The Egyptian Journal of Hospital Medicine (July 2024) Vol. 96, Page 3142-3146

Functional outcomes of Cervical Mobilization on Double Crush Syndrome Patients

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ABSTRACT

Background: The most prevalent type of double entrapment is carpal tunnel syndrome and double crush syndrome in cervical radiculopathy. Individuals experiencing hand pain have been observed to have greater difficulties doing activities of daily living.

Purpose of the study: This study aimed to examine the functional outcome of adding cervical mobilization to patients with double crush syndrome.

Methods: 30 female patients were assessed pre-treatment and post-treatment by VAS & Nine Hole Peg Test. They were divided into two groups: The control group received a standard physical therapy program of nerve glide, hand strengthening exercise and mobilization and the study group that received a cervical mobilization in addition to the standard physical therapy program for 12 sessions.

Results: The study group showed improvement in pain scale and Nine Hole Peg Test parameters in comparison with the control group. **Conclusion:** In view of the results of this study, it could be concluded that cervical mobilization improved functional outcomes in patients with double crush syndrome.

Keywords: Cervical mobilization, Hand function, Double crush syndrome.

INTRODUCTION

Upton & McComas first defined double crush syndrome in 1973 by positing that nerve compression in the proximal section facilitates nerve compression in the distal segment. Additionally, a correlation between cervical arthritis and carpal tunnel syndrome has been observed, which suggests that treating the cervical spine should take into account the influence it may have on patients with double crush syndrome. Double crush syndrome is frequently found in cases of cervical radiculopathy and carpal tunnel syndrome [(1)]. Numerous investigations have attempted to identify the cause of double crush syndrome, largely supporting the hypothesis that a nerve compressed at a proximal site increases the likelihood of a nerve compression at a peripheral site. They discovered that, in experiments on animals, double compression had worse results than when each site was compressed separately [(2)].

The most typical manifestation of double crush syndrome occurs in the upper limb between peripheral median nerve entrapment in the wrist joint (Cervical radiculopathy) and proximal entrapment in the cervical region (Carpal tunnel syndrome)" [(3)]. Individuals with peripheral nerve compression are more prone than the general population to acquire cervical radiculopathy, while individuals with cervical radiculopathy have a higher incidence rate of carpal tunnel syndrome [(2)].

Strength, range of motion, dexterity, and sensibility are some of the components that make up hand function. The normalization of these things contributes to the ease and accessibility of daily living activities. The Nine Hole Peg Test is a reliable and sensitive way to assess hand function since it counts the number of seconds it takes to insert and withdraw nine pegs using a board with holes [(4)].

Cervical radiculopathy may be the cause of long-term disability after surgery in patients who receive anterior cervical decompression and fusion (ACDF) and carpal tunnel release (CTR). These patients are more likely to experience postoperative disability than those who receive CTR alone, but they also experience less pain and functional disability after surgery than those who receive ACDF alone. Furthermore, compared to DC patients, CTR patients experienced a higher risk of postoperative arm pain, which may indicate that these patients frequently had their cervical radiculopathy or other causes of arm pain misdiagnosed [(5)].

In **2024 Jellad *et al.*** [(6)] discovered that cervical traction helps patients with cervical radiculopathy by enhancing hand grip and lowering pain. Furthermore, **Zuckerman *et al.*** [(7)] reported that hand grip improved following cervical decompression surgery. For this reason, we made the decision to investigate the impact of cervical mobilization on patients suffering from double crush syndrome.

SUBJECTS AND METHODS

We used an experimental research design for this work, namely a randomized controlled trial with pre- and post-testing. Thirty female patients diagnosed with double crush syndrome (DCS) with ages between twenty-five and thirty-five were recruited for the study. Patients chosen between November 2023 and July 2024 from The Physical Therapy Outpatient Clinic of Sidi Salem General Hospital in Kafr El-Shiekh Governorate, Egypt. A neurologist or neurosurgeon made the diagnosis and referred each patient as DCS using the clinical diagnostic standards established by the American Academy of Neurology [(8)].

Received: 28/03/2024
Accepted: 28/05/2024

Using sealed envelopes, we divided the patients into two equal groups at random. In addition to a standard physical therapy program for carpal tunnel syndrome (Twelve sessions), the study group's (15) patients received twelve sessions of cervical mobilization. The control group's (15) patients received the same standard physical therapy program for carpal tunnel syndrome (twelve sessions).

Inclusion criteria: Thirty female individuals with DCS according to the American Academy of Neurology's clinical diagnostic guidelines, [8]. The ages of the individuals varied from twenty-five to thirty-five. Patient who experienced upper limb and/or median nerve distribution discomfort, hyperesthesia, or paresthesia [9]. With a fractionated sensory nerve conduction velocity for the median nerve across the wrist of 40 m/s or less, a Nerve Conduction Study (NCS) revealed peripheral entrapment of the median nerve at the level of the carpal bone, a condition known as "Carpal tunnel syndrome" [10] and with sensory peak latency > 3.6 ms and with motor distal latency > 4.4 ms and less than 6.5 ms [11].

Exclusion criteria: Individuals with systemic conditions such as diabetes mellitus (DM), thyroid disorders, rheumatoid arthritis (RA), and pregnant women that may result in DCS. Individuals with a history of neurological conditions such as peripheral neuropathy. Individuals who received a carpal tunnel injection, fracture, or wrist surgery within the two weeks before to the research. Individuals experiencing Thenar muscle atrophy. Individuals who had prior CTS surgery. Individuals with total conduction block during nerve conduction studies, or those who frequently used handheld vibrating instruments in the past and individuals whose median nerve motor distal delay is greater than 6.5 ms [11].

Procedures for assessment: Once all patients had received comprehensive information regarding the objectives, procedures, possible advantages, privacy, and use of their data, they were asked to sign a written consent form. Each participant was subjected to the subsequent evaluation steps: Under the supervision of the same examiner, the patients assessed their level of wrist discomfort using a visual analogue scale (VAS). From the zero anchor to the patient's mark, the score was calculated [12].

The Nine Hole Peg Test was used to gauge each participant's functional ability (9HPT) This test gauges a person's fine motor dexterity by timing how long it takes them to insert nine pegs into a pegboard and take them out [13]. It is made of wood and has a pegboard and circular, shallow peg container built right in. The pegboard section is still 5 inches square, but the exterior corners measure 10 inches by 5 inches. The holes were positioned 1'14 in. apart, measured center to center, and the pegs measured '14 in. in diameter and 1'14 in. in length.

Procedures for treatment: Group A (the study group) underwent cervical mobilization in addition to an hour-long traditional physical therapy program consisting of tendon gliding exercises, median nerve gliding exercises, and strengthening exercises. Group B (the control group) received this program exclusively.

Cervical mobilization: The cervical or upper thoracic vertebrae (C2-C3 to T3-T4) are mobilized using this approach in a posterior-to-anterior manner. The patient was in a prone posture, with the cervical spine in a neutral position, a pillow beneath the chest, and the forehead resting on a towel. At the patient's head, the therapist assumes an athletic diagonal posture. The patient's neck is positioned so that the therapist places both thumbs together and the fingers are in a mid-to-relaxed posture over the posterior lateral portion. The back of the intended articular pillar is where the points of both thumbs are positioned. To evaluate mobility, resistance, end feel, and pain provocation, the therapist gently presses in the anteroposterior direction in the facet joint plane. Gradations I and II of pain can be inhibited, while grades III and IV of motion can be restored, using mild oscillations. The therapeutic effects of this technique can be maximized by varying the force and depth slightly [14].

Median nerve gliding exercises: We used six steps of gliding exercises from an outstretched arm to accomplish the median nerve gliding exercise: In the initial step, the subject was instructed to flex her thumb, all fingers, and hold her wrist in a neutral posture. In the second stage, the participant was instructed to extend her thumb and fingers and hold her wrist in a neutral position. The next stage required the subject to spread her fingers and wrist while keeping her thumb in a neutral posture. The individual was instructed to extend her thumb, fingers, and wrist in the fourth phase. In the sixth phase, the individual was instructed to keep her fingers and thumb extended while supinate her forearm. The patient's thumb was gently stretched by the therapist in the sixth phase. The subjects held each position for seven seconds during the tendon and median nerve gliding movements, making the therapeutic exercise session last roughly five minutes for the afflicted hand [15].

Strengthening exercises: The participant was requested to carry out the following tasks against resistance while seated in a chair with her shoulders in a neutral position and her back supported: Gripping exercises, thumb opposition, finger pinching, pronation, supination, and wrist flexion and extension. Every exercise was performed in three sets of ten repetitions each, with a one-minute break in between [15].

Tendon gliding exercises: Tendon gliding exercises provide active flexibility for the flexor tendons. The exercises were performed with the participant sitting on a chair with her back supported. The shoulders and neck

were in a neutral position, her forearm supinated and flexed ninety degrees. There were five steps in which the patient performs tendon gliding exercises. The 1st step (straight), the participant was asked to hold her hand midway between flexion and extension with her thumb abducted. The 2nd step (hook), the participant was asked to perform flexion of both proximal and distal interphalangeal joints, while extension of the metacarpophalangeal joints of the medial four fingers was maintained and the thumb was adducted. The 3rd (fist), the participant was asked to flex her thumb and fingers. The 4th step (tabletop), the participant was asked to perform extension of both proximal and distal interphalangeal joints, while she flexes her metacarpophalangeal joints of the medial four fingers and the thumb was kept adducted. The fifth step (straight fist), the participant was asked to flex her both metacarpophalangeal joints and proximal interphalangeal joints while extending the distal interphalangeal joints of the medial four fingers and the thumb was adducted [16].

Ethical approval: The Ethics Committee of Physical Therapy College, Cairo University granted clearance for the study (P.T.REC/012/003943). Written approvals were possessed from all study population. The Helsinki Declaration was followed at all stages of the inquiry.

Statistical Analysis

We compared age, weight, height, and BMI using an unpaired t-test. Before and after therapy, as well as between treatment groups, the mean values of the VAS, motor distal latency, sensory peak latency, symptom severity scale, and functional status scale were compared. Every statistical test was conducted with significance set at $p < 0.05$. For the analysis, SPSS version 25. Windows version of the statistical program for the social sciences, was utilized.

RESULTS

Demographic characteristics of participants of both groups are represented in table (1) with non-significant difference between groups.

Table (1): Demographic data of patients in groups (A) and (B)

	Group A	Group B	t-value	p-value	Significance
Age (year)	29.2	30.6	-1.386	0.088	NS
Height (cm)	160.15	164.28	-1.407	0.085	NS
Weight (kg)	71.18	75.57	-0.793	0.217	NS
BMI (kg/m²)	27.75	28	0.003	0.498	NS

NS: non-significant.

Pre- and post-treatment comparison of the measured clinical parameters within and between groups:

I. Effect of adding cervical mobilization on visual analogue scale (VAS) scores: Following therapy, the pain threshold significantly decreased in both groups (p=0.000). When comparing the study group (group A) to the control group, the study group's post-treatment pain level drop was more significant (group B) (p=0.002), figure (1).

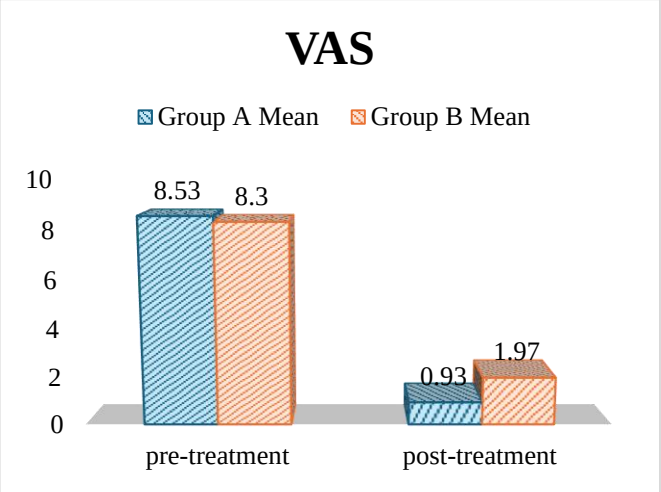

Fig (1): Comparison of mean VAS scores in both groups before and after treatment.

II. Effect of adding cervical mobilization on nine-hole pig test scores (9HPT).

In group A, the pre-treatment mean score of 9HPT was 39.25 and post-treatment mean score was 35.64. There was a highly significant decrease in the nine-hole pig test mean score after treatment (P= 0.00001).

In group B, the mean 9HPT score before therapy was 40.79 while the mean score after treatment was 38.27. There was a highly significant decrease in the nine-hole pig test mean score after treatment (P= 0.00001). After treatment, the mean score on the nine-hole pig test did not significantly differ between the groups, according to comparison, as shown in figure (II).

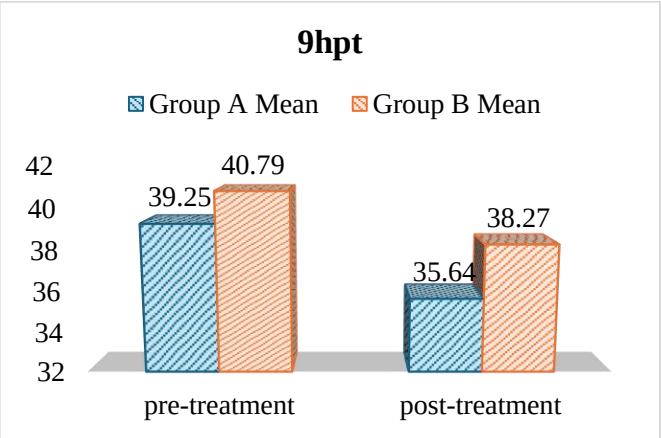

Fig (II): Comparison of 9HPT mean scores before and after treatment.

DISCUSSION

Because the bidirectional flow of vital nutrients along the nerve axon was disrupted, it was hypothesized that the genesis of double crush syndrome was caused by compression at one location in the proximal axon, which in turn caused more injuries in the distal axon. During that period, the nerve axon is unable to obtain and utilize essential nutrients, and the nerve fiber experiences morphological changes that impair its ability to function as needed. These changes result in a failure of the nerve cells, which causes the double crush syndrome symptoms of pain and numbness [17].

In 2021 Diego *et al.* [17] advised that in order to provide better results, any trial aimed at treating a patient with double crush syndrome should focus on the compression sites (In this case, the cervical spine and the carpal tunnel). When it comes to treating cases of cervical radiculopathy and patients suffering from carpal tunnel syndrome, manual treatment works [18, 19]. **Hidayati *et al.*** [20] stated that a promising future direction for treating patients with double crush syndrome is to use cervical mobilization. Therefore, the purpose of this study was to determine whether cervical mobilization could benefit patients with double crush syndrome when added to their treatment regimen.

Following therapy, both groups in this study showed a considerable improvement in pain, particularly the study group, whose results are consistent with **Zarrin *et al.*** [21], who claimed that cervical mobilization desensitization techniques had decreased sensitivity and improved discomfort. Furthermore, **Torun and Tuncer** [22], discovered that for patients with carpal tunnel syndrome, manual therapy has the biggest impact on reducing hand pain. Additionally, **Ozer *et al.*** [23] discovered that individuals with double crush syndrome have reduced spinal mobility. Therefore, cervical mobilization is a helpful addition to the treatment regimen for double crush syndrome patients.

Based on the outcomes of the Nine Hole Pig Test, a test designed to assess upper extremity function and motor ability [24], Following therapy, both groups' hand functions significantly improved, with the study group that added cervical mobilization to their regular treatment program performing better than the other group.

The current study's results showed that both groups, particularly the study group, had improved hand function after therapy, suggesting that adding cervical mobilization to conventional care is advantageous for treating patients with double crush syndrome. Our findings align with **Tal-Akabi, Rushton** [25], who discovered that in individuals with carpal tunnel syndrome, carpal bone mobilization and neurodynamic mobilization improved function status and symptom severity scores. **In 2019**, **Wolny and Linek** [26] discovered that the cervical neurodynamic approach significantly improves function status and lessens the intensity of symptoms. Additionally, **Shem *et al.*** [27] stated that increasing the symptom severity scale with manual treatment and self-stretching works well. Also, **César *et al.*** [28] discovered that the addition of lateral cervical mobilization significantly decreased the BCTQ scores in both parts at one, three, and six months following the initial examination. According to a study, adding cervical mobilization enhanced BCTQ scores over time, improved over a six-month period, and outperformed standard treatment [21].

The study group receiving cervical mobilization showed a higher level of improvement, which is consistent with **Byvaltsev *et al.*** [29] who proposed that treating double crush syndrome all at once is preferable to treating it gradually. Still, **Hansen *et al.*** [30] discovered that following decompression of the carpal tunnel, patients with and without double crush syndrome experience comparable rates of clinical recovery.

CONCLUSION

Based on the study's findings, it can be said that cervical mobilization helps Double Crush Syndrome patients undergoing rehabilitation by reducing their pain and improving the function of their affected hand.

Sources of funding: Funding institutions in the public, commercial, or nonprofit sectors did not award a specific grant for this research.

Conflicts of interest: There are no conflicts of interest according to the authors.

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