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Nonsurgical Vaginal Rejuvenation

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- Vaginal rejuvenation • Vaginal relaxation syndrome • Genitourinary syndrome of menopause • Vulvovaginal atrophy
- Laser • Radiofrequency • Urinary incontinence

KEY POINTS
- In the past 5 to 10 years, a surge of interest in female intimate wellness, specifically vaginal rejuvenation, both surgical and nonsurgical, has been witnessed.
- For both cosmetic and functional reasons, increasing numbers of women have sought alternatives to traditional therapies for dealing with the common but unwelcome changes that occur to the vaginal and vulvar tissues induced by maternity, weight fluctuation, hormonal change (sometimes following cancer care), natural aging, and menopause.
- Traditional nonsurgical options of improving vaginal well-being for the premenopausal as well as postmenopausal woman have proven to have limited long-term benefit, and therefore, patient compliance with these methods can be poor.
- Not only do many of the conditions and symptoms of vaginal relaxation syndrome and genitourinary syndrome of menopause and its associated symptoms of vulvovaginal atrophy affect female intimate wellness over time, affecting quality of life, self-esteem, and the quality of interpersonal relationships, but also these conditions, if left untreated, tend to worsen with age.
- In order to offer patients the most effective and up-to-date therapies, the treatment approach should be individualized, and each practitioner should have a thorough breadth of knowledge regarding the cause of the conditions patients present with as well as a thorough understanding of technology that now exists to treat these issues.

Nearly 5 decades ago, gynecologists and plastic surgeons pioneered the integration of lasers for the ablation of diseased tissue by vaporization, ablation, and tissue contraction [1,2]. Since then, a host of energy-based devices have emerged to treat pelvic pathologic condition, improve fertility, and rejuvenate skin of the face and body. Current fractional (carbon dioxide [CO_2] and erbium:YAG) and hybrid laser-based technologies, nonablative and resurfacing radiofrequency (RF) technologies, and even a novel electromagnetic therapy device may now be used to treat patients dealing with genitourinary syndrome of menopause or vulvovaginal atrophy (GSM/VVA) and vaginal relaxation syndrome (VRS) symptoms as well as their frequently associated symptom complexes of sexual dysfunction, urinary incontinence (UI), and even true skin disorders, such as lichen sclerosus.

INTRODUCTION

The American Society for Aesthetic Plastic Surgery procedural statistics reported an increase of 23% in surgical labiaplasty procedures performed in 2016 by its members compared with 2015 (the first year for which such statistics were available). Thirty-five percent of plastic surgeons now perform surgical labiaplasty, and they

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performed more than 10,000 labiaplasty procedures last year [3]. This number does not include the number of surgical labiaplasties performed by gynecologists. Along with this newer area of surgical interest, there has also been a rapid growth in the number of treatment options for nonsurgical vaginal rejuvenation. Accordingly, more than half a million nonsurgical feminine rejuvenation procedures were performed in 2016, generating $500 million in incremental fees for practitioners [4]. It is thus very important to catalog the most current and effective advances in this rapidly growing field of care of the female patient, so that treatment indications and efficacy remain at the forefront of procedures offered to patients by a variety of practitioners.

PATHOPHYSIOLOGY

GSM or VVA represents a constellation of symptoms [5] that, although underreported, has been estimated to affect up to 50% of postmenopausal women [6] and affects quality of life [7,8] as a result of the natural decrease of estrogen levels after the onset of menopause (naturally or iatrogenic). Before menopause, with normal circulating levels of endogenous estrogen, vaginal canal physiology is characterized by the presence of a thickened, rugated, nonkeratinized epithelial layer that is well vascularized and self-lubricated. As estrogen levels decline (or are deprived as in some patients with hormonally treated malignant conditions), the vaginal wall loses collagen and elastin and becomes thinner, there is a reduction in blood flow, and there is a changed quality and quantity of vaginal secretions. The epithelial surface becomes pale with loss of rugation, more friable with petechiae, and irritation and bleeding may occur after minimal trauma. There is a decrease in the normal epithelial cell metabolism due to loss of normal blood flow and decreased nutritive vaginal transudate, glycogen stores of healthy epithelial cells falls, leading to a reduction in the amount of protective lactobacilli content, which need glycogen to thrive. The latter leads to an increase in the normally acidic pH to a more alkaline state, and some of the protective function of the vaginal wall is lost, allowing the increased susceptibility to trauma, infection, vaginitis, lower urinary infections, and urogenital pain (Fig. 1) [5,9–11].

CLINICAL TREATMENT INDICATIONS

The symptoms of GSM/VVA commonly include, but are not limited to, reductions in the diameter and elasticity

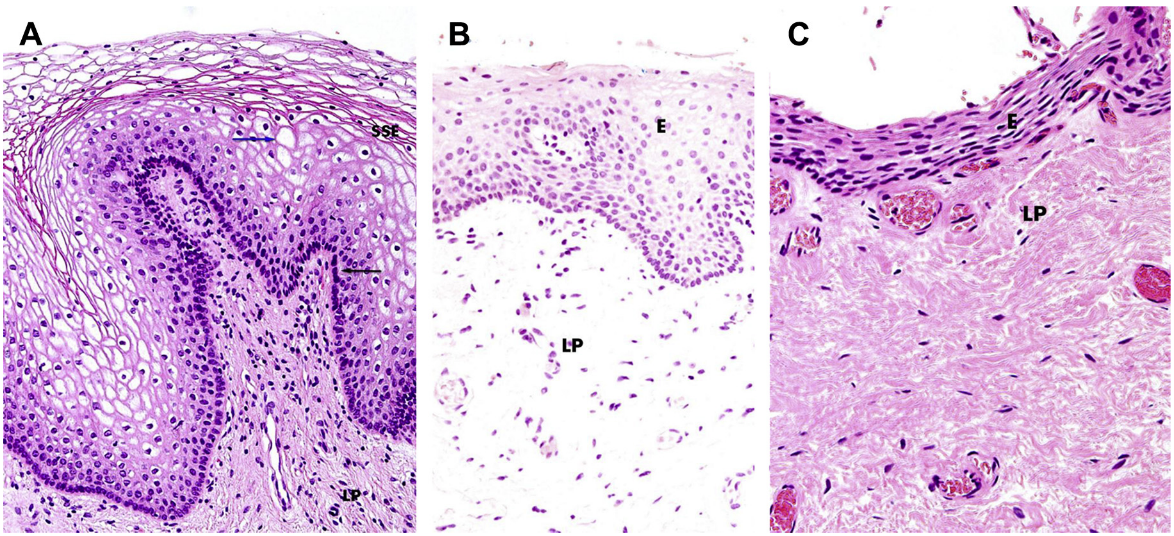

FIG. 1 Histologic sections of the vaginal wall. (**A**) Normal. (**B**) Moderately atrophic. (**C**) Severely atrophic. (**A**) Estrogenized vaginal histology. The 2 upper layers of the vaginal wall are shown: stratified, squamous epithelium (SSE) and the lamina propria (LP). The stratified squamous epithelium is rich in glycogen (larger cells with abundant clear cytoplasm—*blue arrow*) and is nonkeratinizing. The basal cell layer (*black arrow*) consists of a single layer of columnar cells. (**B**) Moderately atrophied vagina: atrophy is shown by thinner epithelium (E) and loss of maturation (smaller cell size with less cytoplasm) on the surface. (**C**) Marked vaginal atrophy. (hematoxylin and eosin stain and ×40 magnification). (*Courtesy of* Ahinoam Lev-Sagie, MD, Hadassah-Hebrew University Medical Center Jerusalem, Israel; with permission.)

of the introitus and internal vaginal canal, thinning of vaginal tissues, and loss of natural lubrication, which often leads to the secondary effects of dryness, itching, irritation, dyspareunia, sexual dysfunction, and dysuria. Stretching and trauma to the vaginal tissues from normal aging, maternity, and childbirth can cause not only functional changes of lack of support to the vagina, urethral mechanism, and pelvic floor, leading to pelvic organ prolapse, rectal or vaginal prolapse, UI, and decreased sensation during coitus [12] to varying degrees, but may also lead to cosmetic concern in many women due to the aged appearance of the vulvovaginal structures over time. The symptoms of VRS can therefore affect premenopausal as well as postmenopausal women and cause many to express both functional and cosmetic concerns. Many complain about the excessively redundant labia minora and clitoral hood areas, asymmetrical labia minora tissue, visible fullness of the labial tissues when viewed naked or in tight clothing, chafing and irritation during exercise (running, biking, horseback riding) or intercourse, and embarrassing periods of audible "vaginal gas." Another common cosmetic concern is the atrophy, deflated appearance, or hyperpigmentation of the labia majora.

TRADITIONAL TREATMENTS MODALITIES

Traditional nonsurgical methods targeted to the vaginal tissues themselves for functional improvement of symptomatic GSM/VVA/VRS include nonhormonal vaginal lubricants, continued sexual activity, and local and systemic estrogen, or estrogen modulator (Ospemifene) therapy. Traditional nonsurgical methods of treating symptoms resulting from the laxity and loss of support of the deeper vaginal tissues include Kegel exercises, bladder training, overactive bladder medications, and the wearing of pessaries or urinary pads [9]. However, because of mixed results, complications of topical estrogen products (uterine bleeding, breast pain, and perineal pain), and poor compliance with many of these measures, many patients in the past have turned to surgical procedures such as vaginoplasty, complex pelvic floor reconstruction, or bladder suspension surgery. Advantages of the newer nonsurgical energy-based treatment modalities are that they do not possess the potential morbidity of the surgical procedures, they favorably affect vascularization on all levels of the vaginal, periurethral, and pelvic floor connective tissue layers (as opposed to the superficial epithelial benefits of estrogen therapy), and their effect appears to have long-lasting benefits (again, as opposed to the dissipation of benefit if estrogen use is discontinued) [13–15]. In addition, many women express concern over hormonal therapies due to cancer-related consequences. Finally, unlike skin complications, such as hypertrophic scarring, unwanted tissue contraction (ectropion), pigmentary change, burns, or disseminated infection, which have all been reported after fractional laser skin resurfacing of the face, neck, or body [16], no major complications have been reported after energy-based vaginal rejuvenation procedures [15].

CURRENT ALTERNATIVE NONSURGICAL VAGINAL REJUVENATION OPTIONS

Among the new nonsurgical modalities being offered to female rejuvenation patients are lasers and RF devices, which target the vaginal connective tissues, and the newest device, which uses electromagnetic therapy that targets muscle.

Lasers, or "light amplification by stimulated emission of radiation," employ wavelengths that are selected in order to target a specific tissue chromophore, such as water in the vaginal tissues [17]. Selective photothermolysis describes the desirable clinical effect of selectively absorbed laser wavelengths by a specific chromophore in the target tissue [18]. In addition, the laser pulse duration can be controlled to confine the thermal damage to the target area, ideally delivering a pulse of light whose duration is less than or equal to the thermal relaxation time (or time for the temperature to decrease by 50% from the temperature immediately after laser exposure) [19]. Furthermore, using fractional beam technology, microthermal zones of tissue injury occur separated by intervening nests of uninjured skin, the effect of which is to hasten recovery and reduce the incidence of adverse events [20,21]. The most commonly used lasers for vaginal rejuvenation are fractional CO_2 and erbium:YAG.

RF devices use electrical conductance, in the form of rapidly alternating electrical current, to cause oscillation of cellular structures that are in the electrical path, thereby increasing intermolecular motion. As the current flows alternatively, molecular collisions increase, thereby creating thermal energy (heat). Thus, RF technology uses the impedance (resistance) of tissue to generate heat rather than directly transferring heat, and energy is dispersed to the bulk of the 3-dimensional tissue as a whole, although at controlled depths. The configuration of electrodes in RF devices can be monopolar, bipolar, or tripolar, and beyond, all of which have been used for cutaneous applications. Historically, most RF vaginal devices were monopolar devices; however, these initial devices could have relatively limited efficacy because of pain, burns, or other adverse effects [22,23]. More recently, bipolar RF devices, incorporating both positive and negative electrodes, have been developed with potentially greater efficacy and an improved safety profile because of the creation of a closed electrical circuit, which makes it easier to control depth of penetration and to potentially target some tissues while sparing others [24,25]. Technical parameters of the various devices discussed are listed in Table 1.

LASER-TISSUE INTERACTIONS: ABLATIVE LASERS

Carbon Dioxide Laser

The CO_2 laser emits light at a wavelength of 10,600 nm, which is strongly absorbed by tissue water [18]. With fractional CO_2 devices, an array of microbeams of laser light is delivered to create microscopic columns of energy-mediated effects using either optical scanners to deliver the spot or a stamping technique [20]. The microscopic lesions extend from the vaginal epithelium into the lamina propria, to depths dictated by laser energy density and spot size. The evolution of this technology has largely been responsible for the conversion of these energy-based devices from cutting and coagulating tools to true cell activation and tissue rejuvenation tools. Lessons learned from the effects of these lasers on skin have been instrumental in the understanding of how they can be used to rejuvenate the vaginal mucosa to treat patients with GSM/VVA/VRS [15]. The mechanism of action of fractional CO_2 occurs via delivery of a supraphysiologic heat energy that causes a rapid thermomechanical tissue destruction (ablation) that is surrounded by a peripheral zone of coagulation that causes tissue tightening through the process of heat-induced collagen shrinkage and neocollagenesis. These desired collagen charges occurs occurs at temperatures between 45°C and 50°C in the zone surrounding the ablated tissue [26,27]. The level of supraphysiologic heat generated by the CO_2 laser induces a rapid and transient heat-shock response that

TABLE 1
Technical Parameters of Vaginal Probes and Device Specifications

Brand Name, Technology	Laser Type/ Wavelength (nm) or RF	Pulse Duration	Maximum Energy/ Pulse	Surface Area "Lased"/"Heated" Exposure
Laser				
Alma lasers	CO_2, 10,600	400 ms	500 mJ (per pixel)	10 mm^2
Fotona	Er:YAG, 2940	250 ms	240 J (per pass) 3 J/cm^2	80 (cm^2), nonablative, entire surface
Focus Medical	CO_2, 10,600	1–200 ms	60 mJ	10 mm^2
Lumenis	CO_2, 10,600	NA	7.5/10/12.5 mJ	NA
Lutronic	Er:YAG,– 2940	NA	NA	NA
Sciton	Hybrid: 2940/1470	150/20 ms	300/100 mJ	1.5–2.5 mm^2
Syneron-Candela	CO_2, 10,600	20–1066 ms	70 mJ	10 mm^2
RF				
ThermiVa	**Monopolar* RF 460 KHz	Continuous	20 W/operator adjustable up to 47°C	10 mm^2
Ultra Femme 360 procedure by BTL Exilis Ultra 360	*Monopolar* RF 3.25 MHz	Continuous	90 W/operator adjustable up to 43°C	235 mm^2
VOTIVA by INMODE (Forma V)	*Bipolar* RF 1 MHz	Single-pulse continuous repeat	40–65 W/operator adjustable up to 43°C (real time)	50 mm^2

Abbreviation: NA, not available.

temporarily alters cellular metabolism and activates a small family of "heat-shock proteins" (HSPs). HSP70, which is overexpressed after laser treatment, stimulates transforming growth factor-β, triggering an inflammatory response that stimulates fibroblasts, which produce new collagen and extracellular matrix. The laser's emissions characteristics specifically target the energy load to the mucosa while avoiding excessive localized damage. This aspect of its design allows for restoration of the permeability of the connective tissue, enabling the physiologic transfer of various nutrients from capillaries to tissues. Several clinical trials and published reports now provide consensus opinion regarding the beneficial and restorative effects of fractional CO_2 treatments upon vaginal tissue histology; however, these studies typically followed patients for only 3 to 6 months after the last of 3 treatments performed at monthly intervals [15,28,29]. A recent study reported that the 1-year outcome of average Vaginal Health Index remained statistically significant after CO_2 laser treatment [30]. Another prospective institutional review board–approved study, performed at 2 clinical sites in the United States by urogynecology and plastic surgery (this author), presented 1-year outcomes and histologic validation of clinically significant improvement in GSM/VVA symptoms for up to 12 months after laser treatment in 100% of 40 postmenopausal patients [31]. Fig. 2 from this study depicts histologic findings at 8 months after baseline (6-month follow-up).

The posttreatment epithelium is thicker with a better degree of surface maturation, and there are an improved vascularity and water content, reduced inflammatory cell infiltrate, and increased collagen and elastin content. Clinical findings from multiple CO_2 published reports in peer-reviewed publications have shown subjective improvement in self-reported sexual function, vaginal tightness, mild to moderate UI, and decreased severity of vaginal pain, burning, itching, dryness, dyspareunia, and dysuria associated with GSM/VVA [30–33].

Erbium:YAG Laser

The Er:YAG laser is a near-infrared ablative laser that emits light at a wavelength of 2940 nm, which is close to the absorption peak of water and yields an absorption coefficient that is actually 16 times higher than that of the CO_2 laser; however, the depth of penetration of Er:YAG compared with CO_2 is more superficial and has less associated thermal effect in surrounding tissue, so that the Er:YAG laser is a true ablative laser pulse [18]. An Er:YAG laser that delivers wavelengths of 2940 nm and 1470 nm to deliver both an ablative and a nonablative pulse is also available. Fractional Er:YAG laser treatment of vaginal mucosa has been shown to create increased thickness and cellularity of the epithelium and a more compact lamina propria with a denser arrangement of connective tissue. Increases in collagen and elastin content were also demonstrated with short-term 2-month follow-up [34].

Radiofrequency

RF energy is dispersed in a 3-dimensional, bulk tissue heating manner, albeit at controlled depths, rather than using the selective photothermolysis mechanism of action used by laser technology. In RF-tissue interactions, heat generated in the dermis reaches a thermal dose threshold, above which collagen begins to denature (~60°C) and to fully denature (70–75°C) [21]. Partial denaturation of collagen by RF is maximal at

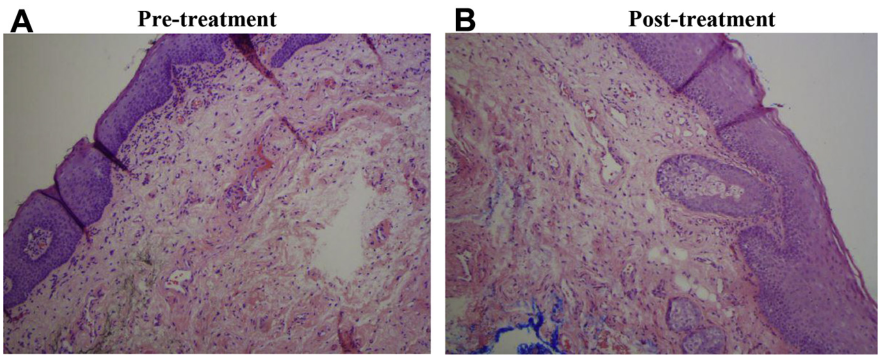

FIG. 2 (**A**) Pretreatment histology of a 71-year-old woman. (**B**) At 5 months after baseline, histology showed increased collagen and elastin staining as well as a thicker epithelium with an increased number of cell layers and a better degree of surface maturation. (hematoxylin and eosin stain and ×40 magnification). (*Courtesy of* Julene B. Samuels, Louisville, KY and Martin Garcia, Jacksonville, FL; with permission.)

67°C, and this correlates with optimal neocollagenesis, neoelastogenesis, and clinical effects in the skin. Temperatures at 40°C to 45°C induce production of collagen by fibroblasts and are effective in skin tightening [35]. However, surface temperatures of the skin exceeding 45°C have been correlated with pain and thermal burns during and after RF treatment.

Current monopolar RF devices for vaginal treatment use "mobile RF delivery," whereby afferent cutaneous pain nerves are cooled to avoid a surface temperature exceeding the trigger threshold of 45°C, whereas heat accumulates in the target collagen and dermal structures [36]. A newer noninvasive bipolar RF device developed for vaginal rejuvenation offers technology that allows for prolonged, controlled dermal heating while limiting the potential for side effects. Because of the configuration of the positive and negative electrodes within the hand piece, the depth of the RF current is carefully controlled to create uniform dermal heating. The device also allows the setting of the optimal dermal temperatures to be maintained throughout the treatment as well as the energy delivered. There are sensors incorporated to monitor real-time impedance, contact, and temperature, with automatically controlled cutoff and reactivation mechanisms designed to maintain the preset parameters throughout the treatment [37]. The manufacturer also offers with the device a bipolar fractional RF hand piece for quick resurfacing of the external vulvar and labial tissues if cosmetic improvement (tightening, textural improvement, and correction of hyperpigmentation) is desired.

When compared with the many beneficial effects of laser tissue interaction, RF appears to provide similar applicability for vaginal rejuvenation with reports in the literature of the creation of new dermal volume, and improvement in skin laxity and elasticity [38]. In addition, when dermal collagen is heated to a certain temperature (by any energy method), the partially denatured collagen serves as a signal for neocollagenesis [35]. RF has also been shown to induce neoelastogenesis and vaginal tightening, especially helpful in cases of VRS [38].

Other points of comparisons to be made between laser and RF technologies include the following considerations:

- Device acquisition cost (advantage RF)
- Maintenance contracts (advantage RF)
- Shorter treatment time (advantage laser and bipolar RF)
- Environmental biohazard, that is, laser plume (advantage RF)
- Ability to treat external lesions (advantage excisional options on laser)
- Ability to treat external vulvar tone, texture, and hyperpigmentation (advantage laser and bipolar RF microneedling, because hyperpigmentation correction requires ablative capacity)

The widths of the vaginal laser probes on devices summarized in this review vary between 19 and 38 mm, and the RF probes are 15 to 25 mm. These probe widths are easily and comfortably accommodated by premenopausal and postmenopausal patients.

BEYOND THE VAGINA: ADDITIONAL APPLICATIONS

Urinary Incontinence

There are 4 main types of UI, the involuntary leakage of urine:

- Urge incontinence due to an overactive bladder
- Stress incontinence due to poor closure of the bladder
- Overflow incontinence due to either poor bladder contraction or blockage of the urethra
- Functional incontinence due to medications or health problems making it difficult to reach the bathroom

Stress urinary incontinence (SUI) is the most common variety, and it is also the most amenable to improvement with nonsurgical vaginal rejuvenation devices. SUI usually results from weakening of the support naturally provided to the bladder, urethra, and pelvic floor by normal healthy collagen and elastic connective tissue because these tissues age or undergo changes with various pathologic conditions [39]. Urethral support, anterior vaginal wall tightening, and even pelvic floor support can be improved by exploiting the energy-induced tightening effect of these devices. Published reports cited previously in this review confirm enhanced urinary control after treatment of SUI with CO_2 laser, Er:YAG laser, and RF, all of which trigger a photothermal effect, as deep as 0.5 mm inside the vaginal wall, resulting in reductions in tissue volume via collagen and connective tissue shrinkage via HSP effects. The mechanical pull induced by the photothermally affected superficial tissue layers is presumed to exert a pull on the deeper tissue layers such that a globally beneficial tightening effect occurs, while at the same time, thermally induced neocollagenesis improves thickness, elasticity, and firmness of the vaginal wall [40,41].

Although all of the energy-based devices discussed here have application and proven clinical efficacy for improving SUI, there are a few devices with special adaptation for the treatment of SUI worthy of mention. Er:YAG laser treatment is available with a special accessory Incontilase kit that offers separate hand pieces, adaptors, and a laser speculum for ease of full spot, fractional, or patterned spot energy delivery to the anterior vaginal wall and periurethral tissues [41,42].

Another new technology to arrive to treat all types of UI is high-intensity focused electromagnetic technology (HIFEM). A noninvasive magnetic field triggers intense pelvic floor muscle contractions by targeting neuromuscular tissue and inducing electric currents. These electric currents depolarize neurons resulting in concentric contractions that are much higher than what can be achieved through voluntary physiologic muscle contraction (eg, Kegel exercises). These contractions, pulsed and comfortably held for several seconds, are created independently of brain function and target directly the peripheral nerves in the pelvic floor. A single session of HIFEM brings thousands of supramaximal pelvic floor muscle contractions, important in muscle reeducation in incontinent patients. Preliminary results show a high response rate (>90%) after 6 total treatments, performed twice weekly, in 60 patients with all types of UI (Fig. 3) (Berenholz J, Sims T, Botros G. HIFEM technology (EMSELLA by BTL)—a new perspective in addressing stress urinary incontinence. Personal communication [2017]).

Lichen Sclerosus

Lichen sclerosus is a benign, inflammatory skin disease of unknown cause that, when affecting genital tissues, may result in vulvar scarring, loss of portions or all of the labia minora due to resorption, clitoral adhesion, and narrowing of the introitus. The disease is progressive, and symptoms include pruritis, soreness, irritation, pain, dysuria, dyspareunia, and sometimes perianal involvement. Treatment traditionally involves topical corticosteroids (clobetasol propionate) [43]. Recently, several reports of successful treatment with fractional CO_2 laser technology have emerged that in many cases lead to not only symptom resolution and curative histologic change but also visible improvement of skin color, elasticity, and vascularity [15]. Clinical trials are ongoing in the use of fractional lasers in the treatment of lichen sclerosus.

Female Genital Aesthetics and Intimacy

The aesthetics of the female genitalia have become an area of particular concern among women over the past decade, possibly facilitated by the popularity of Brazilian waxing, fashion trends, and media promotion of nude

FIG. 3 EMSELLA by BTL. High-intensity focused electromagnetic technology. (*Courtesy of* BTL Industries, Inc, Marlborough, MA; with permission.)

images. In addition to the many functional reasons women seek corrective surgical and nonsurgical options to deal with GSM, VVA, and VRS, there is evidence that the increasing request for vaginal and genital rejuvenation procedures may in fact also derive from women's desire for an improved vulvar aesthetic. The current trend appears to be toward a more minimalistic appearance of the external genitalia: narrowed, minimally visible and symmetric labia minora as well as tighter and "brighter" labia majora that are smooth, tight, nonpigmented, and full. The beauty ideal that seems to be emerging is therefore that of a "clean slit" characterized by a vulvar area that seems to end in a perfect point of nothingness [44]. Prolific use of the Internet and exposure to images of modified vulvas may well influence women's perceptions of what is normal and desirable [45]. Associations have been made between women's satisfaction with anatomy of the genitalia and quality of life and sexual satisfaction, so that demand is on the increase for procedures relating to improving form and function of the female genitalia. It is therefore very important for practitioners in the field to be as knowledgeable regarding treatment indications and alternatives as they are facile in selecting and performing the nonsurgical treatment options of choice.

SUMMARY

The plethora of data being generated from the large number of publications in peer-reviewed journals on cell activation and vaginal wall rejuvenation after the use of light and energy-based devices is encouraging. There seems to be firm consensus that these devices are indeed effective in treating GSM-related symptoms, rejuvenating intimate female anatomy, and restoring a sense of female intimate wellness for many women after childbirth and menopause. The currently available data on the effects of fractional laser and RF devices support a rejuvenation effect on vaginal tissues that results from the following unequivocal histologic changes: thickening of glycogen-enriched postmenopausal epithelium, neovascularization, and neocollagenesis in the lamina propria, increased lactobacilli population, reduced pH, vaginal wall tightening, improved urination control, tightening and brightening of the external vulvar and labial skin, and improved urinary control, and all with minimal risk of short-term or long-term complications [15]. The choice of which device to incorporate into an individual practitioner's practice remains a challenge to all providers in this space. Manufacturers likewise need to continue to enhance and improve ease of operability of their individual patented technologies to try to address the many and varied needs of patients and providers alike.

Controversial issues that remain to be elucidated include the following:

- The determination of which light and energy-based devices provide the most thorough and long-lasting improvements of GSM, VVA, and VRS symptoms, and therefore, which devices offer the longest re-treatment intervals (studies supported by histopathological data comparing the *degree* of induced neocollagenesis, neoelastogenesis, and cellular change as well as nervous tissue changes of laser and RF)
- Age group–specific device usage advantages (are laser or RF more, or equally, effective in different age groups of women, ie, the premenopausal or postpartum woman vs the postmenopausal woman)
- Which devices provide the most cost-effective modality of treatment, given that this analysis includes a consideration of the cost of device acquisition, disposables, and maintenance, as well as a consideration of environmental hazard (laser plume), necessary staffing for device operation, space considerations, or multimodal use indications that benefit a practice
- The further study of the pathophysiology and optimal device treatment of chronic, progressive conditions, such as lichen sclerosis (estimated to affect up to 1 in 59 patients in a general gynecologic practice [43]).
- The potential of the additive effect (if any) upon the use of light and energy-based devices with platelet-rich plasma/growth factor, hyaluronic acid, and estrogen-priming therapies
- Optimization of treatment options and protocols for the treatment of SUI
- Comparative analysis of the cost-effectiveness of light and energy-based treatment options with other interventions
- Further elucidation of any unwanted long-term sequelae
- US Food and Drug Administration approval for use of these devices in sexual function and GSM/VVA (at the time of this writing, only InMode Votiva FormaV has on-label indication)

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