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REVIEW ARTICLE

Gynecology

Efficacy, safety, and feasibility of the treatment of intrauterine pathologies with the mini-resectoscope: A systematic review

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Abstract

Background: Hysteroscopy represents the gold standard for the diagnosis and treatment of intrauterine pathologies. The advent of the mini-resectoscope heralded a new era in intrauterine surgery, both in inpatient and outpatient settings.

Objectives: To evaluate the effectiveness, safety, and feasibility of the mini-resectoscope for the treatment of intrauterine pathologies.

Search Strategy: Electronic databases were searched for English-language trials describing surgical procedures for uterine pathologies performed with a mini-resectoscope until 30 April 2023.

Selection Criteria: Retrospective or prospective original studies reporting the treatment of uterine pathologies with mini-resectoscope were deemed eligible for the inclusion.

Data Collection and Analysis: Data about study features, characteristics of included populations, surgical procedures, complications, and results/outcomes were collected.

Results: Seven papers that met the inclusion criteria were included in this systematic review. Quantitative analysis was not possible due to data heterogeneity. A descriptive synthesis of the results was provided accordingly to the pathology hysteroscopically removed/corrected: polyps and myomas, uterine septum, intrauterine synechiae, and isthmocele.

Conclusions: The mini-resectoscope is poised to play a leading role in hysteroscopic surgery for many pathologies, both in inpatient and outpatient settings. Since some applications of the mini-resectoscope have not yet been thoroughly investigated, future studies should address current knowledge gaps, designing high-quality comparative trials on specific applications.

KEYWORDS
endometrial polyps, fibroids, hysteroscopic surgery, hysteroscopy, isthmocele, mini-resectoscope, uterine anomalies

1 | INTRODUCTION

1.1 | Background

Hysteroscopy originated as a diagnostic procedure aimed at direct visualization of the uterine cavity. Years after its introduction, it is now considered the gold standard for the diagnosis and treatment of intrauterine pathologies, and patients with abnormal uterine bleeding (AUB), infertility/subfertility, and recurrent pregnancy loss frequently undergo hysteroscopic procedures.[1,2]

One of the most relevant advances in hysteroscopy has been the miniaturization of instruments. The development of hysteroscopes better adapted to the characteristics of the cervical canal (CC) has not only contributed to diminished patient discomfort but has also facilitated the transition of procedures from the operating room to the office setting. This shift has allowed the "see-and-treat" approach, yielding tangible cost–benefit advantages and enhancing patient satisfaction.[3,4]

Currently, gynecologists have at their disposal a wide range of instruments to treat intrauterine conditions both in the inpatient and outpatient setting.[3,5,6]

The advent of the mini-resectoscope marked a new era in the management of uterine pathologies. The concept behind reducing the size of the traditional 22F or 26F resectoscope was to enable the execution of intracavitary procedures with a "no-touch technique", eliminating the need for painful cervical dilations while maintaining the surgical capabilities of a traditional resectoscope. The possibility to navigate directly the CC, without speculum use, not only allows mitigation of the risks associated with cervical dilation and the requirement for analgesia or anesthesia but also enhances the potential for performing intrauterine surgery in an outpatient setting.[7,8]

1.2 | Objectives

The aim of this systematic review was to assess the effectiveness, safety, and feasibility of treating intrauterine pathologies with a mini-resectoscope.

2 | METHODS

2.1 | Eligibility criteria

Only original studies (retrospective or prospective) reporting the treatment of uterine and endometrial pathologies using a mini-resectoscope were deemed eligible for inclusion in this systematic review. Mini-resectoscope was defined according to the definition of original articles. No restriction on the size of hysteroscopes was applied.

Case reports, studies describing only the procedure technique ("step-by-step" procedure description), and case series with <10 enrolled patients were excluded.

2.2 | Information sources

This study was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines,[9] available through the Enhancing the Quality and Transparency of Health Research (EQUATOR) network, and the Cochrane Handbook for Systematic Reviews[10] and registered with PROSPERO (international prospective register of systematic reviews) under the registration number CRD42017067264.

MEDLINE, Embase, Global Health, The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Cochrane Methodology Register), the Health Technology Assessment Database, Web of Science, and research register (ClinicalTrial.gov) were searched for studies describing surgical procedures for uterine pathologies performed using a mini-resectoscope.

2.3 | Search strategy

The following medical subject heading (MeSH) and key search terms were used: "hysteroscopy" (MeSH unique ID: D015907) OR "hysteroscopic surgery" (MeSH unique ID: D015907) OR "mini-resectoscope" OR "16 Fr" OR "15Fr" AND "leiomyoma" (MeSH unique ID: D007889) OR "uterine anomalies" (MeSH unique ID: C562565) OR "congenital abnormalities" (MeSH unique ID: D000013) OR "polyps" (MeSH unique ID: D011127) OR "uterine synechiae" (MeSH unique ID: D006175), OR "isthmocele" OR "niche" OR "cesarean defect" OR "uterine diverticulum". We selected papers written in English, since the inception of each database until 30 April 2023.

2.4 | Study selection

Titles and/or abstracts of studies retrieved using the search strategy were screened independently by two review authors (A.E. and A.F.) to identify studies that met the inclusion criteria. The full texts of these potentially eligible articles were retrieved and independently assessed for eligibility by two other review team members (A.S.L. and J.C.). A manual search of the references of the included studies was conducted to prevent the omission of pertinent research. Any disagreement between them over the eligibility of articles was resolved through discussion with a third (external) collaborator. All authors approved the final selection.

2.5 | Data extraction

Two authors (A.E. and A.F.) independently extracted data from articles about study features, characteristics of included populations, surgical procedures, complications, and results/outcomes using a prepiloted standard form to ensure consistency. One author (A.S.L.) reviewed the entire data extraction process.

2.6 | Assessment of risk of bias

Two reviewers (G.R. and F.S.) assessed independently the risk of bias of studies included in this systematic review using a modified version of the Newcastle-Ottawa Scale (NOS).[11] The quality of studies was evaluated in the following five different domains: "study design and sample representativeness", "sampling technique", "description of the hysteroscopic technique", "quality of the population description", and "incomplete outcome data" (Table S1). Any disagreements between the reviewers were resolved by a third reviewer (A.S.L.).

2.7 | Outcomes measures and data synthesis

The primary outcome of this study was to evaluate the effectiveness, safety, and feasibility of the mini-resectoscope in the treatment of intrauterine pathologies.

Effectiveness: Effectiveness was measured through the rate of successful procedures, as determined by the lack of residual lesion at the end of the procedure and/or at follow-up visit.

Feasibility: Feasibility was evaluated as the rate of completed procedures in a single surgical step, without any interruptions due to surgical issues or patient's complaint.

Safety: Safety was determined by the rate of intraoperative and postoperative complications.

Quantitative analysis was not possible due to data heterogeneity (including different settings and surgical procedures). We provided a descriptive synthesis of the results in separate sections based on the type of pathology that was hysteroscopically removed/corrected: polyps and myomas, uterine septum (US), intrauterine synechiae (IS), and isthmocele.

The body of evidence on the usefulness of the mini-resectoscope for each pathology was assessed by two authors (A.V. and A.F.) using the Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence (OCEBM).[12]

3 | RESULTS

3.1 | Study selection

Study selection is displayed in the Figure 1. After the evaluation of full texts, a total of seven papers,[7,8,13–17] which met the abovementioned inclusion criteria, were included in the present systematic review.

3.2 | Study characteristics

The main characteristics of the included studies are summarized in Table 1. All studies were prospective, including three randomized controlled trials (RCTs),[8,15,17] one prospective controlled study,[16] one multicenter prospective cohort study,[14] and two prospective cohort studies.[7,13] Of these, four studies come from Italy,[7,8,13,14] two from India,[15,17] and one from the United Kingdom.[7]

3.3 | Risk of bias of included studies

Of the seven studies included, six were at low risk of bias in three or more domains[8,13–17] and only one was judged at high risk of bias.[7] A detailed description of the risk of bias in each domain among studies is reported in Table S2.

3.4 | Synthesis of the results

Among the included studies, three different types of mini-resectoscopes were utilized according to their caliber: a 16F prototype mini-resectoscope (based on a pediatric resectoscope), a 16F "Gubbini" mini-resectoscope, and a 5-mm mini-resectoscope. The main technical characteristics of the instruments used are summarized in Table 2.

Regarding the type of operative procedures, four studies focused on the removal of myomas and polyps,[8,13,14,16] while other studies focused on the treatment of intrauterine adhesions,[15] isthmocele,[16] or septate uterus (SU).[17] The main characteristics of the included studies and the level of evidence on the use of mini-resectoscope for each operative procedure are summarized in Table 3.

Endometrial polyps and submucous leiomyomas

Endometrial polyps (EPs) are localized tumors of the endometrial mucosa.[18] As a frequent cause of AUB[19] and infertility,[20,21] they represent a common subject of hysteroscopic surgery.[22] Leiomyomas are uterine mesenchymal tumors, representing the most common benign pathology of the female genital tract,[23] causing AUB, pelvic pain, and infertility.[19,24] Hysteroscopic myomectomy is considered the gold-standard treatment for patients affected by submucous myomas (SMs) who experience AUB and/or infertility.[25]

Traditionally, the removal of EPs and SMs has involved hysteroscopic procedures performed with a resectoscope under general anesthesia within a conventional operating room. Currently, modern advancement has introduced a broad spectrum of new approaches for removing such pathologies, ranging from outpatient hysteroscopy using mechanical or electrified instruments as well as laser fibers to tissue removal devices, with or without analgesia/anesthesia. The choosing of the setting, instruments, and need for pain management is strictly related to the surgeon's skill level and the characteristics of the patients and pathology being treated.[22,26–31]

Four studies were found on the treatment of EPs and SM with a mini-resectoscope, including one RCT,[8] one multicenter prospective cohort study,[14] and two prospective cohort studies.[7,13] The general characteristics of these trials are summarized in Table S3.

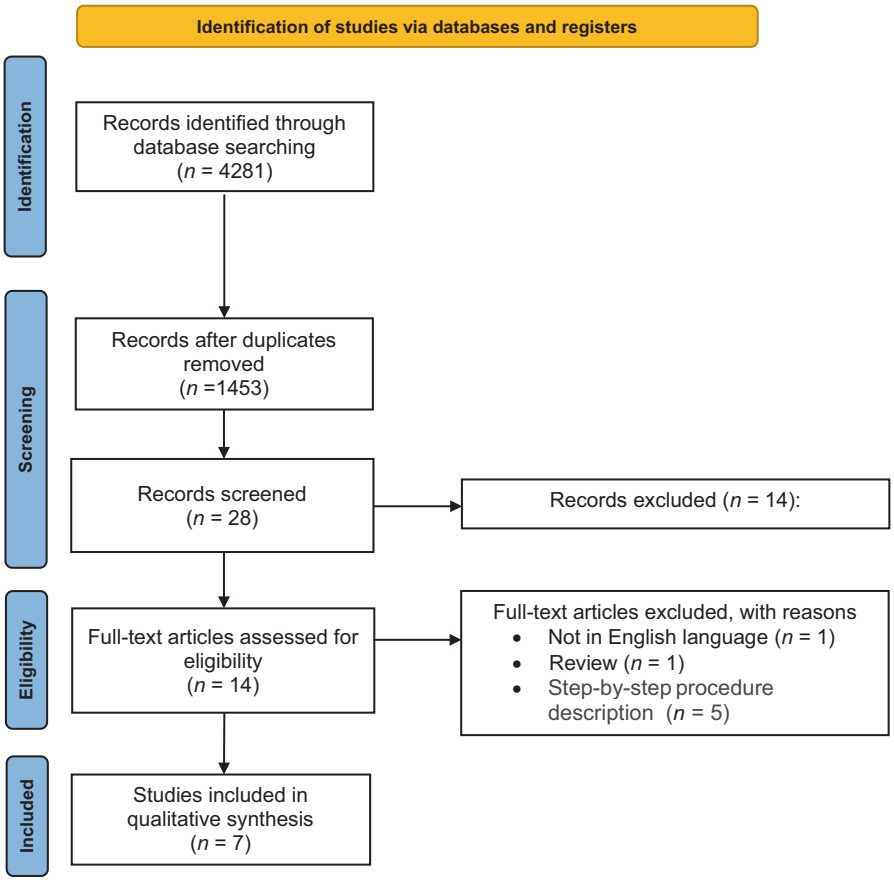

FIGURE 1 PRISMA (preferred reporting items for systematic reviews and meta-analyses) flow diagram. From: Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. doi:10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/.

The first report describing a series of patients treated by mini-resectoscope for EPs or SMs was performed by Papalampros et al. in 2009.[7] The authors conducted a prospective observational study of 30 patients, most of whom presented with AUB. After a preliminary outpatient diagnostic hysteroscopy, 26 patients were diagnosed with EP, and four with SM. Twenty procedures were performed in the operating room, while 10 were performed in an outpatient setting. A traditional insertion technique was used in 22 patients and instrumental dilatation of the CC was needed in 14 of them. A no-touch vaginoscopic approach was used in eight patients. For all patients in whom CC dilation was necessary, local anesthesia with 4.4 mL of 2% lignocaine with adrenaline 1:80 000 was used and the procedure was performed in the operating room. The use of anesthesia was required in 16 patients. Twenty-six patients underwent polypectomy, with the size of the EP ranging from 1 to 5 cm, and in 100% of the cases there was a complete resection of the lesion.

Four patients underwent hysteroscopic myomectomy of one G0 myoma and three G1 myomas. The size ranged from 2 to 3 cm. In all cases, a complete resection by classical slicing was achieved. No complications, fluid overload, or recurrences were recorded. Estimated blood loss was negligible. The postoperative visual analog scale (VAS) was not evaluated; however, the patients included in the study experienced only mild postprocedure pain and seven required oral analgesics (500-mg mefenamic acid). All patients who had the procedure performed in the office were discharged within 20 min after the procedure. Those who had the procedure performed in the operating room were discharged 1 h after their return to the ward.

Similar results were obtained by Dealberti et al. in 2013[13] and 2016[14] in both a single and a multicenter clinical trial, aimed at investigating the feasibility and acceptability of office polypectomy using a 16F mini-resectoscope. Interestingly, all of the procedures were performed in an outpatient setting with the see-and-treat approach and the no-touch technique. For only one patient, the polypectomy failed in only one surgical step, requiring two office surgical treatments to completely remove the lesion.[14] In the same series, seven procedures needed to be stopped due to severe abdominal-pelvic pain complained by patients.

The first and only study that compared a 16F mini-resectoscope with a 22F resectoscope and a 15F hysteroscope for the treatment of uterine cavity lesions was conducted by Ricciardi et al.[8] in 2012. The authors performed an RCT involving 401 patients undergoing hysteroscopic surgery for EPs and SMs. One group consisted of 142 patients, with 32 of them having G0 myomas and 110 with EPs, who were treated with outpatient removal using a 16F mini-resectoscope.

TABLE 1 Characteristics of the included studies.

Author	Year	Type	Main outcome	Country	Patients (*n*)	Age (years)	Group controls (*n*)
Papalampros et al.[7]	2009	Prospective cohort study	Feasibility and acceptability of polypectomy and myomectomy without general anesthesia using the 16F mini-resectoscope (prototype)	United Kingdom	30	48.1 (32–88)[a]	None
Ricciardi et al.[8]	2012	Randomized controlled trial	To compare a 16F mini-resectoscope with a 22F resectoscope and 15F hysteroscope for the treatment of polyps and myomas	Italy	142	53 ± 16[b]	127 controls treated with a 22F resectoscope and 132 controls treated with a 15F hysteroscope
Dealberti et al.[13]	2013	Prospective cohort study	Feasibility and acceptability of office free-anesthesia polypectomy using a 16F mini-resectoscope	Italy	33	47.18 ± 12.48[b]	None
Dealberti et al.[14]	2016	Multicenter prospective cohort study	Feasibility and effectiveness of office free-anesthesia polypectomy using the 16F mini-resectoscope	Italy	175	51.02 ± 12.92[b]	None
Roy et al.[15]	2017	Randomized controlled trial	To compare feasibility and efficacy of 5-mm mini-resectoscope with 9-mm resectoscope in term of the operative, menstrual, and reproductive outcome in hysteroscopic adhesiolysis	India	30	29.6 ± 3.33[b]	30 controls treated with a 9-mm resectoscope
Casadio et al.[16]	2021	Prospective controlled study	To compare the efficacy and safety of 16F mini-resectoscope with 26F resectoscope for the treatment of cesarean scar defect	Italy	154	36 ± 4.3[b]	155 controls treated with a 26F resectoscope
Roy et al.[17]	2021	Randomized controlled trial	To compare a 5-mm mini-resectoscope with a 9-mm resectoscope for the treatment of hysteroscopic metroplasty	India	20	27.7 ± 2.34[b]	20 controls treated with a 9-mm resectoscope

[a]Data are reported as median (minimum–maximum).

[b]Data are reported as mean ± standard deviation.

Another group comprised 127 patients (30 with G0 myomas and 97 with EPs) who underwent resection with a 22F resectoscope in the operating room. The last group included 132 patients (112 with polyps and 20 with G0 myomas) who received outpatient treatment with a 15F hysteroscope equipped with the Versapoint electrosurgical system (Olympus Medical Systems). In the 16F mini-resectoscope and 15F hysteroscope groups, patients were treated with the no-touch technique and did not receive anesthesia/analgesia, while in the 22F resectoscope group, the procedure involved cervical dilation with Hegars and paracervical anesthesia with 20 mL of 1.5% mepivacaine chloralhydrate. Importantly, all of the patients in these groups experienced successful and complete removal of the lesion

TABLE 2 Characteristics of mini-resectoscopes used in the included studies.

Size and name	Telescope	Electrical power	Company	Authors
16F mini-resectoscope (prototype)	2 mm, 0°	Monopolar	Karl Storz, Germany	Papalampros et al.[7]
16F Gubbini mini-resectoscope	2.9 mm, 0°	Monopolar	TONTARRA Medizintechnik GmbH, Germany	Ricciardi et al.,[8] Dealberti et al.,[13,14] and Casadio et al.[16]
5-mm mini-resectoscope	2.9 mm, 30°[a]	Monopolar	Karl Storz, Germany	Roy et al.[15,17]

[a]Roy et al.[17] did not specify the telescope degree.

TABLE 3 Level of evidence related to the pathology treated according to Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence criteria.

Pathology	Studies	Level of evidence
Polyps and myomas	One randomized controlled trial[8]	2
	One multicenter prospective cohort study[14]	
	Two prospective cohort study[7,13]	
Intrauterine adhesions	One randomized controlled trial[15]	3
Isthmocele	One prospective controlled study[16]	3
Septate uterus	One randomized controlled trial[17]	3

in a single surgical procedure. No complications occurred except for few cases of minimal or mild nausea. In the analysis between the studied groups, a significant reduction in the surgical and discharge times in the group treated with 16F mini-resectoscope compared with the group treated with 22F resectoscope were highlighted. Moreover, a significant reduction was observed in all of the studied parameters, including operative time, fluid deficit, postoperative pain scores, and length of stay, in the group treated with the 16F mini-resectoscope compared with the group treated with the 15F hysteroscope. Interestingly, analysis of patients subdivided according to lesion size (<1.5 cm and >1.5 cm in diameter) showed similar results.

Quality of evidence

We found adequate quality evidence (level 2) supporting the effectiveness, feasibility, and safety of using a mini-resectoscope for outpatient polypectomy and myomectomy.

Intrauterine adhesions

Intrauterine adhesions, also known as intrauterine synechiae (IS), are characterized by the development of fibrous tissue connecting the uterine walls and altering the volume of the uterine cavity. Fibrous tissue replaces the endometrium, causing clinical symptoms such as dyspareunia, pelvic pain, and infertility. When severe, IS can result in amenorrhea, which is known as Ashermans syndrome.[32–34] IS are frequently generated after intracavitary procedures in the gravid uterus, such as dilation and curettage for spontaneous or induced abortions as well as for retention of products of conception. However, IS have also been reported after hysteroscopic surgery, uterine artery embolization, and uterine infections.[35–38]

To date, hysteroscopic lysis represents the gold-standard treatment of IS.[39–41] The main goal of hysteroscopic treatment is to restore the anatomy of the uterine cavity, preserving functional endometrium, which may allow for recolonization of the uterine cavity, restoring menstruation and fertility.

Depending on the severity of the IS and the surgeon's skill, hysteroscopic lysis can be performed in either an outpatient or inpatient setting. Procedures using a 22F or 26F resectoscope, as well as a 15F operative hysteroscope, have been reported.[42–44]

Regarding the treatment of IS with mini-resectoscope, there is only one study available, an RCT, that aimed to verify the feasibility, effectiveness, and safety of hysteroscopic adhesiolysis under general anesthesia using a 5-mm mini-resectoscope.[15] Two groups of 30 patients each were compared: one group was treated with a 5-mm mini-resectoscope, while the other received treatment with the conventional 9-mm resectoscope. All patients underwent instrumental dilatation of the CC after preparation with 400 mg of misoprostol. The general characteristics of this study are summarized in Table S4.

The group of patients treated with the 5-mm mini-resectoscope reported a significantly shorter time required for cervical dilatation. However, there was no significant difference in the operating time needed to perform adhesiolysis between the two groups. Interestingly, the postoperative pain score at 30 min after the procedure was significantly lower in the 5-mm mini-resectoscope group compared with the 9-mm resectoscope group. No major complications occurred in either group, but three cases of cervical lacerations and one uterine perforation were reported during scope entry in the 9-mm resectoscope group (with no statistically significant difference). Remarkably, in the patient who experienced uterine perforation, the procedure was discontinued, and adhesiolysis was not performed. However, in all remaining patients, adhesiolysis was performed successfully, restoring the normalcy of the uterine cavity. Regarding the primary outcomes related to the resolution of amenorrhea and reproductive outcomes following adhesiolysis, no statistically significant differences were observed between the two groups.

Although the assessment is based on a single available study, the use of a 5-mm mini-resectoscope appears to be an effective, feasible,

and safe alternative to the 9-mm resectoscope for the treatment of IS under general anesthesia.

Quality of evidence

The evidence concerning the safety, effectiveness, and reliability of employing a mini-resectoscope for the surgical correction of IS under general anesthesia has been classified as evidence level 3.

Isthmocele

The isthmocele, or cesarean scar defect (CSD), develops as a consequence of defective healing of the myometrium at the site of the hysterotomy in patients undergoing cesarean section.[45] The number of cases has risen dramatically in recent years due to the worldwide increase in the cesarean section rate, improvement in ultrasound technology that facilitates the diagnosis, and greater awareness of the condition.[46,47]

Several articles report the hysteroscopic treatment of the isthmocele using the conventional resectoscope,[48–52] but only one has evaluated the efficacy and applicability of the 16F mini-resectoscope for isthmocele repair.[16]

Casadio et al.[16] conducted a prospective controlled study with the aim of comparing the efficacy and safety of the 26F resectoscope and the 16F mini-resectoscope for the treatment of CSD, under general anesthesia. The general characteristics of the study are summarized in Table S5. A total of 309 symptomatic women diagnosed with CSD were divided into two groups: 155 women (control group) underwent isthmoplasty with a 26F resectoscope and 154 women (study group) underwent isthmoplasty with a 16F resectoscope. All patients in both groups received general anesthesia, but only patients treated with the 26F resectoscope required instrumental dilation of the CC. The no-touch technique was applied to the patient group treated with the 16F mini-resectoscope. In terms of efficacy and feasibility, all patients in both groups successfully completed the procedure without encountering any surgical issues. Interestingly, despite the operative time required to perform the isthmoplasty being similar between the two groups, the overall duration of the procedures using the 16F mini-resectoscope was shorter since cervical dilation was not required. In addition, during the postsurgical phone interviews conducted 3 months after the surgery, the authors found that 88% of women treated with the 26F resectoscope and 91% of those treated with the 16F mini-resectoscope were free of postmenstrual AUB and suprapubic pelvic pain, indicating positive outcomes in both groups. Regarding safety, the use of the 16F resectoscope was associated with a significant reduction in the volume of distension medium required to complete the procedure and fluid absorption. Moreover, a significant increase in postoperative complications, such as cervical lacerations, nausea, and pain requiring a hospital stay of more than 4 h, was recorded in the 26F group. However, no major complications such as uterine perforation, hemorrhage, or intravasation syndrome occurred in either group. Patient satisfaction immediately after surgery was significantly higher in the group treated with the 16F mini-resectoscope. However, no significant difference in the length of hospital stay was observed between the two groups. The results reported by Casadio et al.[16] may be partly explained by the need for cervical dilation in patients treated with the 26F resectoscope. Cervical dilation not only affects the overall duration of the surgery but may also contribute to postoperative pain. In addition, the dilation of the CC can cause a "deformation" of the real shape of the isthmocele, flattening the edges of the defect with the risk of undertreatment or overtreatment. Another advantage of using the 16F mini-resectoscope for performing isthmoplasty is the good visualization of the surgical field, due to the narrow nature of the CC. Unlike the 26F resectoscope, which could not work adequately in terms of outflow drainage due to the proximity of the external sheath to the CC, which obstructs the outflow of the distention media, the 16F mini-resectoscope ensures a good inflow and outflow while maintaining good visualization to the surgeon.

Although based on only one study, the use of the 16F mini-resectoscope under general anesthesia for the treatment of isthmocele appears to be a safe and effective alternative, with similar effectiveness and fewer complications compared with the 26F resectoscope.

Quality of evidence

The evidence regarding the safety, effectiveness, and reliability of using a mini-resectoscope in the surgical correction of CSD under general anesthesia was classified as evidence level 3.

Septate uterus

SU falls under class U2 according to the European Society of Human Reproduction and Embryology/European Society for Gynecological Endoscopy (ESHRE/ESGE) classification, which includes all cases with normal fusion and midline septal abnormality.[53] It represents the most common uterine malformation, with an incidence ranging between 0.2% and 2.3% of women.[54] The septum can vary in extent and may divide only a portion or the entire uterine cavity, in some cases extending to the cervix and/or vagina.[53] Women with an SU have an increased risk of subfertility, pregnancy loss, preterm delivery, and fetal malpresentation.[55]

Aiming to improve reproductive outcomes, hysteroscopic incision of the US using the conventional resectoscope has long been recognized as the standard of care.[56,57] The advent of the 15F hysteroscope with operative channel allowed the performance of metroplasty also in an office setting, using 5F cold scissors or electrical instruments.[58]

Currently, the mini-resectoscope is widely used for the treatment of SU. However, there is only one published RCT that investigated the feasibility of using mini-resectoscope for hysteroscopic metroplasty.[17] The authors[17] aimed to compare intraoperative and postoperative outcomes using a 9-mm resectoscope versus 5-mm mini-resectoscope for septal resection under general anesthesia.

The general characteristics of patients treated are summarized in Table S6. Forty patients underwent metroplasty. Twenty women with a partial SU (ESHRE/ESGE U2a) were treated using a 5-mm mini-resectoscope, while 20 patients, including 18 with a partial SU and 2 with a complete SU (ESHRE/ESGE U2b), underwent metroplasty by a "conventional" 9-mm resectoscope. All patients received general anesthesia and instrumental dilatation of the CC with Hegar (up to 9 mm and 5 mm for 9-mm resectoscope and 5-mm mini-resectoscope, respectively). As expected, the mean operating time in the two groups was similar but cervical dilatation time was significantly longer in the 9-mm resectoscope group. The duration of hospital stay (in hours) and the postoperative pain score at 2 h after the procedure were significantly lower in the 5-mm mini-resectoscope group compared with the 9-mm resectoscope group. No intraoperative and postoperative complications nor postoperative adhesions at 6 weeks of follow-up were recorded in either group. Regarding reproductive outcomes, no significant difference was reported in live birth rate after the procedure (92.3% and 64.3% in the 9-mm resectoscope and 5-mm mini-resectoscope groups, respectively). Interestingly, two patients in the 9-mm resectoscope group had short cervical length (<2.5 cm) and underwent cervical cerclage during pregnancy.

Based on the data gathered from the single study available in the literature, it appears that the 5-mm mini-resectoscope can be effectively used for metroplasty, under general anesthesia, with surgical outcomes comparable to those achieved with the 9-mm resectoscope. However, the 5-mm mini-resectoscope offers several distinct advantages, including the need for less cervical dilatation, a shorter operative time, and a significant reduction in postoperative pain.

Quality of evidence

The evidence regarding the safety, effectiveness, and reliability of using a mini-resectoscope in the surgical correction of US under general anesthesia was classified as evidence level 3.

Comparison with existing literature

The available evidence suggests that the mini-resectoscope, regardless of its caliber or type, demonstrates good effectiveness, safety, and feasibility in hysteroscopic surgery. It allows an effective treatment of EPs, SMs, SU, IS, and CSD. This instrument can be used in both outpatient and inpatient settings, ensuring good feasibility of the procedures. In addition, the technical characteristics of the mini-resectoscope allow it to be used even with both the no-touch technique and for the see-and-treat procedures.

The main feature of the mini-resectoscope is the possibility for the surgeon to perform the same surgical gestures as with the conventional resectoscope but in a size that is compatible with a diagnostic hysteroscope. For the surgeon, this means performing intracavitary surgical procedures in an ergonomic setting that is more comfortable and effective when compared with the use of a classic operative hysteroscope with an 5F operative channel. In addition, this aspect could have a positive influence on the learning curve of surgeons with experience using the classical resectoscope. Nevertheless, no trials, to our knowledge, have investigated this aspect so far. Only Ricciardi et al.[8] compared a 16F mini-resectoscope with a 15F hysteroscope in performing outpatient free-anesthesia procedures, showing a significantly better performance of 16F mini-resectoscope in terms of operating time, volume of distension medium delivered, discharge time, and patient discomfort.

Avoiding cervical dilation is one of the main advantages when using the mini-resectoscope. It shortens the surgical procedure, avoiding risks of complications such as cervical lacerations or uterine perforations and decreasing postoperative pain. Furthermore, as previously described, under certain conditions, cervical dilatations could negatively influence the performance of the procedure due to an artificial effect on the pathology to be treated. For instance, the flattening dilator-induced effect to the isthmocele or the dislocation of US toward a lateral uterine wall in cases of U2b uterus according to ESHRE/ESGE classification.[16,17] While the structure and diameter of the mini-resectoscope allows navigation of the CC like a diagnostic hysteroscope, forgoing the need for cervical dilation and/or analgesia/anesthesia, it is worth noting that only Ricciardi et al.,[8] Dealberti et al.,[13,14] and Papalampros et al. (but only in eight of 30 patients)[7] reported the use of mini-resectoscope with the no-touch technique. In the remaining studies,[7,15,17] the mini-resectoscope was applied after cervical dilation under local or general analgesia/anesthesia, except in Casadio et al.,[16] where the mini-resectoscope was inserted without dilation of the CC. In this regard, Roy et al.,[15] reported intravaginal administration of 400 μg of misoprostol 6 h before the procedure to facilitate cervical ripening. Despite this practice being associated with a high risk of preoperative pain and vaginal bleeding,[59] the authors did not record any side effects in this series. However, different than in the 5-mm mini-resectoscope group, among patients treated with the 9-mm resectoscope, three cervical lacerations and one uterine perforation occurred.[15]

Finally, despite the mini-resectoscope being designed to enhance surgical procedures performed in an outpatient setting, allowing for the integration of the diagnostic phase with the surgical one, only Dealberti et al.[13,14] have described procedures conducted with a see-and-treat approach. In both studies, the authors reported the successful treatment of a series of patients who underwent outpatient polypectomy in a see-and-treat manner. No complications were recorded and the mean VAS score after the treatment was <3 in both series. Nevertheless, in terms of effectiveness and feasibility, one case of polypectomy required two procedures for complete removal, and seven procedures had to be discontinued due to patient-reported pain.

Strengths and limitations

To the best of our knowledge, this is the first systematic review investigating the effectiveness, safety, and feasibility of the intrauterine pathologies treatment using the mini-resectoscope.

Despite the widespread use of the mini-resectoscope by experienced gynecological endoscopists worldwide, the gathered evidence is limited, with only seven published studies to date. Notably, it was not possible to collect enough information to assess inclusion criteria for treating intrauterine pathology using a mini-resectoscope according to the specific clinical setting (inpatient or outpatient) and/or to the approach use (no-touch and see-and-treat techniques). However, several step-by-step procedure descriptions[60–64] reports have been published according to the pathology treated. While these descriptions cannot contribute to the accumulation of evidence, they may be of great help from both a scientific and clinical perspective.

Finally, it is important to acknowledge that the level of evidence varied significantly depending on the pathology being treated, ranging from 2 to 3.

Implications

Our review shows that the mini-resectoscope is an efficient and versatile tool for the treatment of intrauterine pathologies. Regardless of the pathology treated, the surgical outcomes of the mini-resectoscope were comparable to the classical resectoscope. Nonetheless, the mini-resectoscope was associated with shorter operative time, lower postoperative pain, shorter hospital stay, and lower rate of surgical complications.

Despite the demonstrated effectiveness, feasibility, and safety in treating many of the intracavitary pathologies, it is important to note that not all potential applications of the mini-resectoscope have been thoroughly investigated. For instance, unlike the traditional resectoscope, there are currently no available studies on fertility-sparing treatment of endometrial cancer using the mini-resectoscope.[65] In the era of precision medicine, the mini-resectoscope may represent a groundbreaking advancement in minimally invasive and fertility-preserving approaches in managing endometrial cancer, particularly for women who desire conception.

4 | CONCLUSIONS

In light of all of the advantages described, the mini-resectoscope is poised to play a leading role in hysteroscopic surgery for many pathologies, both in inpatient and outpatient settings. Such an approach is supported by the scientific evidence synthesized in our review. Since some applications of the mini-resectoscope have not yet been thoroughly investigated, our review can serve as a foundation for identifying current knowledge gaps and for designing future high-quality comparative trials on specific applications and/or populations.

AUTHOR CONTRIBUTIONS

AE and AF were responsible for the acquisition, analysis, and interpretation of the data. AE and AF were responsible for drafting the work. ASL, VC, and AV were responsible for revising the work critically for important intellectual content. FF, JC, SG, and GR gave final approval of the version to be published. AE and AF agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved. All authors met the International Committee of Medical Journal Editors criteria for authorship and have read and agreed to the current version of the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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