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The effectiveness of the treatment of urinary incontinence with erbium laser and CO²: An integrative review

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ABSTRACT
Urinary incontinence is one of the main symptoms that affect women who suffer from the so-called Genitourinary Syndrome of Menopause. This symptom tends to worsen with increasing age and low amount of the hormone estrogen, and should therefore be treated appropriately. Laser therapy, both with the erbium laser (Er-YAG) and the CO² laser, are new modalities studied for the treatment of this symptom, which is a safe and totally outpatient procedure. Thus, this integrative literature review aimed to discuss and compare the effectiveness of each of these lasers in the treatment of urinary incontinence. For this, 17 original articles were used, in the period from 2015 to 2022, searched in the Virtual Health Library (VHL) and PubMed platforms, through the use of descriptors and Boolean operator "and". Through the analysis of such studies, it was possible to verify that with the use of both lasers, there was an increase in collagen production, improvement in vascularization with the production of new blood vessels and microscopic reorganization of the vaginal structure. In addition, age and BMI have also become important factors for the success of this treatment. Therefore, it can be concluded, both through a microscopic analysis and through questionnaires that evaluated the degrees of urinary incontinence, that this new treatment is promising, since it was evident the improvement of patients suffering from urinary incontinence.

Keywords: Urinary Incontinence, Laser Er-YAG, CO2 lasers, Laser Therapy.

1 INTRODUCTION

It is currently called Genitourinary Syndrome of Menopause the set of signs and symptoms that are a result of estrogen deficiency, and can occur frequently in women who are in the climacteric, as well as in other causes of hypoestrogenism. This term began to gain notability in medical practice after the year 2012 (1)When the Council of *International Society for the Study of Women's Sexual Health* (ISSWSH) and administrative of *North American Menopause Society* (NAMS) noted the need to review the term vulvovaginal atrophy after considering the genitourinary symptoms present in the postmenopausal period.(2)

This syndrome includes several genital, urinary and sexual symptoms, among them: vaginal dryness, dyspareunia, irritation and genital burning, frequency, urinary incontinence, nocturia, dysuria

and recurrent urinary tract infections. Such symptoms are directly related to the drop in estrogen that occurs in the postmenopausal period.(1)

There are in the vagina, vulva, pelvic floor muscles, endopelvic fascia and urethra, alpha and beta estrogen receptors and that, due to the low of this hormone in the climacteric, promote histological changes in the organs mentioned. The genital epithelium becomes drier, thinner, pale, with vaginal shortening. In addition, there may be increased sagging of the vaginal mucosa, loss of roughness, change in vaginal flora, and decreased blood flow.(1)(2)

The symptoms that are part of the Genitourinary Syndrome, unlike other symptoms that are also present in the climacteric phase, tend to worsen according to increasing age, as well as with the longer time of low amount of estrogen, if it is not treated properly.(2)

Initially, the treatment is done with the use of vaginal moisturizers. However, for patients who do not respond to this therapy or who have severe vulvovaginal atrophy, treatment is carried out with low-dose estrogen replacement. Laser therapy, on the other hand, is indicated for women who cannot make use of hormones, as adjuvant or substitute therapy for those patients who wish to treat through this method.(2)

The laser (Light Amplification by Stimulated Emission of Radiation), can be used both in gynecological treatment and in surgeries of vascularized organs. It is an accurate and non-invasive technique that treats the symptoms of genitourinary syndrome safely, by increasing the volume of the stratified paving epithelium, in order to improve vascularization and, consequently, local irrigation.(3)

The Erbium YAG laser is a non-ablative laser that has a wavelength of 2940 nm and uses SMOOTH®, which are controlled bursts and long pulses. The use of such technology for the treatment of urinary incontinence has been widely used, causing there to be several studies about such therapy. The CO^2 laser, on the other hand, has a wavelength of 10600 nm, being this one of the first gas lasers produced and widely used for the treatment of vaginal atrophy present in the climacteric.(4)

The application of the carbon dioxide laser in the intimate region, provides a functional and tissue repair of the vagina, through its thermal and microablative action, which is the main difference between both lasers. The laser light, when it comes into contact with tissue, is absorbed and transformed into heat, which is dissipated by moving away from the penetration site. Such heat causes a heat shock at that site, thus stimulating the synthesis of proteins (by the so-called heat shock), which are directly related to growth factors that stimulate the production of collagen, extracellular matrix and local vascularization.(3)

The local application of the non-ablative laser results in contraction of collagen fibers in the exposed area, tissue retraction and increased vaginal elasticity, thus being effective and safe for the treatment of urinary incontinence.(4)

Treatment with both lasers is usually carried out through sessions with three to four applications in each session, each with an interval of four to six weeks. The procedure is entirely outpatient.(1)

In this sense, this literature review aimed to integrate a significant amount of literary findings that concern the effectiveness of the treatment of urinary incontinence with CO^2 and erbium laser, given that this treatment modality is still new and with few studies, especially in the therapy of this clinical picture, which is one of the main components of genitourinary syndrome. In addition, it is important to emphasize that the laser should always have its energy level adjusted according to the age of the patient, in order to alleviate possible adverse effects.

2 METHODOLOGY

The present study refers to an integrative review that seeks to identify the efficacy of the treatment of urinary incontinence with the use of CO^2 laser and erbium laser. Thus, for its elaboration, a search was carried out in the following databases: Virtual Health Library (VHL) and PubMed. Thus, from the total of 354 articles found, seventeen were selected, using the following descriptors searched in Medical Headings (MeSH): In the VHL "Urinary Incontinence", "Treatment" and "CO^2 Laser", and "Urinary Incontinence" and "Erbium Laser". In addition, "Urinary Incontinence" and "CO2 Laser", and "Urinary Incontinence" and "Erbium YAG Laser" were used in PubMed.

The inclusion criterion was articles published between 2012 and 2022, original articles, available in English, Portuguese and Spanish that dealt with the results of the Erbium Laser and CO^2 Laser in the treatment of urinary incontinence. Thus, there were 10 publications with duplicate obtainment in the searched databases. All articles that in a brief reading of title, abstract and methodology, were review articles and that did not address especially with the theme were excluded.

3 FINDINGS

The present study is an integrative review with analysis of 17 articles found through the VHL and PubMed databases. The selected articles are all in English and refer to the period from 2015 to 2022, being: two from the year 2015, three from the year 2016, one from the year 2017, four from the year 2018, three from the year 2019, three from the year 2020 and one from the year 2022.

The studies bring, in general, the action of ablative and non-ablative lasers on the vaginal mucosa during the treatment of urinary incontinence, in order to report the effectiveness of this therapy on this pathology. For this analysis, several questionnaires and scores were used by the respective studies, namely: International Consultation of Incontinence Questionnaire (ICIQ-SF), Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) and Australian Pelvic Floor

Questionnaire (APFQ). Thus, the text below will deal with the results through the data found in the articles searched.

4 LASER ER-YAG

The author M. Gambacciani et al. propose a prospective, longitudinal pilot study, which is the first study conducted to evaluate the use of the Erbium laser in the treatment of Genitourinary Menopause Syndrome. This study confirmed that the non-ablative laser can be used, in addition to showing improvement, in postmenopausal women who suffer from symptoms of SGM, by providing increased glycogen, stimulating angiogenesis, collagen production and cell matrix cellularity. However, this study suggests that noninvasive treatment with this laser is useful in patients suffering from mild to moderate urinary incontinence, improving ICIQ-SF scores. Thus, it can be used even by women who suffer from urinary incontinence and who can not make hormonal use, such as women who have already suffered from breast cancer. In addition, the effects were long-lasting, persisting for at least 6 months since the last session with the laser.(5)

In addition, another study proposed by the same author mentioned above was carried out with the objective of verifying the occurrence of side effects through treatment with this laser. For this, a global survey was conducted among professionals who use the Erbium laser in the treatment of their patients. The survey was conducted during the period from August 2018 to April 2019. A total of 535 professionals were interviewed, who provided information on the number of patients treated and the side effects related to the laser. The research was done from a form that included the side effects known until then of the use of the laser. Of the patients treated with laser, 31% were patients with stress urinary incontinence, 9% had genitourinary syndrome of menopause and 7% of the patients suffered from symptoms of vaginal flaccidity and stress urinary incontinence. The adverse effects reported and observed by the professionals were classified as mild to moderate, transient in nature and low frequency.(6)

G. A. Lapii et al. showed the microscopic changes that occur in the mucosa of the vaginal wall in patients suffering from stress urinary incontinence after laser treatment, thus confirming its effectiveness in improving the symptoms of stress urinary incontinence. This study showed by light microscopy of the biopsy of samples taken from the vaginal tissue, in the period of one and a half to two months after the treatment with the non-ablative laser, that there was a tissue reorganization, with increase of the epithelial layer, formation of new elastic fibers, neoangiogenesis in the stromal layers and neocollagengenesis, so that these changes led to the improvement of the elasticity of the tissue, as well as their resistance. Thus, this study resulted in an improvement in the histology and symptoms of patients suffering from urinary incontinence. (7)

In addition, another study was carried out by the same author mentioned above, in which a morphological analysis was performed by means of a biopsy of the vaginal mucosa of the 18 patients who suffered from stress urinary incontinence with vaginal wall prolapse. It was sought, through an immunohistochemical analysis, to identify the marker of proliferative activity of the Ki-67 squamous epithelium, which identified an increase in epithelial proliferative activity, as well as of cells labeled with Ki-67 after exposure of the vaginal epithelium to the laser. Therefore, there was an improvement in the organization of the vaginal epithelium, mucosal remodeling and cell proliferation, consequently improving the picture of stress urinary incontinence in these women.(8)

According to Christl Reisenauer et al., through a prospective and non-randomized study, it was demonstrated that after two applications of such laser, with an interval of four weeks, 36.3% of the patients were continent, 33.3% obtained a considerable improvement and 30.3% reported a mild improvement or no improvement in the symptoms of urinary incontinence. In addition, there was a significant reduction in the ICIQ-SF scores, even with their values remaining lower than baseline even one month after the last application. This study also demonstrated that after one year, incontinence improved in 77% of patients. Finally, this literature concluded that, despite the notorious effectiveness of the laser, more studies are still needed that show these long-term results.(9)

Another prospective study by Ivan Fistonic and Nikola Fistonic aimed to identify factors that would be predictive of laser efficacy even before treatment was initiated. Among these factors analyzed would be age, BMI, mean birth weight, duration of perineometer compression and score on the ICIQ-UI questionnaire before laser sessions. Through this study, it was concluded, after the analysis of 84 patients aged 30 to 70 years, that better results of laser treatment can be expected in women with BMI below 23.3, at younger ages, with 47.3 years being the age considered critical to perform such a procedure, with an average birth weight of less than 3.6 kg and with baseline 10 of the ICIQ-UI questionnaire.(10)

The study developed by N. Fistonić et al. aims to relate the effectiveness of the laser in the short term and with the age and BMI of the patient. For this, a prospective cohort study was conducted in patients with stress urinary incontinence in mild to severe stages. A sample of 73 patients was recruited, with a median age of 47 years and a BMI of 23, and the degree of incontinence and interference in quality of life were assessed using the ICIQ-UI SF questionnaire. Of these patients, 28 lost follow-up. The study concluded a significant short-term improvement in stress urinary incontinence, as well as a greater reduction in the ICIQ-UI SF questionnaire indices in women with normal BMI and under 39 years, compared to women with BMI in the overweight classification and in those older than 60 years, respectively.(11)

Another prospective longitudinal study by Jack I. Pardo A. et al. aimed to identify the efficacy of non-ablative Er: YAG laser therapy. Among the factors that would be analyzed by the treatment would be the age of the women, with the participation of those of middle age and elderly. Thus, the study infers after analyzing 42 patients with mild to severe SUI, that the improvement was mentioned by 33 patients and was not related to age. In addition, in the first session there was an advance in the strengthening of the vaginal wall, giving great sustainability to the bladder and urethra, causing a creation of new collagen fibers, causing the reduction of symptoms to last for approximately 6 months (12).

According to Andrzej Kuszka et al., the objective is to improve urethral and bladder insufficiency, which aggravates mild to moderate urinary incontinence, and can be treated with non-ablative laser. Thus, a randomized controlled trial study was conducted in patients with predominantly mixed urinary incontinence. A sample of 59 patients, aged 18 years or more, was evaluated, and a cough stress test was performed with patients with full bladder and in dorsal decubitus, the test was performed in a standardized way, lasting 1 hour to reach the clinical diagnosis. Therefore, the study shows a positive result of cure or improvement in a period of 6 months or up to 2 years after laser treatment.(13)

By Kun-Ling Lin et al., a retrospective study was conducted, using an initial sample of 100 patients, aged between 45.9 and 72 years, and 41 completed the study, the 59 patients who were excluded, demonstrated rapid resolution of symptoms after the use of 1 or 2 laser applications, since SUI is related to the limitation of bladder neck mobility after treatment. Among the selected patients, 33 were already in menopause. Laser treatment showed good efficacy, persisting after 6 months, especially for grades I and II, which consisted of 90% of this sample, however, grade III had less efficiency, suggesting the need for further studies for this group (including with small representativeness in the study cited).. (14)

5 LASER CO^2

In the study by Hanin Dabaja et al., 67 female patients with a mean age of 43 years were evaluated. The prospective cohort study ended up selecting 33 women who came from a clinic with a diagnosis of stress urinary incontinence. To make the diagnosis, the urodynamic test was performed. Thus, the use of laser was efficient in only 3 months after three sessions, there was improvement in the symptom of urinary incontinence. It is worth mentioning that it is necessary to expand randomized control trials to realize the efficacy and reliability of laser treatment in the distant future.(15)

The study by A. Nalewczyńska and his collaborators aimed to evaluate the safety and benefit of an insignificantly invasive CO^2 pixel laser method for the treatment of stress urinary incontinence.

This was a prospective cohort study, in which 59 women aged 30-75 years were evaluated. It was found that after three treatments, 80% of those analyzed showed improvement of SUI symptoms within 3 months and the result remained positive in 75% of the participants in the subsequent 12 months. After treatment, through biopsies, epithelial thickening and better organization of the underlying connective tissue were observed, culminating in the improvement of urinary incontinence.(16)

According to A. Menachem and his collaborators, who conducted a multicenter, prospective cohort study with the objective of assessing the subjective and objective efficacy of 1 year of vaginal CO^2 laser in women with urodynamic SUI. We analyzed women between 30 and 75 years of age who had the urodynamic diagnosis of stress-related incontinence, disregarding women who had undergone previous anti-incontinence surgery, grade II pelvic organ prolapse or if the body mass index (BMI) was greater than 38. The study showed an increase in the squamous epithelium, which was much thicker, glycogen storage was increased and more blood vessels were seen in the connective tissue, corroborating a sustained subjective improvement in 64.4% in incontinence in 12 months. Based on the results, the study suggests further research that qualifies laser therapy as an optional treatment for SUI.(17)

Author Damir Francisco et al. proposed a prospective, observational study to analyze the efficacy of CO^2 laser in the treatment of mild, moderate, severe and very severe urinary incontinence. We selected 85 women aged between 42 and 56 years, all diagnosed with urinary incontinence. The clinical examination to confirm the diagnosis occurred with the performance of the cough stress test in the lithotomy position. The efficiency was proven in a few months, where collagen remodeling and improvement in the support and strengthening of the vaginal walls, pelvic floor and middle urethra were evidenced.(18)

The research done by Fariba Behnia and her collaborators, aimed to show the benefit of transvaginal fractional CO^2 laser in women with symptoms of stress urinary incontinence (SUI), for this purpose a prospective observational study was conducted in 58 women with a mean age of 57.4 years. The response to the APFQ questionnaire, which aimed to analyze the results, was performed at the initial point of treatment, after the consecutive three applications and later in the interval of 12-24 months. Treatment with CO^2 Laser has demonstrated evolution of vaginal tissue health in women with atrophy. Regarding the participants, 82% claimed improvement in SUI symptoms at the end of treatment. The effect of treatment decreased relatively when evaluated at follow-up. However, 71% of patients reported continuous improvement in SUI symptoms at 12-24 months. In summary, it shows a promising treatment option, but further studies are needed to determine whether booster treatment is needed to sustain long-term improvements in SUI symptoms.(19)

Through the prospective, non-randomized, observational study without a control group produced by P. Gonzáles and his collaborators, the long-term result of transvaginal treatment with ablative fractionated CO² laser (TACO2L) is highlighted as a new approach to the control of urinary incontinence in women with genitourinary syndrome of menopause (GSM). Such a study showed the effectiveness of the laser to activate collagen and promote elastin formation and modulate the activation of metalloproteinases at the molecular level. We observed 161 postmenopausal women, aged 45 to 65 years, diagnosed with mild SUI. TACO2L therapy was well tolerated and no side effects were observed during the study period. The treatment resulted in an increase in the ICIQ-UI SF score at 12 months, 24 months and 36 months. Based on the reported study, TACO2L appears to be an attractive alternative method and the best option for patients with GSM and mild SUI.(20)

Another prospective observational study developed by Eleni Pitsouni et al. aimed to evaluate the effect of CO² laser in postmenopausal women with signs and symptoms of GSM. We selected 58 postmenopausal women, with a mean age of 57 years, with moderate to severe GSM symptoms, in which 3 patients refused treatment because they found it difficult to proceed with the follow-up and 2 hesitated to participate because it was an innovative therapy. In which, 53 completed the treatment, where they received intravaginal therapy with CO² Laser once a month for 3 months, without serious side effects. Some mentioned only mild ephemeral irritation in the vaginal introitus that began shortly after laser treatment, lasted up to two hours and resolved spontaneously. The study shows that CO² laser therapy may be a great non-hormonal therapeutic option valid for the clinical signs and symptoms of GSM.(21)

Table 1. Results of the selected articles.

Article title	Author and year	Denouement
Vaginal erbium laser: the second-generation thermotherapy for the genitourinary syndrome of menopause.	2015/ M. Gambacciani, M. Levancini, Mauro Cervigni	We evaluated 45 postmenopausal women with GSM before and after the use of Vaginal Ebrio Laser, and of these, 19 suffer from SUI. The result was compared with the use of vaginal estriol in 25 other women. At the end of the study, of the 45 women using VEL, only 43 completed the study, while of the women who used estriol, only 19 completed the treatment. In the 19 patients with SUI, laser treatment resulted in a significant decrease in ICIQ-SF scores.
Safety of vaginal erbium laser: A review of 113,000 patients treated in the past 8 years.	2020/ M. Gambacciani, M. Cervigni, A. Gaspar, A. Novakov Mikiÿ, J. Gaviria, N. Koron & Z. Vizintin	We interviewed 535 professionals from 43 different countries, who reported a total of 113,174 patients on vaginal erbium laser treatment from 2012 to 2019. About 30%

		(n:160) of the interviewees provided detailed information of the patient population, and these sites included 62,727 patients whose data were collected for this respective study. According to the information obtained by these interviews, 31% of the treated patients had SUI and 9% had vaginal flaccidity concomitant with SUI. Therefore, ebrio laser treatment is safe and has a very low risk, with side effects reported to be mild to moderate, transient and at low frequency. The most common were: vaginal discharge (6.53%), edema (3.72%), pain (1.92%), punctual bleeding (1.55%), dryness (0.22%) and UI again (0.28%).
Structural Reorganization of the Vaginal Mucosa in Stress Urinary Incontinence under Conditions of Er:YAG Laser Treatment.	2016 / G. A. Lapii, A. Yu. Yakovleva, and A. I. Neimark	Some relevant changes in the components that are part of the mucosa of the vaginal wall were seen in a study with microscopy, in women with stress urinary incontinence in the presence of vaginal ptosis. The speed of how the tissue was restructured after treatment varied, corroborating the severity of incontinence and vaginal ptosis in each patient. Degenerative changes in the stratified squamous epithelium were mild or moderate and manifested by focal cell disintegration, emergence of epitheliocytes with perinuclear vacuoles and unequal saturation of the cytoplasm with glycogen. Comparative photooptic analyses of vaginal biopsy performed before and 1.5 to 2 months after exposure to Er:YAG laser of women with stress incontinence were performed, showing signs of reorganization of mucosal components, indicating relief of pathological changes and tendency to mucosal restructuring.
Study of Proliferative Activity of Vaginal Epithelium in Women with Stress Urinary Incontinence Treated by Er:YAG Laser.	2017/ G. A. Lapii, A. Yu. Yakovleva, A. I. Neimark and E. L. Lushnikova	A morphological analysis was performed by means of a biopsy of the vaginal mucosa in 18 women with SUI and vaginal wall prolapse who received therapy with the use of erbium laser. Biopsy samples were collected before laser therapy and also after 1 month and a half to 2 months of the laser session. Microscopy of the vaginal mucosa after laser use revealed foci of neocollagenogenesis and neoangiogenesis and high content of

		less fragmented elastic fibers in the stroma. In addition, the presence of numerous fibroblasts with signs of synthetic activity was also noted. Degeneration and atrophy in the stratified squamous epithelium were less manifest compared to initial tissue samples. In addition, immunohistochemical findings showed increased epithelial proliferative activity after laser therapy. Therefore, patients with SUI after the use of erbium laser, presented remodeling of the vaginal mucosa, increased cell proliferation and improvement of cell organization.
Vaginal therapy of mild and moderate stress urinary incontinence using Er:YAG laser: a real treatment option.	2019/ Christl Reisenauer, Sebastian Hartlieb, Birgitt Schoenfsch, Sara Yvonne Brucker, Felix Neis	In the study, 33 women were diagnosed with mild and moderate SUI and MUI with dominant SUI. That said, 23 of 33 women (70%) suffered from SUI and 10 of 33 women (30%) suffered from MUI with dominant SUI. In addition, 7 of the 33 patients (21%) had grade O and the remainder (79%) had grade II SUI according to the Ingelman Sundberg classification. Thus, after the two applications of Era:YAG laser, a significant improvement in the quality of life of the patients was presented. In this sense, while quality of life improved for 22 women, 7 women had lower quality of life at the beginning of treatment and for 4 women the quality of life remained unchanged. However, the mean score of the ICIQ-SF showed that 31 of the 33 women presented positive results, only one presented inferior results and one did not present any alteration.
Baseline ICIQ-UI Score, Body Mass Index, Age, Average Birth Weight, and Perineometry Duration as Promising Predictors of the Short-Term Efficacy of Er:YAG Laser Treatment in Stress Urinary Incontinent Women: A Prospective Cohort Study.	2018 / Ivan Fistonic1,2 and Nikola Fistonic3	A prospective cohort study recruited a total of 145 patients to be analyzed, only 88 had all the criteria to be included in the study, one of them being SUI. In the middle of the treatment, three patients who did not want to continue were lost, and with this the analysis was performed in a final sample of 85 patients aged between 30 and 70 years. The intervention was performed with an Er:YAG laser of wavelength of 2940 nm, 6 months after the intervention the patients with four or five positive predictors achieved a clinically relevant reduction in the ICIQ-UI (MID) of 30%.

First assessment of short-term efficacy of Er:YAG laser treatment on stress urinary incontinence in women: prospective cohort study.	2015/ N. Fistonić, I. Fistonić, A. Lukanovič, Š. Findri Guštek, I. Variety Bilajac Turina > D. Franić	A study of 73 women suffering from stress urinary incontinence was conducted to verify the short-term efficacy of Er:YAG laser treatment, and in a second moment, from 2 to 6 months after the intervention, only 45 (62%) of the women remained in the study. In this perspective, from the first moment to the second, there was a significant improvement in 34 patients of 47 (72.3%), 11 (23.4%) did not express any change in the ICIQ-UI score and 2 participants (4.3%) had worsening of symptoms.
Treatment of female stress urinary incontinence with Erbium-YAG laser in non-ablative mode.	2016/ Jack I. Pardo, Vicente R. Solá, Andrea A. Morales	2 sessions of drunken laser treatment were performed with an interval of 21 to 28 days in 42 women. Before laser therapy, according to the ICIQ score, 9.5% patients had mild SUI, 47.6% moderate, 40.5% severe and 2.4% very severe. After treatment, there was an improvement in parameters, with 26.2% with mild SUI, 23.8% with moderate symptoms, 11.9% with severe SUI. Thirty-eight percent reported complete cure at follow-up.
Erbium:YAG laser treatment of female stress urinary incontinence: midterm data.	2019/ Andrzej Kuszka & Marianne Gamper & Claudia Walser & Jacek Kociszewski & Volker Viereck	Fifty-nine women, aged over 18 years and with clinical and urodynamic diagnosis of SUI or mixed urinary incontinence predominating SUI, were included in a tertiary urogynecological center. Physical therapy was recommended before laser intervention and prohibited during the study. All patients received five sessions of E r:YAG laser (FotonaSmooth XS;® 2,940 nm; Fotona, Ljubljana, Slovenia) in SMOOTH mode following the IncontiLase protocol, one at the beginning and one after 1, 2, 3 and 4 months. At the end of the study it was proven that mild to moderate SUI has efficacy in the treatment using the Er:YAG laser with non-ablative SMOOTH mode technology and still brings showing that the therapy is effective for up to 2 years after treatment.
Effect of Er:YAG Laser for Women with Stress Urinary Incontinence.	2018/ Kun-Ling Lin, Shih-Hsiang Chou and Cheng-Yu Long	This is a retrospective study, in which 100 female patients with SUI were classified using the Ingelman-Sundberg method, which has three degrees of stress incontinence

		classification, depending on the clinical severity of the patient. The Ingelman-Sundberg grades are in agreement with Stamey, classifying it as mild, moderate and severe. All patients underwent three treatments, every 4 weeks were classified into three grades based on clinical severity. The treatment was performed with the vaginal laser Er-YAG with wavelength of 2940 nm. A total of 41 patients completed the study. Before treatment, the frequency and severity of incontinence were evaluated and the median ICIQ-SF score of 7.2 ± 4.5 was obtained, and after treatment it decreased significantly to 3.7 ± 3.5. In a 6-month period after treatment, 36.6% (15/41) of patients were cured of SUI, with 39% (16/41) of patients improving reporting. In ten patients (24.4%) there was no improvement or worsening of SUI symptoms. Er:YAG laser treatment 6 months after treatment showed an efficacy of 75.5% (31/41).
The safety and efficacy of CO2 laser in the treatment of stress urinary incontinence.	2019/ Hanin Dabaja1 & Roy Lauterbach & Emad Matanes & Ilan Gruenwald & Lior Lowenstein.	Prospective cohort study with 67 women selected and 35 considered eligible and willing to participate in the study, 2 of whom were lost and 33 participated in the final result. There was a significant improvement in the UDI-6 score after 3 months of treatment, with return to baseline after 6 months of treatment, a fact observed in all patients. In addition, there was an improvement in the ICIQ-UI score (from 16 to 8) at 3 months after treatment. The use of pads/day decreased from 12 to 7 in 3 months after treatment, and in 6 months this daily average of use returned to 12. The VAS scale did not exceed 3 during treatment.
PixelCO2 laser for the treatment of stress urinary incontinence.	2022/ Agnieszka Aleksandra Nalewczyńska, Michael Barwijuk, Piotr KolczewskiEwa DmochGajzlerska.	In this study, 59 women with SUI symptoms were treated with 3 sessions of pixel CO^2 laser, with an interval of 1 month between them. The evaluations were made before each session and also at 6 and 12 months of follow-up. After the sessions, the Sandvik index revealed significant improvement in symptoms, in which patients with moderate score initially (73%), fell to the group of mild score and patients in the group of severe score

		initially (25%), went to the group of moderate score in the follow-up of 6 and 12 months. The tampon test, as well as the vaginal ph, revealed an improvement up to the 3rd treatment session, with a mild reversal in the following months. The VHI score showed improvement of the index in the 3 treatment and in the 6 month of follow-up. Patient satisfaction with treatment averaged 7 on a scale of 0 to 10. Regarding pain, 51% classified pain as level 3, 20% level 4, 14% level L5 and 10% level 2 pain on a scale of 0 to 10.
Fractional-Pixel CO2 Laser Treatment in Patients With Urodynamic Stress Urinary Incontinence: 1-Year Follow-Up.	2020/Menachem Alcalay, Moshe Ben Ami, Anatoly Greenshpun, Zion Hagay, Eyal Ship	This study was conducted with 64 patients, 8 of whom were excluded during urodynamic evaluation. Fifty-six completed the first treatment and 52 women underwent the 3 treatment sessions. Of these 52 patients, 48 attended the 6-month follow-up and 42 completed the follow-up for 12 months. Initially, the weight of the pillows was on average 7.7g and the severity of incontinence score was moderate in 83%. After the third treatment session, there was a reduction in cushion weight (1h absorbent test), with an even greater reduction from baseline in the 12-month follow-up period. The mean number of incontinence episodes during 3 days of monitoring was reduced only after the third treatment and did not reach significant levels at 6 and 12 months. At the 6-month follow-up, 29 patients repeated the urodynamic examination, of which 12 did not leak. Bladder symptoms improved from first treatment to follow-up at 12 months, according to the PFDI score. During the procedure or follow-up, no serious adverse effects were recorded.
Pixel CO2 Laser for the Treatment of Stress Urinary Incontinence: A Prospective Observational Multicenter Study.	2020/ Damir Franić, Ivan Fistonić, Maja Franić-Ivanišević, Željko Perdija, Miljenko Križmarić	This prospective observational study in which 85 patients with SUI were submitted to CO^2 laser treatment. After the second treatment, only 48 remained in the study, 37 of which were lost for follow-up. Initially, 27% of the women had mild SUI, 25% moderate SUI, 46% severe symptoms and 32% very severe symptoms. The results showed that, according to the ICIQ-UI score,

		after the first treatment 29% had no symptoms, 23% mild symptoms, 38% moderate, 20% had severe symptoms and 1% very severe. After the second treatment, 45.8% had no symptoms, 18.7% mild symptoms, 20.8% moderate symptoms and 14.6% had severe SUI symptoms.
Fractional CO2 laser for treatment of stress urinary incontinence.	2018/ Fariba Behnia-Willisona, Tran T.T. Nguyenb, Behrang Mohamadic, Thierry G.Vancaillied, Alan Lame, Nadia N. Willisonf, Jett Zivkovicf, Richard J. Woodmanf, Monika M. Skubiszg	This is a prospective observational study, in which 58 women with SUI symptoms who were treated with transvaginal fractional CO^2 laser were recruited. The results of the treatment protocol did not show any serious adverse events, but of the participants who completed the treatment, 3 (5.4%) noticed changes in vaginal discharge, diagnosed as candidiasis, which soon resolved with treatment; 2 (3.4%) reported UTI symptoms and were treated with appropriate antibiotics; 1 (1.7%) developed a recurrence of genital herpes and required antiviral therapy. The study showed a change in the prevalence of SUI symptoms before and after CO^2 laser therapy in patients who were pre- and postmenopausal. After 3 treatment sessions at a stipulated interval of 4 to 6 weeks, he obtained an improvement of 80% of SUI symptoms in the period of 3 months, persisting in 75% of the participants in 1 year.
Long-term effect of thermoablative fractional CO2 laser treatment as a novel approach to urinary incontinence management in women with genitourinary syndrome of menopause.	2017/ Pablo González Isaza & Kinga Jaguszewska & Jose Luis Cardona & Mariusz Lukaszuk	In the study, they had good achievements with the treatment of TACO2L, because there were improvements in the scores of the ICIQ-UI SF in the months described by the protocols, an annual treatment session after 12, 24 and 36 months. However, at the end of treatment, 51 patients (32%) had moderate UI.
Microablative Fractional CO2-Laser Therapy and the Genitourinary Syndrome of Menopause: An observational study.	2016/ Pitsouni Eleni, Grigoriadis Themos, Tsiveleka Angeliki, Zacharakis Dimitris, Salvatore Stefano, Athanasiou Stavros.	In this study, 58 women were considered eligible to participate, but 5 withdrew. Thus, 53 patients were included to participate in these studies, that is, to be treated with CO^2 Laser, in 3 sessions with monthly intervals. All participants had Genitourinary Menopause Syndrome. UI symptoms improved significantly, as evidenced by the ICIQ-FLUTS, UDI-6, ICIQ-UI SF and KHQ scores. It was possible to

		verify that 40% urinated 1-6 times a day, 34% 7-8 times a day, 23% urinated 9-10 times a day and 4% 11-12 times a day. In the KHQ questionnaire, there was a change greater than 5 points in all 53 women participants.

Source: Prepared by the authors themselves.

Caption:
EVA: Visual analog scale.
ICIQ-UI: International Consultation of Incontinence Questionnaire.
ICIQ-UI SF: Incontinence Questionnaire-Urinary Incontinence Short Form.
UI: urinary incontinence.
SUI: stress urinary incontinence.
KHQ: King's Health Questionnaire.
PFDI: Pelvic Floor Suffering Inventory.
TACO2L: Thermoablative fractional CO2 laser.
VEL: Vaginal Erbium Laser.
VHI (vaginal health index): Score that integrates vaginal elasticity, fluid volume, vaginal pH, epithelial integrity and humidity.
UDI-6: Escores do Urogenital Distress Inventory.

6 DISCUSSION

Regarding the studies analyzed above, it is verified that there was an improvement in urinary incontinence through the structural reorganization of the vaginal tissue after the applications with both the erbium laser and the CO^2 laser. Referring to the non-ablative laser (Erbium), it was found that, in two studies in which the patients had stress urinary incontinence and in the other due to stress, there was an increase in cell proliferation, increased collagen formation, as well as vascularization of the vaginal mucosa, thus improving tissue resistance. In addition, with regard to the ablative laser (CO^2), it is noted that all studies were conducted in patients with stress urinary incontinence, with activation of the production of collagen and elastin fibers, improvement in the organization of connective tissue with improvement in the strengthening of the vaginal walls. According to the author Nuno David Dias Pardal, there are other superior methods including microscopy, such as Polymerase Chain Reaction and immunohistochemistry, which show in the tissue of the vagina an increase in the messenger RNA of procollagen, tumor necrosis factor, metalloproteinases and cytokines that stimulate the production of fibrosis after the application of lasers. Proving, in this way, the efficiency of this therapy.(22)

In addition, still in the histological aspect Laryssa Caroline Torres Severiano and her collaborators report that both lasers act by changing the histological structure of the dermis and epidermis, causing dermoepidermal lesions so that they generate the same results in both lasers, creating a similar result. Thus, it leaves the corneal extract intact, ruling out possible complications; infections, necrosis, scarring, among other side effects.(23)

It was also the subject of research in some of the studies, the factors that would be predictive of the effectiveness of the laser. This point was further addressed with regard to the Erbium laser,

where two articles analyzed several factors that could bring better results in the treatment, with BMI and age being the common factor of analysis among the studies. Both studies that analyzed these two factors were in agreement that BMI less than 23 and average age around 47 years obtained better results with this type of laser. However, it is verified that more studies are still needed regarding the questions of laser efficacy, especially with regard to the ablative, since no articles were found within the proposed aspects that made analysis of some criteria that could be determinant in the results.

In addition, another instrument widely used to measure the effectiveness of such lasers was the ICIQ-UI questionnaire, being used by four studies that dealt with Erbium laser and only one article that dealt with CO^2 laser. In all these five articles, an improvement in the scores of this questionnaire was verified, which is equivalent to saying urinary incontinence.

With regard to the time in which effects begin to appear and their duration time, these become variable according to each study and type of laser. The erbium, for example, most studies on this issue, agree among themselves that there is improvement of symptoms after about one month to two months at most after the first applications, only one study reports improvement after the use of 1 or 2 applications. Regarding the duration of this effect, all the studies that reported this question were in agreement with the 6-month period with a study that may last up to a year. When it comes to the CO^2 laser, the studies were in agreement that the time to appear the effects is around 3 months and lasts from 12 to up to 24 months. However, for Jaqueline Maria de Azevedo Chagas and collaborators, for such a procedure the benefit is not yet established because it is a recent technique. In view of positive results, it remains to be verified about the duration of this treatment. Studies of the two different types of laser agree that more research is still needed in this area to address the long-term outcome. (3)

In addition, the Brazilian Journal of Gynecology and Obstetrics of Rio de Janeiro 2022 second edition, emphasizes that in the literature there are still few protocols that indicate the type of laser and how the treatment should be (number of sessions and laser intensity). However, it is a little invasive procedure and occupies an important place in the treatment of urinary incontinence.(24)

In addition, the side effects that could arise during this treatment have been reported only by a few studies. In the Erbium laser only one article brought a classification of the adverse effects in mild to moderate, low frequency and transient. In the ablative laser (CO^2), one study said that there were no side effects during the research; Another study highlighted a slight effect of transient duration in the first 2 hours after laser application. A single study on this CO^2 laser highlighted something of paramount importance, which is the fact that it adjusts the frequency of the laser to minimize the chance of side effects. Nuno David Dias Pardal agrees with the aspect discussed when reporting that studies have shown little occurrence in adverse effects with clinical importance. However, minor effects are basically the result of mechanical trauma by the introduction of a probe or by thermal ablation. After

each session or in the short term, vaginal bleeding, mild discomfort, unforeseen discharges, burning and vaginal pain may occur, which in many cases improve quickly and naturally. Therefore, in the medium and long term, there is a very low risk of causing definitive tissue damage that leads to the appearance of bridles, sensitivity, dyspareunia or routine infections. I emphasize that both adverse effects come from the iatrogenic process.(22)

At first it is verified that it is a promising treatment, with so far few side effects and many benefits, which can even serve as the first choice for the treatment of women who suffer from urinary incontinence, but who have contraindications to traditional methods, such as the use of estrogen by patients with breast cancer. However, despite being an advantageous treatment, Laryssa Caroline Torres Severiano and her collaborators bring that its repercussion in public health is still low, given its non-availability in public services, such as the Unified Health System (SUS), due to its high cost.(23)

7 CONCLUSION

Through this literature review it was evidenced that the treatment for urinary incontinence, one of the disorders that make up the Genitourinary Syndrome of Menopause, through erbium and CO^2 lasers is quite effective, a fact that can be proven both through the microscopic changes of the vaginal tissue and through the scores of the questionnaires performed to the various patients submitted to these procedures, as has been shown by several studies discussed above. In addition to being a treatment with results already in the first sessions, it is possible to verify that the side effects are practically absent and when present of a transient nature. In addition, more studies are still needed on the duration of its effects, especially in the long term.

In addition, it is still necessary to create a standardized protocol with the number of sessions, the frequency with which they should be performed, the interval time between them and the total duration of treatment, correlating all these factors with the degree of therapeutic efficacy in improving the symptoms of urinary incontinence, aiming to guide health professionals.

Finally, it is a new treatment, with a still limited amount of research in the area and that therefore still requires more studies, especially those that can compare the results of lasers with those of other therapies that are already used in patients with such a condition, so that the physician acting in the case can individualize each situation and guide the patient in the most appropriate treatment according to her conditions.

REFERENCES

Femina R. Síndrome geniturinária da menopausa. Federação Brasileira das Associações de Ginecologia e Obstetrícia (Febrasgo). 2022 Março.

Farina Kamilos M, Borrelli L. Nova opção terapêutica na síndrome geniturinária da menopausa: estudo piloto utilizando radiofrequência fracionada microablativa. EINSEinstein. 2017 Agosto.

de Azevedo Chagas JM, de Morais Lago A, Caiado Madi , Vieira Sampaio , Fonseca Ramos R, Hudson Carneiro , et al. A utilização do laser fracionado como tratamento para flacidez e atrofia vulvovaginal. Brazilian Journal of Health Review. 2022 Maio: p. 10816-10825.

Jurado SR. O laser e o tratamento da flacidez e atrofia vulvovaginal. Femina. 2018: p. 284-294.

Gambacciani M, Levancini M, Cervigni M. Vaginal erbium laser: the second-generation thermotherapy for the genitourinary syndrome of menopause. 2015.

Gambaccini , C, Gaspar A, Novakov Mikiÿ A, Gaviria J, Koron N, et al. Safety of vaginal erbium laser: A review of 113,000 patients treated in the past 8 years. 2020 October: p. 28-32.

Lapii G, Yu Yakovleva A, Neimark A. Structural Reorganization of the Vaginal Mucosa in Stress Urinary Incontinence under Conditions of Er:YAG Laser Treatment. Byulleten' Eksperimental'noi Biologii i Meditsiny. 2016 October: p. 511-516.

Lapii GA, Yakovleva AY, Neimark AI, Lushnikova EL. Study of Proliferative Activity of Vaginal Epithelium in Women with Stress Urinary Incontinence Treated by Er:YAG Laser. Byulleten' Eksperimental'noi Biologii i Meditsiny. 2016 February: p. 251-255.

Reisenauer , Hartlieb , schoenfisch , Yvonne Brucker S, Neis F. Vaginal therapy of mild and moderate stress urinary incontinence using Er:YAG laser: a real treatment option. Deparment of Obstetrics and Gynecology, University. 2019.

Fistonic , Fistonic N. Baseline ICIQ-UI Score, Body Mass Index, Age, Average Birth Weight, and Perineometry Duration as Promising Predictors of the Short-Term Efficacy of Er:YAG Laser Treatment in Stress Urinary Incontinent Women: A Prospective Cohort Study. Lasers in Surgery and Medicine. 2018.

Fistonic N, Fistonic , Lukanovic , Findri Gustek , Sorta Bilajac Turina , Franic. First assessment of short-term efficacy of Er:YAG laser treatment on stress urinary incontinence in women: prospective cohort study. Effi cacy of Er:YAG laser treatment. 2015 Setembro.

I. Pardo J, R. Solà , A. Morales. Treatment of female stress urinary incontinence with Erbium-YAG laser in non-ablative mode. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2016 June : p. 1-4.

Kuszka , Gamper , Walser , Kociszewski , Viereck. Erbium:YAG laser treatment of female stress urinary incontinence: midterm data. The International Urogynecological Association. 2019 December.

Lin KL, Chou SH, Long CY. Effect of Er:YAG Laser for Women with Stress Urinary Incontinence. BioMed Research International. 2019 January.

Dabaja , Lauterbach , Matanes E, Gruenwald , Lowenstein L. The safety and efficacy of CO2 laser in the treatment of stress urinary incontinence. International Urogynecology Journa. 2019 December.

Aleksandra Nalewczynska , Barwijuk , Kolczewski , Dmoch-Gajzlerska E. Pixel CO2 laser for the treatment of stress urinary incontinence. Lasers in Medical Science. 2022 August : p. 1061-1067.

Alcalay , Ben Ami , Greenshpun , Hagay , Schiff. Fractional-Pixel CO2 Laser Treatment in Patients With Urodynamic Stress Urinary Incontinence: 1-Year Follow-Up. Lasers in Surgery and Medicine. 2020 September.

Franié D, Fistonié , Franié-Ivanisevié M, Perdija Z, Krizmarié. Pixel CO2 Laser for the Treatment of Stress Urinary Incontinence: A Prospective Observational Multicenter Incontinence: A Prospective Observational Multicenter Incontinence: A Prospective Observational Multicenter Study. Lasers in Surgery and Medicine. 2020 August.

Behnia-Willison , T.T. Nguyen T, Mohamadi B, G. Vancaillie , Lam , N. Willison , et al. Fractional CO2 laser for treatment of stress urinary incontinence. / European Journal of Obstetrics & Gynecology and Reproductive Biology. 2019 January.

González Isaza , Jaguszewska , Cardona , Lukaszuk. Long-term effect of thermoablative fractional CO2 laser treatment as a novel approach to urinary incontinence management in women with genitourinary syndrome of menopause. Int Urogynecol J. 2017 May.

Pitsouni , Grigoriadis , Tsiveleka Dimitris , Salvatore , Athanasiou. Microablative Fractional CO2-Laser Therapy and the Genitourinary Syndrome of Menopause: An observational study. 2012 September.

Dias Pardal D. Tratamento a LASER na Síndrome Genito-Urinária da Menopausa. 2019 Junho.

Torres Severiano , Fevereiro Pena K, Victorino Miranda , Teixeira da Costa Lodi. LASERTERAPIA NO TRATAMENTO DA SÍNDROME GENITURINÁRIA DA PÓS-MENOPAUSA. e-Scientia. 2019: p. 34-37.

Condé-Rangel , Davila , Brito. Incontinência urinária de esforço e laser vaginal. Jornal Brasileiro de Ginecologia. 2021 Julho-Dezembro.