Device-based treatment for vaginal wellness
Macrene Alexiades, MD, PhD

Abstract
Genitourinary syndrome of menopause (GSM), encompassing the disorders of atrophic vaginitis, urinary incontinence, and pelvic prolapse, affects the majority of postmenopausal women, as well as patients who are undergoing breast cancer treatment, post-ovarectomy, post-radiation, and breast-feeding. There is a need for better treatment options for these common conditions that adversely affect physical function and quality of life and that are often underserved by existing options. Lasers have been used to treat genitourinary tissue for over 40 years, and over the past decade, several lasers and radiofrequency devices have been developed and clinically tested for the treatment of GSM, with an accumulating body of evidence demonstrating their safety and efficacy. Fractional lasers, including carbon dioxide, erbium:YAG and hybrid technologies, as well as monopolar radiofrequency devices, work by resurfacing and/or stimulating via heat the vaginal lining resulting in a re-epithelialization, neovascularization, and remodeling of the vaginal tissue from an atrophic postmenopausal state to a thickened, glycogen-rich and well-vascularized state similar to premenopausal vaginal lining. These changes are correlated clinically with improved function on a variety of validated vaginal health scales and urinary incontinence tests. Currently cleared for general application to genitourinary tissue, clinical trials are underway for FDA clearance or approval for specific GSM indications.

Semin Cutan Med Surg 37:226-232 © 2018 Frontline Medical Communications

For over 40 years, gynecologists and plastic surgeons have employed devices to ablate genitourinary tissues. Focused carbon dioxide (CO₂) laser has been used for incision and vaporization, defocused CO₂ laser for tissue contraction, and ablative CO₂ for genital wart ablation. Diode lasers have been used for myomectomy, photodynamic therapy with laser for lichen sclerosus, and radiofrequency (RF) for lower genital tract rejuvenation. However, in recent years, the number of devices and their applied uses in women’s genitourinary health have multiplied at a rapid rate.

Vaginal anatomy
The vaginal wall consists of the following 4 layers: (1) superficial nonkeratinized stratified squamous epithelium, estrogen-dependent and glycogen-rich; (2) lamina propria consisting of dense connective tissue, collagen, elastin, and blood vessels; (3) muscular layer of inner circular and outer longitudinal smooth muscle; and (4) adventitia consisting of loose connective tissue and collagen and elastin wall.

Genitourinary syndrome of menopause
The genitourinary disorders targeted by vaginal wellness devices include (1) atrophic vaginitis, also known as vulvovaginal atrophy (VVA) or urogenital atrophy, (2) urinary incontinence (UI), and (3) pelvic prolapse. Collectively, these conditions have been termed the genitourinary syndrome of menopause. Affecting women who are postmenopausal post-ovarectomy, undergoing treatment for breast cancer, post-radiation, and breast-feeding, genitourinary syndrome of menopause is estimated to affect 50% of postmenopausal women.

Vaginal laser interactions
Laser technologies
Fractional ablative and nonablative lasers
Fractional laser resurfacing is a class of laser technologies that deliver an array of microbeams of light to create microscopic columns of energy-mediated effects in the tissue. The creation of microcolumns of treated tissue, separated by intervening areas of untreated skin, speeds recovery and decreases adverse events. In vaginal tissue, the microscopic lesions extend from the vaginal epithelium into the lamina propria, to depths determined by laser energy (fluence), duration of the laser pulse, and spot size. Fractional lasers used in vaginal tissue include ablative wavelengths—including CO₂ laser at 10,600-nm wavelength and erbium:yttrium-aluminum-garnet laser (Er:YAG) at 2970 nm—as well as nonablative lasers such as the 1470-nm diode. Ablative devices vaporize the microcolumns of tissue, whereas nonablative devices induce columns of thermal injury without vaporization. The vaporization or boiling point of water at 1 atmosphere is 100°C; the fluence necessary for pulsed-laser ablation of skin is 5 J/cm². During ablation, the skin temperature rises to 120 °C to 200°C. CO₂ laser at pulse duration <1 ms ablates 20 to 30 µm of tissue with a 100- to 150-µm-deep layer of residual thermal damage (RTD). The fractionated CO₂ microbeam diameters among devices range from 100 µm to 1.25 mm, and beam power density differs accordingly; the penetration depths of the microcolumns vary from 50 µm to 1.6 mm.

Among fractional Er:YAG devices, the microspot ranges from 50 microns to 1.5 mm, and the penetration depth ranges from 1 to 3
in a nonablative mode with a duration of 250 ms, consisting of a coagulation and hemostasis. The 2940-nm laser may be employed additional thermal coagulative pulse that may be administered immediately following the ablative pulse to provide additional thermal coagulation and hemostasis. The 2940-nm laser may be employed in a nonablative mode with a duration of 250 ms, consisting of a fast sequence of individual superpulse-mode (300-μs) micropulses with intrapulse intervals of 50 ms. In this mode, vaginal mucosa temperatures increased to 60°C to 65°C, without inducing superficial ablation. Ablation and coagulation of vaginal tissue with 2 wavelengths such as 2940 and 1470 nm fired consecutively, temperatures increased to 60°C to 65°C, without inducing superficial ablation. Ablation and coagulation of vaginal tissue with 2 wavelengths such as 2940 and 1470 nm fired consecutively, termed “hybrid laser pulse,” combines ablation and thermal injury in microcolumns.1

Radiofrequency

The second major class of devices being applied to women’s genitourinary health is RF emitting within a frequency range of 3 kHz to 24 GHz. The RF devices generate an electric field that produces an oscillating electrical current in tissue. This current induces collisions and motion among charged and polar atoms and molecules resulting in energy transfer to the tissue as heat.7 The author’s published research supports the theory that the controlled volumetric heating induced by RF causes partial collagen denaturation triggering neocollagenesis and neoeLASTINogenesis, which correlates with tissue tightening.8 The configuration of electrodes in RF devices can be monopolar, bipolar, or tripolar, and all have been used for cutaneous applications. In monopolar RF, the electrical current passes through a single electrode in the handpiece to a grounding pad, whereas in bipolar RF, the current passes between electrodes within the handpiece tip in a closed arc-like circuit through the tissue.

In RF–tissue interactions, the heat generated in the dermis reaches a thermal dose threshold such that collagen begins to denature at approximately 60°C and completely denatures at 70°C to 75°C.8 Partial denaturation of collagen by RF is maximal at 67°C and completely denatures at 70°C to 75°C.8,9

TABLE 1. FDA-cleared devices and indications

<table>
<thead>
<tr>
<th>Device</th>
<th>510K</th>
<th>Date</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joule Profile Multi-Platform System, diVA (Sciton), Er:YAG 2940 nm, 1470 nm</td>
<td>K060033</td>
<td>1/4/06</td>
<td>At 2940 nm: “Ablation, vaporization, and coagulation of soft tissue and for skin resurfacing” and at 1470 nm: “Ablation, vaporization, hemostasis, or coagulation of soft tissue.”</td>
</tr>
<tr>
<td>Lumenis Femtough, CO₂</td>
<td>K100415</td>
<td>4/12/10</td>
<td>“Vaporization, incision, excision, ablation or photocoagulation of soft tissue in the surgical specialties of: ENT, Gynecology, Laparoscopic Surgery including GYN Laparoscopy, Aesthetic Surgery, Dental and Oral Surgery, Neurosurgery, Orthopedics, General Surgery and Podiatry.”</td>
</tr>
<tr>
<td>IntraLase/IncontiLase (Fotona), Er:YAG 2940 nm, Nd:YAG 1064 nm</td>
<td>K101817</td>
<td>11/22/10</td>
<td>“Surgical applications requiring the ablation, vaporization, excision, incision, and coagulation of soft tissue in medical specialties including: aesthetic surgery (dermatology and plastic surgery), podiatry, gynecology, neurosurgery, orthopedics (soft tissue), arthroscopy.”</td>
</tr>
<tr>
<td>Femilift (Alma), CO₂</td>
<td>K103501</td>
<td>1/14/11</td>
<td>“Laser incision, excision, ablation and/or vaporization and of soft tissue in gynecology for the treatment of: conization of the cervix, including cervical intraepithelial neoplasia, vulvar and vaginal intraepithelial neoplasia; condylomma acuminate, including cervical, genital, vulvar, perineal, and Bowen’s disease, (Erythoplasia of Queyrat) and Bowenoid papulosa (BP) lesions; leukoplakia (vulvar dystrophies); incision and drainage of Bartholin’s and nubthian cysts; herpes vaporization; urethral caruncle vaporization; cervical dysplasia; benign and malignant tumors; hemangiomas.”</td>
</tr>
<tr>
<td>ThermiVA (Thermi), RF</td>
<td>K130689</td>
<td>11/15/13</td>
<td>“For use in dermatological and general surgical procedures for electrocoagulation and hemostasis.”</td>
</tr>
<tr>
<td>SmartXide2 CO₂, MonaLisa Touch, El En/DEKA/Cynosure</td>
<td>K133895</td>
<td>9/15/14</td>
<td>“Incision, excision, vaporization and coagulation of body soft tissues in medical specialties including aesthetic (dermatology and plastic surgery), podiatry, otolaryngology (ENT), gynaecology, neurosurgery, orthopaedics, general and thoracic surgery (including open and endoscopic), dental and oral surgery and genitourinary surgery. The use with the scanning unit is indicated for ablative skin resurfacing.”</td>
</tr>
<tr>
<td>CORE Intima (Syneron), CO₂</td>
<td>K151655</td>
<td>9/14/15</td>
<td>“Surgical applications requiring the ablation, vaporization, excision, incision, and coagulation of soft tissue in medical specialties including: aesthetic surgery (dermatology and plastic surgery), podiatry, gynecology, neurosurgery, orthopedics (soft tissue), arthroscopy.”</td>
</tr>
</tbody>
</table>

Abbreviations: FDA, Food and Drug Administration; RF, radiofrequency.

μm of tissue per J/cm², yielding an ablative depth among devices of 25 to 1,500 nm with minimal RTD of 10 to 40 μm. An additional technological feature of some fractional Er:YAG devices is the additional thermal coagulative pulse that may be administered immediately following the ablative pulse to provide additional thermal coagulation and hemostasis. The 2940-nm laser may be employed in a nonablative mode with a duration of 250 ms, consisting of a fast sequence of individual superpulse-mode (300-μs) micropulses with intrapulse intervals of 50 ms. In this mode, vaginal mucosa temperatures increased to 60°C to 65°C, without inducing superficial ablation. Ablation and coagulation of vaginal tissue with 2 wavelengths such as 2940 and 1470 nm fired consecutively, termed “hybrid laser pulse,” combines ablation and thermal injury in microcolumns.1

Radiofrequency

The second major class of devices being applied to women’s genitourinary health is RF emitting within a frequency range of 3 kHz to 24 GHz. The RF devices generate an electric field that produces an oscillating electrical current in tissue. This current induces collisions and motion among charged and polar atoms and molecules resulting in energy transfer to the tissue as heat.7 The author’s published research supports the theory that the controlled volumetric heating induced by RF causes partial collagen denaturation triggering neocollagenesis and neoeLASTINogenesis, which correlates with tissue tightening.8 The configuration of electrodes in RF devices can be monopolar, bipolar, or tripolar, and all have been used for cutaneous applications. In monopolar RF, the electrical current passes through a single electrode in the handpiece to a grounding pad, whereas in bipolar RF, the current passes between electrodes within the handpiece tip in a closed arc-like circuit through the tissue.

In RF–tissue interactions, the heat generated in the dermis reaches a thermal dose threshold such that collagen begins to denature at approximately 60°C and completely denatures at 70°C to 75°C.8 Partial denaturation of collagen by RF is maximal at 67°C and completely denatures at 70°C to 75°C.8,9

Partially denatured collagen by RF is maximal at 67°C and completely denatures at 70°C to 75°C.8 Skin surface temperatures exceeding 45°C have been correlated with pain and thermal burns during RF treatment.9 Introduction of mobile RF delivery, in which RF energy is delivered within nanoseconds but repeatedly over the same surface area, enabled the cooling of pain afferents at the dermo–epidermo junction while allowing efficient heating of collagen in the dermis, which bear a significantly higher tₚ (10 μs compared to 225 μs, respectively).9
Current monopolar RF devices for vaginal treatment employ mobile delivery, with target surface temperatures at or below 45 °C or bipolar technologies.

**Histologic effects**

**Fractional lasers**

Histological evaluations following fractional CO₂ laser resurfacing in skin have shown direct correlation between energy output and ablative penetration depth. For a fractional CO₂ device with a 135-µm diameter, microspot fluences ranges of 10 J/cm² to 75 J/cm² correlate with ablative penetration depths from 100 µm to 1.6 mm. A wound-healing process follows, with granulation tissue forming at 1 to 3 days post treatment and subsequent progressive neocollagenesis and dermal remodeling commencing 30 days post treatment and continuing for several months thereafter, as has been observed following standard ablative CO₂ laser resurfacing.

Fractional CO₂ ablative laser histological effects on the vaginal mucosa have reproducibly demonstrated increases in squamous stratified epithelium thickness, epithelial glycogen levels, and glycogen-rich shedding cells at the epithelial surface. Fibroblast activation and increased extracellular matrix content, including collagen and ground substance, have been observed in the lamina propria. Papillae in the lamina propria and undulated epithelium and neovascularization within the papillae have been demonstrated in vaginal histology post treatment. Similar findings have been demonstrated following fractional Er:YAG laser treatment of vaginal mucosa, with increased thickness and cellularity of the epithelium, compact lamina propria, a denser arrangement of connective tissue, and increased collagen and elastin.

Deployment of the fractional laser for the treatment of the atrophic vaginal mucosa leads to neocollagenesis and to production of ground substance components within the connective tissue, as well as glycogen and acidic mucins within the epithelium and on the epithelial surface. These activities revert the vaginal mucosa from an atrophic state to a healthy premenopausal state.

Fractional Er:YAG laser treatment of the vagina demonstrates similar histological findings, with evidence of a thicker and more cellular epithelium and a more compact lamina propria with a denser arrangement of connective tissue. Up to 12 months post treatment, progressive new vessel formation, increased cellularity, neo-angiogenesis, increased papillomatosis, basal cell hyperplasia, and restoration of the lamina propria with angiogenesis and increased extracellular matrix are seen.

**RF energy**

RF energy heats three-dimensional volumes of tissue at controlled depths with the subsequent creation of new dermal volume. Both neocollagenesis and elastogenesis are induced, with improved skin elasticity, correlating with improved skin elasticity correlated by elastometry. Collagen fibers are composed of a triple helix of protein chains linked via interchain bonds to form a crystalline structure. When collagen fibers are heated to specific temperatures, they contract due to breakage of intramolecular hydrogen bonds. Contraction causes the crystalline triple helix structure to fold, creating thicker and shorter collagen fibers. This is thought to be the mechanism of action of immediate tissue tightening seen after skin-tightening procedures. The author has theorized that partially denatured collagen serves as a signal for neocollagenesis and that the creation of new elastin is basis for improvement in laxity. Vaginal histological studies to evaluate the effect of monopolar RF are needed.

**Device protocols**

**Fractional lasers**

Devices for genitourinary application are Food and Drug Administration (FDA) cleared generally for ablation, coagulation, or vaporization of genitourinary tissue; clearances for genitourinary syndrome of menopause are still under clinical trials.

Prior to commencing treatment with fractional lasers in the vaginal tract, a normal speculum examination and negative Panicalou smear are required. Contraindications and relative contraindications to treatment to be considered include the following: urinary tract or genital infection, active or recent malignancy, electrical implant anywhere in the body, significant concurrent illness, anticoagulative or thromboembolic condition or taking anti-coagulation medications 1 week prior to and during the treatment course, immunosuppression and/or immune deficiency disorders or medications, uncontrolled hormonal imbalance, lymph node dissection, conditions in the treated areas, history of keloid scarring, abnormal wound healing, history of collagen vascular disease or vasculitic disorders, use of isotretinoin within 6 months, systemic corticosteroid therapy, dysplastic nvi in the area, prolapse staged >II according to the pelvic organ prolapse quantification system, previous pelvic reconstructive surgery, or the presence of intrauterine devices.

A speculum examination of the entire vaginal vault and external examination should be performed on the day of treatment. No topical or local anesthetic is necessary. The settings on the device are provided by each manufacturer. In general, the fluence is in the low range of approximately 250 to 300 mJ/cm² and the spacing of the microbeams approximately 1 mm apart. The handpiece is inserted fully into the vault. The laser-based devices applied to vaginal tissue are listed in Table 2.

Pulses are administered circumferentially starting distally and retracting the device until the entire vault is treated. Upon reaching the introitus, the device is removed and handpiece exchanged for external treatment. External treatment with fractional resurfacing devices is associated with some discomfort. Topical anesthetic, such as 5% lidocaine gel, may be applied for 10 minutes prior to treatment and affords adequate pain control. The labia majora and minora as well as the clitoral hood may be treated with a single pass.

Each technology provides parameters and precise protocols for treatment. Following ablative resurfacing, a 2- to 3-day recovery time is anticipated, with avoidance of intercourse during this period. Rarely, spotting may occur. Discomfort is minimal to absent during treatment and minimal the first postoperative day. Any discomfort or burning may potentially signify infection, and a prompt evaluation and cultures are recommended.

**RF devices**

RF devices are monopolar and bipolar for vaginal application. The monopolar technologies employ a wand that is inserted into the
There is no aftercare or recovery time.9 With RF mobile delivery, attains with clinical outcomes. Temperatures exceeding this level are uniform surface temperature of 40 °C to 45 °C is attained correlates with clinical outcomes. As per the author’s prior research, mobile delivery of RF until a series, for its use in lichen sclerosus have shown demonstrable improvements.16-19 In several of these studies, between 75% and 80% of patients demonstrated improvement or complete resolution of their symptoms with follow-up of at least 2 years.16-19

### Sexual function

Treatment of sexual function with fractional lasers and RF has been reported in the literature with improvement in vaginal laxity, prolapse, and sexual satisfaction.12,20 In a study of monopolar RF, the clinical findings demonstrated improved "vaginal tightness."20 Treatment with Er:YAG laser showed improvement in perineometer values among all subjects.12 Dynamic quadrupolar RF treatment was reported to yield improvements in laxity, urinary symptoms, VVA symptoms (vaginal dryness, vaginal burning, vaginal itching, dyspareunia, dysuria), and sexual satisfaction.21

### Genitourinary syndrome of menopause

#### Fractional CO2 laser

Atrophic vaginitis and genitourinary syndrome of menopause have been most extensively reported, with numerous publications reporting clinical benefits. Statistically significant improvements in VVA symptoms (vaginal dryness, vaginal burning, vaginal itching, dyspareunia, dysuria) were reported in a study of 50 postmenopausal women treated 3 times with fractional CO2 laser at 12-week follow-up ($P < .001$), as well as in the Vaginal Health Index (VHI) scale, with scores of 13.1 ± 2.5 at baseline versus 23.1 ± 1.9 ($P < .001$).22 Follow-up report of the findings included improvement of vaginal health in a very high percentage of women (84%); VHI score and intensity of vaginal atrophy symptoms data showed significant improvement ($P < .001$) in dryness (80%), burning (90%), itching (80%), dysuria (74%), and dyspareunia (100% of sexually active women).10

A total of 77 subjects with VVA and sexual function were treated with fractional CO2 laser.22 Sexual function and quality of life were evaluated with the Female Sexual Function Index (FSFI) and the Short Form 12 (SF-12), respectively, at baseline and 12-week follow-up. A 10-mm visual analog scale (VAS) was used to measure the overall satisfaction with sexual life and the intensity of VVA symptoms (vaginal burning, vaginal itching, vaginal dryness, dyspareunia, and dysuria) before and after the study period. Statistically significant improvements in the FSFI at 12 weeks and overall satisfaction with sexual life were observed. Out of 20 sexually inactive women due to VVA severity at baseline, 17 (85%) regained a normal sexual life at the 12-week follow-up. Statistically significant improvements in each VVA symptom quality of life evaluation were reported.23

In a study of 48 postmenopausal women with atrophic vaginitis who underwent a series of 3 treatments to the vaginal mucosa with fractional CO2 laser, VVA and VHI improvements were noted. A total of 91.7% were satisfied or very satisfied with the procedure and reported a significant improvement in quality of life.24

Thirty women with genitourinary syndrome of menopause received 3 fractional CO2 treatments to the vaginal mucosa at 6-week intervals and were followed for 3 months.25 Significant improvement in all symptoms were noted, and no pretreatment or posttreatment analgesia was required. Laser settings entailed a power of 30 W, a dwell time of 1,000 μs, spacing between 2 adjacent treated spots of 1,000 μs, and a stack parameter for pulses from 1 to 3. Initial improvement, including increased lubrication within 1 week.
after the first treatment, was reported with further improvement after each session for 3 months.25

Fifty breast cancer survivors in oncological menopause (mean time of menopause 6.6 years) with genitourinary syndrome of menopause and dyspareunia were treated with 3 sessions of fractional CO\textsubscript{2}.26 The Gloria Bachmann VHI score was chosen as system to evaluate the presence of VVA and its improvement after the treatment. Intensity of dyspareunia was evaluated using aVAS. Statistically significant improvements in VVA dyspareunia and VHI scores were recorded 30 days post treatment ($P < .0001$). At 1 month, 76% of subjects were satisfied or very satisfied; at 11 months, 52% were satisfied. No adverse events due to fractional CO\textsubscript{2} laser treatment occurred.26

Sokol and Karam conducted a study of 30 women with VVA treated with 3 sessions at 6-week intervals of fractional CO\textsubscript{2} laser with 3-month follow-up.27 Dilator tolerance, vaginal pH, VAS to assess pain, vaginal burning, vaginal itching, vaginal dryness, dyspareunia, and dysuria, VHI scores, FSFI, and SF-12 questionnaires were used to assess outcomes. Participant satisfaction was measured on a 5-point Likert scale (1 being very dissatisfied, 5 being very satisfied). Average improvement in VAS was 1.7 (3.2) for pain, 1.4 (2.9) for burning, 1.4 (1.9) for itching, 6.1 (2.7) for dryness, 5.1 (3.0) for dyspareunia, and 1.0 (2.4) for dysuria; improvement in average VHI and FSFI scores were statistically significant ($P < .001$). Of 30 participants, 25 (83%) showed an increase in comfortable dilator size at 3-month follow-up. After the second treatment, 86.6% (26 of 30) of women reported better or much better, and after the third treatment, 96% (26 of 27) were reportedly satisfied or extremely satisfied.28 Among the 6 subjects followed up at 1 year, VAS scores improved in a statistically significant manner for all symptoms except dysuria.28 In addition, the differences between 3 months and 1 year were not statistically significant, indicating persistence of positive outcomes. Average pain 1.9 ($\pm 3.4$), burning 1.9 ($\pm 3.1$), itching 1.4 ($\pm 1.9$), dryness 5.9 ($\pm 2.8$), dyspareunia 4.9 ($\pm 3.3$), and dysuria 0.9 ($\pm 3.1$), as well as VHI scores and FSFI scores, statistically significantly improved ($P < .001$). Of 19 women undergoing dilator examination at 1 year, 18 (94.8%) were comfortable with the same or larger dilator size, and 22 of 24 women (92%) were satisfied or extremely satisfied with the treatment at 1 year.28

An important study demonstrated the effects of fractional CO\textsubscript{2} on the microflora of the vaginal tract of postmenopausal women.29 After 3 sessions, the investigators reported normalization of the pH and lactobacilli from a baseline of 30% to a normal level of 70%.29 This study supports the current author’s theory that the microflora of the vaginal tract potentially serves to maintain an acidic mantle and to protect the epithelium from erosion and atrophy.

A long-term follow-up study, by an independent group not funded by industry, of 102 women with genitourinary syndrome of menopause treated with fractional CO\textsubscript{2} laser showed improvement in dryness, incontinence, and sexual function.10

Finally, a large meta-analysis reviewed 14 clinical studies of the treatment of genitourinary syndrome of menopause with fractional CO\textsubscript{2} laser.11 They reported that the pooled mean differences for the various symptoms were as follows: dryness −5.5 (95% CI, −6.7 to −4.4; 7 studies; 12.0%), dyspareunia −5.6 (95% CI, −6.8 to −4.5; 7 studies; 12.0%), itching −4 (95% CI, −5.7 to −2.2; 6 studies; 12.79%), burning −3.9 (95% CI, −5.9 to −2; 6 studies; 12.87%), dysuria −2.9 (95% CI, −5.1 to −0.7; 4 studies; 12.90%), and UI −4.9 (95% CI, −6.4 to −3.4; 2 studies; 12.0%). The King’s Health Questionnaire, Urogenital Distress Inventory Short Form-6 (UDI-6), MCS12/PCS12, FSFI, overall sexual satisfaction, and measurements of the effect of laser therapy on the local pathophysiology improved significantly. They concluded that laser therapy for postmenopausal women with genitourinary syndrome of menopause appears promising and may reduce symptom severity, improve quality of life of postmenopausal women, and restore the vaginal mucosa to premenopausal status. However, they deemed quality of the body of evidence as “low” or “very low,” and therefore evidence-based-modification of current clinical practice was not suggested.11

Recently, 45 postmenopausal women randomized to laser (L), estrogen (E), or LE groups were assessed for vaginal health outcomes.32 At baseline and at 8 and 20 weeks, VHI, VAS for VVA symptoms (dyspareunia, dryness, and burning), FSFI, and maturation value (MV) of Meisels were assessed. VHI average score was significantly higher at weeks 8 and 20 in all study arms. The LE arm also showed incremental improvement of VHI score ($P = .01$). L and LE groups showed a significant improvement of dyspareunia, burning, and dryness and the E arm only of dryness ($P < .001$). The LE group presented significant improvement of total FSFI score ($P = .02$) and individual domains of pain, desire, and lubrication. The L group showed significant worsening of pain domain in FSFI ($P = .04$), but FSFI total scores were comparable in all treatment arms at week 20.32

The current author is near completion of a clinical trial assessing fractional CO\textsubscript{2} laser for the treatment of vaginal atrophy and symptoms of genitourinary syndrome of menopause. In this study, the objective findings of vaginal pH, epithelial integrity, vaginal vault length, and moisture levels were assessed. Following the first of 3 treatments at monthly intervals, the following improvements were observed: 100% elasticity, 91% fluid volume, 73% pH level, and 82% epithelial integrity and moisture. Improvement in total VHI scores was reported by 100% of subjects, with a mean of 9.6 points of improvement at 3-month follow-up (12-month follow-up scores pending). The VHI improvements of the prior study, which showed a mean 8.9-point VHI improvement at 3 months and 10.5-point improvement at 12 months, were reproducible with the same protocol.

**Fractional Er:YAG.** Fractional Er:YAG laser treatment of the genitourinary syndrome of menopause resulted in a significant decrease of VAS of both vaginal dryness and dyspareunia ($P < .01$) with a significant increase of VHI score ($P < .01$). In postmenopausal subjects with mild to moderate stress urinary incontinence (SUI), vaginal erbium laser treatment was associated with a significant improvement of scores on the International Consultation on Incontinence Questionnaire-Short Form ($P < .01$).33 In a 50-subject randomized study of fractional Er:YAG versus topical estradiol, statistically significant ($P < .05$) reduction of dyspareunia, dryness, irritation, and leukorrhea symptoms was observed in the laser group at all follow-ups for up to 18 months post treatment.13 Significant improvement in MV and a decrease of pH in the laser group were detected up to 12 months after treatment. The improve-
ment in all endpoints was more pronounced and longer lasting in the laser group. Histological examination showed changes in the tropism of the vaginal mucosa and also angiogenesis, congestion, and restructuring of the lamina propria in the laser group.13

Hybrid fractional laser. In a study of a hybrid device of fractional 2940 Er:YAG and 1470-nm diode laser for the treatment of genitourinary syndrome of menopause, 57 subjects received 3 treatment sessions.34 Results showed significant improvement over baseline (P ≤ .05): atrophy 40%, dyspareunia 45%, dryness 52%. FSFI scores also improved significantly (P ≤ .05), overall and in all domains.34

Radiofrequency. RF clinical trials have also been published. In one study of 24 subjects with vulvovaginal laxity, improvements on MV-FSFI and Female Sexual Distress Scale-Revised (FSDS-R), Vaginal Laxity and Sexual Satisfaction Questionnaires were reported.20 Several studies of RF for SUI reported benefit.35 A study of 120 subjects treated with a single 30-minute session of transvaginal RF showed improvements in UI symptoms.35 Preoperatively, 101 patients (84%) averaged 1 or more episodes of UI per day. At 3, 6, and 12 months, 57%, 66%, and 59% of patients, respectively, averaged 1 or no daily episodes of UI. At 12-month follow-up, 79 of 109 patients (73%) reported being continent or improved. Preoperatively, 43% of patients reported using 1 or no pads daily. At 3, 6, and 12 months, 69%, 70%, and 72% of patients, respectively, required 1 or no pads daily. On urodynamic evaluation at 12-month follow-up, 76.0% of the patients did not leak with a Valsalva maneuver.35

Another 94-subject study assessed the outcomes on UI of a single transvaginal RF treatment of the bladder neck and urethra.36 Preoperatively, 78% of patients had an average of 1 or more episodes of UI daily. At 1-, 3-, 6-, and 12-month follow-up, there was an average of 1 or fewer episodes of UI daily in 84.7%, 85.6%, 85.9%, and 77.4% of patients, respectively, and at 12 months, 83.5% reported being continent or improved. Preoperatively, 41.2% of patients reported using 1 pad or less daily, while at 1-, 3-, 6-, and 12-month follow-up after RF treatment, 85.6%, 90.4%, 87.2%, and 86.9%, respectively, required 1 pad or less daily. At 12 months, urodynamically evaluation showed no leakage on Valsalva maneuver in 78%.36

In a 25-patient study of RF treatment of sexual dysfunction, 23 patients reported an average reduction in time to orgasm of 33%.15 Patients also noted significant vaginal tightening effects, increased vaginal moisture, and improved clitoral sensitivity. All anorgasmic patients reported the ability to achieve orgasms.15

Among 27 subjects with stress UI and vaginal laxity, a reduction in urinary leakage, improvement in elasticity, and improvement in sexual function were reported.35 The average weekly frequency of urine leakage improved from 2-3 (2.15 ± 1.03 points prior to treatment) to 1 (1.00 ± 0.78 points post treatment) to 0 (0.44 ± 0.51 points at the 1-month follow-up visit). Sixteen subjects (59.3%) reported decrease in leakage amount, and 15 (55.6%) reported no leakage at 1-month follow-up. Interference with everyday life decreased in 88.9% and was eliminated in 62.9%. All results were statistically significant (P < .05). No adverse events were recorded. All subjects reported improvement in vaginal laxity, from very loose (2.19 ± 1.08 points prior to treatment) to moderately tight (5.74 ± 0.76 points at the 1-month follow-up visit). A total of 89% of the patients “agreed” or “strongly agreed” that their SUI condition improved, and 93% of the patients “agreed” or “strongly agreed” that their gratification during intercourse improved.37

At-home device. An at-home transvaginal device (vSculpt/VFit, Joylux) uses light-emitting diodes (LEDs) in the red and infrared range (662-855 nm) to heat the vaginal surface to 41 °C (38.6 °C-44.1 °C). The device also employs vibration at 80 to 110 Hz for up to 10-minute treatment sessions. Improvement in UI showed 84% of patients with >50% improvement, with a reduction in the 1-hour median pad weight test from 18 g to 0 g.38 On the UDI and Incontinence Impact Questionnaire Short Form (IIQ), UDI improved by >50% in 92% of patients, and IIQ improved in 85% of patients and decreased in 69%. On the FSFI and FSDS, improvements in 77% and 81% of patients, respectively, were reported. Patient satisfaction was rated as moderate to extreme at 83%.39 On histology, increases in collagen and elastin production in cells by irradiated fibroblasts were observed. This production was proportional to the duration of exposure.38

Conclusion

Several fractional lasers—including CO2, Er:YAG, and hybrid 1470-nm diode—and RF devices are FDA cleared for vaporization, incision, excision, ablation, or photocoagulation of genitourinary tissue. Fractional CO2 10,600 nm and Er:YAG 2940 nm vaporize—and nonablative 1470 nm heat—microcolumns from vaginal epithelium into lamina propria, which generates granulation tissue and triggers epithelial thickening, angiogenesis, and dermal remodeling. RF devices, both monopolar and bipolar, are theorized to similarly induce neocollagenesis and neoeLASTogenesis as they do in skin to reduce vaginal laxity. Published studies have shown at-home LED and red and infrared light devices to improve vaginal health on various scales and indices and may provide practical alternative to in-office procedures. Clinical trials with the aforementioned technologies are underway for the treatment of genitourinary syndrome, atrophic vaginitis, UI, and pelvic prolapse. The overall approach appears to be fractional lasers for the treatment of atrophy (VVA, UI) and RF for the treatment of laxity (UI, prolapse).

References


