Mohamed Faisal *et al* GRIP STRENGTH AND HAND FUNCTION CHANGES IN UNILATERAL CERVICAL RADICULOPATHY



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GRIP STRENGTH AND HAND FUNCTION CHANGES IN UNILATERAL CERVICAL RADICULOPATHY

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ABSTRACT

Back Ground and Objective: This study was to know and compare the extent of ill effect of cervical radilculopathy in upper limb, by measuring the hand grip strength and hand functions comparing with the normal or unaffected side. Materials and Method: It was a retrospective covariance study, where 30 subjects were selected who satisfied the inclusion and exclusion criteria with a mean age group of 45. All the subjects were explained about the procedures and an informed written consent was obtained. The 30 patients were assessed for grip strength by hand dynamometer and hand function by Jebsen – Taylor hand function test. The assessments were taken three times with an adequate interval of five minutes and the average values were taken. **Results:** The grip strength and hand functions of the affected side were compared with the unaffected or normal side. Paired and independent t test was used for the analysis of data. High significance was seen in hand grip strength with P = 0.028 P < 0.05between affected and unaffected side. Hand function data was analyzed by independent t test for the seven sub tests, in which five tests showed very high significance with P = 0.000, 0.015, 0.000, 0.000,0.043 P < 0.05. Interpretation of Results: Hand grip strength and hand functions were significantly reduced in patients with cervical radiculopathy. There was significant reduction in the hand grip strength and hand function in the patients with unilateral cervical radiculopathy when compared with the unaffected side.

Keywords: Cervical radiculopathy, Hand Grip Strength, Hand function, Jebsen Taylor Test, Hand dynamometer

INTRODUCTION

Cervical radiculopathy is as condition caused by compression of a nerve root in the cervical spine. It is generally from a herniated disc or a bone spur that is pressing against an inflamed nerve root [1]. Nerve roots compression may lead to weakness, numbness and pain where the nerve travels. The pain may be felt as deep, dull and achy or may have sharp shooting pain along the path of the nerve. Muscles controlled by the affected nerve root may also be weakened [2].

Degenerative disc disease (DDD) is extremely common, occurring in up to 5% of women and 13% of men during the 3^{rd} decade, more than 90%

of adults over the age of 50 years and almost 100% by 70 years [3]. Isolated root pathology is commonly caused by protrusion of a disc, although chronic degenerative arthritic changes or abnormalities of the superior facet region may also play a role. The most commonly affected level is $C_5 \cdot C_6$, with 86% of specimens having observable abnormalities. The $C_6 - C_7$ level is the next most frequently affected site in the cervical region. Finally, involvement of the 8th cervical nerve root by a herniated $C_7 - T_1$ disc produces a significant weakness of the intrinsic musculature of the hand. This involvement can lead to rapid atrophy of the interosseous muscles. Loss of the interrossei leads

to significant loss in fine hand motion. The most common areas of the disc herniation are $C_6 - C_7$ and $C_5 - C_6[4]$.

The existing treatments for these conditions are medications. surgical management and physiotherapy [5]. The physiotherapy management for the condition includes; educating the patient, teaching the natural history of Osteoarthritis of the cervical spine, heating modalities like SWD, ultrasound, TENS, infrared lamps, hydrocollator packs, hydrotherapy, stretching of the neck muscles and range of motion exercises. Intermittent cervical spine traction, Special pillows, cervical massage, relaxation techniques to relieve the emotional stress that aggravates the symptoms and cervical manipulation and manual traction are also found to be effective [6].

Functional tests assess a broad spectrum of hand and upper extremity function including ADLs, gross and fine motor abilities, tool usage, manipulations, dexterity, grasp and release of objects and unilateral and bilateral hand use and sensibility [7]. Power is a good indicator of hand function, and its measurement must be included as the part of any hand assessment. The most commonly measured aspects of hand functions include grasp, lateral pinch and opposition pinch. The hand function tests are often timed and used to analyze patterns of grip and form a problem index. They are particularly useful in an assessment situation where the therapist has not had the opportunity to observe the patient using the hand. The hand function test may be used to analyze and evaluate treatment outcomes [8].

Measurement of handgrip strength is an important component of hand rehabilitation because it assesses the patients' initial limitation as compared with norms. Its utility continues throughout the treatment process because it provides a quick reassessment of the patient's progress. Without the ability to grasp, a person ceases to be functionally independent and is unlikely to be able to work or play. Measuring the strength of hand muscles with dynamometer is frequently used as a parameter to asses hand function [9, 10].

Jebsen-Taylor hand function test consist of 7 subtests. Each test is timed, and there are published standardized times against which to evaluate the performance of the patient. It has been widely used to evaluate hand functions in a number of medical and surgical conditions. It evaluates unilateral grasp and prehension patterns. Although this test cannot be purchased commercially, the therapist can assemble it inexpensively. It is fast and easy to administer too [11].

Since cervical radiculopathy can decrease the handgrip strength and the associated functions, there are chances of alternate functional impairment during unilateral cervical radiculopathy, towards the affected side. This can be assessed by using the hand dynamometer for grip strength and Jebsen-Taylor test for functional activity. So this study is to know the extent of the effect of cervical radiculopathy in grip strength and hand functions and to compare the extent of the ill effects of cervical radiculopathy by grip strength and hand functions with the normal side or unaffected side.

MATERIALS AND METHODS

The study included a sample of 30 subjects with age group between 30 to 60 years who were diagnosed with unilateral cervical radiculopathy of the right side, based on their clinical findings, irrespective of their sex. The diagnosed cases were recruited from the Department of Orthopaedics and Neurology of K S Hegde Hospital, Mangalore.

Methods of Data Collection

This study was a retrospective covariance study. The subjects were explained about the condition, experimental procedures, and outcome measures. Formal written consent was obtained from each subject and ethical clearance was obtained from the Institutional Ethical Committee.

Inclusion Criteria

- Diagnosed cases of unilateral cervical radiculopathy of the right hand dominant side, where the patients were under control of pain.
- Age group between 30 to 60.
- Both males and females

Exclusion Criteria

- Subjects who have any other musculo skeletal disorders
- Neurovascular Impairment
- Bilateral cervical radiculopathy
- Cervical Myelopathy
- Acute cases of cervical radiculopathy

Materials required

- Jamar Hand Dynamometer
- Jebsen Taylor Hand Function Kit

METHODOLOGY

The hand dynamometer measures cylinder grip strength and it is widely available to hand therapist, has a standardized method of use, has normative values established for its use, and is widely accepted by hand therapist. The normative values are particularly useful when it is necessary to compare the patient against norms.

The patients were seated in a chair with shoulder adducted, neutrally rotated, elbow flexed at 90 degree, forearm neutral, wrist between 0 degree and 15 degree dorsiflexion and 0 degree and 15 degree ulnar deviation. Hold the dynamometer lightly around readout dial. Then the patient has instructed to hold the handle and "squeeze" as hard as possible and then "Relax". Same technique was repeated with same instructions for the second and third trial. Both the right and left hand has been tested in the second handle position. The peak reading of the three trials was noted and average was taken [9].

The Jebsen-Taylor hand function test is composed of seven subtests that represent various hand activities. The seven subtests include; (1) Writing, (2) Turning over 3 by 5- in cards (which simulates page turning), (3) Picking up small common objects (4) Simulated feeding, (5) Stacking checkers, (6) Picking up and placing large empty objects, (7) Picking up and placing large heavy objects.

The examiner reads the directions to the patient and records the time that the patient requires to complete each subtest with the non dominant and then the dominant hand. The results are compared with normative data available relative to gender and age. Seven subtests were chosen to provide a broad sampling of hand function. Each of the subtests was designed to be administered in precisely the same manner to each subject. The results measured objectively using a stop watch. Each subject was seated in a chair of 18-inch height at a desk of 30-inch height in a well lighted room. Questions were answered after the instructions were given to be certain that the instructions were understood. The subtests were always presented in the same sequence and were always performed with the non dominant hand first.

SUBTEST 1: Writing

Procedure: The subject is given a black ball point pen and for 8-by-11 inch sheets of un ruled white paper fastened one on top of the other, to a clip board. The sentence to be copied has 24 letters. The sentence is typed in all capital letters and centered on a 5-by-8 inch index card. The card is presented with the typed side faced down on a book stand. After the articles are arranged to the comfort of the subjects the card is turned over by the examiner with an immediate command to begin. The item is timed from the word "go" until the pen is lifted from the page at the end of the sentence. The item is repeated with the dominant hand using a new sentence.

SUBTEST 2: Card turning (simulated page turning)

Procedure: Five 3 X 5 inch index cards ruled on one side only, are placed in a horizontal row 2 inches apart on the desk in front of the patient. Each card is oriented vertically five inches from the front edge of the desk. Timing is from the

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word "go" until the last card is turned over. No accuracy of placement after turning is necessary the item is repeated with the dominant hand.

SUBTEST 3- Picking up small common objects

Procedure: An empty 1 pound coffee can is placed directly in front of the subject, five inches from the front edge of the desk. Two 1 inch paper clips oriented vertically, two regular sized bottle caps each 1-inch in diameter placed with inside of the cap facing up and two coins are placed in a horizontal row to the left of the can. The paper clips are to the extreme left and the coin nearest the can. The objects are two inches apart. Timing is from the word "go" until the sound of the last object striking the inside of the can is heard. The item is repeated with the dominant hand.

SUBTEST 4- Simulated feeding

Procedure: Five kidney beans of approximately 5X 8 inch length are placed on the desk in front of the subject 5 inches from the front edge of the desk. The beans are oriented to the left of the centre 2 inches apart. An empty 1 pound coffee can is placed centrally in front of the patient. A regular teaspoon is provided. Timing is from the word "go" until the last bean is heard hitting the bottom of the can. The item is repeated with the dominant hand, the beans being placed to the right of the centre.

SUBTEST 5 – Stacking checkers

Procedure: Four standard sized red wooden checkers are placed in front of the subject, five inches from the front edge of the desk. The checkers are oriented two on each side of the centre in a 0000 configuration. Timing is from the word "go" until the fourth checker makes contact with the third checker. The fourth checker need not stay in place .The item is repeated with dominant hand.

SUBTEST 6- Picking up large light objects

Procedure: Five empty cans are placed in front of the subject five inches from the front edge of the desk. The cans are spaced two inches apart with the open end of the can facing down. Timing is

from the word "go" until the fifth can has been released. The item is repeated with dominant hand.

SUBTEST 7-Picking up large heavy objects

Procedure: Five full 1 pound cans are placed in front of the subject with five inches from the front edge of the desk. The cans are spaced two inches apart. Timing is from the word "go" until the fifth can has been released. The item is repeated with the dominant hand [12].

RESULTS

Thirty patients were taken with unilateral cervical radiculopathy of the dominant right side. The average ages of the patient were 45 + 8.75. Out of 30 patients, 18 were males and 12 were females. The analysis was done using Paired and independent t-test.

The data were compared to check whether there is any significant difference in handgrip strength between the affected and the unaffected side and the statistical analysis shows in hand grip of the total 30 subjects, there was a mean difference of -1.87 with t-value of -2.34 with P-value 0.028, where is P<0.05. It shows there is a highly significant difference in handgrip strength between the affected side and the unaffected side. Handgrip strength is less on the affected side when compared to the unaffected side. [Figure 1]

The data for the hand functions were compared to check whether there is any significant difference in the hand functions between the affected side and the normal. The mean, standard deviation and standard error on hand function were compared. [Table 1 & 2]

The statistical analysis shows that in the writing speed, there was a mean difference of 6.4 with t-value 4.28 with P-value 0.000, which is P < 0.05. It shows there is a very highly significant difference in the writing speed on the affected side when compared to the normal.

The statistical analysis shows that in the card turning, there was a mean difference of -0.82 with t-value of 0.98 with P-value 0.152, which is P>0.05. It shows there is a non significant

difference in the card turning on the affected side when compared to the normal.

The statistical analysis shows that in picking up small objects, there was a mean difference of -1.02 with t-value of 1.23 with P-value 0.105, which is P>0.05. It shows there is a non significant difference in picking up small objects on the affected side when compared to the normal.

The statistical analysis shows that in simulated feeding, there was a mean difference of 0.866 with t-value 2.49 with P- value 0.015, which is P<0.05. It shows there is a very highly significant difference in simulated feeding on the affected side when compared to normal.

The statistical analysis shows that in stacking checkers, there was a mean difference of 1.10 with t-value 5.04 with P-value0.000, which is P<0.05. It shows there is a very highly significant difference in stacking checkers on the affected side when compared to the normal.

The statistical analysis shows that in picking up large light objects, there was a mean difference of 1.15 with t-value 4.84 with P-value 0.000, which is P<0.05. It shows there is a very highly significant difference in picking up large light objects on the affected side when compared to the normal.

The statistical analysis shows that in picking up large heavy objects,, there was a mean difference of 0.52 with t-value 2.06 with P-value0.043, which is P<0.05. It shows there is a very highly significant difference in picking up large heavy objects on the affected side when compared to the normal [Figure 2].

DICUSSION

The present study was designed to know the extent of ill effects of unilateral cervical radiculopathy of the dominant side, by checking the handgrip strength and hand functional activities.

The study result showed a highly significant reduction in handgrip strength on affected side when compared to the unaffected side (p=0.028<0.05). This is because in radiculopathy,

there could be a myotomal involvement which ultimately can lead to the weakness of the intrinsic muscles of hand. This finding has been matched with the findings of **Friendenberg et al**, where the results of their study showed that the involvement of the lower cervical segments produces a significant weakness of the intrinsic muscles of the hand, which in turn leading to significant loss in the hand grip and leading to reduction in fine hand functions [4]. Even though in the current study we have found all of them had an involvement in the lower cervical regions, we have not separately analyzed the difference in the effects of radiculopathy at various levels.

In this study we have used Jebsen –Taylor hand function test to know the functional deficits, which is a reliable and valid measure of hand function assessment in any hand impairments and this scale, consists of tasks representative of everyday functional activity.

In our study we found that, out of the seven subtests of the Jebsen -Taylor hand function tests, only five subtests have got a very highly significant difference, when compared between the affected and the normal. The subtests which had a significant difference were; writing speed, simulated feeding, stacking checkers, picking up large light objects and picking up large heavy objects, where as the remaining two subtests; card turning and picking up small common objects were shown as there was no statistically significant difference. The reason could be those were the activities, which patients were encountering on daily life. Since majority of the components of the Jebsen-Taylor hand function test are affected, it can come in to a conclusion that the functional activities of hand in patients with radiculopathy are also impaired very significantly.

In the present study, we were also trying to find out whether the reduction of hand grip has an impact on the hand function activities, which ultimately shows that there was a significant reduction in the hand function activities in majority of the subtests of the Jebsen-Taylor hand function test in those patients with radiculopathy.

The evaluation of handgrip strength and functional activities of hand are useful to provide an objective index for the functional integrity of the upper extremity. Grip strength is an important prerequisite for good performance of the upper limb and checking the normal activities of hand function also plays a major role in upper extremity assessment. Hence it is not only the pain assessment, but also the assessment of hand grip strength and hand function should also be a part of the evaluation in patients with radiculopathy who come for the rehabilitation program.

In the current study we had included only the right side dominant radiculopathy patients to avoid any bias because the study done by Crosby et al [13] to find out normal hand strength value with dynamometer concluded that the right-sided subjects were 10% stronger in grip strength on the dominant side. In the left-handed subjects, the mean grip was the same for both hands and a study done by Petersen et al [14] to find out the effect of grip strength and hand dominance concluded that 10% rule was valid for right dominant handed persons and for left handed persons, grip strength should be considered equivalent in both the hands. And in a study by Ozcan et al, suggested that in a right- dominant handed subjects, the dominant hand was significantly faster with the time perform test [15].

In this study we have used the Jamar hand dynamometer to assess the grip strength which is having a high intra and inter tester reliability and reference values for checking the hand grip strength, according to Peolsson A et al. The reliability studies showed that handgrip strength measured with the Jamar dynamometer is a reliable method (ICC values 0.85 - 0.98) and can be recommended for using in clinical practice. The reference values for hand strength improve the potential for objective evaluation of patients with arm / hand disorders caused by cervical radiculopathy [16].

And to check the grip strength we have adopted the method suggested by Joseph A. Balogun et al [9], where they found that grip strength was significantly higher (p<0.05) in the elbow 90degree flexion than in the fully extended position, which is further supported by Hebert R, Mercier L et al [17]. Further studies could be conducted with larger samples and in other conditions of neck pain too.

CONCLUSION

Handgrip strength and hand functions were significantly reduced in the patients with unilateral cervical radiculopathy. There were significant reductions in the handgrip and hand functions on the affected side in the patients with unilateral cervical radiculopathy when compared with the unaffected or normal side.

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Conflict of Interest

Authors agree that there was no source of conflict of interest.

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Variable		AFFECTE	D	NORMATIVE			
	MEAN	SD	SE	MEAN	SD	SE	
Writing speed	22.8	8.01	1.46	16.32	2.09	0.38	
Card turning	4.4	1.16	0.21	5.2	0.39	0.07	
Small objects	5.6	1.42	0.26	6.6	0.29	0.05	
Simulated feeding	8.3	1.8	0.34	7.5	0.24	0.04	
Stacking checkers	5.06	1.2	0.21	3.9	0.04	0.009	
Large light objects	4.6	1.2	0.23	3.4	0.09	0.01	
Large heavy objects	4.1	1.37	0.25	3.5	0.09	0.01	

 Table 1: Mean, standard deviation and standard error of the hand function

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Variable	MEAN DIFFERENCE	T-VALUE	P-VALUE	RESULT				
Writing speed	6.4	4.28	0.000	P<0.05 VHS				
Card turning	-0.82	0.98	0.152	P>0.05 NS				
Small objects	-1.02	1.23	0.105	P>0.05 NS				
Simulated feeding	0.866	2.49	0.015	P<0.05 VHS				
Stacking checkers	1.10	5.04	0.000	P<0.05 VHS				
Large light objects	1.15	4.84	0.000	P<0.05 VHS				
Large heavy objects	0.52	2.06	0.043	P<0.05 HS				

Table 2: Comparison of hand function between the affected and the normal







Graph 2: Comparison of hand function between the affected and the normal