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Diagnosis and Treatment of Uterine Septum

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Abstract:

A uterine septum is a congenital malformation resulting from incomplete resorption of the Müllerian ducts during embryonic development, leading to a fibrous or muscular partition that divides the uterine cavity. It is the most common type of Müllerian anomaly and is frequently associated with reproductive complications such as recurrent pregnancy loss, infertility, and adverse obstetric outcomes. Diagnosis relies primarily on advanced imaging modalities, including three-dimensional transvaginal ultrasound (3D TVUS), hysterosalpingography (HSG), and magnetic resonance imaging (MRI), which allow differentiation from other anomalies like bicornuate uterus. Hysteroscopic metroplasty remains the gold standard for both diagnosis and treatment, offering a minimally invasive approach that restores normal uterine anatomy and improves reproductive outcomes. Current management strategies focus on individualized treatment plans based on the septum's morphology, reproductive history, and associated comorbidities.

Keywords: Uterine septum; Müllerian anomalies; Hysteroscopy; Reproductive outcomes; Metroplasty; Infertility; Recurrent miscarriage; MRI; 3D ultrasound.

Introduction:

A uterine septum is a congenital Müllerian anomaly that may result in adverse reproductive outcomes such as infertility, recurrent pregnancy loss, or preterm delivery. The septate uterus is the most common Müllerian anomaly encountered in clinical practice where it accounts for approximately 55% of such diagnoses, although many patients with a septate uterus are asymptomatic **(1).**

A uterine septum is believed to develop as a result of failure of resorption of the tissue connecting the two paramesonephric (mullerian) ducts prior to the 20th embryonic week. While the arcuate uterus represents the mildest form of resorption failure **(2).**

It is congenital uterine malformation where the uterine cavity is partitioned by a longitudinal septum; the outside of the uterus has a normal typical shape. The wedge-like partition may involve only the superior part of the cavity resulting in an incomplete septum or a subseptate uterus, or less frequently the total length of the cavity (complete septum) and the cervix resulting in a double cervix. The septation may also continue caudally into the vagina resulting in a "double vagina" **(3).**

Unlike the septum, it is not considered clinically relevant. The true prevalence of the uterine septum is difficult to ascertain as many uterine septum defects are asymptomatic but appear to range between 1 to 2 per 1,000 to as high as 15 per 1,000 **(4).**

Initially, uterine septa were believed to be predominantly fibrous tissue. However, biopsy specimens and magnetic resonance imaging (MRI) suggest that septa are composed primarily of muscle fibers and less connective tissue **(2).**

Mullerian anomalies in general may be associated with renal anomalies in approximately 11% to 30% of individuals. However, data do not exist to suggest an association between septate uterus and renal anomalies and, as such, it is not necessary to evaluate the renal system in all patients with a uterine septum **(1).**

The size and shape of the septum can vary by width, length, and vascularity, although most have not been categorized systematically, and definitions are not standardized. For example, the definition of the septum by the European Society of Human Reproduction and Embryology and the European Society for Gynecological Endoscopy (ESHRE-ESGE) criteria is an internal indentation extending >50% of myometrial wall thickness, while the American Society for Reproductive Medicine (ASRM) criteria, regarding shape may be either thin linear septum or thick broad septum or irregular septum, provide no strict parameters to define septate configurations **(5).**

It has been proposed additional morphologic criteria for the American Fertility Society (AFS) criteria to better characterize and differentiate a septate from an arcuate uterus. These define a partial uterine septum as having the central point of the septum at an acute angle (to differentiate from an obtuse angle seen with an arcuate configuration) and define the length of the septum to be greater than 1.5 cm, with arcuate defined as having a fundal invagination between 1 and 1.5 cm. As there is no universally accepted standard definition of septate uterus, differences among the available definitions may lead to variability in diagnostic classifications with correspondingly higher/lower incidence of surgery performed to correct these anomalies**(6).**

A complete septate uterus has a single uterine fundus, with a septum extending from the top of the endometrial cavity and continuing through the cervix or may extend into a duplicated cervix. Both may be seen in combination with a longitudinal vaginal septum. This configuration must be differentiated from the uterus didelphys in which the uterine horns are separated. Both of these anomalies have duplicated cervices and typically are associated with a longitudinal vaginal septum **(4).**

The arcuate uterus is difficult to classify. Although developmentally the arcuate uterus may be considered as part of the spectrum of failure of mullerian resorption, it is typically considered a normal variant and therefore functionally not part of the septate spectrum. The AFS classification system placed arcuate uterus in its own category as, in contrast to other uterine malformations, it does not cause adverse clinical outcomes. However, it is important to differentiate arcuate from septate uterus to better direct surgical intervention when appropriate for the septate uterus **(7).**

Diagnosis

The gold standard method for diagnosing mullerian anomalies required direct visualization of the exterior and interior of the uterus using laparoscopy and hysteroscopy. Importantly, assessing both the outer and inner uterine contour makes it possible to distinguish a septate from a bicornuate uterus. As radiologic methods have improved over the past 20 years, the diagnosis of a septate uterus is typically made using radiographic rather than surgical techniques. While hysterosalpingography (HSG) is often the initial test that provides evidence for a mullerian anomaly in patients with infertility or recurrent pregnancy loss, the diagnostic accuracy of the HSG is low for distinguishing septate and bicornuate uteri. Indeed, compared with hysteroscopy/ laparoscopy. The septate uterus may be visualized either directly during a diagnostic or therapeutic hysteroscopy or laparoscopy or indirectly via imaging studies such as 3D ultrasonography (3D US), hysterosalpingography (HSG), or magnetic resonance imaging (MRI)**(8).**

Hysteroscopy

Hysteroscopy is the insertion of a rigid or flexible hysteroscope through the cervical canal into the endometrial cavity. Visualization of the entire endometrial cavity is accomplished using distention media. Hysteroscopy provides a complete view of the contour of the endometrial cavity, both tubal ostia; uterine septa are

directly visualized if present. However, hysteroscopy does not allow visualization of the contour of the serosal surface of the uterine fundus. **(9).**

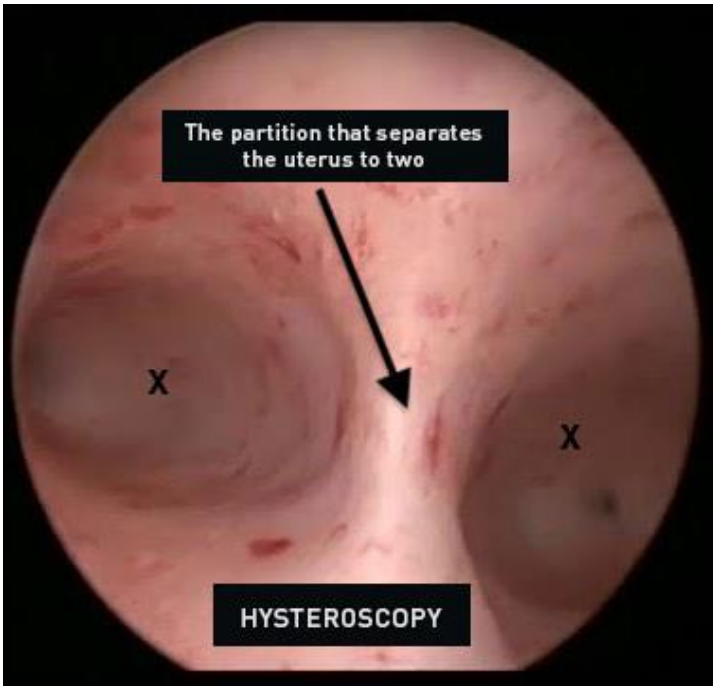

Figure (1): Hysteroscopic diagnosis of septate uterus **(10).**

Laparoscopy

Laparoscopy is a surgical procedure performed under general anesthesia that permits direct visualization of intraperitoneal abdominopelvic structures **(11).**

So,laparoscopy can be used in conjunction with hysteroscopy and HSG to visualize the fundal contour and identify the class of Mullerian anomaly. The method of using hysteroscopy and laparoscopy together has been shown to have the same diagnostic yield for a uterine septum as 3D ultrasound. Thus, 3D ultrasound is the preferable modality given the less invasive approach **(11).**

Ultrasonography

A saline-infusion sonohystogram combines real-time US of the uterus with the injection of sterile saline into the endometrial cavity to visualize its contour. To measure a uterine septum during sonography, one line is drawn from cornu to cornu (line 1), and a second perpendicular line is drawn from line 1 to the tip of the septum (line 2). The length of line 2 is the septum measurement. In one study, sonohysterography was more sensitive and specific for a septate uterus than HSG and diagnostic hysteroscopy. There was no significant difference between HSG and diagnostic hysteroscopy **(12).**

Transvaginal ultrasound is another excellent modality that can be used to accurately diagnose a uterine septum as it has comparable predictive value compared to MRI and it is readily available in many outpatient office settings. Both 3D transvaginal ultrasound and 2D-SIS have a diagnostic accuracy greater than 90%. When 3D transvaginal ultrasound is performed in combination with SIS, the sensitivity and specificity have been reported as high as 100% and can distinguish a septum from an arcuate uterus with high precision **(13).**

Figure (2): 3D-ultrasound coronal view of a uterus with partial septum **(14).**

Hysterosalpingography (HSG)

HSG is the radiologic imaging technique that facilitates structural evaluation of the endometrial cavity and fallopian tubes. Either oil- or water-based radiopaque contrast is delivered into the endometrial cavity under fluoroscopic guidance, and radiographs are taken. A uterine septum may appear as an inverted triangular piece of tissue dividing the uterine cavity. However, the diagnostic accuracy of HSG in a septate uterus is low due to the difficulty distinguishing this finding from a bicornuate uterus. Additionally, if the HSG reveals findings consistent with a septate uterus, this must be confirmed with 3D ultrasound, saline-infused sonogram, MRI, or laparoscopy to visualize the fundal contour and rule out a bicornuate uterus**(15).**

Magnetic Resonance Imaging (MRI)

MRI of the pelvis using T2 images in three planes can measure a uterine septum. Long- and short-axis views are prescribed relative to the endometrium in the sagittal plane. The long-axis view allows visualization of the uterine fundal contour, while the short-axis view allows measurement of the uterine septum. To measure the uterine septum on MRI, you again measure from cornu to cornu (line 1) and measure from the caudal end of the uterine septum to the midpoint of line 1. A study by Ata et al determined that the ability of 3D ultrasound to diagnose a uterine septum is comparable to that of MRI but is the more cost-effective option **(16).**

Differential diagnosis

The differential diagnosis of a septate uterus includes an arcuate uterus, bicornuate uterus, or uterus didelphys. Other forms of uterine malformation need to be considered in the work-up for uterine septum. An arcuate uterus contains a residual cranial septum that is smaller than an incomplete septum but definitions between the two conditions are not standardized, - a cause for discrepancies in the literature. A bicornuate uterus is sometimes confused with a septate uterus as in each situation the cavity is partitioned, however, in the former case the uterine body is cranially doubled (two uterine horns) while in the latter a single uterine body is present. The former represents a malformation of incomplete fusion of the Müllerian systems, and the latter of incomplete absorption. A hysterosalpingogram may not be able to distinguish between the two conditions. The differentiation, however, is important as a septum can be corrected by hysteroscopy, while a bicornuate uterus would be corrected by a metroplasty via laparotomy if necessary **(17).**

Management

When a uterine septum is diagnosed in patients with infertility or a history of poor obstetrical outcomes, the recommended treatment is hysteroscopic resection of the septum. However, there has been only one randomized controlled trial comparing hysteroscopic resection with expectant management in patients with a septate uterus. The Randomized Uterine Septum Transection (TRUST) trial randomized patients with a septate uterus who desired pregnancy and had a history of subfertility, pregnancy loss, or preterm birth to either expectant management or septum resection. The two groups did not differ in time to pregnancy or live birth rate **(18).**

When a septate uterus is diagnosed in the absence of infertility or a history of a poor obstetrical outcome, septum resection can be considered with the appropriate patient counseling and shared decision-making. The ideal timing of septum resection is during the early follicular phase of the menstrual cycle; the uterine lining is thin and does not obscure the hysteroscopic view. Medications such as progestins, danazol, or gonadotropin-releasing hormone (GnRH) agonists can suppress endometrial growth and facilitate hysteroscopic visualization of the uterine septum **(19).**

The goal of the hysteroscopic septal resection is to incise the uterine septum. Transection can be accomplished using cold scissors, unipolar or bipolar cautery, or argon lasers; success rates are similar for each. Complications of this procedure are infrequent. A staged procedure is sometimes required if patients have a thick or complete uterine septum or a concurrent vaginal septum. Ultrasound or fluoroscopic guidance can be used as an adjunct to prevent incising the myometrium. Many techniques have been implemented to prevent intrauterine adhesions and septum reformation after hysteroscopic resection; no significant evidence suggests for or against any of these methods. Methods have included balloon stenting via intrauterine foley catheter placement, intrauterine injection of crosslinked hyaluronic gel, copper, or hormonal intrauterine device placement, and oral administration of estradiol or progestin **(20).**

Hysteroscopic cold scissors require the least amount of equipment and therefore are a cost-effective option and are ideal for use in an office setting. Hysteroscopes with an outer diameter as small as 5 millimeters have been made to accommodate the scissors, and cervical dilation is often not necessary when using a hysteroscope of this size. Additionally, some clinicians prefer to use scissors in order to avoid the use of energy sources in the endometrial cavity that may increase the risk of postoperative intrauterine adhesions or endometrial injury. Some difficulties encountered include poor visibility if the scissors pass through the inflow channel as this reduces flow of distending fluid and clearing of blood. The true risk reduction to endometrial damage with the use of cold scissors for septum incision has not been well studied and remains more of a theoretical concern **(21).**

Many hysteroscopic electrocautery devices have been developed that can also be used for septum incision. These options include hooks, loops, and various pointed tip electrodes. Some of these options are designed to be used with larger diameter hysteroscopes (22 or 26 French) and cervical dilation may be required. When using electrocautery, surgeons must always be aware of the thermal spread from the contact surface of the instrument, which varies depending on the instrument type, power setting, and the application time. In general, bipolar devices result in less thermal spread compared to monopolar devices, with thermal spread up to 2–6 mm recorded for bipolar instruments and thermal spread of greater than 10 mm recorded for monopolar instruments. This risk is important to be aware of when operating within the endometrial cavity as myometrial damage may occur, but also if uterine perforation occurs due to the injury that can then occur to intra-abdominal organs **(22).**

If uterine perforation occurs, the surgeon must decide whether to end the procedure and expectantly manage the patient or whether abdominal exploration to evaluate for injury should be performed. This decision should be made based on the risk of intra-abdominal injury at the time of perforation taking into consideration the risk of potential bladder, bowel, or vascular injury depending on the location of injury and causal instrument. Generally, if perforation occurs with a blunt instrument and no electrocautery, expectant management can be considered if there

are no other signs of vascular or visceral organ injury. If perforation occurs with the use of electrocautery or if the surgeon is concerned for possible intra-abdominal injury based on the type and location of perforation, abdominal exploration should be performed. The hysteroscopic surgeon should be aware and capable of performing management of uterine perforation **(23).**

The choice of distension media to us depends on the time of operative instrument chosen for incision. Both electrolyte-free and electrolyte-rich media can be used. Electrolyte-free media such as 3% sorbitol, 1.5% glycine, and 5% mannitol are commonly used with monopolar devices. The greatest risks that can occur when using these solutions is electrolyte imbalance such as hyponatremia, which has been observed when high amounts of solution are absorbed into the systemic circulation. Maximum absorption of electrolyte-free media is 1000 ml. When using electrolyte-free solutions, the surgeon must always be aware of the operating fluid deficit and institutional procedures and guidelines used to mitigate the risks of fluid overload and electrolyte imbalance. High amounts of distension media absorption are more likely to occur with prolonged procedures. However, uterine septum incision procedures are generally completed in under 30 minutes and therefore high fluid deficits are rarely observed with this procedure **(24).**

When using bipolar instruments, an electrolyte-rich media, such as normal saline, must be used for distention. This media is advantageous because it is isotonic and contains physiologic electrolytes, thus, mitigating the risk of electrolyte imbalances like hyponatremia making it the preferred choice by many surgeons, especially for cases with an expected longer operating time. The maximum fluid deficit with normal saline is far greater than with glycine and approaches 2000–2500. However, high fluid deficits with normal saline can still cause fluid overload and the surgeon must always pay close attention to fluid management during any hysteroscopic procedure **(21).**

Procedural Steps

Partial Septate Uterus

Regardless of the hysteroscopic instrument chosen for septum incision, the principles of the procedure remain the same. Once the hysteroscope is in the uterine cavity, the surgeon should perform a careful survey of the cavity and identify the location of both tubal ostia. It is easy to become disoriented within the endometrial cavity during hysteroscopic septum incision if the surgeon is not constantly monitoring these landmarks. Two techniques can be utilized: shortening and thinning. Shortening involves incising the septum starting at the leading edge and continuing toward the fundal region **(25).**

The septum is incised horizontally typically starting at one side moving across to the other side, parallel to the anterior and posterior uterine walls and in the same plane defined by the tubal ostia. If the incision begins to deviate toward the anterior and posterior walls, this trajectory could eventually lead to uterine perforation if not recognized and corrected. The thinking technique involves incising the septum along the lateral edges of the septum on both sides to reduce the width of the septum. The shortening technique can then be facilitated as the septum will be smaller. Another benefit of this technique is it helps to keep the surgeon in the intended plane throughout the procedure as these incisions are placed in the correct plane midline between anterior and posterior uterine walls and in the plane of the tubal ostia. In practice, it is often helpful to use a combination of these two techniques depending on the size and shape of the septum to be incised **(26).**

If scissors are utilized, small incisions are made at the leading edge allowing the septal fibers to separate. Blood vessels if visualized may be avoided to minimize bleeding. If using electrocautery, a combination of a brief incision with energy followed by gentle blunt dissection without energy can be used to safely incise the septum with the least amount of applied thermal energy. As the incision progresses, the surgeon must constantly be aware of the incisional plane and the uterine orientation by monitoring the location of the tubal ostia in relation to the incision. It is usually not possible to keep the ostia continuously visible during the procedure due to the proximity that must be maintained between the operating instrument and the surface of the septum. Thus, the surgeon must frequently move

the camera from the incision to the ostium to ensure the orientation of the uterus has not been lost. If this occurs, there is a high risk of perforation as the surgeon will no longer be incising the correct plane **(20).**

Complete Septate Uterus

With a complete septate uterus, there is debate regarding whether the cervical septum should be incised as part of the uterine septum incision or left intact. The concern with cervical septum incision is that it could compromise the remaining cervical tissue leading to cervical insufficiency in pregnancy. However, there are no high-quality studies that evaluate pregnancy outcomes after cervical septum incision and results are conflicting. Nor do these studies clearly define a cervical septum or differentiate it from a duplicated cervix. A cervical septum appears as a single thickened outer rim with a band that may be thin or thick dividing the cervix. This band is typically continuous with the uterine septum and longitudinal vaginal septum when present. With a duplicated cervix, there are two distinct cervical entities, and the cervical ostia are separated by a large distance or may even be in different planes **(27).**

Incising the cervical septum along with the uterine septum for a complete septate uterus has been advocated as this procedure has been shown to be significantly shorter, associated with less fluid absorption, less bleeding, and easier when compared to preservation of the cervical septum. The techniques described include cutting the cervical septum with Metzenbaum scissors, or cutting the cervical septum with scissors after first dilating each cervical canal to 10 mm. In lieu of scissors, a 5-mm hand-held tissue sealing device can be used to transect the cervical septum with minimal bleeding **(28).**

It has been reported using the hysteroscopic resectoscope. In these studies, the uterine septum was incised with hysteroscope and either scissors or bipolar or monopolar cautery independent of the technique to remove the cervical septum. All these techniques have been shown to be performed immediately following resection of longitudinal vaginal septum. The cervical septum was observed to recur following incision in 3 of 10 patients in one observational study. Cervical incompetence following incision of cervical septum is a concern with incidence of cerclage in studies ranging from 9% to 24% **(29).**

The complete septate uterus with duplicated cervix, there are a couple of effective techniques to incise the uterine septum without compromising the cervical septum. The main strategy is to make an opening in the septum just above the level of the internal cervical os, to create a leading edge of the uterine septum that can be incised hysteroscopically. The challenge is to identify a thin portion of uterine septum in the correct location and the correct plane to create this opening. One approach is to make a blind entry across at the presumed correct location, but these risks deviating the incision toward the anterior or posterior wall especially if the uterus is rotated thereby increasing the risk of perforation. A safer option is to identify where to incise the septum by placing an instrument in the contralateral side to tent the septum where the incision should be made **(30).**

Instruments that have been used include a foley balloon, a uterine sound, or a thin curved clamp in the endocervical/uterine canal with the hysteroscope in the adjacent canal. The septum may then be incised over the area demarcated by these instruments using scissors, or any hysteroscopic tools used for uterine septum incision. When using a balloon, once it is beyond the cervix, it can be slowly inflated and the incision can be made through the septum above the cervix, using the balloon to delineate the location for the incision and the prevent the instrument from perforating through the contralateral uterine wall. Although the foley is effective, it can distort the anatomy and make it difficult to pass the hysteroscope. A thin long curved clamp can overcome these issues. Once inserted through the contralateral side of the cervix and beyond the cervix, the surgeon can angle the tip of the clamp into the septum and then open the clamp to delineate a clear area where the incision can safely be made to incise the cervix in the lower uterine segment without perforating through the contralateral wall **(31).**

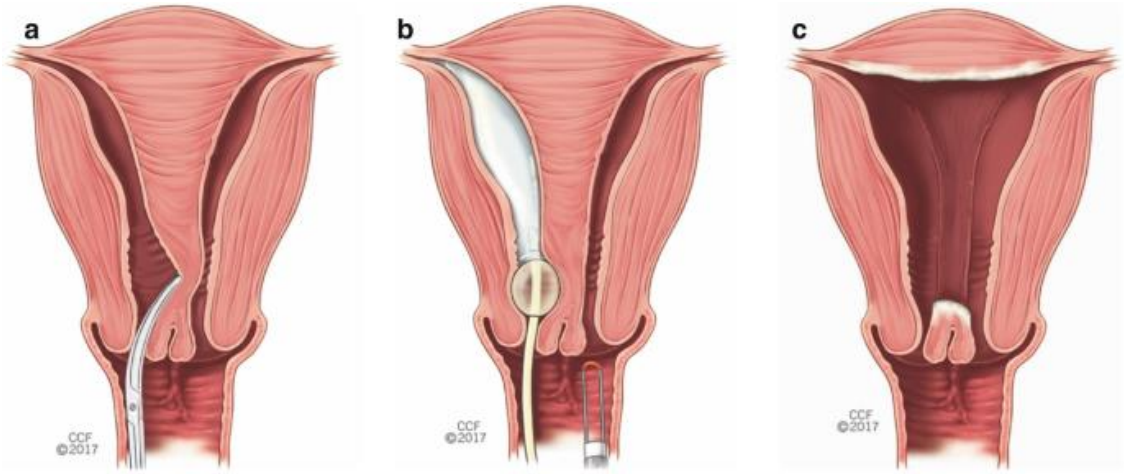

Figure (3): Technique for complete uterine septum incision while preserving cervical septum. **(a)** Using a fine long curved clamp to identify where to cross lower uterine septum. **(b)** Use of foley balloon catheter to mark where to cross lower uterine septum. **(c)** Complete septate uterus following incision of uterine septum while preserving cervical septum **(32).**

Once the septum has been crossed, the hysteroscopic distending media will egress through the adjacent cervical canal and uterine distension may be difficult. When this occurs, occlusion of the second cervical opening can be helpful. This can be done by placing a figure-of-eight stitch around the cervical opening, using an Allis clamp to occlude the external cervical os, or by placing a foley balloon through the cervix, slightly inflating the balloon, and then pulling back on the foley catheter until the second cervical opening is occluded. Interestingly, incidence of cesarean section following preservation of the cervical septum was higher, 7% versus 2% in one randomized study. However, vaginal delivery is not impeded with an intact cervical septum or complete duplicated cervix post hysteroscopic septum as the fetal head displaces the cervix or cervical septum to one side as it descends **(20).**

Clues that the incision is nearing the interstitial line can be gathered from visual signs, direct measurement, and external monitoring with laparoscopy or ultrasound imaging. Visually, the myometrial wall is often much more vascular than the septum. When bleeding begins to occur at the level of the incision, this is a sign that myometrium is near, and the remaining length of the septum should be reassessed. It is important to remember that the septum can contain muscle and vessels which may also cause bleeding during incision and this approach may lead to a large residual septum **(29).**

The length of the residual septum may also be assessed by placing the extended operating instrument and directly measuring the depth. When utilizing this technique, one should know the size of visual markers such as the length of scissors or insulation on the operating instrument. Simultaneous transabdominal or transrectal ultrasonography has been shown to be effective to assess when septum incision is complete and has the advantage of being able to measure the remaining thickness of the uterine wall. Direct external visualization of the uterus with laparoscopy can be used; however, transabdominal ultrasound monitoring is less invasive and has similar efficacy and safety when used to monitor the procedure **(33).**

Comparison between traditional scissor and bipolar in resection of uterine septum

Resection of a uterine septum can be performed using various techniques, with traditional scissors and bipolar electrosurgery being two common methods. Both traditional scissors and bipolar electrosurgery have unique benefits and drawbacks in the resection of a uterine septum.

Traditional Scissors

The advantages of this method include simplicity, precision and low Cost. The use of traditional scissors is straightforward and familiar to many surgeons. Scissors allow for controlled cutting, which can be beneficial in delicate areas. Traditional scissors are generally less expensive compared to electrosurgical devices. Disadvantages appear in the form of hemostasis as scissors do not provide any means of coagulation during cutting, which may lead to increased blood loss. Tissue Handling Requires careful handling and may necessitate additional tools for hemostasis, such as clamps or sutures **(23).**

Bipolar Electrosurgery

The advantages of this method include cauterization, reduced thermal spread and efficiency. Bipolar devices provide simultaneous cutting and coagulation, reducing blood loss and improving visibility during the procedure. Bipolar systems are designed to minimize thermal damage to surrounding tissues, thus preserving adjacent structures. The combination of cutting and coagulation can make surgeries quicker, as fewer steps are needed for hemostasis. Surgeons may require specific training to use bipolar electrosurgery effectively. Bipolar devices and their consumables tend to be more expensive than traditional instruments **(34).**

Table 1. Comparison between traditional scissor and bipolar in resection of uterine septum **(35).**

Feature	Traditional Scissors	Bipolar Electrosurgery
Technique	Manual cutting	Electrosurgical cutting and coagulation
Hemostasis	Manual hemostasis required	Immediate hemostasis
Precision	High precision in cutting	Good precision with reduced thermal spread
Cost	Generally lower	Generally higher
Learning Curve	Familiar technique	Requires training
Efficiency	Can be slower due to hemostasis needs	Often quicker due to combined actions

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