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The Use of Carbon Dioxide (Co2) Lasers in the Treatment of Vulvovaginal Atrophy Symptoms in Perimenopausal and Postmenopausal Women

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ABSTRACT

This study explores the efficacy of pixelated carbon dioxide (CO2) laser treatment in mitigating vulvovaginal atrophy symptoms among perimenopausal and postmenopausal women. This study examines the effectiveness of CO2 laser treatment in reducing vaginal discomfort for women experiencing menopause. With a cohort of 127 participants (mean age 47 ± 5 years), the researchers administered three sessions of vaginal CO2 laser treatment over three months. The primary evaluation metric was patient-reported satisfaction levels, aiming to assess the treatment's impact on alleviating symptoms associated with vulvovaginal atrophy, such as dryness, burning, and discomfort during intercourse. The findings revealed that 98% of the patients experienced significant symptom improvement three months post-treatment. Notably, 89% reported a resolution of sexual dysfunction due to vaginal dryness, and 96% indicated an end to discomfort and burning sensations. The satisfaction of the patients is extremely high, with 98% of the participants being satisfied with the results, and this satisfaction has persisted even after some time following the treatment. Furthermore, 95% of the women encountered no discomfort during the procedure, and any post-treatment complaints were mild and temporary, with a watery discharge being the most common. The study concludes that pixel CO2 laser treatment is a practical, painless, and efficient approach for addressing vulvovaginal atrophy symptoms, yielding high patient satisfaction rates. The study finds that using pixel CO2 laser treatment is a practical and painless way to help with symptoms of vaginal discomfort, and most patients are satisfied with the results.

Keywords: Genitourinary menopause, vaginal rejuvenation, urinary stress, collagen reshaping, sexual dysfunction, vulvovaginal atrophy, CO2 laser treatment

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Perimenopozal ve Postmenopozal Kadınlarda Vulvovajinal Atrofi Semptomlarının Tedavisinde Karbon Dioksit (Co2) Lazer Kullanımı

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ÖZ

Bu çalışma, perimenopozal ve postmenopozal kadınlardaki vulvovajinal atrofi semptomlarının hafifletilmesinde pikselize karbon dioksit (CO2) lazer tedavisinin etkinliğini araştırmaktadır. 127 katılımcı (ortalama yaş 47 ± 5 yıl) ile yürütülen araştırmada, üç ay boyunca üç seans halinde vajinal CO2 lazer tedavisi uygulanmıştır. Ana değerlendirme ölçütü, tedavinin vulvovajinal atrofiye bağlı semptomları, örneğin kuruluk, yanma ve cinsel ilişki sırasında rahatsızlık gibi belirtileri hafifletme etkisini değerlendirmek amacıyla hastaların bildirdiği memnuniyet seviyeleriydi. Bulgular, tedaviden üç ay sonra hastaların %98'inin önemli semptom iyileşmesi yaşadığını göstermiştir. Özellikle, %89'u vajinal kuruluğa bağlı cinsel işlev bozukluğunun çözüldüğünü, %96'sı ilişki sırasındaki rahatsızlık ve yanma hissinin sona erdiğini belirtmiştir. Hastaların memnuniyeti son derece yüksek olup, katılımcıların %98'i sonuçlardan memnun kalmış ve bu memnuniyet tedaviden bir süre sonra bile devam etmiştir. Ayrıca, kadınların %95'i işlem sırasında herhangi bir rahatsızlık hissetmemiş ve tedavi sonrası şikayetler hafif ve geçici olmuş, en yaygın şikayet prosedür sonrası gözlenen sulu akıntı olmuştur. Çalışma, piksel CO2 lazer tedavisinin, vulvovajinal atrofi semptomlarını ele almak için etkili, ağrısız ve verimli bir yaklaşım olduğu sonucuna varmış ve yüksek hasta memnuniyet oranları elde edilmiştir.

Anahtar Sözcükler: Ürogenital menopoz, vajinal gençleşme, idrar stresi, kollajen şekillendirme, cinsel işlev bozukluğu, vulvovajinal atrofi, CO2 laser tedavisi

1 Introduction

Vulvovaginal atrophy, common in perimenopausal and postmenopausal women, significantly affects their quality of life. This condition, marked by thinning and drying of vaginal tissue due to declining estrogen levels, has traditionally been treated with hormonal replacement therapies. However, concerns about side effects have led to interest in alternative approaches. Carbon Dioxide (CO2) laser therapy is emerging as an innovative and minimally invasive option with reduced side effects and quick recovery. This article explores the efficacy, safety, and benefits of CO2 laser treatment for managing vulvovaginal atrophy symptoms in perimenopausal and postmenopausal women, considering current scientific evidence [1,2].

In recent years, the widespread adoption of Fractionated CO2 Lasers, especially in aesthetics and gynecology, has revolutionized medical practices globally, including in our region. This preference is mainly due to their non-invasive nature, offering faster recovery and less discomfort compared to traditional surgeries. Fractionated CO2 Lasers precisely target damaged skin cells without affecting surrounding healthy areas, proving effective in cosmetic applications and gynecological treatments. These lasers are versatile, with minimal side effects, making them a pivotal component in the transition towards non-surgical healthcare options, showcasing the industry's commitment to innovative, patient-centered care [3-5].

Lasers are now used in aesthetic gynecology, especially for short-term non-invasive vaginal treatments. This offers an alternative to hormonal therapy, suitable for patients averse to hormones or with contraindications. Doctors increasingly prefer vaginal CO2 laser over long-term hormonal treatment for

conditions like vaginal atrophy and genitourinary syndrome in peri- and post-menopausal women, where estrogen deficiency impacts quality of life. In premenopause and menopause, decreasing estrogen levels lead to issues like vulvar and vaginal atrophy (VA), significantly affecting women's well-being, with 60% of postmenopausal women experiencing vaginal dryness [6-8].

The vaginal wall typically comprises stratified squamous epithelium with cytokeratin, including the stratum basale, suprabasal layer, and stratum corneum. Originating from the Müllerian layer during embryonic development, vaginal tissue migrates caudally to the endocervical canal. The tissue contains estrogen-sensitive glands with receptors for this hormone, crucial for maintaining standard vaginal wall structure [9].

Vaginal atrophy results from decreased estrogen in vaginal tissue during menopause, causing structural changes and disrupting physiological functions. In our study on postmenopausal women with low estrogen, we examined vaginal mucosa modifications after fractional CO2 laser treatment. Significant glycogen storage was observed in squamous layer epithelial cells, and the epithelial surface had a high glycogen content. Restoration, indicated by shed cells rich in glycogen, was observed. New extracellular matrix components, including activated fibroblasts, collagen, and ground substance, were synthesized in the lamina propria connective tissue. Connective tissue papillae and typical blood capillaries entering the papillae were also noted. Morphologically, Fractional CO2 Laser application demonstrated effectiveness in restoring vaginal mucosa structure and associated physiological trophic changes [5,10].

Introduced in 2014, Genitourinary Syndrome of Menopause (GSM) consolidates conditions like vulvovaginal atrophy, atrophic vaginitis, and urogenital atrophy. Recognized as a chronic disorder, GSM impacts the vulvovaginal area, sexual health, and the lower urinary system. Primarily affecting postmenopausal women due to reduced estrogen levels, symptoms can also occur in premenopausal individuals. Hormonal changes result in issues like vaginal dryness and dyspareunia. Laser therapy, a non-hormonal approach, utilizes a CO2 laser (10,600 nm) to coagulate vaginal tissue, inducing a healing response and promoting collagen and elastin production. Research consistently shows CO2 laser therapy's efficacy in alleviating GSM symptoms in postmenopausal women, even those not producing estrogen [11-13].

Gynecologic cancer treatment significantly affects sexual health and reproductive organ functionality, necessitating consideration of GSM in menopausal or medically induced menopausal women. GSM encompasses symptoms affecting the bladder, vulva, and vagina, with vulvovaginal atrophy (VVA) being a notable manifestation due to estrogen deficiency. VVA presents symptoms like vulvovaginal dryness, burning, dyspareunia, and urinary issues. Without intervention, these symptoms worsen over time. As survivorship increases, addressing sexual and overall quality of life becomes crucial. Various interventions for VVA include hormone replacement therapy, topical vaginal estrogens, selective estrogen receptor modulators (SERMs), and non-hormonal options like hyaluronic acid-containing products. Oral medications acting as SERMs provide an additional treatment avenue. These diverse approaches highlight the significance of holistic care in promoting the well-being of women post-gynecologic cancer treatment [14].

2 Methods

In preparing this article, formal approval was diligently sought and subsequently obtained from the Ethics Committee of Istanbul Gelisim University, per the requirements for conducting research involving human participants. This approval was granted on January 12, 2024, underscoring the research's adherence to the ethical standards and guidelines established for scientific investigation.

Through its comprehensive review process, the Ethics Committee of Istanbul Gelisim University issued an ethics approval with the decision number 2024.01.130. This step validates the research project's ethical integrity. It ensures compliance with the principles of respect, justice, and beneficence, reinforcing the commitment to uphold the highest standards of ethical conduct in academic research.

The study included a total of 127 patients, menopausal and perimenopausal women, who presented to the clinic with vaginal dryness, irritation, pain, or dyspareunia. The criterion for menopause to be considered is evaluated as the absence of menstruation for 12 consecutive months in the patient. Patients who had not undergone vaginal tightening surgery in the past year, who were not pregnant, who did not have acute or recurrent urinary tract infections, active genital infections, undiagnosed vaginal bleeding, or any severe or chronic illness that could interfere with hormonal function or work compliance were included in the study.

Fractional CO2 laser treatment was applied intravaginally to perimenopausal women. The energy level varied between 40-55-75 mJ, depending on the patient's pain tolerance. Before the procedure, a few drops of baby oil or liquid petroleum jelly were used on the laser probe to make it easier to insert into the introitus. Prior to starting the procedure, the vagina was wiped with a saline tampon. The vaginal probe was gently inserted into the vagina, lightly touching the cervix, and rotated 360 degrees within the vagina, applying laser at every 1 cm mark. The probe was slowly withdrawn, and a laser was applied until it reached the introitus according to the marks on the probe. The same procedure was repeated three times in the same session. Three more sessions were performed in the same manner at 4-week intervals. No anesthesia or analgesia was required for the patients. Patients were advised to avoid sexual activity for at least four days after treatment.

After six months, a significant reduction (98%) in symptoms and complaints was observed according to patients' self-reports. Statistically significant improvements were also noted in vaginal elasticity and the disappearance of vaginal dryness during follow-up visits after vaginal laser treatment ($P<0.05$).

Our study employed a state-of-the-art CO2 Pixel Laser Device, as depicted in Figure 1, to carry out the treatments under investigation. This device, renowned for its precision and effectiveness in delivering fractional CO2 laser therapy, was instrumental in facilitating the non-invasive procedures that formed the core of our research. Its utilization enabled us to meticulously target and treat the specific areas of concern, leveraging the device's advanced capabilities to achieve optimal outcomes.

Figure 1: *The CO2 Pixel Laser Device used in our study*

Within the framework of our study, we have incorporated visual documentation to illustrate the procedural methodology precisely, facilitating a more precise understanding and potential replication of the treatment processes. Figure 2, entitled "Intravaginal Application of Laser," depicts the direct application of laser treatment within the vaginal cavity, serving as a critical visual guide to the precise, non-invasive technique employed in our research. It is important to note that Figure 2 was sourced from open-access online platforms, ensuring that the image adheres to the principles of open-source utilization, thereby allowing for its ethical and unrestricted use in academic and research contexts.

Additionally, Figure 3, named "Vaginal Laser Application," extends the visual representation to encompass a broader perspective on the laser treatment's application within the vaginal area. In conjunction with Figure 2, this image offers a holistic view of the laser application technique, underlining the innovative approach adopted in leveraging laser technology for therapeutic interventions within our study. The integration of these images, particularly with Figure 2 being obtained from open-source online resources, emphasizes our commitment to transparency, ethical research practices, and the dissemination of knowledge within the scientific community.

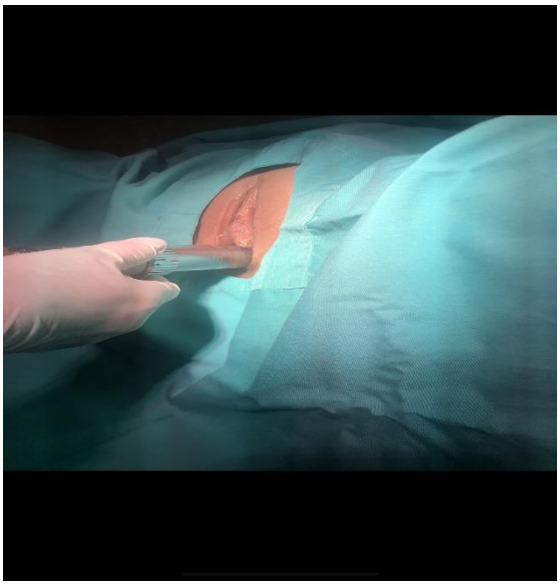

Figure 2: *Intravaginal application of Laser*

Figure 3: *Vaginal Laser Application*

3 Results

In our study, as detailed in Table 1, we analyzed data from a cohort of 127 patients, comprising 70 perimenopausal and 57 postmenopausal individuals, with ages ranging from 46 to 72 years (mean age 59 ± 5 years). These participants underwent a series of three vaginal CO2 laser treatment sessions over three months. The primary objective of our investigation was to evaluate the treatment's effectiveness, focusing specifically on patient satisfaction or dissatisfaction. This assessment was conducted three months following the completion of the final treatment session, aiming to provide a comprehensive overview of the outcomes associated with the CO2 laser therapy. The inclusion of this data in Table 1 not only facilitates a structured presentation of the demographic and treatment-related specifics of our patient group but also underscores the methodological approach adopted in gauging the therapeutic impact of the laser intervention.

Table 1: *Response of the Patients to the Satisfaction Survey According to Age Distribution*

Groups	Nu	Satisfaction Rate 3 Months After Last Procedure	P Value
Premenopause (70)	68	Satisfied (%98)	<0.0001
Postmenopause (57)	56	Satisfied (%98)	<0.0001
Total (127)	124	Satisfied (%98)	<0.0001

Three months after the last laser treatment, significant improvement was observed in 124 (98%) of the patients ($P<0.05$). Among the patients who were called for follow-up three months after the last treatment, 114 (89%) reported that their sexual problems related to vaginal dryness had disappeared, 122 (96%) reported that their complaints related to burning sensation due to vaginal dryness had ended, and 124 (98%) reported that they were satisfied with the treatment. Their satisfaction remained significant even one year after the treatment ($P<0.01$).

Most of the patients, 123 (95%), reported that they did not experience any discomfort or pain during the application and that the procedure was quick. After the treatment, the patients' vaginal complaints were mild and temporary, with the most common complaint being a watery discharge observed in 58 patients (45%) after the procedure.

After the last treatment, patients were called for a follow-up visit three months later, and a total of 127 (98%) out of all patients reported satisfaction with the treatment within 12 weeks. Only two patients (2%) reported being generally satisfied during the follow-up but requested one more session. Patients did not complain of pain during any stage of the treatment except for a very mild burning sensation. No complications occurred.

4 Discussion

CO2 lasers have gained widespread acceptance as a non-invasive treatment option in numerous medical centers for an extended period. This acceptance is attributed to their ability to induce a microthermal effect on tissues, thereby stimulating the activation of new fibroblasts within the submucosal tissue. Consequently, this process leads to an increase in collagen and elastin levels, contributing to tissue regeneration and overall improvement in the treated area.

In 2019, Pearson et al. [15] conducted a study where they explored the efficacy of vaginal CO2 laser treatment. The focus was on patients experiencing vaginal atrophy, particularly those with breast cancer, for whom hormonal treatment was deemed inappropriate. Their research aimed to provide an alternative therapeutic approach for this specific population, offering potential relief from symptoms associated with vaginal atrophy while ensuring safety and efficacy in the absence of hormonal intervention.

Vulvovaginal atrophy is a common problem in breast cancer patients, and many etiological factors are involved. Treatment in these patients is quite tricky, mainly because the use of estrogen is not generally recommended because it is a hormonal treatment. Many studies have reported that vaginal laser application improves atrophy symptoms in patients. In our study, an improvement in VVA symptoms and sexual function was observed in breast cancer patients to whom we applied vaginal laser as a treatment for vaginal atrophy. More randomized, sham-controlled studies are needed to evaluate this treatment further [15].

In a 2020 study by Adabi et al., the focus was on the impact of menopause on women, particularly how hormonal shifts and a decrease in estrogen lead to vaginal atrophy. The research aimed to assess how fractional CO2 laser treatments could improve post-menopausal women's quality of life by addressing the symptoms associated with estrogen-deficient vaginal atrophy. The findings revealed significant enhancements in the discomfort associated with sexual activity and reductions in patient-reported symptoms. Additionally, there was a noteworthy decrease in the occurrence of stress incontinence and improvements were observed across all evaluated vaginal indices. The study concluded that fractional CO2 laser therapy plays a significant role in mitigating vaginal atrophy and related urinary symptoms, offering a promising non-hormonal treatment option for affected women [16].

Fractional CO2 laser therapy has been recognized for its substantial benefits in improving vaginal health and reducing the symptoms of VVA, thereby enhancing sexual satisfaction among perimenopausal women. These positive outcomes have been maintained throughout a 24-week follow-up period. The procedure is noted for its quick execution and minimal discomfort for patients. Additionally, a comprehensive multi-center study in the United States, as reported by Arroyo [14], is currently in progress to assess the long-term effects of this treatment, looking up to 12 months after therapy, mainly focusing on postmenopausal women. This study seeks to provide deeper insights into the lasting advantages and potential effects of fractional CO2 laser therapy on the vaginal health and overall well-being of postmenopausal women.

Our research indicates that fractional CO2 laser therapy is a dependable approach for managing vaginal atrophy. Following the procedure, patients experienced no severe complications, and only a minor fraction reported slight adverse effects, which subsided spontaneously without medical intervention. The majority of discomfort encountered was due to the insertion and movement of the probe. Overall, patients expressed high satisfaction with the outcomes and indicated a willingness to undergo the laser treatment again if necessary [17].

In their article published in 2018, Scott Evan Eder and his colleagues applied vaginal CO2 Laser to 28 postmenopausal patients due to vaginal atrophy. They stated that Fractional CO2 lasers improved VVA and that CO2 laser treatment could be an effective treatment option for relieving the symptoms observed in postmenopausal patients [18].

In their 2024 publication, Lami et al. addressed the prevalent issue of severe VVA among breast cancer patients, for whom hormonal treatments are often deemed contraindicated. They highlighted a notable gap in the literature regarding using non-ablative CO2 laser therapy for this demographic. The primary objective of their research was to assess the efficacy, safety, and patient acceptability of non-ablative CO2 laser treatment in managing vulvovaginal atrophy. Through their investigation, Lami et al. reached a compelling conclusion that non-ablative CO2 laser therapy yields effective outcomes in alleviating symptoms of vulvovaginal atrophy, demonstrating its potential as a viable treatment option for breast cancer survivors facing this distressing condition [19].

We performed a 12-week treatment with a fractional CO2 laser and observed a significant reduction in VVA symptoms in postmenopausal women. However, we believe that further controlled studies are required to confirm the current data and evaluate the long-term effects of the laser procedure on vaginal tissues [1].

Fractional CO2 laser treatment causes thermal heat in submucosal tissue, resulting in edema and erythema, which leads to the formation of new collagen and rejuvenation and narrowing of the vaginal mucosa, greatly improving symptoms that significantly reduce the quality of life in menopausal women.

The decrease and loss of estrogen hormone effect in vaginal tissue causes vaginal atrophy and genitourinary symptoms. CO2 lasers can restore the pH of the vaginal mucosa by releasing glycogen and acidic mucins from the epithelium. Symptoms such as dryness and itching, dysuria, and recurrent infections can be reduced by providing the necessary glycogen to lactobacilli in the vagina.

Due to its non-hormonal nature, pain-free application, and swift treatment process, non-ablative CO2 laser therapy is increasingly favored by patients over alternative treatment modalities. This preference is attributed to its ease of use and minimal discomfort, positioning it as a more attractive and effective solution for addressing genitourinary symptoms in perimenopausal and menopausal patients. Both patients and physicians regard this therapy as a superior alternative, offering significant benefits in symptom reduction compared to other available treatments. Its appeal lies in its clinical efficacy and ability to enhance patient comfort and satisfaction, underscoring its value as a preferred choice in managing menopausal symptoms.

5 Conclusion

This study focused on the efficacy of Fractional CO2 laser therapy in treating GSM and vaginal atrophy, conditions severely affecting the quality of life in perimenopausal and menopausal patients. The results, observed over a 6-month follow-up period, showed highly favourable outcomes, with symptom improvement nearing completeness. The therapy demonstrated an expedited treatment timeline, lacked complications or pain, highlighting its safety and patient-friendly nature.

Conclusively, our study establishes the efficacy and safety of vaginal CO2 laser treatment for managing GSM symptoms in perimenopausal and postmenopausal women, achieving a remarkable 98% satisfaction rate post-treatment. Sustained satisfaction even a year after therapy, coupled with minimal discomfort during the procedure, positions CO2 laser treatment as a viable, non-invasive alternative to traditional hormonal therapies. The minimal and temporary side effects, mainly mild vaginal complaints, further affirm the safety of this approach. These promising results have prompted ongoing multi-center investigations to explore the long-term clinical outcomes of Fractional CO2 laser treatment, aiming to establish a robust body of evidence supporting its use as a reliable, non-invasive treatment for managing GSM and vaginal atrophy symptoms and improving the quality of life in menopausal patients.

6 Declarations

6.1 Study Limitations

This study's primary limitation lies in its reliance on patient-reported satisfaction levels to evaluate the effectiveness of vaginal CO2 laser treatment in perimenopausal and postmenopausal women. While patient satisfaction is an important outcome, the lack of objective measures or clinical assessments to corroborate these findings may limit the comprehensiveness of the results. Furthermore, the study's sample size of 96 participants, although sizable, may not fully represent the broader population affected by the conditions treated. Additionally, the treatment's efficacy was assessed over a relatively short duration of three months, which may not capture long-term outcomes or potential delayed side effects. Future research could benefit from incorporating objective clinical evaluations and longer follow-up periods to provide a more holistic understanding of the treatment's effectiveness

6.2 Acknowledgements

There is no person or institution contributing to this research other than the authors.

6 3 Funding sources

No financial support was received for this research.

6.4 Authors' Contributions

Define the contribution of each researcher named in the paper to the paper.

6.5 Competing Interests

There is no conflict of interest in this study.

7 Human and Animal Related Study

This research did not involve any human or animal subjects.

7.1 Ethical Approval

In preparing this article, formal approval was diligently sought and subsequently obtained from the Ethics Committee of Istanbul Gelisim University, per the requirements for conducting research involving human participants. This approval was granted on the 1st of December, 2024, underscoring the research's adherence to the ethical standards and guidelines established for scientific investigation. Through its comprehensive review process, the Ethics Committee of Istanbul Gelisim University issued an ethics approval with the decision number 2024.01.130. This step validates the research project's ethical integrity. It ensures compliance with the principles of respect, justice, and beneficence, reinforcing the commitment to uphold the highest standards of ethical conduct in academic research.

7.2 Informed Consent

Informed consent form was obtained from all participants for the study that they agreed to participate in the study.

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