How to Cite:
Kushwaha, P., Verma, R., Khan, S., & Sharma, M. (2022). Comparison between electrotherapy and manual therapy in cervical radiculopathy: Literature review. *International Journal of Health Sciences*, *6*(S6), 2030–2042. https://doi.org/10.53730/ijhs.v6nS6.10106

Comparison between electrotherapy and manual therapy in cervical radiculopathy: Literature review

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***Abstract*---**Background: Cervical radiculopathy (CR) is a broad term that included any dysfunction related to the nerve root on cervical area. Most commonly affected nerve root C6- C7. Cervical radiculopathy is the condition in which patient feel pain, numbness, paraesthesia, tingling effect in cervical hand and upper extremity due to impingement of nerve in cervical area. The cause of nerve impingement is PIVD, instability, trauma, athletic changes; slip disc, cervical foraminal stenosis, and bone spur formation. A large number of Physiotherapy treatment was suggested which are feasible for CR including exercise mobilisation isometric exercise with therapeutic modalities TENS, US, IFT. This study is to discover the efficacy of TENS, IFT, US versus mobilization and isometric exercises, as an intervention for the patients having CR. Aim- -The purpose of this study was to compare manual therapy and electrotherapy in cervical radiculopathy patients. Method- We included 30 articles in this study, 15 for manual therapy and 15 for electrotherapy, based on randomised controlled trials. Manual therapy included isometric exercises, mobilisation, and physical exercises, while electrotherapy included ultrasonography and interferential current. The VAS, NDI, and NPRS scales were utilised to determine the outcome. Result - The current study found that manual therapy and electrotherapy were compared in a ratio of 9:8. conclusion- In patients with cervical radiculopathy, manual treatment is more beneficial.

Manuscript submitted: 9 March 2022, Manuscript revised: 27 May 2022, Accepted for publication: 18 June 2022

***Keywords*---**Cervical Radiculopathy (CR), Manual Therapy, Mobilization, TENS, Ultrasound, Interferential Current.

Introduction

Cervical radiculopathy is the condition in which patient feels pain, numbness, tingling effect in cervical, hand and UL due to nerve impingement in cervical. The cause of nerve impingement is PIVD, trauma, arthritic changes, Slip disc, foraminal Stenosis, bone spur [1]. Spinal nerve roots innervate the muscles known as myotome. Swelling or pressure on nerve root can leads to impingement symptoms in the muscles that the nerve root innervates. CR is the most commonly seen problem in patients, and it includes significant indications other than irritation, such as abnormal sensation and muscle atrophy within the dermatome or myotome circulation influenced branch of nerve, and the most common recurrence included nerve branch are C6 & C7, which are commonly caused by cervical (5,6,7) herniation and spondylosis. The reality that participants with CR may have a problem with cervical torment, the majority of those seeking therapeutic care in shoulder torment executives at CR are non-operative, using exercise and modalities as treatments. [2] Annually, there are 107 cases for every 100,000 men and 64 cases for every 100,000 women. Individuals aged 50 to 54 are disproportionately affected.

At cervical joint degeneration or spondylitis, every foramen is lined with joints that are angled. Instability can cause nerve root damage as a result of injury. [3] The special case in C8 nerve root, which exist underneath the 7th vertebral body. Motor part that nerve present in anterior side whereas sensory part present at the posterior (dorsal nerve root), whereas both dorsal and ventral nerve root combines make mixed spinal nerve. Cervical Radiculopathy classified as a 3 part temporary phase, sub-acute phase and constant, acute stage were distinguish to shred of annular fibrosis and compression of nerve , in sub-acute phase patient have pre-existing cervical spondylosis which leads radicular pain where as in chronic stages there is sharp ,burning, aching sensational pain radiating from neck , chest to shoulder and arm that can't be treated by conservative method if C7 is Involve than patient experience pain and Radiation in triceps Region. Sensory symptoms of Radiculopathy are numbness present initially later on continued with motor loss and also affecting reflexes .if C2 and C3 are involved which means 3rd cervical nerve root, patient experience pain and discomfort in sub occipital side that are extending from behind the ear to posterior and lateral side of neck whereas 4th cervical nerve root involved due to any pathological change between C3 and C4 than patient experience worst pain from neck to superior portion of shoulder , dorsal aspect of scapula (rhomboid, trapezium, levator scapulae supplied by 4th nerve) , and also sensory deficiency seen in ventrolateral side of neck, whenever C3,C4 and C5 involve directly patient experience weakness in diaphragm region.[4] The exact diagnosis of cervical radiculopathy starts from patient history taking and physical checkup. Separating between cervical radiculopathy and peripheral nerve compression is a typical symptomatic issue and after doing proper diagnosis it should be easily identified the site of compression.[5] Neck torment is perhaps the most

continuous musculoskeletal pain. Its additionally suggests a 4-grade classification arrangement of neck torment severity.

This classification shows that incapacity in the patient's everyday life and the manifestations related with structure of the cervical spine. On other side they reported short term Electrotherapy used with some patients that analyze TENS with different medicine. There was no difference between those groups. [6, 30] mostly due to disc herniation or spondylotic changes like osteophyte that leads to nerve compression and swelling. A recent review study showed that patient with CR because of disc herniation considerably enhanced level of torment and movement inside the initial 4 to 6 months and were ready to get back to their ordinary exercises after 24 to 36 months. It's given bunch of effect like stretching of tissue and ROM, change in movement of muscle, calmness, irregular torment and reduces soft tissue inflammation and redness. [7] An organized physical therapy plans prescribed preceding seeking after invasive treatment. However, ideal intervention detains still needed clarified. Physical exercise and manual treatment are as of now being utilized in the administration of an assessment of issue and have been shown to be gainful in further developing torment seriousness, psychological wellness and physical activity.

We estimated that exercise could be viable in Lessing torment and incapacity in patient with CR. [8] the regular side effects of cervical radiculopathy include torment, muscle weakness on neck and upper limb diminishes sensations and proprioception deficits. The treatment choices for cervical radiculopathy were based on surgically and conservatively both which mean to decrease torment and manifestation, increment nerve function, and reoccurrence of cervical radiculopathy. There was not any evidence that proof bird surgical procedure was only effective for cervical radiculopathy.[9] there were less common than mechanical neck torment, CR prompts more serious torment and disabilitypeople with joined cross section and radiating manifestations appeared at introduce high function restrictions. In manual therapy procedure for acute and sub acute of cervical radiculopathy mostly include treatment include treatment were enhance the area of Intra vertebral foramen. assumed the several motion those expansion area of Intra vertebral foramen like bending forward contra lateral turn and contra lateral side bending may leads to de- stress an causing nerve root and contra wise, motion in the pattern of bending backward, contra lateral rotation and contra lateral side bending might lessen of Intra vertebral foramen area [10] some thought of common course of span Cervical radiculopathy.

In each research had follow-up with 51 patients with cervical radiculopathy over 2 to19 year tracked down those forty three percent participants having no more indications following couple of months, twenty nine percent gentle & irregular manifestations, and twenty seven percent had been extra impaired torment. According to current researches normal course of cervical radiculopathy is up to year. Examination on the viability of cervical radiculopathy is inadequate. In a best proof that combination to NPFT, just only RCPs were recognized efficiency to invasive v/s traditional intervention to those participants who were having cervical radiculopathy The NPTF inferred due to lack of evidence accessible to decide the viability of non-invasive methods to temporary and durable haul. [11] In this research on RCTs betterment to Physiotherapy or activity to chronic

cervical radiculopathy. Manifestation acute or sub-acute cervical radiculopathy yet not is considered. Thusly we assessed the validity of physiotherapy and home activity and wait for the result. We assumed that treatment strategy(physiotherapy) would bring about a quicker decrease in torment and enhancement in function wait and see the result.[12] the in active way of life, absence of activity and always higher the level of stress that may lead problems in daily life. These elements generate immune systems, muscles and bones fragile just as decay body mechanics. Cervical radiculopathy is one of the conditions whose side effects are incited by extra weight on these weak structures.

That's leads to the compression in nerve root because of herniated disc, spondylotic changes or formation of bony spur and it's also due to road traffic accidents, aggressive and repeated exercises in inadequate posture. In cervical radiculopathy the radiation of torment has been reported to be one sided also both the side however bilateral cases have been just 5-36%. Distinctive diagnostic test of cervical radiculopathy concluded magnetic resonance imaging, electromyography and nerve conduction studies, yet inaccessibility of specific equipment and specialized staff. For analytic purposes, specialists and physiotherapists depend on actual assessment which uncovers less pain during ROM of cervical region, lessen sensation in UE and diminished deep tendon reflexes of involved limbs. Positive demonstrative tests concluded spurling test, distraction test, Valsalva's maneuver [13] In cervical radiculopathy remarkable functional restrictions and inability these are common complaints for those individuals experiencing cervical radiculopathy with the age of 50-54 years old, in light of primary and practically causing neural inflammation, oedema, hypoxia, ischemia thus on. An Examination from the US military discovered a rate of 1.79 per 1000 individual in a year. In cervical radiculopathy the surgical procedure also having some issues like after surgery involving adjoining sections degeneration, decreases the height of intervertebral disc and thus on. In conservative procedure including physical therapy, Manual exercises, cervical collar for immobilization and NSAID these were lessen the torment, increase neurogenic function of cervical radiculopathy and better quality of life.[14]

As per the ICF (International classification system), neck torment is grouped into four significant classes: (1) neck torment with immobility (cervicalgia and torment in thoracic spine).(2) neck torment with head pain (migraine and cervico-cranial condition).(3)neck torment with development coordination disabilities, (twist and shear on the neck region).(4) neck torment with radicular torment (spondylosis to CR and neck circle problems within CR).neck torment shows reliability and chronic constancy. Chronic neck torment is characterized as neck torment with length of indications longer than 3 months and is related with changes in the biomechanics of the neck area. In most of the study either strengthening or endurance exercise procdure were applied. Despite the fact that there has been lot of debate that there were two kind of training is most suitable. The physical therapy strategy concluded hands on technique bye physical therapist to lessen torment and inability. Hakkinet and associates express that manual treatment procedures are powerful in diminishing pain in people with ongoing neck torment however on its own it doesn't comprise an effective strategy for increasing muscle strength. The strategies are spinal mobilization and manipulation, soft tissue release, manual therapy and massage so on. However, the impact to physical

procedure and restorative activity people having constant cervical torment still to be explained. [15] At the point when the symptom is further 84 days for advancement, secures worth to sustain named NCNP. Quantity of common instances to cervical treatment overall were assessed to be 288.7 M, and the quantity of year sustain along in capacitates because of because of neck torment in 2017 overall was assessed to be roughly 28.6 million.

Number of examinations had been assessed the impact to physical treatment and restorative activity patient along to NCNP, determined to check its adequacy for treatment clinical statebut, there was less proof between time length of its effect and time of the activity. Physical therapy includes neurophysiologic instruments like reduction of inflammatory biomarkers, lesson spinal edginess and torment affectaability, and excitation of sympathetic nervous systems. All things considered, despite the fact that restorative activities were showed facilitation result, includes changes withinmotors design, primary variations and expansion within power and perseverance. Two of them had revel adequacy yet being so dissimilar mechanism activity, art of impacts and development were unique [16]. According to Wainner et al. Expand CPR, comprising 4 factors for help health professional analysis to cervical radiculopathy. (a) +ve spurling assessment (b) +ve distraction assessment (c) one side cervical rotation under sixty percent and (d) +ve ULTT middle of inclination along 4 out of 3 factors presents, clinical prediction rule specificness to Ninety four percent and a +ve probability proportion 6.1 along each of the 4factors existing, particularity instruments of hundred percent and +ve probability proportion increments 30.3 using this CPR ,a bunch of four tests, is a valuable technique for clinical diagnosis of cervical radiculopathy.

Conservative treatment of cervical radiculopathy is comprised many exercises and manual techniques i.e., mobilization, isometric exercises, modalities and cervical collar. According to systematic study shows that physical therapy is beneficial for cervical radiculopathy [17]. Neck torment is a common and regular impairment related with inability. Manipulation, mobilization and manual therapy put in as only- modular treatment approaches for neck torment have acquired some help in Cochrane evaluation. A large number of therapists accept that solo care approaches don'tcorrectly act for clinical practice or best practice for singular patients. In our past studies, results assist the utilization of Manual therapy and exercises for short period of time it acts on pain reduction as well as patient satisfaction in both type of neck pain chronic and acute; they might be /might not be cervicogenic headache. According to other reviews results were indecisive about neck torment with cervical radiculopathy as well as functional outcome and quality of life all depend on long term systematic follow up. They use singles as well as multiple Manual and mobilization approach were repeated [18]. Welldefined alterations of the surface electromyography signal can be distinguished during supported wilful muscle contraction.

The examination of myoelectric indication of fatigue gives significant data about physiological changes that creating in muscle. The most regularly chapped surfaceENG factors during the evaluation of myoelectric indication of fatigue are otherworldly factors, for example the mean or median frequency resonance (MDF). Throughout sub maximal isometric perseverance test for the neck extensor and

flexor muscle, a more prominent negative incline of the MDF of the surface EMG signs, and in this way more prominent myoelectric appearance of muscle weakness was recognised in patient with cervical radiculopathy compared with asymptomatic subjects. Compare outcomes had been reported for neck flexor muscle in ladies with constant neck torment during supported neck flexion decrease additionally, clinical results measure has distinguished decreased capacity of neck muscle in patient with cervical radiculopathy, comprise with decrease strength and endurance proof to help active exercise in the manifestation of patients with cervical radiculopathy is scanty [19].

One investigation detailed that 26% of the individual who go through the medical procedure keep on going with significant level of torment at 1 year follow up. 17 examinations propose patient treatedmanually were had great outcomes than surgically. Huge number of MT treatment was shows beneficial for intervention to CR comprise with isometric exercise, manual therapy, mobilization. Review were explain combine of temporary and extended haul of participant results progression to participant having CR serves to manual treatment concluding manuals exercise profound flexor of cervical and scapulothoracic muscle endurance exercise [20].Ultrasonography images allow the estimation of the divisional region to outer nerve and observation segments, spread constriction and inflammation of the affected nerve just as progression in its echogenicity therapeutic ultrasound is constantly utilized in conservative manifestation of cervical radiculopathy in view of thermal and non-thermal effect. Regularly, the thermal effect isutilized for treatment of torment, degree of sub-acute and sustain formation and muscular spasm, and extending tissue densification less portion of non-warm ultrasound utilised to increment in collection of cell restoration and lessen the swelling ultrasound help moreover been appears to expand muscular tightness and blood stream NCS and lengthening to areolar tissue [21, 22].

A large number of exercise-based treatment work proposed to be successfully used TENS treatment tocervical radiculopathy. TENS is mainly used to treating torment. Torment control TENS unit commonly produce a constant beat frequency in the reach 1 to 120 Hz, same as above 200 Hz beats were ordinary quadrilateral/ near quadrilateral from biphasic and beta span typically 52-200 us. The point is specifically to stimulate A and B beta nerve fibre and produce a pain-relieving impact to obtain waves passed on torment{A-S(delta) and C} filaments. Extreme rated Transcutaneous electric nerve stimulator ideally excites A-B (beta) filaments, no any cause high fq. Yet little heart rate. Small beat full length outcome in privileged appointment to biggest breadth nerve filaments. Relief from discomfort has a quick beginning and the incitement can be utilized for broaden the time in the day and for a more period of time. Lower rated Transcutaneous electric nerve stimulator was accepted as enhance creation of epinephrine. Transcutaneous electric nerve stimulator had fastreasoningis utilized formore severetorment, like preceding followed by an excruciating native technique. So according to this study shows that tense is beneficial for patient with cervical radiculopathy [23].

Transcutaneous electrical nerve stimulation verb progressively utilise in MT to temporary comfort and ongoing torment TENS were especially appropriate for the treatment of torment to neurogenic beginning concluding PNI cervical

radiculopathy. pain-relieving drugs and type of tense might be adjusted by a and the genus sedative system through the release if endorphin substance [24] facet spondylosis was related along CR and facet joint bone degeneration represent about forty five percent ongoing LBP occurrence. Primary side effect ofpain, muscle stiffness, reflex Contracture of cervical muscle, restriction in cervical movement, is irradiation to upper extremity rapidly fatigue, dizziness, headache. Manifestation is regularly joined by visual and auditory problem, sleep problem (nervousness and depression). A few medicines propose for cervical torment including pharmacological treatment nonsteroidal drugs Paracetamol, steroids, and narcotic and muscle relaxant. Among the last mentioned the transcutaneous electric nerve stimulator has the best proof of adequacy in the treatment of Neck torment (substance impact vasodilatation, pain relieving impact and warm impact) and it is mostly utilised in relieving electrotherapy.

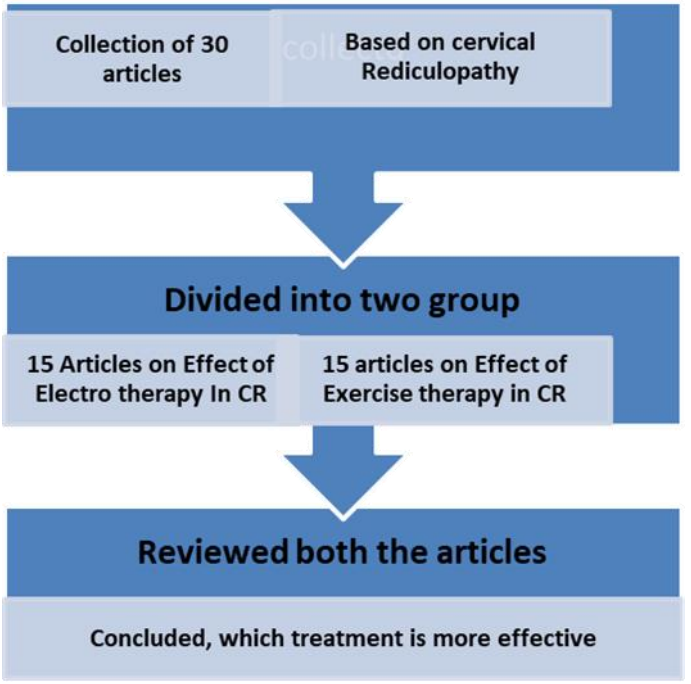
The impulses of TENS are short duration because of this they were table to activate as beta fibre and block nociceptor impulses through the pain Gate theory. The point of this article was to examine the validity of tension patient suffering with acute and chronic cervical torment [25]. Interferential treatment is a typically electrotherapeutic methodology used for treating torment. Interferential current as an enhancement to other interventions are my all accounts more compelling for diminishing pain. In this they were using neck disability index scale the total is can vary from 0 to 50 [26]. Interferential current treatment utilized the critical physiological impact of small frequency IFT treatment might expand blood flow and decrease the torment due to obstructing NC. Review had demonstrated a strong proof based on IFT particularly torment-base treatment. Consequently, IFT might extend viability to activity exercise were essential consideration patients having constant neck torment [27]. TENS were progressively utilized MT were an analgesic for temporary and constant neck torment. transcutaneous electric nerve stimulator was specially study to intervention of neurogenic torment concluding PNI and cervical radiculopathy. There is exploratory proof to propose that the pain-relieving impact of transcutaneous electric nerve stimulator might change due to endogenic depressant by arrival of encephalin neurochemical beta endorphin peptide substance [28].

TENS is a versatile and cheap gadget which created mild pulsed electrical current conveyed across the skin surface to excite the peripheral nerve with the help of electrodes. The recurrence pulse width and the intensity settings can be changed leads to different shot of TENS being utilized in clinical practice. There is a significant discussion in regards to the effectiveness of TENS counting its placebo effect. The effect of TENS in a wide is scope of clinical condition for the more the majority of them showed uncertain outcome because oflow certainty proof this survey is parted from another Cochrane review on electrotherapy for neck torment and focused on TENS for neck torment [29]. Primary executive to neuropathy torment were essentially pharmacology. CR was typical impersonal determination distinguished like problem at nerve branch what's more its pathological procedure which were categorized by particular cervical nerve branch. A large number of treatments were suggested administration of CR concluded exercise, therapeutic exercise and modalities some are effective and some are non-effective trail over nerve response shows tactile nerve branch like important side torment creation as

dermatome dispensation. In proximal area felt like aching pain and industrial area felt like numbness and paresthesia. Review of doctors about manifestation of pain dynamic exercise, TENS, what's more, ultrasound was seen as a better intervention. Previous era announced that TENS fundamentally expended neck mobility in patient with neck pain. A huge number of physiotherapist treatments were suggesting successfully administration in CR, concluded therapeutic exercise and modalities. There is no examination to help a reject the above-mentioned conversation and for the more to set up the predominance of next another.

Methodology

This literature review was included research articles on cervical radiculopathy. This is based on randomised control trial all research article were included in this review were selected through Google Scholar, Pub Med, research gate and Cochrane library.



Inclusion Criteria

Articles on cervical radiculopathy, nerve root pain, chronic neck pain due to nerve involvement which have radicular symptoms as well as comparison between manual therapy physiotherapy (TENS, IFT, US).

Exclusion Criteria

- Cervicogenic headache
- Myofascial Pain Syndrome

Discussion

The goal of this literature review was to compare between manual therapy and electrotherapy on randomised control trial to identify which is more beneficial as intervention for cervical radiculopathy. Isometric, strengthening, stretching, physical exercises in manual therapy where as in electrotherapy only TENS, US and IFT application on cervical area. That is why we selected specific portion of these articles, which truly obstructs the firm reaching of decision. In this study we reviewed 15 articles on manual therapy. Only 9 out of 15 articles have supported that manual therapy were beneficial for cervical radiculopathy some research showed that manual therapy was viable only for short term. Rest 15 articles were reviewed for electrotherapy and only 8 studies have reported that electrotherapy was beneficial for cervical radiculopathy for short term treatment. And some article showed that not only electrotherapy alone is beneficial for treatment of cervical radiculopathy.

According to Joshua A. Clemode.et.althey found that the viability of exercise therapy and reinforcing exercise in a single bunch of patients with cervical radiculopathy. According to Chih-Hsiu Cheng.et.al the physical therapy manifestation of cervical radiculopathy included profound cervical flexion muscles, good posture alignment and muscle extending (stretching). Apparently physical therapy can improve body posture and function just as the movement contributor of the patient According to PIERRE LANGEVIN.et.al manual treatment and exercise are beneficial in decreasing the torment and useful in movement limitations with cervical radiculopathy. According to Erik J. Thoomes.et.al. one low research of basis study showed that a 6 week follow up, physical therapy is more successful on next torment. finally, the NPTF (neck pain task force) recommended that treatment including manual treatment and exercise are more successful than elective techniques for the patient with cervical radiculopathy. According to Muhammad umar.et.al. They found that treatment of cervical radiculopathy concluding manual therapy, isometric exercises and stretching exercises are an important role of the recovery program to modulated torment and making functionally good and the outcome of the study that manual therapy and exercise were leads to important role in patients with cervical radiculopathy. According to Robert Boyles.et.al., although the complaint impairment for treating cervical radiculopathy was not being created. Utilising the manual treatment strategy is effective in expanding capacity just as AROM and diminishing degree of torment and inability.

According to Burcu Metin Ökmen.et.al. discovered therapeutic ultrasound to be beneficial in progress of torment, inability and daily living of patient with chronic cervical radiculopathy. According to Mrudula Pallepat.et.al. after test correlation estimated factor in the middle of gathering shows the genuinely huge ($p<0.05$) decrease the torment and NDI investigation presumed transcutaneous nerve electrical stimulation were better viable of application of CR. According to Dr. Pritam Deka.et.al. treatment was proceeded for 14 day and towards the finish of 14-day patient were re- assessed, utilizing similar scale. The outcome of study where patient with TENS intervention had a great effect shown more huge decrease in torment. According to Teresa Paolucci.et.at. the investigation shows TENS appears that impact of decreasing strength of treatment cervical torment

particularly for short time of period. According to Manuel Albornoz-Cabello.et.al. IFT current stimulation is beneficial for the cervical pain. According to Ronald Prabhakar.et.al. following 3 week of intercessions conclusion, cervical mobilization compared with TENS is similarly beneficial in diminishing torment lessening the radicular pain.

Limitation

Limitation of this study was only taken articles, focused on isometric, strengthening, stretching, physical exercises in manual therapy where as in electrotherapy only TENS, US and IFT.

Conclusion

The aim of this study was comparison between manual therapy and electrotherapy to find which is more beneficial for treatment of cervical radiculopathy. In study not only utilize physical therapy and electrotherapy. It's difficult to go with any statement about treatment that purely diminishing the condition cervical radiculopathy. Due to least evidence it's difficult to clarify any statement that only therapy is the ideal cure for cervical radiculopathy.but, visualizations for many patients appears favourable in the long haul regardless of the treatment predisposed. The viability of manual therapy in cervical radiculopathy is seen for short term. Same with electrotherapy also. Further high-quality randomised control trial studies treating patient with cervical radiculopathy follow up protocol for long-term and wider study like manual therapy with mobilization traction with various modalities at the same time for the treatment of cervical radiculopathy with long term follow up.

References

1. Caridi, J. M., Pumberger, M., & Hughes, A. P. (2011). Cervical Radiculopathy: A Review. *HSS Journal*, *7*(3), 265–272. https://doi.org/10.1007/s11420-011-9218-z
2. Thoomes, Erik J., Scholten-Peeters, W., Koes, B., Falla, D., & Verhagen, A. P. (2013). The effectiveness of conservative treatment for patients with cervical radiculopathy: A systematic review. *Clinical Journal of Pain*, *29*(12), 1073–1086. https://doi.org/10.1097/AJP.0b013e31828441fb
3. Childress, M. A., & Becker, B. A. (2016). Nonoperative management of cervical radiculopathy. *American Family Physician*, *93*(9), 746–754.
4. Levine, M. J., Albert, T. J., & Smith, M. D. (1996). *Cervical Radiculopathy Diagnosis*. *4*(6), 305–316.
5. Escortell-Mayor, E., Riesgo-Fuertes, R., Garrido-Elustondo, S., Asúnsolo-del Barco, A., Díaz-Pulido, B., Escortell-Mayor, E., Riesgo-Fuertes, R., Garrido-Elustondo, S., Díaz-Pulido, B., Blanco-Díaz, M., Bejerano-Álvarez, E., del Camino-Sanz Martínez, M., Lebrijo-Pérez, G., Poza-Montoro, C., García-Salvador, E., Sánchez-Sánchez, B., Pérez-Martín, Y., González-Mazo, A., Cañamares-Muñoz, S., … González-Hernández, B. (2011). Primary care randomized clinical trial: Manual therapy effectiveness in comparison with TENS in patients with neck pain. *Manual Therapy*, *16*(1), 66–73. https://doi.org/10.1016/j.math.2010.07.003

6. Thoomes, E. J. (2016). Effectiveness of manual therapy for cervical radiculopathy, a review. *Chiropractic and Manual Therapies*, *24*(1), 1–11. https://doi.org/10.1186/s12998-016-0126-7
7. Cleland, J. A., Whitman, J. M., Fritz, J. M., & Palmer, J. A. (2005). Manual physical therapy, cervical traction, and strengthening exercises in patients with cervical radiculopathy: A case series. *Journal of Orthopaedic and Sports Physical Therapy*, *35*(12), 802–811. https://doi.org/10.2519/jospt.2005.35.12.802
8. Cheng, C. H., Tsai, L. C., Chung, H. C., Hsu, W. L., Wang, S. F., Wang, J. L., Lai, D. M., & Chien, A. (2015). Exercise training for non-operative and post-operative patient with cervical radiculopathy: A literature review. *Journal of Physical Therapy Science*, *27*(9), 3011–3018. https://doi.org/10.1589/jpts.27.3011
9. Langevin, P., Desmeules, F., Lamothe, M., Robitaille, S., & Roy, J. S. (2015). Comparison of 2 manual therapy and exercise protocols for cervical radiculopathy: A randomized clinical trial evaluating short-term effects. *Journal of Orthopaedic and Sports Physical Therapy*, *45*(1), 4–17. https://doi.org/10.2519/jospt.2015.5211
10. Kuijper, B., Tans, J. T. J., Beelen, A., Nollet, F., & De Visser, M. (2009). Cervical collar or physiotherapy versus wait and see policy for recent onset cervical radiculopathy: Randomised trial. *BMJ (Online)*, *339*(7727), 952. https://doi.org/10.1136/bmj.b3883
11. Umar, M., Naeem, A., Badshah, M., & Amjad, I. (2012). Effectiveness of Cervical Traction Combined With Core Muscle Strengthening Exercises in Cervical Radiculopathy: a Randomized Control. *Jphbs.Com*, *1*(4), 115–120. http://jphbs.com/articals/issue4/5 Cervical Radiculopathy.pdf
12. Liang, L., Feng, M., Cui, X., Zhou, S., Yin, X., Wang, X., Yang, M., Liu, C., Xie, R., Zhu, L., Yu, J., & Wei, X. (2019). The effect of exercise on cervical radiculopathy: A systematic review and meta-analysis. *Medicine*, *98*(45), e17733. https://doi.org/10.1097/MD.0000000000017733
13. Lytras, D., Myrogiannis, I., & Sykaras, E. (2018). The efficacy of manual therapy and therapeutic exercise in patients with chronic neck pain: A narrative review. *International Journal of Physical Education, Sports and Health*, *5*(1), 32–36. www.kheljournal.com
14. Bernal-Utrera, C., Gonzalez-Gerez, J. J., Anarte-Lazo, E., & Rodriguez-Blanco, C. (2020). Manual therapy versus therapeutic exercise in non-specific chronic neck pain: A randomized controlled trial. *Trials*, *21*(1), 1–10. https://doi.org/10.1186/s13063-020-04610-w
15. Boyles, R., Toy, P., Mellon, J., Hayes, M., & Hammer, B. (2011). Effectiveness of manual physical therapy in the treatment of cervical radiculopathy: A systematic review. *Journal of Manual and Manipulative Therapy*, *19*(3), 135–142. https://doi.org/10.1179/2042618611Y.0000000011
16. Miller, J., Gross, A., D'Sylva, J., Burnie, S. J., Goldsmith, C. H., Graham, N., Haines, T., Brønfort, G., & Hoving, J. L. (2010). Manual therapy and exercise for neck pain: A systematic review. *Manual Therapy*, *15*(4), 334–354. https://doi.org/10.1016/j.math.2010.02.007
17. Halvorsen, M., Falla, D., Gizzi, L., Harms-Ringdahl, K., Peolsson, A., & Dedering, Å. (2016). Short-and long-term effects of exercise on neck muscle function in cervical radiculopathy: A randomized clinical trial. *Journal of Rehabilitation Medicine*, *48*(8), 696–704. https://doi.org/10.2340/16501977-

2120
18. Metin Ökmen, B., Ökmen, K., & Altan, L. (2018). Investigation of the effectiveness of therapeutic ultrasound with high-resolution ultrasonographic cross-sectional area measurement of cervical nerve roots in patients with chronic cervical radiculopathy: a prospective, controlled, single-blind study. *Journal of Medical Ultrasonics*, *45*(3), 479–486. https://doi.org/10.1007/s10396-017-0855-9
19. Saharan, A. K., Gouru, V. K., Naragani, A., Saharan, M., Mvgu, P., College, P., Physiotherapist, S., Super, C., Hospital, S., Ortho, M. S., Ortho, M. C., Super, C., Hospital, S., College, J. P., & Vinayak, M. (2019). *OPEN ACCESS EFFECTIVENESS OF TENS VERSUS INTERFERENTIAL THERAPY IN PATIENTS WITH CERVICAL RADICULOPATHY * 1 Mrudula*. *09*, 32129–32133.
20. Sharma, H., & Patel, N. (2014). Effectiveness of Tens Versus Intermittent Cervical Traction in Patients With Cervical Radiculopathy. *International Journal of Physiotherapy and Research*, *2*(6), 787–792. https://doi.org/10.16965/ijpr.2014.693
21. Deka, P., Sarulatha, Bhattacharjee, S., & Dutta, A. (2016). The Combined Efficacy of Neural Mobilization with Transcutaneous Electrical Nerve Stimulation (TENS) Versus Neural Mobilization alone for the Management of Cervical Radiculopathy. *International Journal of Physiotherapy*, *3*(2), 242–245. https://doi.org/10.15621/ijphy/2016/v3i2/94904
22. Paolucci, T., Agostini, F., Paoloni, M., De Sire, A., Verna, S., Pesce, M., Ribecco, L., Mangone, M., Bernetti, A., & Saggini, R. (2021). Efficacy of TENS in cervical pain syndromes: An umbrella review of systematic reviews. *Applied Sciences (Switzerland)*, *11*(8). https://doi.org/10.3390/app11083423
23. V. Rajalaxmi, M. M., & S. Veena, K. (2015). To Compare the Effectiveness of Interferential Therapy with and without Neural Mobilization along with Conventional Therapy in Cervical Radiculopathy Patients. *TJPRC:INTERNATIONAL JOURNAL OF PHYSIOTHERAPY & OCCUPATIONAL THERAPY*, *June*.
24. Albornoz-Cabello, M., Pérez-Mármol, J. M., Barrios Quinta, C. J., Matarán-Peñarrocha, G. A., Castro-Sánchez, A. M., & de la Cruz Olivares, B. (2019). Effect of adding interferential current stimulation to exercise on outcomes in primary care patients with chronic neck pain: a randomized controlled trial. *Clinical Rehabilitation*, *33*(9), 1458–1467. https://doi.org/10.1177/0269215519844554
25. Gore, V., Patil, H., & Chogule, A. (2020). Effect of Cervical Manual Traction, TENS and Neural Tissue Mobilization on Pain and Functional Disability in Unilateral Cervical Radiculopathy. *Website: Www.Ijrrjournal.Com Original Research Article International Journal of Research and Review (Ijrrjournal.Com)*, *7*(10), 198–200. www.ijrrjournal.com
26. Porfírio, G. J. M., Martimbianco, A. L. C., Brønfort, G., Torloni, M. R., & Riera, R. (2015). Transcutaneous electrical nerve stimulation (TENS) for chronic neck pain. *Cochrane Database of Systematic Reviews*, *2015*(10). https://doi.org/10.1002/14651858.CD011927
27. Gibson, W., Wand, B. M., & O'Connell, N. E. (2017). Transcutaneous electrical nerve stimulation (TENS) for neuropathic pain in adults. *Cochrane Database of Systematic Reviews*, *2017*(9).
28. Tao, N. A., & Arora, R. (2015). Effectiveness of cervical traction on pain and disability in cervical radiculopathy. *International Journal of Recent Scientific*

Research, *6*(4), 3609–3611. http://recentscientific.com/sites/default/files/2316.pdf
29. Noori, S. A., Rasheed, A., Aiyer, R., Jung, B., Bansal, N., Chang, K. V., Ottestad, E., & Gulati, A. (2020). Therapeutic Ultrasound for Pain Management in Chronic Low Back Pain and Chronic Neck Pain: A Systematic Review. *Pain Medicine (United States)*, *21*(7), 1482–1493. https://doi.org/10.1093/PM/PNY287
30. Kumar, S. (2022). A quest for sustainium (sustainability Premium): review of sustainable bonds. Academy of Accounting and Financial Studies Journal, Vol. 26, no.2, pp. 1-18
31. Allugunti V.R (2022). A machine learning model for skin disease classification using convolution neural network. International Journal of Computing, Programming and Database Management 3(1), 141-147
32. Chandra Rai, S., Bhagavan, K., & Pinto, D. (2013). Cervical Traction Reduces Pain and Disability in Patients With Unilateral Cervical Radiculopathy. *Int J Cur Res Rev*, *05*(07), 34–41.
33. Widana, I.K., Dewi, G.A.O.C., Suryasa, W. (2020). Ergonomics approach to improve student concentration on learning process of professional ethics. *Journal of Advanced Research in Dynamical and Control Systems*, *12*(7), 429-445.
34. Chanana, M. (2018). Empirical study: relationship between self efficacy and academic performance. International Journal of Health & Medical Sciences, 1(1), 28-34. https://doi.org/10.31295/ijhms.v1n1.36
35. Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. *Computer Applications in Engineering Education*, *29*(3), 550–561. https://doi.org/10.1002/cae.22202