Research Article

ROLE OF HAND FUNCTION AND HAND-EYE COORDINATION EXERCISES ON CERVICAL RADICULOPATHY

Senthil Kumar B[1], Arun.B[2]

[1] Principal & Professor, UCA College of Paramedical Sciences, College of Physiotherapy, Chennai, India
[2]Physiotherapist Grade II, Government District Headquarters Hospital, Erode, India

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Corresponding Author: **B. Senthil Kumar** Email: senthilkumar79@yahoo.com

ABSTRACT

Introduction and Aim: The compression of the cervical nerve roots causes cervical radiculopathy. Pain, motor impairments, sensory deficits, decreased or absent reflexes, or any combination are all clinical characteristics. Non-operative management includes intermittent cervical traction, transcutaneous electrical stimulation, and neck exercises. Hand function and Hand-Eye coordination exercises have shown improvement in people with cervical radiculopathy; therefore, adding them would be beneficial. This study examined how hand function and hand-eye coordination activities affected cervical radiculopathy.

Materials and Methods: An experimental study was conducted in which Group A (Control group) with twenty-two participants, treated with intermittent cervical traction (ICT) for 10 mins, Transcutaneous electrical stimulation (TENS) for 10 mins, and neck range of motion exercises for 10 mins. Group B (Experimental group), with twenty-two participants, was treated the same as the control group, along with hand function training and hand-eye coordination exercises for 10 mins. Pain, disability, and hand-eye coordination are the study's outcomes. The Pain is measured using a 10-cm visual analog scale, the neck disability index is used to assess neck disability, and the wall ball bounce test is used to assess hand-eye coordination.

Results: Statistical analysis was done using SPSS statistical software version 21.0. The collected data were analyzed with a parametric test, a paired 't' test for within-group analysis, and an unpaired 't' test for between-group analysis. The statistical test was interpreted at a 5% level of significance.

Conclusion: This study concludes that the experimental group who received conventional training, hand function, and hand-eye coordination exercises completed well. Therefore, it is essential to add hand function and hand-eye coordination for cervical radiculopathy patients to improve hand functions.

Keywords: Cervical radiculopathy, Hand-eye coordination Intermittent cervical traction, Transcutaneous electrical nerve stimulation, Wall ball bounce test.

INTRODUCTION

Cervical radiculopathy (CR) is a cluster of symptoms associated with dysfunction in the cervical spinal nerve roots (1). It is characterized by pain around the neck that radiates to the upper limbs and often lasts for a few weeks to months. It is also accompanied by motor deficits, sensory deficits, and reflex changes. There may be neck movement restrictions, but patients are often free to move (2).

Cervical nerve compression may occur due to multiple causes. The disk may protrude, or the annular segments may bulge, causing soft herniations, which may impinge the nerve roots and cause radiating symptoms (3). The exact location and pain pattern may vary with dermatomal distributions of pain (4). Pain, neurological dysfunction, and nerve root distribution are commonly seen in CR (3).

Comprehensive physical examinations and history could be used to identify CR. Furthermore, imaging techniques such as CT scans or MRIs may aid diagnosis (2). Examination of the cervical spine is performed to identify the nerve root involvement and identify the myotomes or the dermatomes affected (4). Provocative tests were available to elicit the symptoms of radiculopathy. The standard test used is the Spurling test, which identifies the narrowing of the neuroforamen and produces the symptoms. Distraction tests increase the neuroforamen's space, thereby reducing pain (5). CR may cause sensory and motor disturbances in the upper limb, which affect hand functions (6). Studies have identified that unilateral radiating pain reduces the strength of the handgrip (7). It was also noted that there is about a 20—30% reduction in hand function compared with the normal or non-radiating limb (8). CR could cause various sensorimotor dysfunctions, like reduced cervical proprioception, visual disturbances, poor hand-eye coordination, and impaired balance (9). Studies identified neck pain related to upper limb functional use (10). It also shows that higher severity of neck pain had more significant restrictions on the upper limb functions (11).

Management of the CR includes conservative approaches like rest, traction, medication, immobilization using collars, physiotherapy modalities, and manual therapy (8). Many studies support that conservative therapy would be much more beneficial, providing reassurance of its effectiveness. Exercises play a major role in CR. They effectively reduce pain and improve functional status and quality of life (11). Exercises usually prescribed to the CR focus on cervical and scapular muscle strengthening (11). Intermittent cervical traction reduces radicular symptoms. The researchers hypothesized that applying traction to the nerve roots distracts the neural foramen and relieves compression (12). Traction is most beneficial in reducing acute muscle pain and spasms (12). TENS (transcutaneous electrical nerve stimulation) is an electrotherapy method of treating neck discomfort (4). It delivers a mild electrical current to the skin and promotes pain relief. It causes sensory stimulation without causing the muscles to contract (13). There is a lot of evidence that something that assists individuals with longstanding neck pain (14).

Nerve root compression directly affects the sensory segments in the upper limbs, and in addition, prolonged compression also affects motor functions (15). Impingement of the nerves commonly occurs in the levels of C7, C8 & T1 produces a significant weakness in the intrinsic musculatures of the hand. Rapid atrophy of the hand muscles was also noted (16). CR may create not only difficulties in hand functions but also cause difficulty in hand-eye coordination activities. This causes problems in doing the delicate motor task in the fingers and rapid movements in the hand due to a lack of sensory feedback mechanism from the cervical nerves (16). Therefore, it is assumed that hand-eye coordination is essential in producing smooth and delicate movements. The hand-eye exercises in the CR could improve the coordination and functions of the hands. This novel approach of incorporating hand-eye coordination exercises in CR rehabilitation, which is not commonly part of the rehabilitation of neck pain, is a significant area of interest for further research and clinical application. Based on these assumptions, this research emphasizes observing the influence of hand-eye coordination exercises in cervical radiculopathy rehabilitation.

MATERIALS AND METHODS

An experimental study design was conducted on people with CR who were referred by an orthopedic surgeon to the physiotherapy outpatient department, UCA College of Paramedical Sciences, College of Physiotherapy, Chennai. People with CR who visited the OPD were selected for the study after considering the inclusion criteria. The study inclusion criteria are people with pain in the neck radiating down to the arm, forearm, neck pain for more than three months (17), positive Spurling test, positive distraction test (3), exhibits sensory deficits (18), complaints of numbness in the fingers, restricted cervical rotation to 60 degrees (19), CR with the age group of 35—55 years, and have no motor weakness in the thenar or hypothenar muscles. This study excludes recent surgery around the neck, radiculopathy due to systemic causes, people with cardiac problems, people with diabetes, and people with psychiatric illness (20, 21).

The ethical committee approved the study of UCA College of Paramedical Sciences, College of Physiotherapy (IEC no. 001/03/2023/IEC/UCACOPT) on 4th January 2023. A blinded researcher selected participants for the study, around seventy-five participants who visited the OPD. They were analyzed based on the selection criteria, and informed consent was obtained from each patient before the study. Forty-four participants were included in this study, and the rest were excluded as they did not fulfill the selection criteria. Participants were divided into two groups. Traction, TENS, Exercise group (TTE group) with twenty-two participants treated with intermittent cervical traction (ICT) for 10 mins, Transcutaneous electrical stimulation (TENS) for 10 mins, and neck range of motion exercises for 10 mins (22, 23). The hand function group (HF group), with twenty-two participants, was treated the same as the TTE group and provided finger and hand functional training with hand-eye coordination activities for ten minutes. Hand Function Exercises include squeezing balls of different sizes, various grasp movements, therapeutic putty exercises, wrist curls, finger spreading, and rolling movements. Juggling balls continuously, catching balls, ball toss and catch, peg-board exercises, and ball wall throwing are all examples of hand-eye coordination exercises (24, 25). Treatment was done for eight weeks; for two weeks, the ICT and TENS were applied on alternative days, following that, neck exercises and hand exercises. Same home programs were advised to both groups.

Intermittent cervical traction was applied with the Autotrac 500 (Technomed, India), with a force of 1/10th body weight for 10 mins (6). TENS was applied using Acutens (Technomed, India), with an active electrode placed over the painful location and the inactive electrode set over 1 cm lateral to the active electrode. The biphasic, symmetrical, and low frequency with a pulse width of 120μs was applied for 15 mins. The intensity was used as per the individual perception (18).

The primary outcomes of this study are pain, disability, and hand functions. The pain, disability and hand functions were measured on the first, 4th week, and 8th visits. Pain intensity was assessed using a visual analog scale (VAS). This scale is a 10cm long line with '0' cm representing "no pain" and '10' cm representing "worst pain." Volunteers place a mark on the scale that corresponds to their level of discomfort. Validity and reliability are both present in VAS (26). The neck disability index (NDI) comprises ten questions ranked on a 0—5 rating scale, with 0 indicating that you can do the task and 5 indicating that you cannot. A high score indicates more disability. This has high validity and reliability (27). The wall ball bounce test (WBBT) measures hand-eye coordination, and it is done with the volunteer standing against the wall 2M away from the wall; a tennis ball is thrown from one hand using an underarm throw and tries to catch the ball with the same hand. Several catches in 30 seconds were calculated, three times the individual does the activity with subsequent breaks, and the mean was taken for data analysis (28).

The SPSS statistical program version 21.0 was used for statistical analysis. The Kolmogorov-Smirnov test identifies that the parameters are distributed normally. The study used descriptive statistics to summarize demographical data. The parametric test was conducted to analyze the calculated data. A paired 't' test was done for within-group analysis, and an unpaired 't' test was done for between-group analysis. The interpreted statistical analysis was at a 5% level of significance.

RESULTS

Data Normality Test: Passed based on Normal Q-Q Plot (Fig. 1A, 1B &1C), which satisfies Kolmogorov Smirnov test as the observed data closely follows the expected value of the variants under study. The GroupWise average performance results for all three outcomes are presented in Table 1.

The TTE group's performance in the pre & post-tests within measurement variants is statistically significant, with a p-value < 0.05 at a 5% significance level (Table 2). Similarly, the HF group shows a statistically significant improvement in the pre & post-tests within measurement variants, with a P-value < 0.05 at a 5% significance level (Table 3). It's important to note that the groups were similar at the time of recruitment in baseline in WBBT and VAS, which provides a solid foundation for the subsequent comparisons. However, there was a significant difference in NDI, with TTE group subjects showing slightly higher disability than the HF group. The HF group significantly improved after the intervention in all three outcome measures (Table 4).

Table 1: Mean and SD of WBBT, NDI and VAS scores of both groups.

Group		WBBT		NDI		VAS	
		Pre	Post	Pre	Post	Pre	Post
TTE group	Mean	28.81	31.77	45.63	34.04	9.04	5.95
	N	22	22	22	22	22	22
	SD	1.25	1.68	4.018	4.41	0.78	1.32
HF group	Mean	28.86	38.04	42.77	27.81	8.59	4.90
	N	22	22	22	22	22	22
	SD	0.88	1.81	1.716	3.47	.85	.92
Total	Mean	28.84	34.90	44.20	30.93	8.81	5.43
	N	44	44	44	44	44	44
	SD	1.07	3.61	3.37	5.031	0.84	1.24
WBBT-wallball bounce test, NDI – Neck disability index, VAS – Visual analog scale,N = number of samples, SD = Standard deviation. This table presents the average performance both the groups during various time period with regards to the three outcome measures.							

Table 2: Results of within group analysis of pre-test and post-test values of TTE group.

	Mean	SD	SED	t	P-Value
Pre-NDI &Post-NDI	11.591	2.5941	0.5531	20.957	<0.001
Pre-VAS &Post-VAS	3.0909	1.2309	0.2624	11.778	<0.001
Pre-WBBT &Post-WBBT	-2.955	1.0901	0.2324	12.713	<0.001
WBBT-wallball bounce test, NDI – Neck disability index, VAS – Visual analog scale, M = Mean, SD = Standard deviation, SED = Standard error difference. This table presents how well the TTE group had performed in terms of NDI, VAS, and WBBT.					

Table 3: Results of within group analysis of pre-test and post-test values of HF group.

Paired Samples Test					
	Mean	SD	SED	T	P-value
Pre-NDI &Post-NDI	14.955	2.7164	0.5791	25.822	<0.001
Pre- VAS &Post-VAS	3.6818	0.7799	0.1663	22.143	<0.001
Pre-WBBT &Post-WBBT	-9.182	1.68	0.3582	25.634	<0.001
WBBT-wallball bounce test, NDI – Neck disability index, VAS – Visualanalog scale, M = Mean, SD = Standard deviation, SED = Standard error difference. This table presents how well the HF group had performed in terms of NDI, VAS, and WBBT.					

Table 4: Results of Between-group analysis of pre-test and post-test values of NDI, VAS, and WBBT.

	Group	Mean	SD	SED	t	P
NDI-Pre	TTE group	45.63	4.018	0.931	3.074	0.004
	HF group	42.77	1.716			
VAS-Pre	TTE group	9.04	0.785	0.247	1.837	0.073
	HF group	8.59	0.854			
WBBT-Pre	TTE group	28.81	1.258	0.328	0.138	0.891
	HF group	28.86	0.888			
NDI-Post	TTE group	34.04	4.412	1.197	5.201	<0.001
	HF group	27.81	3.472			
VAS-Post	TTE group	5.95	1.326	0.344	3.036	0.004
	HF group	4.90	0.921			
WBBT-Post	TTE group	31.77	1.688	0.528	11.87	<0.001
	HF group	38.04	1.812			
WBBT-wallball bounce test, NDI – Neck disability index, VAS – Visual analog scale, M = Mean, SD = Standard deviation, SED = Standard error difference. This table explains the difference between the two groups in two differences times and assess if there is any difference between the groups.						

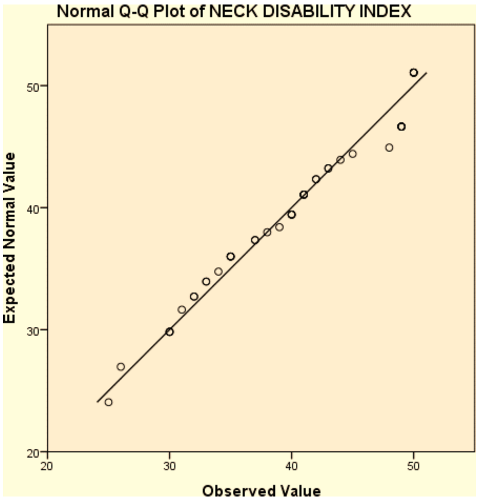

Fig. 1 A: Normal Q-Q Plot - Kolmogorov Smirnov test of Neck Disability Index(Expected Value Vs Observed Value)

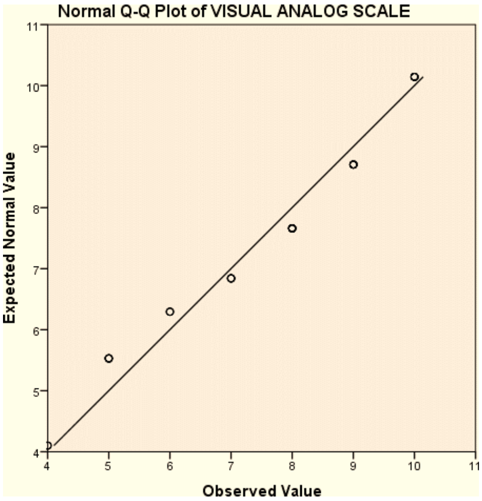

Fig.1 B: Normal Q-Q Plot - Kolmogorov Smirnov test of Visual Analog Scale(Expected Value Vs Observed Value)

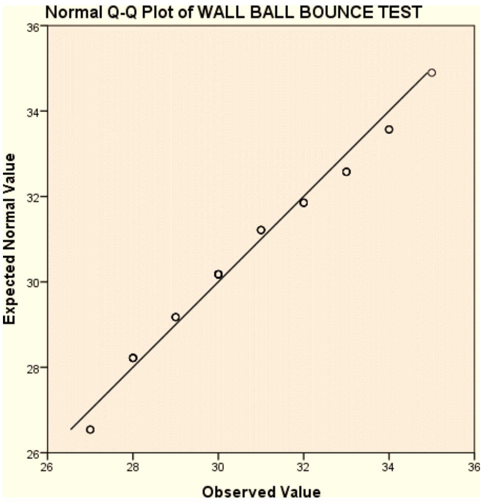

Fig. 1 C: Normal Q-Q Plot - Kolmogorov Smirnov test of Wall Ball Bounce Test(Expected Value Vs Observed Value)

DISCUSSION

This study is conducted to observe the influence of hand-eye coordination exercises in rehabilitating CR. It results from the cervical-nerve root compression (15). Constriction of spinal-nerve roots occurs when there is a bulging annulus fibrosus in the disk, herniated disk, or osteophyte formations (2). CR could cause alteration in the sensory receptors that surround the cervical region. Muscle spindle activity is altered due to pain, which results in the alteration of proprioception of the neck muscles. This also causes motor, sensory, and autonomic neurons to be hyper-excitable to hyper-excitable (7). CR could cause alteration in hand functions due to the loss of myoneural transmission and reduction in the tissue blood flow and oxygenation. It also causes changes in hand functions, particularly in hand-eye coordination (14).

Reaction time and response time are crucial in daily activities. Driving, writing, and tool handling require high-precision functions and movement. Any injury to the sensorimotor areas of the neck would result in an alteration of these functions, which could cause severe damage (29). Hand-eye coordination exercises focus on restoring rapid activities and promoting sensory functions in the upper limbs (24). Hand-eye coordination exercises help improve motor skills and the development of upper limb activities; they also improve general motor skill competency and make it easier to participate in sports and fitness activities throughout life (10).

TENS, a technique that uses low-intensity electric current, is a powerful tool for pain relief. It is theorized that TENS stimulates nerve cells, which block the passage of pain signals and changes pain perception (23). This mechanism, along with the activation of inhibitory interneurons in the substantia gelatinosa in the dorsal horn of the spinal cord (30, 31), makes TENS a reliable method for pain management. Intermittent cervical traction, another technique, also promotes pain relief and joint mobilization. It was hypothesized that traction increases the space between the vertebra and the joint space, where it stretches the muscles and ligaments around the vertebra (22). The application of traction relaxes the muscles around the neck and increases the space on the intervertebral foramen (21).

Hand function exercises can improve hand strength, dexterity, and coordination in patients with cervical radiculopathy. This condition can lead to nerve compression, resulting in weakness, numbness, and reduced hand function. These exercises help restore hand function, improve muscle control, and reduce discomfort, facilitating recovery and a better quality of life for patients. Regular practice is crucial for optimal results (24).

CONCLUSION

The application of ICT, TENS, and home exercises would improve pain and reduce functional disability in both groups. The group that underwent hand-eye coordination exercises performed well when analyzing the wall ball bounce task. The experimental group shows a considerable improvement over the control group. Therefore, it is essential to add hand function training and hand-eye coordination exercises for people with cervical radiculopathy to improve hand functions.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest. There is no Grant or Fund Support for this study.

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