Efficacy Of Phases Of Cervical Spine Rehabilitation Program In Mechanical Neck Pain

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Abstract : Mechanical neck pain is defined as the neck pain of mechanical origin not attributable to a recognizable or a specific known pathology. 30 individuals who met the inclusion criteria were taken. On the 1st week, Phase I: training deep neck stabilizers exercises were given. On the 2nd week, in addition to Phase I, Phase II: training muscle imbalance and scapular stabilizers exercises were given. On the 3rd week, in addition to Phase I & II, Phase III: posture and thoracic mobility training exercises were given. On the 4th week, in addition to Phase I, II & III, Phase IV: re-training the sensory-motor response exercises were given. From 5th to 8th week Phase I, II, III & IV exercises were given. The exercises were given 4 days a week, 30-45 minutes with standardized 10 repetitions of 3 sets in one session for 3-5 times per day. The outcome measure included were Neck Disability Index(NDI), Cervical Range Of Motion Assessment (Measured With Inch Tape), Craniocervical Flexion Test (Using A Pneumatic Compression Device), Cervical Extensor Endurance Test and PostureScreen Mobile Application. The above outcome measures were taken on the first day and the subjects were re-assessed at the end of every week but only the pre-test and end of 8th week evaluation results were delineated in statistical analysis. The outcome measures of the pre-test and post-test evaluation were analysed using paired student t-Test which showed significant improvement. This multimodal approach for subjects with mechanical neck pain proved to be effective in improving their functional activities.

Keywords: Mechanical Neck Pain, Phases of neck rehabilitation, Posture Screen Mobile Application.

I. INTRODUCTION

Mechanical neck pain is defined as the neck pain of mechanical origin not attributable to a recognizable or a specific known pathology (Pranjal Gogoi 2015).[20] The 2010 global burden of disease states that neck pain is ranked 4th among people living with disability affecting 30-50% of the general population, estimated to be 70% of the Indian population, irrespective of age, are sufferers of neck pain (JOSPT 2018)[1] and the prevalence is at an increasing stake among the young adults (GROSS.A Cochrane systematic review 2015).[9] Mechanical neck pain is pervasive and an increased prevalence is found among the subjects who have presented at the outpatient department. Hence several researchers and clinicians suggests that the goals of a rehabilitation program should include pain reduction, normalized range of motion and neuromuscular control as well as adequate strength and endurance of the cervical spine, in order to prevent the incidence of re-occurrence.The literature suggests that the main long-term consequences of neck pain are individual disability and job absenteeism, which are recognized as significant public health and socioeconomic problems.[1,17]

Mechanical neck pain can be produced from involvement of different structures like muscle, ligament, fascia, bone, joint capsule, cartilage and blood vessels. These structures may get pulled or strained causing release of cytokines or chemokines, which stimulate the surrounding structures eliciting pain (Vora, Doerr & Wolfer, 2010).[71]

Mechanical neck pain is pervasive generally, as a series of deterioration process undergoing, not sentient of which started first. The deterioration process is as follows,

- ✓ Reduced strength of neck muscle stabilizers.
- ✓ Poor posture.
- ✓ Weakness and adaptive shortening of certain musculatures around neck.
- ✓ Reduced proprioception.
- ✓ Impaired balance.

Continuous neck pain has the potential to change the biomechanics of cervical spine (Boyoung, Young Kim 2016).[5]

Individuals who are prone to this includes,

- ✓ desk job for more than 4 hours in a row.[1,8]
- ✓ driving for 2 hours and more.[9,14]
- ✓ heavy helmet users.[1,20]
- ✓ bifocal users.[20,23]
- ✓ sleeping with an awkward posture.[1,20,39]
- ✓ carrying heavy weights on head.[1,8,24]

- ✓ activities involving continuous extended neck such as writing on board, repairing, painting etc.[1,39,41]
- ✓ periods of long sitting like attending lecture and driving long term visual display terminal operators, dentist, musicians (violinist, guitarist etc).[41,42]

Researchers suggests that goals of rehabilitation program for chronic neck pain should include pain reduction, normalized range of motion, neuromuscular control as well as adequate strength and endurance of the cervical spine(ROIJEZON 2015)[70] it should be addressed in phases to prevent the incidence of re-occurrence (Bryan 2014).[7,60]

Deep neck stabilizers, the cervical segment is supported by the longus colli muscle anteriorly, semispinalis cervicis and cervical multifidus muscles posteriorly, over the craniocervical region is supported by the longus capitis muscle anteriorly, suboccipital extensor, semispinalis, and splenius capitis muscles posteriorly.[71]

Studies have identified impaired activation of the deep cervical flexor muscles (longus colli and longus capitis) in people with neck pain.[6] Given the role of the deep cervical flexor muscles in postural support and the knowledge of impaired activation of these muscles in people with neck pain, the subject would display deficits in the postural endurance of these muscles.[4,5,10] Indeed, people with neck pain tend to drift more into a forward head position when they are not consciously aware of their posture.[22,50,68]

Range of motion exercises in non-weight bearing is initiated passively in chin retracted position. Performing head nodding and rotation helps to establish the available range of motion.[60,70]

Carrie M.Hall, Lori Thein Brody 2014 describes that isometric exercise is commonly used to increase muscle performance. Although no joint movement occurs, isometric exercise is considered functional because it provides a strong base for dynamic exercise and many postural muscles work primarily in an isometric fashion. Isometric exercise is used as a special technique in proprioceptive neuromuscular facilitation to improve the endurance and to strengthen the muscle.[8,9,60]

Directional preference exercises is the motion in any area of the body that needs to be either repeatedly loaded or the position sustained in non weight bearing or partial weight bearing, is often pushed to end range.[60]

Sterling (2001) found that cervical spine mobilization itself activated deep flexor muscular activity of the cervical spine.[70]

Chin retraction in different positions[13,20] such as sitting, supine, prone, quadruped, brugger relief posture helps to incorporate great amount of neck muscle stabilization.[27,33,60]

Liebensen 2007 and Jull 2008 [73,74] suggest a craniocervical flexion exercise as part of an initial training program to activate the deep flexors of the neck, Dong Yeon Kang 2015 concluded that craniocervical flexion with pressure sensor shows significantly greater outcome in improving muscle endurance and cervical range of motion when compared to the craniocervical flexion training.[22]

L Parazza 2014 suggest that endurance of deep neck extensors such as splenius capitis, semispinalis cervicis and splenius cervicis do play a significant role in neck stabilization.[26]

One of the deleterious effects of chronic neck pain is the presentation of forward neck posture.[2,3,12] Forward head posture is the structural forward positioning of the head, away from the centerline of the body, where lower cervical vertebrae are bent and upper cervical vertebrae are extended, and the weight of the head supported by the neck is increased.[22,38] The flexion moment of the head applies pressure on muscles and joints around the cervical vertebra, in addition to active myofascial trigger points of the suboccipital muscle which may induce neck pain and tension type cervical headaches, while reducing the mobility of the neck. As a compensatory action for the postural deformity of forward head posture, severe extension arises between the upper cervical joint and atlanto-occipital joint, and the upper cervical vertebrae relatively protrude forward while the face directs upwards. Change in the curvature of the neck bone causes upper-crossed syndrome due to an imbalance in muscular pattern, which subsequently leads to rounded shoulder posture (Harman K, Hubley-Kozey CL, Butler H 2016).[50,57,68]

Dolphus thacker 2011 defines Upper Crossed Syndrome as the tightness of the upper trapezius, pectoralis major, and levator scapulae and weakness of the rhomboids, serratus anterior, middle and lower trapezius, and the deep neck flexors, especially the scalene muscles.[3]

Ajith Dabhoikar, Sujatha Yardi 2015 put forth that scapular muscle strengthening must be rendered in individuals with chronic mechanical neck pain.[49]

Jull (2015) points out the evidence that postural training itself can improve neck muscle function.[38]

Improvements in cervical proprioception will allow the patient to maintain a stable cervical position while progressing to a specific strengthening exercises.[74]

Several studies concluded that, fatigued cervical muscle in chronic neck pain impairs postural stability which should also be addressed as a part of rehabilitation protocol. (Mazen M. Alqahtani 2015).[29,30,31]

As per the meta-analysis for individuals with chronic neck pain, the desired recommendation of exercising is 3 sessions per week approximately 30-60 minutes of 10 repetition of 3-5 times.[6]

Generally in common practice, this scenario of mechanical neck pain is often left careless by addressing only the symptom and not the cause. Since it is multifactorial and the several interventions quoted above, proves an evident correction of mechanical neck pain individually, this study is an attempt to amalgamate everything within 8 weeks of duration.

With an increased incidence of mechanical neck pain in addition to the high level of failure of treatment leading to reoccurrence, we are intended to consider the muscle adaptation to exercise (6-12 weeks).[71]

With the advent of technology, the internet is flooded with information and the young adults fail to filter the right content. Thereby ending up, either over or under incorporation of the exercises advised.

NEED AND SIGNIFICANCE OF THE STUDY

As per the suggestions from several researchers, the goals of rehabilitation program for chronic neck pain should include pain reduction, normalized range of motion, neuromuscular control, adequate strength and endurance of the cervical spine (ROIJEZON 2015) and it should be addressed in phases to prevent the incidence of re-occurrence (Bryan 2014). There is scarcity of scientific research studies showing, which method is most effective in the treatment of chronic neck pain. The intent of this study is to address chronic mechanical neck pain with the four phases of rehabilitation intervention in order to evaluate the clinical outcome as objective measure.

AIM OF THE STUDY

To determine the efficacy of phases of cervical spine rehabilitation program in mechanical neck pain.

OBJECTIVES OF THE STUDY

1) To analyze effectiveness of training of deep neck stabilizers in mechanical neck pain.
2) To analyze effectiveness of training neck muscle endurance and scapular stabilization in mechanical neck pain.
3) To analyze effectiveness of posture and thoracic mobility training in mechanical neck pain.
4) To analyze the effectiveness of re-training sensory motor response in mechanical neck pain.
5) To determine the effectiveness of the above phases of cervical spine rehabilitation protocol in improvement of the functional outcome.

HYPOTHESIS

EXPERIMENTAL HYPOTHESIS:

There will be significant changes in mechanical neck pain followed by cervical spine rehabilitation program.

NULL HYPOTHESIS:

There will be no significant changes in mechanical neck pain followed by cervical spine rehabilitation program

REVIEW OF LITERATURE

PETER R.BLANPIED et al (2017) estimates that 22-70% of populations are victims of neck pain at atleast one point in their life. It has been reported that 30% of individual develop chronic symptoms. [1]

ANITA R.GROSS et al (2017) reported that global burden of disease injury and risk factor 2010 study in which neck pain is ranked IV among people living with disability. The neck pain is ranked 21st on overall in global cause of disability adjusted life years. [1, 9]

MEGAN M.HEINTZ et al (2008) explains that mechanical neck pain commonly arises insidiously and is generally multifactorial in origin and encompasses various factors such as poor posture, anxiety, depression, strains, sporting and occupational activities. He also adds that treatment of chronic mechanical neck pain lacks in literature. [57]

SELVAM P.SENTHIL and JINU MERLIN KOSHY (2016) interprets that the occurrence of mechanical neck pain is at higher stake among young adults of age ranging from 18-35 years. [39]

ROIJEZON et al (2015) recommends that the goals of the rehabilitation program should include pain reduction, range of motion, as well as adequate strength and endurance of the cervical spine. [60]
CLIONA O'RIORDAN, AMANDA CLIFFORD et al (2014) conducted the systematic review as of to analyse the Frequency, Intensity, Time and Type principle for individuals with chronic neck pain. [6]

BRYANS et al (2014) for Chronic Non-Specific Neck Pain. [60] Exercise (including stretching, isometric, stabilization, and strengthening) is recommended for short- and long-term benefits (pain, disability, muscle strength, quality of living, cervical ROM) as part of a multimodal approach to the treatment of chronic neck pain when combined with infrared radiation, massage, or other physical therapies. Manual therapy is recommended in the treatment of chronic neck pain for the short and long-term benefit (pain, disability, cervical ROM, strength) in combination with advice, stretching, and exercise.

GROSS et al (2015) in **COCHRANE SYSTEMATIC REVIEW** offered various interventions for chronic mechanical neck pain in phases for better long term effect. Treatment must be multimodal and not by only treating the myogenic pathology. [60]

DONG YEON KANG et al (2016) depicts that individuals who are prone to this includes, desk job for more than 4 hours in a row, driving for 2 hours and more, heavy helmet wearers, bifocal users, sleeping with a awkward posture, carrying heavy weights on head, activities involving continuous extended neck such as writing on board, repairing, painting, periods of long sitting like attending lecture and driving, long term visual display terminal operators, dentist, musicians (violinist, guitarist etc). [22]

SHAHNAWAZ et al (2013) guided pressure-biofeedback deep cervical flexor training helped in alleviating neck pain and improved muscle performance in visual display terminal operators. [23]

ZAHEEN AHAMED IQBAL et al (2017) Deep Cervical Flexor Muscles Training Using Pressure Biofeedback greatly helped in addressing the pain and disability functional outcome in School Teachers with Mechanical Neck Pain. [24]

DEEPTI ARORA et al (2013) there seem to be definitive positive correlation between endurance of deep cervical flexors and lower scapular stabilizers in computer users with chronic neck pain. [33]

YESIM DUSUNELI et al (2009) explains the neck exercise designed to improve spinal stabilization have gained popularity in the conservative treatment of patient with neck pain. [27]

JARI YLINEN et al (2003) illustrates active neck exercise in weight bearing and non-weight bearing helps to improve the functional outcome in individuals. [40]

EDMOND et al (2014) reported 70% of cervical patients presented with directional preference (mostly in extension). [60]

CARRIE M.HALL, LORI THEIN BRODY (2014) describes that isometric exercise is commonly used to increase muscle performance. Although no joint movement occurs, isometric exercise is considered functional because it provides a strength base for dynamic exercise and because many postural muscles work primarily in an isometric fashion. Isometric exercise is used as a special technique in proprioceptive neuromuscular facilitation to improve the endurance and strengthens the muscles in a weak portion of the range. Isometric exercise is most effective when individuals are in a low state of training, because the benefits of isometric exercise decrease as a state of training increases. [18,21]

STERLING et al (2001) found that cervical spine mobilization activated deep flexor activity allowing them to engage more effectively during the training exercise. [74]

MURPHY et al (2016) demonstrates the benefits of chin retraction training in different positions.[66]

LIEBENSEN (2007) AND JULL (2008) suggest a craniocervical flexion exercise as part of an initial training program to activate the deep flexors of the neck.[38]

CHIA-CHI YANG ET AL (2016) explains the motor unit recruitment of isometric flexion exercise in mechanical neck disorders.[14]

GUO LY et al (2012) depicts the three-dimensional characteristic of neck movements in subjects with mechanical neck dysfunction.[16]
PRANJAL GOGOI (2015) shows greater effects in cervical endurance training programme in mechanical neck pain. [20]

SERGIO PARAZZA et al (2014) explains a definitive improvement cervical flexor and extensor endurance training in VAS, disability index in neck pain subjects.[26]

DOLPHUS THACKER (2011) Upper Crossed Syndrome as the tightness of the upper trapezius, pectoralis major, and levator scapulae and weakness of the rhomboids, serratus anterior, middle and lower trapezius, and the deep neck flexors, especially the scalene muscles.[3]

BOYOUNG IM et al (2016) puts forth the effects of scapular stabilization exercise on neck posture and muscle activation in individuals with neck pain and forward head posture.[5]

WON-SIK BAE et al (2016) effect of middle and lower trapezius strength exercises and levator scapulae and upper trapezius stretching exercises in upper crossed syndrome.[2]

DO YOUN LEE et al (2017) there showed to be changes in rounded shoulder posture and forward head posture according to exercise methods.[4]

DVORA SHURMAN et al [2005] Published in their article that though muscle loss happens to everyone, regular exercise develops a reservoir of muscle to call upon. We use elastic bands and balls to enhance certain exercises. For example pulling an elastic band while doing arm activation or cross crawl, turns these movements into strength training.[44]

FOLLAND JP et al [2005]-Demonstrated in their study that strength training with isometric contraction produces large but highly angle specific adaptations.33 active healthy males 18-30 years completed 9 weeks of strength training of quadriceps muscle group 3 times per week. To contrast the contractile mode of isometric versus dynamic training, but diminish the strong angle specificity effect, we compared the strength gains produced by isometric training at for joint angles with conventional dynamic training. Isometric strength increases were significantly greater for trained limb.[40]

KAY TM, GROSS A et al [2005]- Selected studies were randomized and investigated the use of exercise therapy as a treatment in adults with mechanical neck disorders with or without headache. There is a moderate evidence of benefit that neck strengthening exercises reduce pain, improve function and global perceived effect for chronic neck disorder with headache in the short and long term.[9]

LEE H et al [2005]-To investigate associations between categories of response to neck pain/discomfort and (1) the endurance time of neck muscles, neck range of motion, neck and head morphology, (2) sensitization or stretch effects arising from repeating end-of-range measurements, and (3) self-report data from neck pain and disability questionnaires. The affective dimension of Neck Disability Index scores were significantly higher by subjects who had sought treatment than those of the untreated groups.[61]

SHAILESH GARDAS et al (2017) puts forth reduced cervical muscle fatigue causes postural instability.[28]

BEINERT K et al (2013) explains that balance training does have an effect on cervical sensorimotor function and neck pain.[69]

ARRIGO GIOMBINI (2013) treatment to neck balance system in alleviating long term mechanical neck pain.[67]

EYTHOR KRISTJANSSON et al (2009) neck exercise for sensorimotor function.[52]

DEOK JU KIM et al (2015) exercise program for posture correction essential in the management of neck pain.[63,64]

ZAHRA ABDOLLAHZADE et al (2017) illustrates the effects of 4 week protocol posture corrective exercise in addressing the forward head posture with swiss ball.[68]

PEROORU RUPESH et al (2017) neck stabilization tends to improve head re-positioning sense.[13,61]

JULL et al (2008) Improvements in cervical proprioception will allow the patient to maintain a stable cervical position while progressing to specific strengthening exercises.[58]
MAZEN M. ALQAHTANI et al (2015) Several studies concluded that, fatigued cervical muscle in chronic neck pain impairs postural stability which also should be addressed as a part of rehabilitation protocol.[29]

PHIL PAGE et al (2011) portrays that the clinical management of cervical headaches do include stretching and strengthening of neck musculatures.[59]

ARIMI SOMAYEH et al (2018) explains the effects of neuromuscular exercise program for neck to improve size and function of deep cervical flexor muscle in non- specific neck pain.[45]

CHUI TT et al (2012) explains good reliability and validity of cervical range of motion and isometric neck muscle assessment. (ICCs ranged from 0.92 to 0.99).[73]

DEEPAK SEBASTIAN et al (2015) cervical extensor endurance test, the inter-rater reliability was 'very good' (k = 0.800, SE of kappa = 0.109, 95% CI).[48]

ALIAA REHAN YOUSSEF et al (2016) Photogrammetric quantification for postural assessment lacks substantial evidence.[75]

DAVID M. BOLAND, ERIC V. NEUFELD (2017) Posture Screen Mobile Application (Android Version), inter-rater agreement was almost perfect (ICC≥0.81) for four measures and substantial (0.60<ICC≤0.80) for three measures during the fully clothed exam.[43]

MATERIALS AND METHODOLOGY

STUDY DESIGN : Quasi Experimental Design
STUDY SETUP : Outpatient Department,
Meenakshi Faculty of Physiotherapy,
KK Nagar, Chennai.
Vailankanni Physio Clinic,
Royapuram, Chennai.
STUDY DURATION : 8 weeks
SAMPLE SIZE : 30 subjects
SAMPLING METHODS : Convenient sampling technique

SAMPLING CRITERIA:
INCLUSION CRITERIA:

1) Age 20-35 years.[21, 22, 36]
2) Both genders.[20]
3) Quebec Task Force Classification – Grade II [38, 45, 68]
(Grade II: neck complaints and the examining physician find decreased range of motion and point tenderness in the neck).
4) Neck Disability Index : subdivision pain intensity 0,1,2,3.
5) Neck pain with symptoms more than 3 months (pulling type of pain).[1]
6) Neck pain with mobility deficit (clinical practice guidelines 2017).[1]
7) Clinical Predictor Rule for Mechanical Neck Pain.[76]

Predictor Variables

- Initial Neck Disability Index score < 11.50 points.
- Bilateral pattern of involvement.
- Not performing sedentary work> 5 hours/day.
- Feels better while moving the neck.
- Does not feel worse while extending the neck.
- Diagnosis of spondylosis without radiculopathy.

(Individuals matching any 4 of the criteria listed above will be considered).

EXCLUSION CRITERIA:

1) Neck pain radiating to upper limb and other neurological symptoms.[1,20,34]
2) Injury/dysfunctional scapulohumeral muscles.[4,5,22]
3) Impingement/movement impairments in shoulder.
4) Systemic disease including rheumatoid arthritis, type I diabetes and other systemic disease.[1]

5) Congenital disorders specific to neck including torticollis, cervical rib, sprengel's shoulder etc.[16]
6) Vertigo.
7) Vertebrobasilar insufficiency.
8) Recent surgery over neck or shoulder.[20]
9) Cervical canal stenosis or instability.[1]
10) Migraine.
11) Fibromyalgia.
12) Severe psychiatric illness.
13) Pregnancy

TOOLS REQUIRED

High couch
Low couch
Pillow
Sphygmomanometer
Tennis ball
Flexoball
Notebook
Low resistance theraband (YELLOW)
Pulley device
Bolster
Swiss ball
Headgear device with laser light
Pen
Wobble board (uniaxial, multiaxial)
Inch tape
PostureScreen mobile application

OUTCOME MEASURES:

1. Neck disability index[26,37,40]
2. Cervical range of motion assessment (measured with inch tape) [70]
3. Craniocervical Flexion Test (using a pneumatic compression device) [37,47]
4. Cervical Extensor Endurance Test [48]
5. PostureScreen Mobile Application [43]

NECK DISABILITY INDEX

Functional score which grades people with neck pain in criteria of

- Pain intensity
- Personal care (Washing, Dressing etc)
- Lifting
- Reading
- Headaches
- Concentration
- Work
- Driving
- Sleeping
- Recreation

CERVICAL RANGE OF MOTION ASSESSMENT (MEASURED WITH INCH TAPE)

The cervical range of motion is measured actively using inch tape. The subjects were placed in sitting position, with the thoracic and lumbar well supported.

CERVICAL FLEXION:

Patient position: sitting
Initially the direction of the movement was explained, patient was asked to perform and correct sequence was ensured.
With one reference point over tip of chin and another over sternal notch, the reading was noted.
The patient was asked to flex and let loose near the second reference point (sternal notch).
The difference was calculated.
The end feel was noted in case of restriction.

CERVICAL EXTENSION:

Patient position: sitting
Initially the direction of the movement was explained, patient was asked to perform and correct sequence was ensured.
With one reference point over tip of chin and another over sternal notch, the reading was noted.
The patient was asked to extend and let loose near the second reference point (sternal notch).
The difference was calculated.
The end feel was noted in case of restriction.

CERVICAL LATERAL ROTATION:
Patient position: sitting
Initially the direction of the movement was explained, patient was asked to perform and correct sequence was ensured.
With one reference point over chin and another over acromian process, the reading was noted.
The patient was asked to flex and let loose near the second reference point (acromian process).
The difference was calculated.
The end feel was noted in case of restriction.

CERVICAL SIDE FLEXION:
Patient position: sitting
Initially the direction of the movement was explained, patient was asked to perform and correct sequence was ensured.
With one reference point over tip of ear tragus and another over acromian process, the reading was noted.
The patient was asked to flex and let loose near the second reference point (acromian process).
The difference was calculated.
The end feel was noted in case of restriction.

CRANIOCERVICAL FLEXION TEST
(USING A PNEUMATIC COMPRESSION DEVICE)
Patient position: supine
Each patient had to perform the neck craniocervical flexion movement at 6 different pressure levels (22,24,26,28 and 30mmHg) with 10 second hold at each level and 30 second rest between each level.
The testing procedure was terminated if subject could not hold 10 seconds at each pressure level or if the maximum level of 30 mmHg was achieved.
The maximum pressure level achieved (activation score) with 10 seconds hold was recorded for the purpose of analysis.

CERVICAL EXTENSOR ENDURANCE TEST
Patient position: Prone lying and head till shoulder out of bed.
Patient asked to tuck the chin.
Checked for any scalene anterior lengthening.
The target holding second was 20 second.
The difference between pre and post evaluation was recorded for analysis purpose.

POSTURESCREEN MOBILE APPLICATION (ANDROID VERSION)
Mobile fixed on the wall with mobile holder.
The differences of head and shoulder deviations in posture of pre and post test evaluation were taken as the analysis of improvement.

PROCEDURE:
Individuals who met the inclusion criteria were taken for the study and were explained regarding the study objective and procedure. Of which 30 individuals who were willing and interested, were taken in the study for which a written informed consent was received from each individual explaining further benefits of the study. Then the baseline evaluation and the outcome measures [neck disability index, cervical range of motion assessment (measured with inch tape), craniocervical flexion test (using a pneumatic compression device), cervical extensor endurance test, PostureScreen Mobile Application] were recorded for statistical analysis. On the 1st week, Phase I: training deep neck stabilizers exercises were given. On the 2nd week, in addition to Phase I, Phase II: training muscle imbalance and scapular stabilizers exercises were given. On the 3rd week, in addition to Phase I & II, Phase III: posture and thoracic mobility training exercises were given. On the 4th week, in addition to Phase I, II & III, Phase IV: re-training the sensory-motor response exercises were given. From 5th to 8th week Phase I, II, III & IV exercises were given. The exercises were given 4 days a week, 30-45 minutes with standardized 10 repetitions of 3 sets in one session for 3-5 times per day. Each week progression was analyzed and only the 1st and end of 8th week score were compared for the statistical results. Following 8th week the patient was advised to continue the exercises.

TREATMENT PROTOCOL:
- **PHASE I : TRAINING DEEP NECK STABILIZERS**
- **PHASE II: TRAINING MUSCLE IMBALANCE AND SCAPULAR STABILIZERS**
- **PHASE III: POSTURE AND THORACIC MOBILITY TRAINING**
- **PHASE IV: RE-TRAINING THE SENSORY-MOTOR RESPONSE**

PHASE I : TRAINING OF DEEP NECK STABILIZERS

- **Range of motion exercise in non-weight bearing**[15,22,58,70]

Patient's position: supine with pillow
The patient was passively maintained in chin retracted position and moved into flexion, side flexion, lateral rotation.

- **Isometric exercise in weight-bearing**[26,40,75]

Patient position: long sitting
Gentle isometric contractions against finger tip resistance were performed in each of the cardinal directions.

- **Directional preference exercises**[60]

Patient position: long sitting
The patient's pain free movement was prioritized (mostly in extension) and passive overpressure was applied.

EXERCISES FOR DEEP NECK FLEXORS

- **Mobilize each segment of cervical spine**[72]

Patient position: patient preference
Each spinous and transverse process of cervical segment was addressed.

- **Chin retraction – sitting, supine, prone, quadruped, brugger relief position.**[22,37,60]

The patient was asked to actively perform chin retraction in different positions.

- **Craniocervical flexion exercise**[1,22,60]

Patient position: supine with BP cuff under the neck and pressure inflated to 20,22,24,26,28,30mmHg.
Patient was asked to perform the neck craniocervical flexion movement at 6 different pressure levels (20,22,24,26,28 and 30mmHg) with 10 seconds hold at each level and 30 seconds rest between each level.
The testing procedure was terminated if subject could not hold for 10 seconds at each pressure level or if the maximum level of 30 mmHg was achieved.

- **Isometric holds with chin tucks- on couch and outside couch**[20,27,40,75]

Patient position: supine
Patient was asked to tuck the chin with the head resting on the couch and also outside the couch.

- **Isometric holds with ball below chin**[15,27,60]

Patient position: sitting
Tennis ball was placed below chin and asked to hold for 10 seconds

- **Isometric hold with ball on forehead**[60]

Patient position: facing the wall with flexoball on forehead and also above occiput
Patient was asked to hold the ball in place and perform chin tucks.

Exercise for Deep neck extensors[25,44,46]

- **Deep neck endurance training**

Patient position: prone and head till shoulder out of bed
Patient was asked to tuck the chin.
Checked for any scalene anterior lengthening.
The target holding second was 20 seconds.

Co-contraction exercises[60]

- **Quadruped track**

Patient position: quadruped position with one leg lift
Patient was asked to maintain quadruped position and balance a notebook on head in chin retracted position.

PHASE II : TRAINING MUSCLE IMBALANCE AND SCAPULAR STABILIZERS
CERVICAL DEEP FLEXORS EXERCISES:
STRETCHING EXERCISES [1,60,68]

- **Pectoralis muscles**

Patient position: supine with arm in 120 degree Abduction
The patient's hand was passively stretched in downward direction with one hand near the pectorals and other over the elbow.

➢ **Sternocleidomastoid**

Patient position: sitting

The patient's head was passively rotated contralateral to the side to be addressed (say 30 degrees) and brought into slight extension.

➢ **Suboccipital muscles**

Patient position: prone and also in supine

The muscle was stretched by interlocking both the fingers, holding it near the occiput by pulling it upwards.

➢ **Levator scapulae**

Patient position: sitting or standing

Patient was asked to hold on to the chair

The patient's head was tilted to the opposite side and bent forward as in looking upon the knee.

➢ **Upper trapezius**

Patient position: sitting or standing

Patient was asked to hold on to the chair.

With one hand depressing the patient's shoulder and other hand just pulls the head away like as in side flexion.

STRENGTHENING [1,60]

➢ **Lateral flexion and extension with ball against wall**

Patient position: facing the wall with flexoball on forehead and also above occiput

Patient was asked to hold the ball in place and perform flexion, extension, side flexion and lateral rotation.

➢ **Lateral flexion against theraband band**

Patient position: side lying with head out of the couch till shoulder

The theraband was wound around the patient's head and applied a gentle force in the downward direction allowing gravity also in resistance.

Patient was asked to maintain the head in neutral.

EXERCISE FOR SCAPULAR STABILIZERS: [55,63,75]

➢ **Wall angels for lower trapezius**

Patient position: standing against the wall

The patient was directed to draw their scapulae down and in, and then release them back to neutral without moving their glenohumeral joints with the tactile feedback.

➢ **Serratus punch with pulleys**

Patient position: standing

The exercise consists of the patient pushing the upper extremity forward, like a piston, without flexing the elbow or twisting the torso.

This action was originated from the scapula

➢ **Push up with plus for serratus against wall**

Patient position: standing with hand on the wall

Patient was asked to perform push up with the hand placed inverted as the thumb facing downward

Modulated by abducting the arm also.

PHASE III – POSTURE AND THORACIC MOBILITY TRAINING[13,50,64,68]

➢ **Exercise with bolster**

Patient position : crook lying over the bolster placed horizontally and also vertically (parallel).

Horizontal placement: The patient laid over the Styrofoam cylinder which was positioned horizontally just inferior to the vertebra targeted for extension.

They were instructed to relax, allowing the spine to extend over the cylinder.

The hands cradled the head for support, but cervical flexion was avoided. The patient would rise into a bridge with the pelvis held off the floor.

The spine was held in neutral while the patient performed abdominal bracing and abdominal breathing.

Parallel placement: The cylinder was placed along the length of the spine.

While aligning the spine with the cylinder, the patient should make contact with their External occipital protuberance, the Thoracolumbar junction and sacral base.

The dorsum of the hands were laid against the floor; the arms were held at various degrees of abduction as if performing a wall angle.

The starting position was with the arms nearly by their sides and was eventually advanced to 90 degrees of abduction while still maintaining good form.

The patient then simply relaxed and performed abdominal bracing and breathing.
While deep breathing, allowed their shoulders drop to the floor under the influence of gravity.
Each position was held from 30-60 seconds and preferably performed twice a day.

- **Exercise with Swiss ball**

Patient position : crook position on the Swiss bal
The patient relaxes into a back stretch over the ball, head supported by their hands.
This position was sustained, either holding still or with gentle rocking.
Slow, deep diaphragmatic breathing was encouraged.
As the patient was able to progress, the arms were outstretched and the patient arched backward and further back over the ball.

- **Thoracic mobility with breathing**

Patient position : sitting
The patient was asked to clasp both hands and co-ordinate flexion of shoulder by enhancing deep inspiration while taking upwards and relaxed expiration while bringing downwards
The patient was asked to abduct the shoulder by enhancing deep inspiration while taking upwards and relaxed expiration while bringing downwards.

PHASE IV : RE-TRAINING THE SENSORY-MOTOR RESPONSE [29,30,31,60]

- **PNF diagonal patterns- active and passive**

Patient position: sitting
The patient looks down and tries to place his/her chin behind one clavicle, then looks up and away to the opposite side like in extension and rotation.
The pattern was retraced to the starting point.
The complementary pattern repeats the entire process beginning with the opposite side.
This cross pattern was incorporated with eye movement, followed by movement of the head in the same direction.

- **Head re-positioning exercise**

Patient position: sitting or standing
3 feet away from the target, patient practiced by aiming the light on the bull's eye of the target.
Starting with the light on the target or bull's eye, the patient closes his/her eyes, rotates away to one side and with eyes still closed attempts to re-align with the target.
They then open their eyes and check their accuracy.
Next they also try practicing to rotate to the opposite direction and return to the starting point, checking their accuracy.
They then train in flexion and extension.
Once the target was consistently re-acquired with accuracy, the patient was advanced to tracing diagonals.
Movement was kept within a pain free range. More complex exercises consisted of tracing figure of 8's (intersecting through the target) and also at altering speed.

- **Oculomotor training**

Patient position: sitting or standing
A pen was held.
The patient faces forward and moves his/her eyes without any movement of the head.
A pen was moved from side to side and up and down.
The patient tracks the target with his/her eyes, but the head and neck remain still.

- **Balance training**

Uniaxial : patient cradles along the wobble board in standing
Multiaxial : patient cradles along the wobble board in standing
Was also progressed with perturbations.

TREATMENT PROTOCOL

PHASES	EXERCISES	REPETITION
I	**TRAINING DEEP NECK STABILIZERS:** ➢ Range of motion exercise in non-weight bearing ➢ Isometric exercise in weight-bearing ➢ Directional preference exercises EXERCISES FOR DEEP NECK FLEXORS ➢ Mobilize each segment of cervical spine ➢ Chin retraction – sitting, supine, prone, quadruped, brugger relief position. ➢ Craniocervical flexion exercise ➢ Isometric holds with chin tucks- on couch and outside couch ➢ Isometric holds with ball below chin ➢ Isometric hold with ball on forehead EXERCISE FOR DEEP NECK EXTENSORS ➢ Deep neck endurance training CO-CONTRACTION EXERCISES ➢ Quadruped track	4days per week 30-45 minutes 10 repetitions of 3 sets in one session for 3-5 times per day.
II	**TRAINING MUSCLE IMBALANCE AND SCAPULAR STABILIZERS**: CERVICAL DEEP FLEXORS EXERCISES: STRETCHING EXERCISES ➢ Pectoralis muscles ➢ Sternocleidomastoid ➢ Suboccipital muscles ➢ Levator scapulae ➢ Upper trapezius. STRENGTHENING ➢ Lateral flexion and extension with ball against wall ➢ Lateral flexion against theraband EXERCISE FOR SCAPULAR STABILIZERS: ➢ Wall angels for lower trapezius ➢ Serratus punch with pulleys ➢ Push up with plus for serratus against wall	4days per week 30-45 minutes 10 repetitions of 3 sets in one session for 3-5 times per day.
III	**POSTURE AND THORACIC MOBILITY TRAINING** ➢ Exercise with bolster ➢ Exercise with swiss ball ➢ Thoracic mobility with breathing	4days per week 30-45 minutes 10 repetitions of 3 sets in one session for 3-5 times per day.
IV	**RE-TRAINING THE SENSORY-MOTOR RESPONSE** ➢ PNF diagonal patterns ➢ Head re-positioning exercises ➢ Oculomotor training ➢ Balance training	4days per week 30-45 minutes 10 repetitions of 3 sets in one session for 3-5 times per day.

PLATES

PHASE I : TRAINING OF DEEP NECK STABILIZERS

Figure 1: Range of motion exercise in non-weight bearing

Figure 2: Isometric exercise in weight-bearing

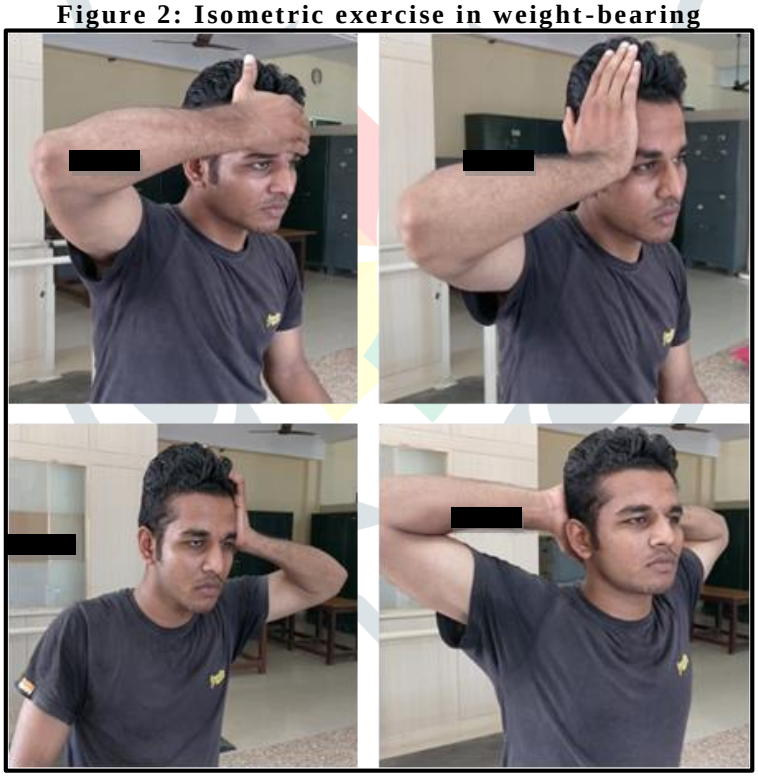


Figure 3: Directional preference exercises

EXERCISES FOR DEEP NECK FLEXORS

Figure 4: Mobilize each segment of cervical spine

Figure 5: Chin retraction – sitting, supine, prone, quadruped, brugger relief position

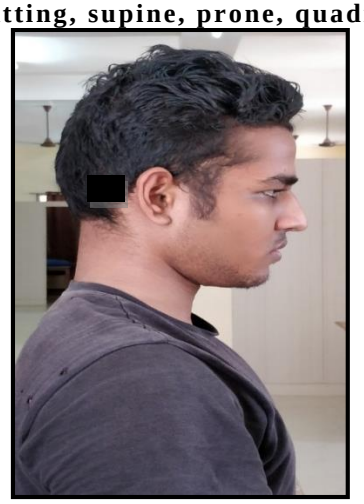


Figure 6: Craniocervical flexion exercise

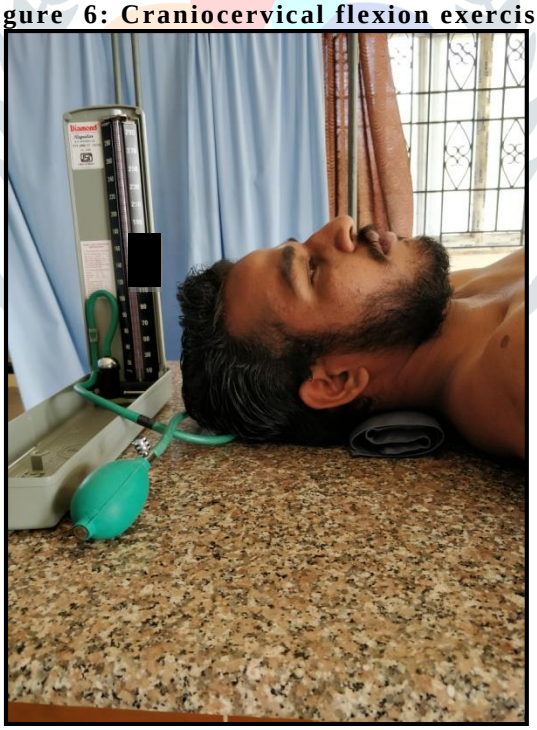


Figure 7: Isometric holds with chin tucks- on couch and outside couch

Figure 8: Isometric holds with ball below chin

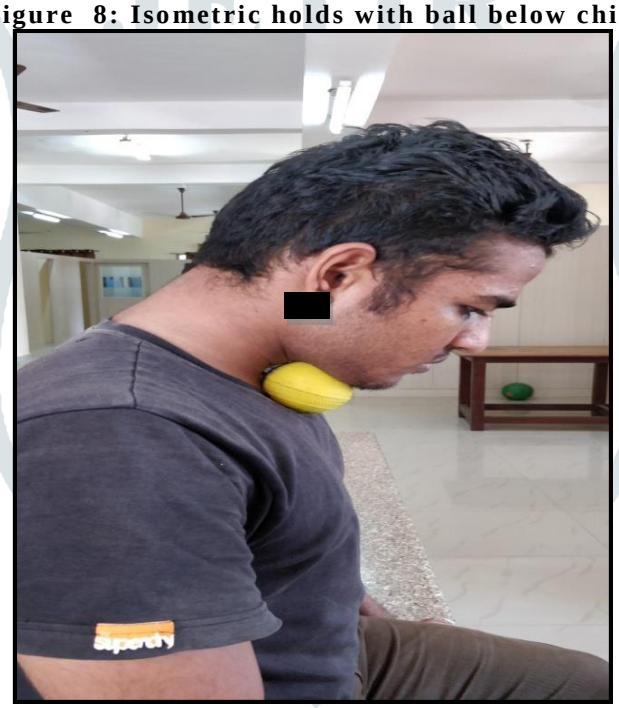
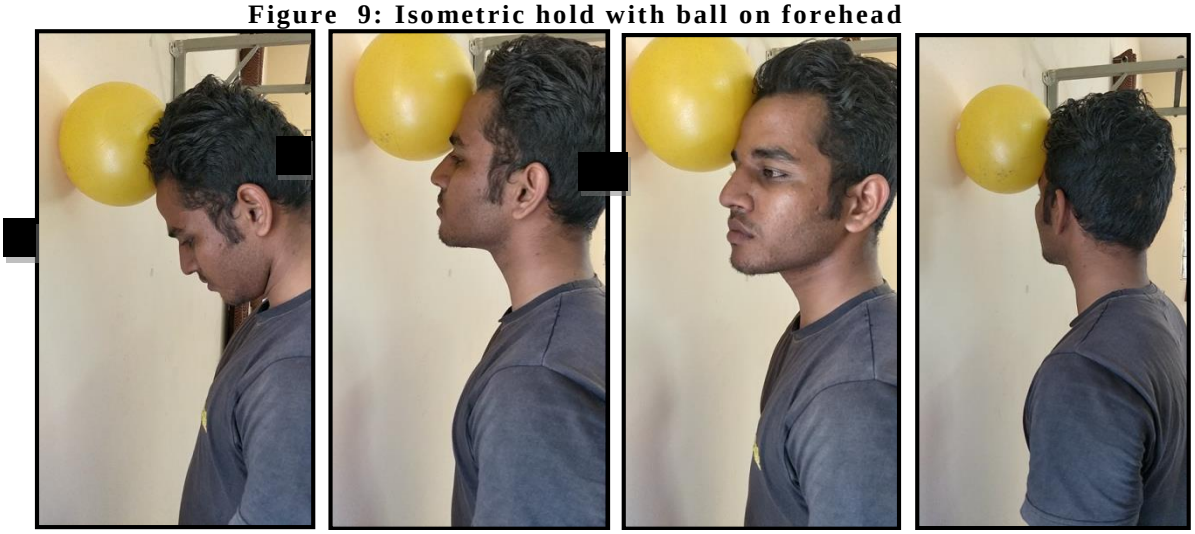


Figure 9: Isometric hold with ball on forehead

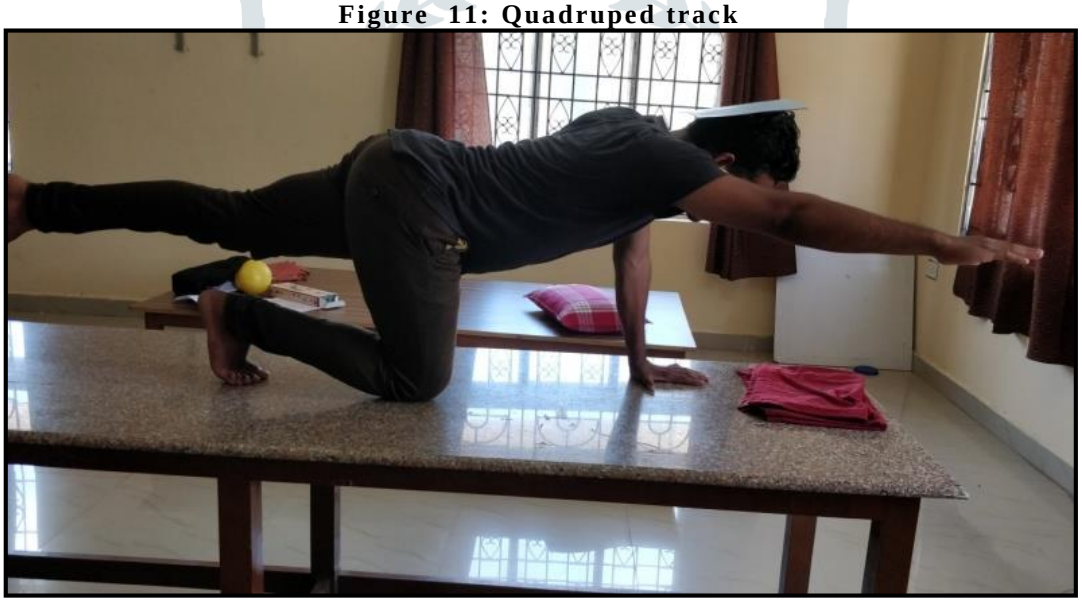


Exercise for Deep neck extensors

Figure 10: Deep neck endurance training

Co-contraction exercises

Figure 11: Quadruped track



PHASE II : TRAINING MUSCLE IMBALANCE AND SCAPULAR STABILIZERS

CERVICAL DEEP FLEXORS EXERCISES:

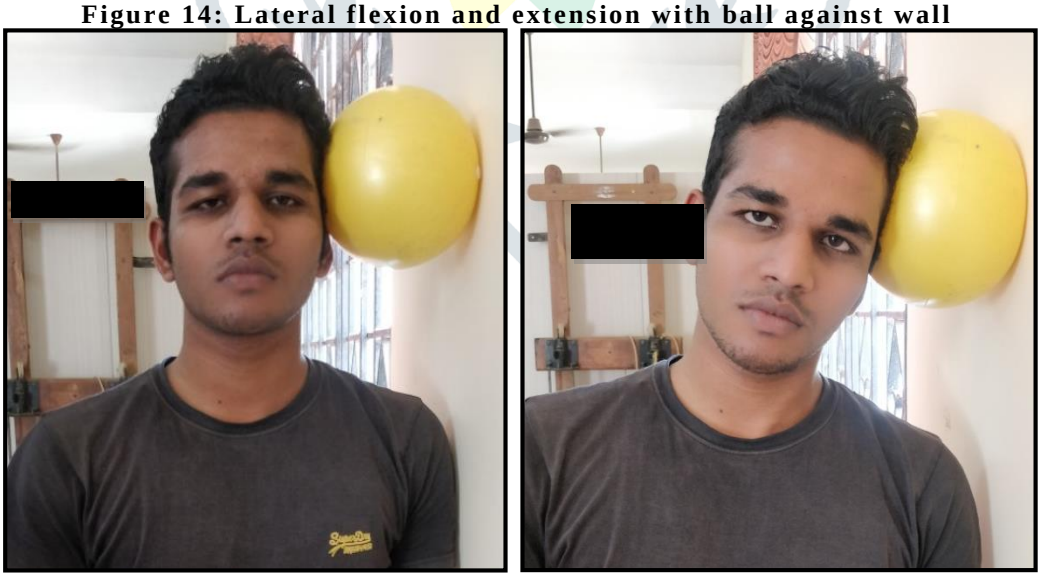
STRETCHING EXERCISES

Figure 12: Pectoralis muscles

Figure 13:
Sternocleiodomastoid, Levator scapulae and Upper trapezius.

STRENGTHENING

Figure 14: Lateral flexion and extension with ball against wall



EXERCISE FOR SCAPULAR STABILIZERS:

Figure 15: Wall angels for lower trapezius – against wall

Figure 16: Serratus punch with pulleys

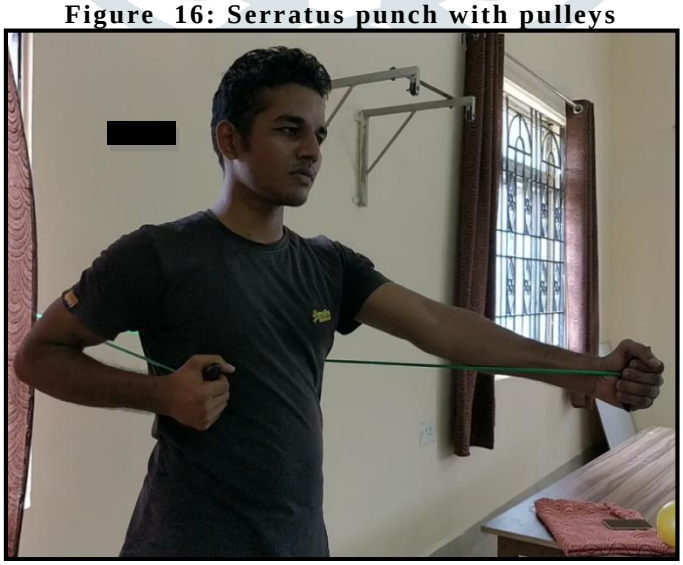
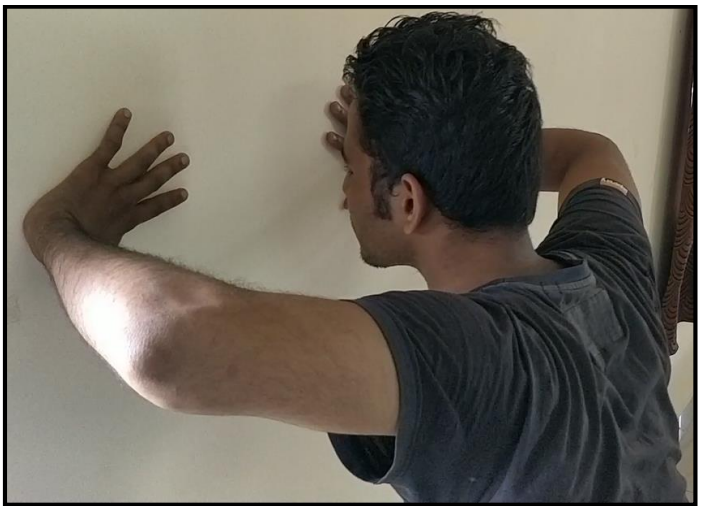


Figure 17:Push up with plus for serratus against wall



PHASE III – POSTURE AND THORACIC MOBILITY TRAINING

Figure 18: Exercise with bolster

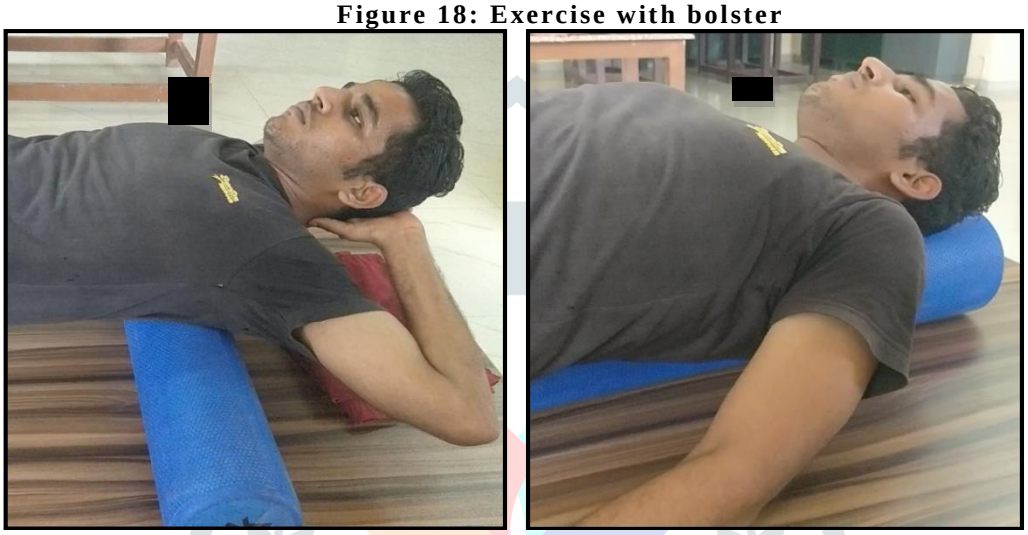


Figure 19: Exercise with swiss ball

PHASE IV:RE-TRAINING THE SENSORY-MOTOR RESPONSE

Figure 20: Proprioceptive neuromuscular facilitation

Figure 21: Oculomotor training

Figure 22: Head re-positioning exercise

STATISTICAL ANALYSIS

TABLE 1:
CRANIOCERVICAL FLEXION TEST - COMPARISON OF PRE AND POST TEST SCORES (mmHg)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
21.6	1.69	29.13	1.008	-20.50	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 1 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of craniocervical flexion test in 30 individuals.

There was a very significant improvement observed.

CRANIOCERVICAL FLEXION TEST - COMPARISON OF PRE AND POST TEST SCORES (mmHg)

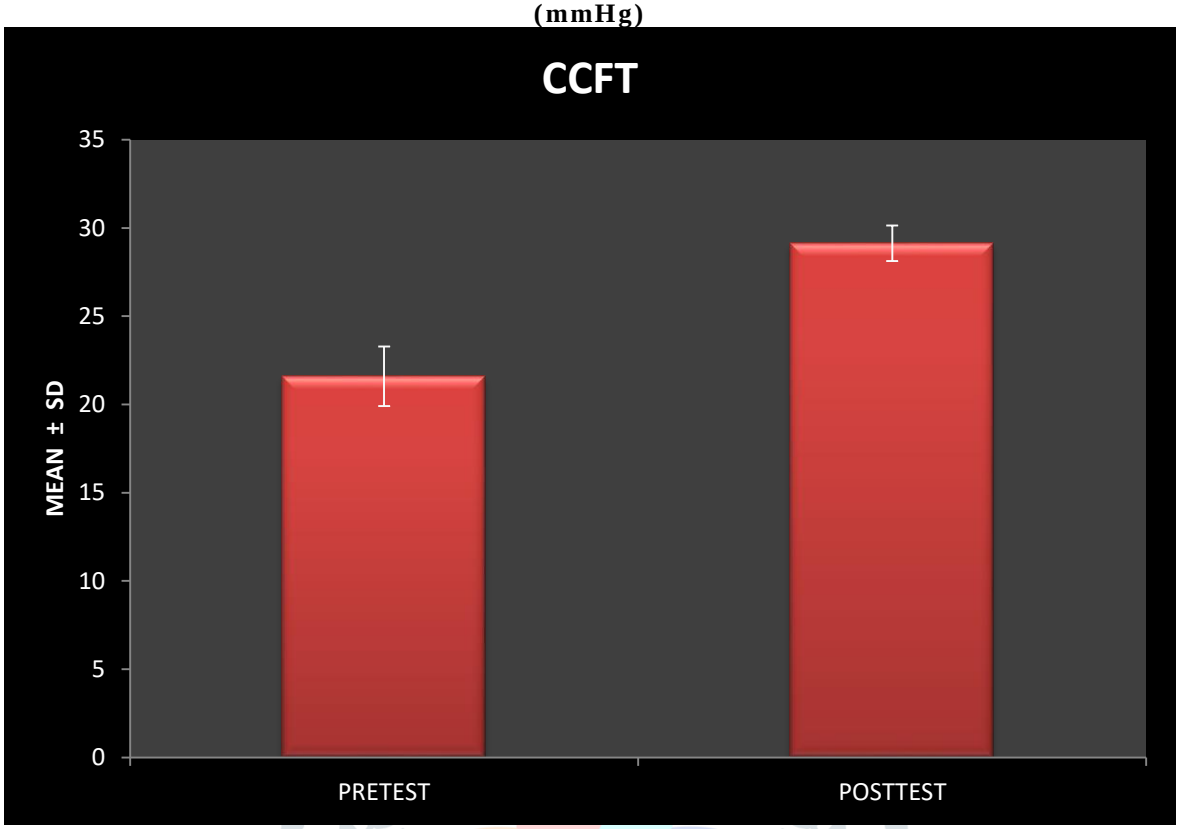


TABLE 2:
CERVICAL EXTENSION ENDURANCE TEST - COMPARISON OF PRE AND POST TEST SCORES (seconds)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
12.4	1.69	19.73	0.58	-22.0	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 2 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of cervical endurance extension test in 30 individuals.

There was a very significant improvement observed.

CERVICAL EXTENSION ENDURANCE TEST - COMPARISON OF PRE AND POST TEST SCORES (seconds)

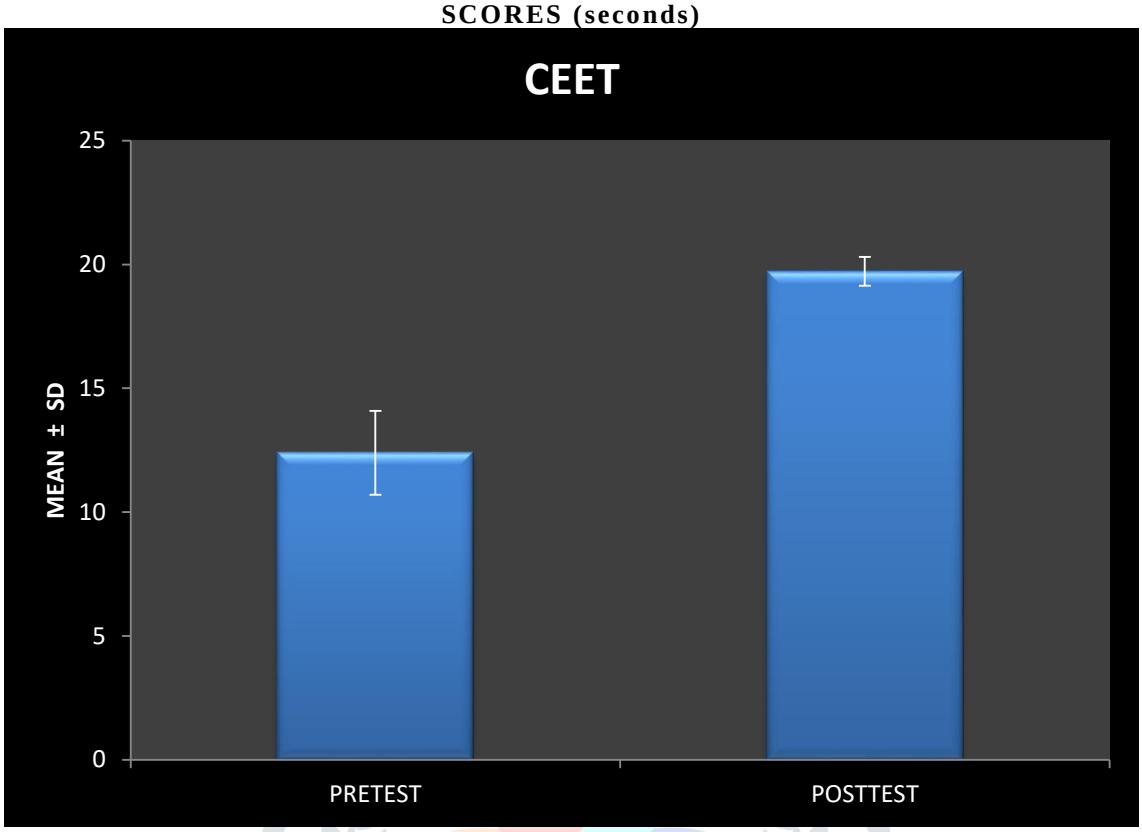


TABLE 3:
NECK DISABILITY INDEX - COMPARISON OF PRE AND POST TEST SCORES (Percentage %)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
22.03	3.83	8.77	1.56	17.75	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 3 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of Neck Disability Index test in 30 individuals.

There was a very significant improvement observed.

NECK DISABILITY INDEX - COMPARISON OF PRE AND POST TEST SCORES (Percentage %)

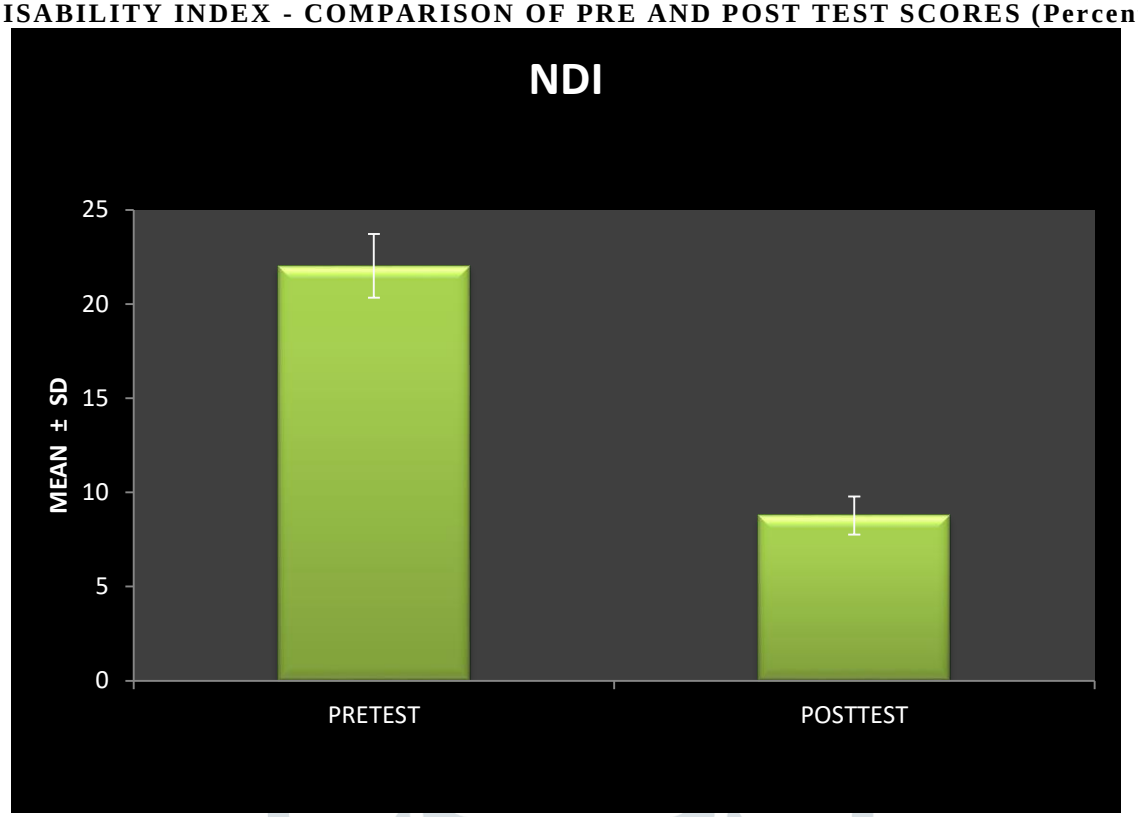


TABLE 4:
POSTURE SCREEN MOBILE APPLICATION (HEAD : FRONTAL VIEW)- COMPARISON OF PRE AND POST TEST SCORES (inch)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
4.8	1.52	1.947	0.52	9.45	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 4 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of Posture Screen mobile application (Head: frontal view) in 30 individuals.

There was a very significant improvement observed.

TABLE 5:
POSTURE SCREEN MOBILE APPLICATION (HEAD : SAGITTAL VIEW) - COMPARISON OF PRE AND POST TEST SCORES (inch)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
41.28	9.24	19.22	4.96	21.44	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 4 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of Posture Screen mobile application (Head: sagittal view) in 30 individuals.

There was a very significant improvement observed.

POSTURE SCREEN MOBILE APPLICATION (HEAD : FRONTAL and SAGITTAL VIEW) - COMPARISON OF PRE AND POST TEST SCORES (inch)

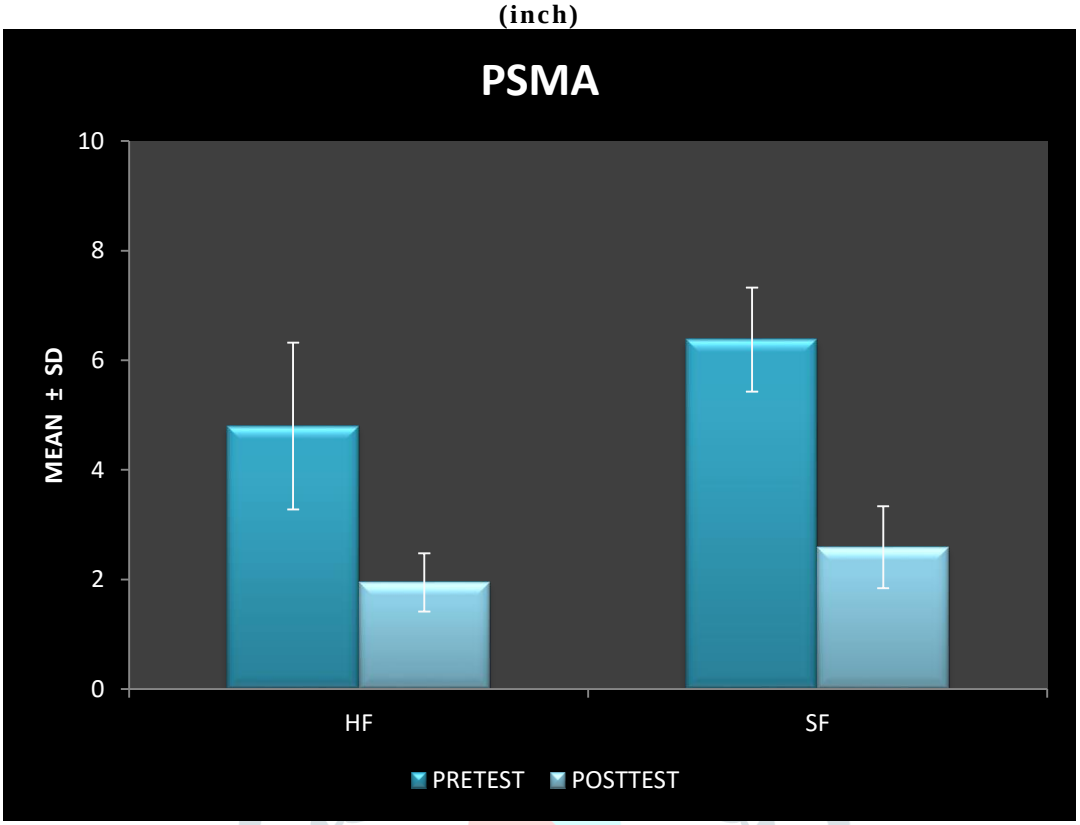


TABLE 6:
POSTURE SCREEN MOBILE APPLICATION (SHOULDER : FRONTAL VIEW)- COMPARISON OF PRE AND POST TEST SCORES (inch)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
6.37	0.94	2.59	0.74	18.64	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 6 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of Posture Screen mobile application (shoulder: frontal view) in 30 individuals.

There was a very significant improvement observed.

TABLE 7:
POSTURE SCREEN MOBILE APPLICATION (SHOULDER : SAGITTAL VIEW)- COMPARISON OF PRE AND POST TEST SCORES (inch)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
18.83	1.85	9.70	1.54	33.41	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 7 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of Posture Screen mobile application (Shoulder: sagittal view) in 30 individuals.

There was a very significant improvement observed.

POSTURE SCREEN MOBILE APPLICATION (SHOULDER : FRONTAL and SAGITTAL VIEW)- COMPARISON OF PRE AND POST TEST SCORES (inch)

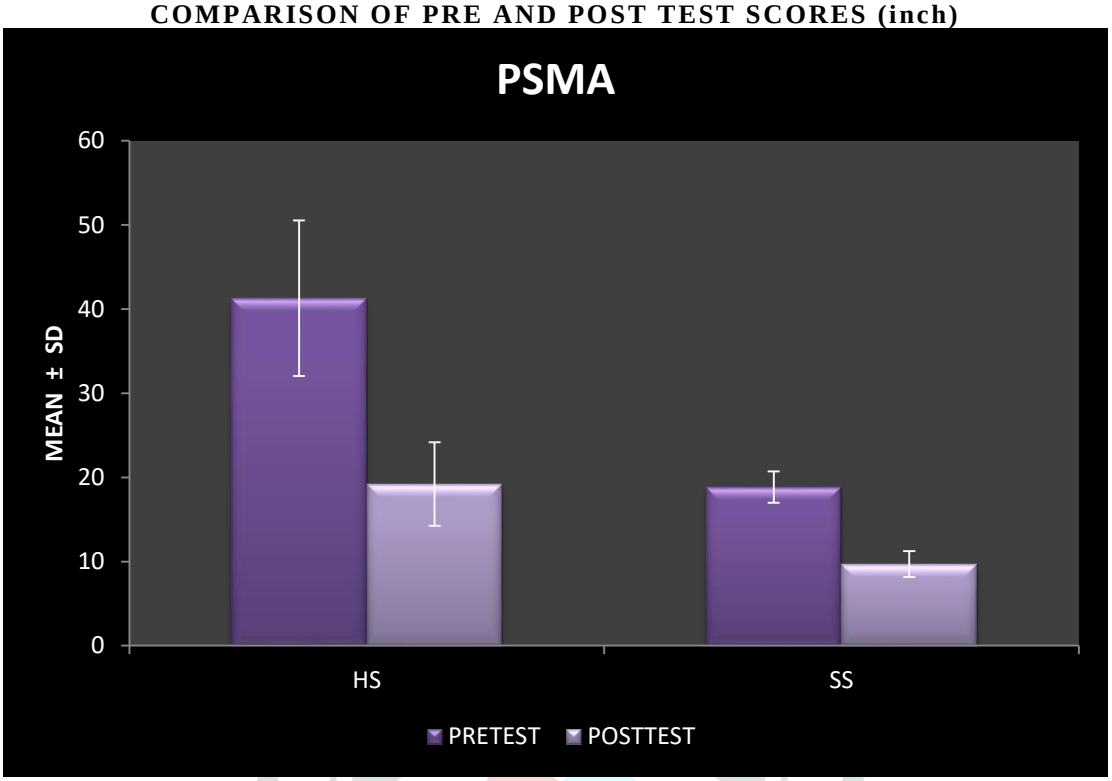


TABLE 8:
RANGE OF MOTION (CERVICAL FLEXION)- COMPARISON OF PRE AND POST TEST SCORES (cm)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
5.10	0.75	6.00	0.000	-6.49	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 8 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of range of motion (cervical flexion) in 30 individuals.

There was a very significant improvement observed.

TABLE 9:
RANGE OF MOTION (CERVICAL EXTENSION)- COMPARISON OF PRE AND POST TEST SCORES (cm)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
2.03	0.669	3.00	0.000	-7.91	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 9 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of range of motion (cervical extension)- comparison of pre and post test scores in 30 individuals.

There was a very significant improvement observed.

RANGE OF MOTION (CERVICAL EXTENSION)- COMPARISON OF PRE AND POST TEST SCORES (cm)

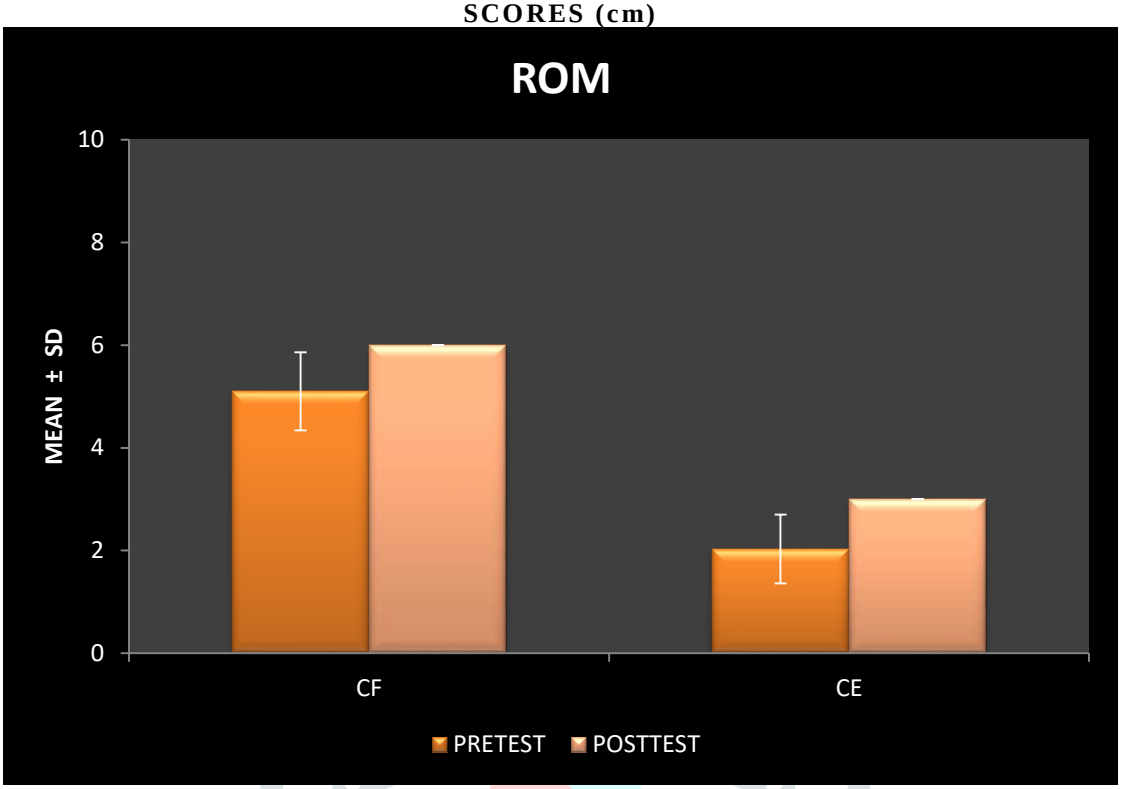


TABLE 10:
RANGE OF MOTION (CERVICAL RIGHT LATERAL ROTATION)- COMPARISON OF PRE AND POST TEST SCORES (cm)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
10.33	1.44	12.47	0.50	-8.30	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 10 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of range of motion (cervical right lateral rotation) in 30 individuals.

There was a very significant improvement observed.

TABLE 11:
RANGE OF MOTION (CERVICAL LEFT LATERAL ROTATION) - COMPARISON OF PRE AND POST TEST SCORES (cm)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
9.97	1.49	12.63	0.490	-12.04	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 11 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of range of motion (cervical left lateral rotation) in 30 individuals.

There was a very significant improvement observed.

RANGE OF MOTION (CERVICAL RIGHT LATERAL FLEXION) - COMPARISON OF PRE AND POST TEST SCORES (cm)

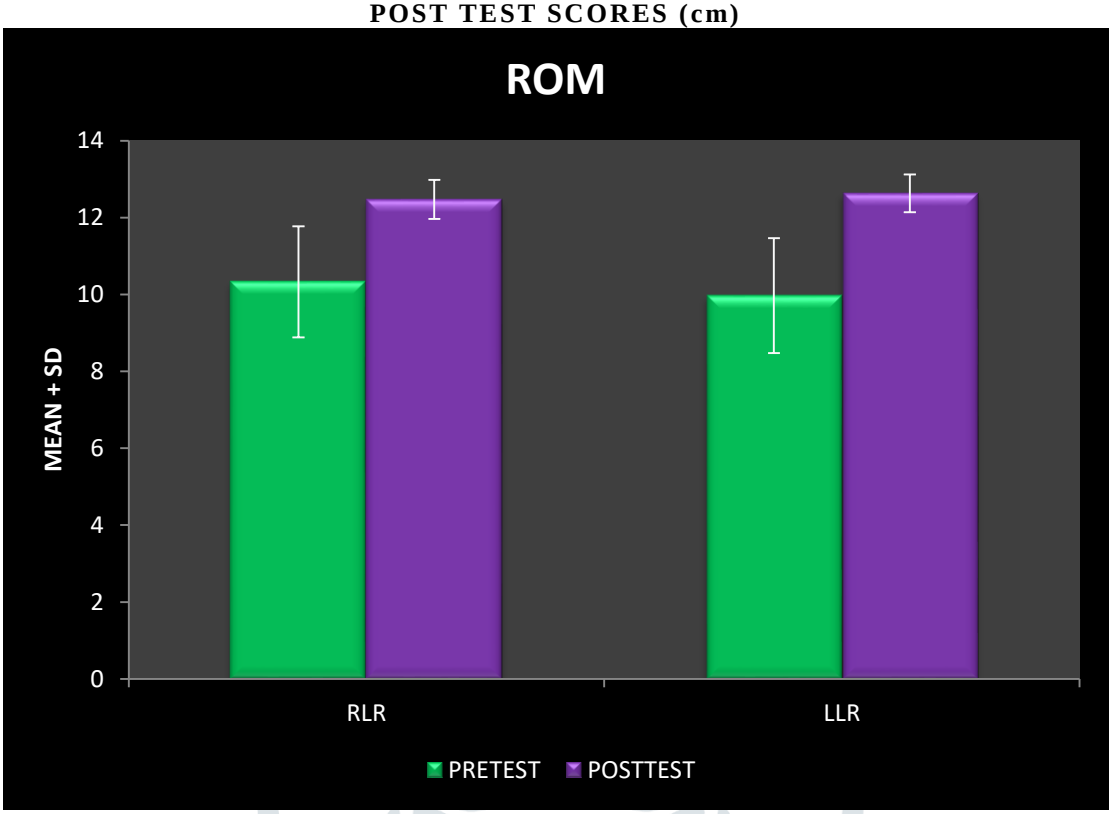


Table 12:
RANGE OF MOTION (CERVICAL RIGHT SIDE FLEXION)- COMPARISON OF PRE AND POST TEST SCORES (cm)

PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
10.30	1.44	12.70	0.46	-11.60	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 12 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of range of motion (cervical right side flexion) in 30 individuals.

There was a very significant improvement observed.

TABLE 13:
RANGE OF MOTION (CERVICAL LEFT SIDE FLEXION)- COMPARISON OF PRE AND POST TEST SCORES (cms)

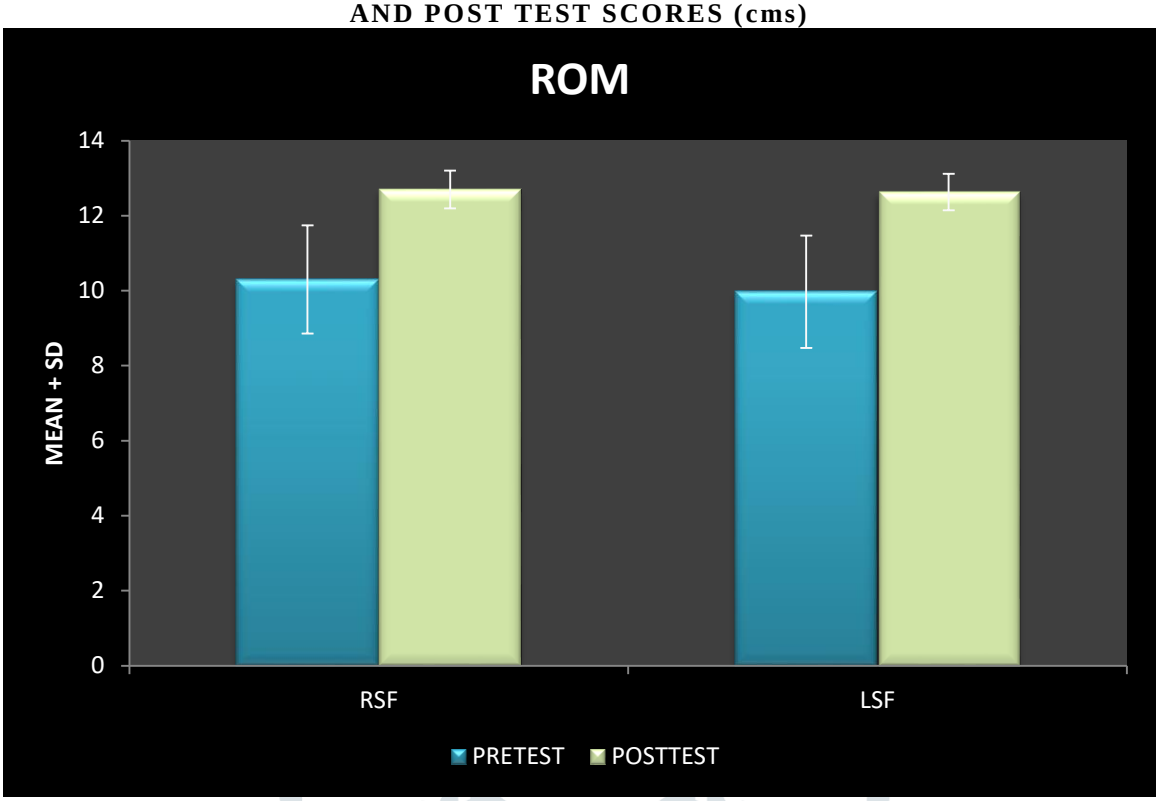
PRE-TEST		POST- TEST		Paired t-TEST	SIGNIFICANCE
MEAN	SD	MEAN	SD		
9.97	1.49	12.63	0.49	-12.99	0.000**

p= <0.05* significant
p <0.000** very significant

This Table 13 shows the mean, standard deviation and p value of paired student t-Test for pre and post values of range of motion (cervical left side flexion) in 30 individuals.

There was a very significant improvement observed.

RANGE OF MOTION (CERVICAL LEFT and RIGHT SIDE FLEXION)- COMPARISON OF PRE AND POST TEST SCORES (cms)



RESULTS

The table 1 shows the mean value of pre-test and post-test evaluation of craniocervical flexion test. The pre-test scores 21.60 and the post-test scores 29.13, were significantly increasing showing the p-value <0.000.

The table 2 shows the mean value of pre-test and post-test evaluation of cervical extension endurance test. The pre-test scores 12.4 and the post-test scores 19.73, were significantly increasing showing the p-value <0.000.

The table 3 shows the mean value of pre-test and post-test evaluation of neck disability index. The pre-test scores 22.03 and the post-test scores 1.56, were significantly decreasing showing the p-value <0.000.

The table 4 shows the mean value of pre-test and post-test evaluation of posture screen mobile application (Head: Frontal View). The pre-test scores 4.8 and the post-test scores 1.95, were significantly decreasing showing the p-value <0.000.

The table 5 shows the mean value of pre-test and post-test evaluation of posture screen mobile application (Head: Sagittal View). The pre-test scores 41.28 and the post-test scores 19.22, were significantly decreasing showing the p-value <0.000.

The table 6 shows the mean value of pre-test and post-test evaluation of posture screen mobile application (Shoulder: Frontal View). The pre-test scores 6.37 and the post-test scores 2.59, were significantly decreasing showing the p-value <0.000.

The table 7 shows the mean value of pre-test and post-test evaluation of posture screen mobile application (Shoulder : Sagittal View). The pre-test scores 18.83 and the post-test scores 9.70, were significantly decreasing showing the p-value <0.000.

The table 8 shows the mean value of pre-test and post-test evaluation of Range of motion (Cervical Flexion). The pre-test scores 5.10 and the post-test scores 6.00, were significantly increasing showing the p-value <0.000.

The table 9 shows the mean value of pre-test and post-test evaluation of Range of motion (Cervical Extension). The pre-test scores 2.03and the post-test scores 3.00, were significantly increasing showing the p-value <0.000.

The table 10 shows the mean value of pre-test and post-test evaluation of Range of motion (Cervical Right Lateral Rotation). The pre-test scores 10.33 and the post-test scores 12.47, were significantly increasing showing the p-value <0.000.

The table 11 shows the mean value of pre-test and post-test evaluation of Range of motion (Cervical Left Lateral Rotation). The pre-test scores 9.97 and the post-test scores 12.63, were significantly increasing showing the p-value <0.000.

The table 12 shows the mean value of pre-test and post-test evaluation of Range of motion (Cervical Right Side Flexion). The pre-test scores 10.30 and the post-test scores 12.70, were significantly increasing showing the p-value <0.000.

The table 13 shows the mean value of pre-test and post-test evaluation of Range of motion (Cervical Left Side Flexion). The pre-test scores 9.97and the post-test scores 12.63, were significantly increasing showing the p-value <0.000.

DISCUSSION

The objective of this study was experimentally attained proving the protocol that will be helpful in the individuals with chronic mechanical neck pain. Treating mechanical neck pain, being the need of the hour, was addressed in a slow pace in order to prevent re-occurrence.

Thus as per cliona o'riordan et al the proposed principle of frequency, intensity, type and time for chronic neck pain of 3 days/ week, 6-12 weeks, 30-60 minutes with 10 repetitions of 3-5 times was formulated in the study and proved quintessential [6]

As per Megan.M Heintz and Selvam P senthil [57] mechanical neck pain being multifactorial and at a higher stake among young adults were proved to be the exact target group with remarkable weak neck muscle endurance and altered posture.

There are found to be ample number of exercises to alleviate neck pain but as per the recommendation of many studies there must be a protocol to address mechanical neck pain and was set on the aspects of training deep neck stabilizers, training muscle imbalance and scapular stabilizer, posture and thoracic mobility training as well as re-training the sensory-motor response in sequence, which helped the individual to a finest recovery within 8 week of duration.

The outcome measures taken were decisive and legitimate to the study individual's primary complaints.

The initial phase was addressed in three aspects in training the deep neck flexors, deep neck extensors and combined co-contraction of the neck musculatures. Following the 1st phase the subjects gained confidence but the pain was still a limiting factor for the improvement of outcome. On a casual assessment, following the 1st week there was not much of improvement. This proved the contrary of many journals of training deep neck stabilizers alone will reduce pain.

The second phase of training muscle imbalances as targeted stretching for Pectoralis muscles, Sternocleidomastoid, Suboccipital muscles, Levator scapulae, Upper trapezius and strengthening of neck muscle which were initially done passively, had a better effect in reducing pain and relieveing the stiffness prevailed.

The objective assessment among subjects on which majority of them had altered posture which was majorly impairing the scapular alignment, was taken care with the exercises to scapular stabilizers. During the second phase the cause for the chronic neck pain was addressed and the ill-effect of the muscle imbalance was treated.

The third phase which included treating the postural alignment and enhancing the thoracic mobility was attained. Simple exercises with bolster of two directional placements and swiss ball were very soothing for the patient during therapy.

More than 1st, the end of 2nd week and 3rd week showed an improvement during casual assessment.

The fourth phase of re-training the sensory and motor response showed significant improvement which was found to be declined earlier due to chronic symptoms. Proprioceptive Neuromuscular Facilitation, Re-positioning, Oculomotor and Balance training were the best tools to maintain and promote the sensory motor component.

The following 4 weeks were the incorporation of all the four phases which was also easy for the patients to elaborately and precisely learn the correct method and sequence of exercises.

The last couple of weeks, the patient were able to perform the outcome measures well. And thus which was also reflected on the statistical analysis showing 99.9% level of high significance.

Thus the phases of cervical spine rehabilitation protocol support the alternate hypothesis with significant and best results.

CONCLUSION

The above results showed the effectiveness of phases of cervical spine rehabilitation for 8 weeks duration in 30 individuals. Hence these phases of training deep neck stabilizers, training muscle imbalance and scapular stabilizers, posture and thoracic mobility training, re-training the sensory-motor response were successfully incorporated and proved to be significantly effective in improving their functional activities.

LIMITATIONS AND RECOMMENDATIONS

LIMITATIONS:

- Sample size was small.
- The study duration was found to be difficult for some individuals.
- Certain individuals, notably 6 were not able to make up to the appointments on the exact dates. Hence a remainder and guidance was given through telecommunication, thereby there were no dropouts.

RECOMMENDATIONS:

- The study could be done with a larger sample size.
- It can be performed on homogenous population.
- Statistical analysis comparing the effectiveness of each week, to know which phases of rehabilitation was beneficial.
- Follow up study.

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APPENDIX - I
INFORMED CONSENT

TITLE OF THE PROJECT:

EFFICACY OF PHASES OF CERVICAL SPINE REHABILITATION PROGRAM IN MECHANICAL NECK PAIN

DESCRIPTION OF THE STUDY:

Experimental Design

NATURE AND PURPOSE OF THE STUDY

To determine the efficacy of phases of cervical spine rehabilitation program in mechanical neck pain.

EXPLANATION OF THE PROCEDURE:

The subject understood that he/she will undergo certain physical assessment relevant to the study -pre and post evaluation. It is explained that he/she will be supervised during the phases of cervical stabilization program which may be tentatively for 8 weeks in which the person is requested to be present for 4 days a week and the treatment time would be less than 45 minutes. Permission has been granted to stop the therapy session anytime if he/she experience any discomfort. He/she will be re-evaluated at the end of each week. Permission has been obtained from the subjects to use their results for research purpose.

BENEFITS TO BE EXPECTED:

He/she has been explained about the benefits of treatment sessions. There could be an improvement activities of daily living and decreased risk of re-occurrence after participating in the treatment.

CONFIDENTIALITY AND USE OF INFORMATION:

The information that is obtained through this program will be treated as privileged and confidential and will be consequently not released or revealed to any person without your written consent.

COST AND PAYMENT OF THE PARTICIPANT:

There is no cost for participation in this study. Participation is completely voluntary and no payment will be provided for this study

PARTICIPANTS'S RIGHTS TO WITHDRAW FROM THE STUDY

Subjects have the right to refuse to participate in this study, the right to withdraw from the study and the right to have your data destroyed at any point during the study without any penalty.

VOLUNTARY CONSENT BY THE PARTICIPANT

Participation in this study is completely voluntary and subject's consent is required before to participate in the study.

CONSENT

I have read this consent form (or it has been read to me) and I fully understand the contents of this document and voluntarily consent to participate in the study. All of my questions concerning this study have been answered. Also questions in the future is said to be addressed and I understand that this consent ends at the conclusion of this study.

PRINCIPAL INVESTIGATOR : R.DEEPIKA CHANDAR
MOBILE NUMBER : +91-9488592050

(In case of illiterate participant, the information is explained and thumb impression is obtained, in the presence of an unrelated witness. Left hand thumb impression for male and right hand thumb impression of female)

By signing this form, I agree to participate in this study with my full co-operation.

Name of the participant:
Date:

Participant's signature
Thumb impression
Witness name

Witness signature

ஒப்புதல் படிவம்

இந்த ஒப்புதல் படிவம் என்னால் படிக்கப்பட்டது (அல்லது எனக்கு படித்துக் காண்பிக்கப்பட்டது) இப்படிவத்தில் உள்ளவை அனைத்தும் என்னால் முழுமையாகப் புரிந்துக் கொள்ளப்படட்து. மேலும் தானாகவே முன்வந்து தான் நான் இந்த ஆய்வில் கலந்து கொள்கிறேன். இந்த ஆய்வின் மீது உள்ள சந்தேகங்கள் அணைத்திற்கும் விடையளிக்கபட்டது. இந்த ஆய்வில் குறிப்பிடப்பட்டுள்ள கால அளவு வரை முழுவதுமாக பங்களிப்பேன் என உறுதியளிக்கிறேன்.

முதன்மை ஆய்வாளர் : தீபிகா சந்தர்
தொலைபேசி எண் : +91-9488592050

[படிப்பறிவற்ற நபருக்கு விவரங்கள் அனைத்தும் கூறப்பட்டு, அவர்களுடைய பெருவிரல் ரேகை பெறப்படும். ஆண்களுக்கு இடது கை பெருவிரல் ரேகையும் பெண்களுக்கு வலது கை பெருவிரல் ரேகையும் பெறப்படும்.]

இப்படிவத்தில் கையெழுத்திடுவதின் மூலம் இவ்வாய்வில் முழு ஒத்துழைப்புடன் பங்களிப்பேன் என உறுதியளிக்கிறேன்.

பங்கேற்பவர் பெயர்:
நாள்:

பங்கேற்பவர் கையொப்பம்
கைவிரல் ரேகை
சாட்சியாளர் பெயர்
சாட்சியாளர் கையொப்பம்

CERTIFICATION OF INFORMED CONSENT

I certify that I have explained the nature and purpose of this study to the above named individual, and I have discussed the potential benefits of this study participation. The questions the individual had about the study have been answered and I will always be available to address further questions.

Date of consent:

Signature of person obtaining consent

Signature of Principle Investigator

APPENDIX - II
EVALUATION PERFORMA

PATIENT PROFILE **DATE:**
NAME
PATIENT ID
AGE/GENDER
BMI
OCCUPATION

CHIEF COMPLAINTS:

SUBJECTIVE EXAMINATION:

PAIN ASSESSMENT	
ONSET	
SITE	
SIDE	
DURATION	
TYPE	
CHARACTER	
AGGREVATING FACTOR	
RELIEVING FACTOR	
24 HOUR PATTERN	
SEVERITY	
IRRITABILITY	
NATURE	

OBJECTIVE EXAMINATION:
ON OBSERVATION:

ON PALPATION:

ON EXAMINATION:
❖ **RANGE OF MOTION : (cm)**

CERVICAL FLEXION		
CERVICAL EXTENSION		
SIDE	**RIGHT**	**LEFT**
CERVICAL LATERAL ROTATION		
CERVICAL SIDE FLEXION		

REMARKS:

❖ **RESISTED ISOMETRICS**

CERVICAL FLEXORS		
CERVICAL EXTENSORS		
SIDE	**RIGHT**	**LEFT**
CERVICAL LATERAL ROTATORS		
CERVICAL SIDE FLEXORS		

REMARKS:

SENSORY ASSESSMENT:
SENSATION:
REFLEXES:

MYOFASCIAL ASSESSEMENT:

REMARKS:

APPENDIX - III

Neck Disability Index

Patient Name: _____

Date: _____

1. Pain Intensity

☐ I have no pain at the moment	+0
☐ The pain is very mild at the moment	+1
☐ The pain is moderate at the moment	+2
☐ The pain is fairly severe at the moment	+3
☐ The pain is very severe at the moment	+4
☐ The pain is the worst imaginable at the moment	+5

2. Personal Care (Washing, Dressing, etc.)

☐ I can look after myself normally without causing extra pain	+0
☐ I can look after myself normally but it causes extra pain	+1
☐ It is painful to look after myself and I am slow and careful	+2
☐ I need some help but can manage most of my personal care	+3
☐ I need help every day in most aspects of self care	+4
☐ I do not get dressed, I wash with difficulty and stay in bed	+5

3. Lifting

☐ I can lift heavy weights without extra pain	+0
☐ I can lift heavy weights but it gives extra pain	+1
☐ Pain prevents me lifting heavy weights off the floor, but I can manage if they are conveniently placed, for example on a table	+2
☐ Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned	+3
☐ I can only lift very light weights	+4
☐ I cannot lift or carry anything	+5

4. Reading

☐ I can read as much as I want to with no pain in my neck	+0
☐ I can read as much as I want to with slight pain in my neck	+1
☐ I can read as much as I want with moderate pain in my neck	+2
☐ I can't read as much as I want because of moderate pain in my neck	+3
☐ I can't hardly read at all because of severe pain in my neck	+4
☐ I cannot read at all	+5

5. Headaches

☐ I have no headaches at all	+0
☐ I have slight headaches, which come infrequently	+1
☐ I have moderate headaches, which come infrequently	+2
☐ I have moderate headaches, which come frequently	+3
☐ I have severe headaches, which come frequently	+4
☐ I have headaches almost all the time	+5

6. Concentration

☐ I can concentrate fully when I want to with no difficulty	+0
☐ I can concentrate fully when I want to with slight difficulty	+1
☐ I have a fair degree of difficulty in concentrating when I want to	+2
☐ I have a lot of difficulty in concentrating when I want to	+3
☐ I have a great deal of difficulty in concentrating when I want to	+4
☐ I cannot concentrate at all	+5

7. Work

☐ I can do as much work as I want to	+0
☐ I can only do my usual work, but no more	+1
☐ I can do most of my usual work, but no more	+2
☐ I can't do my usual work	+3
☐ I can hardly do any work at all	+4
☐ I can't do any work at all	+5

8. Driving

☐ I can drive my car without any neck pain	+0
☐ I can drive my car as long as I want with slight pain in my neck	+1
☐ I can drive my car as long as I want with moderate pain in my neck	+2
☐ I can't drive my car as long as I want because of moderate pain in my neck	+3
☐ I can hardly drive at all because of severe pain in my neck	+4
☐ I can't drive my car at all	+5

9. Sleeping

☐ I have no trouble sleeping	+0
☐ My sleep is slightly disturbed (less than 1 hr sleepless)	+1
☐ My sleep is mildly disturbed (1-2 hrs sleepless)	+2
☐ My sleep is moderately disturbed (2-3 hrs sleepless)	+3
☐ My sleep is greatly disturbed (3-5 hrs sleepless)	+4
☐ My sleep is completely disturbed (5-7 hrs sleepless)	+5

10. Recreation

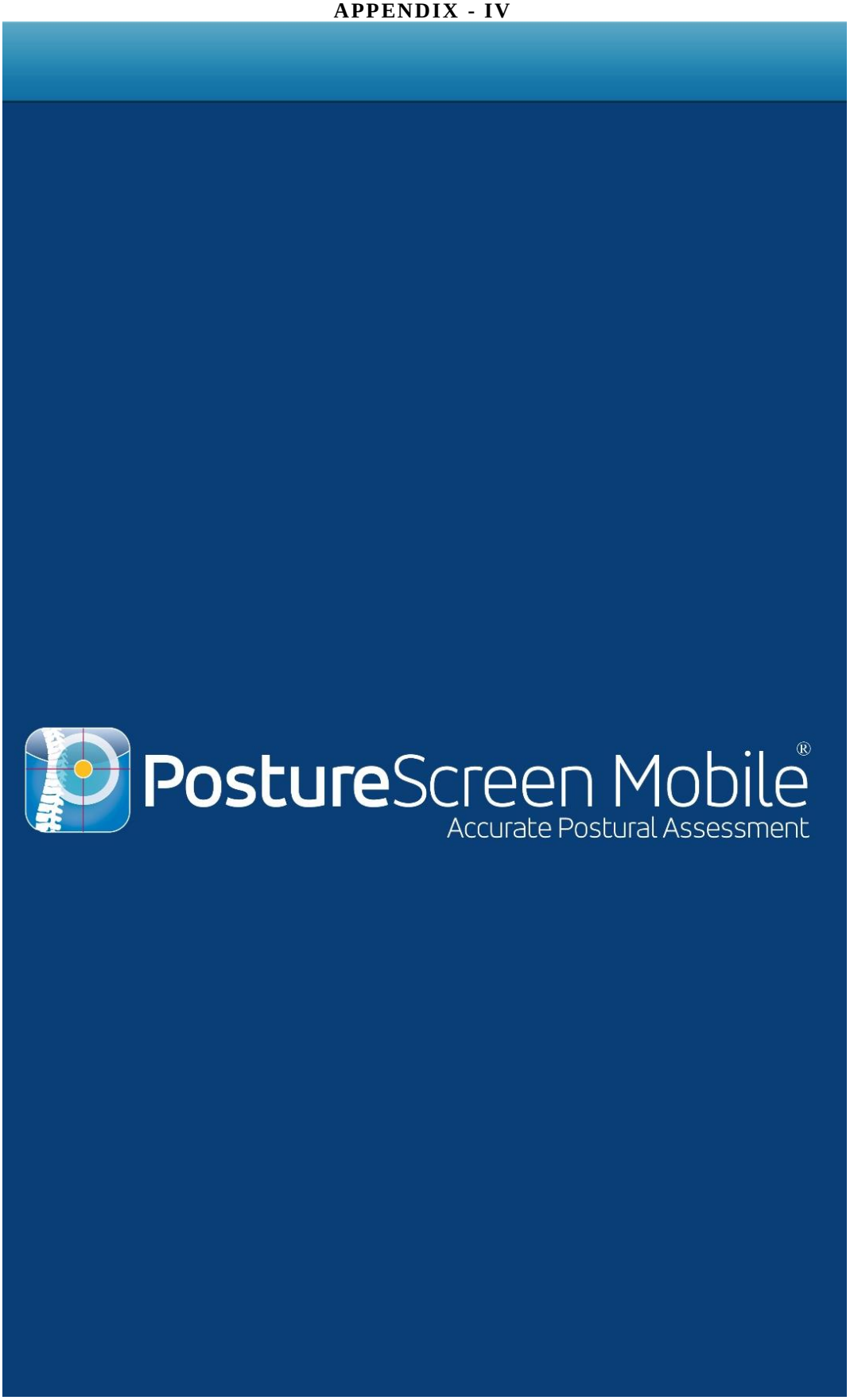
☐ I am able to engage in all recreational activities with no neck pain at all	+0
☐ I am able to engage in all my recreational activities, with some pain in my neck	+1
☐ I am able to engage in most, but not all of my usual recreational activities because of pain in my neck	+2
☐ I am able to engage in a few of my usual recreational activities because of pain in my neck	+3
☐ I can hardly do any recreational activities because of pain in my neck	+4
☐ I can't do any recreational activities at all	+5

Total Score:
Raw Score: Summation of Points
Raw Score: _____ Points

$$\text{Percentage Score: } \frac{\text{Raw Score}}{\#\ \text{Completed Questions} * 5}$$

Percentage Score: _ ___ %

APPENDIX - IV



APPENDIX - V
PRE-TEST EVALUATION
CRANIOCERVICAL FLEXION TEST
(USING PNEUMATIC COMPRESSION DEVICE)

PRESSURE (mmHg)	20	22	24	26	28	30
HOLD TIME						

CERVICAL EXTENSOR ENDURANCE TEST

TARGET TIME (SECONDS)	HOLD TIME
20	

NECK DISABILITY INDEX

SCORE	PERCENTAGE

POSTURE SCREEN MOBILE APPLICATION

	FRONTAL VIEW DEVIATION	SAGITTAL VIEW DEVIATION
HEAD		
SHOULDER		

CERVICAL RANGE OF MOTION ASSESSMENT

CERVICAL FLEXION		
CERVICAL EXTENSION		
SIDE	RIGHT	LEFT
CERVICAL LATERAL ROTATION		
CERVICAL SIDE FLEXION		

APPENDIX - VI
POST-TEST EVALUATION
CRANIOCERVICAL FLEXION TEST
(USING PNEUMATIC COMPRESSION DEVICE)

PRESSURE (mmHg)	20	22	24	26	28	30
HOLD TIME						

CERVICAL EXTENSOR ENDURANCE TEST

TARGET TIME (SECONDS)	HOLD TIME
20	

NECK DISABILITY INDEX

SCORE	PERCENTAGE

POSTURE SCREEN MOBILE APPLICATION

	FRONTAL VIEW DEVIATION	SAGITTAL VIEW DEVIATION
HEAD		
SHOULDER		

CERVICAL RANGE OF MOTION ASSESSMENT

CERVICAL FLEXION		
CERVICAL EXTENSION		
SIDE	RIGHT	LEFT
CERVICAL LATERAL ROTATION		
CERVICAL SIDE FLEXION		