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Examining the Effectiveness of Low-Level Laser Treatment Applied to the Upper Back Region in Individuals with Myofascial Pain Syndrome

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Abstract

BACKGROUND/AIMS: The aim of this research was to examine the effects of the low-level laser therapy (LLLT) application on pain, emotional state, disability, and range of motion (ROM) in myofascial pain syndrome (MPS).

MATERIALS AND METHODS: Sixty patients diagnosed with MPS and randomly divided into treatment and control groups were included in this study. The study group was given LLLT applications at four points on the upper trapezius, while the control group received placebo LLLT. Pain was evaluated using a visual analogue scale, neck ROM using an inclinometer, pain pressure thresholds using an algometer, emotional state using the Beck Depression Inventory, and disability using the Neck Pain and Disability Scale. The effectiveness of the treatment was evaluated by comparing the pre-treatment, post-treatment and first-month results in each group.

RESULTS: The mean ages were 40.4±8.58 years in the treatment group and 37.6±8.88 years in the control group. A significant decrease was observed in the treatment group in terms of pain at the end of treatment and at the first month ($p=0.040$). Similarly, improvement was observed in both groups in terms of emotional state and disability at the conclusion of treatment and at the first month ($p=0.492$, $p=0.497$). In terms of neck ROM, marked improvement compared to the control group was only observed in left lateral flexion measurements at the conclusion of treatment and at the first month ($p=0.010$). Improvements in pain pressure thresholds were significant in both groups ($p<0.05$).

CONCLUSION: The LLLT application exhibited more positive effects than the placebo in MPS patients.

Keywords: Laser, myofascial pain syndrome, trigger point, trapezius

INTRODUCTION

Myofascial pain syndrome (MPS) is a musculo-skeletal disease with trigger points in at least one muscle or connective tissue and progressing with symptoms such as pain, spasms, sensitivity, movement restriction, weakness, and rarely autonomic dysfunction.[1,2] Although factors such as macro and micro trauma, muscle hypercontraction, physical fatigue, psychological stress, and genetic factors have been proposed, the etiology of MPS is still unclear and it has not been attributed to a single factor.[3] Pain, the most pronounced symptom, may be mild or unbearable, sharp or blunt, and continuous or periodic. Trigger points are decisive in this context and are directly proportional to the level of sensitivity and spread.[4] The upper back region is mostly affected in terms of increased trigger points. It is very common in the M. trapezius. Therefore, patients with MPS suffer from pain pressure sensitivity in this region.[5]

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The basic aims in the treatment of MPS are to ameliorate the pain, increase muscle strength, and achieve a full range of motion (ROM) and the appropriate posture of the joint associated with the affected muscle.[6] In addition, since MPS also adversely affects the individual's emotional state and disability status, it is important for treatment to yield psychosocial benefits as well. Studies have reported a higher risk of depression in individuals diagnosed with MPS than in healthy individuals. The relationship between depression level and pain severity is also noteworthy.[7] Since pain leads to restrictions in functional activities, neck disability increases in parallel with the duration of MPS.[8]

Therapeutic methods in MPS include lifestyle modification, medications, stretching exercises, acupuncture, injections, manual therapy, ultrasound, low-level laser therapy (LLLT) applications, electrical stimulation, transcutaneous electrical nerve stimulation (TENS), mesotherapy, massage therapy, and biofeedback.[9,10] Significant progress has been made in the diagnosis and treatment of MPS in recent years. However, no agreed disease management protocol has yet emerged.[11] Light amplification by stimulated emission of radiation (LASER) therapy is a reliable physical therapeutic agent which has been employed for many years. Since the therapeutic LLLT dosage increases tissue temperature by less than 0.5 °C, its effects are not thought to be due to warming alone. Various attempts have been made to explain the analgesic effects of LLLT.[12] Another therapeutic LASER application is the high-intensity laser therapy (HILT) application which is commonly used in the therapeutic protocols of physiotherapy. The main difference between HILT and LLLT is that the more powerful beams (power >500 mW) are irradiated to penetrate deeper, bringing the desired high amount of multi-directional energy to the deep tissues in a short time.[13] Determining the effectiveness of LLLT in MPS and its biopsychosocial effects will make a significant contribution to the existing literature.

The primary aim of this study was to investigate the impacts of LLLT on reducing pain intensity and disability, and on increasing neck ROM and the emotional state in those patients diagnosed with MPS.

MATERIALS AND METHODS

This study was performed with 60 patients (51 women, and nine men) presenting at the Marmara University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Türkiye. Patients aged 18-50 years and diagnosed with MPS who had pain in their upper back region were enrolled in this study. A total of 4 points were applied. The points which were bilateral and the most painful were selected. When the selected trigger points were palpated, explosive and spontaneous pain occurred. Those patients diagnosed with fibromyalgia syndrome based on ACR criteria, with cervical disc lesion, cervical radiculopathy, or myelopathy, those who had undergone neck or shoulder surgery within the year prior to this study, those using drugs due to psychological problems and pregnant women were excluded from this study (Supplementary Figure 1).

This study was approved by the Ethics Committee of Marmara University Faculty of Medicine (approval number: MAR-YÇ-2007-0214, date: 30.11.2007).

The patient who consented to take part in this study were informed about the research aims and methodology. Written consent was received from all the individuals taking part. The participants' sociodemographic characteristics (sex, body weight, and height) were recorded (Table 1). Data were collected using a visual analogue scale (VAS), the Beck Depression Inventory (BDI), and the Neck Pain and Disability Scale. Joint neck ROM and pain pressure thresholds were also measured.

Study Design/Procedure

Evaluations were performed at the beginning and conclusion of the treatment, and again four weeks following the completion of the treatment. The patients received 10 treatment sessions, five times a week for two weeks. The Ga-Al-As laser, which emits a continuous beam of 830 nm with a power density of 0.9 Joule/cm^2 for 30 seconds, in full contact, at right angles to four points on the upper trapezius in the neck region, was applied to the treatment group for 20 minutes, together with a hot pack for 20 minutes, timed TENS, and stretching exercises. The control group received a placebo laser for 20 minutes, a hot pack for 20 minutes, TENS, and stretching exercises. The placebo laser was applied when machine was turned off. However, the patient believed it was turned on. A home exercise program was designed as three sets of 20 repetitions each and it included isometric neck exercises and joint neck ROM exercises. Each patient was shown the exercise program and asked to apply it every day for a period of one month. The study subjects did not use any analgesics.

Outcome Measurements

Visual analog scale: It measures the intensity of pain. It consists of a 10 cm horizontal line with zero indicating "no pain" and ten indicating "unbearable pain".[14]

Neck range of motion measurement: Measurements were performed using a Chattanooga Baseline Bubble inclinometer. Neck flexion, extension, bidirectional lateral flexion, and rotation were measured using an inclinometer. Flexion was measured with the patient in a seated position and with the inclinometer on the apex of the head in the sagittal plane. The inclinometer was zeroed with the patient's head facing forward. The patient was asked to incline their neck forward without using the trunk, and the value shown on the inclinometer was recorded. Neck extension was performed in the same position, with the patient being asked to lower their head backward. Lateral flexion was also measured with the patient in a sitting position. The inclinometer was installed in the coronal plane. The patient was asked to bring his ear to his shoulder, and the value shown on the inclinometer was recorded. The patient was placed in the supine position for rotation measurements. A thin towel was place beneath the head to keep it central. The inclinometer was placed on the patient's forehead in the transverse plane. The patient was asked to turn their head in both directions, and the value on the inclinometer was recorded.[15]

Pain pressure threshold measurement: Measurements were taken using a pressure algometer. This semi-quantitative method is employed for assessing pressure pain sensitivity in tissues and for locating abnormal sensitivity in sensitive areas, trigger points, muscles, and bones. Pain pressure thresholds were determined using the algometer. The Wagner Instruments (Greenwich, CT, USA) brand pressure algometer used in this study consisted of a metal piston with a 1 cm^2 round disc attached to a dial used to measure pressure in both kilograms and pounds. The operator can hold the dial and apply it to the desired part of the body. The dial was calibrated up to 2.5 kg at 25 g intervals. The pressure resulting from the dial being continually pressed against the skin causes the dial hand to move in a clockwise direction. When the device is removed, the needle continues to point to the last measured

Table 1. Sociodemographic data

Features		Study group, (n=30)	Control group, (n=30)	p
Gender	Female	26	25	1
	Male	4	5	
Marital status	Married	26	20	0.125
	Single	4	10	
Employment	Working	13	15	0.343
	Housewife	15	15	
	Student	2	0	
Education	Illiterate	1	1	0.296
	Elementary	12	7	
	Middle school	5	7	
	High school	4	10	
	University	8	5	
Systemic disease	Yes	0	0	1
	No	30	30	
Smoking status	Smoker	7	9	0.447
	Non-smoker	23	21	

value.[8] Once the procedure had been explained, the patient assumed a sitting position in a chair and was allowed to relax completely. The trigger points on the upper trapezius were first identified and marked, after which the metal rod of the pressure algometer was placed on the marked site in a vertical direction. The compression pressure was gradually increased, and the patient was asked to indicate when they felt pain or discomfort, at which time the pressure was stopped.

Beck Depression Inventory: The BDI was developed by Beck in 1967. The reliability and validity of the Turkish-language version were investigated by Hisli[16]. This inventory consists of the patient's selection of somatic, affective (perceptual), and cognitive (sensory) functions over 21 items. These items are ranked from neutral (scored as 0) to severe (scored as 3). The patient reads the items and selects the most appropriate response. The highest possible score is 63. Scores of 1-13 indicate "no depression", scores of 14-24 indicate "moderate depression", and scores of 25 or more indicate "severe depression."

Neck Pain and Disability Scale: This scale was employed for a functional evaluation of the disability levels in the individuals in this study. The Neck Pain and Disability Scale consists of 20 items. Each item is scored using a 10 cm VAS, values ranging between 0 and 5. Total scores are calculated by adding the different item scores and range between 0 and 100. Higher scores indicate more severe pain and impact. The Turkish validity study of this scale was performed by Bicer et al.[17] in 2004.

Randomization and allocation: The participants were divided into two groups, either into the study group or the control group. Lots were drawn to achieve this with the patients blindly selecting balls of different colors. The ball which was selected by them was opened by the researcher, and the groups were determined. According to a homogeneity test, the two groups were homogeneous (Table 1) ($p>0.05$).

Statistical Analysis

Student's t-test was applied to compare the groups' qualitative characteristics (such as age, weight, and height) when the data was normally distributed, and the chi-square test was used in the comparison of categorical characteristics (such as sex, marital status, occupation, smoking status, pack-year values among smokers, and systemic disease).

The groups' pre-treatment, post-treatment and first-month evaluations were compared with the repeated measures ANOVA test as the data was normally distributed. For intra group analysis (in pairwise comparisons), the paired t-test was used to compare pre-treatment and post-treatment, and also post-treatment and first-month measurements for normally distributed data. During the statistical analysis, two-sided p-values were adopted, and values <0.05 were regarded as statistically significant.

Sample size calculation: In this study, a priori sample size calculation was carried out with the G*Power software 3.1.9.4 program (Heinrich-Heine Universität Düsseldorf, Düsseldorf, Germany). In order to examine changes between repeated measurements over time (before, after, 1st month) in the two groups, it was determined that the number of samples should be at least 24 in total in each group, considering an error of 0.05, a power of 0.80 and an effect size of 0.05. Therefore, a total of 30 participants were included in each group of this study.

RESULTS

Intra-group analysis revealed significantly lower pain severity in both groups immediately after treatment compared to pre-treatment ($p<0.001$ for both). Pain severity also decreased significantly one month after treatment compared to pre-treatment ($p<0.001$). In the control group, a significant decrease was observed in the post-treatment and one-month values compared to pre-treatment ($p<0.01$ for both). Inter-group comparisons revealed significantly lower pain severity on the completion of treatment and after one month in the study group compared to the baseline values ($p=0.01$ and $p=0.04$, respectively) (Table 2).

Intra-group analysis revealed a significant decrease in the risk of depression immediately after the completion of treatment compared to the baseline in both groups ($p<0.001$ for both). The risk of depression also decreased significantly in both groups immediately and one

Table 2. Intra-group and inter-group comparisons of pain severity, emotional state, and disability

Measure	Study group, (n=30) Mean ± SD	Control group, (n=30) Mean ± SD	p
Pain severity			
Pre-treatment	7.16±1.82	6.08±1.71	
Post-treatment	4.04±1.91	4.84±1.95	**0.010***
One month after treatment	2.92±2.21	4.95±2.07	**0.040***
p	**0.0001***	**0.0015***	
Emotional state			
Pre-treatment	14.3±8.35	12.8±7.47	
Post-treatment	10.8±6.35	10.9±6.4	0.385
One month after treatment	9.73±6.62	12.7±8.64	0.492
p	**0.0001***	**0.0001***	
Disability			
Pre-treatment	58.0±14.5	54.5±16.6	
Post-treatment	45.3±16.2	46.5±17.8	0.216
One month after treatment	41.7±19.6	45.1±14.4	0.497
p	**0.0001***	**0.0017***	

Repeated measures ANOVA test, Paired t-test, SD: Standard deviation.

month after treatment compared to pre-treatment values ($p<0.001$). Inter-group comparisons revealed no significant difference in the pre-treatment values or in those immediately or one month after treatment ($p>0.05$ for all) (Table 2).

Intra-group analyses revealed a statistically significant decrease in terms of disability status immediately after treatment compared to pre-treatment ($p<0.001$ for both). Significant decreases were observed in both groups immediately after and one month after treatment compared to the baseline ($p<0.001$ for both). No significant difference was observed between the groups in terms of pre-treatment, immediately post-treatment, or one-month post-treatment values ($p>0.05$) (Table 2).

Intra-group analyses revealed a significant increase between repeated all neck ROM measures (pre-treatment, immediately post-treatment and one-month post-treatment) ($p<0.001$) in both groups (Table 3).

Significant differences were observed between the groups in terms of left lateral flexion values immediately after treatment, and after one month ($p<0.001$ for all). However, no significant differences emerged between the groups in terms of flexion, extension, right lateral flexion, or right and left rotation values ($p>0.05$ for all) (Table 3).

No significant changes were registered in the control group after treatment compared to the baseline in the pain pressure threshold values in the right and left trapezius first and second trigger points ($p>0.05$). In the study group, however, significant increases were observed in the values immediately after treatment and in the first month in the right and left trapezius first and second trigger points compared to the pre-treatment values ($p<0.01$ and $p<0.001$, respectively). The differences between the two groups were statistically significant ($p<0.001$) (Table 4).

DISCUSSION

The findings emerging from this research suggest that LLLT is effective in reducing pain severity in MPS, improving emotional state, reducing disability, and increasing neck ROM. The patients' most important complaint in MPS is pain. A previous study suggested that the application of LLLT in MPS reduced pain complaints when at rest and during activity.[18] In their study of patients with MPS, Kavadar et al. [19] examined VAS and algometric measurement parameters and found that pain complaints and trigger point sensitivity decreased significantly in both groups immediately and one month after ultrasound therapy compared to baseline pre-treatment values, while pain thresholds increased significantly, although the improvement in the treatment group was significantly more. In the present study, the severity of pain decreased significantly in the study group compared to the control group, and the pain thresholds in the study group increased compared to their pre-treatment values. There was also another study which reported a significant decrease in pain when at rest and during activity in a laser group compared to a placebo group.[20]

ROM assessment is an important follow-up parameter in MPS. A previous study involving ultrasound in patients with MPS concluded that the stretch level of the upper trapezius muscle was powerfully correlated with a decrease in neck ROM, pain, and disability caused by MPS and with the pain threshold. Increased tension in the trapezius muscle also increases pain, disability, and the pressure pain threshold. This finding shows that the therapeutic methods applied in the present and other studies increased neck ROM by reducing tension in the trapezius muscle.[21] Another study's results showed significant statistical evidence for the short-term effectiveness of LLLT in the treatment of patients with myofascial neck pain in terms of improvements in pain, pain pressure thresholds, and neck ROM.[22]

Yağcı et al. reported an increase in neck ROM values in individuals with MPS following connective tissue massage and exercise education. Another study involving MPS suggested that dry-needling, kinesiology taping, and dry cupping improved neck ROM.[23] Similarly, in the present study, improvement was observed in almost all neck ROM measurements in both groups. Further studies are now needed to reveal the effects of LLLT on neck ROM in MPS patients.

Table 3. Intragroup and intergroup comparisons of joint range of movement			
ROM	**Study group, (mean ± SD)**	**Control group, (mean ± SD)**	**p**
Flexion			
Pre-treatment	50.3±15.0	50.9±13.7	
Post-treatment	58.4±14.4	56.0±13.7	0.258
One month after treatment	58.1±13.7	58.4±15.1	0.411
p	**<0.001***	**<0.001***	
Extension			
Pre-treatment	45.4±14.5	52.7±18.8	
Post-treatment	53.4±17.1	57.8±16.8	0.265
One month after treatment	54.3±17.4	58.6±18.4	0.989
p	**<0.001***	**<0.001***	
Right lateral flexion			
Pre-treatment	33.0±11.8	32.2±11.0	
Post-treatment	42.5±10.9	38.4±11.8	0.109
One month after treatment	44.1±12.3	37.9±13.5	0.238
p	**<0.001***	**<0.001***	
Left lateral flexion			
Pre-treatment	37.3±9.40	36.6±12.7	
Post-treatment	44.9±9.84	44.8±13.6	0.778
One month after treatment	47.7±11.0	43.5±14.6	**0.010***
p	**<0.001***	**<0.001***	
Right rotation			
Pre-treatment	60.9±18.7	65.4±17.6	
Post-treatment	69.7±17.1	71.4±16.6	0.312
One month after treatment	70.0±20.0	72.6±16.9	0.649
p	**<0.001***	**<0.001***	
Left rotation			
Pre-treatment	69.0±15.5	69.6±16.2	
Post-treatment	74.7±13.9	74.7±12.9	0.808
One month after treatment	76.3±16.1	75.8±13.3	0.818
p	**<0.001***	**<0.001***	

ROM: Range of motion, SD: Standard deviation.

The literature shows that LLLT exhibits long-term effectiveness in overcoming pain and symptoms in patients with MPS.[24] LLLT has been shown to reduce trigger point sensitivity in patients with MPS and to increase the pressure pain threshold at trigger points.[24] In line with the previous literature, LLLT also lowered pain while raising the pressure pain threshold in the current research. However, further studies are needed on this issue.

The trigger point pressure pain threshold in patients with MPS is lower than average. Ilbuldu et al.[25] compared LLLT, dry needling, and placebo laser in patients with trigger points in the upper trapezius. Those authors reported a significant alteration in rest and activity pain and pain thresholds in the group receiving LLLT treatment compared to the other groups.

Another study investigated pain threshold measurements with the application of ultrasound, Kinesio taping, and placebo ultrasound on trigger points and they reported significant decreases in algometry measurements in all three groups after treatment.[26] Similarly, in the present study, pain pressure threshold measurements decreased significantly in the study group compared to the control group. We think that LLLT can be applied to trigger points due to its non-invasive and painless nature, as well as ease of application. However, we also think that it is important to adopt a comprehensive approach including stretching and relaxation exercises, the maintenance of proper posture, and lifestyle changes in order to provide long-term therapeutic efficacy. Various parameters associated with dosage, wavelength, duration of treatment, and application sites should be investigated in future studies on this subject.

Study Limitations

There are two limitations of this study. The first is that the number of studies examining its biopsychosocial effects has been insufficient to interpret the results. Based on this, there is a need for well-conducted clinical trials with a better standardization of the parameters to be used in the treatment of this syndrome. The second limitation is that the placebo effect was not investigated thoroughly. Another group to which no treatment was applied was needed in order to determine this.

Table 4. Intra- and inter-group pain pressure threshold comparisons			
	Study group, (mean ± SD)	**Control group, (mean ± SD)**	**p**
Right M. trapezius 1st trigger point pain pressure threshold			
Pre-treatment	1.94±0.44	1.91±0.49	
Post-treatment	2.14±0.31	1.91±0.47	**<0.001**
One month after treatment	2.25±0.31	1.93±0.44	**<0.001**
p	**<0.001***	0.8664	
Right M. trapezius 2nd trigger point pain threshold			
Pre-treatment	1.92±0.35	1.78±0.50	
Post-treatment	2.08±0.29	1.82±0.08	**<0.001**
One month after treatment	2.25±0.23	2.01±0.26	**<0.001**
p	**<0.001***	0.3727	
Left M. trapezius 1st trigger point pain pressure threshold			
Pre-treatment	2.03±0.15	1.91±0.47	
Post-treatment	2.13±0.29	1.91±0.47	**<0.001**
One month after treatment	2.26±0.33	1.98±0.43	**<0.001**
p	**<0.001***	0.4682	
Left M. trapezius 2nd trigger point pain			
Pre-treatment	1.97±0.45	1.84±0.46	
Post-treatment	2.12±0.36	1.89±0.44	**<0.001**
One month after treatment	2.25±0.27	1.97±0.44	**<0.001**
p	**<0.001***	0.1142	
Repeated measures ANOVA test, Paired t-test, SD: Standard deviation.			

CONCLUSION

Taken as a whole, our results showed that LLLT is effective in reducing trigger point sensitivity. Exercise programs which include the suppression of triggering factors, posture training, and stretching tense and short muscles while strengthening weak muscles can be highly beneficial in achieving long-term therapeutic efficacy. In conclusion, LLLT might be employed as a therapeutic option in patients with MPS. Further studies are now needed on this subject.

MAIN POINTS

- LLLT is more effective than placebo laser at reducing the pain intensity and improving the emotional state of individual with MPS.
- LLLT is more effective than placebo laser at reducing disability and increasing neck ROM in individual with MPS.
- LLLT reduces the trigger point sensitivity and increases the pressure pain threshold in individuals with MPS.

ETHICS

Ethics Committee Approval: This study was approved by the Ethics Committee of Marmara University Faculty of Medicine (approval number: MAR-YÇ-2007-0214, date: 30.11.2007).

Informed Consent: Written consent was received from all the individuals taking part.

Authorship Contributions

Concept: A.A.K., O.H.G., Design: A.A.K., O.H.G., Supervision: A.A.K., Data Collection and/or Processing: A.A.K., Analysis and/or Interpretation: A.A.K., Literature Search: A.A.K., O.H.G., Writing: A.A.K.

DISCLOSURES

Conflict of Interest: No conflict of interest was declared by the authors.

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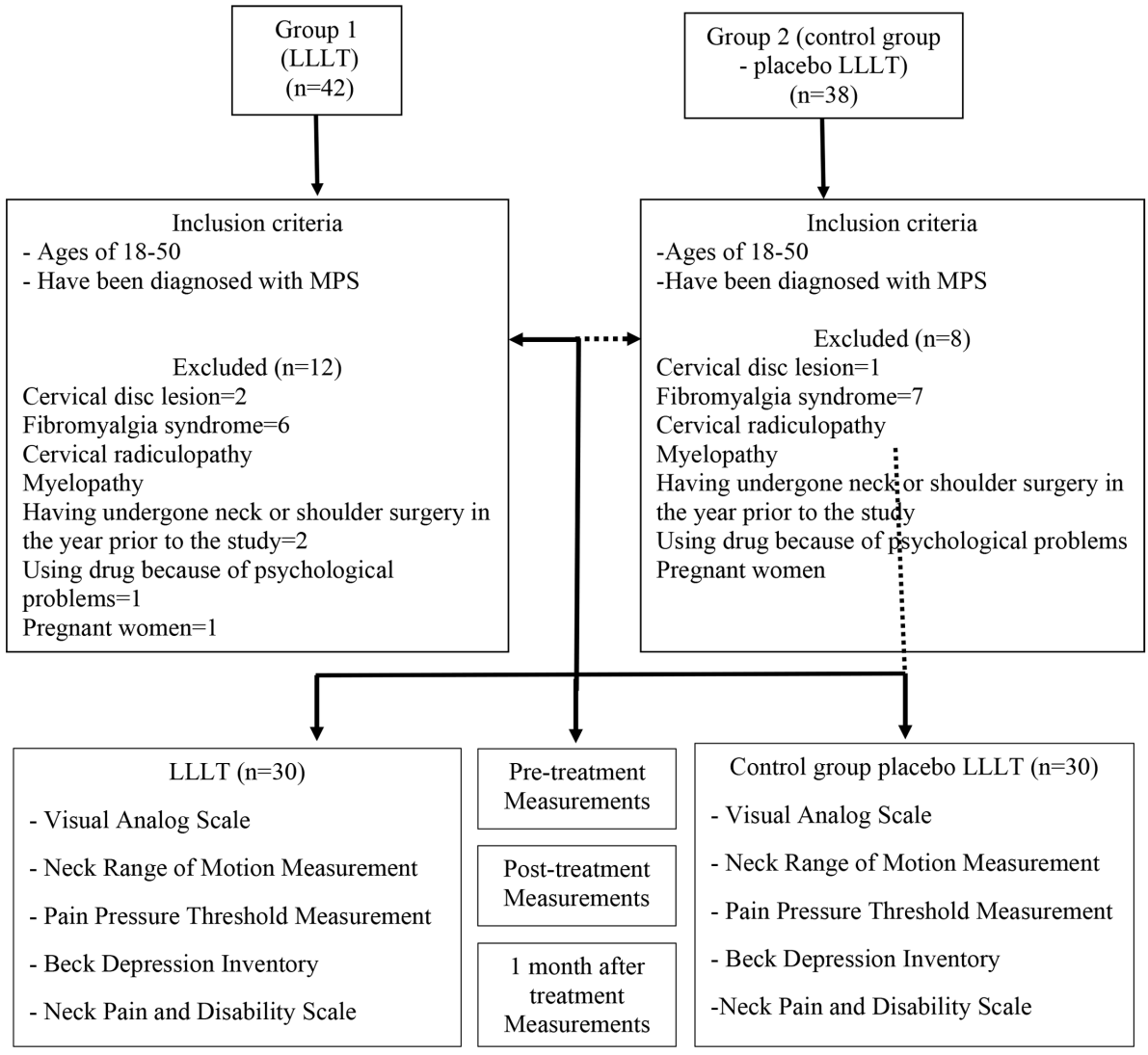

Supplementary Figure 1. The flow diagram.