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TREATMENT WITH CO_2 LASER FOR UROGYNECOLOGICAL CONDITIONS

ABSTRACT

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The dissertation consists of 147 pages, including 86 figures and 1 table. Three survey questionnaires were used in the research. A total of 202 literature sources are cited, 9 of which are by Bulgarian authors and 193 by foreign authors.

The dissertation was discussed and approved for defense by the Departmental Council of the Department of Obstetrics and Gynecology at the Medical University "Prof. Dr. Paraskev Stoyanov" – Varna on 28.04.2025.

The official defense will take place on 10.07.2025 at 10:00 AM in Lecture Hall III, 4th floor, Medical University – Varna, during an open session of the academic jury. All materials related to the defense are available at the Scientific Department and are published on the website of the Medical University – Varna.

CONTENTS

List of Abbreviations

FGR – Female Genital System
SUI – Stress Urinary Incontinence
UI – Urinary Incontinence
BMI – Body Mass Index
CA – Comorbid Condition
UB – Urinary Bladder
SP – Sanitary Pads

I. INTRODUCTION

The concept of "urogynecological conditions" encompasses a number of health issues related to the urinary and reproductive systems in women. This dissertation focuses mainly on urinary incontinence and its treatment through an innovative minimally invasive approach [119, 106].

Traditional treatments for urinary incontinence include medications, physical therapy, and surgical interventions [201, 202]. Recently, there has been growing interest in innovative therapeutic methods [11]. One such novel method is the use of CO_2 laser therapy for urinary incontinence [61, 148, 149]. CO_2 laser therapy offers potential for effective, minimally invasive treatment that may significantly benefit patients by reducing symptoms and improving quality of life [22, 60, 167, 172, 174, 187, 196, 116, 118].

The urinary bladder – vesica urinaria (cystis) – is a reservoir organ that collects urine. In women, the base of the bladder lies directly on the urogenital triangle (trigonum urogenitale) [141, 142]. Its posteroinferior surface contacts the cervix and anterior vaginal wall, separated by connective tissue. The posterosuperior surface is covered with peritoneum.

The urinary tract consists of two interdependent components: the upper tract (kidneys and ureters) and the lower tract (bladder and urethra), forming a complex pipeline system that transforms involuntary urine production into consciously controlled urination [2]. The upper tract functions as a low-pressure conduit with intrinsic peristalsis that transports urine from the nephrons through the ureters to the bladder. The bladder stores and expels urine, operating alternately as a reservoir and a pump [67]. Micturition is a dynamic physiological process that involves storage and expulsion phases coordinated by a complex structural and functional organization. Despite its apparent simplicity, micturition requires the coordinated functioning of organs with dual and opposing roles: the bladder stores and empties, while the urethra seals during storage and serves as a channel during voiding [124]. Micturition in adults is primarily triggered by increased intravesical pressure leading to bladder distension, which initiates the voiding reflex. Bladder filling is mainly passive and relies on the viscoelastic properties of the bladder wall and absence of parasympathetic excitation [29].

Stress urinary incontinence (SUI) arises from damage to pelvic floor muscles, nerves, or connective tissue – or a combination of these [42, 63]. Urethral support in women is maintained by the levator ani muscle via the endopelvic fascia. Damage to this support system or the nerve supply may compromise continence. Impairment of the bladder neck's sealing function may also cause incontinence, even when urethral support is intact.

Incontinentio urinae is any involuntary leakage of urine [3, 24, 176, 178]. It causes physical, social, psychological, occupational, and sexual problems, negatively impacting quality of life [18, 26, 27, 36, 49, 123, 130]. Its prevalence is twice as high in women as in men [25, 95], and ranges from 8% to 51% in developed countries depending on the study methodology [144]. Many women do not seek treatment due to embarrassment, normalization of the condition as age-related, or pessimism about therapeutic options [23, 112, 35, 175].

There are five main types of urinary incontinence, classified by pathophysiological mechanism:

1. Stress incontinence
2. Urge incontinence
3. Mixed incontinence
4. Overflow incontinence

5. Extraurethral incontinence

Stress incontinence is the involuntary leakage of urine during sneezing, coughing, or physical exertion, due to increased intra-abdominal pressure [52]. It occurs when bladder pressure exceeds urethral pressure in the absence of detrusor contraction. Continence depends on urethral support and the function of the urethral sphincter mechanisms, including smooth and striated muscles, vascular plexus, and mucosal coaptation.

There are three types of stress incontinence based on the main pathophysiological mechanism:

- **Type I**: Straightening of the posterior urethrovesical angle.
- **Type II**: Angle straightening plus bladder base and urethral descent.
- **Type III**: Normal bladder neck and urethra location, but with a hypotonic, open urethra – also known as intrinsic sphincter deficiency.

Etiology: SUI is most often a result of vaginal childbirth [109], but it can also occur in nulliparous women, such as elite athletes [71], due to stretching or tearing of pelvic floor muscles. Genetic factors and the quality of connective tissue (collagen types) contribute to the condition. Aging and hormonal changes lead to tissue atrophy, further contributing to SUI [102].

SUI severity is graded into three degrees:

- **First degree**: Leakage during coughing or sneezing while standing.
- **Second degree**: Leakage with movement, stair descent, or coughing/sneezing while sitting.
- **Third degree**: Leakage during minimal effort or even gravity alone, e.g., coughing while lying down [59].

In most cases, incontinence is multifactorial, with varying contributions from anatomical, urethral, and neural damage. Vaginal delivery remains a leading cause, but heavy lifting, obesity [20, 99, 115, 186], and increased intra-abdominal pressure also play significant roles in weakening the pelvic floor [185, 68].

- **Social Aspects and Quality of Life in Patients with SUI**
  One of the globally significant health issues, often referred to as the “silent epidemic” and affecting millions of women worldwide from all cultural backgrounds, is urinary incontinence (UI) [4, 13, 127]. Although not a life-threatening condition, UI has a profound impact on women's quality of life and causes considerable physical, psychological, social, and economic consequences [12, 14, 69, 179, 187]. By nature, urinary incontinence is the spontaneous and involuntary leakage of urine, often associated with urinary disturbances [91]. Despite not being classified as a serious or severe illness, UI significantly impairs mental health, leading to high levels of stress and depressive states [95].
  According to international studies, nearly 7% of women aged 20–39 suffer from incontinence, with the percentage increasing with age—to 17% in the 40–59 age group and up to 23% in women aged 60–79 [19, 45]. According to a report by the National Institute on Aging, the global elderly population (defined as 65 years and older) is growing by 795,000 individuals each month. Projections show that by 2050, more than 20% of the U.S. population will be aged 65 or older [59]. With the rapid increase in the elderly population worldwide, UI is becoming a widespread diagnosis [152, 153]. Stress urinary incontinence (SUI) primarily affects women of active age [62,

193]. The situations that trigger SUI symptoms are typical daily activities that cannot be restricted or avoided [96].

At the same time, women often find it difficult or embarrassing to openly discuss their condition with close relatives, friends, or even their general practitioners, and instead seek help directly from specialists [105]. Besides the discomfort of discussing the topic, it also has a seriously negative impact on the cultural and social lives of affected women [97, 166, 188]. These factors highlight the need for the development of kinesitherapeutic programs for the conservative treatment and prevention of SUI to ensure a high quality of life and full cultural and social participation for women—a globally increasing issue [87, 88, 82, 165, 187].

Although UI is a treatable condition, American women of Korean descent continue to suffer psychologically, socially, and physically from this problem [117]. The scarcity of research on the sociocultural perspective of the condition in elderly Korean-American women suggests that healthcare providers may have limited insights into the transcultural aspects of its management [112, 171, 177]. Understanding the social and cultural factors that directly or indirectly affect patients can lead to better treatment options [86, 119, 69, 157, 189].

An interesting phenomenon is that many women, regardless of age, culture, nationality, or financial status, prefer not to talk about the issue [123, 125], tend to perceive it as normal, or even conceal it from their doctors, despite direct questioning.

Accurate identification of the underlying mechanism is crucial for proper treatment [136, 137]. The assessment starts with medical history and clinical evaluation, followed by imaging and functional studies if necessary [122]. A detailed history helps to determine the type of incontinence. Information is gathered on the circumstances of onset, duration, frequency of episodes, amount of leaked urine, the use and number of pads, frequency of urination during the day and night, previous surgeries, and recurrent infections [81].

The physical examination aims to identify anterior vaginal wall descent, atrophic changes due to estrogen deficiency, and scarring from prior interventions.

To verify and quantify the severity of incontinence, various standardized tests (so-called pad tests) are used in outpatient or home settings. Patients perform specific activities while the pad's weight is measured at the beginning and end of the test [104].

Instrumental methods such as urethrocystoscopy, excretory urography, voiding cystography, videocystourethrography, and ultrasound have no role in the routine diagnosis of UI. Urodynamic studies, which are a combination of functional tests assessing the lower urinary tract [4, 200], also lack routine application in gynecological practice.

The treatment of UI depends on the underlying pathophysiological mechanism. Different types of incontinence require distinct approaches and therapeutic methods [121, 145, 182]. The therapeutic strategy is based on the understanding that UI is due to loss of support and hypermobility of the bladder neck and proximal urethra, as well as impaired urethral sphincter function. Treatment aims to address these pathophysiological factors through conservative or surgical methods [17, 110, 89].

Mechanical devices include various pessary models. These are primarily used for the non-surgical correction of genital prolapse, and by providing support under the urethra, they can also positively impact stress incontinence.

Pharmacological treatment aims to improve urethral sphincter function with medications. Logically, such treatment cannot restore disrupted anatomical relationships or the altered statics of pelvic organs. Medications with various mechanisms of action are used.

The goal of surgical treatment is to elevate the bladder neck and proximal urethra to their normal anatomical position behind the symphysis and provide support for the urethra to be compressed by intra-abdominal pressure [151]. Surgical interventions do not improve urethral sphincter function [66, 84]. Numerous surgeries have been developed for treating SUI, which are categorized by principle and approach. Comparing their effectiveness is challenging due to differences in severity of incontinence, success criteria, and patient-related factors [138].

Periurethral injections [101] induce urethral closure and increase resistance by injecting substances around the urethra. They are used in cases of severely impaired sphincter function or when surgery is contraindicated or refused [151]. The agent is applied under local, regional, or general anesthesia via a transurethral or periurethral route, targeting the urethrovesical junction at 3, 6, and 9 o'clock positions.

Over the past decade, the Ulmsten technique for treating SUI—known as the TVT (tension-free vaginal tape) method—has become widely adopted globally [40, 164]. It differs significantly from previous surgical techniques by aiming to stabilize the mid-urethra rather than repositioning the bladder neck as in colposuspension.

CO_2 Laser Treatment for Stress Urinary Incontinence (SUI)

CO_2 laser treatment is a minimally invasive procedure aimed at improving SUI symptoms by strengthening the vaginal wall tissues and supportive structures [39, 63, 64, 160, 162, 163]. During the treatment, a specialized CO_2 laser delivers controlled pulses of laser energy to the vaginal tissue [47]. This energy creates microscopic thermal injuries that trigger a healing response and stimulate collagen production—a process known as fractional laser therapy.

The production of new collagen tightens and reinforces the vaginal walls, providing better urethral support and reducing SUI symptoms. The treatment also enhances blood flow to the vaginal area, promoting tissue regeneration [6].

CO_2 laser treatment is performed in outpatient settings without the need for anesthesia. The procedure is relatively quick, typically lasting 15–20 minutes depending on the technique and areas treated.

Patients may experience mild discomfort or a warm sensation during the procedure, but it is generally well tolerated without significant complaints.

There is usually no downtime, and patients can typically resume their normal activities immediately afterward.

This treatment is contraindicated in pregnant women and patients with electrical implants (e.g., pacemakers).

CO_2 laser therapy is a simple and safe method for reducing SUI symptoms [48]. The applications of the CO_2 laser in medicine are extensive and can be divided into two categories: in-hospital use for surgical procedures and outpatient use across various medical specialties.

CO_2 Laser Device Structure

The fractional CO_2 laser consists of several key components that work together to generate and deliver laser energy. Although specific designs may vary between manufacturers, the general structure typically includes the following elements:

Laser Source:
The laser source is the core of the CO_2 fractional laser system. It usually contains a gas mixture of carbon dioxide (CO_2), which is energized by an electrical discharge.

Scanner System:
The scanner system is responsible for controlling the delivery of laser energy to the treated area. It typically consists of mirrors or a rotating prism that directs the laser beam to specific locations on the skin or tissue. The scanner system allows for precise targeting and pattern generation.

Fractional Technology:
The CO_2 fractional laser employs fractional technology, meaning that laser energy is delivered in a pattern of small, closely spaced microbeams rather than a continuous beam. This microbeam pattern creates microscopic columns of treated tissue surrounded by intact tissue, which promotes faster healing and minimizes downtime.

Handpiece:
The handpiece is the part of the laser device that comes into direct contact with the patient's skin or tissue. It may include a focusing lens or other components to shape and manage the laser beam. The handpiece is designed to be ergonomic and easy to maneuver during treatment.

Cooling System:
The fractional CO_2 laser generates significant heat during operation, which can be uncomfortable for the patient. To mitigate this, most systems include a cooling mechanism, such as a built-in cooling tip (e.g., sapphire tip) or a stream of cooled air, to protect the outer skin layers and enhance patient comfort during skin-related procedures.

Control Panel:
The laser system usually features a control panel or user interface that allows the operator to adjust various treatment parameters such as energy level, density, and pulse duration. It also provides feedback and monitoring capabilities to ensure safe and effective treatment.

Laser therapy may serve as a conservative alternative treatment for women seeking minimally invasive, non-surgical management of stress urinary incontinence (SUI). No serious adverse effects have been reported. However, large-scale randomized controlled trials are needed to further evaluate the efficacy and safety of laser therapy for SUI and to establish its overall clinical benefits [39].

II. AIM

The aim of the present dissertation is to analyze outcomes and evaluate the effectiveness and clinical significance of CO_2 laser therapy in women with stress urinary incontinence (SUI) during the reproductive and climacteric periods, with minimal risk of side effects and complications.

The focus of the study is the use of CO_2 laser in the outpatient management of urogynecological conditions in women.

III. OBJECTIVES

To achieve the stated aim, the following objectives were defined:

1. To analyze the potential for CO_2 laser treatment in women with SUI during the reproductive and climacteric periods.
2. To evaluate the quality of life in women with SUI.
3. To assess the effect of treatment on biomedical issues in women with SUI.
4. To evaluate the impact of treatment on the social and psychological aspects of SUI.
5. To identify prognostic markers for treatment success and effectiveness in specific patient profiles.
6. To analyze the treatment outcomes of CO_2 laser therapy in women with SUI.
7. To determine the durability of the therapeutic effects of CO_2 vaginal laser procedures.
8. To confirm the safety of CO_2 laser therapy in patients with urinary incontinence.

IV. MATERIALS AND METHODS

4.1. Clinical Population

This retrospective and prospective study included 107 female patients who presented for gynecological consultation in an outpatient setting. The study covered a two-year period (January 2022 – January 2024).

The mean age of participants was 54 ± 6.16 years.
The minimum age was 38 years, and the maximum was 72 years.

Patients were categorized into three age groups: “18–40 years,” “41–63 years,” and “above 63 years.” Participants also represented different BMI categories and were divided into four groups accordingly.

Of the 107 participants, 94 (87.85%) had undergone spontaneous vaginal delivery, and 13 (12.15%) had delivered via cesarean section.

Patient-reported history revealed a diagnosis of SUI with variable duration.

After physical examination, eligibility for laser treatment was evaluated.

A specially developed questionnaire identified absolute and relative contraindications for CO_2 laser treatment of SUI. Data on relative contraindications were analyzed to aid in the development of patient profiles most suitable for successful CO_2 laser therapy.

A profile was created for each patient to determine expected treatment outcomes.

Specially designed questionnaires were used to evaluate the feasibility and success rate of the procedure (Appendix: Questionnaire Forms).

A control group of 27 patients with urinary incontinence who had undergone conventional surgical treatment was also surveyed for the purposes of comparison.

The control group consisted of women aged 39 to 76 years, with symptom duration ranging from 1 to 17 years. Objective examination revealed cystocele without protrusion beyond the hymenal ring upon straining. These patients had undergone classical vaginal plastic surgery – anterior colporrhaphy.

To compare CO_2 laser therapy with conventional surgical treatment for urinary incontinence, the same questionnaire was applied to the control group.

4.2. Statistical Methods Used for Data Processing and Analysis

The following categories and methods were used for the purposes of the statistical analysis:

1. **Descriptive analysis.** The frequency distribution of the studied variables is presented in tabular form.
2. **Variation analysis.** The following were calculated: arithmetic mean, standard deviation (σ), standard error of the mean (SE), and the 95% confidence interval for the mean.
3. **Frequency analysis of qualitative variables (nominal and ordinal).** Absolute, relative, and cumulative relative frequencies (in percentages) were calculated.
4. **Graphical analysis.** Used to visualize the obtained results. The graphs were created using MS Excel, version 2016.
5. **Hypothesis testing methods:**
    - **Parametric methods:**
        - *Independent Samples T-test* – to compare the means of two independent samples and test for equality of means.
        - *Paired Samples T-test* – to compare the means of two related (paired) samples.
        - *One-Sample T-test* – to compare the mean of a single sample to a predefined test value.
    - **Non-parametric methods:**
        - *Fisher's exact test* – to determine statistical significance when analyzing associations between selected parameters.
        - *Chi-square test (Pearson's Chi-square test)* – to compare observed and expected frequencies.
        - *Kolmogorov-Smirnov and Shapiro-Wilk tests* – to assess the normality of distribution of quantitative variables.
        - *Mann-Whitney U test* – to compare the means of two groups for a quantitative variable when the distribution is non-normal.
6. **Regression analysis.** A 95% confidence interval was used in hypothesis testing. The significance level was set at $\alpha = 0.05$. The null hypothesis was rejected if the P-value was less than α.

V. RESULTS AND DISCUSSION

5.1. Evaluation of Patient Eligibility for Laser Treatment

This study aims to demonstrate that CO_2 laser therapy is a simple and safe method for reducing symptoms of stress urinary incontinence (SUI). The potential applications of the

CO_2 laser in medicine are broad and can be divided into two main categories: use in hospital settings for surgical purposes, and use in outpatient practice across various medical specialties.

In gynecology, the CO_2 laser can be employed not only for coagulation but also for simultaneous incision and coagulation, which shortens the duration of surgical interventions and reduces blood loss. This also contributes to improved financial performance of the department.

The focus of this dissertation is the application of CO_2 laser in outpatient practice for the treatment of urogynecological conditions in women. The mechanism of action of the device classifies it as a minimally invasive procedure. The 10,600 μm wavelength has a high affinity for water molecules in the vaginal wall, causing ablation of the targeted tissue. The affected fibroblasts and elastic fibers are stimulated to initiate regeneration, which is the underlying mechanism of the therapeutic effect.

The CO_2 laser can also be considered for the treatment of extragenital conditions in women, including: anogenital warts, lichen sclerosus, hyperpigmentation of the vulvar area, nevi, vaginal dryness, dyspareunia, and labial asymmetry correction. These conditions can affect women across a wide age range, from reproductive age to menopause.

This study explores in depth the condition of stress urinary incontinence in women of reproductive and climacteric age, and the possibilities for treatment with the CO_2 laser.

A total of 107 patients were initially selected for the study based on a questionnaire and objective clinical examination to assess eligibility for laser therapy.

The questionnaire included absolute and relative exclusion criteria for CO_2 laser treatment.

We established the following five conditions as absolute contraindications to CO_2 laser therapy, formulated as follows:

Absolute exclusion criteria:

1. Pregnancy.
2. Presence of an implanted electrical device (e.g., pacemaker).
3. Uterine prolapse grade III or IV.
4. Presence of neoplastic disease.
5. Active urogenital infection.

All 107 surveyed patients met the requirements concerning absolute exclusion criteria (Appendix: Questionnaire Forms).

We also defined a group of **relative exclusion criteria and/or factors that may influence treatment effectiveness**, which were thoroughly examined in the study with the 107 patients (Appendix: Questionnaire Forms):

Relative exclusion and/or influencing factors:

1. Patient age group: 18–40 years; 41–63 years; over 63 years.
2. Body Mass Index (BMI): <18.5 – underweight; 18.5–25 – normal; >25 – overweight; >30 – obesity.
3. Engaging in daily physical activity/work involving abdominal muscle strain.

4. Presence of chronic cough.
5. Number of childbirths – two or more.
6. History of surgical treatment for SUI.
7. Use of local estrogen hormone therapy.
8. Overactive bladder.
9. Use of diuretics.
10. Presence of cystocele extending beyond the hymenal ring.

5.1.1. Relationship Between Age and the Effectiveness of CO_2 Laser Treatment for SUI

The patients were divided into three age groups.
The percentage distribution of patients by age group is presented in **Figure 1**. The majority of patients were in the "41–63 years" age group (n = 99), followed by the "over 63 years" group (n = 5) and the "18–40 years" group (n = 3).

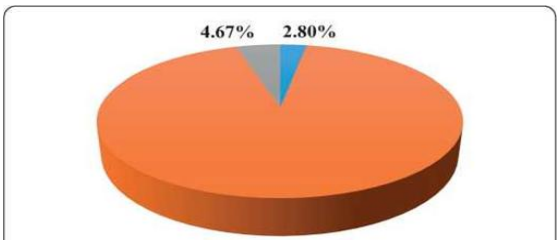


Figure 1. Percentage distribution of patients by age group

- ■ 18–40 years
- ■ 41–63 years (92.52%)
- ■ Over 63 years

The data on age distribution indicate that the condition affects women across different life stages. The widespread prevalence of stress urinary incontinence (SUI) makes it a condition of significant public, social, economic, and medical concern [194].

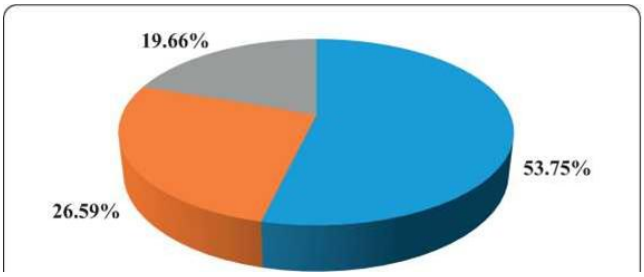
The involvement of such a broad age range reflects negatively on the quality of life for a large segment of the population. Socially, this problem often leads to reduced activity among women suffering from SUI—limited participation in cultural events and reduced physical activity. From an economic perspective, companies manufacturing sanitary pads, waterproof pads/sheets, and adult incontinence underwear are expanding production to meet the needs of a growing consumer base, as many women perceive urinary leakage as a normal condition.

In a survey conducted in two outpatient clinics—MC "St. Sofia" and the Reproductive Center "New Life" in Burgas—among 534 women with symptoms of SUI, we asked the question: **"Would you treat your condition of stress incontinence?"**

The results showed that:

- 287 women (over 50%) answered: **“No, this is normal—my mother/grandmother also leaks urine.”**
- 142 women (26.5%) responded: **“I prefer to wear pads rather than undergo surgery.”**
- 105 women (19.6%) answered: **“Yes, but I don’t want surgery.”**

Figure 2. Distribution of patient responses regarding their willingness to treat SUI



- ■ "I prefer to wear pads instead of surgery"
- ■ "Yes, but I do not want surgery"

These results are concerning. Only a small portion of the women recognized the necessity of treatment.
Another interpretation of the data is that the lack of sufficiently effective and easily accessible treatment methods over the years has led women to perceive SUI as a normal condition, a perception that is then passed on to their daughters and granddaughters.

From the perspective of medicine—as a constantly evolving science that integrates innovative approaches—treatment of SUI is of particular interest. It also reduces the incidence of accompanying conditions such as urinary tract infections in women with SUI.

Another survey, conducted in the same outpatient clinics with 352 women diagnosed with SUI, examined the prevalence of dysuric symptoms. We asked the question:
"Do you experience burning during urination or frequent urination?"
The response options were binary: **"Yes"** or **"No"**.
Of the surveyed women, 258 (73.3%) answered **"Yes"**, while 94 women (26.7%) responded **"No"**.

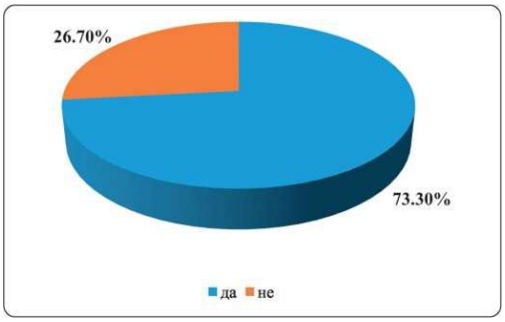


Figure 3. Distribution of patients with dysuric complaints and SUI

The analysis shows that two-thirds of the women with SUI symptoms also experience dysuric symptoms. This confirms the findings in the literature that women with SUI are more likely to develop urinary tract infections.

To examine the relationship between age and therapeutic outcomes across the three age groups, we used a follow-up questionnaire asking:
"Do you experience symptoms of SUI after the third laser procedure?"
Response options included:

- "Symptoms persist daily"
- "Symptoms persist, but not daily"
- "I have no symptoms of SUI after completing three CO_2 laser procedures"

We analyzed the results for the age group **41–63 years** (n = 100) who completed the full course of CO_2 laser treatment. The responses were as follows:

- 3 women (3%) reported that the **symptoms persisted after treatment**
- 7 women (7%) reported that the **symptoms persisted, but not daily**
- 90 women (90%) reported **no symptoms of SUI after three CO_2 laser procedures**

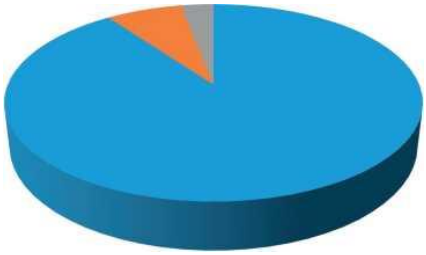


Figure 4. Distribution of CO_2 laser treatment effectiveness in the 41–63 age group

- ■ "No symptoms after 3 CO_2 laser procedures" (90.0%)
- ■ "Symptoms persist, but not daily"
- ■ "Symptoms persist after treatment"

We also analyzed the results for the group of women over 63 years of age (n = 5) with SUI who completed the full course of CO_2 laser procedures using the same questionnaire and response options.
None of the women (n = 0; 0%) reported that their symptoms persisted after treatment. One patient (n = 1; 20%) responded that "symptoms persist, but not daily," and the remaining four

women (n = 4; 80%) reported "no symptoms of SUI after completing three CO_2 laser procedures" (**Figure 5**).

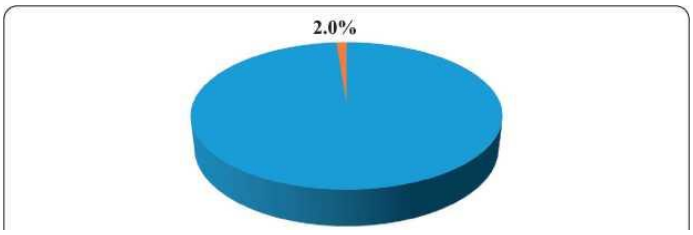


Figure 5. Distribution of CO_2 laser treatment effectiveness in the age group over 63 years

- ■ No symptoms after 3 CO_2 laser procedures (80.0%)
- ■ Symptoms persist, but not daily
- ■ Symptoms persist after treatment

We then examined the results for the group of women aged 18–40 years (n = 2) with SUI who also completed the full course of CO_2 laser treatment. None of the women (n = 0; 0%) reported persistent symptoms, and none (n = 0; 0%) reported non-daily symptoms. Both women (n = 2; 100%) stated that they had **no symptoms of SUI after three CO_2 laser procedures** (**Figure 6**).

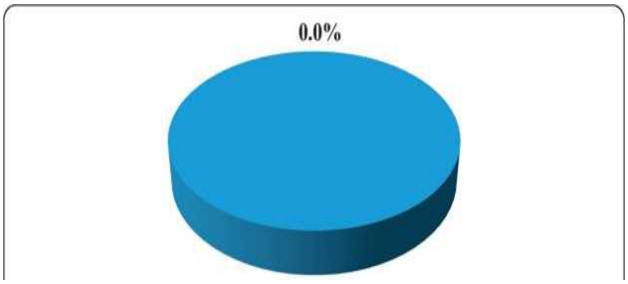


Figure 6. Distribution of CO_2 laser treatment effectiveness in the age group 18–40 years

- ■ No symptoms after 3 CO_2 laser procedures (100.0%)
- ■ Symptoms persist, but not daily
- ■ Symptoms persist after treatment

Despite the small number of participants in the groups over 63 and under 41 years of age, we proceeded with the analysis. The data indicate an almost 100% treatment effectiveness in patients aged 41–63 years and over 63 years, and 100% effectiveness in the group under 41 years.
The results show that the largest proportion of women seeking treatment are between 41 and 63 years of age. A trend is observed suggesting a **correlation between age and the effectiveness of CO_2 laser treatment**. With increasing age, the treatment's effectiveness tends to decrease slightly. The distribution of patients across different age groups allowed us to confirm that this treatment is applicable and effective across all ages studied.

These findings demonstrate that **age is a relative factor and not an excluding criterion** for the use of vaginal CO_2 laser treatment for SUI.

5.1.2. Relationship Between Patient BMI and the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients by **body mass index (BMI)** is shown in **Figure 7**. The majority of patients had **normal body weight** (n = 88), followed by those who were **overweight** (n = 15), **obese** (n = 3), and finally **underweight** (n = 1).

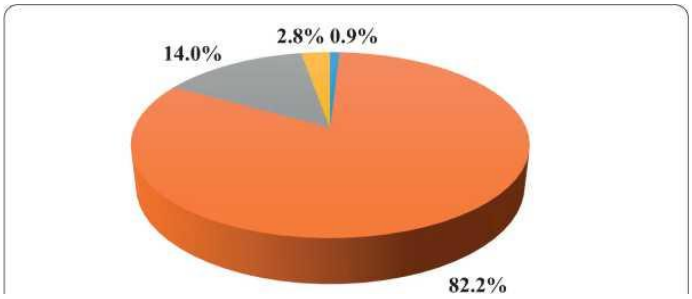


Figure 7. Percentage distribution of patients by BMI category

- ■ Underweight
- ■ Normal weight
- ■ Overweight
- ■ Obese

To investigate the relationship between BMI and the outcomes of vaginal CO_2 laser procedures, patients were divided into four groups: **underweight**, **normal weight**, **overweight**, and **obese**.
The presence of SUI symptoms across all four groups once again confirms the **widespread nature and "epidemiological" scale** of the condition [8, 73, 81, 120].

To assess the therapeutic outcomes in each of the four groups, we used a questionnaire that asked:
"Do you have symptoms of SUI after the third laser procedure?",
with the following answer options:

- "Symptoms persist daily"
- "Symptoms persist, but not daily"
- "I have no symptoms of SUI after undergoing three CO_2 laser procedures"

In the **underweight group**, there was only one participant (n = 1), and in the **obese group**, just three women (n = 3). Due to the **small sample sizes**, we concluded that **no statistically or clinically meaningful conclusions could be drawn** from these groups. Therefore, we **excluded** them from the detailed analysis.

We analyzed the results from the **overweight group** (n = 15) with SUI who completed the full course of CO_2 laser treatments using the aforementioned questionnaire and response options (**Figure 8**).

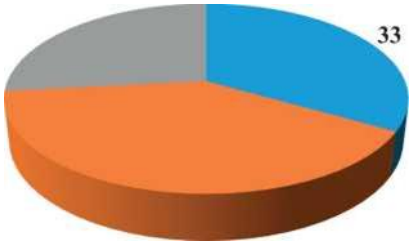


Figure 8. Distribution of CO_2 vaginal laser treatment effectiveness for SUI in overweight patients

- ■ No symptoms after 3 CO_2 laser procedures – 40.0%
- ■ Symptoms persist, but not daily – 33.3%
- ■ Symptoms persist after treatment – 26.7%

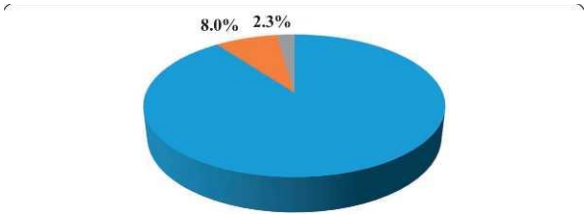
Of these, **four women (n = 4)** reported that symptoms **persisted after treatment** – **26.6%**; **six patients (n = 6)** responded that symptoms **continued but not on a daily basis** – **40%**; and the remaining **five women (n = 5)** stated:
"I have no symptoms of SUI after undergoing three CO_2 laser procedures" – accounting for **33.3%**.

The analysis shows that in **one-third of the overweight participants**, **vaginal CO_2 laser treatment for SUI yields positive results**, indicating **treatment effectiveness**.

We also examined the questionnaire responses from the group of **88 women with normal BMI** and SUI who completed the full course of CO_2 laser procedures.
The same question and answer options were used again.

Among them:

- **Two women (n = 2)** reported that **symptoms persisted after treatment** – **2.2%**;
- **Seven women (n = 7)** responded that **symptoms continued, but not daily** – **7.9%**;
- and the remaining **79 women (n = 79)** stated:
  "I have no symptoms of SUI after undergoing three CO_2 laser procedures" – accounting for **89.7%**.



89.8%
■ No symptoms of SUI after undergoing 3 CO_2 laser procedures

Symptoms continue, but not daily
Symptoms persist even after treatment

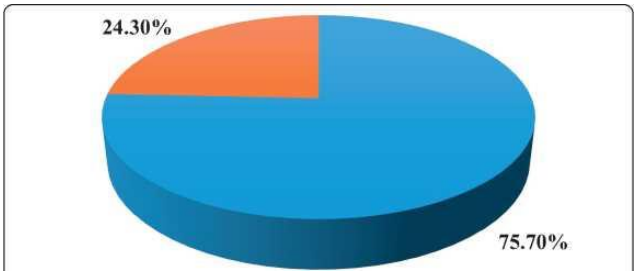
Fig. 9. Distribution of the effectiveness of CO_2 vaginal laser treatment for SUI in patients with normal weight

The analysis of the results shows that in **approximately 90% of participants with normal BMI**, **CO_2 vaginal laser treatment for SUI produces positive outcomes**, confirming the **effectiveness of the method**.

Data show that women with overweight and normal weight more frequently seek treatment for urinary incontinence (UI) with CO_2 laser. A correlation between BMI and the effectiveness of CO_2 vaginal laser treatment was established. As BMI increases, the effectiveness of this minimally invasive method for treating UI decreases. Therefore, BMI is reasonably considered a relative factor for successful and effective CO_2 laser treatment of stress urinary incontinence (SUI).

5.1.3. Relationship Between Patient's Physical Activity/Workload Involving Abdominal Muscles and the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients according to their daily physical activity/work involving abdominal muscle strain is presented in Fig. 10. Patients with abdominal wall strain are (n=81), while those who do not exercise/work with such strain are (n=26).



- Women exercising or working with abdominal muscle strain
- Women not exercising or working with abdominal muscle strain

Fig. 10. Percentage distribution of patients performing daily exercise/work involving abdominal muscle strain

Abdominal muscle strain affects the bladder and, respectively, the m. sphincter urethrae internus et externus. Chronic "stress" on the muscle and bladder impairs all types of treatment for stress urinary incontinence (SUI) — surgical, medicinal, and minimally invasive CO_2 laser treatment.

To evaluate the impact of exercise and work on therapeutic outcomes in these two patient groups, a questionnaire was used with the question: "Do you have SUI symptoms after the third procedure?", with response options: "symptoms persist daily", "symptoms persist but not daily", and "no SUI symptoms after three CO_2 laser procedures".

We surveyed all patients (n=81) in the "stress-exposed" group — those performing daily exercise/work with abdominal muscle strain — after three CO_2 laser procedures. Among

them, 63% (n=51) reported symptoms persisting daily, 21% (n=17) said symptoms persist but not daily, and 16% (n=13) reported no SUI symptoms (Fig. 11).

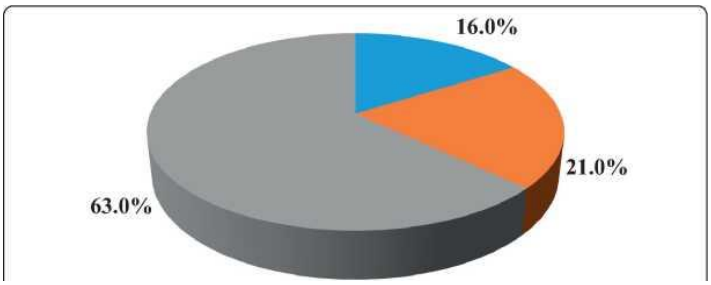


Fig. 11. Percentage distribution of patients with daily exercise/work involving abdominal muscle strain

We also conducted a survey among the "no-stress" group — patients without daily exercise/work involving abdominal muscle strain (n=26). In response to the same question, 2 patients reported symptoms persisting daily, 7 reported symptoms persisting but not daily, and 17 reported no SUI symptoms after three CO_2 laser procedures (Fig. 12).

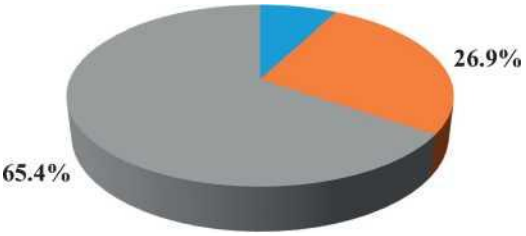
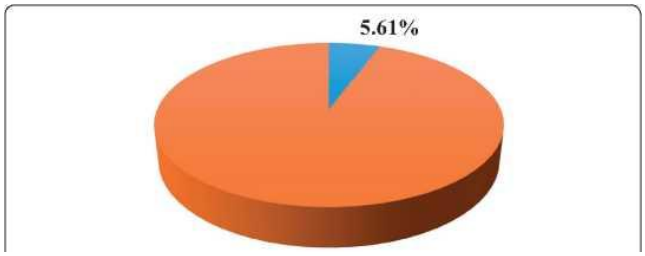


Fig. 12. Distribution of CO_2 laser treatment effectiveness among patients "without stress"

The data show that CO_2 laser treatment effectiveness is present in both groups, with higher results achieved in the "no-stress" group. We demonstrate the applicability of vaginal CO_2 laser treatment for both groups, with a trend of decreased effectiveness in women with daily exercise/work involving abdominal muscle strain. This confirms the relative nature of the factor "exercise/abdominal muscle strain" as one influencing successful therapeutic outcomes with CO_2 laser.

5.1.4. Relationship of the Factor "Chronic Cough" in Patients to the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients according to the presence of chronic cough is shown in Fig. 13. Patients with chronic cough numbered (n=6), and those without chronic cough numbered (n=101).



- Patients with chronic cough
- Patients without chronic cough

Fig. 13. Percentage distribution of patients with chronic cough

We analyzed treatment effectiveness in both groups using the same survey question: “Do you have symptoms of SUI after the third procedure?”
It was found that (n=5) patients reported symptoms persisting daily, (n=1) reported symptoms persisting but not daily, and no patients reported complete resolution of symptoms.
Chronic cough had a 100% negative impact on the treatment of SUI with CO_2 laser in our observed group.

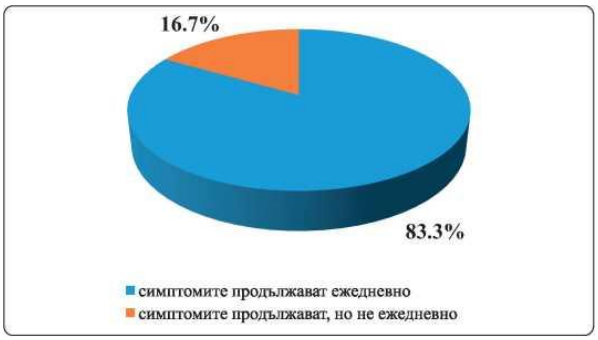
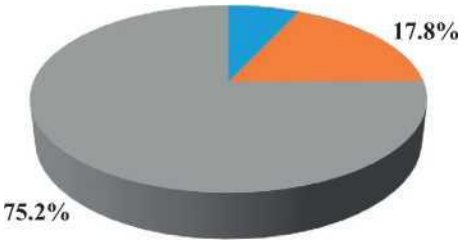


Fig. 14. Percentage distribution of patients with chronic cough

In the group without chronic cough (n=101), for the same question, 7 women reported symptoms persisting daily, 18 reported symptoms persisting but not daily, and the remaining 76 reported no symptoms of SUI after 3 CO_2 laser procedures (Fig. 15).



- Symptoms persist daily
- Symptoms persist but not daily
- No symptoms of SUI after 3 CO_2 laser procedures

Fig. 15. Percentage distribution of patients without chronic cough

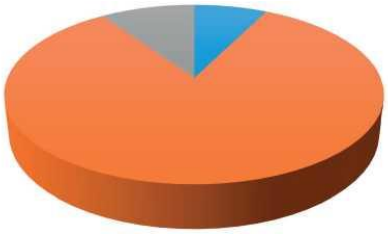
Increased intra-abdominal pressure during coughing affects both the internal and external urethral sphincters similarly. This results in similar treatment outcomes for women with chronic cough and those with abdominal muscle strain—i.e., chronic “stress.”

5.1.5. Relationship of the Factor “Number of Vaginal Deliveries” to the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The distribution of patients by number of vaginal deliveries is shown in Fig. 16. Most patients had 2 deliveries (n=78), followed by those with 3 or more deliveries (n=9), and the fewest had 1 delivery (n=7).

- With 1 delivery
- With 2 deliveries
- With 3 or more deliveries

9.57% **7.45%**



82.98%

Fig. 16. Percentage distribution of patients by number of vaginal deliveries

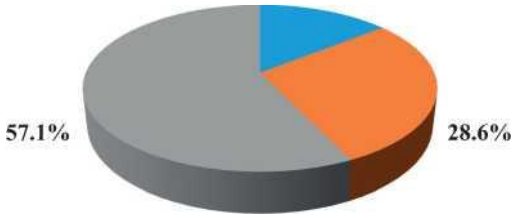
Upon enrolling patients for CO_2 laser treatment, they were asked about their number of deliveries. Vaginal delivery is one of the main risk factors for the appearance of stress urinary incontinence symptoms, as confirmed by the participants in our study. Parity is directly proportional to the appearance of SUI symptoms, though even primiparas were included in the study.

A paradoxical fact is that in our study the largest share was women with two deliveries. We suspect financial reasons influenced the percentage participation and distribution of patients with 1, 2, and 3 deliveries.

We observed the success rate of CO_2 laser treatment in all three groups. We surveyed them regarding results after the third laser procedure with the question: “Do you have SUI symptoms after the third procedure?”

- In the group with 1 vaginal delivery (n=7): 1 patient reported daily symptoms, 2 reported symptoms but not daily, and 4 reported no symptoms after 3 CO_2 laser procedures.
  Fig. 17. Effectiveness distribution of vaginal CO_2 laser treatment for SUI in patients with 1 vaginal delivery

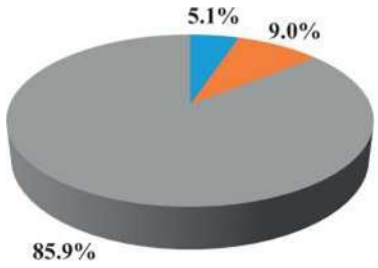
14,3%



- **Symptoms persist daily**
- **Symptoms persist, but not daily**

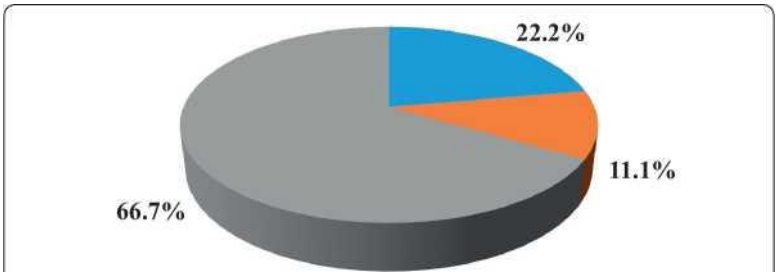
- **No symptoms of SUI after 3 CO_2 laser procedure**

- In the group with 2 vaginal deliveries (n=78): 4 reported symptoms persisting daily, 7 symptoms persisting but not daily, and 67 no symptoms after 3 procedures. The percentage of women with maximal results was 85.8%.
-



- **Symptoms persist daily**
- **Symptoms persist, but not daily**
- **No symptoms of SUI after 3 CO_2 laser procedure**

-
Fig. 18. Effectiveness distribution of vaginal CO_2 laser treatment for SUI in patients with 2 vaginal deliveries
- The outcomes were evaluated in the cohort of women with three vaginal deliveries (n=9): among them, 2 patients reported persistent symptoms of stress urinary incontinence (SUI) on a daily basis, 1 patient experienced intermittent symptoms, and 6 patients were asymptomatic following three sessions of CO_2 laser therapy. The proportion of women achieving complete resolution of symptoms in this subgroup was 66.6%.



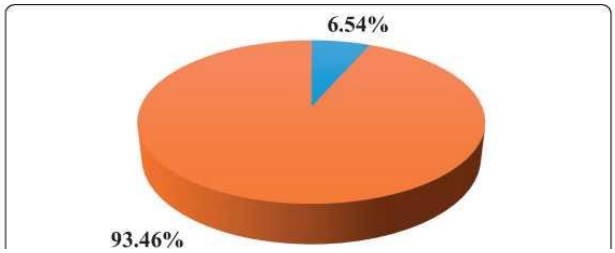
  - Symptoms persist daily
  - Symptoms persist, but not daily
  - No symptoms of SUI after 3 CO_2 laser procedures

- **Fig. 19. Effectiveness distribution of vaginal CO_2 laser treatment for SUI in patients with 3 vaginal deliveries**

Analysis of the three groups shows that effective application of this treatment type is possible in all groups, with effectiveness over 50% in all cases. There is a trend of decreasing treatment effectiveness with increasing number of deliveries, although overall effectiveness remains above 50%. Thus, number of deliveries is not an excluding factor for treatment but a relative one.

5.1.6. Relationship of the Factor "Previous Surgical Treatment" to the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients according to history of previous surgery for SUI is shown in Fig. 20. Patients with previous surgery numbered (n=7), and those without previous surgery (n=100).



■ Patients with prior surgical treatment for SUI → Patients without prior surgical treatment for SUI

Fig. 20. Percentage distribution of patients with previous surgical treatment

The presence of patients with previous surgical treatment for SUI in the study indicates a recurring nature of the condition despite various therapeutic approaches. Differences in treatment outcomes between the two groups were observed, which was considered an important criterion for evaluating patient profiles suitable for vaginal CO_2 laser treatment.

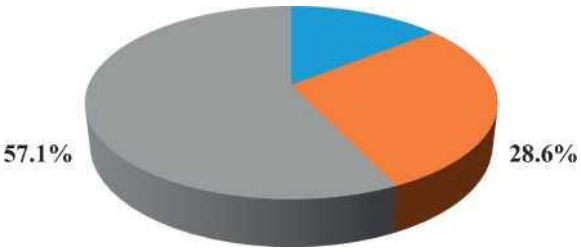
We used the same question again: "Do you have symptoms of SUI after the third procedure?"

Distribution of CO_2 laser treatment effectiveness in women with previous surgical treatment

In the group with a history of surgical treatment for SUI (n=7), only (n=1) woman reported that symptoms persist daily, (n=2) reported symptoms persisting but not daily, and the remaining (n=4) had no symptoms of SUI after three CO_2 laser procedures. The proportion of women achieving maximal results was 57.1%.

We analyzed the data from the group of patients without a history of prior surgical treatment for SUI (n=100)

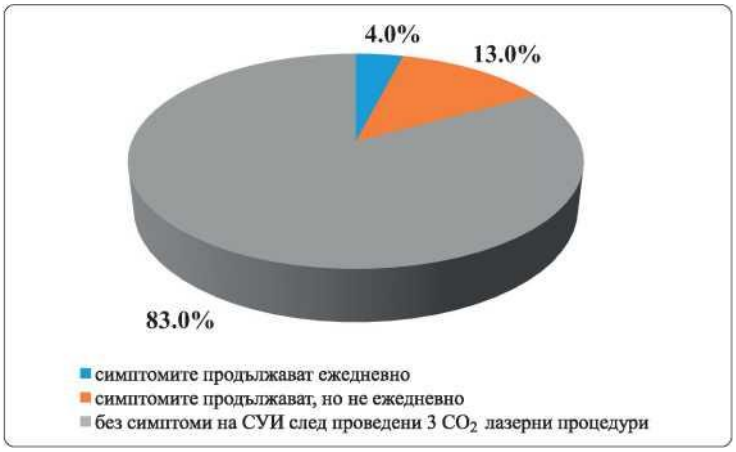
14,3%



■symptoms persist daily
■ symptoms persist, but not daily
■ no symptoms of SUI after three CO_2 laser procedures

Figure 21. CO_2 laser treatment outcomes in women with a history of surgical intervention for SUI

(n=4) women reported that their symptoms persisted on a daily basis, 13 reported that their symptoms persisted but not daily, and the remaining (n=83) women reported no symptoms of SUI after undergoing three CO_2 laser treatment sessions. The proportion of women who achieved maximum treatment effectiveness was 83%.



■symptoms persist daily
■ symptoms persist, but not daily
■ no symptoms of SUI after three CO_2 laser procedures

Fig. 22. Percentage distribution of CO_2 laser treatment effectiveness in women without prior surgery

Our results indicate that vaginal CO_2 laser treatment can be applied successfully in both groups of women for the treatment of urinary incontinence, with maximal effectiveness rates above 50% in both groups. However, a trend of higher effectiveness was observed in women without previous surgical treatment for SUI. We confirmed that a history of surgical treatment for SUI is a relative factor to consider when establishing a patient profile for successful CO_2 laser therapy.

5.1.7. The Role of Local Estrogen Hormone Therapy in the Effectiveness of Vaginal CO_2 Laser Treatment for Stress Urinary Incontinence (SUI)

The percentage distribution of patients based on whether they were undergoing adjuvant hormone therapy with local estrogen is shown in Figure 23. Patients undergoing local estrogen hormone therapy were (n=3), while those not receiving such therapy were (n=104).

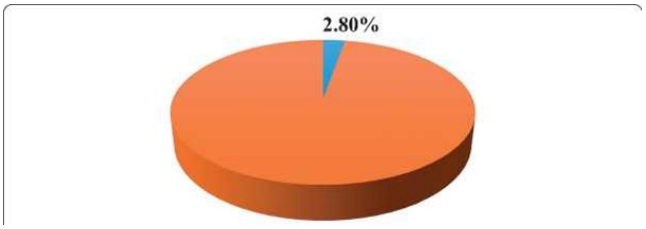


***Figure 23**. Percentage distribution of patients with local estrogen hormone therapy*

During menopause and perimenopause, estrogen deficiency leads to symptoms that compromise vaginal health and female sexual comfort. Common symptoms include vaginal dryness, dyspareunia, postcoital bleeding, and petechial lesions on the vaginal walls [111]. These symptoms are often collectively diagnosed as atrophic (senile) vaginitis.

Therapeutic approaches commonly include local lubricants, vaginal pessaries with hyaluronic acid, and estradiol-based preparations.

According to a survey conducted in two outpatient gynecological practices—MC “St. Sofia” and MC “New Life” in Burgas—with 384 women diagnosed with symptomatic and objectively confirmed senile vaginitis, 85.9% declined local hormonal treatment, 12% were willing to try it for a short period, and only 2% were currently using local estrogen preparations.

We interpret these findings as reflecting skepticism and rigidity in attitudes toward hormone therapy with local estrogen. This also explains the very limited number of participants in our primary study who were using local hormonal therapy—only 3.

We again used the question, *"Do you have symptoms of SUI after the third laser procedure?"* in both treated and monitored groups, to assess both the feasibility and the effectiveness of vaginal CO_2 laser therapy, and to explore any correlation between therapeutic outcomes and the use of local estrogen treatment.

In the group of patients receiving local estrogen therapy, none reported persistent daily symptoms or intermittent symptoms. All 3 patients (100%) reported no symptoms of SUI after three CO_2 laser sessions (Figure 25).

Figure 25. Percentage distribution of CO_2 laser treatment effectiveness in women receiving local estrogen therapy

We also analyzed the effectiveness of CO_2 laser therapy in patients not receiving local estrogen treatment. In this group of (n=104) patients, (n=3) reported persistent daily symptoms, (n=13) reported intermittent symptoms, and the remaining (n=88) had no SUI symptoms following three CO_2 laser procedures. The rate of patients with maximum treatment effectiveness was 84.6%. More than two-thirds of the patients not using local hormone therapy achieved maximum therapeutic benefit (Figure 26).

Figure 26. Percentage distribution of CO_2 laser treatment effectiveness in women not receiving local estrogen therapy

We concluded that the method of treating SUI with vaginal CO_2 laser procedures is satisfactorily effective and applicable in patients regardless of whether they undergo adjuvant local estrogen hormone therapy. We found no evidence of a negative impact on treatment efficacy due to the absence of local estrogen therapy.

5.1.8. The Impact of Overactive Bladder on the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients with overactive bladder (OAB) is presented in Figure 27. Patients diagnosed with concomitant overactive bladder numbered (n=48), while those without such a diagnosis were (n=59) (Figure 27).

■ with concomitant diagnosis of overactive bladder | without concomitant diagnosis of overactive bladder
V I)

Fig. 27. Percentage distribution of patients based on the presence of overactive bladder

We aimed to investigate the correlation between therapeutic outcomes in patients with and without concomitant OAB. The condition is considered a risk factor that may compromise the effectiveness of CO_2 laser treatment for stress urinary incontinence (SUI).
To assess this, we posed the question once again: “Do you experience SUI symptoms after the third completed procedure?” to both treated and observed groups.

We analyzed the results in the group of (n=48) patients with concomitant overactive bladder:
(n=6) women reported that symptoms persisted daily,
(n=8) indicated that symptoms persisted, but not daily,
and (n=34) patients reported no SUI symptoms after the completed three CO_2 laser procedures.

The proportion of patients with maximum treatment effectiveness among those with concomitant overactive bladder was **70.8%** (Fig. 28).
In the group of (n=59) patients **without overactive bladder**, 5 women reported that the symptoms persisted daily, 7 reported that the symptoms persisted but not daily, and the remaining 47 women had **no SUI symptoms** after completing three CO_2 laser procedures.
The proportion of patients with maximum treatment effectiveness **in the group without overactive bladder** was **79.6%** (Fig. 29).

When comparing the results between the two groups, it is evident that the proportion of patients without SUI symptoms in both observed groups exceeds 50%. The effectiveness is satisfactory in both cohorts, which supports the conclusion that overactive bladder is a **relative** factor in the successful vaginal CO_2 laser treatment of urinary incontinence (UI).

5.1.9. The Impact of Diuretic Use on the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients based on diuretic intake is shown in Fig. 30. There were 49 patients taking diuretics and 58 patients not taking diuretics.

■ without diuretic intake ■ with diuretic intake
Fig. 30. Percentage distribution of patients according to diuretic intake

We investigated whether there was a relationship by comparing the therapeutic outcomes of patients taking diuretic medications versus those who were not, in order to determine whether this factor influences the efficacy of CO_2 laser treatment. We considered the possibility of including this parameter in the patient profile for CO_2 vaginal laser procedures in the treatment of SUI. Diuretic intake is regarded as a **risk factor** that may compromise the effectiveness of CO_2 laser treatment for SUI.

To evaluate this, we again posed the question: "Do you experience SUI symptoms after the third completed procedure?" to both treated and observed groups.

The data in the group of 49 patients who were taking diuretics are as follows:

- 14 women reported that symptoms persisted **daily**;
- 18 patients reported that symptoms persisted but **not daily**;
- 17 patients had **no symptoms** of SUI after completing three CO_2 laser procedures. The proportion of women with **maximum treatment effectiveness** in the diuretic group was **34.6%** (Fig. 31).

In the group of 58 patients **not taking diuretics**, 2 women reported that symptoms persisted **daily**, 5 reported that symptoms persisted but **not daily**, and the remaining 51 women had **no SUI symptoms** after three CO_2 laser procedures. The proportion of patients with **maximum therapeutic effectiveness** in this group was **87.9%** (Fig. 32).

Fig. 32. Percentage distribution of treatment effectiveness in women not taking diuretics

When comparing the results between the two groups, we found that the proportion of patients **without SUI symptoms** after three procedures in the **diuretic group** was **below 50%**, which we consider to be a **low treatment success rate**. In the **non-diuretic group**, over **70% of patients** achieved maximum results, i.e., absence of SUI symptoms, which we interpret as a **high success rate** of the procedure.

The identified correlation between **diuretic intake** and treatment outcomes prompted us to include **diuretic use as a factor** in the patient profile for successful and effective CO_2 vaginal laser treatment of SUI.

5.1.10. The Impact of Cystocele Protruding Beyond the Hymenal Ring on the Effectiveness of Vaginal CO_2 Laser Treatment for SUI

The percentage distribution of patients with cystocele protruding beyond the hymenal ring is presented in **Figure 33**.
There were **12 patients** with this condition and **95 patients** without it.

We assumed the possibility of a correlation between the **success rate of CO_2 laser therapeutic procedures** and the **presence of cystocele extending beyond the hymenal ring** in the patient group.

We examined the relationship between therapeutic outcomes in patients with a concomitant cystocele protruding beyond the hymenal ring and those without, in order to evaluate whether this condition is a contributing factor in treatment success. We assumed the possibility of including this factor—**cystocele protruding beyond the hymenal ring**—in the patient profile for effective vaginal CO_2 laser treatment of stress urinary incontinence (SUI).

As described in the literature, **cystocele and SUI are often interrelated**, with a well-documented causal connection. In line with these findings, we also consider the presence of a cystocele extending beyond the hymenal ring to be a **risk factor likely to reduce the therapeutic effectiveness** of vaginal CO_2 laser procedures for SUI.

To assess this, we once again asked the question:
"Do you experience SUI symptoms after the third completed procedure?" in both treated and observed groups.

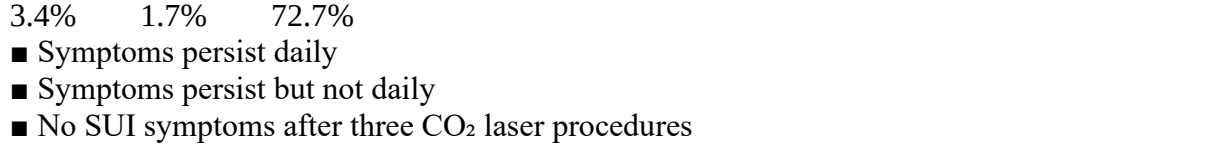


Fig. 34. Percentage distribution of CO_2 laser treatment effectiveness in patients with cystocele beyond the hymenal ring

In the group of 12 patients with a cystocele protruding beyond the hymenal ring:

- 8 women reported that symptoms **persisted daily**,
- 3 reported that symptoms **persisted but not daily**,
- and only 1 patient reported **no SUI symptoms** after three CO_2 vaginal laser procedures.
  Maximum treatment effectiveness was achieved in only **1.7%** of the observed group of women.

In the group of 95 patients **without cystocele protruding beyond the hymenal ring**, 8 women reported that the symptoms **persisted daily**, 13 reported that symptoms **persisted but not daily**, and the remaining 74 patients had **no SUI symptoms** after three CO_2 vaginal laser procedures.
The proportion of women with **maximum treatment effectiveness** in this group reached **77.8%** (Fig. 35).

Fig. 35. Percentage distribution of the effectiveness of CO_2 vaginal laser treatment in patients without cystocele beyond the hymenal ring

We determined that **cystocele beyond the hymenal ring is an important factor** influencing the effectiveness of CO_2 vaginal laser treatment. Nevertheless, we demonstrated **successful therapeutic results in both groups**, which gave us a rationale to include this factor in the patient profile for effective treatment of SUI using CO_2 laser.

5.2. Evaluation of the Patient by Gynecological Examination

A gynecological examination is performed on all patients.
Following the examination, the **presence or absence of cystocele** is assessed, along with the **degree of prolapse**, if present.

We considered cystocele as a key factor potentially influencing treatment outcomes, and we expanded our observation framework accordingly.

For the assessment of cystocele, patients were classified into three groups:

- **Group 1:** No cystocele;
- **Group 2:** Cystocele without protrusion beyond the hymenal ring during straining;
- **Group 3:** Cystocele with protrusion beyond the hymenal ring during straining.

The largest group consisted of patients **without cystocele (n=63)**, followed by patients with cystocele **not protruding** beyond the hymenal ring during straining (**n=32**), and finally the smallest group with **cystocele protruding beyond the hymenal ring during straining (n=12)** (Fig. 36).

11.21%

■ Absence of cystocele
I Cystocele without protrusion in front of the hymenal ring during straining
I Cystocele with protrusion in front of the hymenal ring during straining

Fig. 36. Percentage distribution of patients according to the presence or absence of cystocele

We assumed a correlation between the success of SUI treatment with CO2 vaginal laser procedures and the degree of cystocele. We observed the treatment outcomes in the three groups.
During a survey on the persistence of SUI symptoms after treatment with 3 vaginal CO2 laser procedures, we obtained the following data. To assess the results, we conducted a follow-up survey with the question: “Do you have SUI symptoms after the 3rd procedure?” in the three groups treated and monitored with CO2 laser.

In the group of 12 patients with cystocele protruding in front of the hymenal ring without straining, 8 women reported daily persistent symptoms; 2 patients reported symptoms persisting, but not daily; and 1 patient had no SUI symptoms after 3 vaginal CO2 laser procedures.

■ Symptoms persist daily
■ Symptoms persist, but not daily
■ No SUI symptoms after 3 CO2 laser procedures

Fig. 37. Percentage distribution of treatment effectiveness
in patients with cystocele protruding
in front of the hymenal ring without straining

The remaining 95 patients were divided according to cystocele degree – presence of cystocele in front of the hymenal ring during straining and absence of cystocele.
After objective examination during gynecological checks, we classified these 95 patients into

two groups: the majority were patients without cystocele (n=63), followed by patients with cystocele without protrusion in front of the hymenal ring during straining (n=32) (Fig. 38).

Fig. 38. Percentage distribution of patients according to cystocele degree

In the group of 63 patients without cystocele, 4 women reported daily persistent symptoms; 7 patients reported symptoms persisting, but not daily; and the remaining 52 had no SUI symptoms after 3 vaginal CO2 laser procedures (Fig. 39).

■ Symptoms persist daily
■ Symptoms persist, but not daily
■ No SUI symptoms after 3 CO2 laser procedures

Fig. 39. Percentage distribution of patients
according to cystocele degree

In the group of 32 patients with cystocele without protrusion in front of the hymenal ring during straining, 7 women reported that symptoms persist daily; 6 patients reported symptoms persisting, but not daily; and the remaining 19 had no SUI symptoms after 3 vaginal CO2 laser procedures.
The proportion of women with maximum effectiveness from the CO2 vaginal laser treatment in this group is 59.5%.

■ Symptoms persist daily
■ Symptoms persist, but not daily
■ No SUI symptoms after 3 CO2 laser procedures

Fig. 40. Percentage distribution of patients with cystocele without
protrusion in front of the hymenal ring during straining

The presence of cystocele affects the success of SUI treatment with CO2 vaginal laser procedures, but it is not an excluding factor, since there are cured patients in all observed groups.
The presence of cystocele with protrusion in front of the vaginal introitus without straining noticeably decreases therapeutic results. These data suggest that this factor should be included as influencing treatment with CO2 laser in the patient profile for this approach.

The possibility of applying CO2 laser treatment in all three patient groups has been demonstrated. The CO2 laser is safe for use in all three groups, but the treatment loses its effectiveness in more than half – 66.6% (Fig. 37) – of the observed women in the group with cystocele protrusion in front of the introitus without straining, which is why we consider it unnecessary to spend patients' time and financial resources when this objective assessment is made during the examination.

We found that the achieved effectiveness in patients without cystocele and those with cystocele not protruding in front of the hymenal ring is satisfactory in both observed groups, with the proportion of successfully treated patients exceeding 70%.

During the examination, an objective assessment of the uterus is made according to its position. Patients are divided into two groups according to the position of the organ.

According to the position of the uterus, the following groups were observed (Fig. 41):

1. Anteversio flexio (n=91)
2. Retroversio flexio (n=16)

■ Anteversio flexio
■ Retroversio flexio

Fig. 41. Percentage distribution of patients according to uterine position

The percentage distribution of patients according to the anatomical position of the uterus is shown in Fig. 10. There were 91 patients with anteversio flexio and 16 patients with retroversio flexio.

We examined the effectiveness of therapeutic vaginal CO2 laser procedures for the treatment of stress urinary incontinence (SUI) in these two groups to assess whether uterine position is a factor influencing treatment outcome, and consequently, whether it should be included in the patient profile for successful treatment with this minimally invasive approach.

A questionnaire was used with the question: *"Do you have symptoms of SUI after the 3rd procedure?"* applied to both treated and observed groups.

Among the 91 patients with anteversio flexio, 3 women reported that symptoms persisted daily; 7 patients reported symptoms persisted but not daily; and 81 patients had no symptoms of SUI after completing 3 CO2 laser vaginal procedures. The proportion of women achieving maximal treatment effectiveness was 89%.

Among the 16 patients with retroversio flexio, 1 woman reported symptoms persisted daily; none reported symptoms persisting but not daily; and the remaining 15 patients had no symptoms of SUI after 3 CO2 laser vaginal procedures (Fig. 43).

The proportion of women who achieved maximum treatment effectiveness is 93.7%.

93.8%
■ Symptoms persist daily
■ Symptoms persist, but not daily
■ No SUI symptoms after 3 CO2 laser procedures

Fig. 43. Percentage distribution of treatment effectiveness with CO2 laser in patients with uterus in retroversion-flexion position

We found that in our observation of 107 patients, the proportion of patients with SUI and uterus in anteversion-flexion (AVF) position is much greater—over 5 times higher than those with retroversion-flexion. We consider that a correlation between uterus position and the occurrence of SUI could be investigated, but a much larger patient group would be needed to confirm this with confidence.

The results of our observation show no significant difference in therapeutic outcomes between the two patient groups. This demonstrates both the possibility of applying CO2 laser treatment in both groups and its effectiveness after 3 consecutive procedures over 4 weeks regardless of the uterus position.

All this indicates there is no need to determine uterus position during the gynecological examination.

Analysis of treatment results showed that uterus position does not affect treatment outcome and is neither an absolute nor a relative excluding factor. Thus, CO2 vaginal laser procedures can be applied in both groups.

Uterine descent (descensus) is a condition in which the uterine cervix (PUKU) is located below the interspinous line, and prolapse is present when the uterine cervix protrudes in front of the hymenal ring. Uterine prolapse may be total or subtotal [classification from Gynecology, A. Dimitrov and V. Zlatkov, p. 208].

We categorized the patients into the following groups:

1. Total uterine prolapse
2. Subtotal uterine prolapse
3. Presence of uterine descent (descensus)

Initially, we excluded this type of patients since they are candidates for surgical treatment, and incontinence is often absent in them, replaced by other symptoms and complaints. Thus, we established uterine prolapse/descensus as an absolute exclusion factor for the possibility of treatment with CO2 laser.

The key questions related to the dissertation topic include the benefit/harm to the patient, cost of treatment, recovery period, complications, duration of treatment, and recurrence of the condition.

5.3. Conducting the laser procedures

The CO2 laser scanner provides uniform delivery of the fractional pattern—210 spots each controlled and evenly distributed. This creates small zones of ablation/coagulation in the lamina propria, using energy levels of 10 mJ. The parameters used allow for vaginal regeneration while limiting the penetration depth to 600 microns, thereby ensuring the safety of the fibromuscular layer.

Patients undergo 3 consecutive vaginal procedures spaced 4 weeks apart. Each procedure lasts approximately 15 minutes, during which all vaginal walls are treated along their entire length using a vaginal applicator. The applicator is 9 cm long, marked every 1 cm to facilitate thorough treatment of the entire vaginal wall surface. The rotation angle is 360 degrees, with increments every 45 degrees. Each centimeter in length is treated in 360 degrees. During one procedure, 3 complete passes (glides along the entire vaginal length) are performed. The following machine parameters were used for the procedures.

Table 1

	1-ва процедура	**2-ра процедура**	**3-та процедура**
Urinary incontinence	10 mj energy 10 % density	10 mj energy 10 % density	10 mj energy 10 % density

Procedure Execution According to the Following Technique and Algorithm:

1. Preparation of the display for command execution (using Table 1).
2. Application of baby oil on the probe – vaginal applicator.

3. Insertion of the applicator into the vagina until reaching the cervical os.
4. Activation of the standby mode on the display and delivery of a scanning pulse via the foot pedal.
5. Rotation of the probe by 45° clockwise followed by pulse delivery via the foot pedal. This movement is repeated 8 times to ensure 360° coverage of the treated area.
6. Withdrawal of the applicator by 1 cm and repetition of step 5 to achieve full 360° coverage, gradually treating the entire vaginal length by sequential 1 cm retractions.
7. An essential principle is that the probe's mirror must always remain inside the vagina throughout the laser procedure.

Post-procedure, patients were advised to abstain from sexual intercourse for 72 hours, avoid vaginal douching, and refrain from swimming in pools or the sea. For patients experiencing vaginal dryness, the use of moisturizing pessaries was recommended.

5.4. Side Effects of CO_2 Vaginal Laser Treatment

We monitored for side effects and complications arising from the treatment, categorizing them as:

- **Severe:** genital bleeding, pain, or requirement for analgesics.
- **Mild complaints:** intimate discomfort resolving spontaneously within 24 hours without intervention.

Analysis of the patients revealed no severe complications (such as genital bleeding, pain, or the need for analgesics) following CO_2 laser treatment.

In a survey assessing side effects and reactions from CO_2 laser treatment, in response to the question "Did you experience genital bleeding, pain, or need for analgesics after the procedure?", not a single patient reported such symptoms. The studied group showed a 100% absence of severe side effects.

Again, through a questionnaire survey, we investigated mild side effects with the question: "Did you experience intimate discomfort resolving without treatment within 24 hours after the procedure?". A total of 107 patients were surveyed.

11 of the patients reported mild complaints (scant genital discharge, sensation of intimate discomfort, which resolved within 24 hours) (Fig. 44).

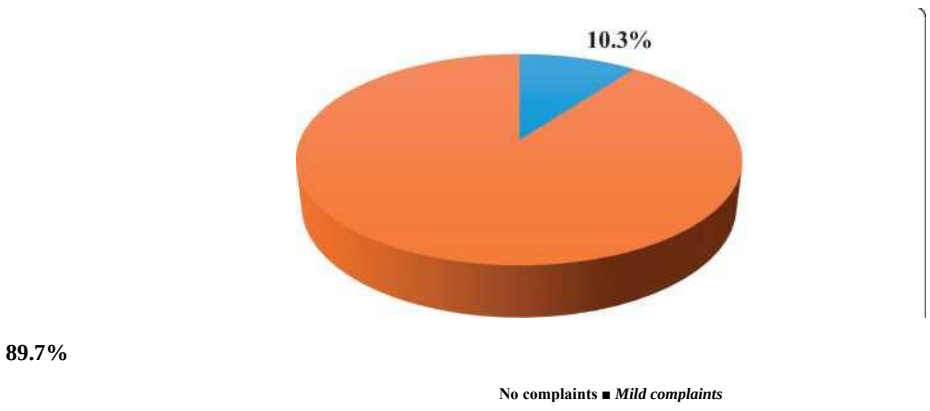


Fig. 44. Percentage distribution of patients with mild complaints after CO_2 vaginal laser treatment for urinary incontinence (UI).

In a survey of 73 patients who underwent surgical treatment for urinary incontinence (UI) regarding the presence of severe complications (genital bleeding, pain, need for analgesics), 71 of them reported such complications, compared to 0 women in the group treated with CO_2 laser.

Thus, we demonstrated the absolute safety of CO_2 treatment and the absence of a recovery period after laser procedures, as well as the lack of severe complications. The data from this observation fulfill task 8 set forth in the dissertation.

We calculated the average hospital stay for surgically treated patients and compared it with the time needed for conducting the 3 laser procedures.

All surgically treated patients were hospitalized under ICD-164 (corrections of pelvic-perineal statics and urinary incontinence in women) with a hospital stay of 3 days – 72 hours. All these patients were issued a document for temporary incapacity for home treatment lasting 30 days.

In comparison, the patients treated with 3 CO_2 laser procedures lasting 15 to 20 minutes each in an outpatient setting all returned to their daily lives immediately after the procedure and did not require a medical certificate for their employer.

The comparative analysis confirms the absence of economic losses for both the patient and the employer.

We may conclude that the data from this analysis support the fulfillment of task 4 set in the present dissertation.

5.4. Evaluation of the Success Rate of Laser Procedures

Using a developed questionnaire, the possibilities for the procedure's success are evaluated (Appendix: Questionnaires).

1. How often do you go to the toilet to urinate during the day? (4-7; 8-10; over 11)
2. How often do you experience incontinence during the day without stress (increased intra-abdominal pressure)? (0; 1-2; more than 3)
3. How often do you experience incontinence during the day under stress (sneezing, coughing, jumping, squatting, standing up)? (1-3/rarely; 4-7/often; 8 or more/every time)
4. Do you use pads daily? If yes, specify the absorbency of the pads (1, 2, 3 drops)
5. Do you use adult diapers? – yes/no
6. Do you leave your home without a pad? – yes/no
7. Does incontinence affect your choice of clothing (pants/dress/skirt)? – yes/no (answered before and after treatment – after the 3rd procedure)
8. Does incontinence affect your choice of color in clothing (dark/light)? – yes/no (answered before and after treatment – after the 3rd procedure)

9. Does incontinence prevent you from exercising/dancing? – yes/no (answered before and after treatment)
10. Have you shared your incontinence condition with your relatives and partner? – yes/no (answered only before treatment)
11. How long after symptom onset did you share with someone? – more/less than 1 year (answered only before procedure)
12. Have your mother or grandmother shared with you about incontinence? – yes/no (answered only before treatment)
13. Do you feel ashamed in front of your partner because of incontinence? – yes/no (answered only before treatment)
14. Have you shared with anyone about your CO_2 laser treatment? – yes/no (answered only after treatment)
15. Does incontinence negatively affect your sexual life? – yes/no (answered only before treatment)

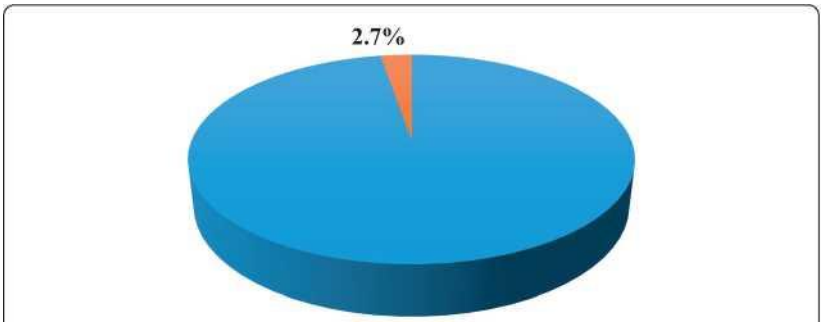


Fig. 45. Percentage distribution of patients with severe complications after surgical treatment of urinary incontinence (UI) and after CO_2 laser treatment.

Thus, we demonstrated the absolute safety of CO_2 treatment and the absence of a recovery period after laser procedures, as well as the lack of severe complications. The data from this observation fulfill task 8 set forth in the dissertation.

We calculated the average hospital stay for surgically treated patients and compared it with the time needed for conducting the 3 laser procedures.

All surgically treated patients were hospitalized under ICD-164 (corrections of pelvic-perineal statics and urinary incontinence in women) with a hospital stay of 3 days – 72 hours. All these patients were issued a document for temporary incapacity for home treatment lasting 30 days.

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5.4. Evaluation of the Success Rate of Laser Procedures

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1) How often do you urinate during the day? (4-7; 8-10; over 11)
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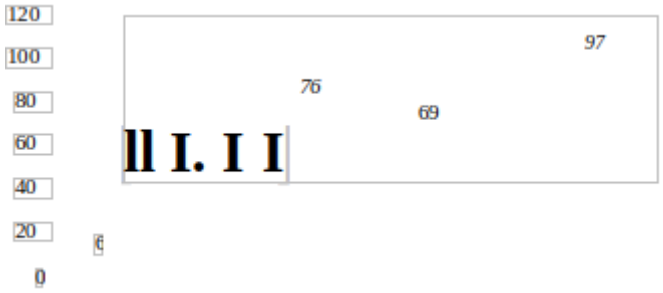
3) How often do you experience incontinence during the day under stress (sneezing, coughing, jumping, squatting, standing up)? (1-3/rarely; 4-7/often; 8 or more/every time)
4) Do you use pads daily? If yes, specify the absorbency of the pads (1, 2, 3 drops)
5) Do you use adult diapers? – yes/no
6) Do you leave your home without a pad? – yes/no
7) Does incontinence affect your choice of clothing (pants/dress/skirt)? – yes/no (answered before and after treatment — after the 3rd procedure)
8) Does incontinence affect your choice of clothing color (dark/light)? – yes/no (answered before and after treatment — after the 3rd procedure)
9) Does incontinence prevent you from exercising/dancing? – yes/no (answered before and after treatment)
10) Have you shared your incontinence condition with your relatives and partner? – yes/no (answered only before treatment)
11) How long after symptom onset did you share with someone? – more/less than 1 year (answered only before procedure)
12) Have your mother or grandmother shared with you about incontinence? – yes/no (answered only before treatment)
13) Do you feel ashamed in front of your partner because of incontinence? – yes/no (answered only before treatment)
14) Have you shared with anyone about your CO_2 laser treatment? – yes/no (answered only after treatment)
15) Does incontinence negatively affect your sexual life? – yes/no (answered only before treatment)
16) Has your self-confidence improved after CO_2 laser treatment? – yes/no (answered only after the 3rd procedure)
17) Have you tried any other treatment up to this point? – yes/no (answered only before treatment)

5.4.1. Frequency of Micturition

Distribution of patients undergoing CO_2 vaginal laser treatment for urinary incontinence (UI) according to how often they urinate during the day. The patients were divided into three groups: frequency of micturition between 4–7; 8–10; and over 10 micturitions per 24 hours. Micturition is a physiological, voluntarily controlled process.

Fig. 46. Distribution of patients according to frequency of urination

How often do you urinate during the day?



Upon asking the question, we analyzed patients' responses before and after each subsequent procedure. We consider normal micturition frequency to be between 4 and 7 times per 24 hours.

Only 6 women in the study had a normal number of conscious micturition events per day before starting CO_2 vaginal laser treatment. After just one procedure, this number increased to 18; the same response was given by 69 women after the second procedure, and by the end of the treatment, 97 women reported having a normal number of micturitions per day. We observe a progression in responses indicating normal micturition frequency after each procedure, reaching maximum results after a full course of three consecutive treatments spaced four weeks apart.

Notable improvements were also observed in responses regarding more than 11 micturitions per day. Before treatment, 40 women reported more than 11 micturitions per day, compared to none after the second and third procedures. This indicates a tendency towards normalization of conscious micturition frequency.

Analysis of responses for micturition frequency between 8 and 10 times per day showed that before treatment, 61 women reported 8–10 micturitions; after the first procedure, 76 women; after the second procedure, 38 women; and after the third, 10 patients.

The observed trend is a decrease in the group with over 11 micturitions and an increase in the group with 8–10 micturitions after each subsequent laser procedure. These results indicate that urinary incontinence affects the physiology of micturition, and the number of CO_2 laser procedures for UI treatment leads to normalization of micturition frequency.

Results from the control group survey showed the following:
Patients were surveyed before treatment and 30 days after surgery.

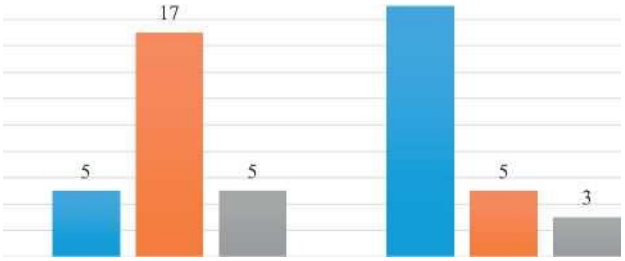


Fig. 47. Distribution of patients in the control group according to frequency of urination

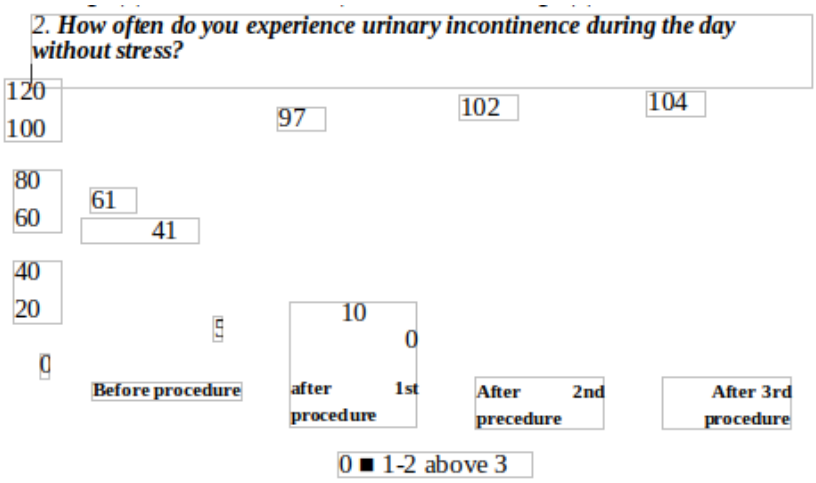
The data analysis shows that before the procedure, more than 60% of patients had over 7 conscious micturitions per day in an effort to prevent urinary incontinence (UI). Following surgical treatment, the table indicates that micturition frequency decreased to 4–7 times per day in 19 of the surveyed women. This trend is also observed among women undergoing CO_2 laser treatment after each procedure. Both treatment methods demonstrate similar results in terms of the number of conscious micturitions before and after treatment.

Thus, we demonstrate that the innovative approach is equally effective as the classical surgical method for treating UI concerning the frequency of micturition per day before and after treatment.

5.4.2. Frequency of Stress-Free Urinary Incontinence Episodes During the Day

Distribution of patients according to the frequency of stress-free urinary incontinence episodes during the day (increased intra-abdominal pressure). We created three observation groups: 0; 1–2; more than 3, and analyzed the results before starting CO_2 laser treatment and after each procedure.

Fig. 48. Distribution of patients according to the frequency of stress-free urinary incontinence episodes during the day



In response to this question, 4.67% of the women in our study reported experiencing stress-free urinary incontinence more than three times per day before starting treatment. Following the first procedure, no patients reported this frequency.

The proportion of patients without any episodes of stress-free incontinence was 57% prior to treatment. This increased to 90.6% after the first procedure, 95.3% after the second procedure, and reached 97.2% upon completion of the full treatment course.

The number of women who answered "1–2 times per day" before treatment was 41. This number decreased progressively after each CO_2 vaginal laser procedure: 10 women after the first procedure, 5 women after the second, and only 3 after the third.

The results from the control group survey showed the following:
Patients were surveyed prior to treatment and again 30 days after surgery.

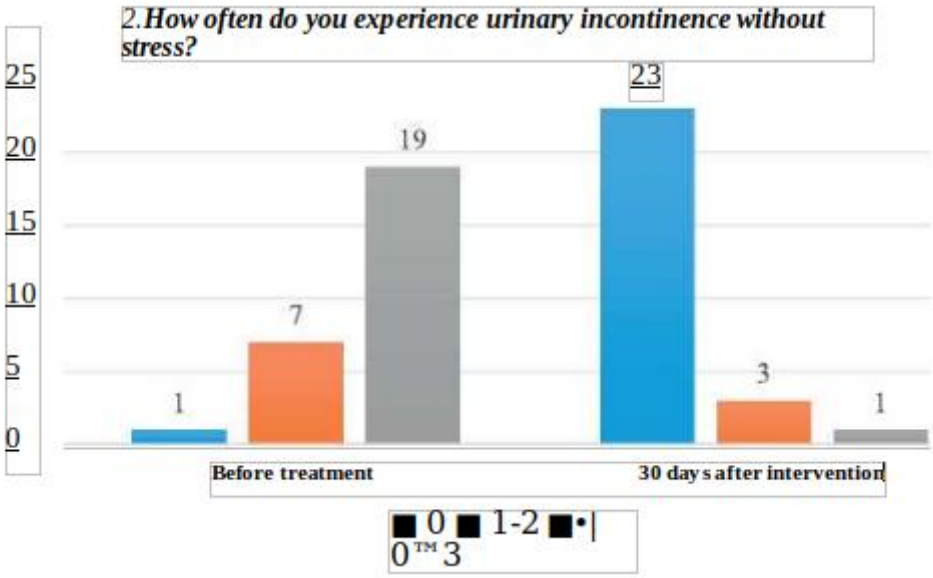


Fig. 49. Distribution of patients in the control group according to the frequency of stress-free urinary incontinence episodes during the day

In response to this survey question, 19 patients reported experiencing “stress-free” urinary incontinence before undergoing treatment. Thirty days after the surgical procedure, only one woman continued to report more than three episodes of spontaneous incontinence.

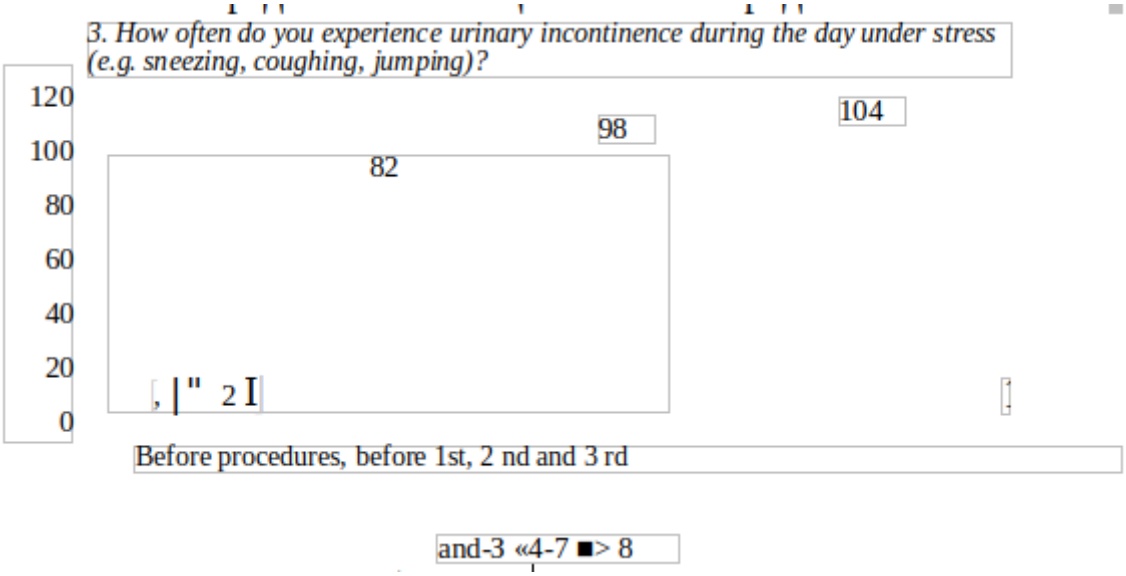
The proportion of women who showed improvement in symptoms—specifically, the absence of sudden daytime incontinence episodes—after surgery was 85.19%, compared to 97.2% among patients treated with CO_2 laser therapy after the third procedure.

The data show comparable results between the study group and the control group. This demonstrates that the effectiveness of the non-invasive procedure is equivalent to that of the surgical approach.

5.4.3. Frequency of Stress-Related Urinary Incontinence Episodes During the Day

Distribution of patients according to the frequency of stress-related urinary incontinence episodes during the day (sneezing, coughing, jumping): 1–3; 4–7; 8 or more.

Fig. 50. Distribution of patients according to the frequency of stress-related urinary incontinence episodes during the day before stress



We surveyed the participants before and after each procedure regarding the frequency of incontinence episodes during the day under "stress" conditions.
Analysis of the results shows that the proportion of women experiencing stress incontinence more than 8 times per day before starting CO2 laser treatment was 34.5%, which sharply decreased to 1.8% after the first procedure. This proportion remained the same after the second procedure and further decreased to 0.9% after three consecutive CO2 laser treatments.

Looking at the group with 4-7 episodes of stress incontinence per day, the data shows that before treatment, 53.2% of women reported this frequency. This number decreased to 21.4% after the first procedure, dropped further to 6.5% after the second, and almost disappeared (0.9%) after three consecutive CO2 laser treatments.

We also analyzed responses from women reporting 1-3 leakage episodes per day, where the trend is an increase in this group: 12.1% before treatment, rising to 76.6% after the first procedure, 91.5% after the second, and reaching 97.1% after the full course of three CO2 laser procedures.

These data demonstrate the effectiveness of the CO2 vaginal laser treatment after completing a course of three sessions spaced four weeks apart.

The results from the control group survey show the following:

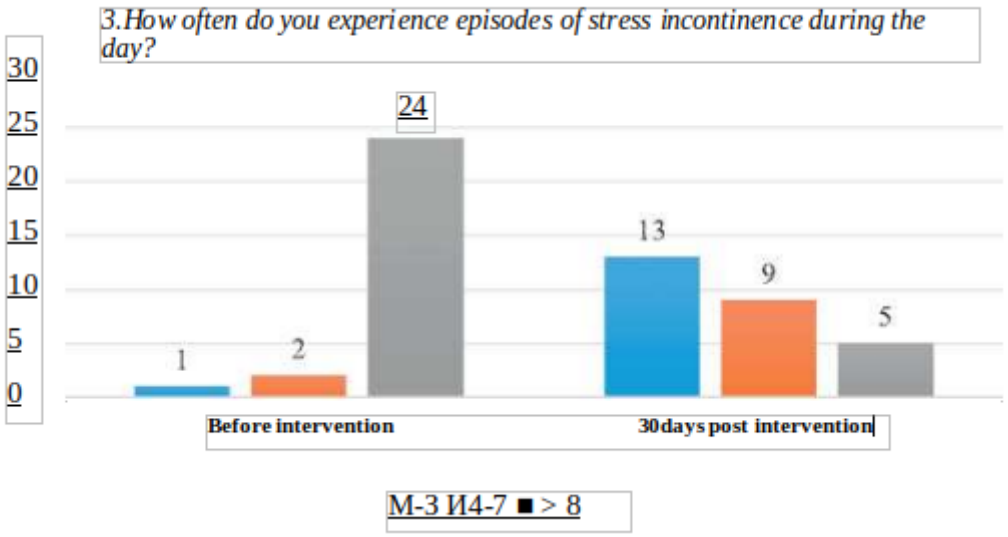


Fig. 51. Distribution of patients in the control group according to the frequency of daytime stress-free incontinence episodes

In the control group, this question was asked again before and after the treatment. The data show that even after surgery, some patients experience recurrent symptoms — stress incontinence more than 8 times per day — accounting for 18.52% of the group. Comparing the results, we found no 100% success rate for either treatment method, with the proportion of patients experiencing more than 8 incontinence episodes per day after the third CO2 laser procedure being 0.93%.

The data analysis indicates that, in terms of stress urinary incontinence, patients treated with the CO2 laser show better outcomes compared to those treated with the classical surgical method.

5.4.4. Frequency of incontinence during walking

Distribution of patients according to the presence of incontinence while walking. Patients were divided into two groups based on their answers — “yes” or “no” — and were surveyed before and after each procedure.

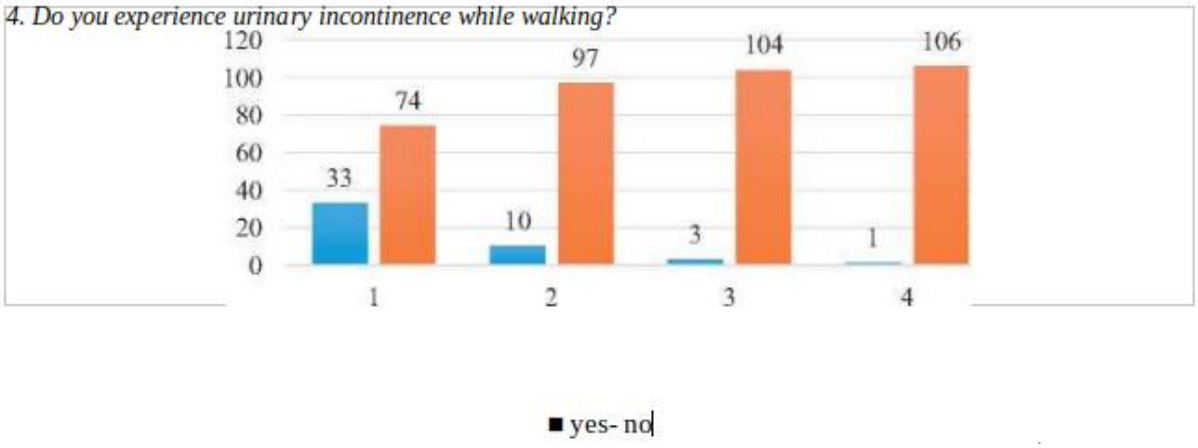


Fig. 52. Distribution of patients according to the presence of urinary incontinence while walking

In a significant number of cases, patients experience urinary incontinence even while walking, which is why we decided to observe the results of CO2 laser therapy in these cases.

Before starting treatment, 30.8% of our patients reported such incontinence. Their proportion decreased to 9.34% after the first procedure, continued to decline to 2.8% after the second procedure, and reached 0.9% after three procedures.

The reduction in the proportion of patients experiencing this symptom following CO2 laser treatment confirms the therapeutic effectiveness of the method.

The results from the control group are as follows:

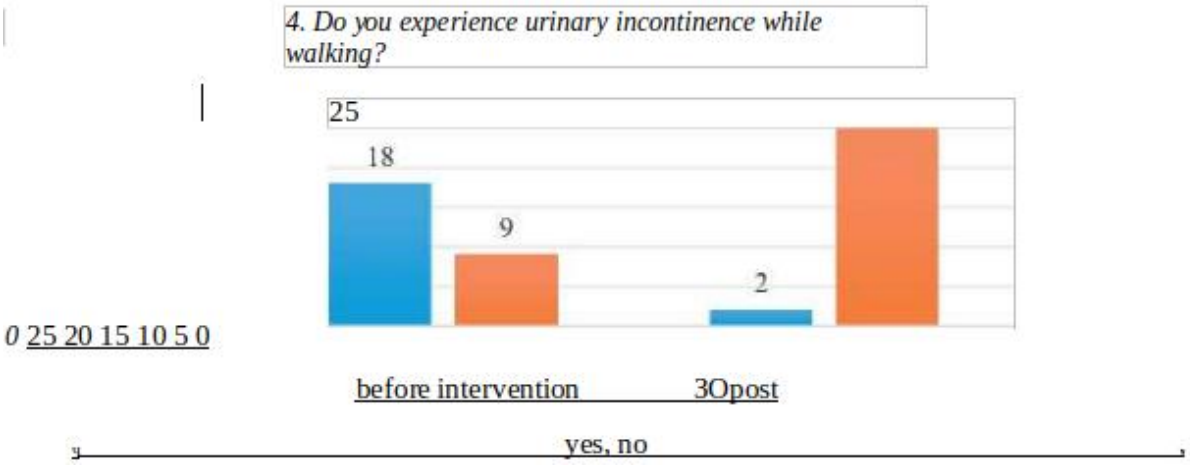


Fig. 53. Distribution of patients in the control group according to the presence of urinary incontinence while walking.

We compared the survey results between the two groups, finding that only 0.93% of patients treated with CO2 laser reported urinary incontinence while walking even after the third procedure, compared to 7.41% in the control group.

5.4.5. Use of Pads in Daily Life by Patients

We asked the patients the question: “Do you use pads daily?” If the answer was yes, they were asked to specify the absorbency level of the pads: 1, 2, or 3 drops. The patients were surveyed again before starting treatment and after each CO2 vaginal laser procedure.

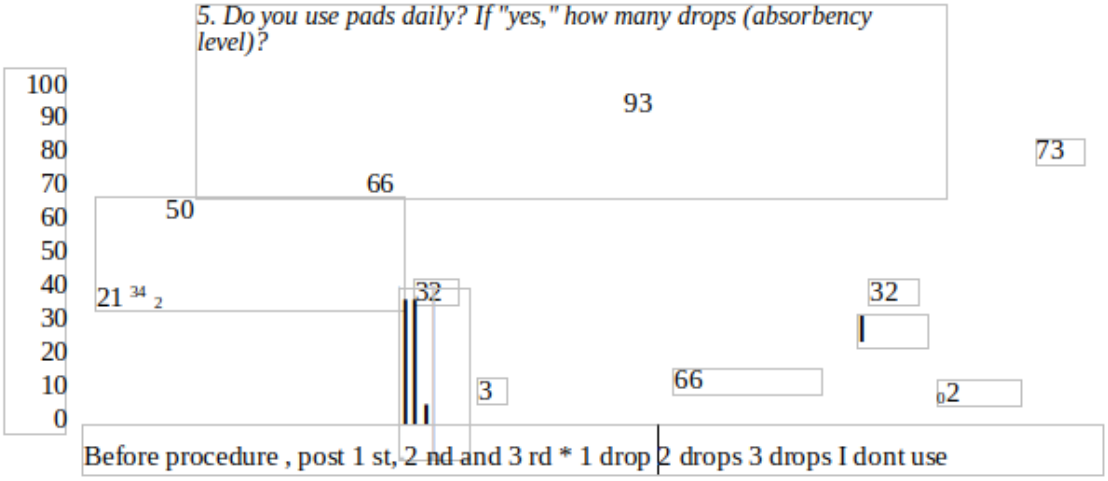


Fig. 54. Distribution of patients according to the absorbency capacity of the pads they use

We surveyed the study participants about their daily use of sanitary pads (SP), as well as the absorbency capacity of these pads, both before and after each procedure.

The results show that the proportion of women who did **not** wear sanitary pads before starting treatment with the CO2 laser was only 1.8%. After the first procedure, this increased to 5.6%, remained the same after the second procedure (5.6%), and then rose significantly to 68.2% after completing three consecutive CO2 laser procedures.

We analyzed the results for patients wearing sanitary pads with different absorbency capacities. Women using pads with a 1-drop absorbency before starting CO2 laser treatment accounted for 19.6%. After the first procedure, this increased to 61.6%, after the second procedure 86.9%, but after three consecutive procedures, the percentage of women using 1-drop absorbency pads decreased to 29.9%, as more women stopped wearing pads daily altogether (68.2%).

For those using pads with 2-drop absorbency, the trend was decreasing. Before treatment, 46.7% of women used 2-drop pads; after the first procedure, this decreased to 29.9%, after the second procedure to 5.6%, and after three consecutive procedures, this dropped to 0%, in line with the increasing group using 1-drop pads.

Regarding pads with 3-drop absorbency, the data showed that 31.7% of women used them before treatment. After the first procedure, this decreased sharply to 2.8%, further reduced to 1.8% after the second procedure, and remained at 1.8% after three consecutive CO2 laser procedures.

Results from the control group survey are as follows:

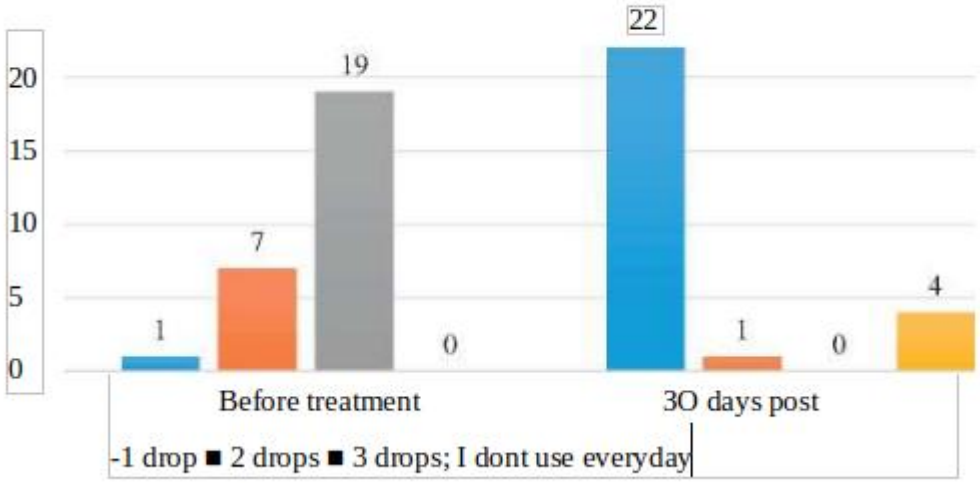


Fig. 55. Distribution of patients in the control group according to the absorbency capacity of the sanitary pads they use.

We found that wearing sanitary pads (SP) is a daily routine for women with urinary incontinence (UI). On one hand, this helps them maintain their "dryness," but on the other hand, it increases their risk of urogenital tract infections as well as allergic/contact dermatitis on the vulvar area caused by the materials of the sanitary pads.

When examining the survey results from both the study and control groups, we observed a trend of decreasing numbers of women who continue to wear sanitary pads daily with both treatment methods. The proportion of patients who stopped daily use of sanitary pads after CO2 laser treatment following the third procedure was 73 women (68.32%), while 30 days after surgery, only 4 women (14.81%) in the control group stopped using them.

We observed a tendency for continued need to use daily sanitary pads in the control group (operated women), with 85.19% still using them, while the group treated with CO2 laser showed a clear trend toward stopping the use of sanitary pads.

5.4.6. Use of Incontinence Underwear by Patients

We asked the patients, "Do you use incontinence underwear?" and tracked the results before starting treatment and after each procedure.

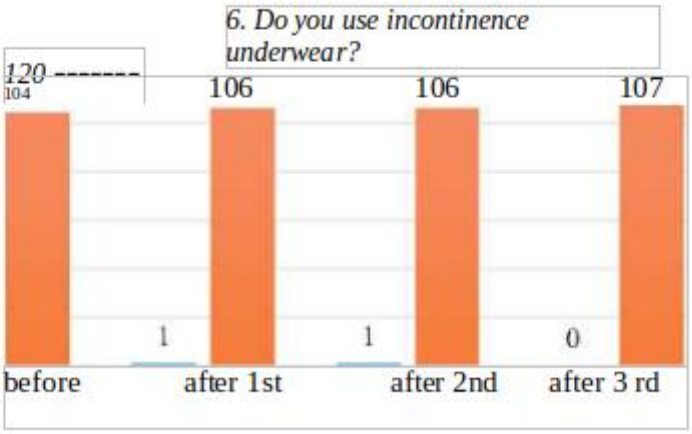


Fig. 56.
Distribution of patients according to whether they use incontinence underwear

The use of incontinence underwear reflects the severity of urinary incontinence in women. Due to two main factors—cost and marketing—we were unable to include a significant number of patients in our study.

Only 3 out of 107 patients reported using incontinence underwear before starting CO2 laser vaginal procedures for the treatment of urinary incontinence. After the first procedure, only 1 patient continued using incontinence underwear, the same number remained after the second procedure, and after three CO2 laser procedures, no woman was wearing incontinence underwear.

Even with this small number of patients suffering from severe urinary incontinence, three consecutive CO2 laser vaginal procedures over 4 weeks resulted in 100% cessation of incontinence underwear use. This undoubtedly improves daily comfort and hygiene for the women and reduces the risk of urogenital infections caused by urine retention in the incontinence pads.

The survey results from the control group show the following: Do you use incontinence underwear?

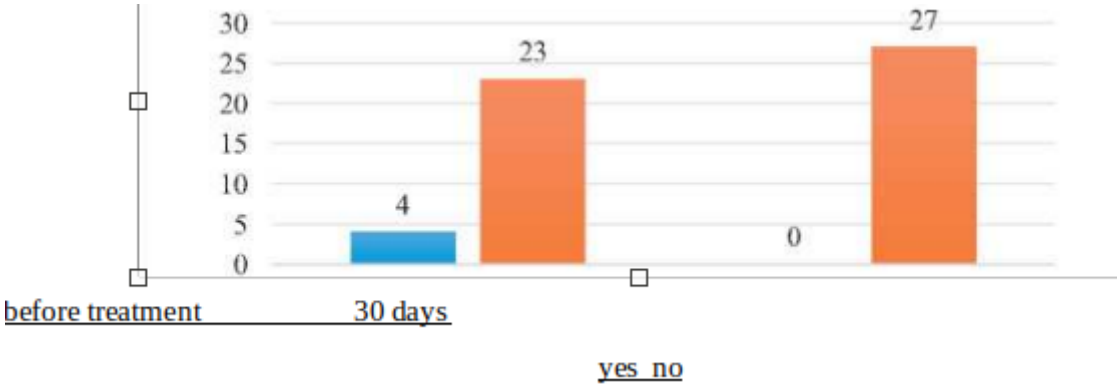


Figure 57. Distribution of patients in the control group according to whether they use incontinence underwear

When surveying the control group of 27 women before and after surgery, we found a 100% agreement with the final treatment outcome for both methods—namely, the complete cessation of using incontinence underwear among patients treated with either method.

5.4.7. Analysis of Patients According to Leaving Home Without a Pad

We reviewed the patients' responses at different stages of treatment regarding their ability to leave home without wearing a pad.

>

7. Do you leave your home without wearing a pad?

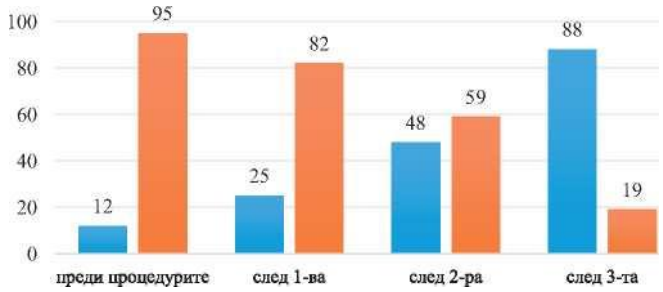


Figure 58. Distribution of patients according to whether they leave their home without wearing a pad.

Daily and continuous use of pads (DP) is considered a factor raising concerns about a woman's ability to maintain urinary continence, as well as a risk factor for developing urogenital infections and allergic reactions. Overall, it negatively affects intimate comfort and quality of life.

Analyzing the responses to this question in our survey, we found the following data: the proportion of women who leave their home without wearing a pad before starting treatment is only 11.2%. After the first CO2 laser procedure, this rises to 23.3%, then progressively increases to 44.8% after the second procedure, reaching a maximum of 82.2% after completing the full course of three procedures.

The trend for women answering "I do not leave home without a pad" shows a decreasing number. Before treatment, 88.7% of women gave this answer; after the first procedure, it decreased to 76.6%, further down to 55.1% after the second procedure, and finally, only 17.7% after completing the full course of three procedures.

The survey results from the control group show the following:

Do you leave home without pad? *30*

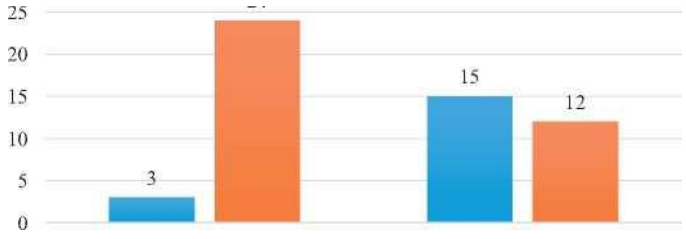


Fig. 59. Distribution of patients from the control group according to whether they leave their homes without assistive devices.

In the group of 27 women who underwent surgical treatment for urinary incontinence (UI), the proportion of those who leave their homes without assistive devices is 55.56%, i.e., slightly more than half. In comparison, among the patients who underwent three CO_2 laser procedures, this share is 82.15%. A general trend can be observed—patients are becoming more confident in leaving their homes without assistive devices following treatment. This tendency is even more pronounced among women who received CO_2 laser therapy, with the effect increasing after each successive procedure.

5.4.8. Analysis of Patients Based on the Influence of Incontinence on Clothing Choice

Does incontinence affect your choice of clothing?

A "Yes" answer refers specifically to the choice between pants/dress/skirt.

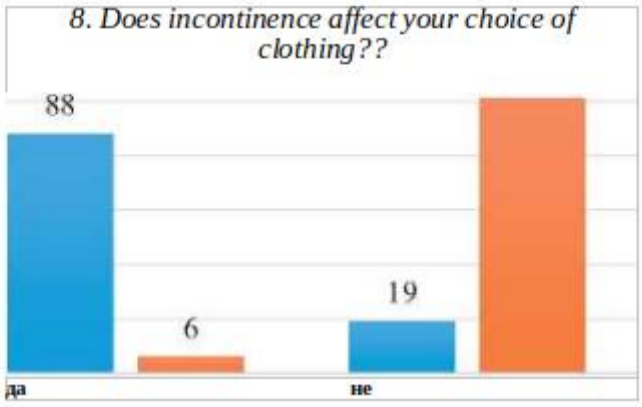


Fig. 60. Distribution of patients according to the impact of urinary incontinence on their choice of clothing

In a survey addressing this specific question, we analyzed patients' responses before treatment and after undergoing three consecutive CO_2 laser vaginal procedures. The data show that, prior to treatment, 82.2% of women reported that urinary incontinence (UI) influenced their choice of clothing. Following the course of CO_2 laser therapy, this percentage significantly decreased to 17.7%.

As for the women who stated that UI did *not* affect their clothing choices, only 5.6% responded "no" before treatment, while this figure rose dramatically to 94.3% after completing the full course of CO_2 laser therapy.

We found that UI has a limiting effect on women's self-expression through clothing choices, which we interpret as a reduction in quality of life. The results suggest an improvement in quality of life following treatment, viewed through the lens of increased freedom in clothing selection. Considering the percentage of patients who no longer have clothing-related concerns post-treatment, we infer that CO_2 laser therapy achieved a high success rate in this group (94.3%).

The results from the survey of the control group show the following:

Data analysis indicates that in 77.78% of women who underwent surgical treatment, concerns regarding clothing choice due to incontinence disappeared. Similar results were observed in the group treated with CO_2 laser therapy, where 94.3% responded "no" to the question "Does incontinence affect your choice of clothing?" after treatment.

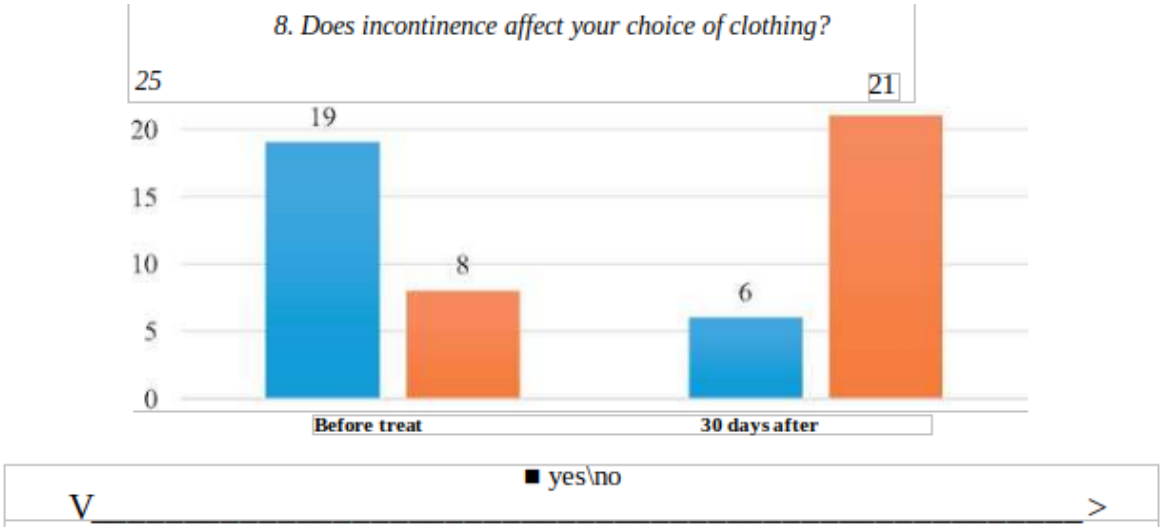


Fig. 61. Distribution of patients from the control group according to the impact of urinary incontinence on their choice of clothing

5.4.9. Analysis of Patients Based on the Influence of Incontinence on the Choice of Color Palette in Clothing
Does incontinence affect your choice of color palette in clothing? If yes, please specify: dark/light.

Fig. 62. Distribution of patients according to their choice of color palette in clothing
To determine whether urinary incontinence (UI) restricts patients' freedom to wear different colors of clothing, the survey included the question: "Does incontinence affect your choice of color palette in clothing? If yes, does this refer to dark or light colors?" We categorize this question among those tracking the quality of life of women.

The analysis shows that 78.5% of the 107 women surveyed before treatment responded that UI influenced their choice of clothing colors, while only 7.4% reported being influenced after completing the full course of treatment.

The proportion of women not influenced by UI in their choice of clothing colors before CO_2 laser treatment was 21.4%, which increased to 91.5% after completing the full treatment course.

We observed a growing percentage of women with freedom in their choices, which we consider an indirect indicator of improved quality of life.

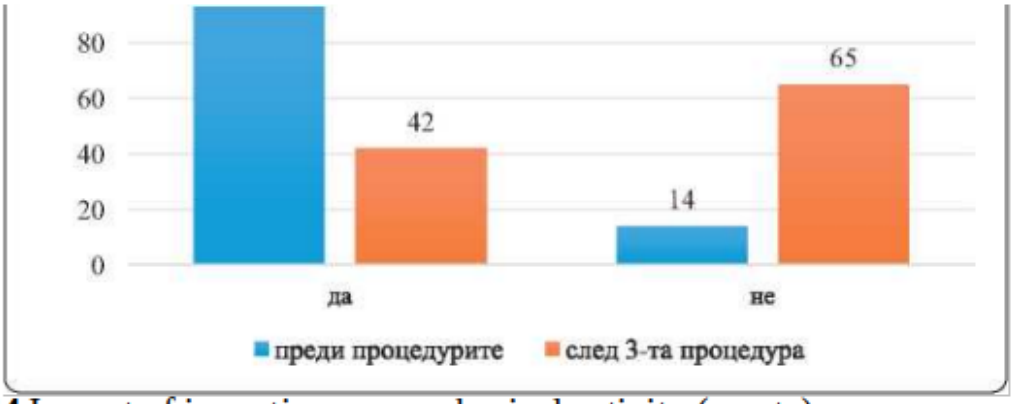
The results from the survey of the control group show the following:

Fig. 63. Distribution of patients in the control group according to their choice of color palette in clothing
The data show that 85.19% of women who underwent surgical treatment for urinary incontinence (UI) have no restrictions or concerns regarding their choice of clothing color. Similar results were observed in the group of women treated with CO_2 laser therapy, where the corresponding share is 91.5%.
With this survey question and the obtained responses, we demonstrate an analogy of the impact of UI treatment on the quality of life of women. The data indirectly indicate an improvement in women's quality of life following UI treatment.

5.4.10. Influence of Incontinence on Patients' Participation in Sports
We asked patients whether incontinence is a reason for not engaging in sports.

9.Does incontinence affect your choice of color palette in clothing?

10. Is incontinence a reason for you not to engage in sports or dancing?



Фиг. 64. Impact of incontinence on physical activity (sports)

We examined whether urinary incontinence (UI) has a restrictive impact on patients' freedom to engage in sports or dancing by asking the following question: "Is incontinence a reason for you not to engage in sports?" This question is also categorized among those assessing women's quality of life.

The analysis shows that 86.9% of the 107 women surveyed before treatment reported that UI affected their ability to participate in sports, while for 13.08%, UI did not influence their participation.

After undergoing the full course of CO_2 laser therapy, 39.2% of women still reported avoiding physical activity due to UI. However, 60.7% stated that UI no longer influenced their decision to engage in sports.

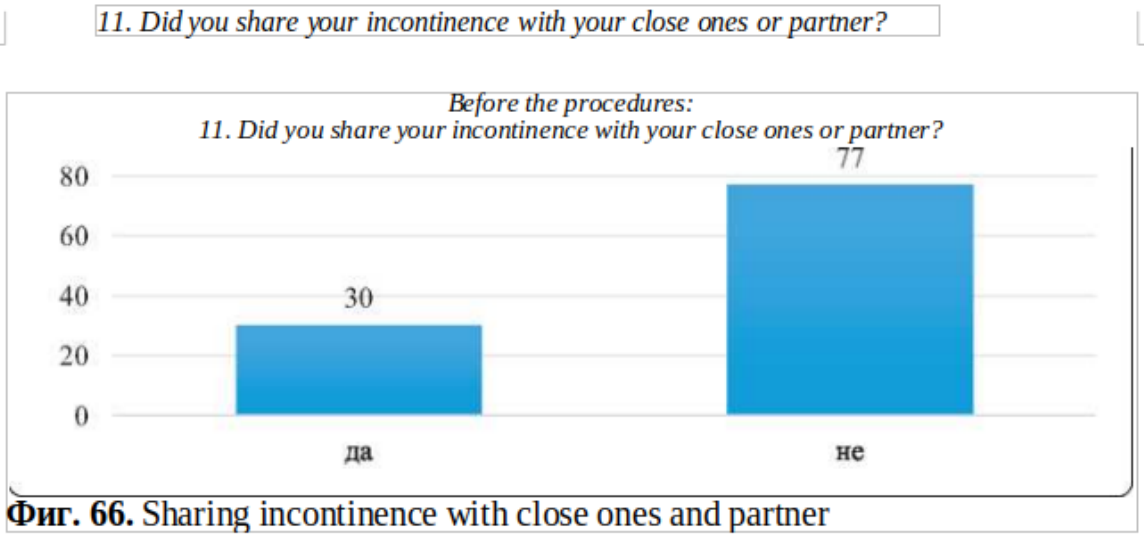
The survey demonstrates that following CO_2 laser therapy, the group of women who feel free to engage in sports or dancing nearly doubled.
This result is also considered an indicator of improved quality of life.

Fig. 65. Impact of incontinence on physical activity in women from the control group
Patients in the control group answered this question both before treatment and 30 days after surgery. The data analysis shows that prior to treatment, 70.37% of women in the control group (n = 27) reported avoiding sports or dancing due to urinary incontinence (UI), similar to 86.92% of the 107 women in the main study group.

When comparing responses after the third CO_2 laser procedure with responses 30 days after surgery in the control group, the following results were observed:
60.7% of women in the study group who received CO_2 laser treatment were no longer influenced by UI in their decision to engage in sports or dancing after the third session. In contrast, this figure was 40.74% in the control group 30 days after surgery.

4.4.11. Analysis of Patients Based on Sharing About UI with Close Ones

To the question “Did you share your incontinence with your close ones or partner?” we received the following responses and analyzed the results.



Фиг. 66. Sharing incontinence with close ones and partner

In clinical practice, women with urinary incontinence (UI) often report feelings of shame regarding their condition. For this reason, we included a question in the survey aimed at assessing whether the issue is kept secret due to embarrassment. The question was: *“Did you share your incontinence with your close ones or partner?”* It was posed to all 107 patients prior to the start of treatment, with the aim of identifying the extent to which the condition is kept private.

We found that 71.9% of participants reported keeping their condition a secret, while only 28.03% had shared the issue. The proportion of women who do not hide their incontinence is nearly three times smaller than those who do.

We associate this result with shame-related behavior, which indirectly reflects a reduction in quality of life for women with UI. For this reason, we categorized this question within the group assessing quality of life.

The results from the control group are as follows:

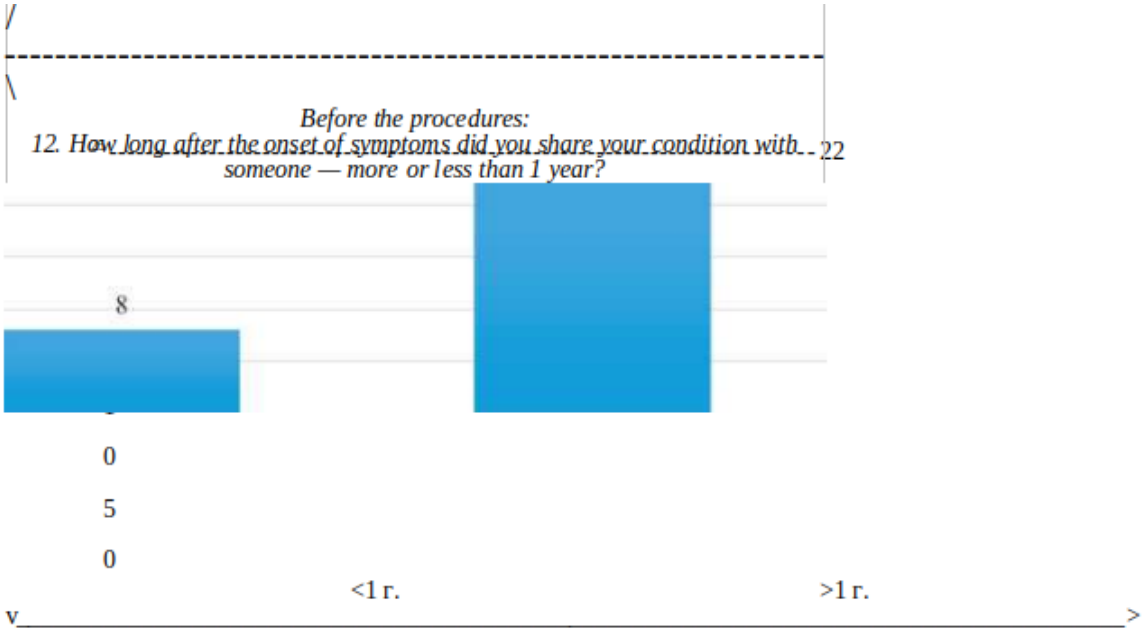
Fig. 67. Sharing incontinence with close ones and partner among the control group

In our control group of 27 women, 51.85% reported that they had shared their problem with their close ones. More than half of the patients in the control group disclosed their condition, unlike the study group of 107 women undergoing CO_2 laser treatment, where only one-third of the participants shared their issue.

Regardless of the type of UI treatment, we demonstrate that the condition leads to a reluctance to discuss the problem and share it with close ones.

5.4.12. Analysis of Patients Based on the Timing of Sharing Their Condition with Close Ones

We analyzed responses to the question: “How long after symptom onset did you share your condition with someone close to you — more or less than one year?

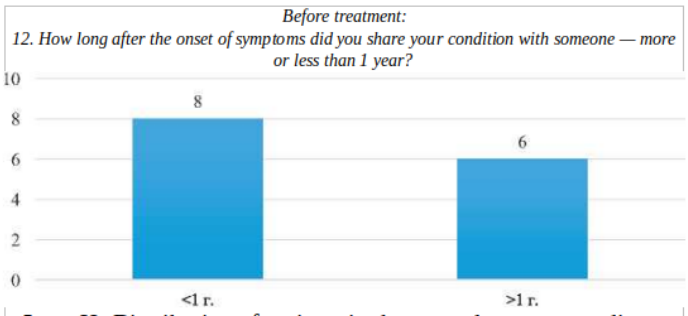


Фиг. 68. Distribution of patients according to how long after symptom onset they shared their condition

We deepened the investigation in this area by asking an additional question to the group of 30 patients who had shared their incontinence with close ones. The question was: “How long after the onset of symptoms did you share your condition with someone close to you?” with response options: “more than 1 year” and “less than 1 year.” This question was asked once before treatment.

We found that out of the 30 patients, 26.6% responded “less than 1 year,” while 73.3% responded “more than 1 year.” The analysis shows that patients often hesitate to talk about urinary incontinence (UI) even with their closest ones and tend to share their condition only after the problem has persisted for at least one year.

The results in the control group are as follows:



Фиг. 69. Distribution of patients in the control group according to how long after symptom onset they shared their condition.

This question was asked only to the women who had shared their problem. In the control group, their number is 14, of whom 8 shared within less than 1 year after the onset of urinary incontinence (UI), and 6 shared more than one year after the symptoms appeared.

The data analysis indicates that the topic is difficult to discuss even with the patients' close relatives. The findings are similar both in the study group of 107 women and in the control group of 26 patients.

5.4.13. Analysis of Results Based on Sharing About the Condition Within the Family Along the Female Line

Have your mother or grandmother shared with you about incontinence?

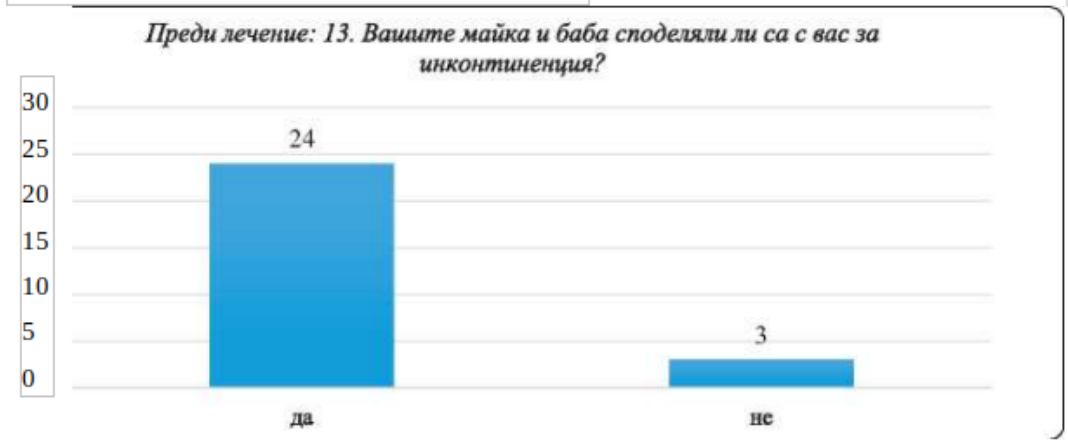
Fig. 70. Number of patients aware of this problem in their mothers and grandmothers

We decided to investigate whether the topic of incontinence is discussed among women within families, considering the possibility that the older generation passes information about UI to the younger one. In our questionnaire, we included the question: "Have your mother and grandmother shared their experiences with incontinence with you?" This was asked before the start of treatment.

The data showed that 78.5% of the respondents are aware of the problem in their mothers and grandmothers. This indicates that the topic is discussed within a close circle and reflects the widespread nature of the issue across different age groups of women. Only 21.45% are not aware of the problem experienced by their mother or grandmother.

We find these results encouraging because when a problem is openly discussed and reaches a wider audience, it is more likely to be resolved more easily.

The results from the control group are as follows::



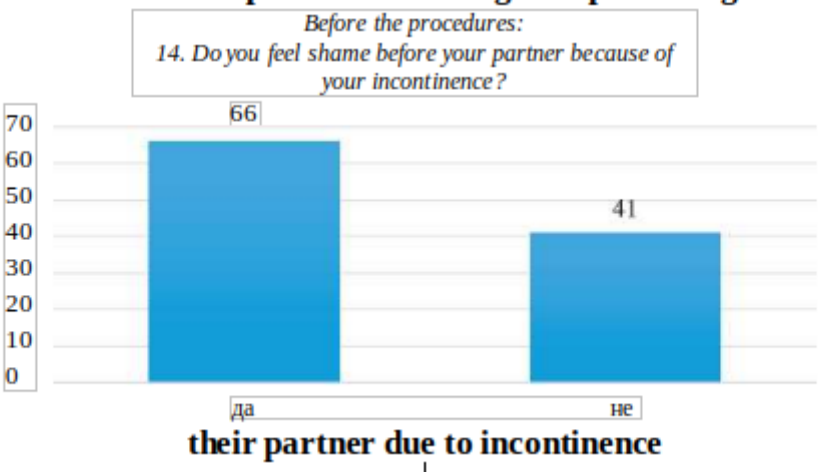
Фиг. 71. Number of patients in the control group aware of this problem in their mothers and grandmothers

The analysis of the data is reciprocal among the surveyed women in the control group. To the question of whether their mothers and grandmothers had shared about "leakage," as many as 88.89% of the participants in the control group responded positively.

5.4.14.Distribution of patients according to experiencing shame before their partner due to incontinence

Do you feel shame before your partner because of your incontinence?

Fig. 72. Distribution of patients according to experiencing shame before their partner due to incontinence



We deepened our investigation regarding patients' feelings of shame by asking the specific question: "Do you feel shame before your partner because of your incontinence?" This question was posed once to all 107 patients before the start of treatment.

We received clear responses. The data show that 61.6% feel shame before their partner due to urinary incontinence (UI), while 38.3% do not feel ashamed of their condition in front of their partner.

We confirmed and demonstrated the presence of shame in women with urinary incontinence. Experiencing shame is considered a factor that worsens the quality of life for these women.

Fig. 73. Distribution of patients in the control group according to experiencing shame before their partner due to incontinence

In the control group, we obtained similar results during data analysis — 77.78% of the surveyed 26 women reported feeling shame. Regardless of the type of treatment for urinary incontinence (UI), the patients experience discomfort discussing the topic and feel shame before their partner.

5.4.15. Analysis of patients according to sharing about their UI treatment with CO2 laser

Distribution of patients according to whether they shared with someone about their treatment with the CO2 laser.

Fig. 74. Distribution of patients according to sharing about their CO2 laser treatment

After completing the procedures for treating stress urinary incontinence (SUI) with CO2 laser, we asked the patients whether they had shared their treatment experience with anyone. The goal was to assess how openly women discuss their condition and the treatment method, especially since we had already established that 61.6% feel shame before their partner due to UI.

The results show that 73.8% of the surveyed women do not share their CO2 laser treatment with anyone, while only 26.1% have shared it with relatives or acquaintances. This confirms that the topic of SUI remains uncomfortable and distressing to discuss, both regarding the condition itself and the treatment methods. Women often conceal their condition, which indicates a strong feeling of shame associated with UI.

This question was included in the group of questions demonstrating that urinary incontinence significantly affects women's quality of life.

Fig. 75. Distribution of patients in the control group according to sharing about their CO2 laser treatment

Data from the control group show that the proportion of women sharing their CO2 laser treatment is significantly lower compared to the study group. Nevertheless, a substantial percentage of patients still keep their therapy information secret, which again highlights the feeling of shame and discomfort related to urinary incontinence and its treatments.

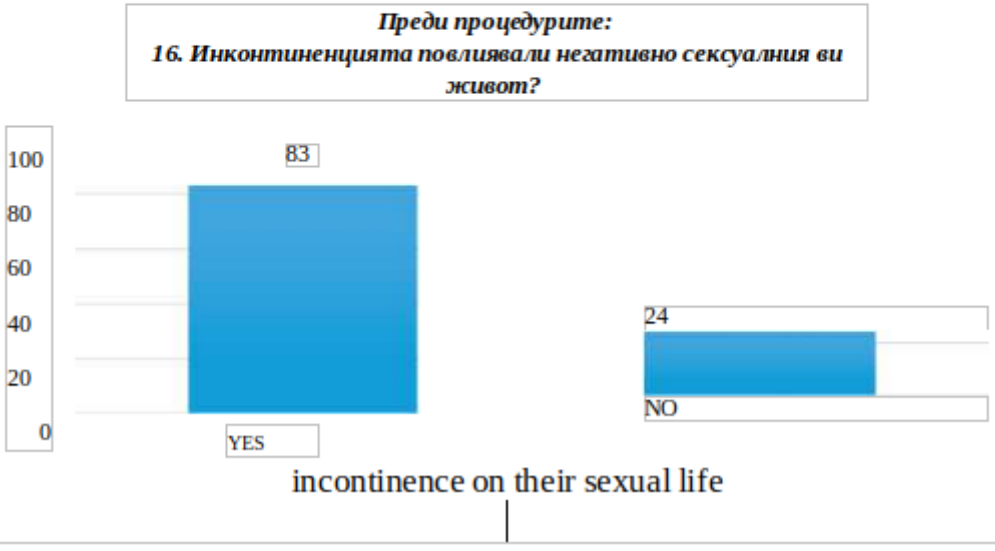
More specific percentages can be added based on available data for a more precise analysis. If you wish, I can help formulate the text including those details.

We deemed it necessary to ask this question also to the control group in order to analyze whether the method of UI treatment affects the likelihood of sharing about the treatment. The data show that 37.04% of the women in the control group share information about their treatment.

5.4.16. 5.4.16. Impact of Incontinence on Patients' Sexual Life

Negative impact of UI on sexual life

Fig. 76. Distribution of patients based on the negative impact of urinary



As part of the group of questions in the survey aimed at demonstrating the impact of stress urinary incontinence (SUI) on quality of life, we included a key question regarding the effect of incontinence on women's sexual life. Patients were surveyed both before and after treatment with the question: **"Does incontinence negatively affect your sexual life?"**

We found that **77.5%** of the participants responded “yes,” indicating that they felt a negative impact of UI on their sexual life, while only **22.4%** reported no such negative effect.

The results from the control group, when asked the same question, were similar. The analysis demonstrates a clear negative influence of urinary incontinence on sexual well-being.

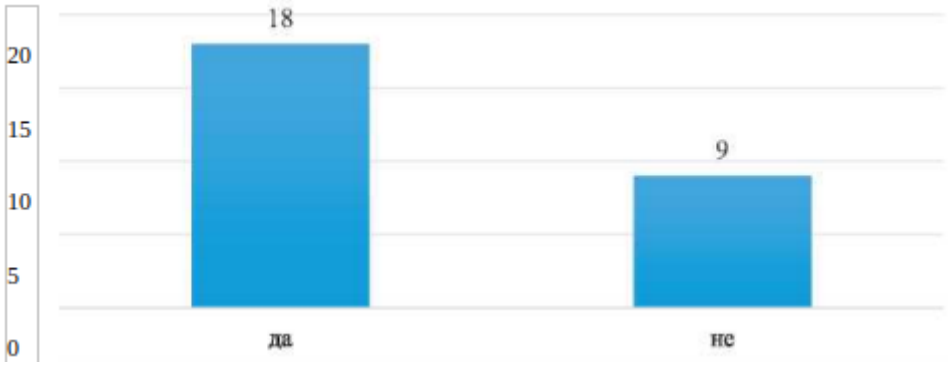


Fig. 77. Distribution of patients in the control group based on the negative impact of urinary incontinence on their sexual life

he sexual life of patients with UI was negatively affected, with **66.67%** of the respondents reporting a negative impact.
This leads us to the conclusion that, regardless of the treatment method chosen by the patients, more than half of them experience impaired sexual life as a result of urinary incontinence.

5.4.17. Has Your Sexual Life Improved After Treatment (CO_2 Laser / Surgical)?

To assess the impact of the therapeutic approach on this aspect of life and on the overall quality of life of the patients, we asked an additional question in both groups.

We found that **91.5%** of the 107 surveyed women treated with CO_2 laser reported an improvement in their sexual life. This indirectly demonstrates an enhancement in quality of life for women undergoing UI treatment with this innovative approach.

We compared these findings with the results from the control group, in which patients underwent surgical treatment.

Fig. 79. Distribution of patients in the control group based on improvement in sexual life after treatment

Following the analysis of the responses from the control group of 27 women who underwent conventional surgical treatment for UI, we found that **only 25.93%** of them reported an improvement in their sexual life after the operation.

Improvement in sexual life was reported by only **25.93%** of the women in the control group following surgical treatment for urinary incontinence (UI). This suggests that although symptom improvement may be present, it does **not correlate strongly with an improvement in quality of life** for this group.

Our conclusion is that regarding the indicator of **sexual quality of life**, **CO_2 laser therapy produces better outcomes**, showing a proportional improvement in both UI symptoms and sexual activity in women.

According to the procedure protocol, **CO_2 laser therapy does not require a significant recovery period**. If a recovery recommendation is to be made, it involves **3 days without sexual activity, vaginal douching, or swimming**. In contrast, **after surgery**, the recommendation is at least **30 days without sexual intercourse**.

We compared the questionnaire results before treatment with those collected after completing a full therapeutic course.

In the post-treatment questionnaire, we again asked all **107 participants** — regardless of their therapeutic outcomes — the same question:
"Does incontinence negatively affect your sexual life?"

After treatment, **only 8 women** reported that stress urinary incontinence (SUI) continued to negatively affect their sexual life, while the **remaining 99 women stated definitively** that they no longer experienced any negative impact on their sexual activity.

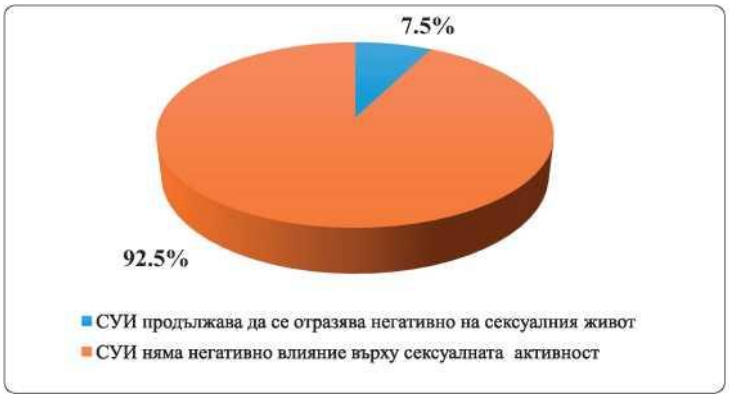


Fig. 80. Percentage distribution of the negative impact of UI on patients' sexual life after CO_2 laser treatment

Thus, the topic of libido is practically addressed here, and it is important to mention that libido is not simply a desire for sex — it is self-esteem, a desire for self-expression, sharing, and affirmation before a partner.

Analyzing the survey data before and after treatment, we found that before treatment, 77.5% of the respondents reported impaired sexual life, while after the therapeutic course, regardless of the achieved treatment effect, only 7.4% stated that urinary incontinence continues to negatively affect this aspect of their lives.

Accordingly, the results are as follows — before treatment, 22.4% of respondents reported no negative impact, whereas after completing the CO_2 laser treatment course, 92.5% reported no negative effect on their sexual life.

5.4.17. Analysis of results regarding the influence on patients' self-esteem

Improvement in the self-esteem of patients with incontinence after treatment with the CO_2 laser is presented in the following Fig. 81.

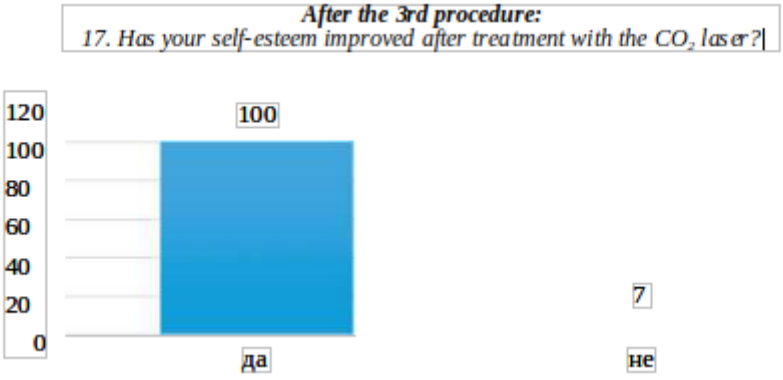


Fig. 81. Distribution of patients according to changes in their self-esteem after treatment with the CO_2 laser

As a factor for patients' quality of life, we considered their overall self-esteem and decided to assess whether treatment with CO_2 laser vaginal procedures affects it. To demonstrate that CO_2 laser treatment for urinary incontinence (UI) in women is not only safe and free of side effects but also enhances their self-esteem, and consequently their quality of life, we surveyed all 107 participants after completing a course of 3 CO_2 laser vaginal procedures, regardless of the achieved results, with the question: “Has your self-esteem improved after treatment with the CO_2 laser?”

The data analysis shows that 93.4% of the women responded positively, stating that their self-esteem improved after treatment with the CO_2 laser.

This proves the direct connection and impact of CO_2 laser treatment on the patients’ quality of life.

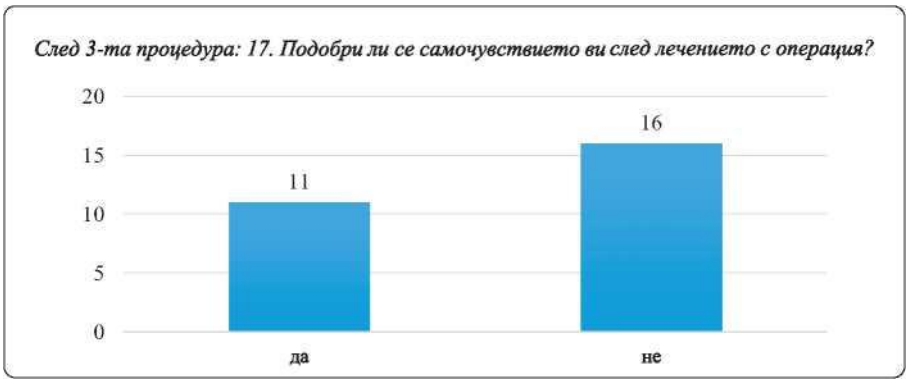
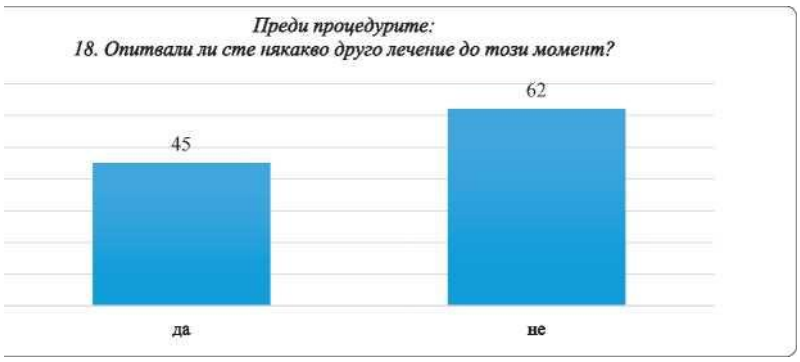


Fig. 82. Distribution of patients in the control group according to changes in their self-esteem after treatment with the CO_2 laser.

We examined the responses in the control group, and the data show that less than half of the women reported an increase in self-esteem after surgical treatment for urinary incontinence — specifically, 40.74%.
Comparative data analysis indicates that women treated with CO_2 laser more frequently report improved self-esteem, unlike patients who underwent surgical treatment.
The improvement in self-esteem among patients treated with the CO_2 laser is an added value of the method overall, along with the improvement of urinary incontinence symptoms.

5.4.18. Distribution of patients according to their experience with other treatments for stress urinary incontinence (SUI)

We asked the question: “Have you tried any other treatment until now?”



We added a question to our survey to obtain information on whether the patients had tried other methods of treating urinary incontinence (UI). This data reflects the patients' general interest in seeking treatment for the problem.
The data show that less than half of the patients—specifically only 42.05%—have tried other treatment methods for UI.
Our analysis of the results suggests that, in general, patients do not wish to share their problem and do not actively seek ways to treat it.
The low level of interest among women regarding treatment confirms the tendency to conceal their condition.

The results in the control group are as follows:

Figure 84. Distribution of patients in the control group according to other treatments tried so far

During the investigation and interpretation of the responses from the women in the control group, we found similar results. The processed information shows that 44.44% of the women (less than half) had tried other treatments for urinary incontinence. This confirmed the data we obtained from the studied group about the low interest in treating UI and the general taboo surrounding the topic.

5.4.19. Analysis of the duration of treatment with CO2 laser

To monitor the success of the treatment and the duration of the therapeutic effects, we followed up with the participants who showed improvement at the 3rd and 6th month after completing the 3rd vaginal CO2 laser procedure.

We asked the question: “Is the therapeutic result from the CO2 vaginal laser treatment for stress urinary incontinence maintained?” three months after the completion of the treatment. Ninety-eight patients were able to participate in the survey, of whom 91 responded that the therapeutic results were maintained at the time of the survey, while the remaining 7 reported that they no longer had the same ability to hold urine as in the first two months after treatment.

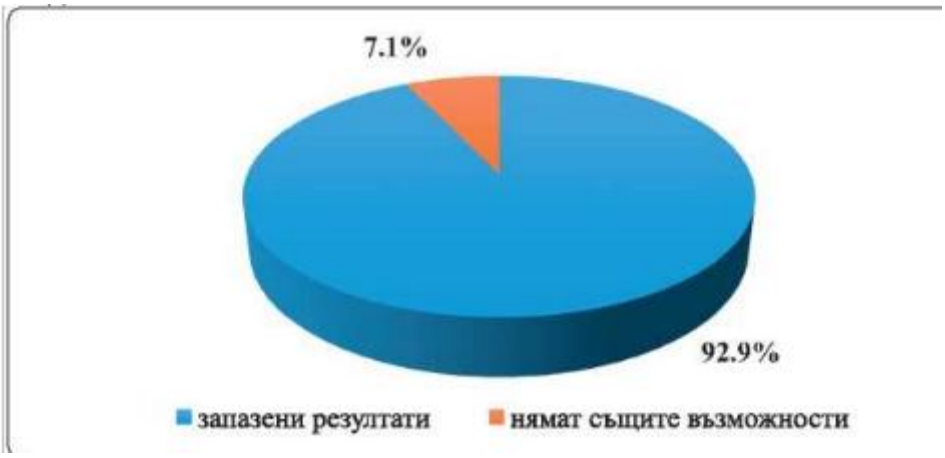


Fig. 85. Percentage distribution of patients according to treatment results with CO2 laser after 3 months

The analysis shows that as many as 92.8% of the surveyed patients experienced effective treatment results at 3 months, which gives us reason to believe that, in general, CO2 laser vaginal treatment for stress urinary incontinence (SUI) provides stable results during the first 3 months after treatment.

We asked the same question — “Is the therapeutic result of CO2 laser vaginal treatment for SUI maintained?” — 6 months after the completion of treatment. The same 98 patients participated in the survey, of whom 87 responded that the therapeutic results were maintained at the time of the survey, identical to the results shortly after treatment, while the remaining 11 reported that they no longer had the same ability to retain urine as during the first 2 months after treatment.

The data indicates that 88.7% of patients in the study maintained treatment results up to 6 months after completion of the CO2 laser therapy.

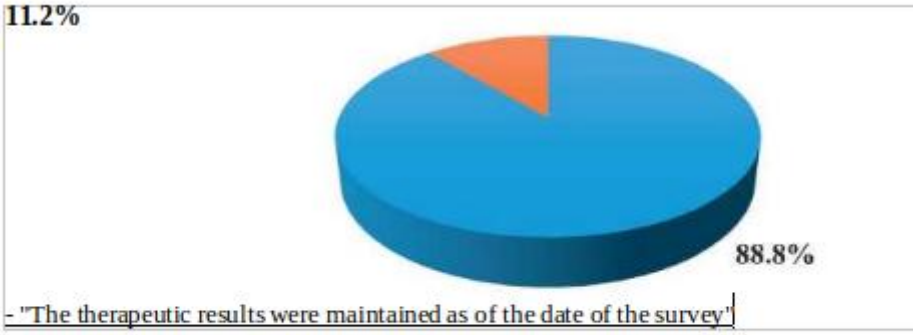


Fig. 66. Percentage distribution of patients according to the results of CO2 laser treatment after 6 months

VI. CONCLUSIONS

1) We demonstrated the safe application of CO2 vaginal laser procedures across all studied age groups with urinary incontinence (UI), achieving symptom improvement in all groups. We identified a correlation between patient age and treatment success with CO2 laser vaginal procedures, establishing age as a key factor in creating a patient profile for successful treatment.
2) We observed a correlation between BMI and treatment efficacy. Data show that treatment effectiveness is highest in patients with normal weight (BMI), which we consider an essential criterion for inclusion in the patient profile to achieve satisfactory and maximal results from CO2 laser treatment.
3) We found that CO2 laser treatment is effective regardless of whether the woman is exposed to stress; however, our study results indicate lower effectiveness of CO2 laser treatment in women exposed to stress, consistent with findings in the control group.
4) We confirmed the applicability of CO2 vaginal laser procedures in patients with previous surgical treatment, with satisfactory success rates and no risk or complications for the patient, similar to women without prior surgical treatment for stress urinary incontinence (SUI).
5) We discovered that overactive bladder is not a contraindication for SUI treatment and does not reduce the effectiveness of SUI treatment with CO2 vaginal laser procedures.
6) We observed a correlation between treatment success and the use of diuretics, establishing this as a factor in the patient profile suitable for SUI treatment with CO2 vaginal laser procedures.
7) We found an interdependence between the presence and severity of cystocele in patients with SUI undergoing CO2 vaginal laser treatment, assessing cystocele presence and severity as key factors and criteria for inclusion in the patient profile.

8) We confirmed that the use of CO2 vaginal laser procedures in outpatient practice for SUI treatment is not only effective and painless but also, most importantly, safe for application—primum non nocere. No severe side effects were reported in the survey compared to the control group, where such effects were registered.

9) Survey results confirmed that treatment effectiveness increases with the number of patient profile criteria met by the woman. Regarding daily urination frequency before and after treatment, the method proved to be as effective as the classic surgical approach.

10) After identifying the impaired lifestyle and quality of life of patients with UI, we demonstrated significant improvement following CO2 laser treatment, tracking its impact on biomedical problems.

11) We confirmed the durability of treatment effectiveness with CO2 laser up to 6 months after the last CO2 vaginal laser procedure.

VII. RECOMMENDATIONS FOR PRACTICE

1. Proper patient selection leads to better therapeutic outcomes from CO2 laser treatment.
2. Use the same frequency and power settings on the CO2 machine for all three procedures, with minimal values—10 mJ energy and 10% density.
3. Maintain the interval between procedures at 4 weeks.
4. In cases of unsatisfactory results after three procedures, CO2 laser treatment can be extended with a 4th and 5th consecutive session, considering the absence of risks and side effects for the patient.

VIII. CONTRIBUTIONS

With a confirmatory character:

1. We confirmed the safety of applying the CO2 laser vaginal procedures across different age groups compared to the classic surgical approach.
2. We established the necessity for objective examination and assessment of cystocele presence and severity in patients starting CO2 laser treatment for urinary incontinence (UI).
3. We affirmed that treatment of UI in the presence of overactive bladder is possible, as it is not a contraindication and does not reduce the success rate of CO2 laser procedures.
4. We proved the safety of outpatient CO2 laser treatment for UI, with no need for any anesthesia.
5. We demonstrated the efficacy of the method and maintenance of achieved results for up to 6 months after the last CO2 laser procedure.

Of original character:

1. For the first time in Bulgaria, a study was conducted on outpatient minimally invasive treatment of stress urinary incontinence (SUI) without the need for anesthesia.
2. Factors influencing the effectiveness of CO2 laser therapy for UI were investigated, leading to the development of a patient profile for successful laser treatment.

3. For the first time in the country, the impact of SUI on quality of life was studied in patients before and after CO2 laser treatment and in patients treated with classic surgical methods.
4. In Bulgaria, this is the first study assessing the success of CO2 laser vaginal procedures for UI treatment in women of different age groups.
5. Therapeutic results were achieved through CO2 laser treatment.

VIII. CONTRIBUTIONS

With confirmatory character:

1. We confirmed the safety of the application of the CO2 laser vaginal procedure method across different age groups compared to the classical surgical approach.
2. We established the necessity for objective examination and assessment of the degree of cystocele in patients beginning CO2 laser treatment for urinary incontinence (UI).
3. We confirmed the possibility of treating UI in the presence of an overactive bladder, which is not a contraindication and does not reduce the success rate of CO2 laser procedures.
4. We proved the safety of CO2 laser treatment for UI in outpatient settings and the lack of need for any anesthesia.
5. We demonstrated the efficacy of the method and the maintenance of achieved effectiveness within 6 months after the last CO2 laser procedure.

With original character:

1. For the first time in Bulgaria, a study was conducted on outpatient minimally invasive treatment of stress urinary incontinence (SUI) without the need for anesthesia.
2. Factors influencing the effectiveness of CO2 laser therapy for UI were investigated for the creation of a patient profile for successful laser treatment.
3. For the first time in the country, the impact of SUI on quality of life was studied in patients before and after treatment with CO2 laser and in patients treated with classical surgical methods.
4. For the first time in Bulgaria, a study on the success rate of CO2 laser vaginal procedures for treating UI in women of different age groups was carried out.
5. Therapeutic results were achieved through CO2 laser treatment in recurrent cases after classical surgical treatment for UI.

IX. SCIENTIFIC PUBLICATIONS AND THE AUTHOR'S PARTICIPATION RELATED TO THE DISSERTATION WORK

Author's Publications

1. Application of CO2 Laser in Outpatient Gynecological Practice
   Darina Davidova, Valentin Irmov
   Black Sea Journal of Medicine and Public Health, ISSN: 2738-8654, Vol. 3, 2023, pp. 47–49

2. Cesarean Section and Stress Urinary Incontinence: Risk and Prevention
   Valentin Irmov, Darina Davidova
   Black Sea Journal of Medicine and Public Health, ISSN: 2738-8654, Vol. 2, 2024, pp. 53–58

3. Observation of the Effectiveness of CO2 Laser in Women with Stress Urinary Incontinence
   Darina Davidova
   Black Sea Journal of Medicine and Public Health, ISSN: 2738-8654, Vol. 2, 2024, pp. 67–71

4. Minimally Invasive Approach in the Treatment of Urinary Incontinence: CO2 Laser Vaginal Treatment
   Darina Davidova, Elis Ismail, Emil Kovachev
   Black Sea Journal of Medicine and Public Health, ISSN: 2738-8654, Vol. 3, 2024, pp. 72–77

5. Urinary Incontinence in Women – Treatment with CO2 Laser
   Darina Davidova, Elis Ismail
   Medical Review, Vol. LXI, 2025, No. 5, pp. 32–37

Conference Presentations

1. Senile Colpitis – An Innovative Treatment Approach
   Darina Davidova, Valentin Irmov
   1st National Conference on Innovations in Obstetrics and Gynecology, Sunny Beach Resort, 25–28 June 2020

2. Observation of the Effectiveness of CO2 Laser in Women with Stress Urinary Incontinence
   Darina Davidova
   4th National Conference on Innovations in Obstetrics and Gynecology, Sunny Beach Resort, 25–28 May 2023

3. Impact of CO2 Laser Treatment on Quality of Life in Women with Stress Urinary Incontinence
   Darina Davidova
   5th National Conference on Innovations in Obstetrics and Gynecology, Sunny Beach Resort, 16–19 May 2024

Clinical Study

The clinical study was conducted at “New Life” – a specialized medical center for gynecology.

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