

Effects of muscle energy techniques versus corrective exercise programme on pain, range of motion and function in patients with upper cross syndrome: a randomised clinical trial

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Abstract

Introduction. Upper crossed syndrome (UCS) is a common musculoskeletal issue that includes the dysfunctional tone of the muscles in the shoulder girdle or cervicothoracic region. The objective of the current study is to compare the effects of muscle energy techniques with the National Academy of Sports Medicine-based exercise protocol on pain, range of motion, and disability in patients with UCS.

Methods. It was a single-blinded randomised clinical trial carried out in the Physiotherapy Department of the University of Lahore Teaching Hospital, Pakistan. Fifty patients with upper cross syndrome aged between 20 to 35 years were randomly allocated into two groups: group A (routine physical therapy combined with muscle energy techniques) and group B (routine physical therapy combined with the National Academy of Sports Medicine-based exercise protocol) for three sessions per week for total 8 weeks. Data were collected at baseline, 4th, 8th, and 12th week for assessing the long-term effects of the treatment protocol as well. The Visual Analogue Scale, Neck Disability Index, and an inclinometer were used to measure the pain, disability, and range of motion of the cervical region, respectively. The data was analysed using SPSS version 23.0 (IBM, New York, USA).

Results. Out of 50 participants, 30 were male and 20 were female. The mean age of all the participants in experimental group A was 29.76 ± 2.89 and that in experimental group B was 30.56 ± 2.48 . At the 4th, 8th, and 12th week, pain and disability were significantly (p -value < 0.05) reduced and cervical range of motion was significantly (p -value < 0.05) improved within both groups. After 8 weeks of treatment, a significant between-group difference was seen in favour of group A in terms of cervical range of motions (flexion, extension, rotation, and side bending) with p -values of less than 0.05 and in favour of group B in terms of pain (p -value 0.03) and disability (p -value 0.04) was seen. These differences were maintained at the 12th week follow-up as well.

Conclusions. This study concluded that both NASM (National Academy of Sports Medicine-based exercise protocol) and METs (muscle energy techniques) are effective treatment options for people with upper cross syndrome. It was also concluded that METs are more effective in improving Range of motion (ROM), while the NASM-based exercise protocol is more effective in improving symptoms of pain and neck-related disability.

Key words: muscle energy techniques, pain, range of motion, and upper cross syndrome

Introduction

Upper crossed syndrome (UCS) is a collective postural dysfunction of the musculature of the shoulder girdle and cervicothoracic area. Some muscles involved in UCS are either weakened (e.g., the rhomboids, trapezius, serratus anterior) or tightened/overactive (e.g., the pectoralis major, elevator scapulae and upper fibres of the trapezius), which may lead to various postural deformities. These deformities include rounded shoulders, enhanced kyphotic curve, forward head posture, and loss of cervical lordosis [1]. Phasic and postural muscles are the two types of muscles involved in UCS. In UCS, the postural muscles get tightened during various physical activities and movements, while the phasic muscles develop inhibition and weakness. Therefore, once dysfunction in muscular tissue begins, typical patterns of altered posture and muscular imbalance ensue. Forward head posture and rounded shoulder posture (RSP) are prevalent in people of all ages and different jobs [2].

Currently, with the development of technology and the novel environment of work, employees have to maintain a sustained stationary posture of the spine, along with repetitive upper limb activity for longer periods in front of a computer. These sustained postures can under-activate several mus-

cles while over-activating other muscles, causing the dysfunctional postural pattern leading to UCS [3].

Many epidemiological studies have shown a high incidence of vertebral postural abnormalities in adults, including the forward head posture (FHP) and protracted shoulder (PS) posture [4]. The incidence of upper cross syndrome-related neck pain in medical students of the University of Lahore, Pakistan and College of Physiotherapy, Ahmednagar, India was found to be 37.1% and 30.43%, respectively [5, 6]. Females and individuals working for an extended period were found to be more prone to UCS [7]. It is most common amongst the young population and among professionals such as musicians and dentists. The incidence among dentists and musicians is 57% and 37.1%, respectively [8].

The prevalence of neck pain due to UCS is approximately 10–15% more common in middle-aged women than men [9]. Increased kyphotic curve in the thoracic region is evident in older individuals, causing a significant health risk. Excessive kyphosis (hyper-kyphosis) causes many disabilities [10]. Also, shoulder pain occurs in 21% of the overall population, due to repetitive overhead use (> 60 degrees of shoulder elevation), constant overhead work, and lifting higher loads. In addition, UCS can cause an irregular thoracic spinal curve, and causes the biomechanics of the glenohumeral joint to be changed.

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Abnormal biomechanics of the cervical spine may lead to a loss of cervical curve and, if not addressed, degeneration of the cervical spine may occur. In people with UCS, chronic headaches can also affect the individual's quality of life [11].

Several therapeutic methods have been used for patients with UCS, including physical therapy, body condition retraining, auxiliary devices, using adhesive tapes and exercises [12]. Recently, muscle energy techniques (METs) are becoming popular among therapeutic modalities to enhance the elasticity of contractile and non-contractile tissues [13]. Muscle energy techniques are a soft tissue softening process used by combining isometric contractions. The use of this method is intended to restore normal tissue formation to normal and provide an indirect effect on the joint associated with inactive muscles and can be used to normalise joint mobility in dysfunctional soft tissue structures [14]. Muscle energy techniques reduce hyper-performance and ease in the forward head posture. The process behind this effect could be a neuro-physiologic process that caused the Golgi Tendon Response, to block the motor neuron and thus compress the sub-occipital muscles [15].

Both conventional therapy and MET were found to be beneficial for the treatment of upper cross syndrome, with a significant difference observed between these two regimes, in which MET was found to be superior to conventional physical therapy. It was better than the stretching technique for improving pain and functional disability in people with mechanical neck pain [16]. Also, MET was found to be more effective in comparison with conventional physical therapy [17]. A study showed that MET is also an effective treatment strategy for the pain in the cervical region occurring especially due to myofascial trigger points [18]. Among other treatments, it has been found that eight-week corrective trials moderate muscle activity and can be used to treat the development of more advanced musculoskeletal disorders in a person with UCS [19]. The eight-week exercise was effective in reducing sternocleidomastoid and upper trapezius muscle function and the upper trapezius/serratus anterior and upper trapezius/lower trapezius ratios, which increased the serratus anterior and lower trapezius activity. In terms of looking for robust results, it can be said that corrective exercise (stretching and strengthening the body) is a safe and inexpensive way to balance the activities of the muscles of the upper quadrant. Exercise can be suggested as an effective way to restore and maintain moderate muscle function in people with UCS [20]. In this protocol, instead of solely lengthening the shortened or stiff muscle, it is better to first use inhibiting exercises, followed by lengthening exercises and activating and integrating exercises on the muscle [12]. The four-step exercise program for upper crossed syndrome begins with preventing or reducing excessive muscle contraction, expanding these same muscles, tightly testing to eliminate dysfunctional muscles, and finally participating in broader muscles to restore functional mobility [21]. Based on the characteristics mentioned in the literature, it can be expected that a NASM(National Academy of Sports Medicine)-based exercise protocol can provide long-term benefits.

According to the null hypothesis of the study, it is proposed that there is no significant difference in pain, range of motion and function of individuals with upper cross syndrome when a NASM-based exercise protocol is applied in comparison with muscle energy techniques.

Most studies available on this topic focused on individual short-term effects of various treatment protocols on different clinical outcomes. To the best of the researchers'

knowledge, no research has been conducted to study the comparative effects of MET and NASM-based corrective exercise programmes on people with UCS. Therefore, this study compares the short- and long-term effects of these treatment protocols on pain, range of motion, and function in patients suffering from upper cross syndrome.

Subjects and methods

Patient information

The calculated sample size was six in each group and was calculated by OpenEpi [19]. We involved 25 patients in each group for a final sample size of 50. The patients were enrolled through non-probability convenient sampling. 55 patients of upper cross syndrome, diagnosed and referred by an orthopaedist, were screened for eligibility according to the exclusion and inclusion criteria. Individuals with upper crossed syndrome presented with a forward head posture, hunching of the thoracic spine as well as changed function in the shoulder girdle, elevated and protracted shoulders, scapular winging and decreased mobility of the thoracic spine, round shoulders, and kyphosis. Postural deviations also included excessive neck protraction and thoracic spine flexion, anterior tilt, and downward rotation of scapula with an inclining tendency and internal rotation of the shoulder.

The fifty patients were randomly allocated into two equivalent groups, as mentioned above (Figure 1). Patients of both sexes (male and female) aged between 20 and 35 years [8] having a clinical presentation of upper cross syndrome for a minimum of 4 weeks [22] were included in the study. Patients with mild-to-moderate disability and pain intensity of VAS score > 3 were included, such as osteoporosis, blood disease, acute rheumatoid arthritis, congestive heart disease, cancer, severe skin sensitisation, major mental disease, and frozen shoulder, were excluded from the study [8]. Patients having a history of recent surgery, joint diseases of the spine, and fractures were also excluded from the study.

Rehabilitation protocol

Patients in group A were treated with a routine physiotherapy programme (30 min) combined with muscle energy techniques (METs) (30 min), three sessions a week for a total of 8 weeks, while Group B patients were treated with a standard physiotherapy programme (30 min) combined with National Academy of Sports Medicine (NASM)-based exercises (30 min), three times a week for a total of eight weeks.

Muscle energy techniques (METs)

In muscle energy techniques, both post-facilitation stretching and post-isometric relaxation techniques were applied. METs were applied to the upper trapezius and levator scapulae muscles for 5 repetitions with 20% of maximal isometric contractions while keeping the stretch beyond the resistance barrier for 20 s [8]. This protocol included 1 set of 5 repetitions per session, 3 sessions per week, along with conventional physical therapy for 8 weeks (24 sessions). The stretching duration was 8–10 s in the post-isometric relaxation [11] technique and 15 s for the post-facilitation stretch (PFS) technique. Patients were positioned either in a supine lying or sitting position [23].

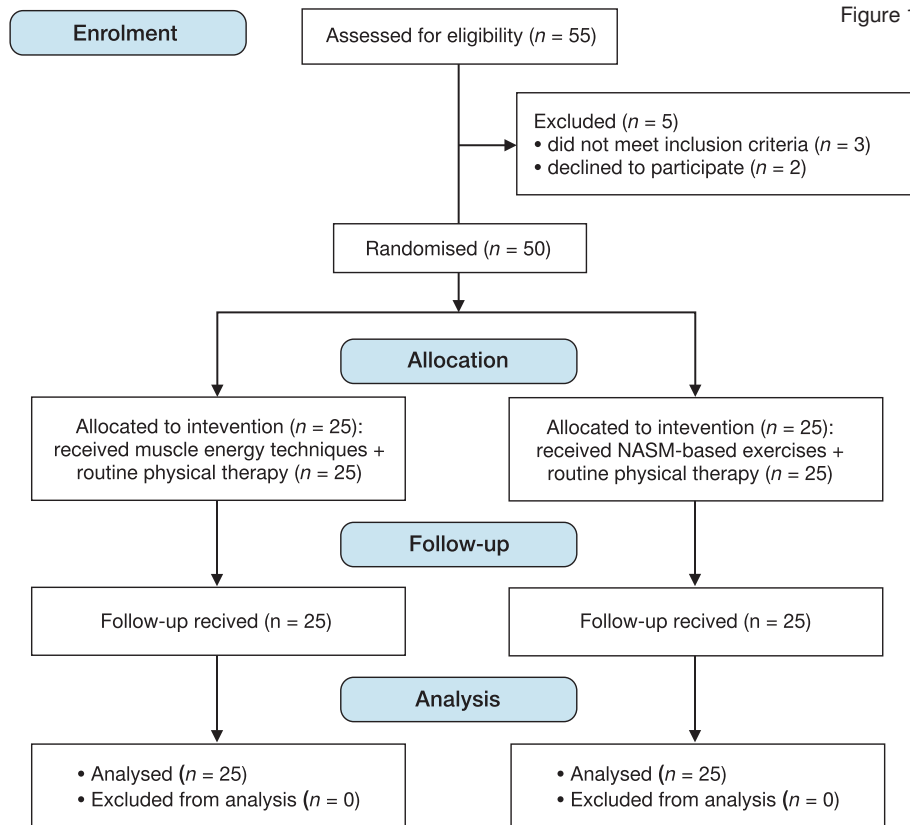


Figure 1. Consort flow diagram of the clinical trial

NASM-based exercise programme

The four-stage exercise for upper cross syndrome begins with preventing or reducing excessive muscle contraction (frequent foam wrapping), relaxing these same muscles, which fully eliminates dysfunctional muscles, and finally restores functional mobility [21].

Step 1: inhibit or self-myofascial release overactive muscles: It includes the levator scapulae, trapezius (upper fibre), and sternocleidomastoid muscles. Hold pressure was applied for 30 s on the tender spots.

Step 2: lengthen/ static stretch.

Upper trapezius

The patient was asked to tuck the chin in and then slowly move the left ear towards the left shoulder.

Levator scapulae

Continue by chin rotation downwards until the patient feels a stretch on the right side.

Sternocleidomastoid (SCM)

The patient was asked to tuck the chin in and then slowly move the left ear towards the left shoulder without the rotation of the chin at the top.

Movements were performed on both sides, and the stretch position was held for 20 to 30 s.

Step 3: activate/strengthen.

Chin tucks

1. The patient was asked to get on their hands and knees with their back straight and head in line with the spine and to extend the chin towards the floor.

2. The patient was asked to scoop the chin down below the chest as much as possible (such as saying 'yes').

Floor cobra

1. The patient was asked to lie down on the floor, keeping their arms to the sides of their body (or arms in front of the body in the 'Superman' position) and palms facing down.

2. They brought their shoulder blades together and raised the chest, held it for 2 s, then gradually returned the body to the ground, keeping the chin tucked in.

Step 4: integrate.

Ball combination

1. The patient was asked to lie on their stomach on a stabilising ball, keeping their feet pointing down and legs straight while holding a dumbbell in each hand.

2. They pushed their chest into the ball by keeping their back and neck in the proper line, stretched their arms in front of their body, and squeezed the gluteus muscles and raise the arms, keeping the thumbs up and the shoulders back and down.

3. The arms were moved straight to the sides with the thumbs in an upward direction (capture).

4. The patients moved their arms to the sides of their body, pulled them back, and retracted the shoulder blades (cobra).

The patients were told to hold each position and then return their arms to an extended position in front of their body. Each exercise was repeated 10 to 15 times, for 1–2 sets.

Routine physical therapy

The routine physical therapy (RPT) protocols included strengthening exercises of the deep cervical muscles, lower fibres of the trapezius, rhomboids, and serratus anterior, (2 sets of 10 repetitions per day), and pectoralis muscle exercises (20 s holding, 5 repetitions). A commercially available cervical hydrocollator moist heat pack (24 inches) was applied for 15 min over the affected part in the neck area before treatment. The temperature of the hydrocollator unit was fixed to seventy degrees and up to eight layers of towels were used [8].

Measurement tools

The severity of pain was measured on a simple, effective,

permissible, and minimal pain scale, i.e., the Visual Analogue Scale (VAS) [24]. The patient has to mark a point on the 10-cm-long line that indicates no pain on one side and extreme pain on the other side. The distance from the no pain point to the patient’s mark indicates the severity of the pain in terms of numbers [25]. The range of motion (ROM) of the cervical spine was calculated using an inclinometer [26]. To use the inclinometer, the therapist holds the instrument near the joint to be measured, turns its dial to the zero reading, then moves the inclinometer along with the patient’s movement. Readings can be seen in degrees on the dial of the inclinometer. Cervical extension, cervical flexion, left- and right-sided rotation, and bending were the measurements taken [27]. To determine the severity of the failure and functional limitations due to neck pain and disability, the Neck Disability Index (NDI) was used. It is a questionnaire comprising 10 questions measuring the disability associated with a patient’s neck pain behaviour. The questions contain the activities of daily life, such as personal care, lifting, learning, working, driving, sleeping, leisure activities, pain intensity, concentration, and headache. Each question is rated on a scale of 0 (no disability) to 5 (worst imaginable pain), and a total of 100 points is calculated by summing the points of each item and then doubling the result. A high NDI score means a significant functional limitation of the patient due to neck pain [28].

Data collection procedure

Fifty participants were randomly allocated into two groups: group A – METs group, and group B – NASM group (25 in each group). Patients were recruited through a physiotherapist that is not directly involved in the application of treatment and randomisation was done by using the sealed envelope method. Patients were treated three times a week for a total of 8 weeks. After allocation to the groups, the participants were assessed at baseline and comparability was checked. Afterwards, data was collected at 4-week intervals until the conclusion of the 8-week interventions. To assess the long-term effects of the treatment protocol, the patients were reassessed at 4-week intervals after the last treatment session. All assessments were performed by the same physical therapist at all stages of the data collection for all patients.

Data analysis

Data were analysed using SPSS version 24.0 (IBM, New York, USA). Means, standard deviations, and mean ranks were used to express descriptive statistics. The normality of the data was tested with the Shapiro–Wilk test. Outcome parameters (pain, range of movement, and functional disability) were assessed by parametric or non-parametric tests, depending on the normality of the data. Between-group differences were calculated by the independent sample *t*-test/Mann–Whitney *U* test. Training-induced change within each group was analysed by repeated measure ANOVA/Friedman repeated tests. A *p*-value < 0.05 was considered significant with a confidence interval of 95%.

Results

Out of the 50 participants, the number of male participants in the METs group and NASM group was 16 and 14, respectively, and the number of female participants was 9 and 11, respectively. The mean (standard deviation) age of the patients in the METs group and NASM group was 29.8(2.9) and 30.6(2.5) years, respectively. In METs group A, the num-

Table 1. Demographics of the participants at baseline before undergoing any intervention

Variables	Group A (RPT + METs)	Group B (RPT + NASM)
Age (mean ± SD)	29.76 ± 2.89	30.56 ± 2.48
Underweight	1(4%)	1(4%)
Normal	10(40%)	9(36%)
Overweight	11(44%)	12(48%)
Obese	3(12%)	3(12%)
4–7 weeks since symptoms started	9	12
8–10 weeks since symptoms started	9	10
> 10 weeks since symptoms started	7	3
VAS (pain)	25.24	25.76
ROM (flexion) (mean ± SD)	42.72 ± 6.10	42.52 ± 6.09
ROM (extension) (mean ± SD)	46.24 ± 5.76	48.08 ± 5.36
ROM (right-sided bending) (mean ± SD)	20.84 ± 2.47	20.12 ± 3.27
ROM (left-sided bending) (mean ± SD)	20.44 ± 2.46	19.92 ± 2.51
ROM (right rotation) (mean ± SD)	42.88 ± 4.60	43.16 ± 3.78
ROM (left rotation) (mean ± SD)	42.28 ± 4.58	42.68 ± 3.95
NDI (mean ± SD)	43.96 ± 9.67	45.20 ± 9.35

RPT – routine physical therapy, METs – muscle energy techniques, NASM – National Academy of Sports Medicine, VAS – visual analogue scale, ROM – range of motion, NDI – Neck Disability Index

bers of underweight, normal, overweight, and obese participants were 1, 10, 11, and 3, and for those in the NASM group, the numbers were 1, 9, 12, and 3. Nine patients in the METs group and 12 patients in the NASM group reported a duration of symptoms of 4 to 7 weeks, while 9 patients in the METs group and 10 in the NASM group reported a duration of symptoms of 8 to 10 weeks. The number of patients who reported a duration of symptoms of more than 10 weeks was 7 and 3 in the METs group and NASM group, respectively. Sixteen patients out of 25 in METs group experienced mild disability and 9 experienced moderate disability, while in the NASM group, 17 patients experienced mild disability while 8 experienced moderate disability at baseline on the NDI Scale. Both the groups were comparable at baseline. Table 1 shows the demographic data of the participants at baseline.

Pain

The pain was significantly reduced in both the METs and NASM groups (*p*-value 0.000), as shown by the within-group comparisons. Table 2 shows the Friedman’s test of pain, as measured by the Visual Analogue Scale. Pain scores were more significantly reduced in the NASM group as compared to the METs group after 8 weeks of intervention. The results of the between-group comparisons for mean change in the Visual Analogue Scale (VAS) scores using the Mann–Whitney *U* test are shown in Table 3.

Disability

Table 4 shows the between-group differences in the NDI. According to the repeated measure ANOVA test, both groups showed significant within-group differences with a value of

Table 2. Friedman’s tests and statistics of pain as measured by VAS

Groups	VAS (pain)	Percentiles			df	Asymp. sig.
		25 th	50 th (median)	75 th		
Group A (METs + RPT)	baseline	4.0	5.0	6.0	3	0.000
	4 th week	3.5	5.0	6.0		
	8 th week	3.0	4.0	5.0		
	12 th week	3.0	3.0	5.0		
Group B (NASM + RPT)	baseline	4.0	5.0	6.0	3	0.000
	4 th week	4.0	5.0	6.0		
	8 th week	2.0	3.0	4.0		
	12 th week	2.0	3.0	4.0		

VAS – visual analogue scale, METs – muscle energy techniques, RPT – routine physical therapy, NASM – National Academy of Sports Medicine; *p* value is significant at ≤ 0.005

Table 3. Between-group comparisons for mean change in VAS scores using Mann–Whitney *U* test

VAS (pain)	Mean rank group A (RPT + METs)	Mean rank group B (RPT + NASM)	<i>p</i> -value	Z-value
At baseline	25.24	25.76	0.896	-0.130
At 4 th week	23.82	27.18	0.400	-0.842
At 8 th week	29.64	21.36	0.039	-2.061
At 12 th week	29.60	21.40	0.039	-2.061

VAS – visual analogue scale, METs – muscle energy techniques, RPT – routine physical therapy, NASM – National Academy of Sports Medicine; *p*-value is significant at 0.005; Z-value shows the number of standard deviations from the mean

Table 5. Between-group change scores for cervical range of motion, including cervical flexion, extension, side bending, and rotations through independent *t*-test

Variables	Period	Group A (RPT + METs) mean \pm SD	Group B (RPT + NASM) mean \pm SD	<i>p</i> -value
Cervical flexion	week 4	45.4 \pm 6.29	44.0 \pm 6.1°	0.429
	week 8	58.68 \pm 4.56	52.92 \pm 6.20°	0.000
	week 12	59.68 \pm 3.90	56.20 \pm 4.15°	0.004
Cervical extension	week 4	58.92 \pm 4.28	56.2 \pm 6.27°	0.080
	week 8	63.04 \pm 3.83	58.68 \pm 5.11°	0.001
	week 12	63.16 \pm 3.59	58.64 \pm 5.20°	0.001
Cervical right-sided bending	week 4	21.72 \pm 2.60	21.44 \pm 2.84°	0.718
	week 8	25.16 \pm 1.99	22.60 \pm 2.5°	0.000
	week 12	25.16 \pm 1.99	23.04 \pm 2.50°	0.002
Cervical left-sided bending	week 4	23.12 \pm 2.69	22.4 \pm 2.73°	0.354
	week 8	25.64 \pm 1.93	22.60 \pm 3.04°	0.000
	week 12	26.1 \pm 1.92	23.40 \pm 2.82°	0.000
Cervical right rotation	week 4	52.56 \pm 3.64	52.28 \pm 3.39°	0.780
	week 8	64.28 \pm 5.63	54.28 \pm 3.56°	0.000
	week 12	64.24 \pm 5.60	54.00 \pm 3.64°	0.000
Cervical left rotation	week 4	53.12 \pm 3.55	53.24 \pm 3.36°	0.903
	week 8	64.72 \pm 5.23	54.24 \pm 3.81°	0.000
	week 12	63.76 \pm 5.79	54.04 \pm 3.63°	0.000

METs – muscle energy techniques, RPT – routine physical therapy, NASM – National Academy of Sports Medicine
p-value is significant at 0.005

Table 4. Between-group change scores for NDI scores

Variables	Period	Group A (RPT + METs) mean \pm SD	Group B (RPT + NASM) mean \pm SD	<i>p</i> -value
Disability	week 4	39.96 \pm 9.24	38.16 \pm 7.93	0.500
	week 8	32.28 \pm 7.05	30.48 \pm 5.50	0.045
	week 12	32.28 \pm 7.28	29.00 \pm 5.44	0.021

NDI – Neck Disability Index, METs – muscle energy techniques, RPT – routine physical therapy, NASM – National Academy of Sports Medicine; *p*-value is significant at 0.005

Wilk’s Lambda test of 0.252, *F* value of 45.45, and *p*-value less than 0.05. The METs group decreased the estimated marginal mean value of the NDI from 43.96 to 39.96 in the 4th week (*p*-value 0.001), and to 38.28 in 8th week. The value remained the same as in the 12th week. The NASM group decreased the mean value of NDI from 45.20 to 38.16 in the 4th week (*p*-value 0.000), to 30.48 in the 8th week (*p*-value 0.000), and to 29.0 in the 12th week (*p*-value 0.000).

Cervical range of motions

Table 5 shows the cervical range of motions, including cervical flexion, extension left- and right-sided cervical rotation to both sides.

Cervical flexion: Both groups showed significant within-group differences with a Wilk’s Lambda value of 0.159, *F* test value of 80.845, and *p*-value of 0.000. In the METs group, the estimated marginal mean value of cervical flexion increased from 45.4° to 59.68° in the 4th to 12th week, respectively (*p*-value 0.00 in the 4th week and 0.01 in 12th week). In the NASM group, the cervical flexion mean values increased from 44° to 58.20°, in the 4th to 12th week, respectively (*p*-value of 0.00 in the 4th week and 0.01 in the 12th week).

Cervical extension: Both the groups showed significant within-group differences with a Wilk's Lambda value of 0.122, F test value of 11.02, and p -value of 0.00. In the METs group, the estimated marginal mean value of cervical extension increased from 58.92° to 62.92° in the 4th to 12th week, respectively. In the NASM group, the cervical extension mean value increased from 56.20° to 59.40°, in the 4th to 12th week, respectively.

Cervical right-sided bending: Both groups showed significant within-group differences with a Wilk's Lambda value of 0.29, F test value of 36.3, and p -value of 0.00. In the METs group, the estimated marginal mean value of cervical right-sided bending increased from 21.72° to 25.16° in the 4th to 12th week, respectively. In the NASM group, the cervical right-sided bending mean values increased from 21.44° to 23.04°, in the 4th to 12th week, respectively.

Cervical left-sided bending: Both groups showed significant within-group differences with a Wilk's Lambda value of 0.183, F test value of 68.2, and p -value of 0.00. In the METs group, the estimated marginal mean value of cervical left-sided bending increased from 23.12° to 26.16° in the 4th to 12th week, respectively. In the NASM group, the cervical left-sided bending mean values increased from 22.40° to 23.4°, in the 4th to 12th week, respectively.

Cervical right-side rotation: Both the groups showed significant within-group differences with a Wilk's Lambda value 0.118, F test value of 114.1, and p -value of 0.00. In METs group, the estimated marginal mean value of cervical right-side rotation increased from 52.56° to 64.24° in the 4th to 12th week, respectively. In the NASM group, the cervical right-side rotation mean values increased from 52.28° to 54°, in the 4th to 12th week, respectively.

Cervical left-sided bending: Both groups showed significant within-group differences with a Wilk's Lambda value of 0.114, F test value of 118.8, and p -value of 0.00. In the METs group, the estimated marginal mean value of cervical left-sided bending increased from 53.12° to 63.76° in the 4th to 12th week, respectively. In the NASM group, the cervical left-sided bending mean values increased from 53.24° to 54°, in the 4th to 12th week, respectively.

Discussion

In upper cross syndrome, tightness of the upper trapezius and other scapular muscles in the posterior area, along with shortening of a few chest muscles as well as weakening of the lower and middle trapezius and deep neck muscles, is seen [29]. This asymmetry interferes with normal joint functions. This condition is prevalent among many professionals, such as students, teachers, and health care workers, including physiotherapists. Despite sufficient knowledge of musculoskeletal disorders and an adequate understanding of ideal posture, management options for neck pain and other complications secondary to UCS are still understudied [30]. Therefore, the current research aimed to study the effects of routine physical therapy when applied with METs or NASM to reduce cervical pain and neck-related disability and to improve cervical range of motions among young patients with the upper cross syndrome. The results of the study show that muscle energy techniques (METs) are more effective in improving range of motion while the National Academy of Sports Medicine (NASM)-based exercise protocol is more effective in reducing pain and neck-related disability in patients with upper cross syndrome.

The current study showed that the mean VAS scores (pain) were reduced in both interventional groups. In group

A (RPT+ METs), the mean pain score at baseline was 4.52, which was reduced to 3.64 by the end of 8 weeks of treatment and these scores were maintained even at the follow-up assessment after 4 weeks. However, this decreasing trend of VAS pain scores was more apparent in group B, where the initial mean VAS pain score was 4.52, which was reduced to 2.96 at the end of eight weeks. A significant difference ($p = 0.039$) was seen between groups in reducing pain in favour of the NASM-based protocol after 8 weeks of treatment. This result is similar to the findings of a study conducted by Almasoodi et al. [19], which concluded that NASM-based exercises showed a significant reduction in pain and functional disability among young males with upper cross syndrome. Another study was also in line with the findings of the current study, in which the NASM-based protocol has a significant effect on posture, pain, and functional disability amongst patients with upper cross syndrome [21].

This study concluded that both groups showed a significant ($p < 0.05$) increase in all cervical range of motions among participants. Possible reasons include the application of routine physical therapy along with the assumed effect of post-isometric relaxation on reducing muscle tone after performing isometric muscle contraction. Moreover, it was also seen that the muscle energy techniques, along with routine physical therapy, are significantly ($p = 0.000-0.001$) more effective in increasing the cervical range of motions (flexion, extension, side bending, and rotations) compared to the NASM protocol with routine physical therapy after 8 weeks of the treatment protocol. The results of the current research are supported by a study conducted by Rana et al., in which METs were found to be more beneficial in the treatment of upper cross syndrome as compared to routine physical therapy because, in METs, the pain perception was reduced by increasing the stretch tolerance of the participants. The mechanoreceptors in the muscles and proprioceptors in the joints are stimulated, while stretching and isometric muscle contractions are completed together. This stimulation finally reduces the pain perceptions [8]. Also, applying METs on tight neck muscles could increase myofascial tissue flexibility. This produces a change in extracellular fluid dynamics and positively affects the viscoelastic tissue of muscles [31].

The results of our study are also comparable with a published study in which METs were proved to be more effective in improving ROM and reducing pain and disability compared to stretching exercises in upper cross syndrome [32]. Vaseghnia et al. [33] also claimed that muscle energy techniques might be effective in reducing the level of pain and disability index, but there were no significant differences in the stiffness index after 24 hours and one week after the treatment and they concluded that applying METs specific to dysfunction (anterior innominate or posterior innominate) might be more effective in improving the patient's symptoms.

The current study showed that the disability was reduced in both interventional groups. However, disability was more reduced in group B (routine physical therapy + NASM) with a mean of VAS (4.54 ± 1.12) at the start of the study and a mean of VAS (3.40 ± 1.37) at the 8th week. A significant difference was seen between groups at the 8th week in terms of pain and disability in favour of group B. Even though the decrease in pain and improvement in the disability is not large, it is still statistically significant. As pain intensity or severity and disability are prominent determinants of the quality of life of the patients [34], even a minor improvement in these domains can have a strong impact on the overall well-being of the patients. These findings are supported by published literature in which the NASM-based exercise protocol has

shown to be effective in several musculoskeletal disorders [35, 36]. Similarly, in a study conducted by Abdolhazad et al. [21], 8 weeks of the NASM exercise program is considered one of the most effective ways to restore upper limb performance by increasing strength and flexibility among patients with the upper cross syndrome.

NASM exercises are designed in such a way that they can be applied to the chain reaction theory given by Janda and Bruegger's gear mechanism. In upper cross syndrome, postural malalignment in one segment of the spine affects distal or proximal segments. The interdependence of neck and shoulder abnormalities and different complications related to them were addressed during this therapy protocol. Instead of solely focusing on lengthening the stiff muscles, it is much better to integrate inhibiting exercises, which are followed by lengthening, activating, and integrating exercises. METs and other traditional structural treatment approaches for treating postural malformations are based on local strengthening and stretching of the weakened and shortened muscles, respectively. NASM exercises were mostly performed in weight-bearing positions with close chain motions to mimic real-life activities, thus reducing neck-related functional disability more efficiently, as measured by NDI. These exercises are actively performed in dynamic patterns by the patient [35].

The NASM-based exercise protocol can enhance the stability of the upper body, control pain and discomfort, and improve functional status. Therefore, implementing this treatment protocol could be of great importance, especially in terms of reducing pain and improving upper extremity functions. Accordingly, in the field of physical therapy, numerous specialists have implemented these novelties, which help them to manage people with UCS and further choose relevant corrective procedures to improve it and anticipate secondary consequences.

Conclusions

This study concluded that both NASM and METs are effective treatment options for people having neck pain and disabilities secondary to upper cross syndrome. It also concluded that when the treatment is given for 2 months, METs are a more effective treatment in improving cervical range of motions (flexion, extension, side bending, and rotation on both sides), while the NASM-based exercise protocol is more effective in improving symptoms of pain and neck-related disability. These improvements are also maintained after 4 weeks of follow-up.

Limitations

1. The sample size of the current study was small, and so it should be conducted on a larger population.

2. Forward head posture (FHP) and kyphosis were not observed or checked.

3. This study did not follow strict diagnostic criteria to analyse posture while including participants.

4. The age range was limited, so the results of this study cannot be generalised to other populations.

5. Besides NASM and METs, routine physiotherapy was also used, making it difficult to say that all the improvements were solely because of NASM or METs, because they might be due to routine physiotherapy sessions.

Availability of data and materials

The data collected and analysed will be accessible from the corresponding author on realistic application. The personal information of participants will be kept confidential.

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Disclaimer

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Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by Ethical Review Committee of the University Institute of Physical Therapy, University of Lahore (approval No.: IRB-UOL-FAHS/883/2021). The study is registered in the Iranian Registry of Clinical Trials (number IRCT20210816052201N1; 06/09/2021)..

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

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Conflict of interest

The authors state no conflict of interest.

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