ISSN: 1607-8322, e-ISSN: 2220-5799 Anaesthesia, Pain & Intensive Care
Vol 26(4); August 2022 DOI: 10.35975/apic.v26i4.1952

ORIGINAL RESEARCH PAIN MANAGEMENT

Comparative effect of upper thoracic spine mobilization with mobility exercises and upper cervical spine mobilization with stabilization exercises in mechanical neck pain: a randomized clinical trial

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Abstract

Background & Objective: Neck pain is a very prevalent health condition. Physiotherapists use multiple treatment options for treating mechanical neck pain. We evaluated the effects of upper thoracic spine mobilization and mobility exercise and upper cervical spine mobilization and stabilization exercises in treating patients with mechanical neck pain.

Methodology: A randomized clinical trial was conducted comprising of 36 patients recruited from different clinics of Faisalabad, both genders, ages from 20-40 y, and randomly divided into two groups. Group A underwent upper thoracic mobilization and mobility exercise while Group B underwent upper cervical mobilization with stabilization exercises for 2 times a week for 4 weeks. Pain scores on Numerical Pain Rating Scale (NPRS) and cervical range of movements (ROM) scores were measured before treatment and then weekly for 4 weeks, while Neck Disability Index (NDI) was assessed at baseline and at the end of 4th week. SPSS version. 22 was used to analyze the data. Independent sample t-test was used for between group compression and $P \leq 0.05$ (95%) was considered as significant.

Results: There was significant improvement in mean NPRS scores at 1st week, 2nd week, 3rd week and 4th week post-treatment ($P < 0.05$). There was significant improvement in mean cervical ROM at 2nd week, 3rd week and 4th week post-treatment readings ($P < 0.05$) and mean NDI score at 4th week ($P < 0.05$).

Conclusion: Both groups were found effective in improving pain, range of motion and neck function, but significant improvement in outcomes was observed in upper cervical mobilization and stabilization exercises group.

Abbreviations: NPRS - Numerical Pain Rating Scale; ROM - Range of movements; NDI - Neck Disability Index; MNP - Mechanical neck pain;

Key words: Adult; Cervical Vertebrae / physiopathology; Disability Evaluation; Exercise Therapy / methods; Female; Humans; Male; Manipulation, Spinal / methods; Neck / physiopathology; Neck Pain / physiopathology; Neck Pain /

rehabilitation; Pain Measurement; Range of Motion, Articular; Thoracic Vertebrae / physiopathology; Treatment Outcome; Young Adult

Citation: Tahir R, Sohail MAA, Ain NU, Aine QU, Mannan H, Maqbool A. Comparative effect of upper thoracic spine mobilization with mobility exercises and upper cervical spine mobilization with stabilization exercises in mechanical neck pain: a randomized clinical trial. Anaesth. pain intensive care 2022;26(4):488-495.

DOI: 10.35975/apic.v26i4.1952

Received: April 11, 2022; **Reviewed:** June 23, 2022; **Accepted:** July 14, 2022

1. Introduction

Mechanical neck pain (MNP) is a distressing condition that arises from the back of the skull and travels towards the neck, shoulder blades and lower cervical spine. The alignment of the vertebrae is disrupted, so they aren't able to utilize their full potential biomechanical advancements that could lead to reduced mobility, resulting in severe discomfort.[1] Mechanical neck pain can be defined as pain in neck aggravated by prolonged posture and movement of neck and palpation of neck musculature. Cervical pain is a major health problem which affects 45-54% of general population and can affect life quality by causing pain and disability.[2] It can influence any race, age, or sex but more frequently in adults more in females in comparison to males.[3] A couple of reasons for neck pain comprise of disc herniation/degeneration, spinal stenosis, joint pain, muscle strain, injury, or malignancy. There may likewise be no known cause.[4] It is postulated that most frequent cause of pain in neck is due to cervical spine mechanical dysfunction. Management of this dysfunction is the emphasis of mobilization or manipulation treatment.[5,6] Physiotherapists use multiple treatment options for treating mechanical neck pain such as joint mobilization, therapeutic exercises, electrotherapeutic modalities, soft tissue release techniques and joint manipulation.[7] The common approach used by physical therapists to treat mechanical neck pain using manual therapy which aims to enhance tissue extensibility, increase range of motion (ROM), mobilize soft tissue or joints, and reduce pain.[8] Cervical mobilization has been shown to be an effective treatment for mechanical neck pain.[9] Stabilization exercises for the spine, in particular, have been used to activate deeper muscles, and minimize over activity of surface muscles. Stabilization exercises have become increasingly popular in management of spinal pains.[10] Regional Interdependence theory proposes that by mobilizing neighboring body segments, a restriction in soft tissue can be broken using instruments for braking adhesions .[11] This paradigm has been assessed in various studies where manual therapy of thoracic spine has been shown to help people with neck pain by lowering pain, increasing mobility, and decreasing disability.[12] Though, there are multiple researches available on evaluating effects of cervical and thoracic mobilization separately on neck pain patients, yet literature has not evaluated their comparative effect in addition with exercises.

The primary objective of the study was to evaluate the effects of upper thoracic spine mobilization with mobility exercises and upper cervical spine mobilization with stabilization exercises in reducing pain and improving cervical ROM and secondary objective was to evaluate functional index in patients with mechanical neck pain.

2. Methodology

This single blinded, randomized clinical trial was performed from June 2021 to October 2021, after approved by the Institutional Review Board of The University of Faisalabad. The study was conducted at Faisal Hospital, Mujahid Hospital, Bin Inam Physical Therapy & Chiropractic Rehab Clinic and Pro Health Wellness Center at Faisalabad, through the use of non-probability sampling technique of purposive type. Informed consent was taken from all research participants after explanation of research procedure to them. All subjects were asked about demographic data and medical history, and they underwent physical examination of the cervical and thoracic spines. Sample size of 30 was calculated with 15 subjects in each group by the use of a formula at OpenEpi tool.[13,14] By the addition of 20% dropout rate, a sample size of 36 was decided with 18 in each group.

$$\text{Sample size} = \frac{2SD^2(Z_{\alpha/2}+Z_{\beta})^2}{d^2}$$

*Where *SD = Standard deviation of the variable, d = significant effect size = difference between the mean values, $Z_{\alpha/2}$ = Z 0.05/2= 1.96 (from Z table), Z_{β}= Z 0.20 = 0.842 (from Z table) at 80% power.*

All of the 36 individuals were randomized to one of the two groups: cervical (n = 18) or thoracic (n = 18) by using online randomization generator software. All participants were told not to share any information regarding their therapy with the other participants (Figure 1). The participants from both genders, ages 20-40 y, patients with primary complaint of neck pain for

for **Table 1: Baseline demographics of the study population (n = 36)**

Parameters		Group A	Group B
Age in Y (Mean ± SD)		28.33 ± 5.19	28.38 ± 5.05
Gender	Male (n = 14)	6 (33.33%)	8 (44.44%%)
	Female (n = 22)	12 (66.67%)	10 (55.56)

Group A: Mobilization with Mobility Exercises. Group B: Mobilization with Stabilization Exercises.

the past l2 weeks, pain rating of more than 2 on Numerical Pain Rating Scale (NPRS), reduced cervical ROM in extension, rotation and side bending, Neck Disability Index (NDI) score of 10 points or more on 0 to 50 scale and committed to comply with treatment plans, were included. Participants with previous history of trauma or surgery to cervical or thoracic spine, whiplash injury, presence of neurological deficits, presence of bilateral upper extremity symptoms, cervical myelopathy or nerve root pathology, patients with positive Lhermitte's sign, vascular diseases of head and neck, presence of any red flags e.g. fracture, tumor, osteoporosis, rheumatoid arthritis, metabolic diseases, blood pressure at rest more than 140/90 mm Hg, chronic history of corticosteroid use, any symptoms of central nervous system (CNS) involvement e.g. hyperreflexia, sensory deficits and muscle atrophy in hands, nystagmus, unsteadiness in gait, loss of visual acuity, abnormal facial sensation, dysgeusia, positive pathological reflexes, patients with psychological disorders or those who couldn't comprehend given instructions were excluded.

Group A received upper thoracic mobilization and mobility exercise and Group B underwent upper cervical mobilization and stabilization exercises. Both groups received 20 min of hot pack application prior to specific group treatment.[15] Initially, Kaltenborn mobilization was given in Grade II and was then progressed into Grade III.[16] Patients received upper thoracic spine mobilization in prone position. Therapist placed left index and middle finger on transverse process of caudal vertebrae of targeted segment of patient. Therapist reinforced left index and middle finger by placing lateral side of the right palm on them. Mobilization was given in ventral to caudal direction. While, mobility exercise technique was performed by the patient actively by doing modified prone trunk lift by clenching hands on cervical spine.[14]

Group B received upper cervical mobilization in seated position on backrest chair. Therapist stabilized lower cervical spine with his right hand and kept his left thumb and index finger on atlas of patient. For giving C_0-C_1 mobilization, therapist placed his little finger beneath the occipital region and pulled patient's head towards his body. Atlantoaxial mobilization was given by moving occipital condyle of the patient in backward direction by using torso and left hand of the therapist. Procedure was then repeated on the other side. While, cervical stabilization exercise technique was performed by the patient through breathing in until he got the feel of occipital bone pushing back. Patient sat on a chair with backrest while performing exercise.[14] In both groups, 3 sets of exercises were performed with 1 set comprising of 10 repetitions for 10 sec each. A rest period of 5 sec was given for each movement and 30 sec per set. Total exercise time was less than 10 min. In both groups, joint mobilization was given for 30 sec, 3 times for every segment. Mobilization lasted for a total of less than 5 min, with a 10 sec break between mobilizations of each segment. Total time of intersegmental movement and rest intervals was 30 sec.[14] Treatment was provided for 2 times a week[17]

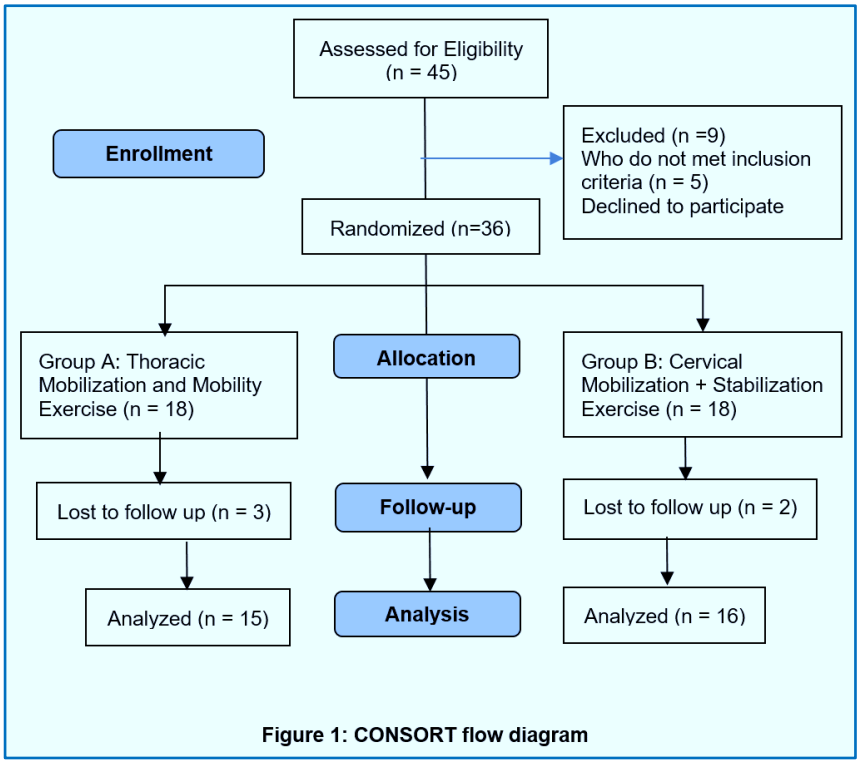

Figure 1: CONSORT flow diagram

Table 2: Within group analysis of NPRS, cervical ROM and NDI. Data given as Mean ± SD

Outcome Measure	Group	Baseline	1st week	2nd week	3rd week	4th week	P
NPRS	Group A	6.44 ± 1.09	5.94 ± 1.47	5.44 ± 1.33	4.68 ± 1.35	4.26 ± 1.09	0.00
	Group B	6.16 ± 1.15	5.00 ± 1.23	3.77 ± 1.26	2.55 ± 1.24	1.00 ± 0.89	0.00
Cervical Flexion°	Group A	38.67 ± 4.05	41.00 ± 3.97	43.11 ± 3.89	45.43 ± 3.84	47.46 ± 4.12	0.00
	Group B	38.83 ± 5.52	43.11 ± 5.41	47.72 ± 5.19	52.11 ± 5.10	57.43 ± 4.74	0.00
Cervical Extension°	Group A	37.78 ± 4.26	39.61 ± 4.07	41.72 ± 3.92	43.68 ± 3.59	45.60 ± 3.73	0.00
	Group B	37.61 ± 5.34	41.61 ± 5.54	45.83 ± 5.83	50.72 ± 5.80	56.37 ± 5.46	0.00
Cervical R. Lateral Flexion°	Group A	26.50 ± 2.97	28.05 ± 3.20	29.27 ± 3.08	30.12 ± 3.13	31.20 ± 3.02	0.00
	Group B	26.72 ± 3.15	29.61 ± 3.18	33.83 ± 3.38	37.83 ± 3.05	41.62 ± 2.96	0.00
Cervical L. Lateral Flexion°	Group A	27.27 ± 3.13	28.61 ± 3.18	29.67 ± 3.04	30.50 ± 3.07	31.53 ± 3.04	0.00
	Group B	27.33 ± 3.21	30.33 ± 3.18	34.11 ± 3.30	37.83 ± 3.03	41.50 ± 2.98	0.00
Cervical R. Rotation°	Group A	51.16 ± 5.15	53.83 ± 5.03	56.05 ± 4.84	59.37 ± 4.41	63.06 ± 4.75	0.00
	Group B	50.56 ± 6.61	55.33 ± 6.31	60.05 ± 6.25	64.83 ± 6.22	70.43 ± 5.81	0.00
Cervical L. Rotation°	Group A	52.72 ± 5.91	55.33 ± 6.08	58.05 ± 6.13	61.31 ± 6.37	63.80 ± 5.44	0.00
	Group B	51.55 ± 6.53	55.72 ± 6.87	60.27 ± 7.16	65.11 ± 7.53	70.56 ± 6.18	0.00
NDI	Group A	27.27 ± 4.38				17.40 ± 5.66	0.00
	Group B	25.94 ± 5.10				5.37 ± 3.46	0.00

for 4 weeks for both groups.

NPRS was used to assess neck pain and universal goniometer to measure active cervical ROM.[18,19] Cervical spine's normal ROM values for adults are 60° for cervical flexion, 75° for cervical extension, 45° for lateral flexion, and 80° for cervical rotation.[20] NDI, original English version and Urdu translated (NDI-U) version has demonstrated excellent reliability to measure neck function in mechanical neck pain patients.[18,21] Primary outcome measures including NPRS and cervical ROM scores were measured before treatment and then weekly for 4 weeks, while secondary outcome NDI was assessed at baseline and at end of 4th week

Statistical analysis

Independent variables in the study were age of the patient, treatment group of the patient; while dependent variables were pain, cervical ROM, and neck function. SPSS version V. 22 was used to analyze the data. The normality of the data was checked through skewness, kurtosis and Shapiro Wilk test for all dependent variables before conducting inferential statistics. Data was found normally distributed, then parametric tests were applied. Repeated measure ANOVA was conducted for within group analysis of NPRS and cervical ROM score at 5 time points. Paired sample t-test was conducted for within group analysis of NDI scores at 2 time points. Independent sample t-test was conducted to find differences in Group A and B at different treatment sessions for all outcome measures.

3. Results

The mean age, and frequency (percentage) of gender in both groups is shown in Table 1.

The NPRS, cervical ROM and NDI significantly improved at post-treatment readings as compared to the baseline values in both groups A and B ($P = 0.00$) as shown in Table 2.

There was significant improvement in mean NPRS scores at 1st week, 2nd week, 3rd week and 4th week post-treatment readings with $P < 0.05$. There was significant improvement in mean cervical flexion, extension, left lateral flexion, right lateral flexion, left rotation and right rotation ROM at 2nd week, 3rd week and 4th week post-treatment readings ($P < 0.05$). Results showed significant reduction in mean NDI scores at week 4 in subjects of both groups ($P < 0.05$).

4. Discussion

This study proved that cervical mobilization along with stabilization exercise was found effective in reducing the pain level, improving the cervical spine ROM, and decreasing functional disability in patients with neck pain. Statistically significant differences in NPRS and cervical ROMs were observed at 2nd week, 3rd week,

Table 3: Between group analysis of NPRS, cervical ROM and NDI (baseline to 4th week).

Outcome Measure	Session	Group A	Group B	P
NPRS	Baseline	6.44 ± 1.09	6.16 ± 1.15	0.46
	1st week	5.94 ± 1.47	5.00 ± 1.23	0.04
	2nd week	5.44 ± 1.33	3.77 ± 1.26	0.00
	3rd week	4.68 ± 1.35	2.55 ± 1.24	0.00
	4th week	4.26 ± 1.09	1.00 ± 0.89	0.00
Cervical Flexion°	Baseline	38.67 ± 4.05	38.83 ± 5.52	0.91
	1st week	41.00 ± 3.97	43.11 ± 5.41	0.19
	2nd week	43.11 ± 3.89	47.72 ± 5.19	0.00
	3rd week	45.43 ± 3.84	52.11 ± 5.10	0.00
	4th week	47.46 ± 4.12	57.43 ± 4.74	0.00
Cervical Extension°	Baseline	37.78 ± 4.26	37.61 ± 5.34	0.91
	1st week	39.61 ± 4.07	41.61 ± 5.54	0.22
	2nd week	41.72 ± 3.92	45.83 ± 5.83	0.01
	3rd week	43.68 ± 3.59	50.72 ± 5.80	0.00
	4th week	45.60 ± 3.73	56.37 ± 5.46	0.00
Cervical R. Lateral Flexion°	Baseline	26.50 ± 2.97	26.72 ± 3.15	0.82
	1st week	28.05 ± 3.20	29.61 ± 3.18	0.15
	2nd week	29.27 ± 3.08	33.83 ± 3.38	0.00
	3rd week	30.12 ± 3.13	37.83 ± 3.05	0.00
	4th week	31.20 ± 3.02	41.62 ± 2.96	0.00
Cervical L. Lateral Flexion°	Baseline	27.27 ± 3.13	27.33 ± 3.21	0.95
	1st week	28.61 ± 3.18	30.33 ± 3.18	0.11
	2nd week	29.67 ± 3.04	34.11 ± 3.30	0.00
	3rd week	30.50 ± 3.07	37.83 ± 3.03	0.00
	4th week	31.53 ± 3.04	41.50 ± 2.98	0.00
Cervical R. Rotation°	Baseline	51.16 ± 5.15	50.56 ± 6.61	0.75
	1st week	53.83 ± 5.03	55.33 ± 6.31	0.43
	2nd week	56.05 ± 4.84	60.05 ± 6.25	0.03
	3rd week	59.37 ± 4.41	64.83 ± 6.22	0.00
	4th week	63.06 ± 4.75	70.43 ± 5.81	0.00
Cervical L. Rotation°	Baseline	52.72 ± 5.91	51.55 ± 6.53	0.57
	1st week	55.33 ± 6.08	55.72 ± 6.87	0.85
	2nd week	58.05 ± 6.13	60.27 ± 7.16	0.03
	3rd week	61.31 ± 6.37	65.11 ± 7.53	0.00
	4th week	63.80 ± 5.44	70.56 ± 6.18	0.00
NDI	Baseline	27.27 ± 4.38	25.94 ± 5.10	0.40
	4th week	17.40 ± 5.66	5.37 ± 3.46	0.00

Group A: Mobilization with Mobility Exercises. Group B: Mobilization with Stabilization Exercises. Data given as Mean ± SD.

and 4th week post-treatment readings between the 2 groups. Statistically significant difference was observed in NDI at 4th week post-treatment readings in both groups. Statistically significant improvement was observed in the upper cervical spine mobilization with stabilization exercises group for all dependent variables. Celenay et al. demonstrated cervical mobilization with

stabilization exercises to be effective in pain reduction, ROM enhancement, and functional improvement in mechanical neck pain patients.[22] Farooq et al. also showed positive effects of cervical mobilization with exercises in improving pain scores, cervical ROM, and neck function.[23] These findings are in agreement with the results of the current study because cervical mobilization along with stabilization exercise was found beneficial in reducing pain level, increasing the ROM of the cervical spine as well as reducing functional disability. Akhter et al. demonstrated that cervical manual therapy in combination with exercises that involve strengthening, stretching, and general ROM was effective in reducing the pain and improving the function of the cervical spine in neck pain patients.[24] The difference with the current study lies in that Akhter used cervical mobilization in conjunction with stabilization exercise. Both treatments reduced the pain and functional disability in neck pain patients. Safdar et al. has shown dissimilar results to the current study. The study showed that cervical mobilization and stretching exercises, combined with or without upper thoracic mobilization in neck pain, demonstrated significant reductions in pain and improved the function of the cervical spine. But ROM of extension and rotation improved more in the upper thoracic spine mobilization group.[25] According to the present study, soft tissue mobilization with exercises greatly improves the ROM of the cervical spine and reduces the pain or function of the cervical spine as compared to the exercises alone.[26] The current study stated contrary findings that cervical mobilization greatly increases the ROM compared to mobilization in the thoracic area. Kim and Hwang Bo agreed with the current study findings by exhibiting pain reduction in neck pain patients by the treatment of cervical stabilization exercises.[27] Another study by Yesil et al. has findings in concordance with this study, as both studies have found cervical stabilization exercises to be beneficial in pain alleviation, ROM improvement, and disability reduction.[28] Griswold et al. compared the effects of cervical and upper thoracic spine mobilization with manipulation in patients with mechanical neck pain. Results of the study demonstrated no significant difference between the manipulation and mobilization groups. The study has shown beneficial effects of mobilization in improving pain and enhancing neck ROM and neck function in mechanical neck pain patients, in line with the findings of our study.[29] Perveen et al. discovered that manipulation at the thoracic spine reduced pain and improved cervical spine function more than mobilization at the thoracic spine.[30] On the contrary, the current study exhibited that cervical mobilization showed more reduction in pain, improved the ROM of the cervical spine, and reduced disability as compared to thoracic spine mobilization in neck pain individuals. Al-Bassiouny and El-Khozamy has demonstrated the beneficial effects of upper thoracic mobilization along with routine therapy in alleviating pain and improving cervical ROM and function.[31] Current study also reveals that thoracic mobilization with stabilization exercises reduced the pain, improved the ROM of the cervical spine, and reduced the functional disability.

We evaluated the results of the study for a month and used NDI Urdu version for the ease of patients to report their functional activities accurately. Evidence is scarce about the combination effects of upper cervical mobilization assessed in combination with stabilization exercises or the combination of upper thoracic spine mobilization with mobility exercises in neck pain patients. This comparison is the distinguishing and innovative feature of the current study.

5. Limitations

Study limitations were; there was no follow-up after the discontinuation of the treatment to observe the long-term effects. It was a single blinded study, in which only patient was kept blind.

Recommendations for future researchers include larger sample size, triple blinded study, evaluation of more outcome measures, use of different treatment options alone or in combination to treat neck pain and long term follow up.

6. Conclusion

Current study concluded that both upper thoracic spine mobilization with mobility exercise and upper cervical spine mobilization with stabilization exercises were significantly effective in improving neck pain, cervical ROM and neck function in patients with mechanical neck pain.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

We gratefully acknowledge the facilitation provided by the Departments of Rehabilitation Science as well as the administrations of the healthcare institutions, which were involved in this study.

9. Trial Registration ID

IRCT20210630051741N1

10. Conflict of interest

The study did not involve any grant or funding, from internal or external sources.

11. Authors' contribution

RT: Conception and design, Collection and assembly of data, Analysis and interpretation of the data, Drafting of

the article, Statistical analysis
MA: Conception and design, Analysis and interpretation of the data, Drafting of the article
NA: Conception and design, Collection and assembly of data
QA: Collection and assembly of data, Manuscript editing
HM: Conception and design, Critical revision of the article for important intellectual content, Final approval and guarantor of the article
AM: Critical revision of the article for important intellectual content, Manuscript editing

12. References

1. Raza SMA, Ashfaq M, Javaid R, Idrees K, Sohail MAA, Razzaq K, et al. Comparative study on the effectiveness of mulligan sustained natural apophyseal glides (SNAGs) vs mulligan natural apophyseal glides (NAGs) in patients with mechanical neck pain. Indo Am J Pharma Sci. 2021 Feb;8(2):185-90. DOI: 10.5281/zenodo.4543729
2. Muñoz-Muñoz S, Muñoz-García MT, Alburquerque-Sendín F, Arroyo-Morales M, Fernández-de-las-Peñas C. Myofascial trigger points, pain, disability, and sleep quality in individuals with mechanical neck pain. J Manipulative Physiol Ther. 2012 Oct 1;35(8):608-13. [PubMed] DOI: 10.1016/j.jmpt.2012.09.003
3. Yelin E, Weinstein S, King T. The burden of musculoskeletal diseases in the United States. Semin Arthritis Rheum. 2016 Dec;46(3):259-60. [PubMed] DOI: 10.1016/j.semarthrit.2016.07.013
4. Epstein NE. The American Association of Neurological Surgeons (AANS) Suspends Surgeon for Arguing Against Unnecessarily Extensive Spine Surgery; Was this Appropriate? Surg Neurol Int. 2018;9(1):265. [PubMed] DOI: 10.4103/sni.sni_423_18
5. Bogduk N. The anatomy and pathophysiology of neck pain. Phys Med Rehabil Clin. 2011 Aug 1;22(3):367-82. [PubMed] DOI: 10.1016/j.pmr.2011.03.008
6. Vasseljen O, Woodhouse A, Bjørngaard JH, Leivseth L. Natural course of acute neck and low back pain in the general population: the HUNT study. PAIN®. 2013 Aug 1;154(8):1237-44. [PubMed] DOI: 10.1016/j.pain.2013.03.032
7. Bryans R, Decina P, Descarreaux M, Duranleau M, Marcoux H, Potter B, et al. Evidence-based guidelines for the chiropractic treatment of adults with neck pain. J Manipulative Physiol Ther. 2014 Jan 1;37(1):42-63. [PubMed] DOI: 10.1016/j.jmpt.2013.08.010
8. Kim G, Lee S, Jeong H. Effects of upper thoracic joint mobilization on dynamic stability of patients with chronic neck pain. J Phys Ther Sci. 2011;23(5):753-6. [PubMed] DOI: 10.1589/jpts.26.1783
9. Park SE, Kim BK, Lee SB, Choi WS, Yeum DM. Effects of central and unilateral posteroanterior mobilization on cervical lordosis, muscle stiffness and ROM in patient with ankylosing spondylitis: case study. J Phys Ther Sci. 2017;29(7):1276-80. [PubMed] DOI: 10.1589/jpts.29.1276
10. Gross AR, Paquin JP, Dupont G, Blanchette S, Lalonde P, Cristie T, et al. Exercises for mechanical neck disorders: A Cochrane review update. Man Ther. 2016 Aug 1;24:25-45. [PubMed] DOI: 10.1016/j.math.2016.04.005
11. Mahmood T, Hafeez M, Ghauri MW, Salam A. Instrument assisted soft tissue mobilization- an emerging trend for soft tissue dysfunction. J Pak Med Assoc. 2021 Mar;71(3):977-981. [PubMed] DOI: 10.47391/JPMA.1168
12. McDevitt A, Young J, Mintken P, Cleland J. Regional interdependence and manual therapy directed at the thoracic spine. J Man Manip Ther. 2015 Jul 1;23(3):139-46. [PubMed] DOI: 10.1179/2042618615Y.0000000005
13. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013 Apr;35(2):121. [PubMed] DOI: 10.4103/0253-7176.116232
14. Cho J, Lee E, Lee S. Upper thoracic spine mobilization and mobility exercise versus upper cervical spine mobilization and stabilization exercise in individuals with forward head posture: a randomized clinical trial. BMC Musculoskelet Disord. 2017 Dec;18(1):1-10. [PubMed] DOI: 10.1186/s12891-017-1889-2
15. González-Rueda V, López-de-Celis C, Bueno-Gracia E, Rodríguez-Sanz J, Pérez-Bellmunt A, Barra-López ME, et al. Short-and mid-term effects of adding upper cervical manual therapy to a conventional physical therapy program in patients with chronic mechanical neck pain. Randomized controlled clinical trial. Clin Rehabil. 2021 Mar;35(3):378-89. [PubMed] DOI: 10.1177/0269215520965054
16. Huijbregts PA, Kaltenborn FM, Kaltenborn TB. Joint mobilization and manipulation. Neck and Arm Pain Syndromes E-Book: Evidence-informed Screening, Diagnosis and Management. 2011 Jan 1:381.
17. Lizis P, Kobza W, Manko G, Jaszczur-Nowicki J, Perlinski J, Para B. Cryotherapy with mobilization versus cryotherapy with mobilization reinforced with home stretching exercises in treatment of chronic neck pain: a randomized trial. J Manipulative Physiol Ther. 2020 Mar 1;43(3):197-205. [PubMed] DOI: 10.1016/j.jmpt.2018.11.030
18. Cleland JA, Childs JD, Whitman JM. Psychometric properties of the Neck Disability Index and Numeric Pain Rating Scale in patients with mechanical neck pain. Arch Phys Med Rehabil. 2008 Jan 1;89(1):69-74. [PubMed] DOI: 10.1016/j.apmr.2007.08.126
19. Farooq MN, Bandpei MA, Ali M, Khan GA. Reliability of the universal goniometer for assessing active cervical range of motion in asymptomatic healthy persons. Pakistan journal of medical sciences. 2016 Mar;32(2):457. [PubMed] DOI: 10.12669/pjms.322.8747
20. Range of Motion [Internet]. United Kingdom. Physiopedia; 2021. Range of Motion Chart [Cited 2021 Apr 2021]. Available from: https://www.physio-pedia.com/Range_of_Motion
21. Farooq MN, Mohseni-Bandpei MA, Gilani SA, Hafeez A. Urdu version of the neck disability index: a reliability and validity study. BMC Musculoskelet Disord. 2017 Dec;18(1):149. [PubMed] DOI: 10.1186/s12891-017-1469-5
22. Celenay ST, Akbayrak T, Kaya DO. A comparison of the effects of stabilization exercises plus manual therapy to those of stabilization exercises alone in patients with nonspecific mechanical neck pain: a randomized clinical trial. J Orthop

Sports Phys Ther. 2016 Feb;46(2):44-55. [PubMed] DOI: 10.2519/jospt.2016.5979

23. Farooq MN, Mohseni-Bandpei MA, Gilani SA, Ashfaq M, Mahmood Q. The effects of neck mobilization in patients with chronic neck pain: A randomized controlled trial. J Bodyw Mov Ther. 2018 Jan 1;22(1):24-31. [PubMed] DOI: 10.1016/j.jbmt.2017.03.007
24. Akhter S, Khan M, Ali SS, Soomro RR. Role of manual therapy with exercise regime versus exercise regime alone in the management of non-specific chronic neck pain. Pak J Pharm Sci. 2014 Nov;27(6 Suppl):2125-8. [PubMed]
25. Safdar M, Sarfraz N, Ishaq I, Sabir M, Mahmooda S, Bashir A. Effectiveness of cervical mobilization and stretching exercise with or without upper thoracic mobilization on non-specific neck pain. Rawal Med J. 2020 Jan;45(1):80-3. [FreeFullText]
26. Mahmood T, Afzal W, Ahmad U, Arif MA, Ahmad A. Comparative effectiveness of routine physical therapy with and without instrument assisted soft tissue mobilization in patients with neck pain due to upper crossed syndrome. J Pak Med Assoc. 2021 Jul 26;71(10):2304-8. [PubMed] DOI: 10.47391/JPMA.03-415
27. Kim GC, HwangBo PN. Effects of cervical stabilization exercise using pressure biofeedback on neck pain, forward head posture and acoustic characteristics of chronic neck pain patients with forward head posture. Korean Soc Phys Med. 2019;14(1):121-9. DOI: 10.13066/kspm.2019.14.1.121
28. Yesil H, Hepguler S, Dundar U, Taravati S, Isleten B. Does the use of electrotherapies increase the effectiveness of neck stabilization exercises for improving pain, disability, mood, and quality of life in chronic neck pain?: A randomized, controlled, single-blind study. Spine. 2018 Oct 15;43(20):E1174-83. [PubMed] DOI: 10.1097/BRS.0000000000002663
29. Griswold D, Learman K, O'Halloran B, Cleland J. A preliminary study comparing the use of cervical/upper thoracic mobilization and manipulation for individuals with mechanical neck pain. J Man Manip Ther. 2015 May 1;23(2):75-83. [PubMed] DOI: 10.1179/2042618614Y.0000000095
30. Perveen S, Mahmood T, Haider R, Ayub A. Effects of low amplitude high velocity thurst manipulation as compare to Grade III maitland mobilization of thoracic spine on mechanical neck pain and disability. Journal of Liaquat University of Medical & Health Sciences. 2020 Dec 31;19(04):252-6. [FreeFullText]
31. Al-Bassiouny HA, Shendy S, El-Khozamy H. Effect of Upper Thoracic Mobilization on Chronic Mechanical Neck Pain. Med J Cairo Univ. 2019;87(3):1449-57. DOI: 10.21608/mjcu.2019.53515

