Review Article

Late-onset Endometrial Ablation Failure—Etiology, Treatment, and Prevention

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ABSTRACT This review summarizes the history and demographics of nonresectoscopic endometrial ablation and global endometrial ablation procedures as well as the presentation, etiology, risk factors, treatment options, and prevention of late-onset endometrial ablation failures. Journal of Minimally Invasive Gynecology (2015) 22, 323–331 © 2015 AAGL. All rights reserved.

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Nonresectoscopic endometrial ablation (NREA) and global endometrial ablation (GEA) are minimally invasive techniques to manage intractable uterine bleeding in women who are unresponsive to medical therapy. The intent of these procedures is to offer appropriate candidates a less invasive alternative to hysterectomy. Long-term follow-up data indicate that several types of late-onset endometrial ablation failures (LOEAFs) cause at least 25% of women to undergo subsequent hysterectomy [1,2]. This review summarizes the history and demographics of NREA and GEA procedures as well as the presentation, etiology, risk factors, treatment options, and prevention of LOEAF.

History of Endometrial Ablation

Synopsis

Endometrial ablation (EA) refers to a series of techniques originating in the 19th century that were blind and used various energy sources to affect thermal destruction to the endometrium. The late 20th century brought an important paradigm shift when a rod lens hysteroscope was colocated to an energy source permitting EA under direct visualization. However, the complexity and morbidity associated with early hysteroscopic and resectoscopic techniques soon gave way to a series of user-friendly methods known as nonresectoscopic EA or GEA. These devices and techniques boast improved safety with acceptable outcomes—features critical to the widespread adoption of EA.

The First Generation: “Blind” Techniques

In 1898, Dührssen [3] reported the first case of EA in the treatment of a 37-year-old woman "exhausted by profuse and persistent menorrhagia by introducing steam in the
uterine cavity for 2 minutes.” Dührssen noted that “as a result, the uterus underwent complete atrophy” [3]. The next EA technique involved the blind introduction of electrosurgery. In 1936, Bardenheuer [4] published Elektrokoagulation (ELK) der Uterusschleimhaut (electrocoagulation of the endometrium) with the introduction of a unipolar Kugelsondenelktronde featuring a 5- to 8-mm diameter steel ball mounted on a 12- to 16-cm shaft (Fig. 1). The system required an electrosurgical generator and a lead or aluminum grounding plate placed under the patient’s buttocks. Bauman [5] reported a series of 387 patients using Bardenheuer’s technique in an office setting employing “light narcosis.” The subjects were divided into groups (i.e., women with menorrhagia, postmenopausal bleeding, endometrial polyps, and leiomyomas). The most common complication was infection, which occurred in 4 subjects (1.29%). Bardenheuer recognized the importance of avoiding electrocoagulation of the internal os to prevent subsequent hematometra formation and pain, providing the first report of LOEAF.

Another blind technique was reported by Schultz in 1937 [6] who reported the results of 204 women who had undergone intruterine insertion of radium with a follow-up period of 2 to 20 years. The dosage (1200–1500 mCi/h hours) produced many undesirable side effects including atrophic vulvitis and subsequent endometrial cancer, causing this form of therapy to be abandoned. However, Schultz was the first to show the direct relationship between patient satisfaction and age.

The blind introduction of a cryoprobe to accomplish EA was first reported by Cahan and Brockunier [7] in 1967. In 1971, Droegemueller et al described a similar technique using both Freon (Dupont, Deepwater, NJ) and nitrous oxide probes [8]. Despite some success, these cumbersome devices never gained acceptance in the gynecologic community.

The Second Generation: The First “Visual” Techniques

A paradigm shift occurred when Goldrath et al [9] and DeCherney et al [10] colocated a rod lens endoscope with an energy source (laser and electrosurgery, respectively) to perform EA under direct visualization. The use of the Nd:YAG laser was associated with both economic and technical challenges. DeCherney et al’s technique, although significantly more affordable, suffered the technical inconveniences of a noncontinuous flow system. In 1989, after the introduction of the first Food and Drug Administration (FDA)-approved continuous flow gynecologic resectoscope, Vancaillie [11] reported the first hysteroscopic EAs using a ball-end electrode. Inexpensive acquisition costs and excellent visualization caused the technique to gain some degree of acceptance within the gynecologic community. However, early reports of fatal complications attributable to excessive fluid absorption and hyponatremic encephalopathy [12] led to a search for safer methods of EA.

The Third Generation: The “Return” of “Blind Techniques”

The next paradigm shift in EA began in 1997 with the introduction of the first NREA or GEA devices or systems. These are often referred to as “second-generation” devices—a term that belies their historic context. Presently, there are 5 FDA-approved NREA devices or systems: the thermal balloon (TheraChoice Uterine Balloon System; Johnson and Johnson, New Brunswick, NJ), the cryoablation system (Her Option; Cooper Surgical, Trumbull, CT), a heated free fluid system (Hydro ThermAblator or HTA System; Boston Scientific, Natick, MA), a bipolar radiofrequency ablation device (NovaSure EA; Hologic, Inc, Bedford, MA), and a microwave ablation system (MEA System; previously produced by Micorsulis Medical Limited, Dornhead, UK). These devices and systems, receiving FDA approval between 1997 and 2003, have been responsible for the widespread expansion of EA in the United States and Europe. With the exception of the Hydro ThermAblator System, these modalities all involve the blind introduction of a thermally active device into the uterine cavity in order to accomplish EA. Compared with resectoscopic endometrial ablation (REA), GEA devices offer technical simplicity, shorter operating times, comparable results, and greater safety [13,14]. Additionally, reminiscent of the first blind techniques of the early 20th century, they are well suited for an office setting.

Demographics of EA

In 2008, GEA procedures were the most common treatment for heavy menstrual bleeding with some 312,000 performed across the United States. The market was dominated by Hologic’s NovaSure device, which was responsible for 66% of all GEA devices used [15] that year. By 2010, the US GEA device market was valued at $407 million [16]. In 2012, Hologic led the US GEA systems market with sales of its NovaSure device and related products, garnering 54.9% of the market. Figure 2 reviews the 2012 GEA device
market share by supplier [17]. The number of GEA procedures in the United States is expected to grow from 430,000 to 490,000 between 2014 and 2017, an anticipated annual growth rate of 4.7% [17].

LOEAF: Incidence and Presentation

LOEAF describes the complications attributable to EA beyond the perioperative period of 1 month. Typically, these LOEAFs present in 1 of 3 ways: persistent or recurrent vaginal bleeding, the development of cyclic pelvic pain, and the inability to adequately assess the endometrium in women who later require sampling [18].

Longinotti et al [2] studied 3681 women who underwent both REA and NREA procedures by 344 physicians at 30 different Kaiser Permanente facilities. The subjects had a mean age of 44.3 ± 6.2 years; 20.2% were noted to have leiomyomas. The majority of LOEAF-related hysterectomies occurred within the first 3 years of EA, with the probability rising to 26% by the 8th year. The most common indications for hysterectomy for LOEAF were vaginal bleeding (51.6%) followed by cyclic pelvic pain (20.3%). The authors found no relationship between the type of EA procedure and subsequent LOEAF requiring hysterectomy.

Shavell et al [19] followed 1169 women who underwent both REA (8.1%) and NREA (91.9%) procedures. One hundred fifty-seven women (13.4%) underwent subsequent hysterectomy during a follow-up period ranging from 1 to 64 months. Sixty percent of hysterectomies were performed within the first 24 months after EA and 80% within the first 3 years. Bleeding unaccompanied by pain was responsible for 26.0% of hysterectomies, whereas the combination of bleeding and pain accounted for another 38.3% of hysterectomies. An additional 7.1% of subjects underwent hysterectomy for symptomatic myomas, with “other indications” accounting for 7.1%.

Vilos et al [20] reported 163 hysterectomies performed after REA—64.4% for cyclic pelvic pain, 23.3% for intractable bleeding and pain, and 12.3% for intractable bleeding alone. Similar results were reported by 1 of the authors (MW) [21] who studied 26 women presenting for reoperative hysteroscopic surgery (RHS) after EA failure. Pain was the most common indication for retreatment, accounting for 61.5% of subjects undergoing RHS.

An often overlooked LOEAF was reported by Ahonkallio et al [22] who noted that endometrial biopsies failed in 23% of women with a previous EA. Moreover, biopsies were likely unreliable in many of the remaining subjects because the endometrium is often sequestered by fibrous tissue in the cornual regions. One of the authors (MW) [23] found that 14% of women treated for GEA failures had undergone 1 or more failed endometrial biopsy attempts, generally for the evaluation of abnormal perimenopausal or postmenopausal bleeding.

Etiology of EA Failure

Recurrent AUB may occur months or years after EA and has been attributed to inadequate endometrial destruction, endometrial regrowth, unsuspected adenomyosis, and persistent or enlarging leiomyomas and endometrial polyps [2,19,23–25].

Inadequate Endometrial Destruction

One of the authors (MW) found that 10% of women who presented for RHS after GEA failure had a normal-appearing uterine cavity or one with minimal or no bioeffect, whereas another 44% had untreated uterine cornua [23]. Using magnetic resonance imaging, Turnbull et al [24] showed persistent or regenerating endometrium in 95% of women undergoing NREA, generally in the upper fundus and cornual regions. The most thorough EA techniques cannot predictably eradicate all of the endometrium because surviving tissue is often found in the interstitial portion of the fallopian tube [25].

Endometrial Regrowth

In a prospective longitudinal study, Taskin et al [26] performed second-look hysteroscopy on 26 subjects who experienced satisfactory results after hysteroscopic EA at a mean follow-up interval of 33.4 ± 2.1 months. Their bleeding patterns included eumenorrhea (21.0%), hypomenorrhea (30.6%), and amenorrhea (48.4%). Women experiencing dysmenorrhea were excluded. The observations were performed at a relatively fixed interval after EA and therefore contained a cohort of women whose histopathologic findings reflected healing in a group of women satisfied with their EA procedure. Taskin et al found that endometrial glands were present in 21 of 26 (80.1%) of subjects and concluded that endometrial regrowth is an anticipated development in many patients and is not necessarily associated with LOEAF. Onoglu et al [27] conducted a prospective randomized trial that included 23 women who underwent
hysteroscopic rollerball EA and 25 women who underwent hysteroscopic endometrial resection followed by secondlook hysteroscopy conducted at least 30 months after their procedure. Onoglu et al concluded that “endometrial regrowth is an expected development in many patients and is not necessarily associated with clinical bleeding that would be termed a failure.”

**Unsuspected Adenomyosis**

The precise role of adenomyosis in determining the success or failure of EA is difficult to understand in part because of the variability in its diagnosis. This inconsistency is underscored by Seidman and Kjerulf [28] in a study of 1252 pathology reports on hysterectomy specimens from women enrolled in the Maryland Women’s Health Study. The frequency of adenomyosis varied from 10% to 88% among the 25 pathologists who reviewed specimens. Although histopathologic guidelines for the diagnosis of adenomyosis have been established, similar guidelines for this diagnosis of adenomyosis in women who have experienced LOEAF do not exist. Nearly all studies that seek to establish a relationship between adenomyosis and LOEAF are retrospective and rely on the histologic examination of hysterectomy specimens. Shavel et al [19] identified adenomyosis in 44.4% of 1169 women undergoing hysterectomy after LOEAF. Riley et al [29] detected adenomyosis in the hysterectomy specimens of 43% of 51 LOEAFs. Unfortunately, these analyses provide no information regarding the presence or absence of adenomyosis in women who have satisfactory outcomes after EA.

In a prospective study, 1 of the authors (AM) [30] was able to correlate the results of a posterior wall myometrial biopsy with the outcome of rollerball EA. Analysis of 50 patients revealed a mean endometrial penetration of 1.65 mm (standard deviation = 1.3 mm; range, 0–6.0 mm). Although patients with adenomyosis ≥ 2.1 mm had increased cyclic pain after EA, its presence did not correlate with poor menstrual outcomes.

Another 1 of the authors (MW) [31] studied a group of 304 women undergoing endomyometrial resection, which provides a histologic specimen consisting of long strips of endomyometrium in which the junctional zone is easily identified. Adenomyosis was found in 69 (22.7%) subjects; 7 (2.3%) were reported as severe with endometrial glands found at the resection margin (4–5 mm). Of the 69 women whose initial specimens revealed adenomyosis, 9 (13.0%) required a second operative procedure (either reoperative surgery or hysterectomy). Of the remaining 235 women whose initial specimen was devoid of adenomyosis, 18 (7.7%) required subsequent surgery. The presence of adenomyosis in this series did not increase the risk of subsequent surgery (p = .17). Unfortunately, this study did not differentiate the depth of adenomyosis with surgical outcomes.

Leiomyomas and endometrial polyps are common findings in women with EA failures. In a series of 50 women presenting with GEA failures, 1 of the authors (MW) identified submucous leiomyomas in 22% of subjects [23]. Gemer et al [32] conducted a longitudinal study of 128 women who underwent REA and noted that the presence of submucosal myomas was associated with an increased hazard ratio (HR) (HR = 5.22; 95% confidence interval [CI], 1.63–16.73) for subsequent surgery. Shamonki et al [33] performed a retrospective analysis of 120 women who underwent EA and observed that the preoperative finding of an intramural myoma resulted in a reduced trend toward success (odds ratio = 0.4, p = .06). Untreated endometrial polyps provide another source of bleeding after EA and play a minor role in LOEAF [23].

Cyclic pelvic pain (CPP) has been documented after both REA and NREA and may begin months or years after these procedures. The pain is often described as sharp, stabbing, or labor-like and may be unilateral, bilateral, or suprapubic [23].

**Intrauterine Scarring and Contracture**

CPP has been primarily attributed to intrauterine scarring and contracture, which, in combination with functioning endometrial tissue or myomas, causes partial or total obstruction of menstrual bleeding [18,20,23]. Magos et al [34] performed second-look hysteroscopies at 3 months (n = 53) and 12 months (n = 15) after endometrial resection and showed that the majority of subjects had a small fibrotic and contracted uterine cavity. Taskin et al [26] performed second-look office hysteroscopy on 26 women who had undergone a thermal EA 33.4 ± 2.1 months earlier. The authors discovered complete atrophy, partial adhesions, or obliteration of the cavity associated with fibrosis. When fibrosis and contracture coexist with functioning endometrial tissue or another source of bleeding, such as a myoma, obstructed bleeding and CPP ensues.

Hopkins and Creedon [35] were the first to show that intrauterine “synchieae tend to develop with increasing time after endometrial ablation” and may explain why many complications require time to manifest. The authors studied 25 patients with menorrhagia who requested hysteroscopic sterilization at the time of their radiofrequency EA. Of the 21 patients who underwent a hysterosalpingogram (HSG) at 3 months, 9 subjects (43%) had normalappearing cavities, 5 (24%) had mild synchieae, and 7 (33%) showed “subtle filling defects thought to be synchieae.” In the 2 patients who underwent an HSG at 6 months, an increase in intrauterine synchieae was noted. Severe synchieae were present during an HSG performed 9 months after their radiofrequency ablation.

Postablation tubal sterilization syndrome (PATSS) was first identified in 1993 by Townsend et al [36]; they described 6 women who presented with unilateral or bilateral CPP associated with vaginal spotting. All of the subjects had undergone a tubal ligation followed by rollerball EA. In each case, the proximal portion of 1 or both fallopian tubes
was swollen and resembled the appearance of an early ectopic pregnancy. The mechanism that produces PATSS is thought to result from functioning endometrial tissue remaining in the uterine cornua producing menstrual bleeding whose outflow is constrained by the proximal portion of the fallopian tube. The actual incidence of PATSS appears to be quite low. Although El-Nashar et al [37] were able to show that a history of bilateral tubal ligation appeared to be a risk factor for LOEAF, they were unable to show a single case of PATSS in a group of 816 women who underwent GEA. In other larger studies of hysterectomy subsequent to EA failure, neither Shavell et al [19] nor Longinotti et al [2] reported a single case of PATSS of 931 hysterectomies performed on 4850 women undergoing REA or NREA procedures.

Risk Factors for LOEAF

Numerous risk factors of EA failure have been reported including the patient’s age at the time of EA, previous tubal ligation, the presence of uterine leiomyomas and polyps, anatomic distortions of the uterus, and whether or not the procedure was performed in an outpatient or office setting. Other risk factors such as pelvic endometriosis, previous cesarean section, and obesity are briefly considered.

Age

Longinotti et al [2] reported that women younger than 35 years at the time of their EA had a significantly greater risk for hysterectomy (HR = 3.2; 95% CI, 2.4–4.2) compared with women aged 50 or older. Dutton et al [38] also showed that women younger than 35 years of age had a markedly increased risk for hysterectomy (HR = 0.28; 95% CI, 0.10–0.75) compared with women who were at least 45 years of age at the time of their EA. Shavell et al [19] reported the rate of hysterectomy in the youngest quartile of women (age 21–36 years) was 20.8% compared with 10.5% for women in the oldest quartile (≥47 years of age) at the time of their EA.

Tubal Ligation

El-Nashar et al [37] reported a hysterectomy HR of 2.5 (95% CI, 1.4–4.5) for women with a prior tubal ligation procedure. Istre and Langebrekke [39] noted that women who underwent a prior sterilization procedure were significantly more likely to require reoperative hysteroscopic surgery than women with no such antecedent history. However, other authors such as Shavell et al [19], Longinotti et al [2], Comino and Torrejon [40], and Kreider et al [41] were unable to show such an association.

Leiomyomas and Endometrial Polyps

Various authors have shown that leiomyomas may increase, decrease, or not influence the incidence of immediate LOEAF. Longinotti et al [2], in their study of 3681 women (the largest retrospective analysis of EA failure), noted that the presence of leiomyomas did not appear to influence the risk of subsequent EA failure. This was also the conclusion drawn by Glasser and Zimmerman [42] in a study of 22 women followed for 12 to 20 months with leiomyomas <4 cm. By contrast, Comino and Torrejon [40] reported the presence of leiomyomas and endometrial polyps (found in half of their subjects) significantly increased the risk for hysterectomy subsequent to EA. The association between the presence of submucous leiomyomas and EA failure was also shown by Geimer et al [32], who concluded that their presence had a statistically significant positive predictive value of the risk of failure (HR = 5.22; 95% CI, 1.63–16.73). By contrast, Phillips et al [43] in a large observational cohort study of 1000 consecutive endometrial laser ablations found that the presence of intrauterine pathology such as myomas or polyps actually decreased the risk of subsequent hysterectomy.

Anatomic Distortions of the Uterus

One of the authors (MW) [23] reported that in 12% of LOEAFs after a GEA procedure patients were noted to have a uterine septum, which was always accompanied by active endometrial tissue at the cornua.

Analgesia and Anesthesia

Longinotti et al [2] found that the probability of hysterectomy at 4 years after hydrothermal EA was 21.9% if performed in a setting where deep anesthesia was offered compared with 5.9% when it was offered in a setting where it was unavailable. Longinotti et al speculate that “it is possible that less thorough procedures are performed in the outpatient setting [deep anesthesia unavailable] for hydrothermal procedures due to issues related to pain control.”

Endometriosis

There are surprisingly little data on the association between endometriosis and subsequent LOEAF. One might assume that endometriosis would be a common finding at the time of hysterectomy, particularly in women who experience CPP after EA. Longinotti et al [2] identified endometriosis in 51 (7%) of 774 EA failures who underwent subsequent hysterectomy. Unfortunately, Longinotti et al provide little information regarding the staging and relationship of endometriosis to the subsequent requirement for hysterectomy. In fact, most reports of hysterectomy subsequent to EA failure rarely mention endometriosis as an intraoperative finding [19,29,34].

Dysmenorrhea

Peters et al [44] and El-Nashar et al [37] have shown that a history of severe dysmenorrhea is an important predictor of EA failure.
Other Risk Factors: Previous Cesarean Section and Obesity

Peters et al [44] and Khan et al [45] were unable to show a relationship between a previous cesarean section and EA failure. Similarly, Madsen et al [46] were unable to show a relationship between obesity and EA failure.

Treatment Options of EA Failure

There are several minimally invasive approaches for the treatment of LOEAF. In general, strategies include simple observation, medical management, minimally invasive surgery, and hysterectomy.

Observation

Women with a prior history of EA may develop new-onset premenopausal vaginal bleeding. Cyclic bleeding, which is neither excessive nor associated with significant dysmenorrhea, can be safely observed. A baseline ultrasound examination should be performed because it may disclose functioning endometrial tissue, leiomyomas, and polyps [47].

Medical Management

A complete discussion of the medical management of LOEAF is beyond the scope of this article. If one can exclude the presence of significant endometrial or myometrial pathology, medical management may be considered in the absence of any contraindication. Unfortunately, women who have undergone EA have often shown a past poor response to medical management or find its side effects unacceptable. Occasionally, gonadotropin-releasing hormone agonists are useful for the temporary relief of pain secondary to obstructed bleeding. However, definitive management generally requires surgical intervention.

Minimally Invasive Surgical Management of EA Failure: Reoperative Hysteroscopic Surgery

Before the popularization of GEA devices and methods, many authors reported the use of RHS. In 1992, Gimpelson and Kaigh [48] reported a series of 16 women who underwent repeat hysteroscopic EA procedures with either an Nd:YAG laser or an electrosurgical ball. Hysterectomy was avoided in all patients during a relatively limited period of observation. Garry et al [49] reported 1 of the largest series on RHS after hysteroscopic laser EA. Of the 524 women who underwent a laser EA, 75 underwent a single RHS, whereas 1 patient underwent a second RHS for a total reoperation rate of 14.3%. Overall, Garry et al were able to avoid hysterectomy in all but 34 women (6.8%) during a mean follow-up of 15 months (range 6–42 months). Istre and Langebrekke [39] noted that of 668 women who underwent transcervical resection of the endometrium or transcervical resection of a myoma, 118 (17%) required a repeat resection. Of the 118 women undergoing RHS, Istre and Langebrekke successfully avoided hysterectomy in 72%. The authors did not use ultrasound guidance and reported no complications. Recently, Hansen et al [50] reviewed the results of RHS in 65 women who presented with late-onset complications of transcervical resection of the endometrium and provided some of the longest follow-up available on RHS with a median of 56 months (range 40–110 months). In all, 57% were able to avoid hysterectomy although several subjects required 2 retreatments. Operative complications occurred in 9% and included excessive fluid absorption and uterine perforation.

In 2001, 1 of the authors (MW) [21] reported a series of 26 women who developed a LOEAF after resectoscopic EA and subsequently underwent ultrasound-guided RHS. Hysterectomy was avoided in 88.5% during a mean follow-up of 23.2 months. In 2014, the same author (MW) [23] reported a series of 50 women who developed LOEAF after a variety of GEA procedures and were subsequently treated with ultrasound-guided RHS. The mean duration of follow-up was 18.1 months (95% CI, 13.8–22.4) with hysterectomy successfully avoided in 88.9% of subjects. Of the 76 subjects in the 2 studies, none experienced complications.

The advantages of ultrasound-guided RHS are numerous. First, it is minimally invasive and obviates the need for hysterectomy in the majority of properly selected candidates. Second, it allows for near complete exploration of the uterus including central and cornual hematomata. Third, ultrasound-guided RHS produced a histologic specimen, which is especially important in the evaluation and management of perimenopausal and postmenopausal women in whom an endometrial biopsy may be either unsuccessful or unreliable. Lastly, in experienced hands, the procedure is safe and was not associated with immediate postoperative complications.

Hysterectomy

Hysterectomy is often the only available surgical option for managing LOEAF. Most communities have not developed the expertise necessary for RHS. Even when RHS is available, other factors often determine the best course of management for LOEAF.

Choosing between Hysterectomy and RHS

Although there are no well-studied guidelines for discerning whether patients would be best served with RHS or hysterectomy, a number of factors seem to be evident.

Age of the Patient

Just as the patient’s age at the time of her primary EA has been determined to be an important predictor of success, it is very likely an important factor when considering whether or not she should be offered RHS. In general, women who are at least 45 years old when they present for RHS are likely to
expect better results than women younger than 40 years of age.

**Duration of Improvement: The Latent Period**

The relationship of the latent period to successful outcomes after RHS is unknown. One of the authors (MW) has observed that latent periods after GEA and NREA may vary from 2 months to 15 years. Women with longer latent periods (i.e., greater than 2 years) have already shown a good response to EA and often benefit from the removal of small areas of endometrium sequestered behind dense synechiae. By contrast, women with short latent periods are often found to have unusually large uterine cavities, untreated submucous leiomyomas, or unrecognized uterine anomalies [23], which preclude adequate EA. One of the authors (MW), in a study of 50 subjects with LOEAF after GEA [23], observed that 10% of subjects had nearly normal-appearing uterine cavities at the time of RHS, whereas another 28% had only minimal fibrosis in a cavity with abundant endometrium. These women experienced little or no improvement after GEA, suggesting that the procedure may have failed because of a device malfunction or an inability of the device to provide proper thermal destruction to the entire endometrial cavity.

**Leiomyomas**

Leiomyomas are found in nearly a quarter of GEA failures [23]. Carefully selected patients frequently benefit from hysteroscopic myomectomy as part of their RHS.

**Availability of Service**

RHS is not commonly performed by most gynecologists. However, experienced hysteroscopists can easily manage women with untreated grade 0 and 1 leiomyomas that are <3 cm. If the period of time between the primary EA and the onset of symptoms is <6 months, there are generally only a limited number of synechiae [36], and RHS is often no more complex than a primary resectoscopic EA.

**Requirement for Ultrasound Guidance**

An experienced sonographer offers the surgeon great reassurance in the presence of severe adhesions as well as cornual and central hematomata. Even when hematomata cannot be sonographically demonstrated, their presence should be strongly suspected in women with CPP with or without menstrual bleeding. Nonetheless, numerous authors [39,48–50] have reported successful rates of hysterectomy avoidance without sonographic guidance.

**Patient Motivation**

Women who require surgical management are often predisposed toward whether or not they wish to undergo a uterus-sparing procedure. A failed EA procedure, particu-

larly one that has produced little relief of the patient’s symptoms, often leaves a woman with little enthusiasm for anything but a definitive approach toward managing her symptoms. By contrast, women who have enjoyed several years of symptom relief after EA are often highly motivated toward RHS.

**Other Factors**

Numerous other factors may dissuade physicians from considering hysterectomy. These issues include a history of multiple previous abdominal surgeries; the presence of morbid obesity; and other comorbid conditions such as diabetes or the presence of cardiovascular, pulmonary, hepatic and renal disease.

**Prevention of LOEAF**

Patient selection at the time of primary EA is critical in reducing the subsequent rate of LOEAF. Age may be the single most objective predictor of outcomes after primary EA with the risk of LOEAF inversely related to the subject’s age [2,19,37]. Another important consideration in choosing proper candidates is the presence of uterine pathology (i.e., submucous and intramural leiomyomas as well as endometrial polyps) [23,32,33]. There are insufficient prospective data to determine whether smaller submucous leiomyomas can be adequately managed with some GEA devices alone. The authors strongly suggest that submucous leiomyomas and endometrial polyps be removed in their entirety immediately before EA.

The presence of a uterine septum or a “T-shaped” uterus should be noted before performing any GEA procedure. The efficacy of the most commonly used GEA devices—radiofrequency and thermal balloon ablation devices—has not been prospectively studied in uteri with even mild to moderate anatomic variants. These anatomic variants may be better treated with REA.

The literature does not address the impact of a patient’s motivation to avoid hysterectomy or to select EA as a predictor of EA success or failure. However, the authors feel that patient motivation is an important selection criterion for EA. Properly informed women who are unwilling to accept the possibilities of LOEAF, absent a strong medical or surgical contraindication, may be better served with hysterectomy.

Proper device selection has not been well studied in the literature. GEA devices that have a fixed configuration such as the NovaSure mandate preapplication testing to determine whether the longitudinal and transverse dimensions of the uterus are sufficient to accommodate the device. However, no specific contraindication exists to their use in the presence of a uterus with an extended transverse diameter to ensure an adequate bioeffect at the cornua. Physicians should be aware of this fact when selecting a method or device to accomplish EA.
Partial endometrial ablation (PEA) was developed as a method to reduce the incidence of obstructed bleeding after EA. A PEA involves ablation or removal of only the anterior or posterior wall so that an injured exposed myometrial surface is opposed by a healthy endometrial surface in order to reduce or eliminate adhesions and contracture of the uterus. During PEA, the cornual areas are left untreated. In 1999, 1 of the authors (AM) [51] published a prospective study of 50 consecutive subjects treated with a rollerball PEA. After a minimum follow-up of 3 years, 76% of subjects were satisfied, 10% were partially satisfied, and 14% were unsatisfied with the results. Thirty-eight (76%) of the subjects agreed to undergo diagnostic hysteroscopy, and none were found to have intrauterine adhesions, contractures, or hematometra. Although hysterectomy was eventually required in 5 subjects, all were found to have diffuse adenomyosis with penetration greater than 2.5 mm. There were no cases of CPP caused by obstructed bleeding.

Another PEA technique was described by Litta et al [52]; they resected the endomyometrium to a depth of 4 to 5 mm throughout the uterine cavity but spared the uterine fundus and cornua. Seventy-three women were available for longitudinal analysis and underwent hysteroscopies at 3, 12, 24, and 60 months. The rates of eumenorrhea, hypomenorrhea, and amenorrhea were 68.5%, 5.5%, and 13.7%, respectively. Persistent menorrhagia occurred in 9.6%, and another 2.7% reported recurrent AUB. Importantly, all of these patients were able to undergo hysteroscopic assessment of the uterine cavity, including the cornual areas and the tubal ostia. None of the subjects reported CPP symptoms related to obstruction. The authors also note that because their modification avoids resection in the thinnest portions of the uterus (i.e., the fundus and tubal ostia) they were able to successfully avoid uterine perforation in all cases.

Summary and Conclusions

Since the introduction of NREA devices and techniques between 1997 and 2003, EA has become the most commonly performed surgical procedure in the United States for the management of AUB [15]. Only recently have we begun appreciating the frequency with which hysterectomy is used to manage LOEAFs [1,2]. The actual incidence of patient dissatisfaction that can be attributed to LOEAF is likely greater because many subjects may choose to accept suboptimal results rather than undergo hysterectomy. Strategies to reduce hysterectomy after LOEAF require a multipronged approach including optimizing patient and device selection for primary EA, the adoption of RHS, and the search for new EA techniques and devices.

Proper patient selection for EA requires a thorough discussion of the risk of LOEAF and how its incidence may be affected by individualized risk factors such as age [2] and submucous leiomyomas [4,23,32]. Physicians should be attuned toward a woman’s motivation to undergo EA and to avoid hysterectomy. Subjects who are unwilling to accept the possibility of LOEAFs should be encouraged to seek other forms of therapy for AUB. Along with patient selection, physicians must sort through a variety of EA devices and methods in order to determine what device or method is best suited for women with a variety of anatomic variants. Women with symmetrically enlarged uterine cavities may not be well served with fixed geometry devices.

RHS, although proven to reduce the need for hysterectomy in women with LOEAF [21,23,39,48,49], is presently not an available option in most communities. However, experienced hysteroscopists should strongly consider adding RHS to their surgical armamentarium, especially if an experienced sonographer is available. In adopting new techniques, such as RHS, it is always best to begin with less complex subjects—those with a relatively short latent period and who have an average size uterus.

The future for new techniques and devices to accomplish EA requires a dual focus—one on producing more reliable endometrial destruction and the other on addressing the issue of obstructed uterine bleeding. One of the authors (MW) observed that 10% of women presenting for RHS seemed to have little or no thermal injury after a GEA procedure, whereas 44% of subjects had untreated cornua [23]. These findings strongly suggest that unevenness of the bioeffect produced by currently available GEA devices requires further examination.

The technique of PEA [51] deserves greater study in the form of randomized prospective clinical trials. Although PEA may not produce the dramatic reduction in menstrual bleeding that occurs with EA, it appears to avoid CPP, which is a leading cause of hysterectomy because of LOEAFs. At least 2 presently used GEA devices, bipolar radiofrequency ablation and thermal balloon ablation, could be modified to perform such a procedure.

References

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