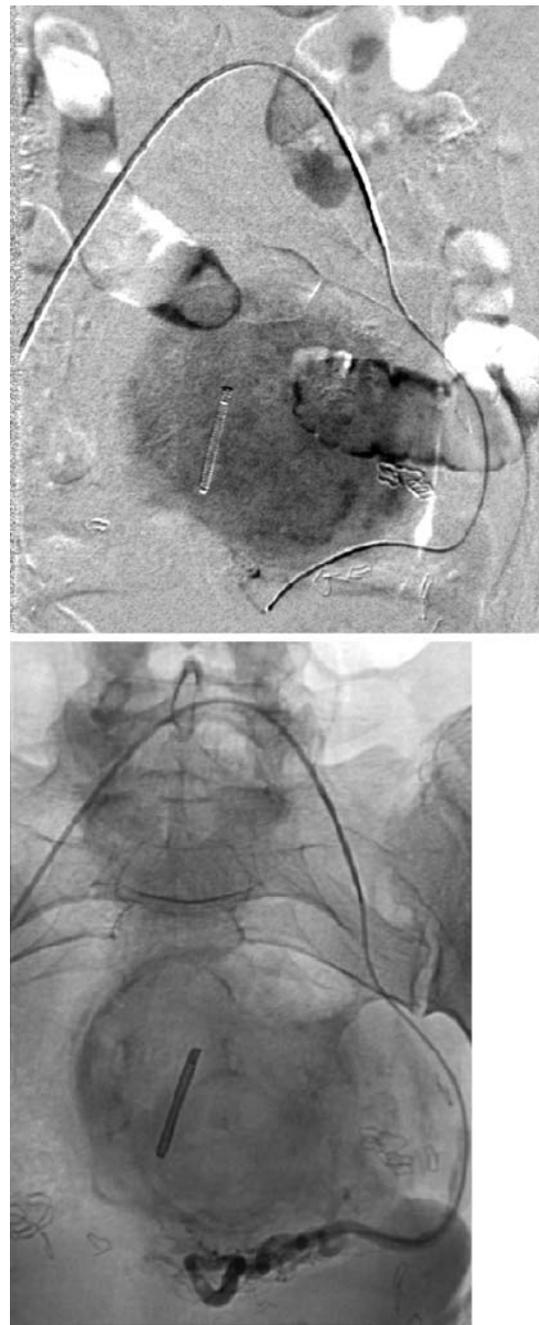
### Treatment of leiomyoma by restriction of blood circulation

Since 1995, patients with symptomatic intramural fibroids have been able to be treated by embolisation of uterine arteries [17, 30] (Figs. 4, 5, 6). Laparoscopic ligation of uterine arteries can be regarded as a possible alternative [22, 23]. Gynaecologists counseling patients asking for alternative treatment to surgical myomectomy or hysterectomy are confronted with these novel alternatives.

Embolotherapy was first performed by radiologists in 1995, using 500–900-micron particles injected bilaterally into the uterine arteries to the point of complete occlusion of the uterine arteries or the occlusion of the vessels feeding the myoma.

Since the publication of descriptions of the principles of interventional embolotherapy [30] and the efficacy of this treatment, there have been several case reports of typical complications [1, 3, 13, 25, 27, 29, 35, 36, 37, 38, 50]. Thereafter, studies with greater numbers of patients describing the whole range of complications were published.

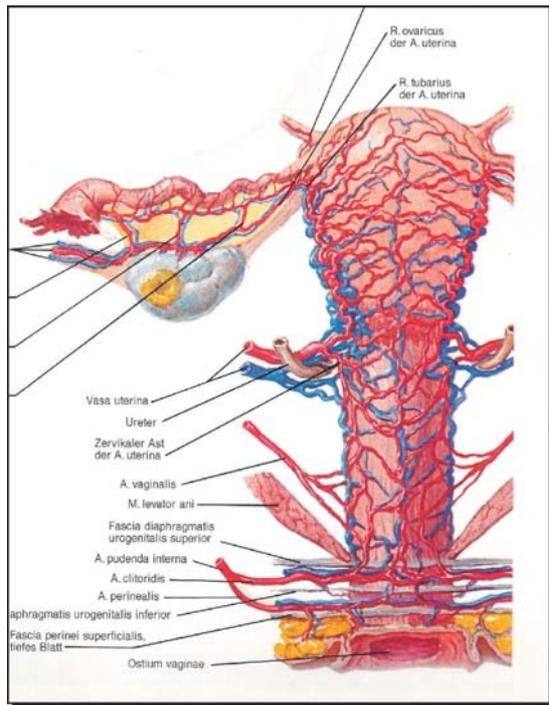
The treatment outcome has been evaluated with regard to the differences in size of myoma and reduction of volume of the uterus, the impact on fibroid-related abnormal uterine bleeding and the overall satisfaction of the patients. Short-term evaluations have shown an im-



**Fig. 4** Embolisation of uterine arteries. Angiography before and after embolisation

provement of clinical symptoms observed in 80–95% of cases. Overall, 90% of patients were satisfied after embolotherapy [2, 9, 13, 14, 17, 28, 32, 33, 34, 49] (Table 1).

In November 2002, Walker et al. published the largest study in this field assessing 400 patients who had undergone embolotherapy [41]. Here, patients showed a great degree of satisfaction after embolisation of the uterine arteries. In 84% of patients, uterine bleeding could be reduced, and in 79% there were fewer perimenstrual symptoms. Furthermore, 12% of the women achieved successful pregnancy after embolotherapy. The rate of peri- or postoperative complications was 8.5%. Beside minor side

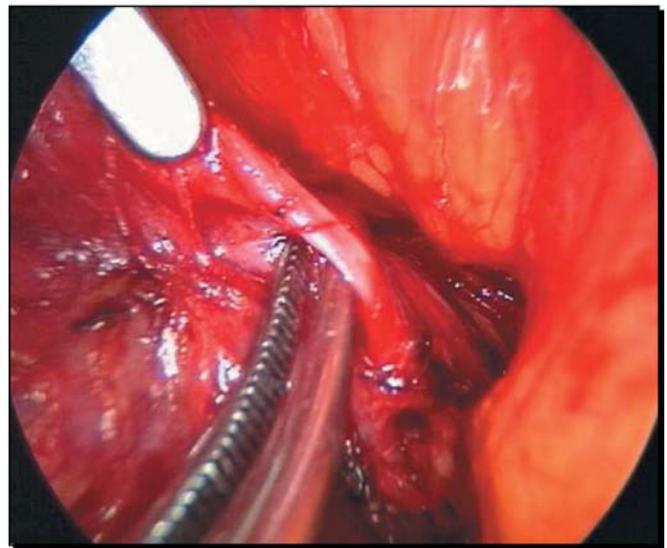
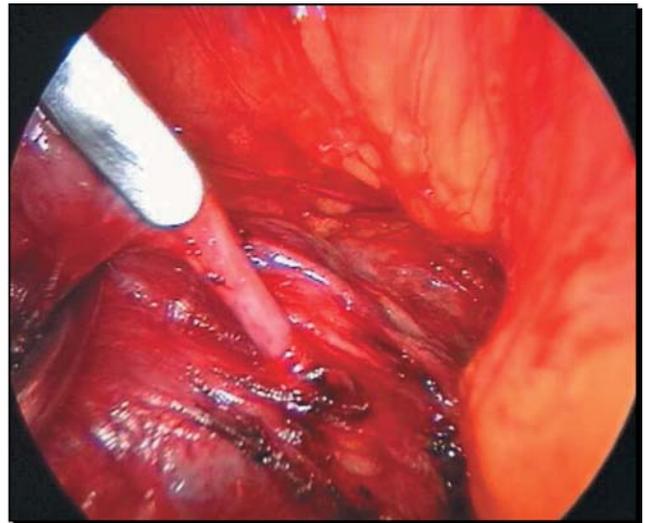


**Fig. 5** Vascularisation

effects such as minor infection, severe complications such as pulmonary embolism, arterial or venous thrombosis or embolism of other organs such as the ovaries have been reported because of aberrant/dispersed microspheres. Severe complications as mentioned above have occurred in only 0.5 to 2% of the cases.

At the same time, Broder published results of a study comparing the long-term outcomes of 51 patients after embolotherapy with 38 patients with abdominal myomectomy 5 years after their procedures [9]. Thirty-nine percent of embolisation patients had to have further invasive treatment because of reoccurrence of fibroid-related symptoms, whereas only 3% of myomectomy patients required surgical intervention in the intervening years.

Publications of Friese [12] or Günther [14] from 2002 assess the efficacy of transcatheter embolotherapy and complications common with this treatment. Most of the severe complications were likely to be caused by the dispersal of microns leading to occlusion of other vascular systems. Other complications were caused by uterine and vascular puncture itself. The most frequent complication, described in around 80% of patients after uterine artery embolisation, is pelvic pain involving significant analgesia requirement and longer inpatient stay. Other typical side effects mentioned are headaches and nausea. In addition to these transient and minor problems, some rare but severe complications have been reported. In 2–5% of the cases, for example, septic necrosis or protracted infections required emergency hysterectomy. Twenty-one of these patients died of overwhelming septicemia although they had full treatment [39]. What is more, some cases of postoperative ovarian failure, amenorrhoea or



**Fig. 6** Preparation of vessels before clipping

endometrial atrophy have been reported that resulted in reduced fertility.

In around 6% of patients, fibroid size could not be reduced despite correct embolisation. During long-term observation, 39% of patients required further intervention because fibroids were growing again [9]. One of the main reasons for frequent treatment failure might be anastomoses of uterine arteries with ovarian arteries, which cannot be occluded by bilateral embolisation of the uterine arteries [25].

In 2003 Sena-Martins et al. published similar results of a study evaluating the effects of treatment by embolization of the uterine artery in 32 women with symptomatic fibroids. He reports of a significant reduction in uterine and dominant myoma volume as well as decreased menstrual volume (90%) and shortened menstrual duration (81%). Adverse effects such as pain immediately after embolotherapy were described in 100% of patients. 34% of pa-

**Table 1** Major studies on transcatheter embolisation of uterine leiomyoma

Author	Number of patients	Follow-up time	Symptoms	Improvement of initial symptoms	Side effects, complications
Worthington-Kirsch et al. (1998) [49]	53	3 months	Bleeding disorder (100%), pelvic pain (58%), anaemia (41%)	Improvement of bleeding disorder and anaemia (88%), of pelvic pain (94%), average volume reduction of myoma (46%)	Postembolisation syndrome (24 patients); nausea/vomiting (22 patients); pelvic pain (20 patients)
Hutchins et al. (1999) [18]	305	12 months	Menorrhagia, pelvic pain	Average volume reduction of the uterus (48%), improvement of menorrhagia, pelvic pain in 92% after 12 months, hysterectomy in six cases, in five cases myomectomy	No severe complications
Goodwin et al. (1999) [13]	60	16.3 months	Bleeding disorder, pelvic pain	Average volume reduction of uterus and myoma for 42.8 and 48.8%; improvement of clinical symptoms in 81%	Postembolisationsyndrome in six cases; one case of amenorrhoea; one case of protracted infection with subsequent hysterectomy
Vashisht et al. (2000) [40]	21	12 months	Menorrhagia (66%), abdominal tension (33%)	Improvement of bleeding disorders in 9/13 cases, improvement of abdominal tension in 2/7 cases, 1 pregnancy	One case of lethal overwhelming septicemia
Ravina et al. (2000) [32]	286	6 months	Bleeding disorders, pelvic pressure	Reduction of myoma volume of 60%, significant improvement of uterine bleeding in 80%, 18 pregnancies	No severe complications
Pelage et al. (2000) [28]	80	24 months	Uterine bleeding, pelvic pain	Improvement of menorrhagia in 90%, three pregnancies	Septical necrosis of myoma requiring hysterectomy in one patient; permanent amenorrhoea in four patients
Siskin et al. (2000) [28]	49	3 months	Bleeding disorder, anaemia, abdominal tension	Average reduction of uterine volume of 47.5%, general improvement of symptoms in 88% of patients	Pelvic pain, nausea/vomiting
Brunereau et al. (2001) [10]	58	3–24 months	Bleeding disorder, pressure, pelvic pain	After 1 year 2/27 patients with no change, 3/27 improvement, 22/27 reduction of uterine size in 26% and of myoma in 51% without symptoms	In three cases fever, headaches, nausea/vomiting
Andersen et al. (2001) [2]	62	12 months	Menorrhagia, pain	In two cases no change, reduced uterine bleeding in 21 patients (96%), reduction of bleeding in 21 patients (70%), less pelvic pain in 18 patients (61%), less pelvic pressure, reduction of uterine volume of 68%, one pregnancy	Endometritis in one patient, allergies in four patients, haematoma due to vascular puncture in two patients

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**Table 2** Embolisation of uterine arteries vs. laparoscopic clipping. Results of a study by Olaf Istre for the European Society of Gynaecological Endoscopy assessing 49 premenopausal patients with symptomatic myoma. → less postoperative pain after clipping

	Embolisation	Clipping
Reduction of volume	33% after 3 months, 30% after 6 months	30% after 3 months, 39% after 6 months
Bleeding	↓	↓
Pain (score)	↓↓	↓
Requirement of analgesia	↑↑	→
Further invasive treatment required	2	3

tients suffered from fatigue. There was one case of surgical myomectomy because of myoma degeneration.

Ravina et al. most recently performed UAE on 454 patients with menorrhagia or bulk-related symptoms due to myoma. Follow-up examination showed a reduction in fibroid size in 55% of patients at six months and 70% after one year. 27 Women became pregnant. However, principal complications were amenorrhoea and fibroid sloughs.

As to the efficacy of uterine artery embolization for symptomatic adenomyosis there is still controversy. Cases of pyoadenoma with sepsis and focal bladder necrosis after embolotherapy for adenomyosis have been reported.

### Laparoscopic restriction of blood circulation

A new alternative approach leading to effective restriction of blood circulation in leiomyoma is bilateral laparoscopic ligation of both uterine arteries and anastomotic sites of uterine arteries with ovarian arteries [22, 23]. One of the major advantages of this method is that complications due to dispersal of occluding particles into other parts of the body can be avoided. Clipping or bipolar coagulation of uterine arteries and anastomotic sites can be performed under sight control. Further advantages of a laparoscopic approach are that other causes of clinical symptoms such as pelvic pain may be diagnosed and treated simultaneously. Moreover, although malignancy of myoma is rare, in some cases malignancy has been overlooked in the course of embolotherapy [20]. During laparoscopy, on the contrary, misdiagnosing can easily be avoided by taking biopsies if there are doubts about the dignity of fibroids.

February 2001 saw the publication of a prospective study on 87 patients who underwent laparoscopic bipolar coagulation of uterine vessels and anastomotic sites with the ovarian vascular system [23]. The results showed a low rate of intraoperative complications as well as symptomatic improvement in 90% of patients. Reductions of around 76% in the dominant fibroid size and 4% in the uterine volume were sonographically demonstrated.

On behalf of the European Society of Gynecologic Endoscopy, O. Istre recently published a study assessing the risk-benefit ratio of both uterine artery embolisation and laparoscopic ligation of uterine vessels (Table 2). With both treatments, fibroid size was reduced equally well. Furthermore, as to loss of blood or the frequency of further invasive treatment needed, there were no differences between both of these methods. However, there was a statistically significant difference in pain intensity and

**Table 3** Problems of embolisation and laparoscopic ligation of uterine arteries

Embolisation
Necrosis of myoma and its consequences
·Prolonged inpatient stay for high-dose analgesia
·Non-selective embolisation and uncontrolled occlusion of ovarian or tubarian anastomoses
·No histology
·High rates of further invasive treatment
·High rate of complications
·Non-standardised procedures
·No long-term follow-up of endocrine consequences available at present
·Ovarian failure and unwanted loss of fertility
·Endometrial atrophy
·Underdiagnosis of malignancy (rate of sarcoma 0.5%)
·Revascularisation
Laparoscopic ligation
·No standardisation
·Low level of evidence, low number of cases
·Only few studies on long-term outcome, but low rates of complications and easily accessible during staging laparoscopy

the requirement of analgesia. Patients after embolisation of the uterine arteries needed significantly more analgesia than patients after laparoscopic clipping of the uterine vessels. Park et al. evaluated the efficacy of laparoscopic uterine artery ligation and uterine artery embolisation with similar results [26]. In assessing 40 patients and evaluating specimens obtained from biopsies taken after each procedure, they suggest that uterine artery embolisation results in tissue necrosis, whereas the corresponding result of uterine artery ligation is apoptosis, i.e., programmed cell death.

Full-term pregnancies have been achieved in a small number of patients after either embolisation or ligation of uterine arteries [11, 31, 32]. Yet, as there have been several publications reporting amenorrhoea, endometrial atrophy and ovarian failure, it is necessary to inform patients that embolisation of uterine arteries might result in reduction or loss of fecundity [3, 36, 38]. Therefore, embolotherapy cannot be considered as an alternative option for young women who desire future fertility. Table 3 summarizes the problems of embolisation and ligation of uterine arteries.

### Conclusion

Minimally invasive organ-preserving laparoscopic myomectomy remains the best treatment option for patients

with symptomatic fibroids who wish to retain their uterus. However, in certain cases other options such as embolisation or laparoscopic ligation of uterine arteries might serve as viable alternatives. For postmenopausal women, transcatheter embolisation of uterine arteries is a possible treatment alternative. Laparoscopic ligation of uterine arteries and anastomotic sites of uterine arteries with ovarian arteries might also be viable for young women who desire to preserve future fertility.

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