EFFECT OF EXTRACORPOREAL SHOCK WAVE THERAPY ON CHRONIC MECHANICAL LOW BACK PAIN PATIENTS

Walaa Kh. Fadl¹, Maher A. El Kabalawy², Yasser M. Aneis²
¹Lecturer of Physical Therapy, Ahmed Maher Teaching Hospital, Cairo, Egypt
²Department of basic sciences of physical therapy, faculty of physical therapy, Cairo University, Cairo, Egypt
E mail: walaa_26pt@yahoo.com

ABSTRACT

Background: Mechanical low back pain (MLBP) can limit function and ability in individuals with regard to life and work. Therefore, it is recognized as a critical health problem globally.

Objective: This paper aims to evaluate the effect of extracorporeal shock wave therapy (ESWT) on pain, pressure pain threshold (PPT), range of motion (ROM) and function in chronic mechanical low back pain (CMLBP) patients.

Methods: In this randomized controlled experimental trial, 60 patients complaining from CMLBP, aged 20 to 40 years old, were allocated randomly into two equal groups. Group A, an experimental group that received ESWT in addition to the conventional treatment (Infrared radiation, ultrasound waves, transcutaneous electrical nerve stimulation, and exercise), and group B, a control group that received conventional treatment only. All the patients were evaluated at baseline and after 6 weeks of intervention. The evaluation tools used were the visual analogue scale (VAS), for pain intensity; algometer, for PPT; inclinometer, for lumbar flexion ROM; and Oswestry disability index (ODI), for functional disability.

Results: In the intra-group comparisons, both groups have revealed highly statistically significant improvement (P < 0.01) in pain intensity, PPT, lumbar flexion ROM and functional disability. On the other hand, the intergroup comparisons have revealed that these improvements are significantly higher (P< 0.01) in the ESWT group than in the conventional treatment group.

Conclusion: The application of ESWT combined with the conventional treatment is much better than using the conventional treatment alone to manage CMLBP, in terms of pain intensity, PPT and lumbar flexion ROM.

KEYWORDS: Mechanical low back pain, Extracorporeal shock wave therapy, Pressure pain threshold

I. INTRODUCTION

Low back pain (LBP) is considered as the main cause of disability throughout the world. In addition, it affects the patients’ life quality and puts a considerable financial load on medical care systems [1]. Actually, 80 to 90% of all lower back pain patients suffer from a mechanical pain. This is due to vertebral muscles strain and abnormal stress where the pain is rising from the spinal structures such as bones, joints, discs, ligaments, nerves and meninges [2].

Moreover, mechanical low back pain (MLBP) is a significant health problem. It occurs at least once in 85 % of people younger than 40 years. It affects the lumbar spine and adjacent joints mobility, which leads to marked functional disability [3]. Thus, it is the most common and most expensive cause of work-related disability. Consequently, it occasionally affects the individual’s whole life.
Furthermore, myofascial trigger points (MTrPs) are caused by a muscle fibers overloading or an injury that leads to involuntary muscular shortening and lack of nutrient and oxygen supply with augmented metabolic demand of tissues [4]. There are many conditions linked to MTrPs. However, low back pain is the most important one [5].

Many types of LBP are managed by different therapeutic modalities that are compatible with LBP causes. The first choice treatments frequently used with patients are treatment modalities such as taking rest, assistive aids, electrical stimulation, heat therapy, manual therapy and spinal traction [6]. Additionally, the extracorporeal shock wave therapy (ESWT) has been one of the recent conservative treatments adopted [7]. Therefore, in our study we compare the effect of ESWT against that of the conventional treatment program with regard to managing chronic mechanical low back pain (CMLBP) patients.

ESWT is a therapeutic modality that distributes pressure waves produced outside the body. They can be converged at a particular location within the body to encourage blood vessels regeneration and to induce or restore connective tissues healing process, including bones and tendons. Consequently, it results in relieving pain and functional improvement [8].

Moreover, many different musculoskeletal disorders are treated by ESWT. They include shoulder, calcified tendinitis, lateral epicondylitis, patellar and Achilles tendinopathies, chronic planter fasciitis, femoral head osteonecrosis and non-union and delayed union of fractures [9]. The treatment of the musculature is considered an extension of the indications for ESWT. Furthermore, it has become a considerable area of concern, especially with regard to MTrPs therapy [10].

Despite of ESWT high popularity and recency, only a small number of randomized clinical trials have been found while examining the available literature on the application of it for LBP patients [11]. In addition, most of these trials do not run into the highest standards of Evidence-Based Physiotherapy. Furthermore, only few studies have investigated the effect of shock wave on MTrPs associated with MLBP or on pain, range of motion (ROM) and functional disability [12]. Therefore, this study aims to evaluate the effect of ESWT in the treatment of CMLBP patients. We have hypothesized that ESWT would improve pain, pressure pain threshold (PPT), ROM and function in CMLBP patients.

II. MATERIALS AND METHODS

2.1. Study design

This is a two-arm parallel group randomized controlled trial (RCT) with a repeated measures design of two (group) by two (time). Moreover, data collection occurred from December 2017 to June 2019 at the Physiotherapy Outpatient Clinic in Ahmed Maher Teaching Hospital. Ethical approval was also provided by the Research Ethics Committee of the Faculty of Physical Therapy (No: P.T. REC/012/001722).

2.2. Subjects and allocation of participants

Sixty-four subjects, aged between 20 to 40 years old, were referred to the outpatient clinic. They were diagnosed with CMLBP by an orthopedist or a neurologist. Then, they were chosen to be the participants of the present study. However, during the assessment for eligibility, four subjects were excluded because they did not meet the inclusion criteria as shown in Figure 1. Patients with surgical interventions to the lumbar vertebrae region, spondylosis, disc prolapse, spondylolisthesis, spinal tumor or inflammatory diseases, such as rheumatism, were also excluded from the study. Finally, the consenting subjects were assigned randomly into either the shock wave group or the conventional treatment group at a 1:1 ratio with blocked randomization. Additionally, the randomization was done by a random generator and permuted blocks of the same size.
It is also worth mentioning that the sixty subjects (males: 24 and females: 36) who participated in this study received verbal and written explanation of the purpose of the research. They also signed the consent form (to conduct this study for a total period of six weeks).

2.3. Examinations

In this study, first, the level of pain intensity was assessed by the visual analogue scale (VAS). Second, PPT was determined using an algometer. Third, an inclinometer was used to measure flexion ROM of lumbar spine. Finally, functional disability was measured by the Oswestry Disability Index (ODI). In addition, the assessments were performed twice: at baseline and after 6 weeks of intervention.

Pain

Pain was assessed using the VAS, which is a 10cm calibrated line where a 0 (zero) represents no pain and a 10 represents the most severe pain [13]. First, the examiner illustrated the meaning of the VAS to the patient. Second, the patient was asked to make a mark at the point which represents his pain. Finally, the distance between zero and the mark was measured and recorded.

Pressure pain threshold

PPT was measured using a pressure algometer (Wagner FPN 50 Algometer, Wagner Instruments, Inc. Greenwich, CT). Additionally, measurements were taken prior to and shortly after the intervention to determine the PPT. First, the patient was in prone lying position on an exam table, with his forearms over the sides of the table. Next, the measurement sites were identified during the first measurement (T0) to ensure that the same site was assessed throughout the process, as well as T0 and T1. Then, the evaluator positioned the circular algometer probe perpendicular to the skin and pressed it at a rate of about 1kg/cm2/second. After that, the patient was asked to say "stop" when a pressure feeling turns into an obvious pain feeling. Finally, for every site within the lower back, at intervals of 30 seconds, three measurements were taken. In the data analysis, the mean of 3 measurements was used [14]. We chose the two bilateral sites that we anticipated were connected to LBP. Additionally, these sites were obviously identifiable by anatomical landmarks. The subsequent bilateral sites which have been chosen are:

- Paravertebral muscles (longissimus muscle /erector trunci muscle), 3 cm from the first lumbar vertebra L1 laterally.
- Quadratus lumborum muscle, 5 cm from the third lumbar vertebra L3 laterally [15].

ROM
Lumbar flexion ROM was measured using an inclinometer ((Plurimeter-V; La Conversion, Switzerland)). The measurements were taken in two positions, neutral and maximum flexion. The platform center of the first inclinometer was positioned on T12 spinous process. Furthermore, the second inclinometer was positioned on S1 spinous process. Both inclinometers were zeroed and the lumbar spine motion was read at the flexion and extension extremes directly from the inclinometer scale. The lower inclinometer (sacral flexion) readings were subtracted from those of the upper inclinometer ones (total lumbar flexion) to obtain only the true lumbar flexion [16].

Functional disability
The Oswestry Disability Index (ODI) was used to evaluate each patient’s functional disability. It is a valid and reliable tool [17]. Actually, ODI is a self-administered questionnaire that consists of 10 sections used to evaluate the limitations of different daily living activities. The ODI also includes 1 section on pain and 9 sections on daily living activities (personal care, lifting, walking, sitting, standing, sleeping, sex life, social life and traveling) [18]. Moreover, each section is scored on a scale of 0–5. The greatest disability is represented by score 5. First, the index is calculated by dividing the sum of the patient’s score by the entire potential score. Then, it is multiplied by 100 to be expressed as a percentage. In the end, the highest scoring statement is recorded as a real evidence of disability [19].

2.4. Interventions
In Group A, the subjects received ESWT in addition to the conventional physical therapy program, which consists of infrared radiation IR, ultrasound US wave, transcutaneous electrical nerve stimulation TENS and exercise program. On the other hand, in Group B, the subjects received the conventional program alone. All treatments were applied twice per week for 6 weeks.

Extracorporeal shock wave therapy
The Chattanooga RPW shock wave device (Chattanooga is a brand of DJO LLC in Lake Vista, USA) was used to conduct ESWT. In addition, a continuous shock mode was applied. First, the patients were in a prone lying position. Then, they received 2,000 shock wave impulses with (5 Hz) frequency at 0.10 mJ/mm$^2$ energy flux density using a head of 17 mm [11]. Next, surgical lubricant was placed on the body surface of contact after defining trigger points regions through physical examinations. Finally, the shock wave energy was applied to the bilateral points selected previously (3 cm lateral from lumbar vertebra L1 - 5 cm lateral from lumbar vertebra L3) [15].

Ultrasound waves
The US waves intervention was delivered by using The chattanooga Intelect Transport Ultrasound Unit with a 5 cm$^2$ applicator at 1.2 W/cm$^2$ intensity and 1 MHz frequency in continuous mode for 5 minutes. The conductive gel has been also utilized to improve the absorption of the US waves and produce thermal effects of deep muscle [20].

Transcutaneous electrical nerve stimulation
The patients received the treatment through the Chattanooga Intelect Transport 2-Channel Electrotherapy, which combines continuous high-frequency stimulation (80 Hz) with low-frequency stimulation bursts (2 Hz) every three seconds. On each side of the painful area, four electrodes were placed on the healthy skin. At the beginning of the stimulation, the intensity was increased gradually until the patient reached a painless tingling sensation. This process took 20 minutes [21].

Infrared procedure:
Superficial heating (infrared radiation lamp) at a distance of 60 cm from the lumbar region was applied to the patients for 20 mins. per session. The subjects were in a prone lying position. They received 12 sessions: two sessions per week for six weeks [22].

Exercise program

www.turkjphysiotherrehabil.org
A-Fingers to toes: From long-sitting position, the patient was instructed to touch his toes with his fingers through flexing the trunk while keeping knees extended with 15-second hold, within limits of pain. The exercise was done five times per session, with one-minute rest between each set. It was also carried out two days per week for six weeks [23].

B-Bridging exercise: From crook lying, the patient was instructed to raise his buttocks off the treatment table with six-second hold and repeat this five times in the session, with one-minute rest between each set. Moreover, the exercise was done two days per week for six weeks [23].

C-Back extension from prone position: From prone lying position with arms rested beside the trunk and the palms facing upwards, the patient was instructed to lift his head, shoulders and upper trunk as much as he/she could with six-second hold, within the limits of the pain. This exercise was also done five times per session and twice per week for six weeks [23].

2.5. Statistical Analysis
The data were coded, entered and handled on the computer using the Statistical Packaged for Social Science SPSS for windows, version 18 (SPSS, Inc., Chicago, IL). Additionally, in order to assess the research data, descriptive statistical methods (mean and standard deviation) and the Kolmogorov–Smirnov distribution test, to examine normal distribution, were used. MANOVA was also utilized to compare the test variables of interest in the various tested groups and the measurement periods. At the 95% confidence interval, P < 0.05 significance level, the results were measured.

III. RESULTS

Regarding the baseline characteristics of the patients, no statistically significant difference in terms of age, weight, height and BMI was found between the two groups (P > 0.05), as shown in Table 1.

Table 1. Baseline demographic and clinical characteristics of patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group A Mean ± SD</th>
<th>Group B Mean ± SD</th>
<th>Mean difference</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs.)</td>
<td>34.6 ± 2.98</td>
<td>35.23 ± 3.3</td>
<td>-0.63</td>
<td>-2.26388; .99721</td>
<td>.438 NS</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>69.1 ± 10.63</td>
<td>69±11.01</td>
<td>0.1</td>
<td>-5.25970; 5.45970</td>
<td>.972 NS</td>
</tr>
<tr>
<td>Height (Cm)</td>
<td>165.27 ± 11.01</td>
<td>165.37 ±9.85</td>
<td>-0.1</td>
<td>-5.67515; 5.47515</td>
<td>.971 NS</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>25± 2.18</td>
<td>25.07 ± 2.05</td>
<td>-0.07</td>
<td>-1.30680; 1.17346</td>
<td>.913 NS</td>
</tr>
</tbody>
</table>

SD = standard deviation; CI= confidence interval; NS=non-significant; level of significance at P ≤ 0.05. Yrs. =years; BMI=body mass index

Regarding all the examined variables (pain; pressure pain threshold for the right paravertebral muscles ppt1; pressure pain threshold for the left paravertebral muscles ppt2; pressure pain threshold for the right quadratus lumborum muscle ppt3; pressure pain threshold for left quadratus lumborum muscle ppt4; range of motion ROM; and functional disability), the within-group analysis has revealed a highly significant improvement in both groups relative to baseline (P = .000**), as shown in Table 2&3.

However, the between-group analysis has revealed a highly significant improvement of the "post" test results in group A (shock wave) relative to group B ( control group) (p = .000 **), as shown in Table 4.

Statistical analysis using mixed design MANOVA indicated that there was a significant main effect of group, F (7, 110) = 39.435, p < 0.001, Wilks' Λ = .285. Also, a significant main effect of time, F (7, 110) = 45.476, p < 0.001, Wilks' Λ = .257 and a significant group × time interaction were identified, F (7,110) = 27.127, p < 0.001, Wilks' Λ = .367. These results indicate that the treatment group significantly improved all tested dependent variables from baseline to post-test as compared to the control group.
Table 2. Pain, Ppt, ROM and functional disability pre- and post-intervention for group A

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pre Mean ± SD</th>
<th>Post Mean ± SD</th>
<th>Mean difference</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pain</td>
<td>7.33 ± 1.6</td>
<td>2 ± 1.14</td>
<td>5.33</td>
<td>4.85965 ; 5.80701</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 1</td>
<td>764.33±237.15</td>
<td>1814.3±255.05</td>
<td>-1049.97</td>
<td>-1182.37906 ; -917.62094</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 2</td>
<td>736.80± 264.82</td>
<td>1887.3± 248.36</td>
<td>-1150.5</td>
<td>-1261.46202 ; -1039.60465</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 3</td>
<td>745.67±283.99</td>
<td>1988.5±308.81</td>
<td>-1242.83</td>
<td>-1385.42624 ; -1100.24043</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 4</td>
<td>781.67±276.42</td>
<td>2093.2±539.39</td>
<td>-1311.53</td>
<td>-1507.98632 ; -1115.01368</td>
<td>.000**</td>
</tr>
<tr>
<td>ROM</td>
<td>29.17 ± 7.32</td>
<td>60.67±5.83</td>
<td>-31.5</td>
<td>-35.07453 ; -27.92547</td>
<td>.000**</td>
</tr>
<tr>
<td>Functional disability</td>
<td>50.57±10.87</td>
<td>8.87 ± 5.36</td>
<td>41.7</td>
<td>37.79087 ; -45.60913</td>
<td>.000**</td>
</tr>
</tbody>
</table>

SD = standard deviation; CI= confidence interval; **= highly Significant; level of significance at P ≤ 0.05.
ppt1= pressure pain threshold for the right paravertebral muscles, ppt2 = pressure pain threshold for the left paravertebral muscles, ppt3= pressure pain threshold for the right quadratus lumborum muscle, ppt4 = pressure pain threshold for the left quadratus lumborum muscle, ROM = range of motion.

Table 3. Pain, Ppt, ROM and functional disability pre and post-intervention for group B

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pre Mean ± SD</th>
<th>Post Mean ± SD</th>
<th>Mean difference</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pain</td>
<td>7.37 ± 1.56</td>
<td>6.1 ± 1.73</td>
<td>1.27</td>
<td>.99047 ; 1.54287</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 1</td>
<td>628.33±270.13</td>
<td>776.83±304.12</td>
<td>-148.5</td>
<td>-204.22725 ; -92.77275</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 2</td>
<td>678.33± 233.64</td>
<td>818.73± 282.24</td>
<td>-140.4</td>
<td>-201.80425 ; -78.99575</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 3</td>
<td>708.67± 196.71</td>
<td>831.83± 208.06</td>
<td>-123.16</td>
<td>-156.54167 ; -89.79167</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 4</td>
<td>743.67±235.68</td>
<td>836.07±312.73</td>
<td>-92.4</td>
<td>-136.97158 ; -47.82842</td>
<td>.000**</td>
</tr>
<tr>
<td>ROM</td>
<td>29.33 ± 8.48</td>
<td>35.67±7.85</td>
<td>-6.34</td>
<td>-8.02708 ; -4.63959</td>
<td>.000**</td>
</tr>
<tr>
<td>Functional disability</td>
<td>49.13±10.04</td>
<td>43.07 ± 9.57</td>
<td>6.06</td>
<td>4.57004 ; 7.56329</td>
<td>.000**</td>
</tr>
</tbody>
</table>

SD = standard deviation; CI= confidence interval; **= highly Significant; level of significance at P ≤ 0.05.
ppt1= pressure pain threshold for the right paravertebral muscles, ppt2 = pressure pain threshold for the left paravertebral muscles, ppt3= pressure pain threshold for the right quadratus lumborum muscle, ppt4 = pressure pain threshold for the left quadratus lumborum muscle, ROM = range of motion.

Table 4. Pain, Ppt, ROM and functional disability post-intervention for both groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group A Mean ± SD</th>
<th>Group B Mean ± SD</th>
<th>Mean difference</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pain</td>
<td>2± 1.14</td>
<td>6.1±1.73</td>
<td>-4.1</td>
<td>-4.80270 ; -3.39730</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 1</td>
<td>1814.3±255.05</td>
<td>776.83±04.12</td>
<td>1037.47</td>
<td>866.62369 ; 1208.37631</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 2</td>
<td>1887.3± 248.36</td>
<td>818.73± 82.24</td>
<td>1068.57</td>
<td>920.95812 ; 1216.24188</td>
<td>.000**</td>
</tr>
<tr>
<td>Ppt 3</td>
<td>2088.5±308.8</td>
<td>758.5± 40.84</td>
<td>1330</td>
<td>-1493.43314 ; -1166.56686</td>
<td>.000**</td>
</tr>
<tr>
<td></td>
<td>Ppt 4</td>
<td>ROM</td>
<td>Functional disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>-----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2189.83 ± 542.1</td>
<td>60.67±5.83</td>
<td>8.87 ± 5.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>772.73±298.12</td>
<td>35.67 ± 7.85</td>
<td>43.07 ± 9.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1417</td>
<td>25</td>
<td>-34.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1167.13056 ; 1667.06944</td>
<td>22.14105 ; 27.85895</td>
<td>-37.95384 ; -30.44616</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SD = standard deviation; CI= confidence interval; **= highly Significant; level of significance at $P \leq 0.05$.

**ppt1** = pressure pain threshold for the right paravertebral muscles, **ppt2** = pressure pain threshold for the left paravertebral muscles, **ppt3** = pressure pain threshold for the right quadratus lumborum muscle, **ppt4** = pressure pain threshold for the left quadratus lumborum muscle, **ROM** = range of motion.

### IV. DISCUSSION

In many cases, CMLBP has caused discomfort and disturbance in daily life, making conservative therapy ineffective. As a result, searching for alternative treatment modalities has become inevitable [12]. The objective of this study is to evaluate the effectiveness of ESWT on (pain intensity, PPT, improving lumbar flexion ROM and functional disability) in CMLBP patients. This is done through comparing it to the effects of the conventional treatment program used with those patients.

The within-group comparisons show that there have been highly significant decreases in pain and functional disability. Moreover, highly significant increases in PPT and lumbar flexion ROM have occurred in the shock wave group and the control group after intervention completion. The between-group comparison also shows that these improvements have been larger in the shock wave group than in the control group. Furthermore, the findings of the present study point out that the decreases in the VAS scores have happened due to the analgesic effects of ESWT, which are superior to the conventional modalities.

In addition, the highly significant pain improvement caused by the shock wave in this study can be explained by Harniman et al. [24]. They have found that ESWT shock waves are reflected or refracted by tissues with various acoustic impedances; and this kinetic energy can cause changes within the tissues. The shock waves in the neuron membrane can also cause reversible damage or improve permeability. The analgesic effects of ESWT can be explained by that mechanism. Improved blood circulation and levels of hydroxyproline have been also noticed at the application places, which have accelerated cell regeneration [25].

Additionally, the highly significant improvement of PPT by the shock wave can be explained by Gür et al. [26]; they have concluded that ESWT, through restoring normal vascularization, can break the vicious cycle of pain-spasm-ischemia-pain. They have also suggested that these changes in the TrPs may lead to decreased pain scores. Besides, the influence of ESWT on the process of inflammation, activation of tissue regeneration and reduction of neuropeptide may have contributed to the patients’ clinical improvement.

Regarding the improvement in lumbar flexion ROM, the relationship between TrPs and joint hypomobility has been discussed in several theories. Maybe that muscle shortening and the increased tension of the taut muscular bands caused by TrPs in addition to facilitation of motor activity maintain and/or aggravate abnormal joint tension that causes joint dysfunction in the vertebralae decussated with these muscles. Another explanation would be that TrPs are reflexively activated by an abnormal sensory input from joint hypomobility [27]. This theory has been proved by Lowe [28]; who has discovered that joint dysfunction could enhance the respond of the motor neurons of the adjacent muscles to TrPs nociceptive input. Moreover, according to Lowe, it is thought that the muscle TrPs can provide the dorsal horn neurons with a nociceptive barrage and, thus, facilitate segmental hypomobility.

All the patients in our study have shown a highly significant decrease in functional disability after 6 weeks of ESWT application, with regard to reducing the pain, decreasing MTrPs numbers and increasing ROM. Actually, Sejun et al. [29] have documented that the decreasing of muscle spasms may be caused by MTrPs relaxation and normalization of disability-related movements. As a result, physical functions significantly improve after the release of MTrP.
In addition, our findings are supported by Hyeonjee et al. [12]. They have found that ESWT relieves chronic low back pain. Consequently, it enhances the physical functions of the patients and their ability to perform activities of daily living. It also leads to considerable reductions in the indexes of low back pain disability.

Moreover, our results come in consistent with the results found by Notarnicola et al. [30] They performed a randomized clinical trial in which LBP-affected patients were managed by focused shock waves (the shock wave group) or a standard rehabilitative exercise protocol (the control group). At weeks 4 and 12, the patients in the shock wave therapy group exhibited a significant improvement in pain and functional ability when compared to the patients of the control group.

The findings of Han et al. [31] study come in agreement with our findings since the patients in their study also received standard physical therapy and shock wave procedures. At the end of the study, the pain decreased and the functional status improved in both groups. These results were significantly better in the shock wave group than in the control group (p<0.01).

Additionally, our conclusions are relevant to those of the study by Moon et al. [32] where they treated patients with LBP. Slightly stronger shock waves (0.2 ml/mm2) were used in one group, in comparison to our study. However, the other parameters were similar to those used by us and they should be pointed out when referring to the placebo group. In the ESWT group, pain decreased significantly at post-treatment compared to baseline. Moreover, ODI improved. They also emphasized the high efficiency of shock waves in LBP therapy, which is in line with our findings.

On the other hand, our findings come in disagreement with Ioppolo et al. [33] who stated that clear mechanism of therapeutic effect of ESWT is unknown. They added that the different biological effects of either focused and radial ESWT or their clinical results in different cases have remained incompatible. On the contrary, the majority of the published papers have revealed beneficial and positive effects of using ESWT as a treatment for different musculoskeletal disorders. Furthermore, they provided hugely successful results, without or with rare complications. However, any inefficacy may be related to indefinite objective diagnostic criteria, inconsistency of the enrolled patients and unclear SWT parameters such as focal depth, number and intensity of impulses.

The results of this study are contradicted with Walewicz et al. [34] who found that the strongest impact of ESWT occurs in the long term when it is used to treat LBP. Moreover, without abrupt relapse, this treatment achieves a beneficial, stable impact compared to the conventional treatment. However, the pain relief which follows using ESWT is not successful based on treatment in the short term; and the outcomes are even worse when compared to that of the conventional treatment. This could indicate that ESWT does not exhibit any noticeable pain reduction outcomes directly after the treatment period is completed. The weakness of Walewicz et al.’s study may be due to the small sample size, imprecise measuring tools and insufficient treatment period in short-term results. In contrast, in the present study, the sample size is larger, more precise measuring tools are used and the treatment period was more sufficient.

Limitations
The potential limitation of this trial may be related to a lack of blinding, lack of a placebo group and lack of follow-up. Hence, the long-term effects of ESWT were not reported.

V. CONCLUSION
This study demonstrates that the application of ESWT to MLBP patients has lead to significant improvement in pain, PPT, ROM and functional disability after six weeks of intervention in comparison to applying the conventional treatment alone.

Acknowledgment
The authors express their gratitude to all the patients who participated in the study.

Disclosure statement
No author has any financial interest or has earned any financial benefit from this research.

Conflict of interest

www.turkjphysiotherrehabil.org
The authors state no conflict of interest.

REFERENCES


