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# Effect of Static Versus Dynamic Ultrasound on Pain in Subjects with Trigger Point in Quadratus Lumborum Having Non-Specific Chronic Low Back Pain

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## ABSTRACT

**Background:** Static Ultrasound has been a very effective means of treating trigger points in low back pain. Recently dynamic ultrasound has been introduced. The purpose of this study was to compare static and dynamic ultrasound for treating trigger points in Quadratus Lumborum in patients having non-specific low back pain.
**Method:** An experimental study was done where 21 patients were distributed among 3 groups. Group A was given Dynamic ultrasound, Group B was given static ultrasound 3Mhz and Group C was given static ultrasound 1Mhz. All groups were given hot packs and exercises. Treatment was assessed in terms of numeric pain rating scale (NPRS), Active knee extension (AKE) test, Modified schober test for lumbar flexion and extension (MSTF and MSTE).
**Result:** Using the Wilcoxon test difference in means for NPRS Group A(W=-2.371,p=0.018), Group B(W=-2.371,p=0.018), Group C(W=-2.371,p=0.018), for AKE Group A(W=-2.388,p=0.017), Group B(W=-2.392,p=0.017), Group C(W=-2.264,p=0.024), for MSTF Group A(W=-2.388,p=0.017), Group B(W=-2.392,p=0.017) Group C(W=-2.530,p=0.011), for MSTE Group A(W=-2.041,p=0.041), Group B(W=-2.414,p=0.016) Group C(W=-2.121,p=0.034). Applying Kruskal-Wallis test, difference was seen between groups in pain (Kw=8.624,p=0.013), AKE(Kw=9.374,p=0.009) MSTF (Kw=8.963, p=0.011) MSTE(Kw=2.260,p=0.323). Bonferroni post hoc test shows significant difference between the effects of Dynamic Ultrasound and static US for pain, AKE and flexion range of motion.
**Conclusion:** Dynamic and static 1MHz and 3MHz Ultrasound, all are effective in reducing pain and increasing range of motion of lumbar spine and length of hamstrings. Dynamic ultrasound was found to be more effective than static ultrasound for the same.

***Keywords:*** Ultrasound, static, dynamic, trigger point, low back pain

## INTRODUCTION

Low-back pain (LBP) is the most frequent self-reported type of musculoskeletal pain. It is often recurrent and has important socioeconomic consequences. Estimates of the prevalence of LBP vary considerably between studies and reach 33% for point prevalence, 65% for one-year prevalence, and 84% for lifetime prevalence [1]. Nonspecific low back pain (LBP) is defined as pain between the costal margins and the inferior gluteal folds, usually accompanied by painful limitation of movement that may be associated with referred pain, without an identifiable anatomical or neurophysiological cause and may be of mechanical, musculoskeletal, or multifactorial origin. Musculoskeletal pain problems involve fibromyalgia and

myofascial pain syndrome. The myofascial pain syndrome is a common non-articular local musculoskeletal pain syndrome caused by myofascial trigger points located at muscle, fascia or tendinous insertions [4]. A trigger point is defined as a hyperirritable spot located in a palpable, taut band of muscle fibres. Trigger points can either be active, which are tender and spontaneously painful, or latent, which are tender but not spontaneously painful.

The Quadratus Lumborum (QL) muscle plays a prominent role in normal body mechanics. This muscle group is composed of several small muscles located deep within the lower back. QL helps to extend the lumbar spine, cause lateral flexion and is also an important stabilizer of lumbar spine. A sustained contraction of the QL is required during sitting, walking, lying and other functional activities in order to stabilize the trunk and maintain body mechanics. Poor posture and body positioning alters the body mechanics which results in development of muscle trigger points (MTrPs) in this muscle. There are four potential trigger points in the QL muscle including, Upper - found just lateral to where the lumbar paraspinal muscles and the 12th rib meet; Lower – lies deep where paraspinal muscles meet the hip crest; Middle or deep – lies closer to the spine next to the 3rd and 4th lumbar vertebrae. QL MTrPs were seen more commonly in the younger age group, with the highest prevalence i.e. 48% found to be in patients 20-30 years of age [4]. Because of low back pain, the patient may present with hamstrings tightness and a decrease in the back range of motion [6]. Muscle tightness may be linked to postural disturbances. It is also seen that low back pain patients have relatively less range of motion of lumbar spine. Reduced extensibility resulting from increased hamstring stiffness could be a possible contributing factor to low back injuries.

Therapeutic ultrasound (US) is among the commonly used physical modalities for treating soft tissue injuries, tender points, trigger points and pain. Therapeutic US is delivered in two frequencies 1Mhz and 3Mhz. 1Mhz have a deeper penetrating effect as compared to 3Mhz. One reaches the deeper tissues while the other allows for superficial heating. Ultrasound waves were till now delivered through the transducer (head) which gave static sound waves. To prevent side effects of unstable cavitation and subsequent dangerous heating, the therapist has to keep moving the head over the part to be treated. Recently Dynamic Ultrasound has been introduced, where the head changes the frequency at a random rate. Studies regarding dynamic ultrasound are still few. The effect of ultrasound in the myofascial trigger point is well established but there is no exact dosage available on treating a QL MTrPS in low back pain patients.

Numerical pain rating scale is a scale to measure severity of pain, grade of tenderness is a subjective scale used to know the severity of the tender area, Modified Schober method is used to know the range of motion of flexion, extension at the lumbar spine and Active Knee Extension test measures the hamstring tightness. The purpose of this study was to compare the effect of static versus dynamic ultrasound on pain, tenderness, lumbar range of motion and hamstring tightness in patients having QLMTrP and to know the appropriate dosage of static ultrasound to treat back pain.

## METHOD

This cross sectional study was done at college of physiotherapy and permission to do the study was taken from the head of the department. 98 patients having low back pain were screened out of which 21 patients who satisfied the inclusion criteria were included in the study using convenience sampling.

Subjects between the age of 19 – 40 years, having low back pain for over a month or had recurrent episodes of pain in last 6 months for more than 3 times, having at least one trigger point over the Quadratus

Lumborum muscle were included in the study. Patients having pain related to conditions such as fractures, spondylitis, trauma, tumor, infections, neurological conditions, disc herniation, abnormal sensations, skin lesion, nerve root compression, tingling sensation below thigh, positive SLR(straight leg raise test), positive slump test, osteoarthritic changes of spine on radiology, history of any lumbar or back surgery were excluded.

The study was explained to the subjects. Consent to participate was taken from the patients satisfying the criteria and they were randomly divided into 3 groups. Demographic data collected was name, age, gender, occupation, contact number. Outcome measures assessed were numerical pain rating scale (NPRS), active knee extension(AKE) test, modified Schober test for flexion and extension (MSTF and MSTE) and grades of tenderness.

Numerical pain rating scale is a 11 point scale (0-10). Numerical pain rating scale was taken by asking the patient to rank the severity of their pain from 0-10 with 0 being no pain and 10 being the most unbearable pain [8]. For the active knee extension test the patient position was supine on a plinth, pillow under head. The affected side leg was held in 90˚ hip flexion and the patient is asked to straighten the knee actively as much as possible. The therapist stands over the test leg, uses a goniometer with fulcrum over the lateral condyle of femur, stable arm parallel to the femur, movable arm parallel to the fibula, and measures the angle at the knee [8]. In the modified Schober Method patient position is standing, therapist position is behind the patient. Patient S2 vertebrae is marked. 10cm from S2 towards neck (point1) and 5cm towards foot from S2 is marked (point2). Now the patient is asked to try to touch toes while the knee is straight and the distance is measured between points. Similarly the patient does extension and distance is measured [8]. QL trigger points are located on the lateral aspect of the transverse process from L1-L5. To assess the grade of tenderness, pressure is applied anteriorly and medially. With every palpation the patient response was noted and graded as follows: Grade 1: Patient complains of pain, Grade 2: patient complains of pain and facial expression changes, Grade 3: patient lauds out of pain and withdraws the part, Grade 4: patient does not allow palpating the part because of severe pain [8].

After taking the data, three groups were formed of 7 patients each. Ultrasound was given using Striker Brio series machine Group A, Ultrasound Dynamic intensity 1.0 W/cm² for 5 minutes, group B, Ultrasound Static 3MHz Continuous mode intensity 1.2 W/cm² for 5 minutes, group C Ultrasound Static 1MHz Continuous mode intensity 1.0 W/cm² for 5minutes. Along with the US, all patients were given whole back hot pack for 15 minutes and the following exercises

1. Relaxed passive stretching of hamstring muscle, 3 repetitions, each repetition of 30second hold. 2. Isometric abdominal exercises 10 repetitions of 10second hold each. 3. Patient was in supine position, hip and knees were flexed so that feet rested on the plinth and a sandbag was placed between the flexed knees. Patient was asked to press the sandbag and hold the pressure for 10 second and repeat it 10times. 4. Isometric back exercise, the patient was in supine position and was asked to press down towards the plinth from the heel of the foot and head, hold for 10 second and 10 repetitions. They were given treatment for 3 consecutive days. The outcomes were again measured on the last day after exercise.

Level of significance was kept at 5%. SPSS version 20 was used for data analysis.

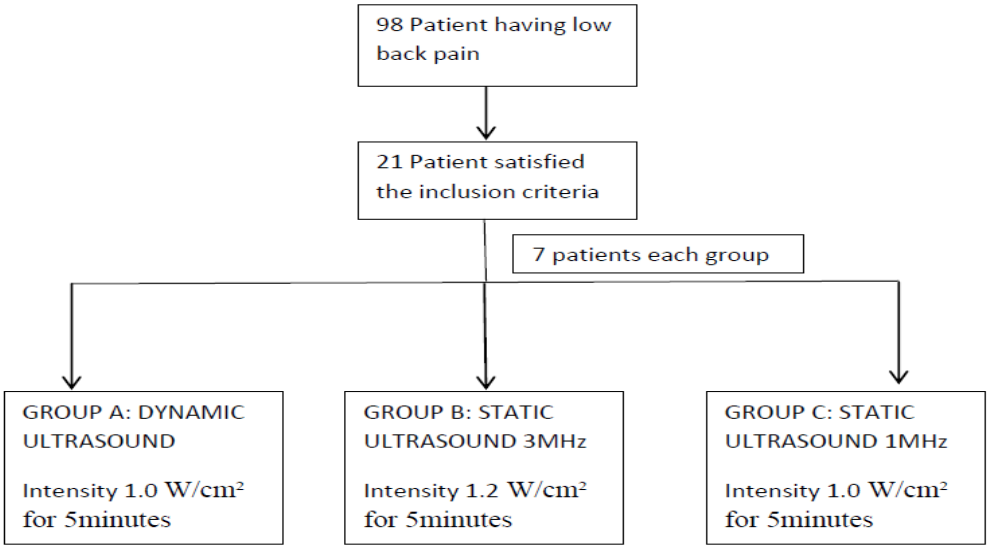


**Figure 1: Flow chart of the study.**

## RESULT

**Table 1 : Demographic data of patients**

| | All subjects | Group A | Group B | Group C |
|---|---|---|---|---|
| No. of subjects | 21 | 7 | 7 | 7 |
| Age | 31.47±7.18 | 31.85±5.36 | 31.85±8.45 | 30.71±8.4 |
| Gender M/F | 12/9 | 6/1 | ¾ | 3/4 |

**Table 2 : Mean value of outcome measures on day 1**

| Outcome measure | Group A | Group B | Group C |
|---|---|---|---|
| NPRS | 5.14±1.12 | 4.28±1.29 | 3.19±1.76 |
| AKE | 53.57±10.69 | 50.71±11.70 | 42.88±7.55 |
| Modified Schober test flexion | 3.57±0.93 | 4.14±0.85 | 4.14±0.74 |
| Modified schober test extension | 1.92±0.18 | 1.78±0.75 | 2.35±0.37 |
| Grades of tenderness | 1.85 ±0.37 | 2.42±0.53 | 2±0.57 |

**Table 3 : Mean difference in outcomes in group A**

| Outcome | Pre Day 1 Mean±SD | Post Day 3 Mean±SD | W value | p value |
|---|---|---|---|---|
| NPRS | 5.14±1.12 | 1.61±0.8 | -2.371 | 0.018 |
| AKE | 53.57±10.69 | 31.71±7.67 | -2.388 | 0.017 |
| Modified Schober test Flexion | 3.57±0.93 | 5.28±1.03 | -2.388 | 0.017 |
| Modified Schober test Extension | 1.92±0.18 | 2.57±0.44 | -2.041 | 0.041 |
| Grade of Tenderness | 1.85 ±0.37 | 0.28±0.48 | -2.428 | 0.015 |

**Table 4 : Mean Difference in outcomes in Group B**

| Outcome | Pre 1 Mean±SD | Post 3 Mean±SD | W value | p value |
|---|---|---|---|---|
| NPRS | 4.28±1.29 | 2.80±0.81 | -2.371 | 0.018 |
| AKE | 50.71±11.70 | 38.42±10.45 | -2.392 | 0.017 |
| Modified Schober test Flexion | 4.14±0.85 | 5.07±0.53 | -2.392 | 0.017 |
| Modified Schober test Extension | 1.78±0.75 | 2.57±0.60 | -2.414 | 0.016 |
| Grade of Tenderness | 2.42±0.53 | 1.28±0.48 | -2.530 | 0.011 |

**Table 5 : Mean Difference in outcomes in Group C**

| Outcome | Pre 1 Mean±SD | Post 3 Mean±SD | W value | p value |
|---|---|---|---|---|
| NPRS | 3.19±1.76 | 1.52±0.99 | -2.371 | 0.018 |
| AKE | 42.88±7.55 | 34.28±8.38 | -2.264 | 0.024 |
| Modified Schober test Flexion | 4.14±0.74 | 5.21±0.63 | -2.530 | 0.011 |
| Modified Schober test Extension | 2.35±0.37 | 2.78±0.39 | -2.121 | 0.034 |
| Grade of Tenderness | 2±0.57 | 0.71±0.48 | -2.460 | 0.014 |

Twenty one subjects completed the study. The demographic details are shown in table 1. Wilcoxon test was used to compare differences within the groups. Table 2 shows the mean value of all outcome measures on day 1. Table 3 shows mean difference in outcomes in group A, table 4 shows mean difference in outcomes

in Group B and table 5 shows mean difference in outcomes in Group C. Kruskal Wallis test was used to find the difference between the groups. Table 6 shows the mean difference in outcome measures between groups.

**Table 6: Mean difference in outcome measures between groups**

| OUTCOME MEASURES | KW | P |
|---|---|---|
| NPRS | 8.624 | 0.013 |
| AKE | 9.374 | 0.009 |
| Modified schober test Flexion | 8.963 | 0.011 |
| Modified schober test Extension | 2.260 | 0.323 |
| Grades of tenderness | 2.857 | 0.240 |

Bonferroni Post Hoc test was applied. For NPRS difference in group A and B (p=0.006), for A and C (p=0.013) B and C (p= 1). For AKE difference in group A and B (p= 0.015), A and C (p=0.001), B and C (p=0.689). For MSTF difference in group A and B (p=0.005), for A and C (p=0.022) B and C (p= 1). For MSTE difference in group A and B (p=1), for A and C (p=1) B and C (p= 0.441). For grades of tenderness difference in group A and B (p=0.319), for A and C (p=0.815) B and C (p= 1).

## DISCUSSION

The present study was done to find the difference in static versus dynamic ultrasound and to find the most effective dose for treating nonspecific low back pain and trigger points over the quadratus lumborum muscle. There was a statistically significant difference seen in participants given three different types of doses of ultrasound in pain, AKE, MSTF, MSTE and Grades of tenderness. Between the groups statistically significant differences were seen in pain, AKE, MSTF.

In Group A, NPRS (W=-2.371, p=0.018), AKE (W=-2.38, p=0.017), MSTF (W=-2.388, p=0.017) and MSTE (w=-2.041, p=0.041) showed a statistically significant difference at the end of 3 days. Group A was given dynamic ultrasound over the trigger point. The methodology of dynamic ultrasound involves selection of a particular intensity. Dynamic US means the frequency of application fluctuates between 1MHz and 3 MHz at regular intervals. During the application the head has to be held over the part to be treated. This is in contrast to the usual way of giving US in physiotherapy where one needs to move the head in circular motion. This movement is to prevent the formation of stable and unstable cavitation and to avoid standing waves and overheating. The mechanism of effect of dynamic US is similar to as described due to 1 MHz and 3 MHz. The heating of superficial and deep layers can be seen with dynamic US as the frequency changes the depth of penetration also changes.

In Group B, static Ultrasound 3MHz was given which showed that pain (W=-2.371, p=0.018), AKE (W=-2.392, p=0.017), MSTF (W=-2.392, p=0.017), MSTE (W=-2.414, p=0.016) and Grades of Tenderness (W=-2.530, p=0.011). This shows that all the outcomes showed a significant improvement. This finding is similar to findings by David O Draper [7]. The half-value depth of 3MHz ultrasound is 3cm in humans [9]. As the ultrasound head moves through the tissues there is some amount of energy absorbed and this leads to generation of heat within the tissues. As a result of the thermal effect in the tissues there is increased blood flow to the tissue, removal of noxious chemicals. As a result there is reduction of pain and spasm. There is heating of the collagen fiber which forms the joint capsules, tendon, and ligaments. The trigger points when subjected to heating, the fibers get elongated and there is an increase in range of motion of the joint and decrease in stiffness of the involved tissue as seen with a change in the active knee extension range of motion in the present study. There is rapidly changing pressure on cells and tissue structure due to the effect of ultrasound. The compression and rarefaction waves of ultrasound gives a micromassage to the area further helping in releasing the trigger point [9]. Similarly, David O Draper [7] in his study on releasing trigger points in trapezius muscle gave the US dosage of 3MHz at intensity 1.4w/cm²

for 5min, treatments over the course of the 2 weeks also showed that the trigger points of the ultrasound groups got softer with an increase in depth. Our findings also concur with those of Gulick et al [10] who were able to decrease trigger point pain when using 3 MHz ultrasound with methyl nicotinate as the ultrasound couplant. Their treatments lasted for 7 minutes at 1 W/cm2.

Group C, the static Ultrasound 1MHz group, showed pain (W=-2.371, p=0.018), AKE (W=-2.264, p=0.024), MSTF (W=-2.530, p=0.011), MSTE (W=-2.121, p=0.034) and Grades of Tenderness (W=-2.460, p=0.014). The findings are similar to those of Dilek Durmus [11] and Koldao Dofan et al. [12]. The half-value depth of 1MHz ultrasound is 6.5 cm in humans [9], the degree of absorption of the ultrasound waves depends upon, the nature of tissue, degree of vascularization and the frequency of the ultrasound. As with frequency of 1MHz a higher value of depth is seen, the waves are more absorbed as a result there will be a higher degree of thermal energy produced by 1MHz at a more tissue depth than 3MHz so there will be more blood flow to the area and more noxious chemicals will be removed than as seen in 3MHz. As there will be more waves reaching to deeper structures the Quadratus lumborum muscle which is relatively a deep muscle of back, the spasm of the muscle the releasing of the trigger point is released by 1MHz theoretically which also concur with the present clinical experiences. Dilek Durmus [11] while comparing the effect of ultrasound and electrical stimulation, applied US therapy for 6 weeks totalling 18 treatments (10 min, 1 W/cm2, continuous, 1 MHZ frequency). He found that US is very effective in treating the patients having low back pain. The patients were evaluated according to pain, disability, walking performance, endurance, mobility, QOL, depression. Koldao Dofan et al. [12] in their study compared the efficacy of three different therapies on patients with CLBP. He applied US for 6 weeks 3 times per week (10 min, 1.5 W/cm2, continuous, 1 MHZ frequency) and showed positive results in treating patients with ultrasound.

For NPRS difference in group A and B (p=0.006), for A and C (p=0.013) B and C (p= 1). For AKE difference in group A and B (p= 0.015), A and C (p=0.001), B and C (p=0.689). For MSTF difference in group A and B (p=0.005), for A and C (p=0.022) B and C (p= 1). For MSTE difference in group A and B (p=1), for A and C (p=1) B and C (p= 0.441). For grades of tenderness difference in group A and B (p=0.319), for A and C (p=0.815) B and C (p= 1). Between the groups statistically significant differences were seen in pain, AKE, MSTF. Dynamic US used a combination of 1MHz and 3 MHz frequency. So it probably had an advantage of treating both superficial and deep layers of the muscle. Also movement of the head was not required with dynamic US. This probably resulted in the treatment been given to the target tissue with more beneficial effects. However studies regarding dynamic US are less. A statistically significant difference between the groups was seen in range of motion of knee extension and back flexion. This can be attributed to the heating effect seen with US which released the trigger point. Following this release an increase in the range of motion was seen. The findings are similar to M. Hauck [13] on his study comparing the effects of 1 MHz and 3 MHz therapeutic ultrasound on endothelium-dependent vasodilation of humans showed that there is significant increase in vasodilation as a result of ultrasound.

A limitation of the study was that the physics of dynamic US could not be studied, difference in side effects could not be studied. The study only saw the immediate effects. Long term studies can be performed of 2 week duration. It can be seen that dynamic US can be used to release trigger points more effectively than conventional US. This can be used in trigger points of various muscles clinically.

## CONCLUSION

The dynamic ultrasound (Continuous mode intensity 1.0w/cm² for 5minutes.), static 3MHz (Continuous mode intensity 1.2w/cm² for 5minutes.) and the static Ultrasound 1MHz (Continuous mode intensity 1.0w/cm² for 5minutes.) all were found to be effective in reducing pain and increasing the range of motion of lumbar spine. The dynamic ultrasound was found to be more effective in reducing pain, increasing the lumbar flexion range and reducing hamstring tightness as compared to other doses.

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