Maturitas 99 (2017) 10–15

Contents lists available at ScienceDirect

Maturitas

journal homepage: www.elsevier.com/locate/maturitas

Laser therapy for the restoration of vaginal function

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ARTICLE INFO

Article history:
Received 12 October 2016
Received in revised form 16 January 2017
Accepted 25 January 2017

Keywords:
Genitourinary syndrome of menopause
Urinary incontinence
Pelvic organ prolapse
Vaginal relaxation syndrome
Vaginal laser therapy

ABSTRACT

Laser therapy has a therapeutic role in various medical conditions and most recently has gained interest as a non-hormonal treatment for genitourinary syndrome of menopause (GSM) and as a non-invasive option for stress urinary incontinence (SUI). Several therapies are available to alleviate GSM symptoms, including hormonal and non-hormonal products. Both microablative fractional CO_2 laser and the non-ablative vaginal Er:YAG laser (VEL) induce morphological changes in the vaginal tissues, and data from non-randomized clinical trials suggest that laser therapy can alleviate vaginal dryness and dyspareunia. VEL has been reported to improve SUI as well as vaginal prolapse. Although large randomized trials have not been reported, the evidence suggests that VEL can be offered as a safe and efficacious alternative to hormone replacement therapy (HRT) for GSM, as well as a first-line treatment for mild to moderate SUI, before surgical procedures are resorted to. Randomized studies are needed to compare laser treatments with other therapies, as well as to assess the duration of the therapeutic effects and the safety of repeated applications. Research is presently evaluating both an automated robotic probe for VEL treatments and an intraurethral probe for the treatment of severe and type III SUI.

Contents

The word ‘LASER’ is an acronym for ‘light amplification by stimulated emission of radiation’. Lasers generate a beam of photons released from the laser medium; the medium determines the specific wavelength of the light emitted and also typically gives the type of laser its name. Current medical lasers emit wavelengths from the ultraviolet to the mid-infrared portions of the spectrum. The medium is activated with some form of energy, which is usually either light or electricity. The stimulated emission of photons occurs in the medium, which is then amplified in the laser cavity. The cavity consists of the medium bounded in the front and rear by mirrors. The photons emitted are of identical wavelength and are precisely synchronised in phase, temporally and spatially. Moreover, the beam is more or less parallel, a feature known as collimation. The sum of these three characteristics of laser light is termed ‘coherence’, and it is coherence that gives a laser beam its

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http://dx.doi.org/10.1016/j.maturitas.2017.01.012
0378-5122/

uniquely high photon intensity and allows it to be focused on very small areas. Biological tissues such as blood and substances such as melanin and water generally have very different absorption spectra (i.e. they optimally absorb light of different wavelengths). Laser treatment has been long been used safely and effectively used in many areas, such as dermatology, dentistry, ophthalmology and cosmetic medicine. More recently, several innovative publications on the use of laser in gynaecology have also appeared.

This paper reviews the use of laser therapy for the treatment of genitourinary syndrome of menopause (GSM). An extensive search was performed using EMBASE and PubMed Central (PMC)-NCBI for scientific publications written in English, with keywords including genitourinary syndrome of menopause (GSM); vulvo-vaginal atrophy (VVA); atrophic vaginitis; postmenopausal symptoms; and vaginal laser therapy. All publications reviewed were in English and were published within the last 8 years. The present review is based on a total of 20 prospective studies and 1 randomized controlled study; reported only in an abstract. In addition; 11 review articles and 11 in vitro studies were found to meet the inclusion criteria. The characteristics of the full-length studies published in scientific journals and included in our review are presented in Table 1.

1. Genitourinary syndrome of menopause (GSM)

Genitourinary syndrome of menopause (GSM) includes a constellation of symptoms related to a decline of circulating ovarian hormones, such as vaginal dryness, dyspareunia, recurrent urinary tract infections and urinary incontinence. GSM replaces the term 'vulvo-vaginal atrophy', as agreed by the joint terminology conference sponsored by the North American Menopause Society (NAMS) and the International Society for the Study of Women's Sexual Health (ISSWSH) [1–5]. All these symptoms may interfere with sexual function and quality of life [6–11].

Several therapeutic options are available to alleviate GSM symptoms, including hormonal and non-hormonal products. Moisturizers and lubricants tend to provide only temporary relief, whereas local vaginal estrogen administration offers long-term relief and so is the treatment of choice [12–17]. However, some women may not wish to take HRT long term or have contraindications to estrogen therapy [12–17]. Recently ospemifene has been introduced as an oral medication for the treatment of dyspareunia. It provides an alternative to oral and local estrogen therapies [18–20]. New management strategies for GSM mean that women can choose from a wide range of options, with due consideration to the benefits and risks associated with each. One such option is laser therapy, which can be used to stimulate tissue repair and to restore normal vaginal function.

2. The CO_2 laser: first-generation laser treatment for GSM

The carbon dioxide laser (CO_2 laser) was one of the earliest gas lasers developed, and is still one of the most commonly utilized lasers in various industrial and medical applications [21,22]. The CO_2 laser emits light at 10,600 nm, the only chromophore for which is water, the major constituent of mucosal tissues. Ablative-pulsed CO_2 lasers are used to treat vaginal atrophy [23–35]. In 2011, Gaspar et al. [23] first demonstrated that vaginal fractional CO_2 laser treatment induced a significant improvement in the clinical and histological signs of vaginal atrophy. Subsequently, in seminal observational paper, Salvatore et al. [24] reported a 12-week study where symptoms were analysed before and after 3 sessions (one per month) of fractionated CO_2 laser. In the sample of 49 patients, vaginal dryness was improved in 43 women (86.0%), vaginal burning in 45 (90.0%), vaginal itching in 40 (80.0%) and dysuria in 37 (74.0%). Dyspareunia was improved in all women who were sexually active. Similar results were obtained in younger women suffering from VVA due to treatment for endometriosis [25]. The effects of microablative fractional CO_2 laser therapy on VVA led to an improvement of both sexual function and quality of life [26].

These studies started a new era for the non-hormonal treatment of GSM. The effects of CO_2 laser were also evaluated on ex vivo vaginal specimens from postmenopausal women, and the samples showed remodelling without damage to surrounding tissue [27]. Zerbinati et al. [28] published elegant studies that produced histological evidence of the restoration of vaginal mucosal structure following microablative fractional CO_2 laser treatment, as well as increased collagen and extracellular matrix production, together with an increase in the thickness of the vaginal epithelium, with the formation of new papilla [28]. Microablative fractional CO_2 laser technology has since been presented extensively to healthcare practitioners and directly to consumers. There are now some other CO_2 laser systems marketed for the treatment of GSM, using different machines and technologies, with claims of similar effects [23–35]. However, at present no efficacy and safety data are available for GSM treatment with different CO_2 lasers.

Recently, Perino et al. [35] reported that fractionated CO_2 laser therapy might also improve overactive bladder in post-menopausal women. No data are available about the possible effects of CO_2 laser therapy on SUI. No data from randomized trial (sham versus treatment) have been produced and no data on the duration of treatment effects are available.

3. Vaginal erbium laser (VEL®) treatment

The non-ablative 2940 nm Er:YAG (so-called because it uses an erbium yttrium-aluminum-garnet medium) laser uses precisely controlled, sequentially packaged bursts of long pulses, termed SMOOTH® mode. In this paper vaginal erbium laser (VEL) refers to SMOOTH technology. Studies of its thermal effects on human soft tissue have shown deep collagen remodelling and new collagen synthesis [36–44]. Exposure of tissues to an appropriate controlled temperature increase result in a rapid contraction of collagen fibres, leading to the contraction and shrinking of the exposed tissue [38]. The increased temperature elicits collagen remodelling, resulting in the generation of new collagen and an overall improvement in the tightness and elasticity of the treated tissue [44]. In one study of the application of laser therapy to the genital tract, the high success rate for the treatment of multifocal lesions, excisions and tissue coagulation with Er:YAG lasers was accompanied by an interesting and unexpected effect, on vaginal tightening, which in turn resulted in an enhanced sexual experience [43]. This observation inspired further research in the direction of developing a minimally invasive, non-surgical and non-ablative laser treatment [44–73]. Tightening of the vaginal canal and consequently the improvement of sexual gratification have been observed [44–48]. Specific vaginal probes have been designed to enable a uniform and well-controlled VEL distribution on the whole length and circumference of the vaginal canal. The use of erbium SMOOTH technology for vaginal tightening and incontinence has spread around the world and many additional studies have been initiated to further assess this technology and treatment approach. We have to underline that much of the published evidence has been obtained using the non-ablative solid-state Er:YAG laser with a wavelength of 2940 nm. The SMOOTH mode allows the use of a full beam and patterned handpieces to deliver laser energy with different influences on vaginal tissue.

Recent publications suggest that VEL may provide non-ablative, second-generation laser photothermal vaginal therapy [48–73]. Vaginal laser has profound effects on the vaginal epithelium and lamina propria [47,48]. Gaspar et al. [49] presented seminal data on the effects of VEL in comparison with estrogen vaginal administra-