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TEST-RETEST RELIABILITY OF HAND GRIP STRENGTH MEASUREMENT USING A JAMAR HAND DYNAMOMETER IN PATIENTS WITH ACUTE AND CHRONIC CERVICAL RADICULOPATHY

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ABSTRACT

Background: To evaluate the test-retest reliability of Jamar hand held dynamometer for measuring handgrip strength (HGS) in patients with acute and chronic cervical radiculopathy and to find out the difference in measurement of the handgrip strength between acute and chronic cervical radiculopathy.

Methods: A prospective, observational and non-experimental, the comparative study design was used. A sample of 72 subjects (37 women and 35 men) suffering from cervical radiculopathy were divided into two groups i.e., Group A(acute) and Group B(chronic), handgrip strength was measured using Jamar hand held dynamometer on two occasions by the same rater with an interval of 7-days. Data collection was based on standard guidelines of American Society of Hand Therapists. Three gripping trials (measured in Kg) with patient's arm in standardized arm position were recorded. The data was analyzed from the mean score obtained from the sample.

Result: One-way Analysis of Variance(ANOVA) was used to evaluate test-retest reliability and Tukey-Kramer Multiple Comparison Test used to find the difference between handgrip strength among acute and chronic Cervical radiculopathy cases. Greater P-value (>0.05) in both testing session, as well as 95% of the confidence interval, shows the reliability of the instrument and lesser p-value (<0.05) in male subject shows a significant difference in handgrip strength and greater p-value (>0.05) in female subjects shows no significant difference in handgrip strength between the two groups.

Conclusion: Excellent test-retest reliability for hand grip strength measurement was measured in patients with acute and chronic cervical radiculopathy shows that the equipment could be used as an assessment tool for this patient and significant difference exists among male handgrip strength between acute and chronic cervical radiculopathy cases whereas no difference exists among female handgrip strength between acute and chronic cervical radiculopathy cases.

Keywords: reliability, Handgrip strength, jamar hand dynamometer, acute and chronic cervical radiculopathy.

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INTRODUCTION

Cervical radiculopathy is a pathological process marked by nerve root compression produces axial neck pain and radiating arm pain with the sensory deficit and motor dysfunctions such as numbness, paresthesia, muscle weakness, altered reflexes and loss of active movements in the neck and upper extremity depending on the level involved [1-4].

Eight cervical nerves arise from the cervical spine which exit above the designated vertebral level at all level except the last one (C8 below the C7 vertebra). And then terminate into branches to supply muscles that enable the shoulder, arm, hand, and fingers to function. They also carry sensory fibers to the skin and muscles that provide sensation [1,2].

Acute pain is an unpleasant sensory, perceptual, emotional and mental experience provoked by acute pathological or with autonomic, psychological and behavioral response lasts for 3 to 6 months. Chronic pain is a persistent uneasiness that lasts beyond the expected time frame[3]. Nerve root compression can be due to an acute disc prolapse, or also from chronic spondylosis and/or instability caused by impingement from uncovertebral osteophytes or hypertrophied facet joint, and reduced disc space[4].

The clinical diagnosis could be confirmed by a provocative test such as compression test, distraction test, upper limb tension tests and magnetic resonance imaging or computed tomography can confirm the level of neurological impingement [5-7].The initial prognosis of individuals with cervical radiculopathy is favorable. Most individuals improve over time with conservative management [3].

A limited number of population-based study has depicted the annual incidence of cervical radiculopathy cases to be 83 per 100,000 people in the population, with age onset 13 to 41 years and increasing prevalence in older age group. Men are more affected than women [3,8,9].

Upper limb muscle weakness, atrophy, and numbness are common symptoms presented by patients with cervical radiculopathy. On the basis of kinetic chain principles that the upper extremity is an inter-linked segment works together to perform daily activities. These symptoms along with pain perception as a consequence of disease process in the affected limb reduce the strength of gripping activities [10-13]. As the disease progresses the disability will also increase.

Sufficient muscle strength is required for energy efficient physical functioning. Low muscle strength indicates physical limitations. thus hand grip strength measurement is the basis of assessment in a patient suffering from any pathology which affects upper limb functioning.

Jamar hand dynamometer is the most reliable and acceptable tool for measuring grip strength [14]. It detects and quantitatively determines the degree of weak grip strength (GS). The measure is taken before and after treatment helps in intervention outcome [15].

The measurements obtained on one occasion must give a similar and stable result on different occasions when applied at the same rate. However, there is a limited number of researchers have been done to show the test-retest reliability of jamar hand held dynamometer in measuring hand grip strength in cervical radiculopathy patients. Therefore, the purpose of the present study is to find the test-retest reliability of GSM using a jamar hand dynamometer in patients with cervical radiculopathy on the basis of chronicity.

METHODS

Design and Rater

A prospective, observational, non-experimental, comparative design was used. The study sample is a representative sample of the population living in New Delhi, India. The protocol was approved by Ethical Committee (IEC) of Jamia Hamdard, New Delhi and participants signed on informed consent. The same rater measured the patient's grip strength on two occasions with a gap of 7-days in between to prevent potential learning effect. A blinded rater recorded patient's core. The rater was a qualified physiotherapist, and during data collection, he was not aware of the purpose and nature of data collection.[8]

Patients

A total number of 72 patients suffering from cervical radiculopathy, in which 34 patients of acute CR(18 male and 16 female: mean±SD age, 42.26±13.37) and 38 patients of chronic CR (17 male and 21 female: mean±SD age,41.02±11.89), participated in the study The subjects were divided into two groups according to the chronicity of Cervical radiculopathy, Group A(acute and Group B (chronic). All participants (n=72) were blinded to the HGS score to minimize expectation bias, which could influence the outcome score during trials. All the participants were diagnosed cervical radiculopathy cases, by orthopedic doctor and were indulged in the study on the basis of inclusion criteria such as MRI, reported unilateral dominant hand sensory-motor deficits including sharp ache, muscle weakness, numbness in the upper limb, aggravated by certain neck movements.[8,9]. Also, Participants were included if they showed the positive result to a clinical diagnostic procedure such as Spurling's test, compression test, distraction test, and upper limb tension tests.

Patient were excluded if they had been undergoing physiotherapy during the current period, also patient having any other pathology affecting upper limb functioning and cervical myelopathy or bilateral radiculopathy, and non-cooperative patients were excluded.

The informed consent form approved by Ethical Committee (IEC) of Jamia Hamdard, New Delhi, was signed by the participants before the test. A participant information sheet containing all the necessary information about aim and procedure of the study was complemented to the participants. Patient' right to privacy, anonymity and confidentially as well as their right to quit the study at any time was mentioned and discussed.

Equipment

Jamar Hand Held dynamometer is a device that controls the velocity of motion and provides accommodating resis-

tance proportional to the force generated by the person using the machine [16,17]. In 1954, Bechtol introduced the Jamar Dynamometer. It became the most accepted instrument for quantitative measurement of hand grip [14].

PROCEDURE

The procedure of HGS data collection was executed as endorsed by the American Society of Hand Therapists [18].

During the session of data collection patients had to sit on a straight back chair with their feet flat on the floor, shoulders at the neutral position, elbow flexed at 90^0, forearm rested in a neutral position, with their wrist in ulnar deviation and extension, positioned between 0^0 and 30^0 and 0^0 and 15^0 respectively [22-24]. After achieving the standard position, Jamar hand dynamometer was given to the participants and encouraged to get familiarized with the procedure. The patients were asked to exert 3 maximum gripping efforts for 5 seconds, and a relapse of 15 seconds between each trial were given to prevent fatigue effect. Instruction how to perform the task was given by the rater during the procedure. The blinded rater measured and recorded the patient's score. Same procedure was followed during the second trial, conducted after 7-days of first. The mean value of 3 trials (measured in Kg) was used for data analysis.

The same dynamometer was used for all testing sessions.

Analysis of Data

Analysis of data was performed using INSTAT version 2010 software. All the data analyzed by One-way Variance (ANOVA) for window software importing Microsoft excel master sheet containing subject data. Descriptive statistics were used to analyze and find out mean, standard deviation, percentiles and frequencies of subject's hand grip strength. Between groups, the analysis was done by using Tukey-Kramer Multiple Comparison Test. Probability level less than 5% was accounted as statistically significant. All the data were also analyzed by percentage variation between the two groups.

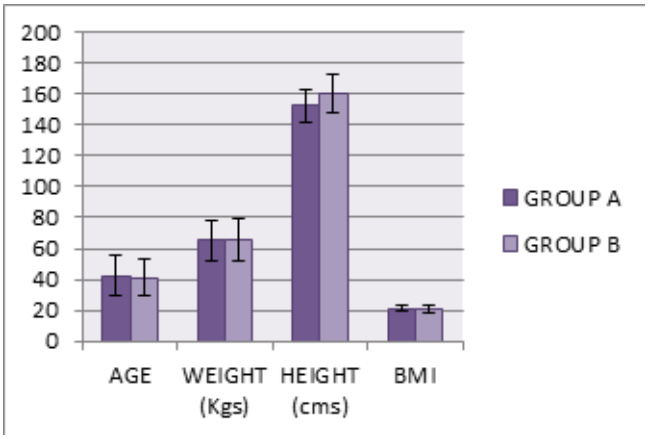
RESULT

A total of 72 patients (35 males and 37 females) were in the study. The subjects were grouped into two groups on the basis of chronicity, i.e., Group A acute and Group B chronic. A number of subjects in Group A were 34(18 male and 16 female) and in Group B was 38 (17 male and 21 female).

A total of 72 patients (35 males and 37 females) were included in the study. The subjects were grouped into two groups on the basis of chronicity, i.e., Group A acute and Group B chronic. A number of subjects in Group A were 34(18 male and 16 female: mean±SD of age 42.26±13.37 and BMI 20.97±1.95) and in Group B was 38 (17 male and 21 female: mean±SD of age 41.02±11.89 and BMI 20.71±2.18). the mean value of demographic data shows no significant difference as shown in Table-1.1 and Graph-1.1

Variables	GROUP A Mean±SD	GROUP B Mean±SD	p-value
AGE	42.26±13.37	41.02±11.89	0.12
WEIGHT (Kgs)	65.10±13.44	65.90±13.52	0.11
HEIGHT (cms)	152.70±10.65	160.40±12.13	0.81
BMI	20.97±1.95	20.71±2.18	0.32

Table-1.1: Demographic Data i.e. Age, Weight, Height and BMI of Group A and B



Graph 1.1: Demographic Data i.e. Age, Weight, Height and BMI of Group A and B

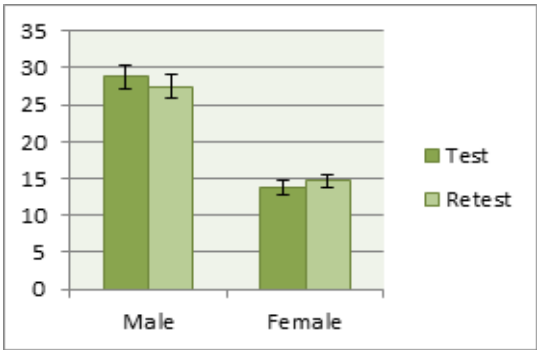
Between trial analysis of Grip strength shows statistically no significant difference between test and retest in Group A, i.e. in acute CR cases. The average values for grip strength of Group A test (male=28.81±1.61 and female= 13.74±0.99) and retest(male= 27.51±1.51 and female= 14.68±0.91) and their P-values as shown in table-1.2 and graph-1.2.

GROUP A	Test Mean±SD	Retest Mean±SD	P-value
Male	28.81±1.61	27.51±1.51	^{NS}P>0.05
Female	13.74±0.99	14.68±0.91	^{NS}P>0.05

GROUP A- acute

^{NS}P>0.05- nonsignificant SD- standard deviation

Table-1.2 Test-Retest Reliability of the J. Dynamometer in Acute CR cases



Graph-1.2 Test-Retest Reliability of the J. Dynamometer in Acute CR cases

Between trial analysis of Grip strength shows statistically no significant difference between test and retest in Group B, i.e. in chronic CR cases. The average values for grip strength of Group B test(male= 34.08±2.01 and fe-

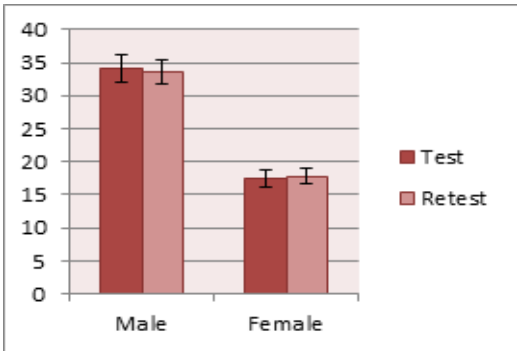
male= 17.53±1.35) and retest (male= 33.54±1.87 and female=17.74±1.18) and their P-values are shown in Table-1.3 and Graph-1.3.

GROUP B	Test Mean±SD	Retest Mean±SD	P-value
Male	34.08±2.01	33.54±1.87	^{NS}P>0.05
Female	17.53±1.35	17.74±1.18	^{NS}P>0.05

GROUP B- chronic

^{NS}P>0.05- nonsignificant SD- standard deviation

Table 1.3: Test-Retest Reliability of J. Dynamometer in Chronic CR cases



Graph-1.3 Test-Retest Reliability of J. Dynamometer in Chronic CR cases

Between-group analysis of grip strength shows significant difference among male subjects and no significant difference among female subjects. The average values for grip strength of Group A test (male=28.81±1.61 and female= 13.74±0.99) and retest(male= 27.51±1.51 and female= 14.68±0.91), and Group B test(male= 34.08±2.01 and female= 17.53±1.35) and retest(male= 33.54±1.87 and female=17.74±1.18) and their P-values are shown in Table-5.4 and Graph-5.4(Male), Table-1.5 and Graph-1.5(Female).

Male	GROUP A Mean±SD	GROUP B Mean±SD	P-value
Test	28.81±1.61	34.08±2.01	**P<0.01
Retest	27.51±1.51	33.54±1.87	*P<0.05

GROUP A- acute GROUP B- chronic *P<0.05- mild significant **P<0.01- moderate significant SD- standard deviation

Table 1.4 Test-Retest GSM in Between Acute and Chronic CR Male patient

Graph 1.4: Test-Retest GSM in Between Acute and Chronic CR Male patient.

Female	GROUP A Mean±SD	GROUP B Mean±SD	P-value
Test	13.74±0.099	17.53±1.35	^{NS}P>0.05
Retest	14.68±0.91	17.74±1.18	^{NS}P>0.05

GROUP A- acute GROUP B- chronic ^{NS}P>0.05- nonsignificant SD- standard deviation

Table 1.5: Test-Retest GSM in Between Acute and Chronic CR Female patient

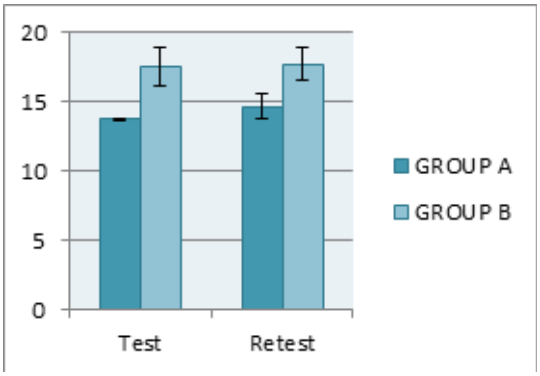


Table 1.5: Test-Retest GSM in Between Acute and Chronic CR Female patient.

DISCUSSION

Pain and sensory-motor deficit arising from Cervical radiculopathy can be a disabling disorder. Use of GSM as an outcome measure in CR is widely applied by physiotherapists and doctors of chiropractic to identify weak GS [19]. However, little attention has been given with respect to its test-retest reliability. Thus, the aim of this study was to explore the test-retest reliability of GSM in patients with CR on the basis of chronicity as well as to see the differences in measures between HGS among acute and chronic cases of CR.

The present study revealed that GSM using a Jamar Hand Dynamometer is a reliable outcome measure in cervical radiculopathy owing to its ability to provide similar and precise results of GS on repeated trials [8], and between the group comparison shows that there is a significant difference in GS scores of acute and chronic CR among male subjects and there is no significant difference exists between acute and chronic CR among female subjects.

The present study included 72 patients of CR, in which 34 patients of acute CR(18 male and 16 female) and 38 patients of chronic CR (17 male and 21 female). Grip strength of the dominant hand of the two group was measured. Using the ANOVA, test-retest reliability of GSM was found to be excellent with 95% of the confidence interval and using Tukey-Kramer Multiple Comparison Test the difference in HGS in male subjects of acute and chronic cases was found significant with a p-value of 0.01 in the first trail and a p-value of 0.05 in the second trail and in female subjects of acute and chronic cases was found non significant with p-valu>0.05 in both trials. The 95% of confidence interval in between the two groups reflect significant difference among the HGS between the two groups in male and less significant difference in HGS between the two groups in female[8].

Test-retest reliability of GSM has been found to be affected by various factors including the testing position, number of grip trails, type of dynamometer, and time of day[8,12]. In order to remain the patient's GS unchanged across repeated trials, these factors were controlled. In contrast information regarding the intensity of neck pain and radicular pain or the level of CR was not collected because, to our best knowledge, it has yet to be established whether these symptoms and characteristics of CR can influence test-retest reliability.

Test-retest reliability of GSM has been investigated only by two reliability study, and similar findings have been reported. In this study 72 patients experiencing CR were measured by the same rater within a 1-week period, and GS data analysis revealed excellent test-retest reliability. Also during data collection, the rater was blinded. However the external validity of these finding has been questioned because of various methodological limitations including small sample size and estimation of measurement error[12].

The difference in mean±SD value of male HGS score between acute (28.81±1.61) and chronic (34.08±2.01) in trail one and mean±SD value of HGS score in second trail between acute (27.51±1.51) and chronic (33.54±1.87) shows that the HGS are more affected in acute cases of CR in males whereas there is no marked difference in mean±SD values of HGS in acute and chronic cases of CR in females shows that HGS are equally affected in both cases in females.

The significant difference in HGS among the two groups among male and non significant difference in HGS between the two groups among female is may be due to psychological factors playing role in pain and disability perception. In a study done by Dennis C Turk an anesthesiologist, the University of Washington in 2002, and Akiko Okifuji, University of Utah School of Medicine 2002, on psychological factors in chronic pain: evaluation and revolution, they found that a number of psychological factors play role in developing an attitude toward chronic pain. Patient belief about symptoms, ability to withstand pain and impact of pain in ADLs are associated with psychological functioning.

Combez, Vlaven, and Lysens, (1999) found fear and anxiety to be responsible for provoking pain beyond the expected time.

McCracken and Edmands, (1993) evaluated that in the chronic disease condition, anxiety arising from fear of pain and discomfort may accentuate the pain experience. However patient with chronic pain with exaggerated pain-related anxiety tend to intercept higher levels of pain then those with low anxiety and this interception often results in depressed behavioral performance [19].

In a sex-based study on differences in pain perception and treatment by Channing J. Paller and colleagues, indicated that female subjects experience greater clinical pain, suffer greater pain-related distress, and show heightened sensitivity to experimentally induced discomfort compared with male subjects. A number of factors contributing to this difference such as psychological factor, gonadal hormone level [20]. Thus on the basis of these researchers, it is concluded that if the disease is not progressing, the HGS in chronic CR cases in the male is less affected is due to with time, pain-related fear and anxiety decrease in men.

A number of researchers have been done to evaluate the normal value of GS on dominant hand of normal subjects and revealed that men have more values of GS(i.e., GS=35-50 kg) than women (i.e, 24-40 kg) and also there is a decline in the GS value in older age group due to poor health and activeness . Hence on the basis of literature in the study, the result of GS in CR patient was compared to normal value present in literature and found a significant decrease in CR cases [21,22].

According to studies done on HGS on healthy men and women it was found that men have twice the value of HGS then women, the discrepancy in the ratio of HGS is due to the difference in the configuration of muscle fibres in both the genders(i.e. men have more concentration of typeII fiber than women)and also due to demand of activity. So in this study, the result of HGS of men and women were analyzed separately between the groups, i.e, Group A male was compared with Group B male and Group A female was compared with Group B female to avoid gender-based biasing [21,23].

Grip strength assessment is important as it is required for the fine activities of daily living such as manipulating and holding objects. Grip strength is the essential for upper limb functions. Grip strength plays a significant role in daily activities in active age population and plays a supreme role in daily activities like opening a bottle, chopping vegetables, driving a car, driving a scooter, riding bike, writing, riding a bicycle, carrying a bag of groceries and holding a book, holding a comb, wearing and weaning off clothes etc. Hence it is important to assess grip muscle strength of these conditions so that appropriate remedial management can be given from the time of diagnosis because the physical disability or functional dependencies is difficult to rehabilitate later.

Clinical relevance

If grip strength were assessed at the time of diagnosis and routine assessments are taken during clinical follow up could prevent further deterioration in grip strength and development of discomfort in activities of daily living. Pain management with TENS and preventive equipment like strengthening exercises can be incorporated to decrease the rate of deterioration of muscle strength along with the cervical pain management. Therefore, it will be helpful in delaying the late musculoskeletal complications occurring in cervical radiculopathy patients due to deterioration in muscle strength. In one of the latest research conducted by Adrienne Visocchi et al (2010) have emphasized that handgrip exercises make blood vessels more flexible, improve blood vessel function, and lower down high blood pressure [6].

Limitation of the study

Although the present study is the first satisfactory powered study in this area, there are certain limitations. the population under investigation was to some extent heterogeneous regarding the gender of the participants as there were more women than men. Also, the population evaluated was from a specific geographical area hence the result could not be generalized. In addition, the current study the participants are from mixed age group, so there could be age-related differences exist among younger to older age group, also the current study did not classify the participants according to the cause of their symptoms or specific cervical level where the nerve irritation occurred.

Future Research

The kind of classification could be the aim of future research interest in studies including according to cause and cervical level involvement as well as further classification of patients with mechanical or inflammatory cause for their CR.

CONCLUSION

Great Test-retest reliability for GSM has been obtained in patients with acute and chronic cervical radiculopathy demonstrating its important use for outcome measure in clinical practice. A significant difference exists in between GSM of acute and chronic cases of CR, i.e., GS of acute cases are more affected than that of chronic cases. Further investigation is now required to explore the test-retest reliability of GSM in CR according to cause and spinal level where the nerve irritation occurred.

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