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Efficacy of fractional CO₂ laser treatment for vaginal rejuvenation

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ABSTRACT

Objective. To evaluate and assess the safety and efficacy of micro ablative fractional CO₂ laser for vaginal rejuvenation in women complaining of vaginal laxity.

Materials and Methods. This study included 20 sexually active women with symptoms of vaginal relaxation syndrome. They were scheduled into 3 treatment visits (V1, V2, and V3) with a 4-week interval and received fractional CO₂ laser sessions. The participants' satisfaction was assessed after each laser session and at a 1-month follow-up visit (V4).

Results. There was a highly significant improvement between different visits as regards the Vaginal Health Index (VHI) score, the Vulvovaginal Symptoms Questionnaire (VVSQ), the Female Sexual Function Index (FSFI) questionnaire, the Urogenital Distress Short Form (UDI-6) questionnaire, and the Incontinence Impact Questionnaire Short Form (IIQ-7). Regarding complications, there were burning sensations in 3 cases (15%), itching in 2 cases (10%), mild pain in 2 cases (10%), and numbness in only one case (5%).

Conclusions. Fractional CO₂ laser therapy is an effective and safe treatment option for women suffering from vaginal laxity.

INTRODUCTION

Vaginal laxity occurs frequently and can impair sexual performance and standard of life. The most prevalent symptom is decreased sexual satisfaction. However, it's unclear if vaginal laxity and sexual dysfunction are actually linked [1].

Vaginal structural weakening occurs with repeated deliveries due to foetal head-induced overstretching of collagen fibres in the vaginal wall. Incomplete postpartum recoil may cause persistent

laxity. Concurrently, vaginal relaxation syndrome is associated with vaginal atrophy, and epithelial thinning. This thinning reduces glycogen synthesis, elevating vaginal pH and altering flora: diminished Lactobacilli dominance, increased bacterial diversity, and heightened inflammation risk [2-4].

A variety of surgical procedures are used in surgical vaginal rejuvenation to reduce the opening and diameter of the vaginal canal, nevertheless. These procedures may cause neurological damage, scarring of delicate vaginal tissues, and a reduction in

sensory function. Surgery techniques are not risk-free, being associated with increased pain and a lengthier recovery period [5].

Traditional non-surgical treatments include systemic hormones and topical hormonal and non-hormonal treatments. For moderate to severe symptoms, estrogen treatment is the most effective therapeutic option [6]. On the other hand, non-hormonal local moisturizers and lubricants can be safe and efficient in relieving minor symptoms as well as other menopausal symptoms; however, they must be used regularly for maximum results [7].

Recently, there has been a rise in the proposed use of novel, non-invasive techniques that promise to be successful and have no or few post-surgical consequences. Radiofrequency (RF) devices generate electromagnetic waves that create heat and, as a result, stimulate collagen and elastin formation as well as fibroblast migration [8]. Utilization of microablative fractional CO₂ laser systems in dermatology and plastic surgery has grown in popularity due to scientific confirmation that they provide safe, effective treatment for vulvovaginal atrophy (VVA), with high patient satisfaction and no severe complications reported [9-11].

Nevertheless, certain gaps persist regarding long-term effectiveness, safety standardization, and improvement of the urological symptoms. Our aim in this study was to evaluate and assess the safety and efficacy of micro ablative fractional CO₂ laser for vaginal rejuvenation in sexually active women with symptoms of vaginal relaxation syndrome.

MATERIALS AND METHODS

Study registration, ethical, and methodological standards

This pilot study evaluated the efficacy and safety of the fractional CO₂ laser for vaginal rejuvenation. A total of 20 Egyptian women were recruited after written informed consent was provided and ethical committee approval was obtained.

Patient and public involvement

Our inclusion criteria were sexually active women whose ages ranged from 30 to 60 years with symptoms of vaginal relaxation syndrome. They had the desire for vaginal rejuvenation treatment and the ability and willingness to follow the study visits schedule. We excluded the following cases: history of hormonal therapy within the past 6 months, hi-

story of vaginal moisturizer or lubricant applications within the past 30 days, cases with acute/recurrent urinary tract infection, cases with active genital infection, cases with prolapse stage II or more, or cases with a chronic condition that could interfere with study compliance.

Data collection

All participants were scheduled into 3 treatment visits (V1, V2, and V3) with a 4-week interval, where all participants received 3 laser sessions 4 weeks apart using AMIMED BX300® fractional CO₂ laser. The outcome was measured after each laser session and at a 1-month follow-up visit (V4). The participants' satisfaction with the treatment and any adverse events they experienced during the study were assessed. The assessment included the Vaginal Health Index (VHI) score, the Vulvovaginal Symptoms Questionnaire (VVSQ), the Female Sexual Function Index (FSFI) questionnaire, the Urogenital Distress Short Form (UDI-6) questionnaire, and the Incontinence Impact Questionnaire Short Form (IIQ-7).

Assessment of the VHI score included 7 main parameters: the moisture/consistency of fluid, PH, Rugosity, elasticity, length of the vagina, epithelial integrity, and vascularity. The range of scores for each parameter is 1-3, and the range for the total scores is 7-21. The VVSQ assessed the valvular and vaginal skin symptoms, which consisted of 21 questions; the range of total scores is 0-21. The FSFI questionnaire assessed sexual dysfunction, which consists of 19 questions; the range of total scores is 2-36.

The Urogenital Distress Short Form (UDI-6) assessed urinary incontinence, consisting of 6 questions; the average score of items responded to was calculated, and the average range from 0 to 3 was multiplied by 33.333 to put scores on a scale of 0 to 100. The Incontinence Impact Questionnaire Short Form (IIQ-7) assessed urinary incontinence, which consists of 7 questions; the average score of items responded to was calculated, which ranges from 0 to 3, and was multiplied by 33.333 to put scores on a scale of 0 to 100.

Laser treatment sessions

- Vaginal rejuvenation was performed using The AMIMED BX300, Korean fractional Carbon Dioxide Laser device 10, 6,000 nm.
- Following the cleaning of the vulvovaginal area, the vaginal handpiece was commenced into the

vaginal canal without causing over-stretching or pain.

- The treatment was performed with 30 W, stack 2, dwell time 1,000 μ s, and spacing 1000 μ m (5% density) settings.
- The vaginal handpiece was rotated to apply 12 pulses at each 1-cm marking (application of laser energy at 3-10-cm depths) until the distal end of the vaginal probe reached the introitus.
- Each session lasted between 15 and 20 minutes. Eye goggles were used during the sessions to protect the eyes.
- Participants were instructed to refrain from sexual activity or intravaginal devices for at least 3 days following the operation due to temporary local irritation of the vaginal mucosa caused by laser application.
- Any side effects such as prolonged erythema (> 3 days), edema, scarring, or infection were observed, and pain was graded as mild, moderate, and severe. They were recorded at each treatment session and in the follow-up visit.
- One month after the final treatment, during the last visit (V4), the participant's satisfaction with the therapy and any adverse events they experienced throughout the trial were evaluated.

Statistical analysis

The collected data was tabulated using the "Statistical Package for Social Science" (SPSS 27). Data was presented, and suitable analysis was performed according to the type of data obtained for each parameter. Regarding descriptive statistics, mean \pm Standard error (SE) for numerical data. Regarding analytical statistics, the repeated-measure ANOVA test was used to assess the statistical significance of the difference between more than two means measured multiple times for the same study group. P-value was considered for the significance level, significant if $p < 0.05$ and non-significant if $p > 0.05$.

RESULTS

The mean age of the cases was 41.75 (\pm 5.29) with a range of (30-50), the mean BMI was 28.59 (\pm 2.7) with a range of (23.3-31.9), and the mean parity was 3.05 (\pm 1.32) with a range of (1-5). Among the cases studied, there were 15 (75%) premenopausal and 5 (25%) postmenopausal.

Table 1. Assessment tools in the four visits.

	Visit 1 (mean \pm SE)	Visit 2 (mean \pm SE)	Visit 3 (mean \pm SE)	Visit 4 (mean \pm SE)	P-value
VHI	13.7 \pm 0.62	15.4 \pm 0.67	16.2 \pm 0.7	17.45 \pm 0.68	< 0.001
VVSQ	16.1 \pm 0.71	12.45 \pm 0.71	10.65 \pm 0.82	8.5 \pm 1.21	< 0.001
FSFI	22.85 \pm 1.05	23.72 \pm 1.05	24.61 \pm 1.09	25.15 \pm 1.11	< 0.001
UDI-6	47.48 \pm 5.29	37.77 \pm 4.22	30.83 \pm 4.17	24.16 \pm 5.39	< 0.001
IIQ-7	36.88 \pm 4.56	24.75 \pm 3.29	21.18 \pm 3.44	16.91 \pm 4.1	< 0.001

SE: standard error; VHI: Vaginal Health Index; VVSQ: Vulvovaginal Symptoms Questionnaire; FSFI: Female Sexual Function Index; UDI-6: Urogenital Distress Short Form; IIQ-7: Incontinence Impact Questionnaire Short Form.

Regarding the assessment tools, there was a highly significant improvement between different visits as regards the Vaginal Health Index (VHI) score, the Vulvovaginal Symptoms Questionnaire (VVSQ), the Female Sexual Function Index (FSFI) questionnaire, the Urogenital Distress Short Form (UDI-6) questionnaire, and the Incontinence Impact Questionnaire Short Form (IIQ-7) as shown in **Table 1**. Regarding complications, there were burning sensations in 3 cases (15%), itching in 2 cases (10%), mild pain in 2 cases (10%), and numbness in only one case (5%).

DISCUSSION

Main findings

Our study included 20 women complaining of vaginal laxity. They underwent three fractional CO₂ laser treatment sessions, spaced four weeks apart. Data were collected at four visits (before each laser session and at a follow-up visit), allowing for a comprehensive evaluation of the treatment's short-term outcomes. The results demonstrated substantial improvements in all clinical measures. Vaginal symptoms were significantly reduced, as measured by the Vulvovaginal Symptom Questionnaire (VVSQ). At baseline, the mean VVSQ score was (16.1 \pm 0.71), which decreased to (8.5 \pm 1.21) by the final visit ($p < 0.001$). This reduction reflects a notable improvement in symptoms like vaginal dryness, irritation, and discomfort. The Vaginal Health Index (VHI) scores in this study showed improvement from a mean of (13.7 \pm 0.62) at baseline to (17.45 \pm 0.68) after treatment ($p < 0.001$), indicating enhanced tissue elasticity, moisture, and overall vaginal health.

One of the key findings of this study was that the significant improvement in sexual function, as measured by the Female Sexual Function Index (FSFI), improved significantly in this study. The mean

FSFI score increased from 22.85 ± 1.05 at baseline to 25.15 ± 1.11 post-treatment ($p < 0.001$), with improvements seen in all domains, including desire, arousal, lubrication, orgasm, and satisfaction. The treatment also significantly reduced urinary symptoms, as evidenced by a decrease in UDI-6 scores from a median of 47.48 ± 5.29 to 24.16 ± 5.39 ($p < 0.001$), while IIQ-7 scores decreased from 36.88 ± 4.56 to 16.91 ± 4.1 ($p < 0.001$). These findings suggest that fractional CO₂ laser effectively manages mild to moderate stress urinary incontinence (SUI) and related symptoms.

Interpretation and comparison with other literature

Several studies were conducted to study the role of fractional CO₂ laser for vaginal rejuvenation. The improvement in lubrication and orgasmic function observed in our study could be attributed to the laser's ability to restore tissue elasticity and hydration through collagen remodelling and neocollagenesis. This biological mechanism, which underpins many of the clinical effects of fractional CO₂ laser, has been well-documented in several studies, including those by Salvatore *et al.* and Athanasiou *et al.*, who found that fractional CO₂ laser promotes collagen and elastin production, thereby enhancing tissue elasticity and improving sexual function [9, 10].

Similar improvements have been reported by Salvatore *et al.*, where a significant reduction in vulvovaginal symptoms was observed following fractional CO₂ laser treatment in postmenopausal women. This consistency across studies highlights the effectiveness of fractional CO₂ laser in treating a range of vaginal symptoms associated with laxity, particularly in postmenopausal women and those affected by childbirth [9].

Leibaschoff *et al.* also reported significant improvements in urinary incontinence following fractional CO₂ laser treatment, with reduced leakage episodes and improved bladder control. The laser's ability to stimulate collagen production and enhance the structural support of the pelvic floor likely contributes to these results, offering a non-surgical alternative to traditional interventions for urinary incontinence [12].

The safety profiles reported in other studies, such as Sadick and Rothaus, show that fractional CO₂ laser has minimal side effects and a low risk of complications. The transient nature of the side effects is well-documented in the literature and does not detract from the overall positive outcomes of the procedure [8].

The relatively low incidence of complications and the absence of serious side effects, such as scarring or prolonged discomfort, make fractional CO₂ laser a safe option for vaginal rejuvenation. The non-invasive nature of fractional CO₂ laser therapy is particularly advantageous for women who wish to avoid surgery. The short recovery time and minimal side effects make it a favourable option, especially for women with mild to moderate urinary symptoms [13].

In addition, recent studies confirmed that fractional CO₂ laser is an effective and safe non-estrogen therapy for managing VVA, especially in gynaecological and breast cancer survivors. It offers significant improvements in quality of life and sexual function. The CO₂ laser presents a novel approach to relieve the unpleasant and discomforting symptoms of VVA, particularly in young and fragile women who cannot use hormonal therapies [14, 15].

On the contrary, the results of Abedi *et al.* found that non-surgical vaginal tightening methods, including laser treatments, had a limited impact on sexual function in women with higher parity (≥ 3) [16]. This discrepancy could be due to differences in laser parameters or the population studied, but it suggests that fractional CO₂ laser may be more effective for restoring vaginal tone and function in women with severe vaginal laxity due to multiple childbirths.

Strengths and limitations

The main limitations of this study are the relatively small sample size of 20 participants and the relatively short follow-up period, which highlights the need for further research. Larger, multicentre studies with more extended follow-up periods are necessary to confirm the durability of the treatment's benefits. Additionally, randomized controlled trials comparing fractional CO₂ laser with placebo or other non-surgical therapies would provide more definitive evidence of its efficacy and would also help refine treatment options for patients.

CONCLUSIONS

The findings of this study suggest that fractional CO₂ laser therapy is an effective and safe treatment option for women suffering from vaginal laxity. The treatment led to significant improvements in vaginal health, sexual function, and urinary symptoms, with minimal adverse effects and high patient satisfaction.

COMPLIANCE WITH ETHICAL STANDARDS

Authors' contribution

M.A.E.: Conceptualization, supervision, writing – review & editing. D.O.A., M.A.R.: Data curation, investigation, validation, writing – original draft, writing – review & editing.

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Study registration

N/A.

Disclosure of interests

The authors declare that they have no conflict of interests.

Ethical approval

The Research Ethics Committee of the National Institute of Laser Enhanced Science approved the study protocol. All methods were conducted following the guidelines and regulations of the National Institute of Laser Enhanced Science.

Informed consent

All participants gave their consent after being informed of the study's goal and design. They were given the choice to leave the study at any time.

Data sharing

The data supporting this study's findings are available from the National Institute of Laser Enhanced Science. However, restrictions apply to the availability of these data, which were used under license for the current study and are not publicly available. Data are, however, available from the authors upon reasonable request and with the permission of the National Institute of Laser Enhanced Science.

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