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GENERAL GYNECOLOGY

Evaluation of the efficacy of fractional CO_2 laser in the treatment of vulvar and vaginal menopausal symptoms

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Abstract

Purpose The objective of this study was to evaluate the efficacy of fractional CO_2 laser to manage vulvar and vaginal symptoms of Genitourinary Syndrome of Menopause (GSM) in postmenopausal women.

Methods All postmenopausal women with symptoms of GSM undergoing fractional CO_2 laser treatment in our centers were asked to fill out a validated quality of life questionnaire (Global Quality of Life Questionnaire), Visual Analog Scale (VAS) for symptoms, a questionnaire on overall discomfort related to pelvic floor symptoms, and the Female Sexual Function Index (FSFI) at several points: before each session (three sessions at monthly intervals) and one 3 months after treatment completion. Statistical analysis compared pre-therapy data and data at 3 months of treatment.

Results Forty-six women were included with a mean age of 57.3 years (± 11.1 years). A significant improvement was demonstrated in vaginal dryness ($p = 6.34\ 10^{-6}$) and for symptoms of stress urinary incontinence ($p = 0.043$). Among sexually active patients, there was a significant improvement in the degree of symptom discomfort affecting their satisfaction ($p = 0.007$), dyspareunia ($p = 0.001$) and sensitivity during sexual intercourse ($p = 0.001$). Significantly, more women were able to achieve ($p = 0.026$) and maintain ($p = 0.018$) lubrication during intercourse.

Conclusion CO_2 laser treatment seems to improve the quality of life and sexual health of patients as well as GSM symptoms at 3 months of treatment; long-term reevaluation is necessary to demonstrate that improvement persists over time.

Keywords Fractionated CO_2 laser · Menopause · Vulvovaginal atrophy · Genitourinary menopause syndrome · Vaginal dryness · Quality of life · Sexual activity

Introduction

The International Society for the Study of Women's Sexual Health (ISSWSH) and the North American Menopause Society (NAMS) defined the Genitourinary Syndrome of Menopause (GSM) in May 2013 as the clinical and functional consequences of vulvovaginal and lower urinary tract changes associated with menopause [1]. The definition includes cellular, histological, anatomical, and functional changes due to estrogen deficiency [1–3]. It is estimated to affect 10–50% of postmenopausal women [2] and is responsible for a significant impairment of quality of life in at least 25% of symptomatic postmenopausal women [4]. The management of these symptoms is therefore a public health issue.

Women with GSM are often managed with hormonal treatments by the systemic (menopausal hormone therapy (MHT)) or local (local estrogen) routes: MHT improves vaginal lubrication, blood flow and trophicity of genital tissues [5, 6], and small doses of intravaginal estrogen increase vaginal pH and the epithelial maturation index and restore vaginal flora with minimal systemic effect [7, 8]. The Women's EMPOWER Survey conducted in 2017 to evaluate women's perception of the different therapeutic alternatives of GSM showed that approximately 35% of women refuse hormonal treatments, whether systemic or local, for fear of adverse effects [9]. Non-hormonal alternatives in this context are therefore essential and currently include lubricants, moisturizers, hyaluronic acid, and physical methods such as perineal rehabilitation. Furthermore, due to contraindications

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to hormonal treatments (hormone-dependent cancer) and the constraints of use and variable effectiveness of local treatments, other therapeutic options have been developed such as erbium light amplification by stimulated emission of radiation (laser), CO_2 laser, light emitting diode (LED), and radiofrequency (RF). The application of thermal energy to the genital mucosa stimulates tissue repair and leads to the proliferation of a healthy, glycogen-rich, multilayered epithelium, the formation of collagen in the lamina propria, and neo-vascularization all of which lead to an improvement in lubrication and local tissue properties [10, 11]. Although the various studies are reassuring about the side effects of these treatments, their long-term adverse effects remain to be defined [12]. The use of this device must be done safely, by trained health professionals, with certified devices, in precise indications, in ideal circumstances with respect to contraindications.

The objective of our study was to evaluate the efficacy of laser treatment by the Mona Lisa CO_2 vaginal laser on GSM symptoms in a prospective approach based on quality of life questionnaires completed by treated patients.

Materials and methods

Study population

This was a two-center, hospital–office-based, retrospective study. Data collection took place from January 2018 to May 2019 in a hospital gynecology, breast surgery and oncology department as well as in an office-based practice in Paris. Our study protocol has been approved by the ethics committee: the Comité d'Ethique de la Recherche en Obstétrique et Gynécologie (CEROG). The submission number is CEROG 2020-GYN-0602.

The inclusion criteria for the study were as follows: menopausal women, presenting a symptom of GSM and having given her consent for laser treatment after being informed of the benefits and risks.

The exclusion criteria for this study were as follows: symptomatology not falling within the scope of GSM (deep pelvic pain) and/or the presence of a contraindication to the use of fractional CO_2 laser (an abnormal smear test; untreated cervical, vaginal or vulvar dysplasia lesions; active infections; uninvestigated metrorrhagia; vaginal and/or cervical wounds; previous genital tract reconstructive surgery; sub-urethral bandage perceptible on examination; or deep pelvic pain).

Clinical variables included the woman's age, body mass index (BMI), menopausal status, the presence of early ovarian failure, history of breast or pelvic cancer and resulting treatment, prior use of MHT, local estrogen therapy, lubricants or hyaluronic acid for treatment of GSM.

Questionnaire

The patients were asked to complete a pre-therapy questionnaire, then one before each session and finally a questionnaire 3 months after the completion of treatment. The questionnaires were retrospectively analyzed.

The questionnaire was composed of the following validated quality of life questionnaires frequently used in other studies on GSM:

- Global Quality of Life Questionnaire (quality of life SF12) [13].
- Visual Analog Scale (VAS) on GSM symptoms (discomfort/prolapse sensation, low sensitivity during intercourse, vaginal loss, vaginal dryness, vaginal pruritus, dyspareunia, dysuria) where 0 denotes the absence of symptom and 10 the presence of a very disabling symptom.
- Questionnaire on overall discomfort related to pelvic floor symptoms (PFDI-20) [14].
- The Female Sexual Function Index (FSFI): patients are asked about their sexual feelings and behavior over the previous 4 weeks, differentiating between sexual activity, sexual intercourse and sexual stimulation [15].
- One question at the end about the overall level of satisfaction.

Vaginal laser therapy

The device used was a fractional CO_2 laser (MonaLisa Touch®, DEKA M.E.L.A. SRL., Calenzano). The treatment plan consisted of three sessions at monthly intervals with an evaluation consultation 3 months after treatment completion. The patients were treated according to the protocol already described and published by our team [16].

The laser treatment was administered during an outpatient consultation, in a gynecological position, without local anesthesia and after a complete interrogation and clinical examination including checking the integrity of the lower genital tract.

The device was unlocked manually with a safety key and the parameters selected manually by the practitioner: vulvovaginal laser (V2LR) mode; laser shot power at 30–35 watts; vaporization depth in the mucous membrane from 1 to 5; laser pulse time (1000 microseconds); pulse mode: DOT scan (split); D-Pulse type and distance between shots (1000 microns).

Once the settings had been made, the vaginal probe was inserted up to the vaginal fundus without prior lubrication. A circular ring at the base of the probe allowed the vestibule to be identified. Once correctly positioned,

the operator triggered the laser shots by a foot pedal. The probe was progressively removed millimeter by millimeter firing two shots with a 45-degree rotation between each shot to cover the entire surface.

After each session, the patients were advised to refrain from sexual intercourse and bathing for 48–72 h. They were warned that minimal bleeding or, more rarely, pelvic pain may be experienced for 2–5 days following the procedure.

Statistical analysis

To describe the clinical and demographic characteristics of our population, we used means with standard deviations. Statistical analysis was based on Student's *t* test. For non-binary variables, the paired Wilcoxon test was used to compare the differences between pre- and post-therapy responses. For binary variables, the McNemar test was used. The difference was considered significant if $p < 0.05$.

Results

Population characteristics

The characteristics of the population are detailed in Table 1. Forty-six patients 32 patients at the hospital and 14 at the office-based practice received the full treatment protocol and attended the assessment consultation at 3 months.

The patients had a mean age of 57.3 years (±11.1 years). Forty-three patients (93.5%) were menopausal, and three (6.5%) had premature ovarian failure (IOP). The average BMI was 25 (±4.7) for the hospital patients and 20.2 (±3.2) for the office-based practice ($p = 0.003$). At the hospital, 13 patients had breast cancer and four pelvic cancer. In the office-based practice, one patient had pelvic cancer and none had a history of breast cancer. Overall, 18 patients (39.2%) presented a hormone-dependent cancer and therefore a contraindication to hormonal treatments.

The details of therapy used by patients before considering laser vaginal therapy for GSM are presented in Table 1.

Results per symptom

Vaginal dryness and vulvovaginal symptoms (Fig. 1)

There was a significant improvement in vaginal dryness; the mean VAS before treatment was 7.28 (±3.14) versus 4.05 (±3.12) after treatment ($p = 6.34\ 10^{-6}$). The same improvement was observed for vaginal atrophy ($p = 0.011$). There was no significant difference found for pruritus ($p = 0.122$).

Urinary, gastrointestinal and prolapse symptoms (Fig. 2)

Overall, the patients reported a slight improvement in urinary symptoms. A significant difference was found in patients with stress urinary incontinence (SUI) symptoms (47.8% before vs. 30.4% after treatment, $p = 0.043$). There was no significant difference in pollakiuria ($p = 0.181$). There were an equal number of patients with urgency before and after full treatment (34.8%). There was a

Table 1 Patients characteristic and previous therapy for Genitourinary Syndrome of Menopause

	Total ($n = 46$)	Pitié Salpetrière ($n = 32$)	Odéon ($n = 14$)	*p*
Age (années): M ± EC	57.3 ± 11.1	57.4 ± 13.5	57.3 ± 10.2	0.958
Poids (kg): M ± EC	62.4 ± 14.2	68.7 ± 14.4	52.3 ± 5.5	0.0004
Taille (cm): M ± EC	163.1 ± 8.1	164.7 ± 8.2	161.5 ± 8.1	0.343
IMC (kg/m^2): M ± EC	23.2 ± 4.7	25 ± 4.7	20.2 ± 3.2	0.003
Ménopausée: *n*, (%)	40, (87.0%)	30, (93.8%)	12, (85.7%)	0.574
Utilisation d'un THM *n*, (%)	14, (30.4%)	7, (21.9%)	7, (50%)	0.748
Utilisation d'un traitement Hormonal local: *n*, (%)	20, (43.5%)	13, (40.6%)	7, (50%)	0.084
Utilisation d'acide Hyaluronique: *n*, (%)	11, (23.9%)	5, (15.6%)	6, (42.9%)	0.065
Utilisation de lubrifiant: *n*, (%)	23, (50%)	11, (34.4%)	12, (85.7%)	0.003
Cancer du sein: *n*, (%)	13, (28.3%)	13, (40.6%)	0, (0%)	0.004
Cancer pelvien: *n*, (%)	5, (10.9%)	4, (12.5%)	1, (7.1%)	1
Radiothérapie pelvis: *n*, (%)	3, (6.5%)	2, (6.3%)	1, (7.1%)	1
Radiothérapie sein: *n*, (%)	11, (23.9%)	11, (34.4%)	0, (0%)	0.020
Chimiothérapie: *n*, (%)	11, (23.9%)	10, (31.3%)	1, (7.1%)	0.133
Hormonothérapie: *n*, (%)	10, (21.7%)	10, (31.3%)	0, (0%)	0.020
IOP: *n*, (%)	3, (6.5%)	3, (9.4%)	0, (0%)	0.543

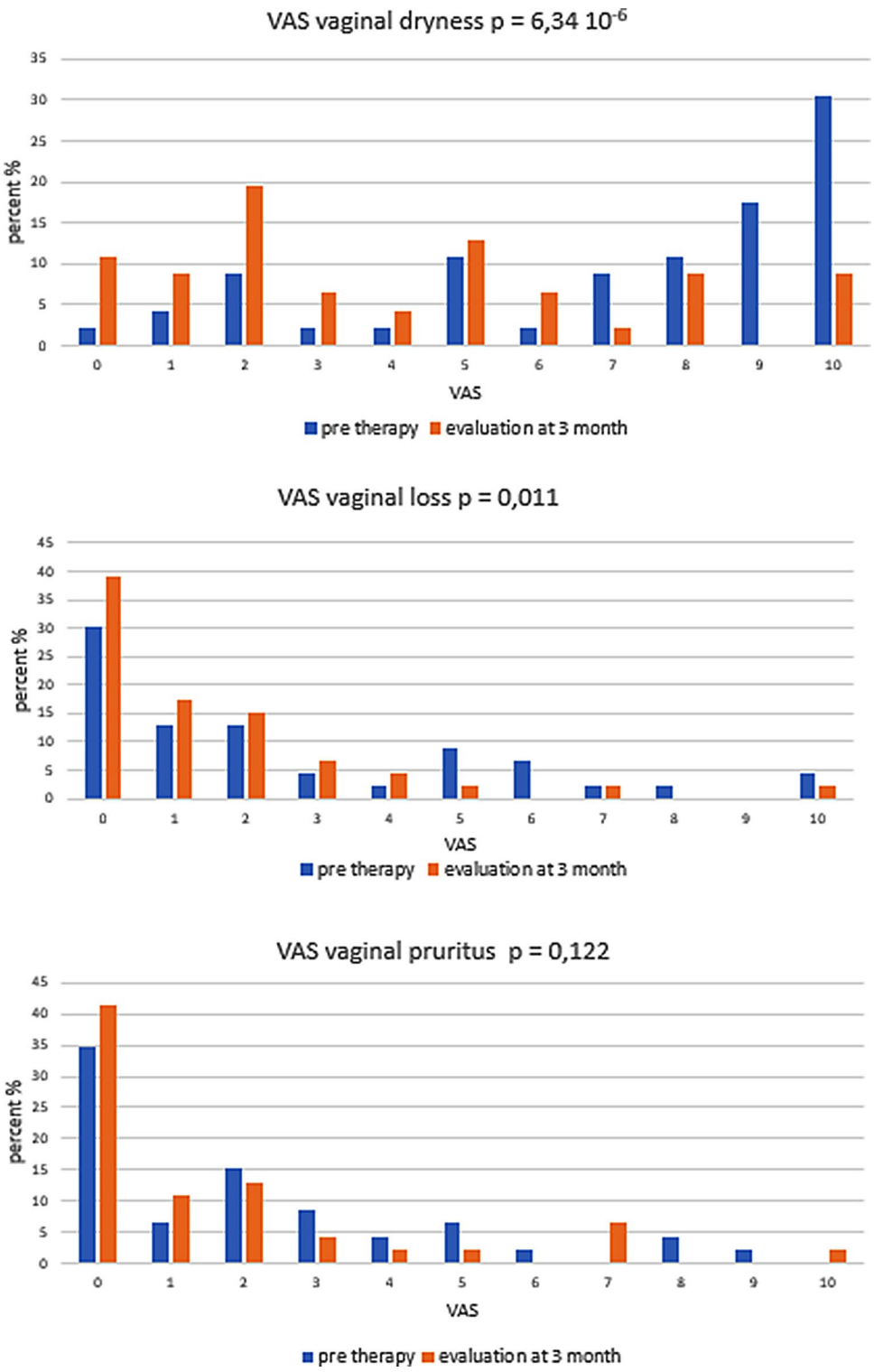

Fig. 1 Intensity of the symptom "vaginal dryness", "vaginal loss" and "vaginal pruritus," reported on a visual scale before and after vaginal laser treatment

non-significant decrease in the number of patients with urinary leakage (32.6% vs. 23.9%, $p = 0.505$). The VAS for dysuria did not show a significant difference; the mean VAS before treatment was 1.89 (± 3.51) versus 16.1 (± 3.10) after treatment ($p = 0.281$).

There was no significant difference in digestive symptoms after the treatment: 34.8% of patients reported having difficulties with bowel movements pre-therapy and 37% post-therapy ($p = 0.371$); 21.7% of the patients reported

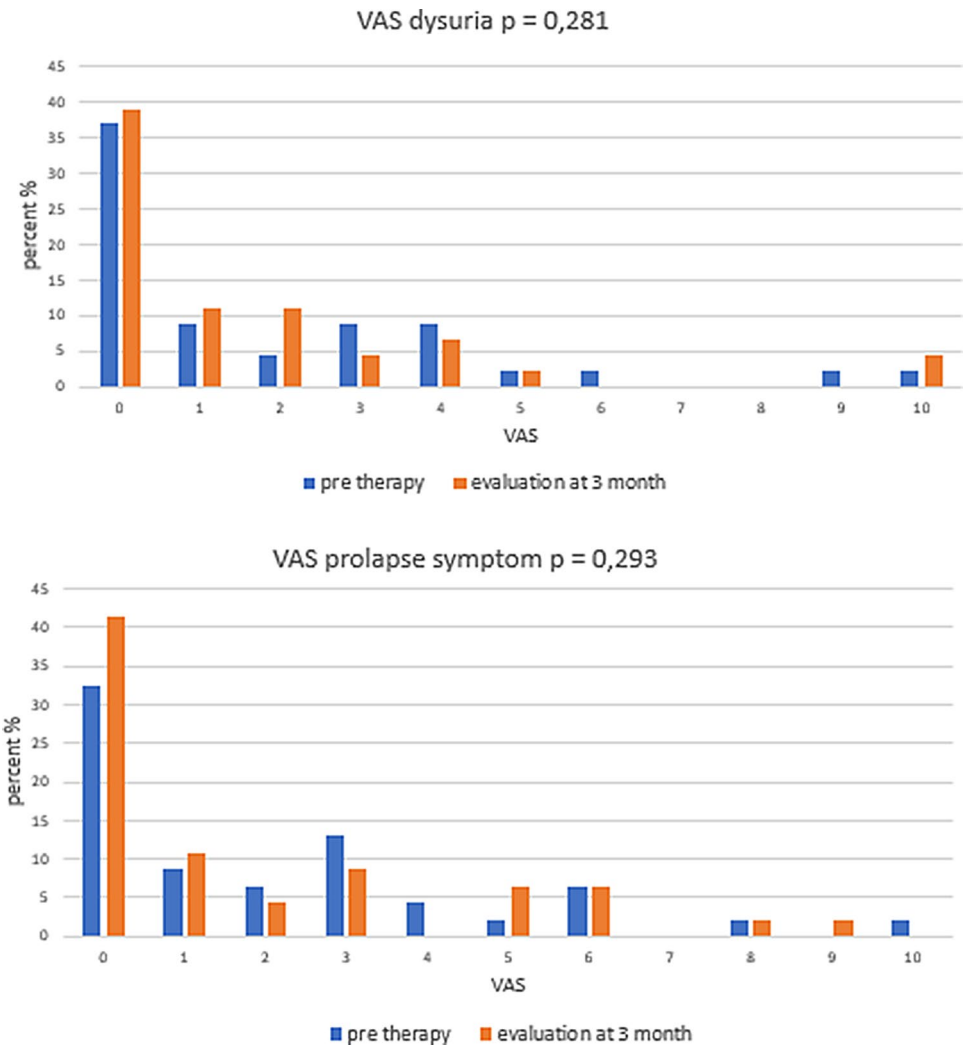

Fig. 2 Intensity of the symptom "vaginal dysuria" and "prolapse symptom", reported on a visual scale before and after vaginal laser treatment

passing gas or stool leakage pre-therapy and 26.1% post-therapy ($p=1$).

Similarly, there was no significant difference in symptoms of prolapse: 8.7% of the patients had a pelvic weight or vaginal ball sensation pre-therapy and 10.9% 3 months post-therapy ($p=1$). Consistent results were seen with the prolapse discomfort VAS ($p=0.293$).

Sexual health (Fig. 3)

There was a significant difference in the degree of discomfort of symptoms related to sexual activity: with 39.1% of patients experiencing a lot (21.7%) or a great deal (17.4%) of pain or discomfort reducing their satisfaction pre-therapy, compared to 8.7% who experienced a lot (6.5%) or a great deal (2.2%) of symptoms reducing their satisfaction post-therapy ($p=0.007$).

There was a significant improvement in the VAS of dyspareunia; the mean pre-therapy was 6.03 (± 2.60) versus 3.18 (± 2.52) post-therapy ($p=0.0001$). Likewise, for the symptom "low sensitivity" during sexual intercourse, the mean pre-therapy score was 5.26 (± 3.18) versus 3.05 (± 2.87) post-therapy ($p=0.001$).

The patients reported that overall satisfaction with their sexual life was higher after treatment: 8.7% were very satisfied before treatment versus 28.3% after treatment and 19.6% were dissatisfied before treatment versus 13.0% after treatment. This difference is not significant ($p=0.076$). There was no significant difference in satisfaction with the degree of intimacy ($p=0.098$) or sexual compatibility ($p=0.108$) felt with their partner.

The women had significantly less difficulty achieving ($p=0.026$) and maintaining ($p=0.018$) vaginal lubrication during intercourse or sexual activity post-therapy. Similarly, a significant decrease was found in the pain felt during and after vaginal penetration after laser treatment and for both combination (during and after) ($p=0.003$, $p=0.009$ and $p=0.004$).

There was no significant difference in the frequency or degree of sexual desire or interest after the laser treatment

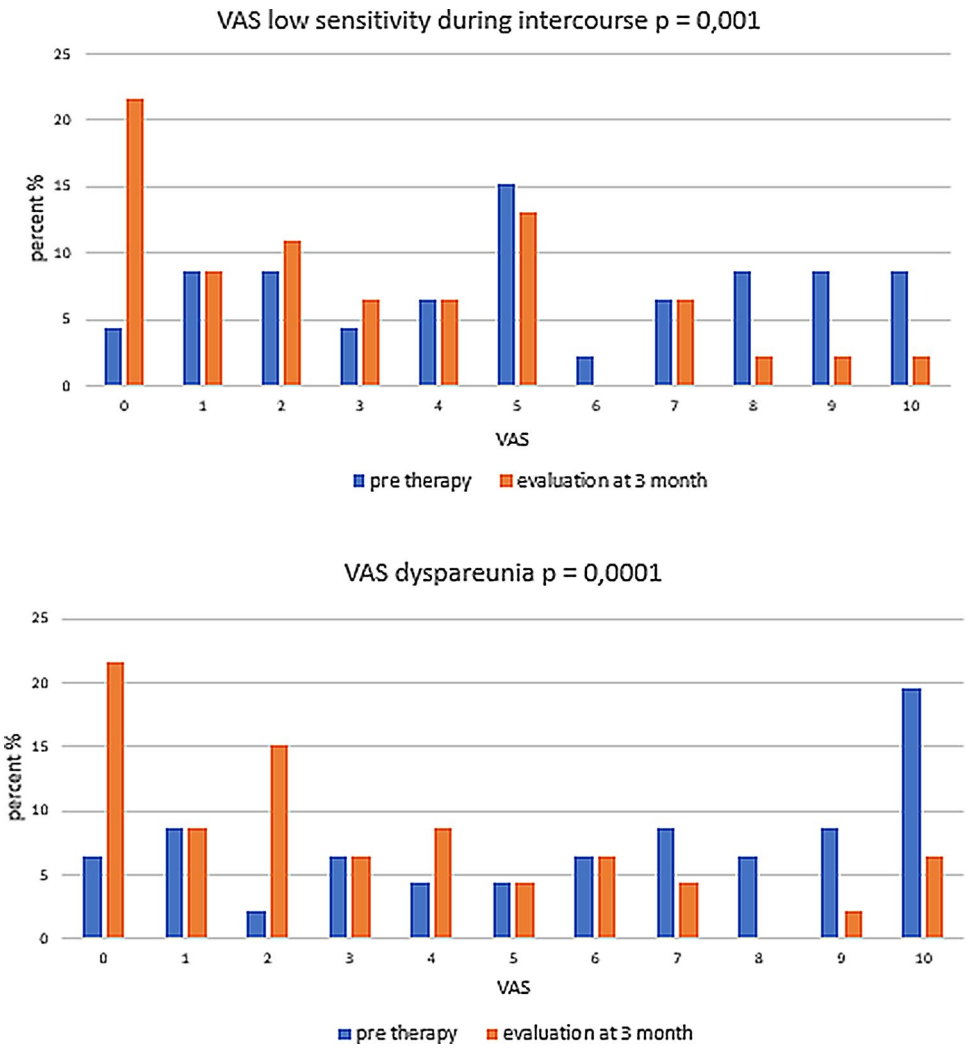

Fig. 3 Intensity of the symptom "low sensitivity during intercourse" and "dyspareunia", reported on a visual scale before and after vaginal laser treatment

($p=0.133$ and $p=0.074$, respectively). There was no significant difference in the frequency of pleasure felt by the patients ($p=0.865$) or in the level of pleasure achieved by the patients ($p=0.407$). Similarly, there was no significant difference in the frequency of reaching orgasm ($p=0.471$) but a non-significant trend in difficulties in reaching it ($p=0.121$) and greater satisfaction with their ability to reach orgasm after treatment ($p=0.747$).

Quality of life and overall comfort (Fig. 4)

An improvement in the quality of life of the patients was demonstrated 3 months after the laser treatment with 21.7% very satisfied and 45.7% satisfied although some patients (21.7%) did not show any significant improvement in their well-being or quality of life. At the end of the treatment, 6.5% of the patients were not satisfied and 4.3% were very dissatisfied. When analyzing the VAS evaluating the general satisfaction of the laser treatment, 54.3% of patients rated their satisfaction between 0 and 2 (low), 23.9% between 3 and 5 (moderate), 4.4% between 6 and 8 (good) and 2.2% between 9 and 10 (high).

The results of the SF12 showed that significantly fewer patients felt discouraged and downhearted ($p=0.005$). There were no significant differences in the impact on physical fitness or emotional problems in daily activities ($p=1$ for both), work ($p=1$, $p=0.387$) or social life ($p=0.240$).

After treatment, 19.5% of patients rated their health as very good or excellent vs. 13.0% before therapy and no patient rated it as poor at the end of treatment versus 4.3% before therapy ($p=0.437$).

One patient with a history of pelvic cancer treated with surgery, radiation therapy and brachytherapy presented with a vaginal evisceration. No other complications or side effects were reported.

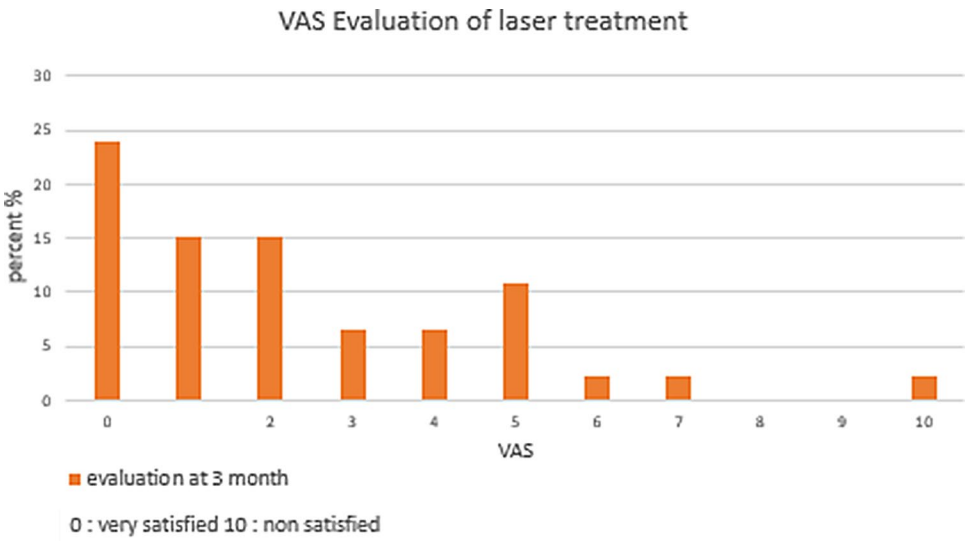

Fig. 4 Evaluation of laser treatment reported on a visual scale after treatment

Discussion

Fractional CO_2 laser treatment appears to have a beneficial impact on the quality of life and management of patients with GSM. In our study, 67.4% of patients claimed to be satisfied or very satisfied after treatment and a significant improvement was demonstrated in vaginal dryness, one of the main symptoms of GSM.

Among the sexually active patients, there was a significant improvement in the degree of discomfort of the symptoms affecting their satisfaction. A significant improvement in dyspareunia and sensitivity during sexual intercourse was also found. Significantly more women were able to achieve and maintain lubrication during intercourse. After laser treatment, more patients expressed feeling desire and pleasure, and could reach orgasm.

In general, all the studies agree that laser treatment improves genital symptoms overall and associated dyspareunia. One randomized multi-center study compared the efficacy and safety of CO_2 laser versus local estrogen use for 6 months in the management of GSM, including vaginal dryness. No serious adverse events were reported. A large majority of patients were satisfied and a similar improvement in GSM and in urinary and sexual function was observed [17]. A randomized study of 72 postmenopausal patients compared the effects of CO_2 laser (3 sessions), local estrogen (promestriene 10 mg) and non-hormonal lubricants in the management of GSM and their impact on sexual function. After 14 weeks of treatment, improvements in vaginal elasticity, volume, moisture, and pH were found in the CO_2 laser and promestriene groups. Improvement in vaginal maturation was more significant in the CO_2 laser group ($p < 0.001$) and a higher VIH score was found in the same group. No significant differences were found in the FSFI, but there was an improvement in the desire and lubrication in CO_2 laser group [18].

An overall improvement in urinary symptomatology was demonstrated in our study with a significant improvement in SUI symptoms (47.8% before vs. 30.4% after treatment, $p = 0.043$). This improvement in urinary symptoms (SUI, pollakiuria, dysuria) by laser treatment is an objective reflection of the spontaneous oral return of patients in consultation and has been demonstrated more recently. In another study, 161 postmenopausal patients with SUI were treated with four CO_2 laser sessions spaced 30–45 days apart, followed by an annual maintenance session at 1, 2 and 3 years. A significant improvement was observed in the pad test and International Consultation on Incontinence—Urinary Incontinence short scores (ICUI-UI SF). The results were confirmed at 36 month [19].

Similar to other studies investigating the effect of CO_2 laser treatment on pelvic floor symptoms, we found no impact on digestive symptoms or prolapse [20].

In 2017, Tadir et al. reached a consensus on the clinical efficacy of energy-based therapies on GSM symptoms after conducting a review of the literature. A number of cellular and histological changes were demonstrate [10]. The results of our study seem to confirm the current data in the literature on the subject. However, most publications dealing with CO_2 laser are non-randomized observational studies based mainly on subjective evaluation criteria (quality of life questionnaires, symptom severity scales). It is therefore essential to obtain clinical data based on large, controlled, prospective and randomized therapeutic trials with satisfactory power before this treatment can be validated and recommended by healthcare professionals.

Although the various studies are reassuring about the side effects of these treatments, their long-term adverse effects remain to be defined. This device must be used safely, by

trained health professionals, with certified devices, in precise indications, and in ideal circumstances with respect to contraindications. In July 2018, the FDA alerted patients and healthcare professionals about the use of energy-based devices that may be associated with serious adverse events (vaginal burning, scarring, pain during intercourse and recurrent pain) [21]. Of all the articles on the use of the laser, few side effects are reported, either of early or late onset [22].

A French position paper gathering the opinion of four experts on the subject was published in a French journal in September 2019 [23]. Based on published evidence, they concluded that laser should not be used in patients with vulvodynia, vulvar sclerotic lichen, genital prolapse or urinary incontinence [23]. It is becoming increasingly obvious that an evaluation of current practice and therapeutic indications is necessary [24]. A learned society the Research and Innovation Group in Genital Restoration (GRIRG) bringing together professionals from all disciplines was set up in France in 2015: Their goal is to increase knowledge and awareness in this field and to promote good practice [25]. Vaginal laser could be a valuable alternative to perineal rehabilitation and surgery in the management of SUI [26]. Such techniques are particularly interesting for patients being treated for cancer and who suffer the long-term consequences of the treatments received or who present a contraindication to hormonal treatments [27]. In this setting, moisturizers are recommended as a first-line treatment as are low-dose local estrogen for a short period of time. A systematic review and meta-analysis (including eight articles) was conducted to evaluate the efficacy and safety of laser use on the sexual health of patients with breast and/or gynecological cancer and found that symptoms such as vaginal dryness and dyspareunia improved as well as the FSFI score [28]. Our study included a high number of patients with hormone-dependent cancer which is often associated with an altered quality of sexual life. It thus stands to reason that this aspect of post-cancer care should be taken into consideration though the question is rarely addressed by health professionals.

Two other alternative techniques are being developed to support patients with GSM: RF and LEDs. RF is mainly used in the treatment of vaginal laxity and resulting sexual dysfunction [29]. Symptoms such as vaginal dryness and dyspareunia were improved by micro ablative RF in a pilot study and there was no further need of vaginal lubricant [30]. LEDs trigger intracellular photo biochemical, physiological, and nonthermal reactions, activating collagen production and stimulating all cellular functions. In gynecology we use intravaginal probes or panels that are positioned at the entrance of the vagina and emit red or infrared lights. Sessions generally last 15 min and are repeated several times a week. The indications for LEDs in gynecology are as follows: inflammation and healing (ulcers, vulvite, burns, episiotomy, surgical wounds), treatment of genital skin lesions (lichen, psoriasis, eczema, herpes, vaginosis), repair of functional disorders (vaginal dryness, dyspareunia, discomfort, vaginismus, vulvodynia) and vulvovaginal rejuvenation (usually associated with laser treatment). There are no contraindications.

Some limitations to this study deserve to be mentioned. Like many others on the subject, the population size was small, and we experienced a few setbacks in terms of follow-up. We plan to recontact the patients 1 year after the end of treatment to refine the long-term efficacy and satisfaction data. We also found that some patients had difficulty understanding the questionnaires. Our analysis did not include an objective endpoint. Even if the ultimate interest of such a therapy is patient satisfaction, it would be interesting to document the clinical results with a histological evaluation of the treatment effect on the vaginal mucosa and a study dedicated to intracellular signaling pathways investigations. However, questionnaires used are validated and identical to those found in the literature, which allows a more reliable comparison and better reproducibility of the results. One of the strong points of our study was the city-hospital-based recruitment which offers an interesting insight into the use of the technique given the importance of these devices in office-based practices.

Conclusion

Fractional CO_2 laser seems to have its place in the management of the GSM. Our study confirms the current data in the literature suggesting that this tool could bring a benefit in terms of quality of life to many patients with minimal exposure to side effects, subject to strict compliance with its indications and implementation protocols. Nevertheless, clinical data based on high-level evidence-based therapeutic trials remain necessary for this treatment to be validated and recommended by healthcare professionals. The use of this new therapy is particularly interesting for patients with a contraindication to hormonal treatment, as it is an effective alternative with a long duration of action and very few adverse effects reported in the short term.

Author contributions HA contributed to conceptualization and idea and methodology. TSF and CLV helped with literature search and data analysis. TSF and HA contributed to writing—original draft preparation. GC, JLM and EOEC helped with writing—review and editing. CU, GC and HA contributed to supervision.

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Compliance with ethical standards

Conflict of interest T. Sindou-Faurie declares that she has no conflict of interest. C. Louis-Vahdat declares that she has no conflict of interest. E. Oueld Es Cheikh declares that she has no conflict of interest. G. Canlorbe declares that he has no conflict of interest. JL. Mergui declares that he has no conflict of interest. C. Uzan declares that she has no conflict of interest. H. Azaïs declares that he has no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

References

1. Portman DJ, Gass MLS, Vulvovaginal Atrophy Terminology Consensus Conference Panel (2014) Genitourinary syndrome of menopause: new terminology for vulvovaginal atrophy from the International Society for the Study of Women's Sexual Health and the North American Menopause Society. Maturitas. 79(3):349–354
2. Nappi RE, Palacios S (2014) Impact of vulvovaginal atrophy on sexual health and quality of life at postmenopause. Climact J Int Menopause Soc 17(1):3–9
3. Wysocki S, Kingsberg S, Krychman M (2014) Management of vaginal atrophy: implications from the REVIVE survey. Clin Med Insights Reprod Health 8:23–30
4. North American Menopause Society (2013) Management of symptomatic vulvovaginal atrophy: 2013 position statement of The North American Menopause Society. Menopause 20(9):888–902
5. Palacios S, Castelo-Branco C, Currie H, Mijatovic V, Nappi RE, Simon J et al (2015) Update on management of genitourinary syndrome of menopause: a practical guide. Maturitas 82(3):308–313
6. Mendoza N, Abad P, Baró F, Cancelo MJ, Llaneza P, Manubens M et al (2013) Spanish Menopause Society position statement: use of tibolone in postmenopausal women. Menopause 20(7):754–760
7. Lethaby A, Ayeleke RO, Roberts H (2016) Local oestrogen for vaginal atrophy in postmenopausal women. Cochrane Database Syst Rev 8:CD001500
8. Cardozo L, Bachmann G, McClish D, Fonda D, Birgerson L (1998) Meta-analysis of estrogen therapy in the management of urogenital atrophy in postmenopausal women: second report of the Hormones and Urogenital Therapy Committee. Obstet Gynecol 92(4 Pt 2):722–727
9. Kingsberg SA, Krychman M, Graham S, Bernick B, Mirkin S (2017) The Women's EMPOWER survey: identifying women's perceptions on vulvar and vaginal atrophy and its treatment. J Sex Med 14(3):413–424
10. Tadir Y, Gaspar A, Lev-Sagie A, Alexiades M, Alinsod R, Bader A et al (2017) Light and energy based therapeutics for genitourinary syndrome of menopause: consensus and controversies. Lasers Surg Med 49(2):137–159
11. Athanasiou S, Pitsouni E, Antonopoulou S, Zacharakis D, Salvatore S, Falagas ME et al (2016) The effect of microablative fractional CO_2 laser on vaginal flora of postmenopausal women. Climact J Int Menopause Soc 19(5):512–518
12. Behnia-Willison F, Sarraf S, Miller J, Mohamadi B, Care AS, Lam A et al (2017) Safety and long-term efficacy of fractional CO_2 laser treatment in women suffering from genitourinary syndrome of menopause. Eur J Obstet Gynecol Reprod Biol 213:39–44
13. Ware J, Kosinski M, Keller SD (1996) A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 34(3):220–233
14. de Tayrac R, Deval B, Fernandez H, Marès P (2008) Validation linguistique en français des versions courtes des questionnaires de symptômes (PFDI-20) et de qualité de vie (PFIQ-7) chez les patientes présentant un trouble de la statique pelvienne. J Gynécol Obstét Biol Reprod 36(8):738–748
15. Rosen R, Brown C, Heiman J, Leiblum S, Meston C, Shabsigh R et al (2000) The Female Sexual Function Index (FSFI): a multidimensional self-report instrument for the assessment of female sexual function. J Sex Marital Ther 26(2):191–208
16. Jardin I, Louis-Vahdat C, Canlorbe G, Mergui J-L, Uzan C, Azaïs H (2018) How I do? A treatment with fractional CO_2 LASER for vulvovaginal atrophy symptoms in menopausal women. Gynecol Obstet Fertil Senol 46(10–11):735–739
17. Paraiso MFR, Ferrando CA, Sokol ER, Rardin CR, Matthews CA, Karram MM et al (2019) A randomized clinical trial comparing vaginal laser therapy to vaginal estrogen therapy in women with genitourinary syndrome of menopause: the VeLVET Trial. Menopause 27:50–56
18. Politano CA, Costa-Paiva L, Aguiar LB, Machado HC, Baccaro LF (2019) Fractional CO_2 laser versus promestriene and lubricant in genitourinary syndrome of menopause: a randomized clinical trial. Menopause 26(8):833–840
19. González Isaza P, Jaguszewska K, Cardona JL, Lukaszuk M (2018) Long-term effect of thermoablative fractional CO_2 laser treatment as a novel approach to urinary incontinence management in women with genitourinary syndrome of menopause. Int Urogynecology J 29(2):211–215
20. Sipos AG, Kozma B, Poka R, Larson K, Takacs P (2019) The effect of fractional CO_2 laser treatment on the symptoms of pelvic floor dysfunctions: pelvic floor distress inventory-20 Questionnaire. Lasers Surg Med 51:882–886
21. FDA (2018) Health C for D and R. FDA Warns Against Use of Energy-Based Devices to Perform Vaginal 'Rejuvenation' or Vaginal Cosmetic Procedures: FDA Safety Communication. FDA, Washington
22. Sokol ER, Karram MM (2016) An assessment of the safety and efficacy of a fractional CO_2 laser system for the treatment of vulvovaginal atrophy. Menopause 23(10):1102–1107
23. Madelenat P (2019) When an editorial becomes a subject of real debate. Gynecol Obstet Fertil Senol 47(9):689
24. Deval B, Swift S, Mourad S, Hayward L, Digesu A (2019) Application of laser in uro-gynecology: warning! Gynecol Obstet Fertil Senol 47(9):690–691
25. Mares P (2019) Emerging techniques in uro-gynecology: a new deal. Gynecol Obstet Fertil Senol 47(9):696–697
26. Deffieux X (2019) Vaginal laser in pelviperineology: fears and facts. Gynecol Obstet Fertil Senol 47(9):694–695
27. Azaïs H (2019) Vaginal LASER therapy, a pragmatic option for patients after cancer. Gynecol Obstet Fertil Senol 47(9):692–693
28. Athanasiou S, Pitsouni E, Douskos A, Salvatore S, Loutradis D, Grigoriadis T (2020) Intravaginal energy-based devices and sexual health of female cancer survivors: a systematic review and meta-analysis. Lasers Med Sci. 35(1):1–11
29. Millheiser LS, Pauls RN, Herbst SJ, Chen BH (2010) Radiofrequency treatment of vaginal laxity after vaginal delivery: nonsurgical vaginal tightening. J Sex Med 7(9):3088–3095
30. Kamilos MF, Borrelli CL (2017) New therapeutic option in genitourinary syndrome of menopause: pilot study using microablative fractional radiofrequency. Einstein 15(4):445–451