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Effect of Low Intensity Laser Therapy on Painful Bladder Syndrome

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ABSTRACT
Background: Laser therapy is a developing treatment for painful bladder syndrome (PBS), also known as interstitial cystitis (IC). Two main types of lasers are used for IC/PBS: Erbium:YAG (Er:YAG) lasers and low-level laser therapy (LLLT). More research is needed to determine the long-term effectiveness and safety of laser therapy for IC/PBS.

Objective: This study aimed to determine the effect of low intensity laser therapy (LILT) on painful bladder syndrome.

Subjects and methods: This study included fifty male patients with painful bladder syndrome or interstitial cystitis. They were split into two equal groups: Study group (A) and control group (B). Every patient in the two groups had the same standard physical treatment along with pelvic floor exercises to perform at home. Every patient also received the same prescription drugs and medical attention. For three months, Group (A) got low-intensity laser therapy in addition to conventional physical therapy and medical attention. For three months, the control group (B) only got standard medical care and physical therapy; each treatment session lasted for twenty minutes. The patient was in a comfortable supine posture when the 10-minute LILT application was placed suprapubically, and the patient was in a comfortable prone position when the other 10-minute application was placed beneath the lower back (T10-L1). Visual analogue scale (VAS) measurement and clomipramine medication consumption estimation (CMI) were used.

Results: Results showed a highly significant reduction in VAS and CMI at the end of the treatment program in groups (A) only.

Conclusion: So, LILT was effective in improving the interstitial cystitis/painful bladder syndrome as manifested by the highly significant reduction in VAS and CMI.

Keywords: Interstitial cystitis/painful bladder syndrome, Low intensity laser therapy, Visual analogue scale (VAS), Clomipramine medicament intake.

INTRODUCTION

The characteristics of interstitial cystitis (IC) are what define it because there is a global absence of conventional diagnostic criteria. The phrase "inflammation of the bladder wall" (IC) has undergone changes in both its definition and terminology over time. Urinary symptoms of significantly decreased bladder capacity and cystoscopic discoveries of Hunner's ulcers are the hallmarks of IC, which is sometimes known as the "classic IC" because Messing and Stanley discovered a "non-ulcer IC" in 1978**.** It affects about one million people in the United States. The female to male ratio is less than 9:1, the typical age is between 30 and 50, and the prevalence of IC is higher in the USA than in the UK and Europe. It seems to be more common in Jewish women, 90% of whom are Caucasian, has a low frequency in the Black community, and may also affect younger and older people. Urine frequency (including several midnight voids), urine urgency, and suprapubic pelvic pain associated to bladder filling are the most prevalent symptoms **(1-6)**.

Dyspareunia, or pain during sexual activity, chronic constipation, a sluggish urine stream, food sensitivities that exacerbate symptoms, and radiating pain in the groin, vagina, rectum, or sacrum are associated symptoms. Anxiety, depression, migraines, vulvodynia, fibromyalgia, chronic fatigue syndrome, dysmenorrhea, irritable bowel syndrome (IBS), urethral burning, and pelvic floor dysfunction are co-morbidities that are associated with these conditions **(7,8)**.

While most oral drugs for IC have not been explicitly investigated for individuals with IC/BPS (Bladder pain syndrome), they are typically used "off-label" in this way. Pentosanpolysulfate (Trade name: Elmiron) is the only oral treatment for IC that has received FDA approval. The purpose of this medication is to improve the bladder's glycosaminoglycan (GAG) layer. According to theory, it keeps urine's inflammatory and harmful substances from penetrating the bladder's subepithelial layer. Individuals may not experience the intended impact for up to six months, according to reports **(9,10)**.

The term "light amplification by stimulated emission of radiation" is shortened to "LASER". Einstein proposed this approach in 1917, and it is the foundation for producing collimated, monochromatic, coherent light that has a higher power density and more spectrum purity than any other light source. The emission wavelength of a laser varies from one to the other. It starts at 0.2 μm in the ultraviolet and goes up to 10 μm in the infrared. Since the majority of lasers operate on a limited electron spectral transition, they are typically not as tuneable as radio transmitters. The free-electron laser, vibronic solid-state lasers, and dye lasers are the only ones that don't fall under this category. Depending on the type of gaseous media chosen, certain gas lasers have many fixed wavelengths **(11-13).**

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The technical and physical configuration of laser systems differs, particularly in terms of the emission's temporal properties and constructional design. The laser is merely a light source by itself. To direct the radiation to the tissue to be treated, an end device and a full system comprising a beam transmission system and a way to control the effect are needed. The radiation is transmitted using an articulated arm, a hollow waveguide, a fiber bundle, or a quartz glass fiber, depending on the wavelength. An endoscope, slit light, or surgical microscope with a micromanipulator are a few examples of the end device [14-15].

Under the influence of an externally provided electrical field, the schematic structure of a typical semiconductor laser is illustrated. Positively charged holes are injected from the p-type gailium aluminium arsenide layer down words into a so-called active layer of gailium arsenide. Concurrently, electrons from the gailium aluminum arsenide n-type layer are propelled upward into the active layer. The amount of aluminum present in the gailium aluminium arsenide layers determines the precise quantum energy and wavelength of the photon of light produced by the combination of electron and hole as the excess populations of holes and electrons interact within the active layer. When photons strike the highly polished ends of the semiconductor at an angle, they are reflected back and bounce around within the active layer of gallium arsenide. This process eventually creates an intense photon resonance within the layer, and a portion of the photons escape through one of the polished ends of the semiconductor diode, allowing the device to emit laser light. The photochemical effects of LILT are attributed to modifications in photoacceptor molecules, sometimes referred to as chromophores, which are molecules with the capacity to absorb photonic light and cause cell reactions. There is still much to learn about LILT's precise mode of action. On the other hand, it is well known that photonic energy absorbed by cells during laser irradiation is integrated into chromophores, thereby stimulating cellular metabolism [11, 12, 14, 15, 16, 17].

MATERIAL AND METHODS

Subjects: The study included fifty male patients with painful bladder syndrome. They were selected at random from Cairo University Hospitals' Urology Department, with ages ranging from 30 to 50 years. They were split into two equal groups: one for the study (A) and another for control (B). Every patient in the two groups (A) and (B) had the same standard physical treatment along with pelvic floor exercises to perform at home. Every patient also received the same prescription drugs and medical attention. For three months, group (A) had low intensity laser treatment (LILT) in addition to conventional physical therapy and medical attention. For three months, the control group (B) only received traditional physical therapy and medical care. Each treatment session lasted twenty minutes, and two applications of LILT were administered. The first application, which lasted ten minutes, was placed suprapubically (contact technique) with the patient in a comfortable supine position, and the second, which lasted ten minutes, was placed under the lower back (T10-L1) with the patient in a comfortable prone position [2, 5, 11, 13, 16, 17, 18].

Instrumentation:

- This low intensity laser therapy machine used for LILT, had the following treatment settings: Type of laser: gallium arsenide (Ga-As), wave length: 820 nm, maximum repeat rate: 5 kHz, maximum average power: 5 mW. It has an energy density of up to 50 J/cm^2, a beam spot size of 0.1256 cm^2, and a power density of 0.39 W/cm^2 when safety glasses type 5213693 is worn by both the patient and the physical therapist during treatment [11- 17].

Procedures and Evaluation:

1- **Visual Analogue Scale (VAS):** Visual analogue scale (VAS) was used to measure the amount of pain before treatment (first record) and again after 4 months (second final record). The VAS was a line that was usually 10 cm long and had labels at each end that showed the level of pain from "no pain" to "unbearable pain." The patient was asked to mark the line where he felt the most pain, from "no pain" to "worst pain". Then, the operator used a ruler to measure the distance in centimeters from the "no pain" mark to the end of the line.

2- **Estimation of the Clomipramine Medicament Intake (CMI):** It was used to see how much the interstitial cystitis/painful bladder condition got better. All of the above parameters (VAS and CMI) were tested twice: the first time was before the study began, and the second time was 4 months after the study began [2, 19, 20].

Treatment:

The people who were getting treatment were told to report any side effects that happened during treatment. All of the patients in groups (A) and (B) got the same standard physical therapy and medicines. LILT treatment plan, including where the patient should be placed and where the laser tool should be placed: As part of the treatment, the LILT was used once a day, three times a week for three months. LILT was applied twice a day for 20 minutes each time. One application was placed suprapubically (contact technique) while the patient was lying on their back and feeling comfortable, and the other application was placed under their lower back (T10-L1) while they were lying on prone position and feeling comfortable [2, 11, 12, 16, 17].

Ethical approval: The study was approved by ethical committee of Faculty of physiotherapy, Cairo

University (number P.T.REC/012/004679). Written informed consent was obtained from all participiants.

Data analysis

Before and after the treatment program, VAS and CMI were recorded. The collected data were put into a computer for statistical analysis. For each group, descriptive statistics like mean, standard deviation, minimum, and maximum were found. The t-test was used to see how the mean difference between the two groups before and after the application compared to the mean difference within each group. An alpha number of 0.05 was used to prove that something was important [21, 22].

RESULTS

This study looked at how low intensity laser treatment (LILT) can help people with painful bladder syndrome. For the study group, the mean VAS value before treatment was 9.450 ± 0.55053 degrees and after treatment it was 3.4500 ± 0.50551 degrees, as shown in table (1) and figure (1). The results showed that VAS went down by a very large amount (P < 0.0001). The control group's mean VAS value before treatment was 9.3500 ± 0.537 degrees, and it was 8.9777 ± 0.3522 degrees after treatment. These numbers showed that the VAS level decreased significantly (P < 0.05).

Table (1): Comparison of the mean values of VAS before and after treatment in the two groups in degrees

	Before treatment		After treatment		Mean difference	T.value	P.value
	Mean in degrees	± SD	Mean in degrees	± SD			
Study group (LILT group)	9.450	0.5505	3.4500	0.5055	6.0000	40.14	< 0.0001
Control Group	9.3500	0.5377	8.9770	0.3522	0.37300	2.90	<0.05

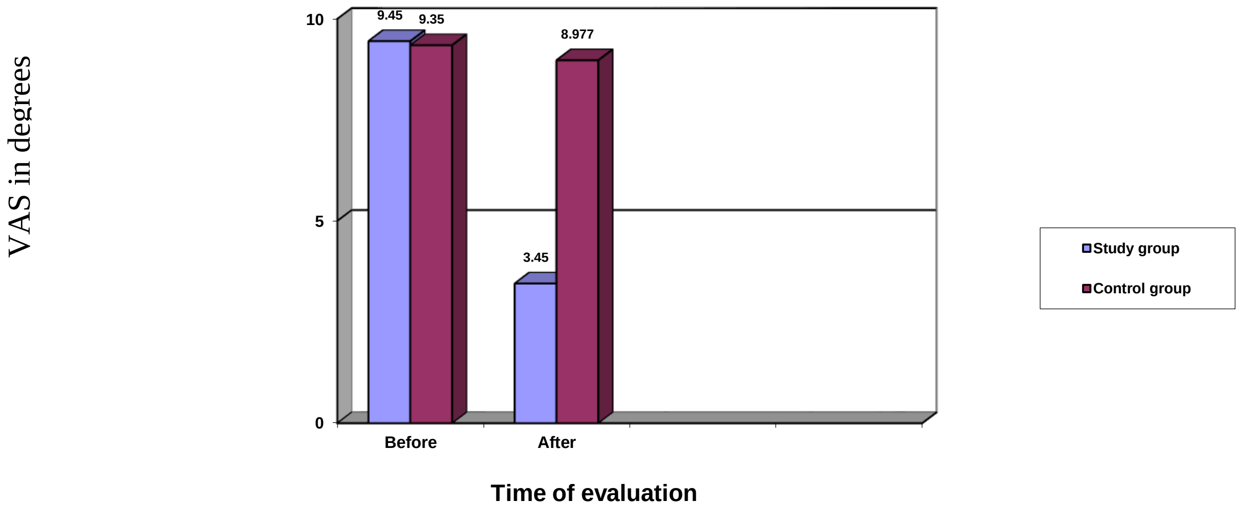

Figure (1): Mean values of the VAS before and after treatment in the two groups.

As shown in table (2) and figure (2), the mean value of CMI before treatment was 67.00 ± 11.45 mg in the study group (LILT group), while after treatment it was 20.00 ±9.33 mg. These results revealed a highly significant reduction in CMI (P < 0.0001). The mean value of CMI before treatment was 66.00 ± 10.902 mg in the control group, while after treatment it was 58.00 ± 11.79 mg. These results revealed only significant decrease in CMI (P < 0.05).

Table (2): Comparison of the mean values of CMI in mg before and after treatment in the two groups

	Before treatment		After treatment		Mean difference	T value	P value
	Mean in mg	± SD	Mean in mg	± SD			
Study group (True TENS group)	67.00	11.45	20.00	9.33	47.0000	15.91	< 0.0001
Control group (False TENS group)	66.00	10.902	58.00	11.79	8.0000	2.49	<0.05

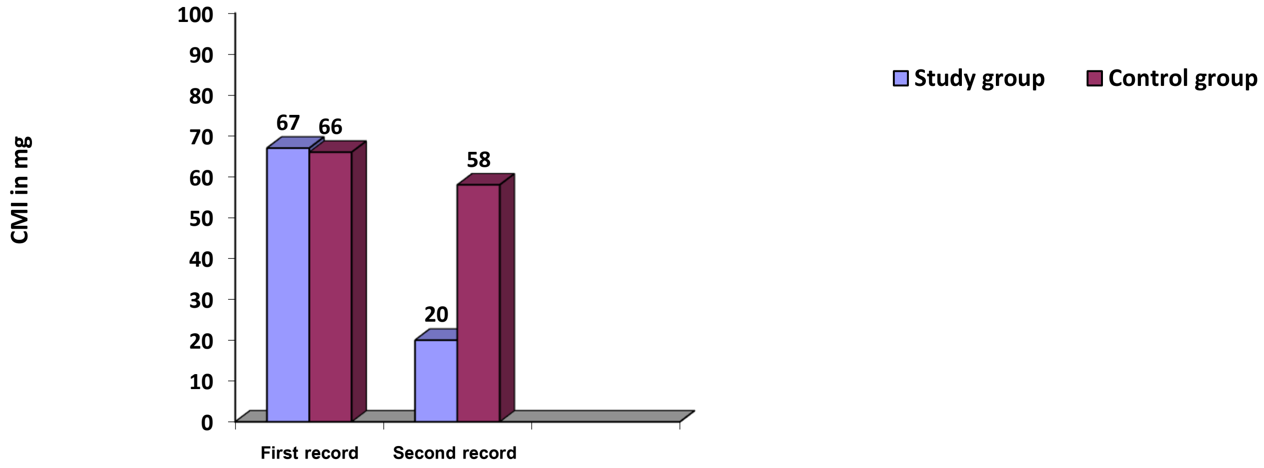

Figure (2): Mean values of the CMI in mg before and after treatment in the two groups.

DISCUSSION

This study looked into what low intensity laser treatment (LILT) can do for people with painful bladder syndrome. Results showed that the mean values of VAS and CMI went down significantly in the study group after the LILT was applied. This showed that the LILT helped improve the painful bladder syndrome.

People in the control group got better because most people with IC and/or any other type of chronic pelvic pain syndrome had a lot of problems with their pelvic floor muscles. It is possible for active trigger points to form when hypertonic muscle failure does. So, the muscles in the pelvic floor can cause pain that won't go away, even if the bladder is aggressively treated for inflammation and activation. It's possible for acute or primary muscle injuries to cause chronic myofascial pain that makes the central nervous system more sensitive. This can lead to chronic pelvic pain conditions. This can then lead to neurogenic cystitis because of the way the antidromic transmission works in the bladder afferents [(23)].

The goal of pelvic floor training is to restore balance in the way the pelvic structures work physiologically. This is done through regular training that relieves the stress that different conditions, including long-term pain, can put on the pelvic floor, leading to reflex contractures. This training works backwards, from the glands that control reflexes to the nervous system. This is how it tries to control reflections backwards [(24)]. This comes in agreement with **Fitzgerald *et al.*** [(25)] and **Cozean** [(26)] found that pelvic floor exercises had a big impact on women with IC/PBS. Eighty-one women took part in this study. Ratings for pain, urgency, and recurrence went down. A study by **Borrego *et al.*** [(27)] showed that biofeedback (BFB) training for the pelvic floor muscles can help women with bladder pain syndrome or interstitial cystitis as an extra treatment. 123 women with IC took part in this controlled study. The study found that working the pelvic floor muscles with BFB makes it more likely that people with BPS/IC will have a better quality of life and less pain.

The mean values of VAS and CMI went down more significantly in the study group. Several things could be to blame for this. Laser therapy has a feature called photo-modulation. It is thought to work by sending photons, which are tiny particles of light, to the tissues. These can have a number of effects on cells. Some of these benefits are lowering inflammation, making pain better, and speeding up the healing of tissues [(28)].

Neuromodulation is another important feature of laser treatment that might help change the way the nervous system works. Laser therapy may help IC patients feel less pain because it can affect how they feel pain by making nerves less sensitive. The epithelium, which lines the outside of the bladder and protects it, is damaged in these people. If there is a leak in the epithelium, pee chemicals may be able to irritate the bladder wall and cause pain [(29)]. This comes in accordance with **Okui *et al.*** [(23)] who found that women with IC and vulvodynia who got laser treatments for their vagina and vulva felt a lot better afterward. 15 women who were patients in the study took part in it. At 6 and 12 months, there were big changes in the vulvodynia test, the average amount of urine passed, and the number of times a day that the person had to go to the bathroom. There was a link between short-term changes in IC pain scores and improvements in the vulvodynia test.

According to guidelines from the American Urological Association in 2022, laser studies show that at follow-up times of up to 23 months, a lot of patients (up to 46%) may need to get treatment again and again to keep their symptoms under control. In real life, this number is probably much higher, especially at longer follow-up times [30].

Our findings are consistent with **Berry *et al.*** [31] who showed that low-level laser treatment worked by showing a big drop in pain scores on the VAS and the amount of clomipramine that people with IC used. People with Hunner ulcers felt less pain than people who did not have Hunner ulcers. 54% of Hunner patients said they had good results or no longer had problems, compared to 26% of non-Hunner patients. A case study by **Sasaki *et al.*** [32] who presented an IC patient who successfully underwent LILT using an 830 nm GaAs laser diode. After 40 sessions of LILT therapy. For six months in a row, symptoms of severe bladder irritation, pelvic pain, urine urgency, and frequency got almost completely better. This study confirms that of **Malloy *et al.*** [33] who used low-level laser treatment (LLLT) in 19 physical therapy sessions spread out over 3 months. People who had IC were able to go back to full-time work and sexual activity with little to no pain. The Short-Form McGill Pain Questionnaire showed that pain had gone down by almost 80%. This means that laser treatment for people with interstitial cystitis should only be given to those who have been identified and have tried and failed other less invasive treatments. Additionally, the laser treatment is very helpful for easing bladder pain when it is used with the right power settings and amount of energy. The treatment is safe and has few side effects.

Consistent with the literature, **Rofeim *et al.*** [34] showed that the great way to treat interstitial cystitis that doesn't involve surgery is laser treatment. Although, it's not a cure, it gives people a chance to have fewer symptoms for a longer time, and it can be done again if needed. Twenty-four people who had interstitial cystitis were looked into. The laser dose was between 15 and 30 watts, and each pulse lasted between one and three seconds. Follow-ups were said to happen every 10 and 23 months. Within two to three days, all of the patients' problems got better. Things did not go wrong. But 11 patients had to go through one to four more treatments because they relapsed. Pain, pressure, and other symptoms were relieved for good in 80 to 100 percent of patients, and nocturia. A study by **Butrick** [35] looked into how the neodymium-YAG laser could help twenty people with severe interstitial cystitis who had not reacted to standard treatments. Within a few days of starting therapy, patients no longer had severe bladder pain or had to go to the bathroom often. The objective study of these patients also found that their bladder capacity had improved overall. The risk of side effects from this type of therapy was very low. After treatment, the patients were watched for 3 to 15 months. So far, none of them had major interstitial cystitis symptoms again, though some had mild voiding symptoms again.

Our results come in contradiction with **Mowafy *et al.*** [36] who reported that transcutaneous electrical nerve stimulation (TENS) was the subject of a study. Thirty people who had bladder pain took part in the study. A total of 16 patients were split evenly between two groups. The treatment group received TENS therapy (four electrodes, two placed suprapubically and two under the lower back - T10-L1), while the control group received physical therapy and a laser. Pain VAS scores and clomipramine use went down, but not significantly, in patients who were not treated with TENS. This disagreement might be because everyone with this disease reacts differently, and it might take some time to find the best mix of treatments for each person.

Limitations: There were some problems with this study that needed to be pointed out. First, there was the variation in how well patients stick to their practice schedules. Also, the sickness was different for each patient because it was hard to pinpoint exact stages. Lastly, there was no way to rule out the possibility that pain is caused by problems with the pelvic floor muscles.

CONCLUSION

It was clear that the LILT helped people with painful bladder syndrome because there was a large drop in both VAS and CMI in the study group (A).

- **Declaration of interest:** The authors report no conflicts of interest.
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