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# Effect of focal muscle vibration on flexibility and perceived stiffness in patients with mechanical low back pain

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## ABSTRACT

**BACKGROUND & OBJECTIVE:** Low back pain is a major disabling pathology worldwide. A focal muscle vibrator can be a treatment option for reducing pain in such patients. The objective of this study was to determine the effects of focal muscle vibration on flexibility, perceived stiffness and pain intensity in patients with mechanical low back pain.

**METHODOLOGY:** A randomized clinical trial was conducted at Railway General Hospital Rawalpindi. Reviewing the limited number of studies done using focal muscle vibrator for low back pain, 44 participants were randomly divided into two groups. The experimental group received a focal muscle vibrator and physical therapy treatment, while the control group received conventional physical therapy treatment. Sessions were planned thrice a week for a total of four weeks. Baseline data was recorded at the start, with a final recording at the end of the fourth week for pain, muscle soreness and flexibility.

**RESULTS:** A total of 44 patients with mechanical low back pain aged between 25 to 45 years were recruited. Both groups showed improvement in pain, muscle soreness and flexibility, but there was a significant improvement in pain and flexibility in the experimental group ($p \leq 0.05$). There was no significant difference noted in muscle soreness in between group analysis ($p \geq 0.05$).

**CONCLUSION:** Focal Muscle Vibrator (myovolt 120 Hz frequency) along with Physiotherapy protocol is effective in improving pain and flexibility of mechanical low back pain patients, but muscle soreness showed less significant improvement in both groups, while between the groups analysis showed no significant statistical difference.

**KEYWORDS:** Back muscles, Exercise therapy, Low back pain, Pain perception, Vibration

## INTRODUCTION

Back pain, specifically lower back pain, is a symptom instead of a disease. Like many other symptoms, including dizziness, and headache, it may have many causes. Lower back pain's most common form is nonspecific lower back pain or mechanical low back pain, when patho-anatomical cause of low back pain is not determined, these terms are used.

By definition nonspecific low back pain can be defined as not attributable to an identifiable or any recognized pathology, specifically the examples of which can range from structural deformities, fractures, cauda equine syndrome, infection, tumor and inflammatory disorders [1].

The leading cause of disability in both developing and developed countries is low back pain, while in terms of disease burden overall, it is sixth [2]. Prevalence of low back pain, according to a worldwide review in 2008, included 165 studies and 54 countries, 18.3% mean point prevalence was estimated. In females, low back pain is more prevalent than males with age group of 40-69 years. A cohort study suggests risk factors for developing low back pain including weight lifting, smoking, depression, obesity and sedentary life style [1].

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Diagnosis of nonspecific low back pain is frequently associated with musculoskeletal issues, as there is no specific cause. Clinical presentation of low back pain consists of: lumbar region pain, which may have a sudden or gradual onset. Mechanical low back pain can be caused by any disorder in ligaments, tendons, muscles. Bad ergonomics and long sitting or standing posture can be the causative factor [3].

There are many factors which may contribute in altering the biomechanical properties of disc structures, including chemical mediators which sensitize nerve endings and the ingrowth of neurovascular structures responsible for initiating backache. may initiates back pain. The growth of neurovascular structures (blood vessels & nerve fibers) inside annulus fibrosis are main contributing factor in degeneration of discs. The biomechanical response of damage disc structures may alter loading response and malalignment of spinal column, which includes ligaments, para-spinal muscles and facet joints which ultimately also exacerbates pain [4].

There are many treatments currently available for low back pain, which may vary according to the condition's classification & duration of symptoms. The list of treatments includes medication, electrotherapy agents, exercise and stabilization exercises for the spine, manual therapy and behavioral cognitive therapy as well [5].

Painful musculoskeletal conditions may develop well-known alteration of sensory function among patients with low back pain. These altered sensation present in patients with low back pain generally affects many physiological functions, including decreased sensory perception, change in patterns of muscle recruitment and somatosensory reorganization of brain cortex[6].

To assess muscle spindle contribution in movement control, focal muscle vibrator is often used. The importance of muscle spindles has been highlighted in previous studies regarding proprioception. Focal vibration stimulation, the muscle spindle is activated through 1a afferent fibers, which results in neuromuscular reaction raising tonic vibration reflex [6].

Kim H et all, conducted a study to explain the effect of vibration on low back pain and suggested that both horizontal and vertical body vibration improves muscle strength, functional disability and pain[7]. The vibration caused by the focal muscle vibrator leads to the activation of the muscle spindle, which causes motor neuron activation and contraction of inactive muscle fibers. This process increase the cumulative force generated by the targeted muscle group. This impact is increased via combined stimulation of motor neuron action and increased neural drive during the abrupt contraction of muscle. This adaptation in neural structures is known to be the cause of improved strength and tension in the muscle [8].

While comparing vibration with exercise therapy on low back pain patients, the author concluded that vibration group provides additional benefits to patients as compared to the exercise group[8]. Local muscle vibration improves impaired motor cortex by inducing plastic changes in selected neuronal circuits and produces the effects on muscle tone, disability and pain in stroke patients and valued in terms of patient safety and financial burden over the patient [9].

As the literature supports the efficacy of focal muscle vibration in different population of musculoskeletal, neurological background by influencing the neuromuscular mechanism. Focal muscle vibrator is supposed to reduce pain and increase muscle flexibility when applied in conjunction with physical therapy treatment. The study was designed in order to analyze its effects on patients with chronic low back pain. Multiple studies have been conducted worldwide to highlight the impact of focal muscle vibration on pain, flexibility and muscle soreness. But a limited number of studies were conducted in Pakistan. Additionally, low back pain survivors needs a quick easy and accessible solution that needs the least assistance hence the, focal muscle vibration might be the possible solution for low back pain. Therefore, the core objective of the current study was to identify the effects of focal muscle vibration on flexibility, perceived stiffness and pain intensity in patients experiencing mechanical low back pain.

## METHODOLOGY

Approval for this randomized controlled trial was granted by the ethical committee of Riphah International University 'RIPHAH/RCRS/REC/Letter-00906' and registered with 'clinicaltrials.gov' number NCT04760379, conducted in Pakistan Railway General Hospital, Rawalpindi from January to November 2021. Non-probability purposive sampling was used. The sample size was 44 patients, calculated through an open epitool, randomly allocated through the sealed envelope method. The control group (n=22) and the experimental group (n=22)(Figure-I).

Inclusion criteria were as follows: (1) self-reported chronic low back pain levels persisting at least three months, (2) age between 25 and 45 years, (3) no change in medications during the 4 week intervention period, (4) ability to exercise three times weekly during the 4 week intervention period, (5) pain score (NPRS) of at least 3 during the past week.

Exclusion criteria were as follows: (1) severe osteoporosis (T-score −2.5 and below with a history of a fracture) or severe cardiovascular, progressive endocrine, or nervous disease; (2) rheumatoid arthritis, dislocation, ankylosing spondylitis, fracture, or previous surgical history; (3) low back pain resulting from visceral diseases; (4) participation in whole body vibration training in the past three months; (6) uncontrolled hypertension, pregnancy; (7) low back pain caused by a specific disease; (8) low back pain duration less than three months.

Focal muscle vibration, through Myovolt (Myovolt model 2-3 MS), digital frequency range up to 120 Hz along with physical therapy including the Mc Kenzie exercises, stretching exercises for quadratus lumborum, erector spinae, and transcutaneous electrical stimulation (TENS) for 10 minutes of constant mode with para spinal electrode placement applied to the experimental group while the control group received the physical therapy treatment only as same as an experimental group. The intervention was applied to each group after informed consent from the participants for three days a week for four weeks. Patients were assessed at baseline and 4th weeks using the stiffness likert scale for muscle soreness, numerical pain rating scale (NPRS) for pain and sit and reach test for flexibility.

Likert stiffness scale is a 7-grade scale with 0 indicating complete absence of soreness, and 6 indicating severe pain which halts the movement. For sit and reach test, the patient is supposed to reach his/her toes while long sitting with the knee extended. The distance is recorded in cm and the average of three attempts is considered as final score. Shapiro-Wilk test showed that pain and flexibility (p-value<0.05) are not normally distributed, while muscle soreness (p-value>0.05) is normally distributed. An Independent t-test was used to analyze the mean differences of muscle soreness between the groups as this was found to be normal distribution, while Mann Whitney U test was used for pain and flexibility as they were not normally distributed. Wilcoxon was used to analyze pain and flexibility within the group, while paired t-test was used to analyze muscle soreness. The data was analyzed through SPSS version 21, and the p-value of less than 0.05 was considered statistically significant.

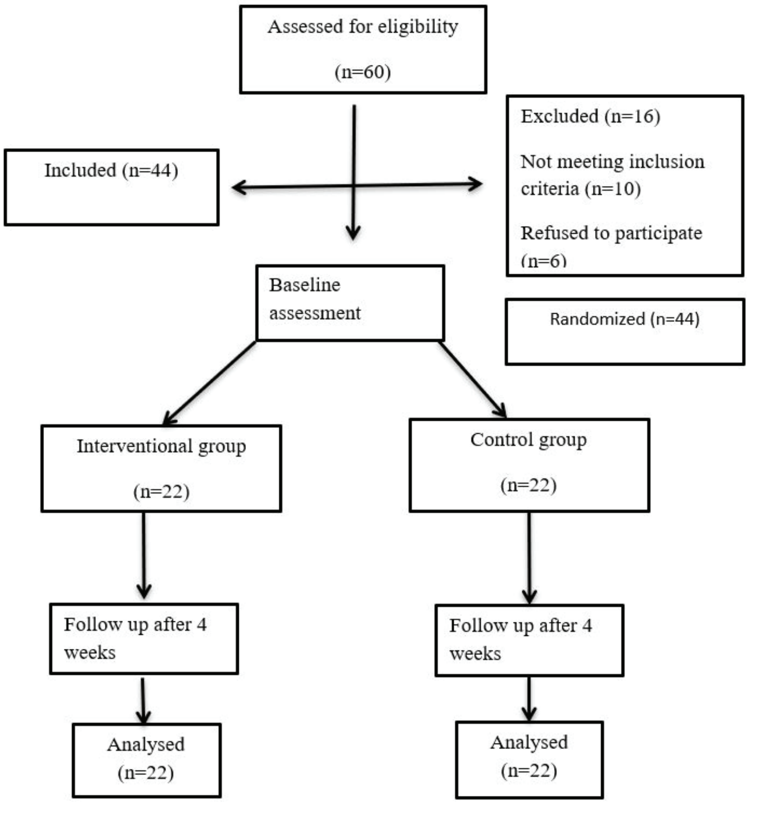


**Figure -I: Consort Diagram**

## RESULTS

A total sample of 44 patients with mechanical low back pain aged between 25 to 45 years were recruited, out of which 17 (38.6%) were male while 27 (61.3%) were female. The mean age of male was 44.8±11.1SD years, while for females was 42.2±9.06SD years. All the patients have symptoms for more than 3 months (Table-I).

**Table –I: Demographics of the participants.**

| Variables | | Mean ± SD |
|---|---|---|
| Age | Male | 44.8±11.1 |
| | Female | 42.2±9.06 |
| Duration of onset (months) | | 8.79±6.9 |

Assessment of patients was done at baseline and after 4 weeks in both experimental and control groups. Both groups were compared to analyze the improvements made in terms of NPRS, Muscle soreness and flexibility at baseline and at four weeks. The experimental group showed significant improvement as compared to a control group in both NPRS and Muscle flexibility (p≤0.05) (Table-II).

When both groups were compared in terms of Muscle soreness (at baseline and at 4 weeks) there was no significant difference noted among both groups (p≥ 0.05) (Table-III). Comparison of baseline and 4 weeks assessment was also done within the groups. When a comparison between baseline and 4 weeks assessment of control group were made in terms of NPRS, muscle soreness and flexibility significant improvement was noted. (p≤0.05) Similarly, the experimental group also showed improvement in NPRS, muscle soreness and flexibility when compared at baseline and at 4 weeks (p≤ 0.05) (Table-IV).

**Table-II: Between the groups analysis for NPRS and flexibility.**

| Variable | Time period | Groups | Mean Rank | Median (IQR) | p-value |
|---|---|---|---|---|---|
| NPRS | Baseline | Control | 23.86 | 8.0 (2.0) | 0.468 |
| | | Experimental | 21.14 | 8.0 (2.25) | |
| | 4th week | Control | 26.8 | 4.0 (4.0) | 0.024 |
| | | Experimental | 18.2 | 3.0 (2.0) | |
| Flexibility | Baseline | Control | 22.05 | 16.0 (14.25) | 0.81 |
| | | Experimental | 22.95 | 17.0 (7.5) | |
| | 4th week | Control | 17.7 | 25.5 (10.75) | 0.014 |
| | | Experimental | 27.7 | 30.0 (9.5) | |

**Table-III: Between the groups analysis for muscle soreness.**

| Time period | Groups | Mean±SD | p-value |
|---|---|---|---|
| Baseline | Control | 3.18 ±0.95 | 0.071 |
| | Experimental | 3.77±1.15 | |
| 4th week | Control | 1.59±0.59 | 0.849 |
| | Experimental | 1.63±0.78 | |

**Table-IV: Within group analysis for nprs, flexibility and muscle soreness.**

| Variable | Time period | Experimental group | | Mean±SD | p-value |
|---|---|---|---|---|---|
| | | Mean±SD | p-value | | |
| NPRS | Baseline | 7.4±1.46 | 0.00 | 7.59±1.79 | 0.00 |
| | 4th week | 2.95±1.52 | | 4.31±1.91 | |
| Muscle Soreness | Baseline | 3.77±1.15 | 0.00 | 3.18±0.95 | 0.001 |
| | 4th week | 1.63±0.78 | | 1.59±0.59 | |
| Flexibility | Baseline | 17.34±6.78 | 0.00 | 17.54±7.46 | 0.00 |
| | 4th week | 31.4±6.09 | | 25.9±7.41 | |

## DISCUSSION

Research was conducted to understand the impact of stimulation (vibration), controlled by patient, along with heat or cold therapy. It was noted that both acute and chronic pain decreased after the four hours of vibration session [10] as in the current study. The results showed a significant effect in pain among the low back pain survivors. Pain, disability and overall quality of life can be reduced when vibration is applied along with standard physical therapy protocols [11]. Additionally, motor control and overall performance of muscles can improve with the application of focal muscle vibrations [12]. The vibration of five minutes improved the overall flexibility and strength of the muscles among the elderly population with low back pain[13]. The effects of muscle vibration can persist for a long time, depending on their impact on the nervous system, by generating either negative or positive feedback to improve muscle length and overall work generated by the muscle [14].

Through focal muscle vibration, the results show significant improvement in terms of pain reduction and flexibility. Similarly, it is confirmed that FMV in neuropathic patients was associated with improved pain and mobility [15]. A study was conducted on students to check the improvement in muscle length of the subject after the application of local vibratory devices. Muscle length is associated with an increase in various conditions and deteriorate further muscular injury. The joint range was improved in all the participants[16].

The findings are interesting as the results suggest that focal muscle vibrators, when used for low back patients, increased flexibility and reduced the low back pain. Muscle soreness did improve significantly when assessed within the group analysis, but the overall result does not reflect significance. Soreness is mostly due to overwork or exercise-induced, known as DOMS. It is a duration-based phenomenon which requires time for betterment. When vibrators were used to decrease DOMS, it showed alleviation in pain but not a solid conclusive result and warrants for further study [17]. The use of focal muscle vibrators to decrease pain and increase flexibility is further claimed by studies which suggest its use for enhanced athletic performance, focusing on its therapeutic effects and considering it an important matter [18]. For enhanced neuromuscular performance, mechanical oscillation through vibration could be an effective exercise intervention. Vibration can be applied locally or for the whole body. Vibration therapy can decrease muscle soreness, increase the range of motion, improve muscular strength, kinesthetic awareness, and power development and increase blood flow in the area applied [19].

Muscle soreness changes the posture moving towards rigidity, and the soreness perception is the main cause for it, but following vibration therapy, the pain perception decreases, causing a decrease in soreness perception, too [20].

The current study has some limitations. The first limitation is the lack of BMI calculation as it is importantly corelate with low back pain. The second limitation is the subjective tools utilization for the data collection, as objectivity may affect the sensitivity of the data and results as well. Hence, the author may suggest considering the objective measurements of clinical features like an algometer for pain/tenderness etc. As the sample size was calculated with the online sample size calculator instead of the prevalence model for calculation, hence it might affect the generalizability among the low-back population.

## CONCLUSION

Focal muscle vibrator of 120Hz frequency along with physical therapy exercise protocol (experimental group) is superior in improving pain and flexibility of patients having mechanical low back pain in comparison to physical therapy protocol alone (control group), but muscle soreness was improved in both groups there was statistically no significant difference observed in between-group analysis.

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**Authors Contribution:**

***Mirza Obaid Baig:*** Substantial contributions to the conception and design of the work
***Maham Malik:*** Acquisition of data for the work.
***Anam Pervez Qureshi:*** Analysis, and interpretation of data for the work.
***Abdul Wasay Nafe:*** Drafting the work for important intellectual content.
***Zarlish Ayan:*** Final approval of the version to be published.
**Aqsa Liaquat:** Interpretation of data for the work.


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