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Immediate effects of myofascial release (foam-rolling) with static stretching in patients with mechanical neck pain-a randomized controlled trial

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Abstract
Background: Faulty posture is a frequent cause of neck pain and disability. As the posterior neck musculature needs to support the weight of the head against the pull of gravity, they are in a constant state of contraction. This sustained contraction leads to connective and soft tissue changes and shortening of these structures, eventually leading to lengthening and weakness of the opposing group of muscles and contributing to pain. Thus, treatment must aim at pain relief and lengthening these tightened structures. With this purpose in mind, the use of a foam-roller for administering Myofascial release to the posterior neck muscles in patients with mechanical neck pain has not been adequately explored. Hence, the aim of this study was to find out if foam-rolling for neck used in conjunction with static stretching yield significantly greater improvements in mobility and pain, immediately post intervention, in patients with acute mechanical neck pain.
Methods: 78 individuals, of any gender, in the age group of 19-35 years, experiencing mechanical neck pain for < 3 months were allocated to the study after screening for inclusion and exclusion criteria. After obtaining written consent, the participating individuals were randomly allocated into: a control group receiving 10 minutes of Hot Fomentation followed by 10 minutes of static stretching and an experimental group receiving Myofascial release using foam-roller for 5 minutes in addition to hot fomentation and stretching. Intensity of neck pain was assessed using Visual Analogue Scale (VAS) and active cervical range of motion using a universal goniometer prior to and immediately post intervention.
Results: The mean reduction in VAS score in experimental group was 27 mm (SD 16) while in control group it was 9.2 mm (SD 8.1). The mean increase in active cervical range of: flexion was 7.8° (SD 4.7) v/s 4.4° (SD 2.9), extension was 10° (SD 6) v/s 4.1° (SD 2.7), right lateral flexion was 6.7° (SD 3.8) v/s 3.4° (SD 2.4), left lateral flexion was 7.4° (SD 3.1) v/s 2.8° (SD 2.5), right rotation was 7.7° (SD 5.4) v/s 3.7° (SD 3) and left rotation was 9.8° (SD 5.5) v/s 3.8° (SD 2.9) in the experimental group and control group respectively.
Conclusion: Individuals with mechanical neck pain experience better short-term improvements in pain and cervical mobility post foam-rolling used in conjunction with stretching.

Keywords: neck pain, range of motion, myofascial pain syndromes, static stretching, visual analogue pain scale

1. Introduction
Neck pain is a significant health problem in the general population associated with disability and carrying important health and economic costs [1]. In the Global Burden of Disease 2010 study, neck pain is ranked the fourth leading cause of disability [measured in years lived with disability (YLDs)] with an estimated global age-standardised point prevalence of neck pain around 4.9%, with about 50% of the patients experiencing persistent pain after 1 year [2]. Mechanical neck pain or non-specific neck pain is defined as pain in the neck arising from poor posture, sustained, long term, and abnormal physiologic loads on the neck. These loads compromise the pain sensitive structures and therefore affect the function of the cervical spine causing a musculoskeletal imbalance in the upper quarter of the body [3].

Trauma to the cervical spine from faulty posture is a frequent cause of pain and disability. Postural tension implies that the extensor muscles of the cervical spine must be in sustained isometric contraction to support the head in its ahead of the centre of gravity position [4]. This leads to changes in connective tissue length and strength, because of stretching of the anterior structures of the neck and shortening of the posterior muscles [1].

Sustained muscular contraction accumulates excessive muscular metabolites, which become irritants and cause resultant muscular contraction. The contracted muscles literally constrict the intrinsic blood vessels, so that when there is excessive muscular contraction requiring blood supply there is diminished blood flow. Ischemia results, and there is venous lymphatic compression, which prevents washing out of the accumulated metabolites. A vicious circle results, with ischemic pain as the end point [4]. This leads to formation of hyperirritable spots (Myofascial trigger points) associated with a taut band of a skeletal muscle that is painful on compression or stretch, in the neck and shoulder muscles which contribute to symptoms in mechanical neck pain [5]. Greater numbers of active as well as latent trigger points were explored in the upper trapezius, splenius capitis, semispinalis capitis, sternocleidomastoid, levator scapulae, and scalene muscles [6].

Myofascial release (MFR) is a collection of approaches and techniques that focus on freeing the restrictions of movement that originate in the soft tissues of the body due to musculo-fascial tightness. The application of controlled and focused force, applied in a purposeful direction, acts to stretch or elongate the muscular and fascial (Myofascial) structures toward the goals of restoring the fluid/lubricative

quality of the fascial tissue, the mobility of tissue, and normal joint function [7]. Myofascial release along with conventional therapy is more effective in alleviating primary symptoms of pain and movement restriction thus enhancing the functional capabilities of the patients [8]. Stretching has also been found to be effective in decreasing pain and increasing cervical range of motion in patients with chronic neck pain [9]. Static stretching consists of a sustained external end range force applied by manual contact or a mechanical device to the tightened structures [10].

Foam roller is a tool of administering Myofascial release in which the individual uses his/her body weight to apply pressure to the soft tissues during the rolling motion [11]. Foam rollers are commonly used as an adjunct to a stretching program or in some cases may serve as a replacement of regular static stretching. Evidence states that Myofascial release therapy could be better than a multimodal physiotherapy program for short term improvement of pain in patients with neck pain and it was found to be more effective than manual therapy for recovering range of motion in occupational mechanical neck pain [12, 13, 14]. However, the use of a foam roller for administering Myofascial release to the posterior neck muscles in patients with mechanical neck pain has not been adequately explored.

Hence, the aim of this study was to find out if foam rolling for neck used in conjunction with static stretching yield significantly greater improvements in range of motion and pain, immediately post intervention, in patients with acute mechanical neck pain.

2. Materials and Methods

2.1 Design (Figure 1)

This was a two-arm, parallel group, randomized controlled trial with random allocation. The study was performed in the institution's Out Patient Department of Musculoskeletal physiotherapy. 100 adults in the age group of 19-35 years experiencing mechanical neck pain for less than 3 months were approached. 78 eligible and willing participants were assessed for the outcome measures and then randomized in a 1:1 ratio to either the control intervention (static stretching) or the experimental intervention (foam-rolling followed by static stretching) provided for 20-25 minutes. Randomization was achieved using a computer-generated random sequence. A single physiotherapist applied the exercise protocols and measured the outcomes in this study.

2.2 Participants, therapists, centers

Individuals recruited in this study could be of any gender and had to be in the age group of 19-35 years and must be experiencing mechanical type of neck pain since less than 3 months. Patients with: history of degenerative musculoskeletal conditions (e.g. prolapsed intervertebral disc, spondylosis, spondylolisthesis etc.), history of traumatic or surgical conditions like fractures affecting the cervical vertebrae, scapula, clavicle or humerus, instrumentations of cervical spine etc., history of inflammatory disorders (e.g. rheumatoid arthritis, ankylosing spondylitis etc.), any metabolic or endocrine conditions (e.g. diabetes, hypothyroidism, goitre etc.), neurological involvement, or vertebra-basilar insufficiency, clinically diagnosed mental health illness and on treatment for the same (e.g. Depression, drug / alcohol abuse, etc) and pregnant female individuals were excluded from the study.

2.3 Outcome measures

The intensity of pain at rest was measured in millimeters on a Visual Analogue Scale of 0-100 mm. The data record sheet containing a 100 mm line with the starting point marked as 0 (No Pain) and end point marked as 10 (most severe pain) was provided to the participants. The participants were asked to mark a point on the line that best quantified their current intensity of neck pain from 0 to 10. The distance from the starting point to the marked point was measured in millimetres (mm) using a ruler and was recorded [15].

The active range of cervical flexion, extension, right lateral flexion, left lateral flexion, right side rotation and left side rotation was measured using the universal goniometer [16]. The patient was seated erect on a chair without arm rests. The patient was asked to keep the neck relaxed and to look straight.

Flexion: For measuring flexion, the fulcrum of the goniometer was placed over the external auditory meatus, the fixed arm of the goniometer was kept perpendicular to the ground and the movable arm was aligned with the base of the nares. The participant was then asked to bend the neck forward as much as possible while keeping the shoulders and trunk fixed. The movable arm was aligned with the base of the nares and the reading was recorded in degrees [16]. The normal range for cervical flexion in the age group of 20-29 is 60± 10 SD and for the age group of 30-39 is 58± 8 SD [17].

Extension: For measuring extension, the fulcrum of the goniometer was placed over the external auditory meatus, the fixed arm of the goniometer was kept perpendicular to the ground and the movable arm was aligned with the base of the nares. The participant was then asked to bend the neck backward as much as possible while keeping the shoulders and trunk fixed. The movable arm was aligned with the base of the nares and the reading was recorded in degrees [16]. The normal range for cervical flexion in the age group of 20-29 is 75± 10 SD and for the age group of 30-39 is 69± 10 SD [17].

Side Flexion: For measuring either side flexion, the fulcrum of the goniometer was placed over the spinous process of the C7 vertebra. The fixed arm was aligned to the spinous processes of the thoracic vertebrae so that it was perpendicular to the ground. The movable arm was aligned with the dorsal midline of the head, using the occipital protuberance as a reference. The participant was then asked to bend the head sideways as if to touch the right ear to the right shoulder without turning the head, for measuring right side flexion and as if to touch the left ear to the left shoulder for measuring left side flexion. At the end of either side flexion the fixed arm was maintained in the starting position and the movable arm was aligned to the dorsal midline of the head and the reading on the goniometer was recorded in degrees [16]. The normal range for side flexion in the age group of 20-29 is 46±7 SD and in the age group of 30-39 is 42±7 SD [17].

Rotations: For measuring rotations, the fulcrum of the goniometer was aligned over the centre of the cranial surface of the head, the fixed arm was aligned parallel to an imaginary line joining both the acromion processes and the movable arm was aligned with the tip of the nose while the head was in neutral position. The participant was then asked to turn their head to look to their right as much as possible without moving from their trunk for measuring right

rotation and turn to look left for left rotation. At the end of rotation, the fixed arm was kept aligned to the starting position and the movable arm was realigned to the tip of the nose. The reading was recorded in degrees for right and left rotations [16]. The normal range for rotations in the age group of 20-29 is 78±7 SD and for the age group of 30-39 is 79±8 SD [17].

2.4 Intervention

The participants allotted to the control group received 10 minutes of hot water fomentation using a standard hydro collator pack followed by static stretching of bilateral upper trapezius, scalenes, levator scapulae and sub occipital muscles as follows.

Upper Trapezius: Patient was relaxed and in sitting position with the ipsilateral hand behind the back to stabilise the scapula. The head was rotated to the tight side. The stretch was applied passively by adding a combination of cervical flexion, further rotation to the tight side, and side bending away from the tight side. The distal clavicle and scapula were further depressed with other hand. The stretch position was maintained for 30 seconds. A short period of recovery was allowed and three such cycles were carried out. The process was repeated for the contra lateral side [18]. (Figure: 2-A)

Levator Scapulae: The patient was positioned in relaxed sitting. The head was rotated to the side opposite to the side of tightness and bent forward. The arm on the side of tightness was abducted and placed behind the head. The head was stabilised and the superior angle of scapula depressed. With this position maintained the patient was instructed to breathe in and out for 30 seconds. A recovery period was given after which the cycle was repeated to carry three such cycles in total. Process was repeated on the contra-lateral side [18]. (Figure: 2-B)

Sub occipital muscles: Patient was positioned in relaxed sitting. The spinous process of the second cervical vertebra was stabilized with the thumb and index finger around the transverse process. While maintaining the stabilisation, the patient was instructed to carry out the head nod, guided by the therapist. This position was maintained for 30 seconds. Time for recovery was given and three such cycles were carried out [18]. (Figure: 2-C)

Scalene Muscles: Patient was positioned in relaxed sitting. The patient was instructed to carry out a chin tuck and straighten the neck. The head was bent to the side opposite to the tightness and rotated to the side of tightness. This position was maintained with the thorax stabilised for 30 seconds while the patient was instructed to carry out deep inhalation and exhalation. Time for recovery was given and three such cycles were carried out. The process was repeated on the contra lateral side [18]. (Figure: 2-D)

Those allotted to the experimental group received 10 minutes of hot water fomentation followed by 5 minutes of foam rolling to the sub occipital muscles using neck decompress and base of skull shear techniques as instructed by the therapist certified in Myofascial Release Technique, followed by stretching as done for the control group.

For neck decompress, the patient was lying in a supine position with knees bent. The foam roller was placed behind the neck one inch below the hairline. The patient was instructed to tip his/her nose toward the ceiling and apply gentle pressure on the roller and this pressure was maintained throughout this movement. Further instructions were- “inhale slowly, and on exhalation slowly nod your chin down. Inhale as you hold this position and on exhalation lift your chin slightly and return your nose toward the ceiling”. (Figure 3) This process was repeated 4 times. Then the roller was removed to allow for recovery. The cycle was repeated thrice. For base of skull shear, the patient was lying on the right side with the base of the skull behind the right ear lying on the foam roller. The knees were kept bent and the right arm extended out to relax the shoulders. The patient was instructed to take a deep breath while creating small circular motions of the head in either directions 5-6 times. Then after a pause, the left knee was opened towards the ceiling so that the patient was lying on the right half of the back. The roller was still under the base of the skull, an inch or so away from the right ear closer to the centre of the base of the skull. The patient was again told to take a deep breath and repeat the circular motion of the head. (Figure 4) The same procedure was repeated with the patient lying on the left side. Then the patient was instructed to lie on the back with knees bent with the centre of the base of skull on the roller with chin lifted slightly. While maintaining consistent pressure, the patient was instructed to inhale deeply and carry out 5-6 figure of eight motions of the head while exhaling [19].

2.5 Data analysis

The calculation of the required sample size was based on power of 80%, an alpha of 5%, a smallest worthwhile increase of 3 degrees, and an anticipated standard deviation of 5 degrees in cervical range of motion [20]. This calculation gave a sample size of 70 participants (35 per group); this was increased to 78 participants, considering 10% non-response rate. The data was entered using Microsoft Office Excel 2016 and was analysed using a statistical software. Mean and standard deviations for the quantitative variables were calculated. Normality of data was assessed using the Kolmogorov – Smirnov Test. Inter- group analysis was done using parametric test for data that passed normality (unpaired t-test) or non-parametric test if data did not pass normality (Mann-Whitney test). The analysis was conducted at 95% confidence level. P value less than 0.05 was considered statistically significant.

3. Results

There were 27 females 28 females (72%) and 11 males (28%) in the experimental group whereas there were (69%) and 12 males (31%) in the control group. There was a statistically significant difference in the mean age of individuals in both the groups. The groups were similar with respect to baseline measures of pain intensity and mobility except for left rotation range of motion which was statistically significant. (Table 1)

The intensity of pain reduced by a mean of 27 mm (SD 16) post intervention in the experimental group whereas it reduced by a mean of 9.2 mm (SD 8.1) post intervention in the control group. A significantly greater reduction in the intensity of pain was seen when Myofascial release using a foam roller was added to static stretching. (Table 2) (Figure 5)

The mean increase in active cervical range of: flexion was 7.8° (SD 4.7) v/s 4.4° (SD 2.9), extension was 10° (SD 6) v/s 4.1° (SD 2.7), right lateral flexion was 6.7° (SD 3.8) v/s 3.4° (SD 2.4), left lateral flexion was 7.4° (SD 3.1) v/s 2.8° (SD 2.5), right rotation was 7.7° (SD 5.4) v/s 3.7° (SD 3)

and left rotation was 9.8° (SD 5.5) v/s 3.8° (SD 2.9) in the experimental group and control group respectively. Thus, a much greater increase in cervical mobility was found when Myofascial release using a foam roller was added to static stretching. (Table 2) (Figure 6)

4. Discussion

The results from this study showed that the individuals receiving Myofascial release with a foam roller in adjunct to static stretching and hot fomentation perceived much lesser intensity of pain in the neck and as a result also had a better cervical mobility than those who received only static stretching and hot fomentation.

Therapeutic heat reduces the concentration of pain producing toxic metabolites by increasing local circulation, reduces painful muscle spasm and is psychologically relaxing, thereby favourably modifying emotional response to pain. Stretching results in stress relaxation in the muscle creating an acute increase in joint range of motion which may be related to an analgesic effect allowing the person to tolerate a greater stretch. These acute effects of increased range of motion and analgesia tend to persist for 60 to 90 minutes [10].

Foam rolling reduces the pressure pain thresholds and releases the area of impaired sliding fascial mobility thus improving pain perception over a short duration [13, 14]. It is an effective way to address fascial restrictions when there is limited time for manual soft tissue mobilisation techniques. Foam rolling a muscle causes autogenic inhibition which can help improve soft tissue extensibility by relaxing the muscle, thus allowing for activation of the antagonist muscle [21]. This allows correction of muscle imbalances and in turn relieves the pain and disability associated with faulty postures causing trauma to the cervical spine. The gate control theory of pain suggests that the faster moving pressure stimuli with foam rolling interfere with the transmission of painful stimuli to the brain thus closing the gate to the brain's perception of pain [8]. All the above-mentioned mechanisms might explain the additive effect of foam rolling along with the therapeutic effects of stretching and hot fomentation in achieving greater pain relief.

Various studies have found that foam rolling with static stretching was superior to foam rolling or static stretching alone for increasing the range of motion in the hip, knee and ankle [11]. Myofascial release using a foam roller may mechanically shear out the cross-links in the tight fascia and breakdown scar tissue, remobilizing the fascia back to its gel-like state. If heat from rolling friction, mechanical stress, massage or pressure is applied to the fascia, it flushes out the muscle inflammatory exudates and pain metabolites, breaks down the scar tissue, desensitizes the nerve endings and reduces muscle tone allowing for a greater range of motion [22, 23]. It is also known that stretching leads to a significant increase in range of motion mostly due to increased stretch tolerance and a significant reduction in most forms of muscular performance due to acute stress-relaxation in the muscle [10]. Our study also supports these findings as an acute increase in the range of motion in all planes was found, more so when stretching was combined with foam rolling.

This study has limitations as the results cannot be generalised to patients with chronic neck pain and those having non-mechanical neck pain. It also does not compare the manual methods of Myofascial release to foam rolling. Another limitation was the uneven age distribution in both the groups with a slightly more number of younger patients in the experimental group which could have affected the results.

Clinically important difference (CID) values of mean change in pain intensity on VAS range from 20.9 to 57.5 mm and the CID optimal cut off point from 11.5 to 28.5 mm [23]. In the present study, the mean change in VAS score obtained in the experimental group was 27 while in the control group it was 9.2. Thus, it can be said that there was a clinically significant change in the pain intensity when foam rolling was combined with static stretching. According to a study, measures of active cervical ROM in the sagittal (flexion/extension) and transverse (rotation) planes were found to be significantly associated with disability scores and improvements in active ROM will most likely be clinically relevant to patients' overall functional improvement and can be correlated to their overall prognosis [25]. Hence, a greater improvement in the active cervical range of motion achieved by combining foam rolling with static stretching will lead to a better prognosis of patients. Static stretching is widely taught to the patients as a part of self-management and foam rolling being a form of self-Myofascial release can also be taught to the patients for managing recurrent bouts of acute neck pain independently.

Table 1: Characteristics of the participants (n = 78).

Characteristics	Experimental group (n=39)	Control group (n=39)	p value
Age (years), Mean (SD)	26 (4.1)	29 (4.2)	< 0.001
Gender, n male (%)	11 (28%)	12 (31%)	
VAS score (mm), mean (SD)	52 (13)	53 (14)	0.86
Flexion ROM (degrees), mean (SD)	35 (10)	34(9.8)	0.88
Extension ROM (degrees), mean (SD)	53 (10)	56 (9)	0.11
Right. Lateral flexion ROM (degrees), mean (SD)	32 (4.3)	31 (6)	0.23
Left Latteral flexion ROM (degrees), mean (SD)	29 (5.7)	30 (5.5)	0.44
Right Rotation. ROM (degrees), mean (SD)	69 (7.8)	71 (6.8)	0.41
Left Rotation ROM (degrees), mean (SD)	67(7.9)	71 (5.3)	0.019

SD: Standard Deviation, VAS: Visual Analogue Scale, ROM: Range of Motion

Table 2: Comparison of difference in the intensity of pain and cervical mobility post intervention in the two groups.

Outcome measure	Experimental group (n=39)	Control group (n=39)	Difference	P value
VAS score (mm), mean (SD)	27 (16)	9.2 (8.1)	18	<0.0001
Flexion ROM (degrees), mean (SD)	7.8 (4.7)	4.4 (2.9)	3.41	0.0006
Extension ROM (degrees), mean (SD)	10 (6)	4.1 (2.7)	5.9	<0.0001
Right Lateral flexion ROM (degrees), mean (SD)	6.7 (3.8)	3.4 (2.4)	3.2	<0.0001
Left Lateral ROM (degrees), mean (SD)	7.4 (3.1)	2.8 (2.5)	4.5	<0.0001
Right Rotation ROM (degrees), mean (SD)	7.7 (5.4)	3.7 (3)	3.9	0.0005
Left Rotation ROM (degrees), mean (SD)	9.8 (5.5)	3.8 (2.9)	6	<0.0001

SD: Standard Deviation, VAS: Visual Analogue Scale, ROM: Range of Motion

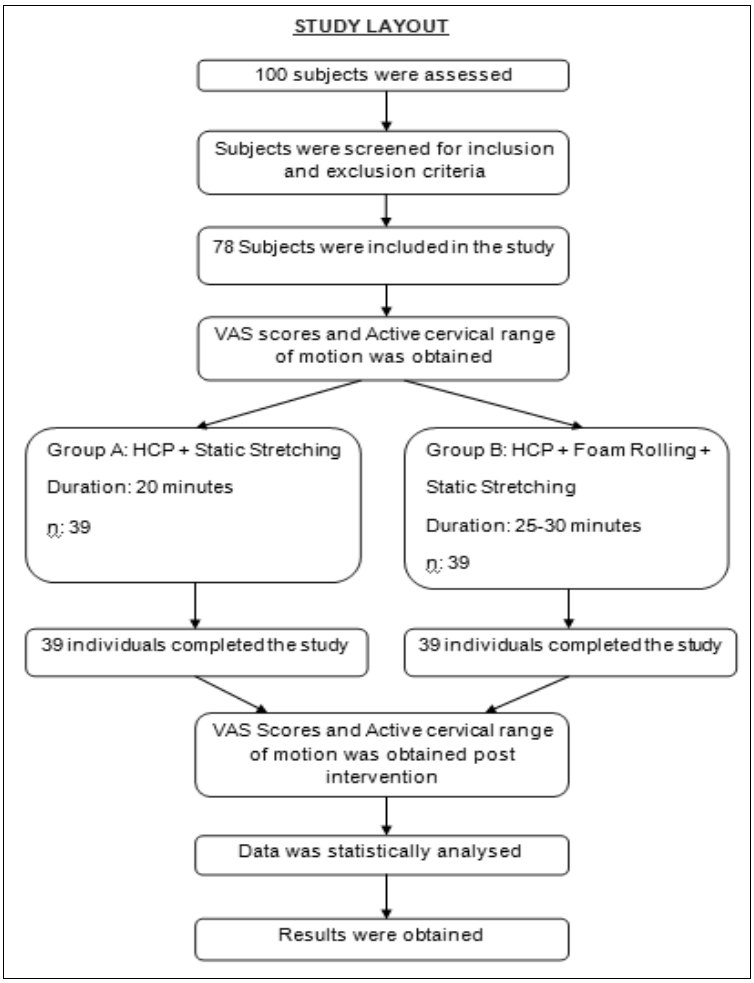

Fig 1: Flow of patients throughout the study

Fig 2: Therapist performing static stretching for the participants.

Fig 3: Participant performing neck decompress method of foam-rolling for the neck.

Fig 4: Participant performing base of skull shear technique of foam-rolling for the neck.

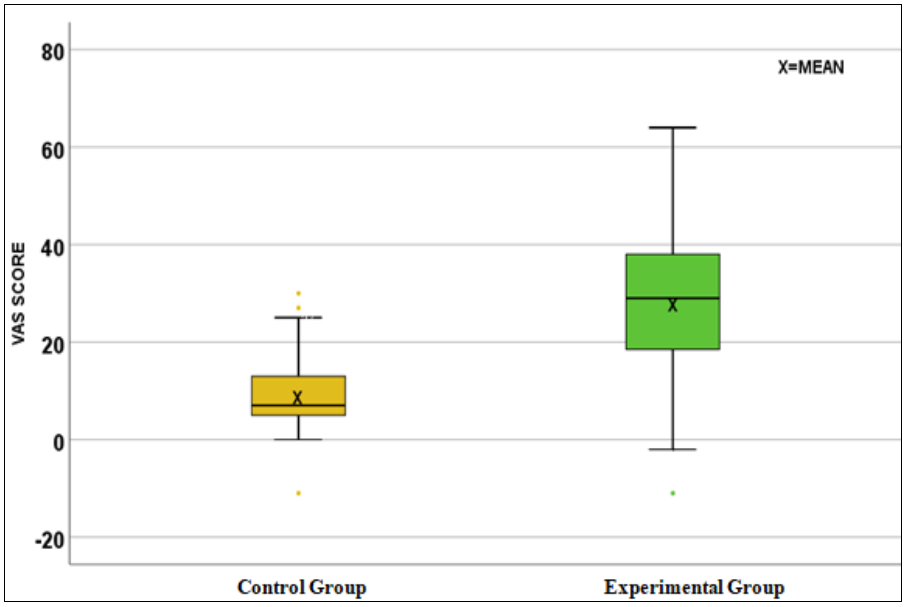

Fig 5: Comparison between mean decrease in the VAS scores post intervention in both the groups. (p value <0.0001)

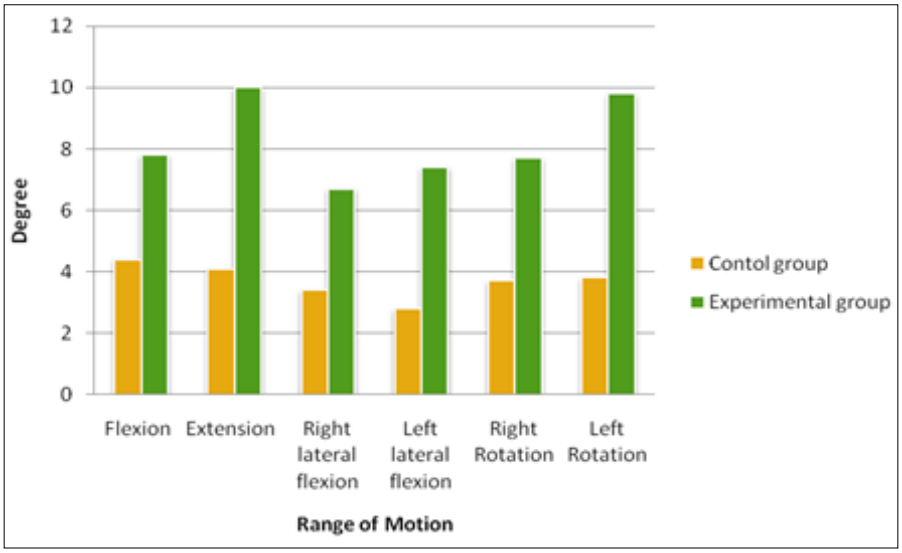

Fig 6: Comparison between mean increase in active cervical range of motion post intervention in both groups. (P value < 0.0006)

6. Conclusion

Through our study we reinforce that a multidisciplinary approach is needed in the management of individuals with chronic neck pain, especially targeting the myofascial dysfunctions which lead to myofascial pain syndromes related to mechanical neck pain.

This study concludes that Myofascial release using a foam roller combined with static stretching is better than static stretching only in reducing pain and improving the active cervical range of motion in patients with mechanical neck pain.

Thus, myofascial release therapy using a foam roller to the suboccipital muscles combined with static stretching had a better outcome than static stretching alone, for reducing pain and enhancing active cervical range of motion.

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