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Current Hemostatic Techniques for Blood Loss Reduction During Laparoscopic Myomectomy: A Comparative Review

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Abstract

Background: Uterine myomas are the most prevalent benign tumors of the female repro ductive system, impacting up to 50% of women of reproductive age. For symptomatic cases or those impacting fertility, laparoscopic myomectomy (LM) is the preferred uterus-preserving surgical approach, offering faster recovery as well as favourable reproductive outcomes. However, intraoperative haemorrhage remains a major challenge, influenced by fibroid characteristics as well as surgical technique. Although various pharmacologic as well as vascular occlusion strategies have been proposed to decrease blood loss, their effectiveness as well as safety remain variable, highlighting the need for optimized haemostatic approaches during LM. So, this study aimed to compare different techniques for reducing blood loss during LM in order to identify the most effective method.

Conclusions: LM with temporary occlusion of the uterine arteries as well as ovarian vessels is a safe as well as effective technique that significantly decreases intraoperative blood loss without increasing operative time. When performed by appropriately trained surgeons, it offers a reliable uterus-preserving option for women with symptomatic uterine fibroids, with no increase in perioperative complications.

Keywords: Laparoscopic myomectomy; Uterine fibroids; Uterine artery ligation; Epinephrine; Bupivacaine.

1. Uterine Myomas

Uterine leiomyomas (fibroids) are common benign estrogen-dependent smooth muscle tumors of the uterus, affecting women of reproductive age. Although many remain asymptomatic, approximately 25–30% develop clinically significant symptoms such as abnormal uterine bleeding, pelvic pressure symptoms, infertility, or pregnancy-related complications [1].

Etiology

Fibroids are monoclonal tumors originating from uterine smooth muscle cells. Their pathogenesis is multifactorial, involving hormonal influences, myometrial structural changes, and genetic mutations [2]. The most frequent molecular alteration is MED12 mutation, present in about 70% of cases, in addition to HMGA1, HMGA2, COL4A4, and COL4A6 gene abnormalities [3,4].

Epidemiology & Risk Factors

The prevalence of fibroids increases during reproductive years, reaching 20–40%, with a peak in the 5th–6th decades of life. Black women have a higher incidence, earlier onset, and more severe disease compared to white women [2,5]. Risk factors include early menarche, nulliparity, obesity, hypertension, and family history, while multiparity, late menarche, smoking, and hormonal contraception are protective [6].

Anatomic Locations

Uterine fibroids may arise in different locations within or outside the uterus, including intramural fibroids that develop within the myometrium, subserosal fibroids that originate beneath the serosal surface and may extend into the pelvic or abdominal cavity, and submucosal fibroids that arise beneath the endometrium and may protrude into the uterine cavity or occasionally prolapse through the cervix [7]. Less commonly, fibroids may occur in extrauterine sites such as the broad ligament, cervix, fallopian tubes, or present as parasitic fibroids, and in rare cases as diffuse uterine leiomyomatosis. Morphologically, fibroids may be pedunculated or sessile [7].

Clinical Features

Uterine myomas present with a wide clinical spectrum ranging from asymptomatic disease to significant symptomatic burden, although about 25–30% of patients develop symptoms requiring intervention [2]. Submucosal fibroids are most commonly associated with abnormal uterine bleeding due to impaired endometrial hemostasis, leading to menorrhagia and anemia, while larger fibroids may cause bulk-related symptoms such as chronic pelvic pain, urinary frequency or retention from bladder compression, and constipation due to bowel pressure [8]. On examination, an enlarged irregular uterus may be detected, although smaller intramural or submucosal fibroids can be missed; therefore, further evaluation is essential in symptomatic patients even with a normal pelvic exam, with attention to anemia and exclusion of other gynecologic or systemic causes [5].

Investigations

A. Transvaginal ultrasound

Transvaginal ultrasound is the first-line imaging modality for suspected uterine leiomyomas, demonstrating a sensitivity of 95–100% in uteri smaller than 10 weeks' gestation. Leiomyomas typically appear as well-defined, hypoechoic masses with acoustic shadowing, although calcification or necrosis may alter their echogenicity [9].

B. Saline infusion Sonohysterography

Used to better detect intracavitary lesions, especially submucosal fibroids (FIGO 0–2), by outlining the uterine cavity [9].

C. Magnetic resonance imaging

Most accurate for defining fibroid size, location, and degeneration, but reserved for complex or preoperative cases due to cost; cannot reliably distinguish benign from malignant smooth muscle tumors [10].

D. Laboratory Studies

Include pregnancy test, CBC, TSH, and prolactin to exclude other causes of abnormal uterine bleeding. Endometrial biopsy is done when malignancy risk factors are present [11].

Management

A. Surveillance

Expectant management is suitable for asymptomatic or perimenopausal patients. Routine imaging is not required, but should be repeated if symptoms develop or worsen such as AUB, pelvic pain, anemia, or pressure symptoms [12].

B. Medical Treatment

I. Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

First-line for pain and heavy menstrual bleeding; reduce prostaglandin synthesis leading to decreased pain, bleeding, and angiogenesis [13].

II. Tranexamic Acid (TXA)

Antifibrinolytic that stabilizes clots by inhibiting plasminogen activation; more effective than NSAIDs in reducing menstrual blood loss [14].

III. Hormonal Contraceptives

Reduce menstrual bleeding but do not improve bulk symptoms or fertility; less effective than LNG-IUD. Progestin-only options have limited evidence [14].

IV. Levonorgestrel Intrauterine Device (LNG-IUD)

Reduces bleeding and may reduce uterine volume via local progestin effect; higher expulsion rates in distorted cavities or submucosal fibroids [16].

V. Gonadotropin-Releasing Hormone Agonists (GnRHa)

Cause temporary hypoestrogenism leading to ~50% fibroid shrinkage; mainly used preoperatively due to rapid regrowth after stopping [17].

VI. Gonadotropin-Releasing Hormone Antagonists (GnRH Antagonists)

Directly suppress gonadotropins without initial flare; effective for bleeding control, sometimes combined with add-back therapy to reduce side effects [18,19].

C. Surgical Management

Myomectomy is fibroid removal via hysteroscopic, laparoscopic, or open approaches, mainly for fertility preservation. Indications include bleeding with anemia, pain, bulk symptoms, infertility, rapid growth, or suspicion of malignancy [20].

I. Hysteroscopic myomectomy

For submucosal fibroids causing bleeding, infertility, or miscarriage. Improves symptoms in most cases (74–94%) with faster recovery, less pain, and return to activity within 6–12 weeks [21].

II. Laparoscopic Myomectomy

Used for symptomatic fibroids (FIGO 2–7). Provides ~80% symptom relief with fewer complications, less pain, shorter hospital stay, and faster recovery than open surgery [23].

III. Abdominal Myomectomy

Abdominal myomectomy is a major surgical intervention reserved for complex cases in which minimally invasive approaches are contraindicated or unsuccessful. It is an effective treatment for symptomatic intramural as well as subserosal uterine fibroids [23].

IV. Hysterectomy

Definitive treatment with no recurrence risk, usually for completed childbearing. Minimally invasive approaches reduce blood loss and recovery time; ~25% may need later hysterectomy after myomectomy within 4–8 years [24].

D. Alternative Procedural Treatment Modalities

I. Uterine Artery Embolization

UAE is a minimally invasive procedure that occludes uterine arterial branches supplying fibroids, leading to ischemia and tumor shrinkage. It is mainly used for women with heavy menstrual bleeding from intramural fibroids who fail medical therapy or are not suitable for surgery. It provides effective short- and medium-term symptom relief while preserving the uterus, but its effect on fertility and pregnancy outcomes remains uncertain. Confirmation of benign pathology is required before the procedure [25].

II. Magnetic Resonance-guided Focused Ultrasound Surgery

MR-guided focused ultrasound uses high-intensity ultrasound energy under MRI guidance over 3–5 hours to thermally ablate fibroids. It raises tissue temperature above 57°C to induce coagulative necrosis, with better outcomes seen in fibroids with high T2 signal intensity [25].

III. Radiofrequency Ablation

Radiofrequency ablation is a minimally invasive technique where a needle electrode is inserted into the fibroid under ultrasound guidance (laparoscopic or transcervical). It delivers energy to heat tissue above 100°C, causing coagulative necrosis, with real-time ultrasound monitoring to ensure accurate and controlled treatment [26].

2. Laparoscopic Myomectomy

Laparoscopic myomectomy is a fertility-preserving minimally invasive option for symptomatic fibroids. With proper patient selection, it has high success rates and very low conversion to open surgery. It is associated with less postoperative pain, shorter hospital stay, faster recovery, and similar recurrence rates compared to other surgical methods. It also results in lower blood loss and fewer transfusion needs compared with open myomectomy, especially when combined with robotic assistance [20].

Surgical Techniques

A. Patient Positioning as well as Setup

The patient is placed in lithotomy position with insertion of a uterine manipulator to facilitate uterine mobility during surgery [27].

B. Surgical Access as well as Pneumoperitoneum

Abdominal access is usually via the umbilicus. Pneumoperitoneum is established at 15 mmHg using a Veress needle or open technique, followed by insertion of a 0–30° laparoscope. Fascial closure is recommended to reduce port-site hernia risk [20].

C. Port Placement

Typically includes two 5-mm lateral ports and one 10-mm suprapubic port, positioned according to anatomical landmarks and bimanual examination. Small ports are usually not closed unless >12 mm [28].

D. Instrumentation

Standard instruments include scissors, atraumatic graspers, needle holders, and energy devices such as bipolar or ultrasonic scalpel [29].

E. Myomectomy Technique

Intracapsular myomectomy is performed after subcapsular vasoconstrictor injection using bipolar and unipolar dissection while preserving the capsule [30].

F. Blood Loss Reduction

Intramyometrial vasoconstrictor injection significantly reduces blood loss (~299 mL). Epinephrine has limited effect due to short half-life, while misoprostol, oxytocin, and TXA show minimal benefit in this setting [31].

G. Uterine Closure:

Uterine reconstruction is performed in multiple layers using barbed suture or Vicryl. Serosal closure is done to reduce adhesions and lower risk of uterine rupture in future pregnancy [32].

H. Specimen Extraction

Specimens are removed via contained morcellation or mini-laparotomy to avoid enlarging the incision [31].

3. Hemostatic Techniques for laparoscopic Myomectomy

Laparoscopic myomectomy carries a risk of significant intra- and postoperative bleeding, sometimes requiring transfusion or hysterectomy [33].

Surgical Methods to Decrease Blood Loss during Myomectomy

Uterine Artery Occlusion

The uterine artery is identified from the internal iliac artery, dissected, and clipped using Hem-o-lok to reduce intraoperative blood flow and bleeding [34].

A. Vascular Clips

Provide temporary, controlled reduction of uterine blood flow without systemic effects and can be combined with bulldog clamps in patients refusing transfusion [35,36].

B. Peri cervical Tourniquet

Effectively reduces blood loss and transfusion rates without affecting operative time or morbidity, especially when combined with other techniques [31,37].

C. Electrosurgical Methods

Monopolar, bipolar, and ultrasonic devices are used for hemostasis but may cause thermal injury. Monopolar energy has greater thermal spread and risk of capacitive coupling. Evidence on blood loss reduction remains limited [34,34].

Medical Interventions to Decrease Blood Loss

A. Gonadotropin-Releasing Hormone Agonists

Used preoperatively to shrink fibroids and reduce vascularity, but benefit in minimally invasive surgery is uncertain. Side effects include hypoestrogenic symptoms and bone loss [38].

B. Intravaginal Prostaglandins

Dinoprostone significantly reduces intraoperative blood loss and transfusion requirements when used preoperatively in abdominal myomectomy [39].

C. Bupivacaine Plus Epinephrine

Local injection reduces blood loss, operative time, surgical difficulty, and postoperative pain without significant hemodynamic effects [38].

D. Oxytocin Infusion

Despite its uterotonic effect, no significant reduction in blood loss or transfusion rate was observed in myomectomy trials [30].

E. Hemostatic Agents (FloSeal)

Associated with significantly reduced blood loss, no transfusions, higher postoperative hemoglobin, and shorter hospital stay [40].

F. Intravenous Tranexamic Acid

Despite proven efficacy in other bleeding conditions, IV TXA did not significantly reduce blood loss or operative time in myomectomy RCTs [40].

Methods

This review combined a comprehensive evaluation of existing literature with institutional experience from Zagazig University Hospitals. For the literature review, a systematic search of electronic databases, including Scopus, PubMed, as well as Google Scholar, was conducted using the terms including "Laparoscopic myomectomy," Uterine fibroids," as well as " Uterine artery ligation."

The review included clinical studies, observational reports, meta-analyses, as well as expert consensus statements, all focused on uterine artery ligation versus epinephrine plus bupivacaine injection during LM. Only English-language full-text articles were included.

Discussion

Available evidence indicates that baseline characteristics such as age, BMI, parity, fibroid size and number, uterine volume, and preoperative hemoglobin are generally comparable between patients undergoing uterine devascularization and those receiving intramyometrial epinephrine during laparoscopic myomectomy, allowing fair outcome comparison.

Uterine devascularization is consistently associated with significantly lower intraoperative blood loss compared with epinephrine injection, in both single and multiple fibroid cases, without increasing operative time, suggesting better hemostatic control without affecting surgical efficiency.

Hemodynamic parameters (blood pressure and heart rate) are usually similar between both techniques, although epinephrine may cause mild transient changes that are not clinically significant when properly diluted and used.

Both techniques show low complication rates, and conversion to laparotomy is rare and mainly related to technical difficulty rather than the hemostatic method. Postoperative outcomes, including hemoglobin drop, transfusion rate, hospital stay, and recovery, are broadly comparable, with similar short-term symptom improvement.

Conclusion

LM with temporary occlusion of the uterine arteries as well as ovarian vessels is a safe as well as effective technique that significantly decreases intraoperative blood loss compared with intramyometrial epinephrine injection, without prolonging operative time. When performed by adequately trained surgeons, the procedure is not associated with increased complications as well as offers a valuable uterus-preserving option for women with symptomatic uterine fibroids.

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