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Energy Based Device Applications in Female Urology*

Learning Objective: At the conclusion of this continuing medical education activity, the participant will be able to describe the various energy based devices that are currently available along with potential applications to female urological conditions.

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***This AUA Update addresses the Core Curriculum topics of Urinary Incontinence and Overactive Bladder and Surgical Energy, and the American Board of Urology Module on Neurogenic Bladder, Voiding Dysfunction, Female Urology, BPH and Urethral Stricture.**

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INTRODUCTION

Energy based devices have been employed across a broad range of specialties including gynecology, urology, plastic surgery and dermatology. CO_2 laser was utilized to treat erosions of the uterine cervix in 1973.[1] A few years later, the use of an argon beam laser was described in the urological literature.[2] In the intervening decades the technology has advanced such that lasers are used to treat benign prostatic hyperplasia, urolithiasis, urinary stricture and bladder tumors.[3] More recently, energy based devices have been employed in the treatment of genitourinary syndrome of menopause, stress urinary incontinence and overactive bladder. This Update will review and analyze the literature that is currently available.

OVERVIEW

The 2 main EBDs with applications in female urology include laser and radiofrequency.

Laser. Laser is an acronym for "light amplification by stimulated emission of radiation." When an energy source usually in the form of light or electricity is applied to a laser medium (type), a beam of photons with identical wavelengths are generated, which are then amplified and ultimately delivered to the target tissue.[4] Laser mediums operate at various portions of the electromagnetic spectrum including ultraviolet (157–400 nm), visible (400–800 nm), near-infrared (800–3,000 nm), mid-infrared (3,000–30,000 nm) and far-infrared (>30,000 nm).[5]

Selection of an appropriate laser medium depends on the absorption characteristics of the target tissue, the wavelength of emitted radiation, and the time and pattern of energy application. The ideal laser is able to maximize absorption on target chromophores while minimizing impact on surrounding tissue. A chromophore is a molecule that is able to absorb the laser energy and convert it into heat. Sample chromophores might include water, melanin or hemoglobin. The wavelength of the energy has direct bearing on the absorption length of the tissue. A short absorption length laser will yield a maximal zone of photo vaporization (crater), with a minimal zone of photocoagulation (provides hemostasis without concomitant tissue injury) and minimal lateral heat conduction. A longer absorption length laser offers a more inefficient vaporization with a wider zone of photocoagulation and a bigger thermal spread. The time and frequency (pulse) at which the laser is applied to a target area also has implications on therapeutic efficacy and the degree of lateral kinetic energy diffusion, which is termed "thermal relaxation."[6] Lasers can also be characterized as ablative or nonablative. Ablative devices rapidly heat and vaporize the top layer of tissue, whereas the nonablative therapies heat the underlying tissue, with minimal injury to the surface. Fractionated lasers divide the laser source into multiple small beams of energy allowing for intermittent treatment across a target area.

CO_2 lasers function at a wavelength of 10,600 nm, whereas Er:YAG emits at 2,940 nm. Er:YAG is associated with less postoperative discomfort with faster healing times, but the CO_2 laser treatment is bloodless.[7] There is also a hybrid laser, which operates at 2,940 and 1,470 nm. **Each laser type has been applied for similar indications, and there is little evidence directly comparing modalities.**

Radiofrequency. Pioneered in the 1920s for electrocoagulation, with subsequent applications for incompetent veins and joints and also prostate cancer, radiofrequency involves the transmission of electric currents from 3 kHz to 300 MHz. The energy from these currents are passed to the applied tissue where ions collide creating resistance which transforms into heat. At a target temperature of 40C to 45C, collagen production is stimulated by fibroblasts.[8] In monopolar RF a grounding pad is placed on the subject while the handpiece delivers treatment to the target area. This may be coupled with the use of cryogen cooling. In contrast, in unipolar RF the treatment handpiece constitutes the single electrode applied to the patient.

Treatment procedure. For the devices currently in use, there are a variable number of "passes" with the energy source and number of suggested treatments. For example, with a CO_2 laser the energy based wand may be used to make one pass through the vagina, treating the entire area. Patients will then return for subsequent treatment approximately 4 weeks later. For the hybrid laser, each treatment may entail one or two passes with a similar re-treatment interval (fig. 1). Most laser providers offer 3 initial treatments with a single re-treatment in 8 to 12 months or when the desired effect has abated; however, this will vary based on the device and provider. In contrast, radiofrequency devices involve a series of passes with the energy wand through the vaginal canal to uniformly raise the temperature of the epithelium without overheating or burning any one area. Additionally, there is some variability between the amount of energy or treatment time within each device

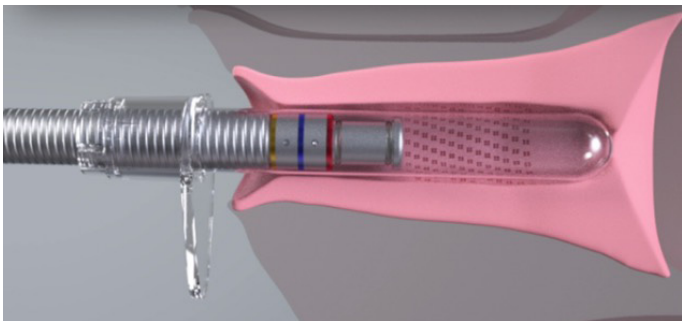

Figure 1. Schematic of hybrid laser (2,940 + 1,470 nm) treatment. Disposable strengthened quartz dilator is placed into vagina. Laser is then inserted into dilator and treatment is initiated. Thermal energy is applied across length of vagina via automated pullback in 360-degree fashion. Dark squares depict intermittent uniform treatment application. Reprinted with permission from Sciton Systems.

ABBREVIATIONS: EBD (energy based therapy), Er (erbium), FSFI (Female Sexual Function Index), GSM (genitourinary syndrome of menopause), ICIQ (International Consultation on Incontinence Questionnaire), OAB (overactive bladder), RF (radiofrequency), SUI (stress urinary incontinence), VHI (Vaginal Health Index)

or provider protocol. **It should be noted that while there are general guidelines offered by the manufacturers, this standard is not predicated upon strong evidence based data. In assessing the peer-reviewed literature, these treatment parameters should be noted as substantial variability exists within devices (see table).**

Pre-treatment criteria. At this time there are no evidenc based guidelines suggesting definitive pretreatment exclusion criteria. The American Urogynecologic Society released a consensus statement based on expert opinion recommending that prior to EBD therapy it would be prudent to exclude patients with a history of pelvic malignancy, active vaginal infection or concerning vaginal lesions from treatment. **It is also recommended that patients undergoing EBD therapy should have had a gynecologic examination within 1 year of treatment.**[9] Prior studies have performed a vaginal swab and Pap smear prior to initiating treatment.[10] There is also very little information published about patients with a history of vaginal mesh or midurethral sling mesh who subsequently undergo EBD treatment.

GENITOURINARY SYNDROME OF MENOPAUSE

Pathophysiology. As women age and enter menopause, physiological changes occur that can lead to bothersome symptoms such as vaginal dryness, dyspareunia, itching and irritation. Declining levels of estrogen lead to in a decrease of collagen and elastin in the vaginal epithelium, which consequently results in decreased rugae, narrowing of the vagina and a thin, pale epithelial layer.[11] This constellation of symptoms had previously been variably described individually or characterized as "vulvovaginal atrophy." In 2012 the International Society for the Study of Women's Sexual Health and the Board of Trustees for the North American Menopause Society convened and replaced "vulvovaginal atrophy" with the term genitourinary syndrome of menopause" (GSM). In addition to the aforementioned signs and symptoms, supportive findings include a pH >5, increased parabasal and decreased superficial cells on Vaginal Maturation Index.[12] These changes coupled with epithelial thinning lead to a shift in the vaginal flora including a decrease in lactobacilli and theoretically may increase the risk of urinary tract infections.

Treatment for women with GSM is varied and tailored based on symptom severity. **The North American Menopause Society has recommended moisturizers and lubricants as first line therapy for symptoms of vaginal atrophy with low dose vaginal estrogen for women who have persistent symptoms.**[13] Vaginal estrogen has been shown to be superior to systemic estrogen for relief of symptoms.[14] The application of vaginal estrogen increases the Vaginal Maturation Index score, lowers vaginal pH, improves epithelial integrity and tissue vascularity and restores the bacterial flora.[15] Localized preparations of estrogen include creams, tablets, ovules and rings, which have all been shown to have equivalent therapeutic efficacy. Other researched treatment options for GSM include Tibolone, a synthetic steroid with estrogenic effects on the vagina; ospemifene, a selective estrogen receptor modulator; and vaginal dehydroepiandrosterone.[15] EBDs have recently been explored as an alternate option for women who have a contraindication to or otherwise decline vaginal estrogen. **Lasers have been shown to improve vascularity, glycogen storage and collagen production, in addition to increasing the thickness of the vaginal squamous epithelium (fig. 2).**[16]

CO_2 laser. Cruz et al reported on a randomized, double-blind, placebo controlled study comparing fractional CO_2 vaginal laser with either local estrogen or laser + local estrogen.[17] Forty-five

Table. A sample of energy based devices and potential treatment parameters

Device	Company	Energy Type	Treatment Number	Treatment Time/ Passes	Intervals
Mona Lisa Touch	Cynosure, Westford, MA	CO_2 - 10,600 nm	2–3	1	4–6 wks
Intimalase, Incontilase, Renovalase, G-Runner	Fotona, San Clemente, CA	Er:YAG - 2,940 nm	3	3 stages, multiple passes	4 wks
DiVa	Sciton Systems, Palo Alto, CA	Hybrid - 2,940 + 1,470 nm	3	1-2 passes	4 wks
ThermiVA	ThermiAesthetics, Southlake, TX	Unipolar RF - 460 kHz	3	30 min	4–6 wks
Viveve	Viveve Medical, Sunnyvale, CA	Monopolar RF cryogen cooled	1	30–45 min	n/a
Silensa System	Amphora Medical, Minneapolis, MN	RF applied to trigone	1	60 seconds	n/a

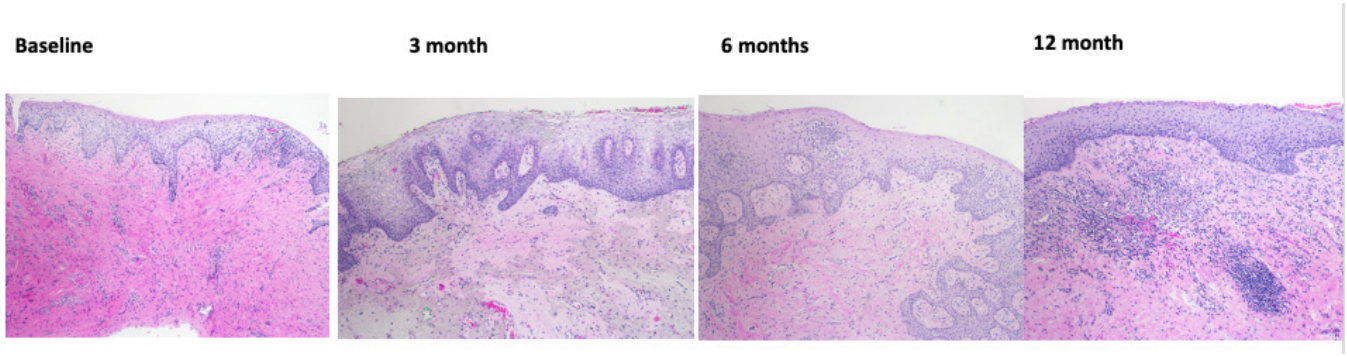

Figure 2. Slides of vaginal epithelium at baseline, 3 months, 6 months and 12 months after treatment with hybrid laser (2,940 + 1,470 nm) show increased epithelial thickness. H&E, reduced from ×4. Reprinted with permission from Sciton Systems.

subjects were enrolled, and outcome measures included the Vaginal Health Index, a visual analogue scale for vulvovaginal atrophy, FSFI and the maturation value of Meisels taken at baseline and at 8 and 20 weeks into treatment. Those allocated to the laser arm underwent 2 treatments at 0 and 4 weeks with CO_2 vaginal laser (SmartXide^2 system, MonaLisa Touch®) with a vaginal estrogen placebo.[18] The local estrogen arm received 1 mg vaginal estriol 3 times per week for 20 weeks with 2 sham laser treatments at 0 and 4 weeks. The group receiving vaginal estrogen and laser received both active treatments as listed above. No adverse events were noted during any of the laser treatments. All 3 groups had statistically significant improvement in their VHI scores. The laser and laser plus estriol groups reported significant improvement in dyspareunia, burning and dryness, whereas the estrogen group only reported improvement in dryness. The laser plus estriol group had a significant improvement in FSFI scores; however, the laser group had a significant worsening in the pain domain of the FSFI (p=0.04). In comparing CO_2 laser, laser + vaginal estrogen or estrogen alone, this study was not designed to determine superiority.

In a prospective observational trial Pitsouni et al enrolled 53 women with GSM and treated them with CO_2 vaginal laser (SmartXide2 V2LR, MonaLisa Touch) for 3 treatments 4 weeks apart and then evaluated them 1 month after the last procedure.[19] Primary outcomes included the Vaginal Maturation Index and VHI, which both increased significantly, suggesting improvement in the physiological parameters associated with GSM. On the Patient Global Impression of Improvement, the majority of subjects stated that they felt "much better" or "very much better." Secondary outcomes, which focused on lower urinary tract symptoms, were assessed via ICIQ-Female Urinary Tract Symptoms, ICIQ-Urinary Incontinence Short Form, Urogenital Distress Inventory 6 and the King's Health Questionnaire, and all decreased significantly.[19]

Sokol and Karram treated 30 women with GSM with 3 CO_2 vaginal laser (SmartXide^2 V^{2}LR) treatments 6 weeks apart and then assessed vaginal pain, burning, itching, dryness, dyspareunia and dysuria via a visual analogue scale, noting statistically significant improvement at 3 and 12 months for all categories except dysuria.[20] VHI and FSFI were also statistically improved, and elasticity, as measured by dilator examination, was either stable or improved in 94.8% of subjects.

Er:YAG laser. In a parallel cohort study of 50 subjects with GSM, Gaspar et al treated one group with either estriol ovules for 8 weeks or estriol ovules for 2 weeks followed by 3 treatments with 2,940 nm Er:YAG laser (XS Dynamis, Fotona) in nonablative mode.[21] The authors' rationale for pretreatment with vaginal estrogen is that, because the erbium laser has a very high absorption in water, this would maximize EBD efficacy. At 6-month follow-up both groups reported a statistically significant reduction in symptoms; however, the effect of the laser group remained statistically significant at 12 and 18 months and abated for the estriol group (who were only treated with estrogen for 8 weeks). **Biopsy with histological analysis was also performed in 6 patients at baseline and through 6 months following Er:YAG laser treatment, which showed an increase in epithelial thickness, angiogenesis and a change in the architecture of the extracellular matrix.** Side effects were mild for both groups, with 4% of those treated with laser reporting a sensation of warmth or mild to moderate pain; however, no anesthetic was used for treatments.

Gambacciani et al assessed postmenopausal women with GSM by treating them with either Er:YAG laser (FotonaSmooth XS) or vaginal estrogen (45 vs 25 patients).[22] The laser group underwent 3 treatments one month apart to both the vaginal canal and the introitus/vestibule. The vaginal estrogen group was treated with 1 gm gel containing 50 μg estriol twice weekly for 3 months. On evaluation of GSM symptoms with a visual analogue scale, there was a statistically significant decrease in dyspareunia and vaginal dryness ($p < 0.01$) at 24 weeks post-treatment in the laser group, and these values were both significantly different ($p < 0.05$) than corresponding responses from the estriol group. The VHI increased significantly in both treatment arms, with a positive effect noted at 24-week follow-up in the laser group.

The use of Er:YAG laser (FotonaSmooth XS) has also been described in 43 women with a history of breast cancer with symptoms of GSM.[23] The laser protocol was the same as described above.[22] Subjects reported improvement in dyspareunia and dryness on visual analogue scales and had improved VHI that was statistically significant from baseline up through 12 months of follow-up. At the 18-month assessment each of these metrics was improved from baseline; however, they were no longer statistically significant. Notably there were no adverse events that were reported within this cohort. **This study shows preliminary evidence that EBDs could be a plausible option in women who are seeking an alternative or have a contraindication or aversion to vaginal estrogen therapy; however, more evidence is needed.**

A systematic review sought to assess efficacy of laser based

(CO_2 and Er:YAG) treatments for GSM.[24] Of the 14 included studies containing 542 participants it was noted that all GSM symptoms (dryness, dyspareunia, itching, burning, urgency and frequency) decreased significantly in all publications. Although the follow-up period ranged from 1 to 18 months, the majority of the included studies had a mean follow-up time of 1 to 3 months.

Radiofrequency. Much of the literature on female pelvic applications of radiofrequency focuses on treatment of vaginal or vulvar laxity; however, there are a few studies that include assessment of improvement in GSM. Thirteen postmenopausal women with symptoms of GSM were treated with dynamic quadripolar radiofrequency for four 10-minute sessions 10 days apart. Over the 2-month follow-up improvements in GSM as measured by a visual analogue scale were noted along with overall patient satisfaction.[25]

While both laser and radiofrequency have been used to treat GSM, the preponderance of literature focuses on the former. **There are no data that currently evaluate the impact of EBDs on patients with a history of recurrent urinary tract infections; however, based on the current literature showing improvement in GSM and the health of the vaginal epithelium, this topic should be explored in the future.**

STRESS URINARY INCONTINENCE

Female SUI is defined by the International Continence Society as "the complaint of involuntary loss of urine on effort or physical exertion (eg sporting activities) or on sneezing or coughing."[26] First line treatments include the use of pelvic floor exercises/physical therapy. If symptoms persist, patients can proceed with an incontinence pessary or consider surgical options such as the mid-urethral sling or periurethral bulking. Intraurethral and vaginal EBDs have been investigated as alternative therapies. **Currently the midurethral sling is the gold standard for the treatment of SUI, and to date there have been no randomized controlled trials comparing mid urethral slings with EBDs.**

CO_2 laser. In a prospective open label cohort 33 women with urodynamically proven SUI underwent a series of 3 CO_2 treatments and were evaluated by sanitary pad usage, Urogenital Distress Inventory and International Consultation on Incontinence Questionnaires at 1, 3 and 6 months. Although improvement was noted initially at 1 to 3 months, pad usage and questionnaire scores returned to baseline by 6 months.[27]

Er:YAG laser. Okui performed a nonrandomized study of 150 patients with SUI or mixed incontinence stress predominantly treated with either a tension-free vaginal tape, transobturator tape or Er:YAG laser therapy every other month.[28] Outcomes were then compared at baseline and 1 year post-treatment. All groups had similar statistically significant improvements in 1-hour pad tests and Incontinence Questionnaire-Short Form questionnaires.

Blaganje et al performed a randomized single-blinded trial in which 114 women were randomized to either a single session of nonablative Er:YAG laser (XS Dynamis) or sham EBD procedure.[29] In this study subjects were anesthetized with lidocaine spray prior to treatment with mean duration of the procedure lasting 20 minutes; 80% of the interventional cohort reporting overall tolerability of the procedure as "good or better than good." Increased vaginal discharge was noted in 49 of 56 of the interventional group lasting up to 3 weeks, and 2 subjects reported transient urinary urgency. At 3-month follow-up the ICIQ-Urinary Incontinence Short Form ($p < 0.001$), Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire 12 ($p=0.014$) and FSFI ($p=0.025$) were all significantly improved relative to the sham cohort.

In the trial by Gambacciani et al comparing Er:YAG with estriol described above, they also included an additional cohort of 19 subjects with SUI who received the baseline 3 laser treatments as described above in addition to an additional pass along the anterior vaginal wall with the IncontiLase® phase 1 procedure.[22] Treatment efficacy was assessed with ICIQ-Urinary Incontinence Short Form with statistically significant improvement up through 24 weeks of follow-up.

In a retrospective study of 41 patients, Lin et al sought to assess improvement in SUI after 3 treatments at 4-week intervals with the Fotona Er:YAG laser.[30] Subjects were treated per manufacturer guidelines in 3 separate phases: 1) entire vaginal canal, 2) anterior vaginal wall, 3) vestibule. Outcome metrics included Incontinence Questionnaire-Short Form, Urogenital Distress Inventory 6, Incontinence Impact Questionnaire 7, Overactive Bladder Symptom Score and the Pelvic Organ Prolapse Distress Inventory 6. At 6 months post-treatment there was statistically significant improvement across all questionnaires. Thirty-six percent of women were reported as cured of SUI; however, 24.4% reported no improvement or worsening of symptoms. Perineal ultrasound performed at baseline and 6 months showed a decrease in bladder neck mobility (mean±SD 16.1±6.4 mm to 10.5±4.6 mm, $p=0.039$). On perineometry (assessment of vaginal pelvic floor contraction) there was no difference after treatment.

Radiofrequency. The application of transurethral RF collagen denaturation for the treatment of SUI was analyzed in a Cochrane review where they found no evidence to suggest that it offers any significant benefit.[31] This review only included 1 study that enrolled 173 subjects to either intervention or control in a 2:1 fashion.[32] Included patients had evidence of SUI, with bladder neck hypermobility and leak point pressure ≥ 60 cm H_2O. There were no serious adverse events recorded over the follow-up period of 12 months. On evaluation with the Incontinence Quality of Life Questionnaire, 48% of treatment and 44% of sham subjects demonstrated ≥10-point improvement ($p=0.7$).

OVERACTIVE BLADDER

OAB is defined by the ICS as "urgency, with or without urge incontinence, usually with frequency and nocturia."[33] The spectrum of presentation is variable; however, it may have substantial implications on quality of life and sexual function and affects 16.9% of women.[34] First line therapy includes behavioral modifications, followed by medical management with anticholinergic or a beta-3 agonist, with third line therapies including either chemodenervation with botulinum toxin, sacroneuromodulation or percutaneous tibial nerve stimulation. While the majority of the literature available on EBDs focuses on GSM and SUI, some studies have noted improvement in symptoms of OAB.

CO_2 laser. One small study of 30 postmenopausal patients with symptoms of vulvovaginal atrophy and OAB underwent 3 vaginal treatments 30 days apart with fractional CO_2 laser system (SmartXide^2 V^{2}LR) and were found to have an improvement in the number of urge episodes and symptoms

based on the Overactive Bladder Questionnaire Short Form ($p < 0.0001$). Urge episodes were assessed by a micturition diary that was completed 3 days prior to the 1-month follow-up. Nine of 30 patients (30%) who had incontinence episodes pretreatment reported an improvement. There was also a statistically significant improvement in vulvovaginal atrophy symptoms as measured by the VHI.[10] The proposed mechanism of action for improvement in OAB symptoms in this study is the reactivation of the extracellular matrix and collagen synthesis in the urethra and bladder; however, future research is needed to substantiate this statement.

Er:YAG laser. A comparative study of Er:YAG laser versus either anticholinergic or beta-3 agonist therapy was performed in 150 post-menopausal women with OAB.[35] They were assigned to each index therapy in sequential order of presentation to clinic. Those in the Er:YAG group underwent 3 treatments 4 weeks apart with the FotonaSmooth XS. The anticholinergic and beta-3 agonist cohorts were treated with 4 mg fesoterodine and 25 mg mirabegron, respectively. Efficacy was determined with the Overactive Bladder Symptom Score questionnaire and VHI. At 12-month follow-up all 3 groups showed statistically significant improvement on the Overactive Bladder Symptom Score ($p < 0.001$) and, as expected, improvement on the VHI was only noted in the Er:YAG cohort. There were no adverse events noted within the laser treatment cohort. This author postulates that the mechanism of action for improvement of OAB symptoms may stem from the potential increase in blood flow to the tissues surrounding and near the bladder; however, limited supportive evidence is presented.

Er:YAG therapy was utilized in 30 women with urodynamic stress incontinence and overactive bladder to investigate the effect on 2 treatments (XS Dynamis) 1 week apart on incontinence parameters and sexual function.[36] OAB symptoms as measured by the Overactive Bladder Symptom Score were significantly improved at 3 months ($p=0.027$), particularly when assessing urinary frequency (question 1, $p=0.001$), but efficacy had diminished by 12-month follow-up. Similarly, significant improvement was seen on the Incontinence Questionnaire-Short Form and Urogenital Distress Inventory at 3 months but not at 12-month follow-up. Mean±SD objective assessment via 1-hour pad tests at baseline and 3 months showed improvement from 13.2±17.7 gm to 6.1±11.6 gm ($p=0.039$).

Radiofrequency. Selective bladder denervation with radiofrequency was developed in order to address the theoretic upregulation of afferent nerves in the trigone that transmit the feeling of urgency in some sufferers. In an international multicenter study 35 women with at least a 6-month history of OAB refractory or intolerant to medical management were treated with selective bladder denervation with RF (Silensa System applied to the trigone under cystoscopic guidance. A series of temperature controlled RF ablations lasting 60 seconds each were applied across the trigone with placement and 3 mm below the urothelial surface. Clinical success defined as ≥50% reduction in urgency urinary incontinence was 53% at 1 month and 69% at 1 year. The Overactive Bladder Questionnaire and 6 of 9 items on the Kings Health Questionnaire were improved and statistically significant at 1 year. Six patients (17%) experienced an adverse event, which included transient burning, urethral bulging sensation, vaginitis and ureteral obstruction.[37]

COMPLICATIONS

On July 30, 2018, the U.S. Food and Drug Administration issued a warning against EBDs to alert patients and providers that the use of these devices for vaginal "rejuvenation" and to treat symptoms related to menopause, urinary incontinence or sexual function may be associated with adverse events and that the safety and efficacy have not been established.[38] Much of the impetus for this stemmed from the particular marketing of these devices. Despite the fact that EBDs occupy a staple treatment armamentarium within the plastic surgery and dermatology specialties for the treatment of body and facial skin conditions, a persistent concern remains surrounding the potential for adverse events in female urological applications given the relative paucity of data.

The MAUDE (Manufacturer and User Facility Device Experience) database is a collection of mandatory medical device reports from manufacturers along with voluntary reports from providers and patients to chronicle adverse events and device issues. In a cross-sectional analysis of the MAUDE database from October 2015 to January 2019, 45 distinct events were recorded, of which the most common adverse event was pain in 19 patients. Of these, 33 reported chronicity associated with their injury with the following device breakdown: RF = 12, fractional CO_2 = 17, hybrid fractional nonablative Er:YAG = 2, nonablative Er:YAG = 1, unknown device = 1.[39] It should be noted that, given that these adverse events are submitted on a voluntary basis, they are subject to reporting bias and therefore cannot be extrapolated to determine overall incidence of adverse events.

CONCLUSION

EBDs have evolved substantially from their inception in the mid-20th century as a destructive therapeutic intervention to the present day, where much of the focus has shifted to regenerative and restorative treatment. Despite the substantial number of devices on the market, there are limited data on their efficacy, particularly with regard to long-term follow-up. **As each energy based modality and device operates via a different mechanism, depth of penetration and treatment duration, they should not be considered interchangeable or equivalent. Currently the most promising application of EBDs, specifically laser therapy, is in the treatment of GSM. There is scant literature for the treatment of OAB and SUI, and EBDs have not been analyzed in any of the American Urological Association Guidelines for these topics given the paucity of data. Future research is needed to determine optimum treatment parameters of each device and to establish the role of these therapies in the treatment of female urological conditions.**

DID YOU KNOW?

- Energy based devices are comprised of carbon dioxide laser, Er:YAG laser and radiofrequency. While they fall within the same category of treatment modality, they each operate with a different mechanism of action with variable treatment parameters and should not be considered equivalent or interchangeable.
- Energy based devices have shown promise for the treatment of genitourinary syndrome of menopause.
- The data for stress urinary incontinence and overactive bladder are scant, and there is little evidence to provide meaningful recommendations to clinicians at this time.
- While energy based devices are well studied for other indications, adverse event data for female urological applications are limited.

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Study Questions Volume 40 Lesson 4

1. During radiofrequency therapy collagen production is stimulated by fibroblasts at a target temperature of
   a. 30C to 35C
   b. 40C to 45C
   c. 75C to 80C
   d. 95C to 100C

2. A 52-year-old woman who went through menopause a year ago is bothered by episodes of vaginal dryness, itching and irritation. She occasionally has dyspareunia. The recommended first line therapy is
   a. moisturizers and lubricants
   b. moisturizers, lubricants and vaginal estrogen
   c. Er:YAG laser
   d. CO_2 laser

3. Vaginal biopsies from women with GSM treated with vaginal Er:YAG laser therapy 6 months previously will show in comparison to pretreatment biopsies a(n)
   a. decrease in vascularity
   b. decrease in collagen production
   c. increase in melanocyte production
   d. increase in vaginal squamous epithelial thickness

4. Selective bladder denervation for the treatment of overactive bladder is achieved by
   a. radiofrequency ablation of the trigone
   b. radiofrequency ablation of the dome of the bladder
   c. CO_2 laser treatment of the trigone
   d. Er:YAG laser treatment of the dome of the bladder

5. A characteristic finding associated with the genitourinary syndrome of menopause is
   a. vaginal pH >5
   b. decreased parabasal cells on Vaginal Maturation Index
   c. increased superficial cells on Vaginal Maturation Index
   d. increased vaginal lubrication