LASER versus Ultrasound in Treatment of Mechanical Low Back Pain

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Abstract: Low back pain (LBP) is musculoskeletal disorder, that are most commonly felt in the back, and are frequently associated with functional limitations. The aim of this study was to compare between the effect of LASER in combination with traditional exercise therapy and the effect of ultrasound in combination with the same traditional exercise therapy in the treatment of mechanical back pain. One hundred and fifty patients with mechanical LBP were randomly assigned to two equal groups. Group (A) received LASER therapy in combination with traditional exercise group. Group (B) received ultrasound therapy n combination with traditional exercise group. Study participants received 24 treatment sessions of LASER or Ultrasound therapy over a period of 8 consecutive weeks. Outcome measures were, a visual analog scale (VAS), and modified Shober's test for spinal range of motion (ROM). There were no significant differences between-group at baseline in VAS and modified shober's test. For LASER group the visual analogue scale values proved reduction in the pain level and increase of the ROM of the spinal column after 4 weeks and 8 weeks of treatment (P= 0.000). After 4-weeks, there was no significant difference between LASER group and ultrasound group in pain reduction (P= 0.312). However, after 8 weeks the reduction of pain of LASER group was significantly higher than ultrasound group (P= 0.003). For ultrasound group the modified Schober's test values proved improvement in ROM of the spinal column after 4 weeks and 8 weeks (P= 0.000). After 4 weeks there was a significant improvement in the ROM of LASER group than ultrasound group (P= 0.042). Moreover, after 8 weeks the improvement of LASER group ROM was significantly higher than ultrasound group (P= 0.000). Participants of both groups diagnosed with mechanical LBP showed greater reduction in pain and improvement in trunk movement. Especially LASER therapy group showed better results than ultrasound therapy group over a period of 8 consecutive weeks.

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1. Introduction

Low back pain (LBP) is a common musculoskeletal disorder that has high prevalence in the general population. It is the most common causes of long term disability in middle age and patients who are affected usually present persistent and frequent symptoms that justifies the use of self-management therapies. Musculoskeletal symptoms are most commonly felt in the back, and are frequently associated with functional limitations [1].

In adults between one-half and three-quarters of the population will experience back pain at some point in their life [2] and it is one of the most commonly treated disorders in outpatient physical therapy practice [3]. Eighty percent of adults seek care at some time for acute low back pain, and one third of all disability costs in the United States are due to low back disorders [4]. Low back pain is a leading cause of disability in the United States. It has a significant economic impact not only on lost productivity but also on healthcare expenditures. Approximately a fifth of patients will see multiple physicians in their quest for relief of low back pain [5].

Considering the overall expenses involved in treating this condition, even with all the advances in modern medicine, there continues to be inconsistent success in the management of mechanical LBP. In response to this fact, many health care professionals including physical therapists, chiropractors and osteopaths are continuously attempting to improve the quality of care for this epidemic condition [6]. A survey showed that physical therapists have generally a positive attitude about evidenced based practice and are interested in improving their skills necessary to implement evidence into their clinical practice [7].

Physical therapy in the form of ultrasound, LASER therapy, manual therapy, interferential current therapy, and aerobic work have been reported often with mixed results [8-10]. Interestingly, a large meta-analysis on low intensity level laser therapy suggested positive effect of various wavelengths on tissue repair and positive overall treatment effect for pain control although the included trails were not specific to LBP [11]. Laser therapy is based on the belief that Laser radiation, and possibly monochromatic light in general, is able to alter cellular and tissue function in a manner dependent on the characteristics of light itself (*e.g.,* Wavelength, coherence) [12]. Therefore, it is assumed that any biological effects are secondary to direct effects of photonic radiation, and are not the result of thermal process [13].

Among physical therapeutic modalities, meta-analysis and systematic reviews suggested that there seemed to be little evidence to support the use of ultrasound therapy in the treatment of musculoskeletal disorders [14]. However, a recent randomized clinical study on nonspecific LBP suggested that ultrasound group had significant better functional status and range of motion (ROM) but not significant different electromyographic findings in comparison with the control group [15]. So, the purpose of this study was to compare between the effect of LASER in combination with traditional exercise therapy and the effect of ultrasound in combination with the same traditional exercise therapy in the treatment of mechanical back pain.

2. Materials and Methods

Subjects

Sample of 150 patients suffering from mechanical low back pain collected from the public and private hospitals, and student of College of Applied Medical Sciences in Taif participated in this study, randomly distributed into two equal groups. Their demographic data are illustrated in Table (I). The exclusive criteria of participants are if the patients had neurological disorders (as lumbar disc prolapse, polyneuropathy, sciatica), developmental, congenital or neuromuscular scoliosis and previous back or abdominal surgeries, also obese patients have been excluded. Prior to participation in the study, participants received an explanation of the study procedures and they provided informed consent to the College of Applied Medical Science, Taif University.

Table I. Demographic data for LASER and Ultrasound groups.

Groups	LASER group, $n = 75$ Mean ± SD	Ultrasound group, $n = 75$ Mean ± SD
Age, years	23.57 ± 9.46	24.72 ± 7.32
Weight, kg	74.76 ± 13.20	78.35 ± 11.97
Height, cm	175.28 ± 6.76	179. 54 ± 5.45

SD: standard deviation.

Procedure

The assessment procedure conducted through the following steps:

1. X- ray investigation:

Antero-posterior (AP) and lateral views of lumbar spine to exclude other pathologies as spondylotic changes, fractures and spondylolithesis.

2. Visual Analogue Scale (VAS):

A Visual Analogue Scale (VAS) is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured. For example, the amount of pain that a patient feels ranges across a continuum from none to an extreme amount of pain.

3. Modified Schober's test:

The ROM and aggravation of pain in different planes of motions registered. Flexion, lateral flexion and extension measured by modified schober method as modified by Moller and Wright [16]. Flexion measured by plotting marks on the lumbosacral junction and ten centimeters above and 5 centimeters below lumbosacral junction. The distance between the upper and lower marks will be measured in standing erect and then on maximal flexion. The difference between the distances represents the ability to flex the spine. Lateral flexion measured by plotting one mark on the iliac crest and the other mark on horizontal line through the xiphoid process on the mid axillary line of the trunk. The distance between the two marks measured in standing and in maximal lateral flexion. The difference between the distances represented the lateral flexion of the spine.

The above clinical examination conducted 3 times; the first evaluation (pre-test) conducted prior to the clinical interventional procedure whether ultrasound or LASER therapy in combination with the traditional exercise therapy. The second evaluation (post-test1) conducted at the end of the 4th week post the clinical interventional procedure whether ultrasound or LASER therapy in combination with the traditional exercise therapy. The third evaluation (post-test2) conducted at the end of the 8th week post the clinical interventional procedure whether ultrasound or LASER therapy in combination with the traditional exercise therapy.

Treatment procedure:

It includes

(A) Laser treatment group; this group received infra-red laser therapy (904 nm) three times per week at the level of low back paravertebral muscles at a power of 1 to 2 J/cm^2; Low-intensity Laser Therapy (LILT). In combination with traditional exercise therapy.

(B) Ultrasound treatment group; this group received ultrasound therapy three times per week at the level of low back paravertebral muscles at a power of 1.5 w/cm^2 at a frequency of 1 MHz, in combination with traditional exercise therapy.

Traditional exercise therapy consisted of; stretching of the back muscles, hamistrings and hip flexors in addition to a graded strengthening exercises of the back and the abdominal muscles within the limit of pain which is repeated 3 times per day in addition to mobilization and stretching exercises.

The exercise program used in this study (according to Liddle *et al.* [17] includes:

A- *Stretching exercises:*

- Knees to chest position from crook lying to stretch the lumbar and hip extensors (without making holding in breathing) for 2 minutes and repeated 3 times each session.
- Fingers to toes exercise from long sitting to stretch short hamstring muscles and back extensors (without making holding in breathing) for 1 minute and repeated 3 times each session.
- General spinal flexibility exercise (from standing to full squatting and maintain squatting for 2 minutes) repeat this exercise for 3 times each session.
- Stretch flexor of the hip joint start with prone lying with support under the chest then prone on elbows (both positions were maintained for 4 minutes).

B- *Strengthening exercises:*

- Bridging to strength back extensors (repeated for 10 times each session with making maintaining bridging for 30 seconds each time).
- Upper back strengthening: active extension from prone lying position with maintaining upper limbs beside the body (repeated for 10 times each session with making maintaining for 30 seconds each time).
- Posterior pelvic tilt exercise to strength the gluteus maximus muscle, abdominal muscles and adductors of the hip (repeated for 10 times each session with making maintaining for 30 seconds each time).
- Sit-ups to strengthen the abdominal muscles (repeated for 10 times each session with making maintaining for 10 seconds each time).

Data analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS version 16). Analysis of variance (ANOVA) was used to investigate the effect of LASER in combination with traditional exercise therapy and the effect of ultrasound in combination with the same traditional exercise therapy in the treatment of mechanical back pain. Level of significance was set at 0.05 for all statistical tests.

3.Results

Descriptive statistics of the two groups (Laser group and Ultrasound group) in the form of means and standard deviation (SD) of visual analogue scale and modified Schober's test for ROM are presented in Table (II) and (Fig.1).

Table 2. Means and standard deviation of VAS and modified schober's test of LASER and Ultrasound groups.

		VAS			Schober's test		
		Pre	Post1	Post2	Pre	Post1	Post2
Laser group (*n*=75)	Mean	6.84	5.53	4.65	4.42	5.47	6.47
	± SD	1.04	0.62	0.67	0.55	0.57	0.61
Ultrasound group (*n*=75)	Mean	6.75	5.67	5.05	4.42	5.25	5.99
	± SD	0.93	0.68	0.80	0.60	0.67	0.81

SD: standard deviation.

For laser group the visual analogue scale values proved reduction in the pain level after 4 weeks (Post1) and 8 weeks (Post2) of treatment (P= 0.000). For ultrasound group the visual analogue scale values proved reduction in pain level after 4 weeks (Post1) and 8 weeks (Post2) of treatment (P= 0.000). After 4 weeks of treatment there was no significant difference between the level of improvement of laser group and ultrasound group (P= 0.312). However, after 8 weeks of treatment the reduction of pain level of laser group was significantly higher than ultrasound group (P= 0.003).

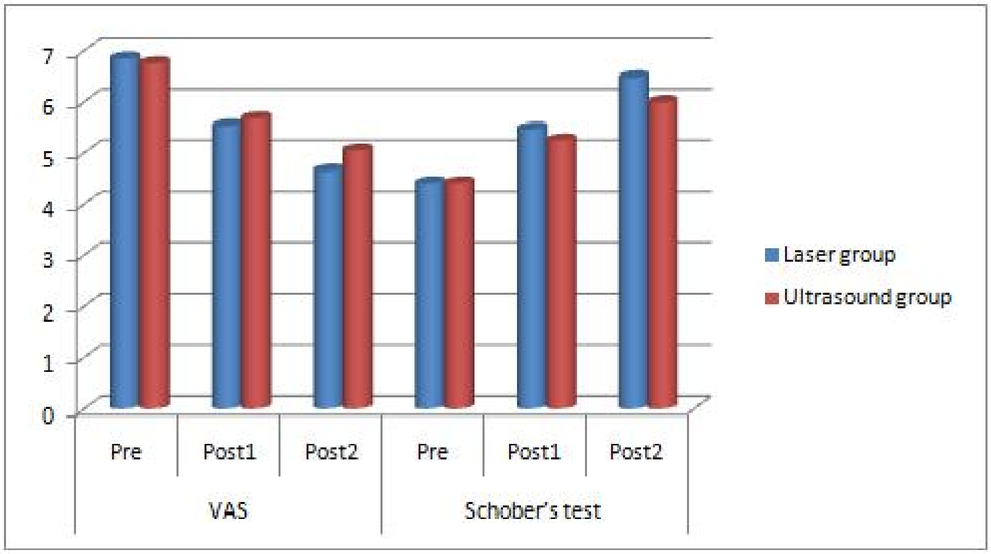

Figure 1. Visual analogue scale and Modified Schober's test of laser and ultrasound groups.

For laser group the modified Schober's test values proved improvement in the ROM of the spinal column after 4 weeks (Post1) and 8 weeks (Post2) of treatment (*P*= 0.000). For ultrasound group the modified Schober's test values proved improvement ROM of the spinal column after 4 weeks (Post1) and 8 weeks (Post2) of treatment (*P*= 0.000). After 4 weeks of treatment there was a significant improvement in the ROM of laser group than ultrasound group (*P*= 0.042). Moreover, after 8 weeks of treatment the improvement of laser group ROM was significantly higher than ultrasound group (*P*= 0.000).

4. Discussion

The present study was conducted to compare between the effect of laser in combination with traditional exercise therapy and the effect of ultrasound in combination with the same traditional exercise therapy in the treatment of mechanical back pain. The group treated with laser showed a greater reduction of pain and an improvement of spinal motion compared with group treated by ultrasound therapy especially after 8 weeks of treatment. Among physical therapy modalities ultrasound and laser showed contrasting findings in treatment of musculoskeletal disorders [11-14,18- 21]. Djavid *et al.* [18] proved that there was no greater effect of laser therapy compared with exercise for any outcome, at either 6 or 12 weeks. There was also no greater effect of laser therapy plus exercise compared with exercise for any outcome at 6 weeks. However, in the laser therapy plus exercise group pain had reduced by 1.8 cm, lumbar range of movement increased by 0.9 cm on the Schober test and by 15 degrees of active flexion, and disability reduced by 9.4 points more than in the exercise group at 12 weeks.

The pathogenesis of mechanical low back pain varied, but the cause of pain is to some extent always inflammation. Theoretically, ultrasound therapy can have a different impact in various diseases and many explanations of the effect of this treatment have been postulated. However, in literature there is neither evidence for such an assumption nor conclusive explanation for how pain is relieved by ultrasound [22]. Contrasting results are shown in literature also for laser therapy [11,18,19, 23]. In fact, some authors suggested that laser with low level without association with exercise could be useful in the management of low back pain [18,19]. Other authors, measuring pain in those receiving laser therapy and in those receiving exercise, did not show any significant differences between the groups in short-term and intermediate term follow-ups, so concluded that there was no significant difference between laser therapy and exercises, the pain was measured by using VAS, that is the cause of designing our study in the form of combination of exercise with laser and ultrasound.

Fiore *et al.* [22] stated that LILT is more beneficial than placebo when applied as a single intervention for patients with low back pain in the short time. The present study after 4 weeks of treatment (12 sessions) the results proved that there was reduction in the pain level and increment in the spinal ROM but no difference between both groups in relation to pain level but the improvement of ROM of group treated with laser in combination with traditional exercises was higher than that of group treated with ultrasound group in combination with traditional exercises. However, after 8 weeks of treatment there was significant reduction in the pain level of the group treated with laser in combination with traditional exercises that the group treated with ultrasound group in combination with traditional exercises. Moreover, after 8 weeks the spinal ROM of the group treated with LASER in combination with traditional exercises was significantly higher than the group treated with ultrasound group in combination with traditional exercises.

So, laser therapy produced improvement level better than ultrasound therapy this may be due to it utilizes a particular waveform with regular peaks of amplitudes elevated value and distant among them to decrease thermal accumulation phenomenon, able to induce in the deep tissue photochemical and photothermal effects that increase blood flow, vascular permeability, cell metabolism, and photomechanical level of tissue [24]. The action of laser developed on nervous terminations with an analgesic effect, whereas there was not an evident diminution of the inflammation [25, 26].

Laser radiation in general produce monochromatic light, that is able to alter cellular and tissue function in a manner dependent on the characteristics of light itself (e.g., Wavelength, coherence) [12] . By definition LILT (often also known “low-energy” or “low-power” laser therapy) takes place at low radiation intensities. Therefore, it is assumed that any biological effects are secondary to direct effects of photonic radiation, and are not the result of thermal process [13]. Written recently, high-intensity laser therapy (HILT), which involves higher-intensity laser radiation and which causes minor and slow light absorption by chromophores, has been used. This absorption is obtained not with concentrated light but with diffuse light in all directions (scattering phenomenon), increasing the mitochondrial oxidative reaction and adenosine triphosphate, RNA, or DNA production (photochemical effects) and resulting in the phenomenon of tissue stimulation (photobiological effects) [27].

The results of the current study are supported by the findings of Saunders [28] who stated that patients with tendinitis of the supraspinatus tendon, the data revealed that the patients treated with LILT had less pain, less secondary weakness, and less tenderness after the treatment than before. However, in another study of patients with shoulder tendonitis, LILT had only a short-term benefit for pain, self-reported function, active ROM, stiffness, and restriction after 2 weeks of treatment when compared with a placebo laser. A recent meta analysis suggested analgesic and tissue repair actions of LILT [11], whereas another study reported that 10 applications of LILT for 2 weeks did not induce significant pain relief and improvements in articular function relative to the findings for a group control given a placebo [29].

Contrasting findings have been reported for ultrasound therapy and laser therapy in the treatment of Subacromial impingement syndrome (SAIS) and other shoulder disorders [30, 31]. There is little evidence that active therapeutic ultrasound is more effective than placebo ultrasound for treating people with soft-tissue disorders of the shoulder, including SAIS [31-33]. Several authors [32, 34, 35] have reported no differences between true ultrasound and sham ultrasound for subjects with soft-tissue disorders of the shoulder that is against the result of current study. Conversely, studies by other researchers have supported the efficacy of ultrasound therapy in reducing pain, improving activities of daily living, and improving quality of life [36, 37]. In particular, Ebenbichler and colleagues [37] reported that 24 daily applications of ultrasound therapy at 2.5 W/cm^2 (5 times per week for 3 weeks and then 3 times per week for 3 weeks) reduced the painful symptoms in patients with calcific tendinitis of the supraspinatus tendon; in addition, the calcium deposits resolved in 19% of patients in the ultrasound therapy group and decreased by at least 50% in 28% of the patients that is support the result of present study.

Limitations of the present study include the lack of a control group receiving no treatment; this limitation constrains our ability to claim cause and effect. Participants in both groups may have improved simply because of the passage of time and the avoidance of strenuous activity for the treatment period. We have compared a new treatment program (LILT and traditional exercise) with an accepted physical therapy modality, ultrasound therapy and traditional exercise. As discussed above, some studies have shown ultrasound therapy to be effective in improving symptoms [36, 37], and functional status in low back pain [15, 38, 39]. The advantage of the current study is the follow-up data and addition of rehabilitation program with exercise of the leg and spine and stretching to reduce the frequency of low back pain that lacked in most of previous studies.

5. Conclusion

Although further studies are needed to confirm the effectiveness of physical therapy interventions for mechanical low back pain, LILT in combination with exercise was shown to have greater benefit for mechanical low back pain than ultrasound therapy in combination with exercise in reducing pain and improving the functional ROM. In spite of both technique reducing the pain and improve the ROM. The results of the present study are encouraging, but other studies with larger samples, longer term findings, and possible comparisons with other conservative interventions or placebo control groups are needed.

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