

THE EFFECT OF VAGINAL CO₂ LASER TREATMENT ON STRESS URINARY INCONTINENCE SYMPTOMS

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Abstract

Background

Stress urinary incontinence (SUI) in women leads to physical discomfort, deteriorate quality of life and emotional burden. While pelvic floor exercises have been advocated as initial treatment, surgical interventions have demonstrated better efficacy and durable results. However, the possible morbidity of even the most minimally invasive surgical interventions, make many patients reluctant to undergo surgery. Recently, vaginal CO₂ laser treatments have been introduced as a conservative option to treat SUI. This study aimed to assess the effect of vaginal CO₂ laser on bladder and vaginal symptoms in patients with SUI.

Methods

This was a retrospective, multi-center evaluation of 133 consecutive patients with SUI symptoms, who underwent vaginal Pixel CO₂ laser treatments (FemiLift hand piece, Alma Lasers). Patients were interviewed 3-12 months following completion of treatment to evaluate their symptoms and satisfaction.

Results

Eighty percent of the 133 participating patients had SUI symptoms and 20% had mixed incontinence symptoms. The 105 patients successfully contacted to complete the post-treatment questionnaires, reported a significant decline in number of pads used per day, with 80.6% of patients requiring no pads following treatment, in contrast to the 47.8% of patients requiring no pads before treatment ($p < 0.0001$).

Significant reductions in urinary urgency and frequency were reported, with >97% patients reporting no or mild urgency and frequency following treatment, versus 7.9% and 5.3%, respectively, reporting moderate symptoms before treatment ($p = 0.03$ and 0.04 , respectively).

In addition, 91.4% of the patients reported no pain during intercourse following laser treatment, while the remaining 8.6% experienced mild pain only ($p = 0.04$).

Satisfactory global improvement was reported by 66.7% of the patients, with a higher incidence of such reports among women with SUI versus other types of urinary incontinence. No significant changes in nocturia were noted by patients following treatment. No adverse events were reported by any patients or recorded in patient charts

Conclusions

The vaginal CO₂ laser treatment yielded promising initial results in treatment of stress urinary incontinence symptoms and vaginal symptoms, with no adverse events.

The potential benefits of this outpatient treatment include improved patient compliance, alongside a high safety profile. Further studies are needed to prospectively assess the long-term efficacy of the pixelated laser treatment on SUI.

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Introduction

Stress urinary incontinence (SUI) is often initially addressed via pelvic floor exercises and behavioral modification. However, surgical interventions continue to be the mainstay of SUI therapy, as they provide the most effective long-term cure¹. Midurethral slings are the most common surgical interventions today for SUI treatment, and are well accepted as minimal invasive procedures.

A recent meta-analysis of the prospective randomized controlled trials comparing midurethral slings to Burch or pubovaginal sling showed that mean objective and subjective cure rates for midurethral slings were 86.3% and 71.6%, without significant differences from Burch colposuspension.² However, these minimal invasive procedures are not free of complications, as reported in a perspective survey of the Nationwide Inpatient Sample database, which included 147,473 SUI surgery patients³. The overall complication rate was 13%, with bleeding (4.4%) and urinary/renal (4.3%) complications being most common.

Laser-based treatments have been reported to stimulate collagen neogenesis and skin and tissue remodeling and rejuvenation in wound healing, dermatological, gynecological and dental applications⁴⁻¹⁴. When recruiting this technology for intravaginal gynecological treatments, it is expected to exploit natural healing responses to trigger epithelial tissue regeneration, that may strengthen urethral support.

Recent application of endovaginal Er:YAG laser-based treatment to treat SUI symptoms, brought to significant decreases in urinary incontinence severity and to significantly improved quality of life, within one month of treatment, which were maintained throughout the 6-month follow-up period.¹⁵ Improved SUI symptoms, including first sensation, first desire and maximal urethral closure pressure were reported following application of an Er:YAG laser treatment regimen in 50 female patients.¹¹ Similarly, distinctive symptomatic improvement was reported following a three-series deployment of the FemiLift CO₂ laser to treat SUI symptoms in a 50-year-old woman with a 6-year history of urinary leakage.¹⁶ The aim of this retrospective, multicenter audit, was to assess the efficacy of vaginal CO₂ laser treatment in SUI patients.

Methods

Patients:

Treated patients (n=133) suffered from symptoms of urinary stress incontinence. Patients concomitantly taking medicines that induce photosensitivity, with an active vaginal infection, active urinary infection, diagnosed collagen disease, herpes infection, undergoing corticoid therapies and/or with gynecological oncological pathologies were not treated. Pregnant women were not treated either.

The Technology:

The FemiLift CO₂ laser (Alma Lasers) delivers energy to the deep submucosal vaginal tissue through a holographic lens, which pixelates the beam into 81 microscopic pixels in a 9x9 mm pattern (Figure 2). The thermal effect is achieved in microscopic columns, while the surrounding tissue remains intact. In consequence, existing fibers contract and neocollagenesis is stimulated, while cells located in the unaffected tissue hastens the healing process, finally leading up to vaginal wall rejuvenation.

Ablative Laser Treatment:

Treatment was performed in an outpatient setting, without sedation or local anesthetics. The treated area was cleaned of mucus secretion with a gauze pad before treatment. Oral prophylactic antiviral agents to prevent outbreak of herpes simplex virus, were administered. FemiLift (by Alma Lasers) is a CO₂ laser with a single-use hygienic probe that delivers pixelated laser energy. The probe, lubricated with baby oil, was set at a low to moderate (Figure 1) energy setting (30-40 mJ/pixel) before being positioned under the mid-urethra location, with the laser's energy window oriented at 12 o'clock position.

It was then rotated by one hour at a time after each laser pulse, between positions 10 o'clock to 2 o'clock to address the urethra up to the bladder neck. After completing the 10-2 o'clock rotation, the handpiece was pulled back by one centimeter and the rotation was repeated. Three such passes were repeated. The energy intensity and pulse durations were only increased if the patient expressed no signs of discomfort.

The maximum energy setting was 70 mJ/pixel for postmenopausal women and 100 mJ/pixel, for premenopausal women. Pulse duration varied (130 - 270 ms).

A minimum interval of 30 days was required between 3 sessions.



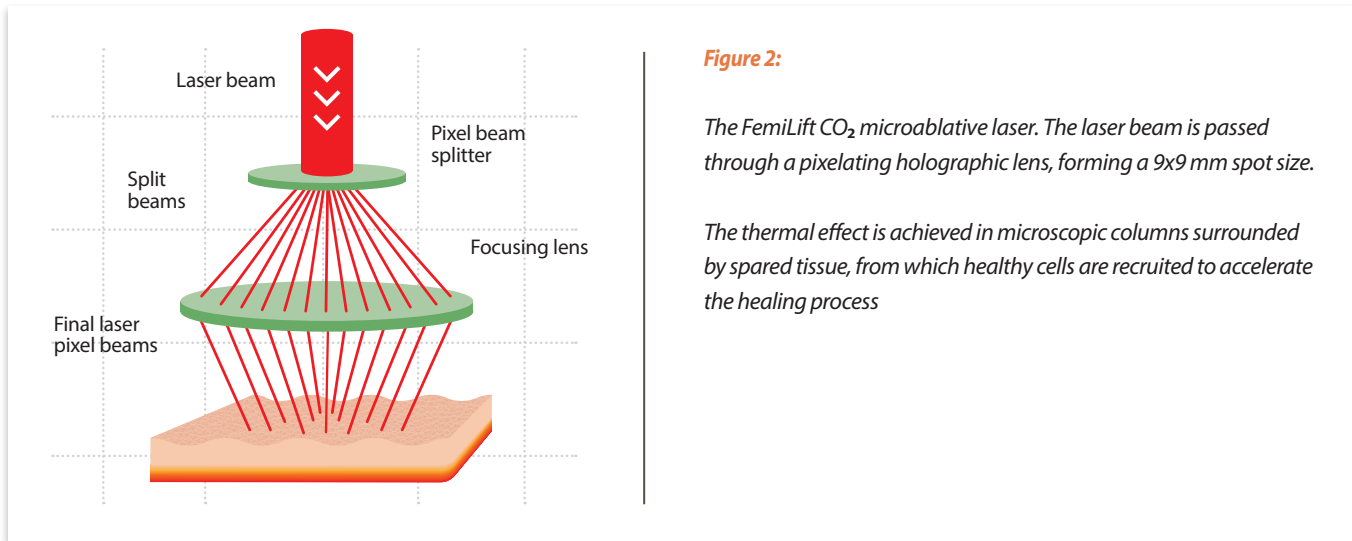
Figure 1: FemiLift handpiece with a single-use hygienic probe

Questionnaires:

Patients were interviewed retrospectively with questionnaires, which included selected questions from the Pelvic Floor Distress Inventory (PFDI) questionnaire, and the 10-cm visual analog scale (VAS) Vulvo Vaginal Atrophy symptoms questionnaires about their symptoms before and after treatment. Patients were interviewed 3-12 months following treatments.

Statistical Analysis:

Statistical analyses were performed with SAS v9.3 (SAS®, SAS Institute Cary, NC USA) software. Study data was tabulated and summarized by data type, continuous variables with a mean and standard deviation and discrete data by a count and percentage. Bowker's test of symmetry was used to assess if there was a statistically significant change in clinical symptoms. A p-value of 0.05 or lower was considered statistically significant. Nominal p-values are presented.



Results

Patients:

The patients participating in this survey included women with stress urinary incontinence (72.2%), urge incontinence (1.0%) or mixed urinary incontinence (19.6%) (Table 1). At baseline, 21.1% of patients reported mild to moderate urinary urgency, 24.2% mild to moderate urinary frequency and 10.1% complained of grades mild-moderate nocturia.

In addition, before treatment, 52.2% of the patient population reported use of protective pads, with 40.3% requiring two or more pads per day, and 20% reported some degree of vaginal dryness and painful intercourse.

Following treatment, significant improvements in urinary urgency and frequency were reported, with 97% of patients reporting no or mild urinary urgency and frequency ($p=0.03$ and 0.04 , respectively) (Table 2).

No cases of moderate nocturia were reported post-treatment and only 5 (4.6%) of the 109 evaluated patients reported mild symptoms. Vaginal itching, reported by 8 patients at baseline, manifested

following treatment among three patients only. Moreover, the number of reported pads used per day declined significantly, with 80.6% of the treated patients requiring no pads following treatment and the remainder requiring up to two pads per day ($p<0.0001$, figure 3).

Similarly, a 13% rise ($p=0.009$) in the number of post-treatment reports of no vaginal dryness was observed, with a total of 93.6% patients reporting no dryness and 6.4% reporting mild dryness only. In addition, 91.4% of the patients reported no pain during intercourse following laser treatment, while the remaining 8.6% experienced mild pain only ($p=0.04$).

When assessing the Vulvovaginal Atrophy questionnaire scorings 66.7% of the women reported moderate to significant responses to treatment (Figure 3), with a greater percentage of SUI patients reporting such marked effects (72.9%), when compared to women with other types of urinary incontinence (50%).

Discussion

Implementation of CO₂ (CO₂; 10,600 nm) laser therapy has been previously reported in gynecological applications, and has been shown to restore the vaginal epithelium and provide symptomatic relief of vaginal atrophy.¹⁷ Following selective absorption of CO₂ illumination by tissue water, increased fibroblast and epithelial cell activity have been reported, with enhanced synthesis and deposition of extracellular matrix and vascular components¹⁸, and eventual improvement in tissue function.

The fractionated CO₂ laser therapy reported here, maximized therapeutic efficacy, via a long-pulsed, fractionated illumination regimen, yielding deeper, yet safe (<500 microns) penetration and more intense heating of the high water-content submucosa.

The resulting thermal and ablative effects led to rejuvenation of the treated tissue and eventual refirming of the vaginal and mid-urethra structures, as manifested by symptomatic improvement of clinical vaginal and bladder parameters. More specifically, significant patient-rated improvements in urinary urgency and frequency were recorded as well as a 59.1% rise in the number of patients requiring no pads following treatment.

Moderate to significant global improvements were noted by 66.7% of the women. Of note, SUI patients were more satisfied with the treatment compared to patients with other types of UI, a difference which may have been incidental due to the small sample size of women with mixed urinary incontinence.

Self-managed lifestyle modifications and conservative SUI treatments, such as pelvic floor training, are typically adopted as first-line treatments. While cost-effective and relatively free of side effects, they rely heavily on patient compliance and adherence over time, and have been shown to be of greatest impact in younger patients¹⁹ and when performed under supervision and for at least three months.²⁰ Weighted vaginal cones provides similar efficacy to pelvic floor muscle training, but is associated with a 25% drop-out rate.²¹ Occlusive continence devices demand a high degree of patient motivation and clinical trials assessing their effectiveness have reported marked drop-out rates.¹

In addition, as they are typically disposable and replaced after each void and during sexual activity, they incur substantial costs and inconvenience.¹ Most importantly, as the devices fail to treat the underlying problem, they leave patients indefinitely dependent on them to maintain continence.

Pharmacological agents have been associated with a high rate of adverse events and unsatisfactory clinical outcomes. In their

systematic review of nine trials, evaluating the efficacy and tolerability of duloxetine, a serotonin and noradrenaline reuptake inhibitor, in management among of over 3000 SUI cases, Mariappan et al. report significantly improved quality of life and rates of symptom improvements when compared to placebo-treated patients. However, 71% of the population suffered from side effects, leading to discontinuation of treatment in one in eight patients²².

Stimulation of bladder neck and urethra a-adrenergic receptors, by various pharmacological agents, have led to low cure rates (£14%), a 19-60% reduction in incontinence and side effects in 5-33% of patients.²³

While the optimal treatment for UI is determined by a spectrum of factors, and will differ between types of UI, there exists a consensus that surgical approaches provide the most effective and enduring therapies. However, they come hand-in-hand with morbidity, cost and inconvenience.

There exist over 200 surgical options for SUI management, many of which are associated with poor long-term success rates and are associated with significant complications. While minimally invasive options also exist, few studies have demonstrated their superiority or equivalence to conventional surgery.²⁴⁻²⁶ The tension-free vaginal tape method incurs significantly less pain and morbidity, when compared to other surgical options, and has been associated with a high (84.7%) 5-year cure rate, with minimal complications when implemented in 90 SUI patients.²⁷ Injectable bulking agents have gained popularity, but have failed to demonstrate significant effectiveness over time and come along with significant pain during injection.²⁸⁻³⁰ In addition, transient urinary retention and voiding dysfunction following treatment are commonly reported.

The CO₂ laser-based minimally invasive, outpatient approach, requires no anesthesia and provides immediate results, with no adverse events and no reliance on patient compliance and adherence to treatment regimens. In addition, the unique matrix design of the illuminating pixels and the extended pulse length avoided severe and long-lasting complications (e.g., hypertrophic scarring, ectropion formation, disseminated infection) which have been reported for fractionated laser skin resurfacing devices.³¹ While its long-term effectiveness remains to be determined, it reduced clinical symptoms and improved patient quality of life.

The limitations of this study include its retrospective nature and the absence of objective evaluations of clinical symptoms.

TABLE 1.

Patient demographics and baseline characteristics (N=133)**AGE (YEARS)**

| | |
|-----------|-------------|
| Mean (SD) | 51.2 (11.7) |
| Min, Max | 34.0, 86.0 |

URINARY INCONTINENCE, n (%)

| | |
|---------|-----------|
| Mixed | 26 (19.6) |
| Stress | 96 (72.2) |
| Urge | 1 (0.8) |
| Unknown | 10 (7.5) |

HRT USE PRETREATMENT, n (%)

| | |
|-------|------------|
| None | 2 (1.8) |
| Local | 109 (98.2) |

SEXUAL ACTIVITY PRETREATMENT, n (%)

| | |
|-----|-------------|
| No | 17 (14.4) |
| Yes | 101 (85.60) |

TABLE 2.

Clinical symptoms before and after CO₂ laser treatment

| SYMPTOM | PRETREATMENT % (n) | POSTTREATMENT % (n) | BOWKER'S TEST |
|--------------------------|-----------------------|------------------------|------------------|
| Pads per day | | | |
| None | 47.8 (32) | 80.6 (54) | p=0.0001 |
| 1 | 11.9 (8) | 10.5 (7) | |
| 2 | 31.3 (21) | 9.0 (6) | |
| 3 | 9.0 (6) | 0.0 (0) | |
| Urinary urgency | | | |
| None | 79.0 (90) | 82.5 (94) | p=0.0341 |
| Mild | 13.2 (15) | 14.9 (17) | |
| Moderate | 7.9 (9) | 2.6 (3) | |
| Urinary frequency | | | |
| None | 76.1 (86) | 82.3 (93) | p=0.0377 |
| Mild | 18.9 (21) | 15.0 (17) | |
| Moderate | 5.3 (6) | 2.7 (3) | |
| Nocturia | | | |
| None | 89.9 (98) | 95.4 (104) | p=0.0719 |
| Mild | 7.3 (8) | 4.6 (5) | |
| Moderate | 2.8 (3) | 0.0 (0) | |
| Vaginal itching | | | |
| None | 91.4 (85) | 96.8 (90) | p=0.4232 |
| Mild | 5.4 (5) | 3.2 (3) | |
| Moderate | 2.2 (2) | 0.0 (0) | |
| Severe | 1.1 (1) | 0.0 (0) | |
| Vaginal dryness | | | |
| None | 79.6 (74) | 93.6 (87) | p=0.0093 |
| Mild | 10.8 (10) | 6.5 (6) | |
| Moderate | 8.6 (8) | 0.0 (0) | |
| Severe | 1.1 (1) | 0.0 (0) | |
| Dyspareunia | | | |
| None | 80.7 (75) | 91.4 (85) | p=0.0430 |
| Mild | 11.8 (11) | 8.6 (8) | |
| Moderate | 6.5 (6) | 0.0 (0) | |
| Severe | 1.1 (1) | 0.0 (0) | |

TABLE 3.

***Vulvovaginal atrophy questionnaire ratings after CO₂ laser treatment,
by type of urinary incontinence***

| | | Stress UI | | Other UI | | Overall | |
|---------------------------------------|------|-----------|------|----------|------|---------|------|
| | | N | %# | N | %# | N | %# |
| GLOBAL IMPROVEMENT ASSESSMENT* | 1-5 | 26 | 27% | 18 | 50% | 44 | 33% |
| | 6-10 | 70 | 73% | 18 | 50% | 88 | 67% |
| Dysuria** | 1-5 | 76 | 96% | 16 | 100% | 92 | 97% |
| | 6-10 | 3 | 3.8% | . | . | 3 | 3.2% |
| Vaginal Itching** | 1-5 | 79 | 99% | 16 | 100% | 95 | 99% |
| | 6-10 | 1 | 1.3% | . | . | 1 | 1.0% |
| Vaginal Dryness** | 1-5 | 80 | 98% | 15 | 94% | 95 | 97% |
| | 6-10 | 2 | 2.4% | 1 | 6.3% | 3 | 3.1% |
| Dyspareunia** | 1-5 | 78 | 99% | 16 | 100% | 94 | 99% |
| | 6-10 | 1 | 1.3% | . | . | 1 | 1.1% |

The presented percentages represent the percentage of each column for each assessed parameter.

* 1-10 scale, where 1=no change and 10=significantly better

** 1-10 scale, where 1=absence of symptoms and 10 = symptoms as bad as it could be

FIGURE 3.

Number of pads used per day before versus after treatment, as reported by patients ($p < 0.0001$)

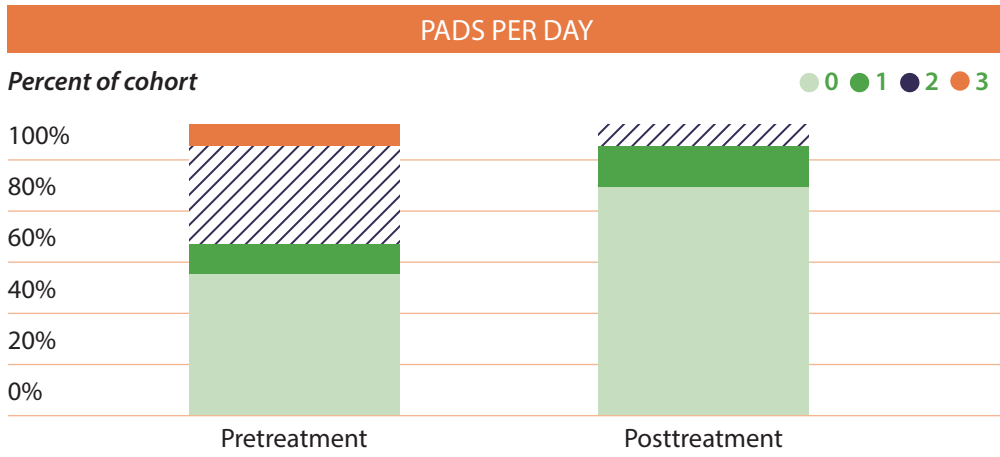
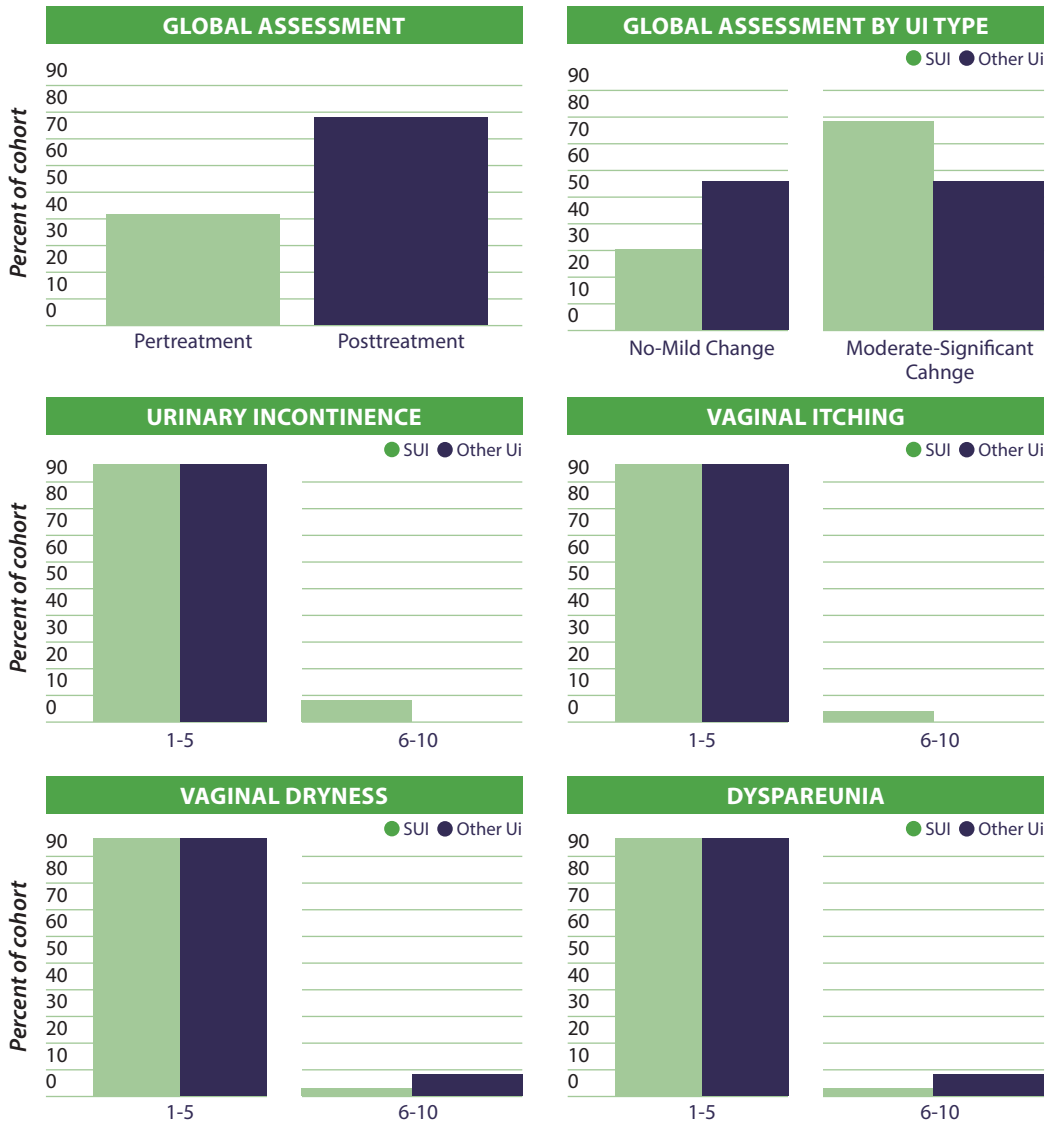


FIGURE 4.

Vulvovaginal atrophy questionnaire ratings after CO₂ laser treatment, by type of urinary incontinence



References

1. Rovner ES, Wein AJ. Treatment options for stress urinary incontinence. *Rev Urol.* 2004;6 Suppl 3:S29-47.
2. Novara G, Artibani W, Barber MD, et al. Updated systematic review and meta-analysis of the comparative data on colposuspensions, pubovaginal slings, and midurethral tapes in the surgical treatment of female stress urinary incontinence. *Eur Urol.* Aug 2010;58(2):218-238.
3. Taub DA, Hollenbeck BK, Wei JT, Dunn RL, McGuire EJ, Latini JM. Complications following surgical intervention for stress urinary incontinence: a national perspective. *Neurourol Urodyn.* 2005;24(7):659-665.
4. da Silva JP, da Silva MA, Almeida AP, Lombardi Junior I, Matos AP. Laser therapy in the tissue repair process: a literature review. *Photomed Laser Surg.* Feb 2010;28(1):17-21.
5. Sadick NS. Update on non-ablative light therapy for rejuvenation: a review. *Lasers Surg Med.* 2003;32(2):120-128.
6. Harashima T, Kinoshita J, Kimura Y, et al. Morphological comparative study on ablation of dental hard tissues at cavity preparation by Er:YAG and Er,Cr:YSGG lasers. *Photomed Laser Surg.* Feb 2005;23(1):52-55.
7. Loffer FD. Hysteroscopic endometrial ablation with the Nd:Yag laser using a nontouch technique. *Obstet Gynecol.* Apr 1987;69(4):679-682.
8. Alexiades-Armenakas MR, Dover JS, Arndt KA. The spectrum of laser skin resurfacing: nonablative, fractional, and ablative laser resurfacing. *J Am Acad Dermatol.* May 2008;58(5):719-737; quiz 738-740.
9. Woodruff LD, Bounkeo JM, Brannon WM, et al. The efficacy of laser therapy in wound repair: a meta-analysis of the literature. *Photomed Laser Surg.* Jun 2004;22(3):241-247.
10. Lapidoth M, Yagima Odo ME, Odo LM. Novel use of erbium:YAG (2,940-nm) laser for fractional ablative photothermolysis in the treatment of photodamaged facial skin: a pilot study. *Dermatol Surg.* Aug 2008;34(8):1048-1053.
11. Reilly MJ, Cohen M, Hokugo A, Keller GS. Molecular effects of fractional carbon dioxide laser resurfacing on photodamaged human skin. *Arch Facial Plast Surg.* Sep-Oct 2010;12(5):321-325.
12. Trelles MA, Mordon S, Velez M, Urdiales F, Levy JL. Results of fractional ablative facial skin resurfacing with the erbium:yttrium-aluminium-garnet laser 1 week and 2 months after one single treatment in 30 patients. *Lasers Med Sci.* Mar 2009;24(2):186-194.
13. Trelles MA, Shohat M, Urdiales F. Safe and effective one-session fractional skin resurfacing using a carbon dioxide laser device in super-pulse mode: a clinical and histologic study. *Aesthetic Plast Surg.* Feb 2011;35(1):31-42.
14. Trelles MA, Velez M, Mordon S. Correlation of histological findings of single session Er:YAG skin fractional resurfacing with various passes and energies and the possible clinical implications. *Lasers Surg Med.* Mar 2008;40(3):171-177.
15. Fistonc N, Fistonc I, Gustek SF, et al. Minimally invasive, non-ablative Er:YAG laser treatment of stress urinary incontinence in women—a pilot study. *Lasers Med Sci.* Feb 9 2016.
16. Bader A. Non-invasive management and treatment of female stress urinary incontinence with a CO₂ laser. *HJOG.* 2015;14(4):106-110.
17. Gaspar A, Addamo G, Brandi H. Vaginal Fractional CO₂ Laser: A Minimally Invasive Option for Vaginal Rejuvenation. *American Journal of Cosmetic Surgery.* 2011;28(3):156-162.
18. Zerbinati N, Serati M, Origoni M, et al. Microscopic and ultrastructural modifications of postmenopausal atrophic vaginal mucosa after fractional carbon dioxide laser treatment. *Lasers Med Sci.* Jan 2014;30(1):429-436.
19. Dumoulin C, Hay-Smith J. Pelvic floor muscle training versus no treatment, or inactive control treatments, for urinary incontinence in women. *Cochrane Database Syst Rev.* 2010(1):CD005654.
20. Ghaderi F, Oskouei AE. Physiotherapy for women with stress urinary incontinence: a review article. *J Phys Ther Sci.* Sep 2014;26(9):1493-1499.
21. Herbison P, Plevnik S, Mantle J. Weighted vaginal cones for urinary incontinence. *Cochrane Database Syst Rev.* 2000(2):CD002114.
22. Mariappan P, Alhasso A, Ballantyne Z, Grant A, N'Dow J. Duloxetine, a serotonin and noradrenaline reuptake inhibitor (SNRI) for the treatment of stress urinary incontinence: a systematic review. *Eur Urol.* Jan 2007;51(1):67-74.

References

23. Clinical Practice Guideline, authors. Urinary Incontinence in Adults. In: Agency for Health Care Policy and Research UDoHaHS, ed1992.
24. McDougall EM. Laparoscopic management of female urinary incontinence. *Urol Clin North Am.* Feb 2001;28(1):145-149, x.
25. Leach GE, Dmochowski RR, Appell RA, et al. Female Stress Urinary Incontinence Clinical Guidelines Panel summary report on surgical management of female stress urinary incontinence. The American Urological Association. *J Urol.* Sep 1997;158(3 Pt 1):875-880.
26. Rofeim O, Yohannes P, Badlani GH. Minimally invasive procedures for urethral incontinence: is there a role for laparoscopy? *Int Braz J Urol.* Sep-Oct 2002;28(5):403-412.
27. Nilsson CG, Kuuva N, Falconer C, Rezapour M, Ulmsten U. Long-term results of the tension-free vaginal tape (TVT) procedure for surgical treatment of female stress urinary incontinence. *Int Urogynecol J Pelvic Floor Dysfunct.* 2001;12 Suppl 2:S5-8.
28. Kerr LA. Bulking agents in the treatment of stress urinary incontinence: history, outcomes, patient populations, and reimbursement profile. *Rev Urol.* 2005;7 Suppl 1:S3-S11.
29. Haab F, Zimmern PE, Leach GE. Urinary stress incontinence due to intrinsic sphincteric deficiency: experience with fat and collagen periurethral injections. *J Urol.* Apr 1997;157(4):1283-1286.
30. Herschorn S, Glazer AA. Early experience with small volume periurethral polytetrafluoroethylene for female stress urinary incontinence. *J Urol.* Jun 2000;163(6):1838-1842.
31. Metelitsa AI, Alster TS. Fractionated laser skin resurfacing treatment complications: a review. *Dermatol Surg.* Mar 2010;36(3):299-306.