Cervical spine mobilization versus Thoracic spine manipulation in subjects with unilateral C6 and C7 Cervical Radiculopathy - Comparative study

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ABSTRACT :

Background & Purpose: Cervical radiculopathy is a common entity. Several non operative interventions, with varying success rates, have been described for treatment of Cervical Radiculopathy. But the available evidences of comparing the effectiveness of one manual therapy over the other are very few. So, the purpose of this study is to compare the effectiveness of Cervical Spine Mobilization versus Thoracic Spine Manipulation in the treatment of unilateral C6 and C7 cervical radiculopathy.**Subjects :** 45 subjects with chronic unilateral C6 and C7 cervical radiculopathy of age group range between 17 to 60 years were enrolled in this study.**Methodology:** Patients who were willing to participate in the study and fulfill the inclusion and exclusion criteria were included in the study and they were divided into three Groups (1, 2 & 3) with randomized sampling method. Group 1 was treated with Cervical Spine Mobilization, intermittent cervical traction and strengthening exercise; Group 2 was treated with Thoracic Spine Manipulation, intermittent cervical traction and strengthening exercise and Group 3 (control group) was treated with intermittent cervical traction and strengthening exercise. The duration of the treatment was 4 weeks in all the three groups. Subjects were assessed at baseline, at the end of 2nd week, 4th week and 8th week (follow-up). Three outcome measures: 0-11 NPRS, Hand grip strength and NDI Questionnaire were taken for assessment and analysis.**Results:** A statistically significant ($p \leq 0.05$) difference between all the 3 groups over the total follow-up period of 8 week for Numerical pain rating scale, Hand grip strength & Neck disability index are found with greater change scores in the Group 2.**Discussion and Conclusion:** The result indicate that Cervical Spine Mobilization and Thoracic Spine Manipulation were effective in all three measures when compared to control groups. However, the subjects in group 2, who received Thoracic Spine Manipulation, intermittent cervical traction and strengthening exercise showed better improvement in reducing neck pain, improving Grip Strength & neck disability when compare to Cervical Spine Mobilization group ($p<0.05$).

Keywords: Cervical Spine Mobilization, Thoracic Spine Manipulation, Unilateral C6 and C7 Cervical Radiculopathy, Intermittent Cervical Traction and Strengthening Exercise.

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INTRODUCTION: Pain is the most common symptom of which the human kind complaints. Pain from musculoskeletal system is very common.[1] Musculoskeletal pain constitutes mainly back pain, neck pain, shoulder pain, etc. in order of prevalence rate.[2]

The latin term signify "of the neck" is "cervical".[3] Neck pain is the second common condition after low back pain in Goa population.[4] With an increasing sedentary population, especially with reliance on computer technology in the workplace, the prevalence rate of neck pain will continue to rise.[5] Cervical radiculopathy is a condition encountered commonly in the evaluation of the neck pain that may result in significant discomfort and functional limitations and disability.[6] It is a condition caused by the compression of the nerve root in cervical spine that commonly manifests as neck pain and it may also radiate from the neck into the distribution of the affected nerve root. It might be unilateral or bilateral.[7,8]

Cervical radiculopathy constitutes 5 to 36% of all radiculopathies. In decreasing order, the incidences of root involvement in cervical radiculopathy are C7 (69% to 70%), C6 (19% to 25%), C8 (4% to 10%), and C5 (2%).[9] The incidence rate has been reported at 83.2 cases per 100,000 people per year (107.3/100,000 for males and 63.5/100,000 for females), with peak incidence in those aged 50–54 years.[9,10,11]In the cervical disc herniation, postero lateral herniation of disc material results in foraminal encroachment; and in the cervical spondylosis posterior vertebral body osteophytes and/or facet joint/ligamentum flavum hypertrophy encroach upon the intervertebral foramen. In either case, cervical nerve root pain and dysfunction can occur.[12]

The three principle classifications of neck pain causes, according to McKenzie include the following 3 mechanical syndromes: postural syndromes, dysfunction syndromes and derangement syndromes. A cervical herniated disc falls under the classification of a derangement syndrome.[13,14] There are the seven types of Derangement syndromes classified acoording to McKenzie.[15]

Cervical disc herniation and cervical spondylosis have been attributed as the main causes of cervical radiculopathy in the literatureand the most frequently involved nerve roots are the cervical 6 (C6) and cervical 7 (C7) cervical roots which are typically caused by C5-C6 or C6-C7 disc herniation or spondylosis.[11,15] Cervical spondylosis mainly seen in 60% of those > 45 years, 85% of those > 60 years, and cervical disc herniation mainly in those 17-60 years.[19] Most often it is the result of compressive or inflammatory pathology from a space occupying lesion such as a disc herniation, spondylitic spur or cervical osteophyte.[16,17,18,19]Various conditions causing cervical radiculopathy include : cervical rib , spinal stenosis, thoracic outlet syndrome, whiplash injuries.[12,20,21] Factors associated with increased risk include heavy manual labor requiring the lifting of more than 25 pounds, smoking and driving or operating vibrating equipment.[12] These causes lead to muscular imbalance followed by instability of spineleading to bony impingement or compression of neural or vascular structure.[22]

The location and pattern of symptoms will vary, depending on the nerve root level affected.Patients usually presents with complaints of pain, numbness, tingling, paraesthesia and weakness in the upper extremity which often results in significant functional limitations and disabilities.[15]Patients also may have scapular pain, headaches and neck pain.[23]In **C6** radiculopathy, there occur weakness of elbow flexion or wrist extension and brachioradialis muscle. They may have pain or sensory disturbances into the biceps region of the arm, radial aspect of the forearm, and into the thumb and sometimes, index finger. The brachioradialis reflex may be diminished.[24] In **C7** radiculopathy, there occur weakness of elbow extension or wrist flexion and triceps muscle. They may have pain or sensory disturbances down the posterior aspect of the arm and postero lateral aspect of the forearm to the index, long, ring finger. The triceps reflex may be diminished.[24]Because the weakness of wrist extensor and

finger flexor muscles and wrist flexor and finger extensor muscles which is the common motor deficit pattern associated with C6 and C7 root involvement respectively and considering the role of synergistic function of these muscles in hand grip, it is shown a decrease of grip strength in patients with cervical radiculopathy.[11]

Diagnostic imaging (Radiographs, CT Scan, Magnetic Resonance Imaging, Myelogaphy, Discography) and electrophysiological tests (Nerve Conduction Velocity Studies, Electromyography) are commonly used to confirm a diagnosis of Cervical Radiculopathy. [12,15,25]Various special tests such as Spurling test, Upper limb tension test, Cervical distraction test, cervical compression test, provocation test, etc. [1]arealso used for diagnosis.[15]

A multi disciplinary rehabilitation approach including patient education, pain control and physical therapy are the first line of treatment recommended for cervical radiculopathy patients.[6,26] Conservative therapy is believed to be symptomatic relief for it. Physical therapy is aimed at disease consequences such as pain, numbness, tingling and weakness in the upper extremity.[27] There are various therapeutic interventions to treat cervical radiculopathy like rest, moist heat, ice, cervical collar, postural education, neck exercises, strengthening exercises, ultrasound, TENS, IFT, SWD, US, PEME, EMS, cervical traction, cervical and thoracic spine manipulation/mobilization, and neural mobilization. [10,12,28]Manual therapy has been known to supplement and contribute to other medical specialties, Various mobilization techniques commonly used in physiotherapy practice are Maitland, Mulligan's, McKenzie, Kaltenborn, Cyriax, etc.[29]

Medication mainly focuses on pain reduction, reduce morbidity and prevent complications.[27] If there is no significant improvement in the given time frame or when nonsurgical treatment fails to relieve symptoms or if a significant neurologic deficit exists, surgical decompression may be necessary.[8,30]Anterior cervical discectomy and fusion (ACDF) using Smith-Robinson technique, posterior foraminotomies and cervical total disc replacement[35] are the surgical procedures done for it.[24,30]

Physical therapists often use several interventions and modalities in the management of cervical radiculopathy including joint mobilization, manipulation, therapeutic exercise, and traction. However, strong evidence to support the use of many of the aforementioned management strategies is still lacking.[31]Thus, the purpose of the study is to find the effective treatment program for cervical radiculopathy patients and this study will be helpful for the physiotherapist and the patients who are suffering from cervical radiculopathy.

MATERIALS AND METHODS

An Experimental Design [Comparative Study] was conducted with Simple Random Sampling method. Study was done on subjects who have unilateral C6 and C7 cervical radiculopathy. Fourty-five (n=45) subjects were included who fitted in inclusion and exclusion criteria and they were divided into three groups, Group 1 (Cervical Spine Mobilization technique, n=15), Group 2 (Thoracic Spine Manipulation Technique, n=15) and Group 3 (Control Group- Strengthening Exercise and Intermittent Cervical Traction, n=15) and treated for 4 weeks. Study is done in Out Patient Department of Physiotherapy, C. U. Shah Physiotherapy College, Surendranagar, Gujarat. Study has been approved by the Institutional Scientific Committee and Institutional Ethical Committee affiliated by Saurashtra university, Rajkot, Gujarat, India.

Subjects for the study were selected based on the following inclusion criteria :Age-17 to 60 years,[15]Both Gender,[35] Subjects diagnosed with unilateral C6 and C7 radiculopathy (due to cervical disc prolapse) by orthopedic or neurosurgeo,. Neck and unilateral radiating pain of more than 3 months (chronic),[35]Baseline Neck Disability Index score of 10 or greater,[35]Has not received treatment for the past one month,[36]Presence of 4 positive examination findings (Spurling test, upper limb tension test, cervical distraction test, and less than 60° cervical rotation towards the symptomatic side),[10]According to Derangement 5 :Unilateral or asymmetrical pain about C5-6-7, With or without scapula or shoulder pain and with arm symptoms distal to the elbow, No deformity, Extension and lateral flexion towards side of pain obstructed, Often rapidly reversible.[37] Subjects were not included based on the following exclusion criteria :Red flags (i.e. tumor, fracture, metabolic disease, rheumatoid arthritis, osteoporosis, prolonged use of steroid, infection, severe spondyloarthropathy , etc), [10,36]Present and Past history of any other musculoskeletal, neurological, and cardiopulmonary problems, History of whiplash injury,[35]Diagnosis of cervical spine stenosis,[35]Bi-lateral upper extremity radicular symptoms,[10]Had progressive neurological deficit, myelopathy, or severe incapacitating pain,[36]Prior surgery to the neck, thoracic spine and involved upper extremity,[10] Inability to comply with treatment and follow-up schedule,[35]Pregnant woman.[35] Inform consent form was signed by the subject, who fulfilled inclusion criteria before the treatment started.

Materials used in the study are Cervical traction unit with its accessories[32] (Mfg. by : Electromed-Autotrac), Baseline Hydraulic Hand dynamometer[34] (Mfg. by : Baseline), Orthopedic assessment kit, Orthopedic assessment chart and pen, Inform consent form, NDI sheet,[34]Examination table, Pencil and Paper, Weighing machine, Chair and Pillow.

Qualitative Outcome :11 Point Numeric Pain Rating Scale (NPRS) : for pain intensityandThe Neck Disability Index (NDI) : for functional ability;Quantitative Outcome : Hand grip strength by Hydraulic Hand Dynamometer (Baseline) as outcome measures was collected at baseline, at the end of 2nd week, 4th week and follow-up at the end of 8th week.

CERVICAL SPINE MOBILIZATION[10,33]

(1) Cervical Postero-Anterior Central Vertebral Mobilization :

Subject position : The subject lies face downwards.
Therapist position : The physiotherapist stands at the head of the subject/table
Hand placement : Therapist with his/her thumbs held in opposition and back to back, with the tips of the thumb pads on the spinous process of the vertebra to be mobilized.
Procedure : Apply symmetrical pressure through the articular pillars with both the thumbs. The pressure is repeated rhythmically with a progressive increase of force as the therapist each time places more body weight through the hands. The therapist should progress to grade IV mobilizations for 30 seconds or 15–20 repetitions at desired level.

(2) Cervical Retraction Mobilization :

Subject position : The subject lies supine with the head and neck extending over the treatment table down to the level of approximately T4.
Therapist position : The therapist stands to one side of the head of the treatment table perpendicular to subject's head.

Hand placement : The therapist holds the patient's head with one hand under the occiput and places the web space between the thumb and index finger of the other hand over the subject's chin. The head of the subject is held in the horizontal plane gently, but firmly, against the left waist/anterior thigh.
Procedure : While bending and straightening the knees, the force is directed vertically downward, creating simultaneous upper cervical flexion and lower cervical extension. There should be a gradual increase in mobilization force to end range (grade IV) for approximately 30 seconds or 15–20 repetitions.

(3)Cervical Rotation Mobilization (Right) :

Subject position : The subject is positioned supine with the head and neck extending over the end of the treatment table.
Hand placement : The therapist cradles subject's head between the left forearm and chest wall with one arm, while the right hand's metacarpophalangeal area of the index finger is placed so that its radial side rests firmly against the articular pillar at the desired level.
Procedure : With the right hand, the therapist rotates the subject's head to end range while the left hand accentuates the rotation pressure in the plane of the apophyseal joints. The pressure is repeated rhythmically with a progressive increase of force to grade IV mobilizations for 30 seconds or 15–20 repetitions at each desired level toward the symptomatic side.

(4)Cerivcal lateral glides :

Subject position : Subject is in supine lying position.
Therapist position : Examiner places the subject's upper extremity into ULTT1 (median nerve bias) position viz; scapular depression, shoulder abduction, forearm supination, wrist and finger extension, shoulder external rotation, and elbow extension by a second clinician. If the second operator is not available, then the subject's arm is supported in this position with a plinth, chair, pillows or something similar. If the subject is unable to tolerate this position , the subject's elbow is flexed to the point where symptoms are diminished to a tolerable level.
Procedure : With the involved upper extremity in this position, the therapist cradles the subject's head and neck and performs a lateral translation towards the contralateral side (away from the side of symptoms). Oscillatory translational mobilizations of the neck towards the non-symptomatic side in the plane of the apophyseal joints are repeated rhythmically, with a progressive increase of force to grade IV for 30 seconds or 15–20 repetitions at each desired level.

THORACIC SPINE MANIPULATION[10,33]

(1) Upper Thoracic Spine Manipulation :

Subject position : The upper thoracic spine procedure is to be administered first and performed with the subject in the supine position. Target between segments T1 and T4 with this technique. The subject is instructed to clasp his or her hands across the base of the neck.
Therapist position : The subject's arms then are to be pulled downward to create spinal flexion down to the upper thoracic spine.
Hand placement : The therapist's manipulative hand is to be used to stabilize the inferior vertebra of the targeted motion segment,

Procedure : His or her body applied force through the subject's arms to produce a high-velocity, low-amplitude thrust. If a pop sound occurred, then the therapist should move on to the next procedure. If not, the subject was repositioned, and the technique was performed again. This procedure was performed for a maximum of 2 attempts.

(2) Middle Thoracic Spine Manipulation :

Subject position : The subject remained in the supine position, and the treating therapist perform a middle thoracic spine thrust manipulation. Target between segments T5 and T8 with this technique. The subject is instructed to clasp his or her hands to the opposite shoulder.
Therapist position : The subject's arms then are to be pulled downward and the therapist then flexes the subject's flexes head, neck and thoracic spine to create spinal flexion down to the targeted motion segment.
Hand placement : The therapist's manipulative hand is to be used to stabilize the inferior vertebra of the motion segment,
Procedure : His or her body is used to apply force through the subject's arms to produce a high-velocity, low-amplitude thrust. If no pop sound is heard on the first attempt, then the therapist repositioned the subject and perform the manipulation again. A maximum of 2 attempts were made.

STRENGTHENING EXERCISES[10,33]
Following the thoracic spine manipulation, subjects will be instructed in to perform exercises focusing on strengthening of the **deep neck flexors** and **scapulothoracic muscles** regardless of their strength levels. 3 sets per session, 1 set consist of 10 repetition.

(A) Deep neck flexor strengthening

Subject position : The subjects performed deep neck flexor strengthening exercises as described by Petersen, without the use of a biofeedback unit. The subject was supine, with the cervical spine in neutral position.
Procedure : The subject is instructed to slowly nodding the head and flatten the curve of the neck without pushing the head back into the table/bed. This position was held for 10 seconds and repeated 10 times. The therapist or subject monitors the sternocleidomastoid muscles to ensure minimal to no activation of these muscles during deep neck flexor contraction.

(B)Scapulothoracic exercises included serratus anterior and both middle and lower trapezius muscle strengthening, as described by Flynn et al. All subjects will be instructed to perform all the strengthening exercises at home, twice daily.

Lower and middle trapezius strengthening :The subject should horizontally abduct the shoulder with scapular depression, adduction and upward rotation.This should be performed at approximately 120 to 135 degree abduction for lower trapezius muscle re-education and at approximately 90 degree abduction for middle trapezius muscle re-education.Note that the shoulder should be externally rotated so the thumb points up towards the ceiling and scapula should not elevate towards the head.Also, the subject may place his/her head and neck in any comfortable posture. If unable to rotate the neck, place a pillow under the upper chest and keep the neck in neutral, with the forehead resting on the subject's opposite forearm or a small towel roll.

Serratus anterior strengthening :The subject should stand at the wall with the arms approximately shoulder width apart.The subject performs a "push-up with a plus" exercise by pushing away from the wall until the elbows are fully extended and the scapulae are protacted as far as possible.

MECHANICAL INTERMITTENT CERVICAL TRACTION[33]

Cervical traction has been shown to decrease pain and perceive disability in subjects with cervical radiculopathy; however, no standard parameters have been reported.Treatment duration : 15 minutes per session, Traction force: 10% of the subject's body weight, Ratio of hold:rest (On/off cycle) : 50:10, Patient position : supine with the cervical spine placed at an angle of approx. 15 degrees of flexion.

RESULTS

All statistical analysis was done using SPSS 16.0 software for windows. Descriptive analysis was obtained by mean & standard deviation. Intra- and Inter- group comparison of baseline, 2nd week, 4th week and 8th week (follow-up) scores of Numeric Pain Rating Scale, Grip Strength & Neck Disability Index Questionarrie was done using**One way ANOVA** test**.One way ANOVA post hoc analysis** was done to compare the difference in effectiveness within the groups.

Age Distribution : The patients were divided into three groups with the help of simple randomized sampling method; Group 1 (Cervical spine mobilization group), Group 2 (Thoracic spine manipulation Group) and Group 3 (Control group) with mean age (mean ± SD) of 52 ± 5.24 years, 52.53 ± 6.08 years and 52.67 ± 5.85 years respectively.

Gender Distribution : In this study out of fourty-five patients, Group 1 consists of 7 male (46.67%) and 8 female (53.33%), Group 2 consists of 8 male (53.33%) and 7 female (46.67%) and Group 3 consists of 8 male (53.33%) and 7 female (46.67%). In fourty five patients, total 23 males (51.11%) and 22 females (48.89%) participated in the study.

The p value of mean age, gender, mean BMI and hand dominanace being >0.05 i.e. mean age (p=0.975), gender distribution (p= 1.000), mean BMI (p=0.794) and hand dominance distribution (p=0.690), it suggest that age, gender, BMI and hand dominance are not factors that will affect the results.

Intra-group and Inter-group comparison of NPRS-pain intensity in Group 1, 2 and 3 :
(1) Intra group analysis : The p value of Group 1, 2, 3 comparing baseline, 2nd week, 4th week, 8th week treatment scores of NPRS is 0.000, 0.000, 0.01 respectively. This comparison is done through One-way ANOVA.The p value of all three groups being <0.05it shows that all 3 groups is significant in improving pain intensity. However, thoracic spine manipulation group is highly significant in improving pain intensity comparatively to both the other groups at the end of the 8th week. The percentage of improvement in NPRS score at the end of 8th week is 48.02 %, 67.5% and 11.16 % of group 1, 2, 3 respectively.
(2) Inter group analysis : Inter group comparison of baseline, 2nd week, 4th week, 8th week treatment scores of NPRS was done of group 1, 2, 3. This comparison is done through One-way ANOVA. At baseline, the p value is > 0.05. It shows that there is no significant difference between the pre treatment scores of NPRS. Hence it proves that the groups are homogenous. The p value comparing 2nd week, 4th week, 8th week of group 1, ,2, 3 is 0.000,

0.000, 0.000 respectively which is suggestive of significant improvement at 2nd week, 4th week and 8th week.

Intra-group and Inter-group comparison of Hand Grip Strength in Group 1, 2 and 3 :
(1) Intra group analysis : The p value of Group 1, 2, 3 comparing baseline, 2nd week, 4th week, 8th week treatment scores of hand grip strength is 0.000, 0.000, 0.025 respectively. This comparison is done through One-way ANOVA.The p value of all three groups being <0.05it shows that all 3 groups is significant in improving hand grip strength. However, thoracic spine manipulation group is highly significant in improving hand grip strength comparatively to cervical mobilization and control group at the end of the 8th week. The percentage of improvement in hand grip strength score at the end of 8th week is 39.12 %, 50.14% and 20.24% of group 1, 2, 3 respectively.
(2) Inter group analysis : Inter group comparison of baseline, 2nd week, 4th week, 8th week treatment scores of hand grip strength was done of group 1, 2, 3. This comparison is done through One-way ANOVA. At baseline, the p value is > 0.05 (i.e. p=0.998). It shows that there is no significant difference between the pre treatment scores of hand grip strength. Hence it proves that the groups are homogenous. The p value comparing 2nd week, 4th week, 8th week of group 1, ,2, 3 is 0.046, 0.000, 0.000 respectively (which is <0.05) which is suggestive of significant improvement at 2nd week, 4th week and 8th week.

Intra-group and Inter-group comparison of scores of NDI-for functional disability in Group 1, 2 and 3 :
(1) Intra group analysis : The p value of Group 1, 2, 3 comparing baseline, 2nd week, 4th week, 8th week treatment scores of NDI is 0.000, 0.000, 0.011 respectively. This comparison is done through One-way ANOVA.The p value of all three groups being <0.05it shows that all 3 groups is significant in improving functional ability. However, thoracic spine manipulation group is highly significant in improving functional ability comparatively to cervical mobilization and control groups at the end of the 8th week. The percentage of improvement in NDI score at the end of 8th week is 48.65 %, 55.51% and 36.65 % of group 1, 2, 3 respectively.
(2) Inter group analysis : Inter group comparison of baseline, 2nd week, 4th week, 8th week treatment scores of NDI was done of group 1, 2, 3. This comparison is done through One-way ANOVA. At baseline, the p value is > 0.05 (i.e. p=1.000). It shows that there is no significant difference between the pre treatment scores of NDI. Hence it proves that the groups are homogenous. The p value comparing 2nd week, 4th week, 8th week of group 1, 2, 3 is 0.730, 0.328, 0.131 respectively.

DISCUSSION

Cervical radiculopathy is one of the conditions which can be treated by a wide variety of physiotherapy methods. There has been emerging evidence to suggest that patients who meet the diagnostic classification for cervical radiculopathy might benefit from a multimodal treatment package that includes manual therapy, mechanical traction, and strengthening exercises. Hence the aim of this study was to compare the effectiveness of Cervical Spine Mobilization versus Thoracic Spine Manipulation in the treatment of unilateral C6 and C7 cervical radiculopathy.

Results indicate that there is significant improvement in pain, grip strength and functional status in patients with unilateral C6 and C7 cervical radiculopathy at the end of 8 weeks in all the three groups viz, cervical spine mobilization with conventional physical

therapy group 1, thoracic spine Manipulation with conventional physical therapy group 2 & conventional physical therapy alone group 3. All the three treatment groups obtained successful outcomes as measured by significant reductions in NPRS and NDI scores and significant increase in Grip Strength score after 4 weeks of intervention and at the end of 8th week follow-up. There is significant difference in intensity of pain as per NPRS, Grip Strength as per Hand Dynamometer and functional ability as per NDI between three groups.

The study was conducted on fourty-five subjects with chronic unilateral C6 and C7 cervical radiculopathy. The patients were divided into three groups with the help of simple randomized sampling method. During the 4 weeks of duration, all the three treatment interventions were associated with substantial improvement in patient-reported symptoms. There was tendency for two experimental groups to perform better than the control group in almost all of the patient-rated outcomes. The results showed that patients of Cervical Spine Mobilization group and Thoracic Spine Manipulation group had demonstrated a highly significant improvement in chronic pain, grip strength and functional disability (which were measured by NPRS, Hand Dynamometer & NDI respectively).

Statistical analysis shows the percentage of reduction in Numerical pain rating scale between Group 1, 2 and 3. In Group 1, 2 and 3 there is 48.02% , 67.5% and 11.16% of reduction in pain which suggest that highest reduction in pain is there in thoracic spine manipulation group. Statistical analysis shows the percentage of improvement in Hand grip strength between Group 1, 2 and 3. In Group 1, 2 and 3 there is 39.12 %, 50.14% and 20.24% of improvement in Hand grip strength which suggest that highest improvement is there in thoracic spine manipulation group. Statistical analysis shows the percentage of improvement in Neck disability index between Group 1, 2 and 3. In Group 1, 2 and 3 there is 48.65 %, 55.51% and 36.65% of improvement in Neck disability index which suggest that highest improvement is there in thoracic spine manipulation group.

In our study, we found that Cervical Spine Mobilization and Thoracic Spine Manipulation both were effective in reducing pain and disability and in improving grip strength in patients with unilateral C6 andC7 Cervical Radiculopathy. But Thoracic Spine Manipulation was more effective than Cervical Spine Mobilization in reducing pain and disability and in improving grip strength in patients with unilateral C6 and C7 Cervical Radiculopathy.

Impairments of the thoracic spine may be related to complaints of neck and shoulder pain. Immediate improvements in AROM and pain have been demonstrated in patients with neck pain following thoracic thrust manipulation. While there is evidence that the lateral cervical glide mobilization may be beneficial for patients with a positive ULNT.It is interesting to understand mechanisms of treatment effects as two differenttreatment methods i.e Cervical Spine Mobilization and Thoracic Spine Manipulation achieved almost similar outcomes. Both treatment methods are likely to induce quite local and central afferent input in to the system to modulate pain perception and motor activation.

There are researches to suggest that the afferent input induced by manipulative therapy procedures may stimulate neural inhibitory systems at various levels in the spinal cord, and may also activate descending inhibitory pathways, for example the lateral periaqueductal gray (PAG) area of the midbrain.Experiments carried out by Thabe (1986), Taylor et al (1994) and Murphy et al (1995) using electromyography demonstrated that joint mobilization and manipulation had a reflex effect on the activity of segmental muscles.

Gerrard andMatyas (1980) on the other hand, were unable to demonstrate any changes in muscle activity with gentle mobilization techniques performed in the resistance-free part of the range. This can be demonstrated clinically when a mobilization performed too strongly results in protective muscle spasm.Mulligan (1995) proposed that a minor positional fault of the joint may occur following an injury or strain, resulting in movement restrictions or pain. Lewit (1985) has shown that reduced joint mobility can often be a result of a "mechanical block" from inert structures within a joint.

Biomechanical changes caused by spinal manipulation are thought to have physiological consequences by means of their effects on the inflow of sensory information to the central nervous system. Muscle spindle afferents and Golgi tendon organ afferents are stimulated by spinal manipulation. Smaller-diameter sensory nerve fibers are likely activated, although this has not been demonstrated directly. Mechanical and chemical changes in the intervertebral foramen caused by a herniated intervertebral disc can affect the dorsal roots and dorsal root ganglia, but it is not known if spinal manipulation directly affects these changes. Individuals with herniated lumbar discs have shown clinical improvement in response to spinal manipulation. The phenomenon of central facilitation is known to increase the receptive field of central neurons, enabling either subthreshold or innocuous stimuli access to central pain pathways.

Numerous studies show that spinal manipulation increases pain tolerance or its threshold. One mechanism underlying the effects of spinal manipulation may, therefore, be the manipulation's ability to alter central sensory processing by removing subthreshold mechanical or chemical stimuli from paraspinal tissues. Spinal manipulation is also thought to affect reflex neural outputs to both muscle and visceral organs. Substantial evidence demonstrates that spinal manipulation evokes paraspinal muscle reflexes and alters motoneuron excitability. The effects of spinal manipulation on these somatosomatic reflexes may be quite complex, producing excitatory and inhibitory effects. Strengthening exercises for the deep cervical flexors and scapular muscles were chosen to address the postural impairments, which were considered a contributing factor to the patient's condition since they reported that their symptoms were affected by changing their posture.

The present study had demonstrated that both, Cervical Spine Mobilization and Thoracic Spine Manipulation are effective in relieving pain, improving Grip Strength and Functional ability but thoracic spine manipulation was found to be more effective in patients with unilateral C6 and C7 cervical radiculopathy. So, these interventions can be applied in clinical setup in combination with conventional treatment for the better and long term improvements.

Limitations of the study are no blinding was done, no long term follow up was done, home programmed taught to the patients was not supervised and the study consist of a small quantity of subjects. So the further recommendations for future studies need to be done with large group and longer follow-up. Further studies can be taken up using the same intervention procedures and parameters for other orthopedic conditions with muscle imbalance. Further studies can be taken up with different intervention procedures, parameters for relief of pain, hand grip strength and improving function in unilateral C6 and C7 cervical radiculopathy.Further studies can be taken up at different levels in the cervical spine.The same study can be done with other age group.

CONCLUSIONS

The results indicate that Cervical Spine Mobilization and Thoracic Spine Manipulation is more effective in decreasing neck pain , improving hand grip strength and functional status of patient with unilateral C6 and C7 cervical radiculopathy than control group.

However, the subjects in Group 2 who received Thoracic Spine Manipulation with conventional physical therapy showed better improvement in reducing pain, improving hand grip strength and functional status than Group 1 and 3 who received Cervical Spine Mobilization with conventional physical therapy and Conventional Physical Therapy alone respectively.

List of Abbreviations :

1. ANOVA : Analysis Of Variance
2. AROM : Active Range Of Motion
3. BMI : Body Mass Index
4. NDI : Neck Disability Index
5. NPRS : Numeric Pain Rating Scale
6. ULTT : Upper Limb Tension Test

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NPRS – for pain intensity						
Duration / Group	Baseline	2nd week	4th week	8th week	p value (intra)	% of improvement
Group-1	8.33	7.07	5.4	4.33	0.000	48.02%
Group-2	8.4	6.47	4.4	2.73	0.000	67.5%
Group-3	8.33	8.4	7.6	7.4	0.01	11.16%
p value (inter)	0.976	0.000	0.000	0.000	-	-

Table no. 1 : Intra-group and Inter-group comparison of NPRS-pain intensity in Group 1, 2 and 3

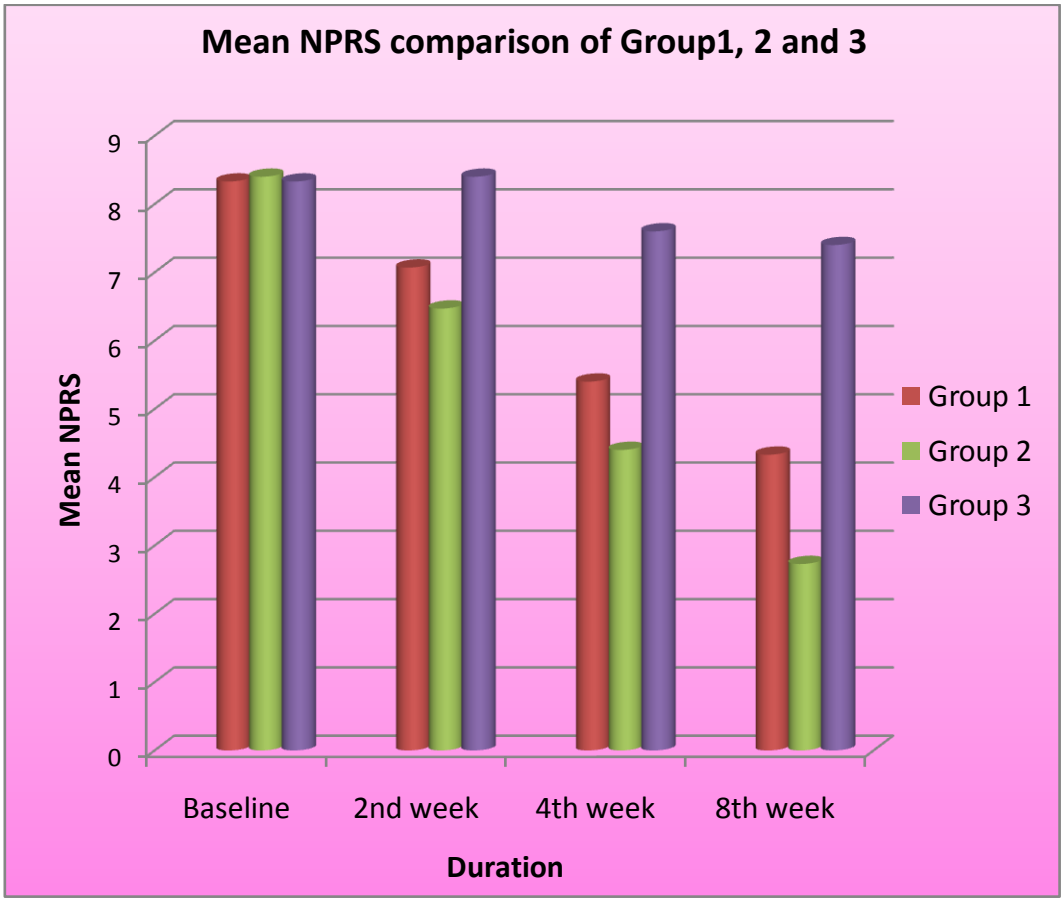
Table 2 : Intra-group and Inter-group comparison of Hand Grip Strength in Group 1, 2 and 3

Hand grip strength (kg)						
Duration / Group	Baseline	2nd week	4th week	8th week	p value (intra)	% of improvement
Group-1	11	13.2	15.4	18.07	0.000	39.12%
Group-2	11.07	15	18.73	22.2	0.000	50.14%
Group-3	11.07	12.27	12.88	13.88	0.025	20.24%

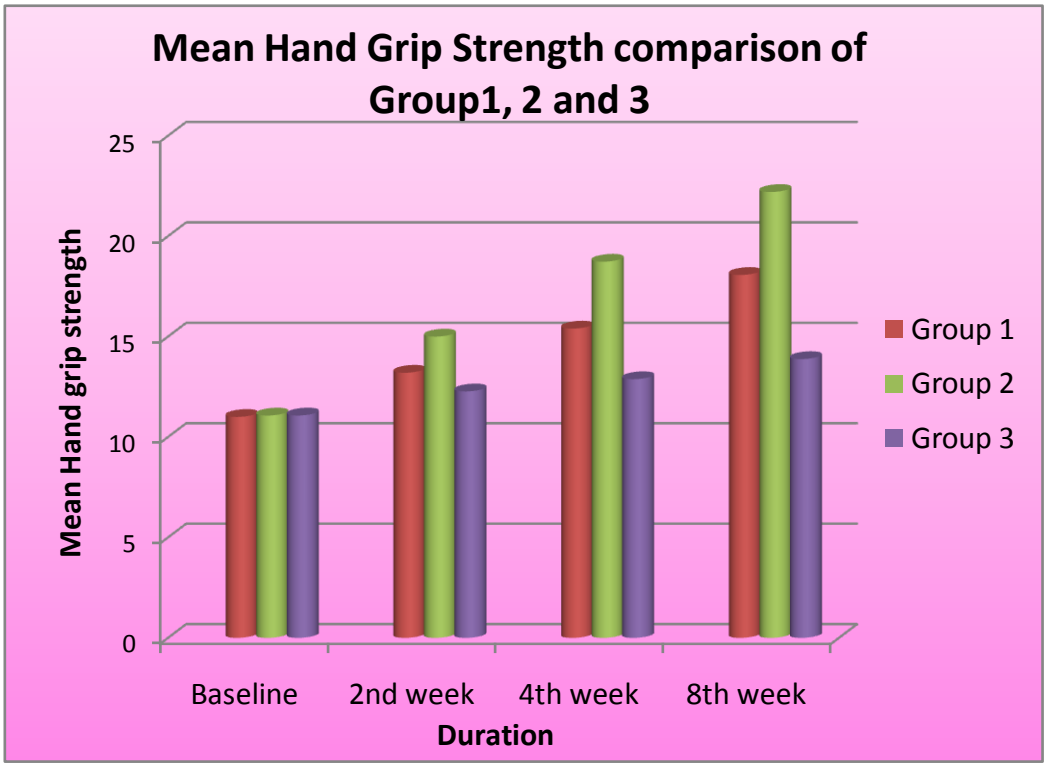
p value (inter)	**0.998**	**0.046**	**0.000**	**0.000**	**-**	**-**

Table 3 : Intra-group and Inter-group comparison of scores of NDI-for functional disability in Group 1, 2 and 3

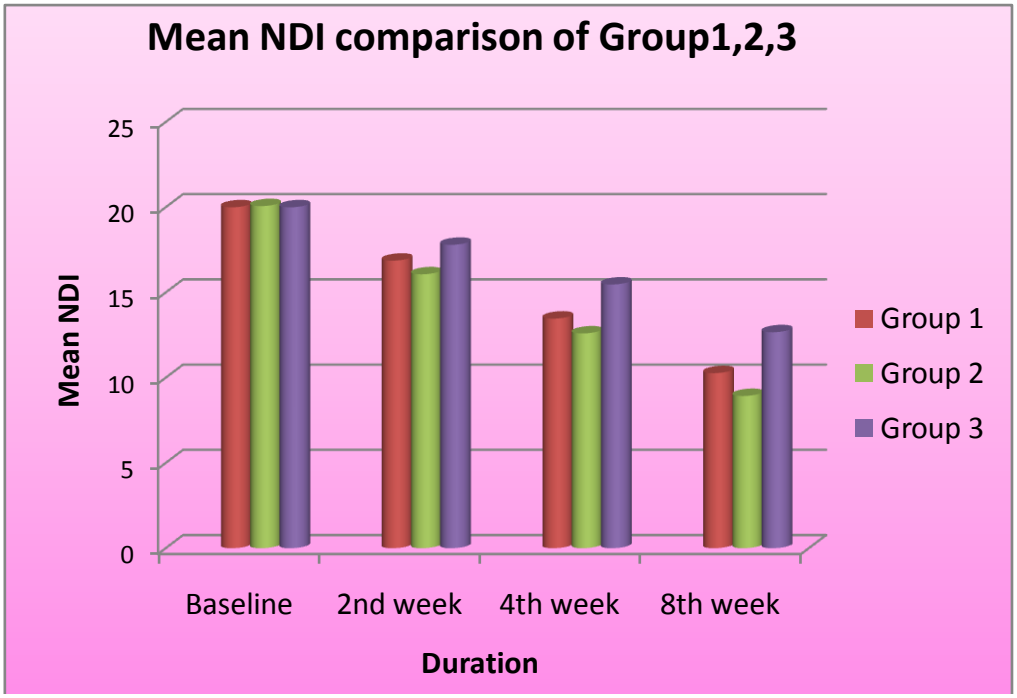
Neck disability index – for functional disability						
Duration / Group	Baseline	2nd week	4th week	8th week	p value (intra)	% of improvement
Group-1	20	16.87	13.47	10.27	0.000	48.65%
Group-2	20.07	16.07	12.6	8.93	0.000	55.51%
Group-3	20	17.8	15.47	12.67	0.011	36.65%
p value (inter)	1.000	0.730	0.328	0.131	-	-



Graph No. 1 :Mean NPRS comparison of Group1, 2 and 3



Graph No. 2 :Mean Hand Grip Strength comparison of Group1, 2 and 3



Graph No. 3 :Mean NDI comparison of Group1, 2 and 3