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Comparison of Pain Pressure Threshold, Grip Strength and Pinch Grip in Dominant and Non-Dominant Hands In Older Adults

Ms. Sarita Shevatekar[1] & Dr. Deepali N Hande[2]
[1]Post graduate student, [2]Associate Professor, Community Physiotherapy Department,
Dr. A.P.J Abdul Kalam College of Physiotherapy, PIMS, Loni, Maharashtra, India.

Abstract *Aging in humans refers to a multidimensional process of physical , psychological, and social change. As one ages, many changes occur that may affect hand function. Changes in coordination, visual, touch, and auditory processes in addition to changes in the muscular, skeletal, and nervous systems occur with increasing age. The objective of the present study was to compare the pain pressure threshold (PPT), grip strength and pinch grip in dominant and non-dominant hands in older adults. This Prospective study consists of thirty male and female participants age ranging from 60-85 years were selected as per inclusion and exclusion criteria. Age related changes like pain pressure threshold, pinch grip and grip strength were assessed instrumentally within dominant and non-dominant hands. Result showed that Pain pressure threshold, Pinch Strength and Grip Strength of the dominant hand of right handed person is greater than compared to left handed. Study concluded that PPT, Grip strength and pinch are independent of dominance of participant between these three groups.*

1. Introduction

Aging in humans refers to a multidimensional process of physical, psychological, and social change. Research shows that even late in life, potential exists for physical, mental, and social growth and development. Aging is an important part of all human societies reflecting the biological changes that occur, but also reflecting cultural and societal conventions. As one ages, many changes occur that may affect hand function. Changes in coordination, vision, touch and auditory processes in addition to changes in the muscular, skeletal and nervous systems occur with increasing age. A decrease in muscle mass that is highly correlated with a decrease in muscle strength occurs with aging, especially after the age of 60 years Nervous system changes include decrease in nerve conduction velocity, sensory activity rate and magnitude of reflex responses [1].

On the basis of the importance of hand manipulation in activities of daily living (ADL), deterioration of hand function because of various factors reduces quality and independence of life of the geriatric population. The aim of this study was to identify age-induced changes in manual function and to quantify the correlations between hand-muscle function and activity restriction in the geriatric age group through grip, pinch and pain pressure threshold (PPT) measurements.To compare findings within and between age groups. To evaluate the changes in pain pressure threshold, grip strength and pinch grip in dominant and non-dominant hands of older adults [2].

Hand function weakens with age in both men and women, especially after the age of 65. As the age of older people increases, they may have sensorimotor impairment, which affects upper extremity (UE) performance and thus independence in the activities of daily life. Upper extremity's (UE) motor coordination, muscle strength and sensibility are essential for adequate performance of manual tasks. Manual asymmetry refers to the tendency to favour one hand for performance of skilled manual tasks, and is important in every sensory and motor function. Superior performance has been linked to several factors, including the processing characteristics of the left hemisphere/right-hand system and task complexity [3].

Measurement of grip strength is an important component in hand evaluation. Handgrip is a measure of strength of several muscles in the hand and forearm. These muscles play a vital role in the performance of day to day activities of normal life such as using tools etc. Grip strength is the force applied by the hand to pull on or suspend from objects. The power of grip is the result of forceful flexion of all finger joints with a maximal voluntary force that the participant is able to exert under normal bio kinetic conditions. Hand grip strength is a physiological variable that is affected

by a number of factors including age, gender and body size etc [4].

Grip strength was measured instrumentally. The difference between maximum and average of three consecutive measurement of grip strength was found significant for both hands. Therefore, average of three consecutive measurement of grip strength is more consistent for standard hand evaluation. Grip force varies according to elbow position, and numerous studies have investigated this aspect of manual performance with respect to sex, age, and hand dominance. Understanding the differences in overall performance and motor and sensory capacity of dominant and non-dominant hands of right- and left-handers is important when assessing progress during hand rehabilitation [3,4].

"Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. It is initiated by stimulation of nociceptors in peripheral nervous system or by damage to or malfunction of peripheral or central nervous system". The concept of pressure pain threshold (PPT) and the measurement of the onset of pain sensation using the algometer have been the focus and attention of much research and interest among clinicians and researchers. The pressure algometer is used to determine the pressure pain threshold of specific muscle and bone locations [6].

Over the last 25 years, the algometer has become widely used and accepted in the research literature as well as the clinical environment as a valid tool to evaluate 1 aspect of pain. The gradual application of pressure on a section of skin/muscle is detected by force displacement transducer within the algometer. The progressive development of pressure, by the application of the algometer head, produces a gradual displacement/depression of the local skin surface. The PPT is the point where the amount of pressure being applied produces a local sensory shift from pressure to pain. Measurements of PPT in healthy muscle obtained with a simple non-electronic algometer were reliable from trial to trial within the same day and from day to day over 3 consecutive days. Algometer is employed for quantification of tenderness in diagnosis of tender spots, trigger points, fibromyalgia and muscle spasm [5,6].

As pain pressure threshold, grip strength and pinch grip proves to be an important factor in hand rehabilitation therefore a convenient and useful tool and data need to be formulated which will directly focus on these three parameters. This study is carried out to understand the differences in motor and sensory performance like grip strength , pain pressure threshold and pinch grip respectively in older adults which will prove to be important when assessing progress during hand rehabilitation [7,8].

2. Method

This Prospective study was conducted within 30 participants with age group ranging from 60-85 years. Ethical approval was received from the Institutional Ethical Committee (Reg. no. PIMS/CPT/INT/2014/08). Study was conducted in rural area. There were no significant differences between the groups with respect to age or gender. Informed consent form was taken from each participant before starting the assessment. The participants were positioned in comfortable sitting position and assessed thoroughly for pain pressure threshold, grip strength and pinch grip measurement. Dominant hand was defined as the one used for writing. All tests were conducted on the dominant hand first, and then on the non-dominant hand. There was a rest period of 5 min between each test category. All data were collected using the same test equipment. Inclusion criteria of the study comprised of males and females of age between 60 to 85 years. Exclusion criteria of the study comprised of participants with upper limb trauma, any recent surgery of upper limb, referred and radiating pain from cervical/shoulder region and carpal tunnel syndrome.

Pain pressure threshold was assessed using Pressure Algometer. The measurement in each hand was the tip of the middle finger. Pressure was applied in increments of 1 kg/cm^2/sec. In each participant, three trials were made at each site. The mean was recorded as the PPT value. The grip strength of both right and left hands was measured using a standard adjustable hand grip dynamometer also known as Jamar Dynamometer. Pinch grip was assessed by using pinch gauge, by placing pinch meter between thumb and fingers in high sitting position. The participants were asked to put maximum pressure on the pinch gauge from both the hands. The average value was recorded in pounds. 3 pinch strength that is key pinch, three fingered pinch and finger tip pinch were tested with the instrument in a standard position. For each of the two groups (right-handed and left-handed participants),mean values(M) and standard deviations (SD) were calculated for the grip strength (kgs), PPT (kg/cm^2) and pinch grip(lbs)test results in the right and left hands [9,10,14].

The paired "t" test was used to compare differences between right and left hand within each group. The unpaired " t" test was used to compare differences between right and left hand between each group. A p value <0.05 was accepted as significant.

3. Result

In this study total 30 older adults were participated in the study. Statistical analysis was performed on the data obtained from 30 participants. Data was analyzed using Graph Pad Instat Trial Version 13.3. Descriptive statistics for the outcome measure were expressed as;

Figure 1.Mean Grip Strength of Right hander's

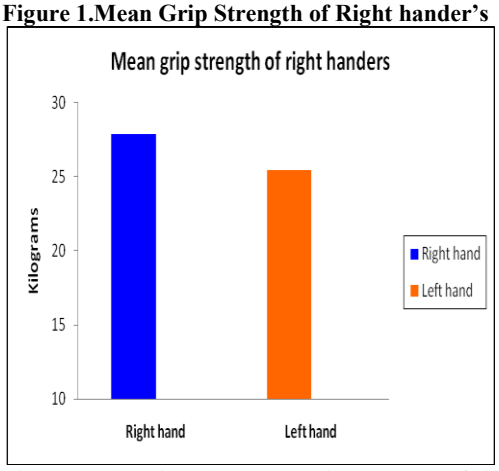

Figure1. Showing the mean grip strength of right hander's in which Mean±SD of Right hand was 27.86±6.66.Whereas,for left hand it was 25.46±6.46.Here,p < 0.05(Significant)

Figure 2.Mean Grip Strength of Left hander's

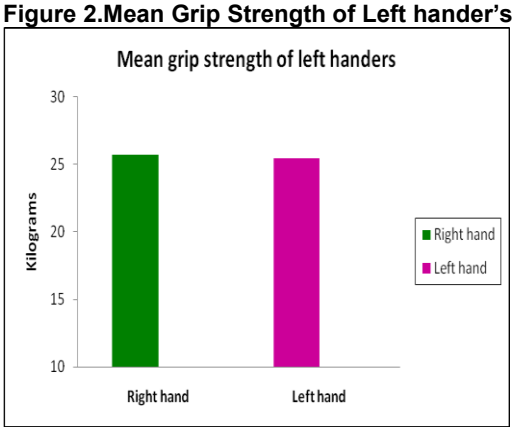

Figure 2. Showing the mean grip strength of Left hander's in which Mean±SD of Right hand was 25.73±4.25.Whereas,for left hand it was 25.46±4.20.Here, p > 0.05(Not significant)

Figure 3. Mean Pain Pressure Threshold of Right hander's

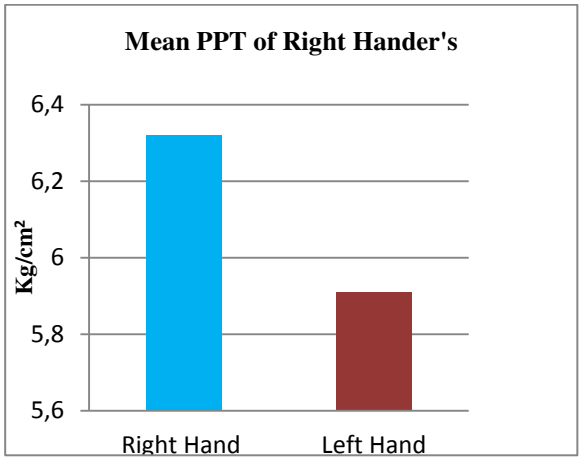

Figure 3. Showing the mean pain pressure threshold of Right hander's in which Mean±SD of Right hand was 6.32±0.704.Whereas,for left hand it was 5.91 ± 0.670.Here, p <0.05(Significant)

Figure 4. Mean Pain Pressure Threshold of Left hander's

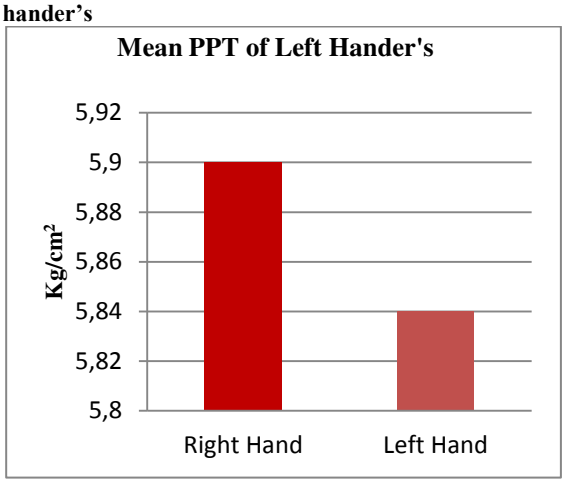

Figure 4. Showing the mean pain pressure threshold of Left hander's in which Mean±SD of Right hand was 5.90±0.328.Whereas,for left hand it was 5.84 ± 0.379.Here, p >0.05(Not Significant)

Figure 5. Showing mean pinch strength of right hander's.

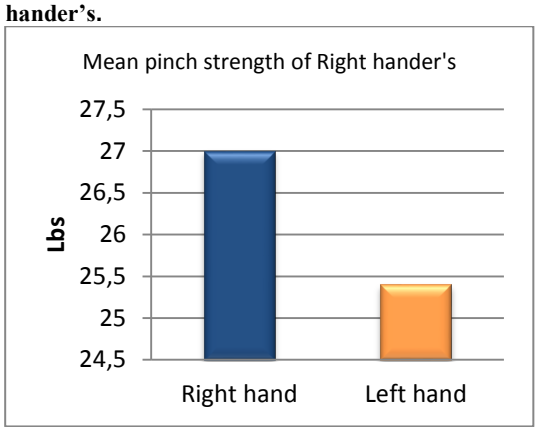

Figure 5. Showing the mean pinch strength of Right hander's in which Mean±SD of Right hand

was 27.0±4.2.Whereas,for left hand it was 25.4 ± 2.9.Here, p <0.05(Significant)

Figure 6. Mean showing mean pinch strength of Lefthander's

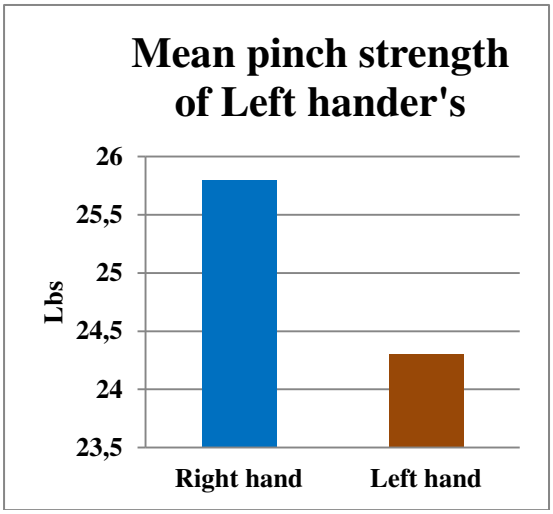

Figure 6.Showing the mean pinch strength of Left hander's in which Mean±SD of Right hand was 25.8±2.6.Wheras,for the left hand it was 24.3±2.6.Here,p>0.05(Not significant)

Figure 7.Showing mean pain pressure threshold of dominant hands.

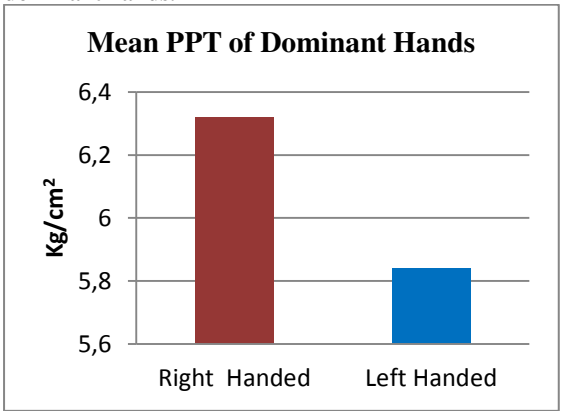

Figure 7. Showing the mean pain pressure threshold of Dominant hands in which Mean±SD of Right hand was 6.32±0.704.Whereas,for left hand it was 5.84 ± 0.379.Here, p >0.05(Not Significant)

Figure 8.Showing mean grip strength of dominant hands.

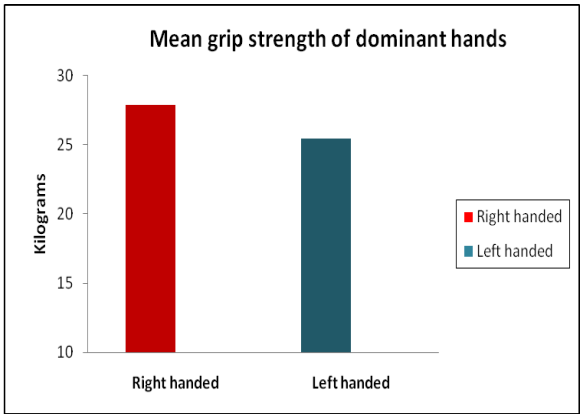

Figure 8. Showing the mean grip strength of dominant hands in which Mean±SD of Right hand was 27.86±6.66.Whereas,for left hand it was 25.46 ± 4.20.Here, p >0.05(Not Significant)

Figure 9.Showing mean pinch strength of dominant hands.

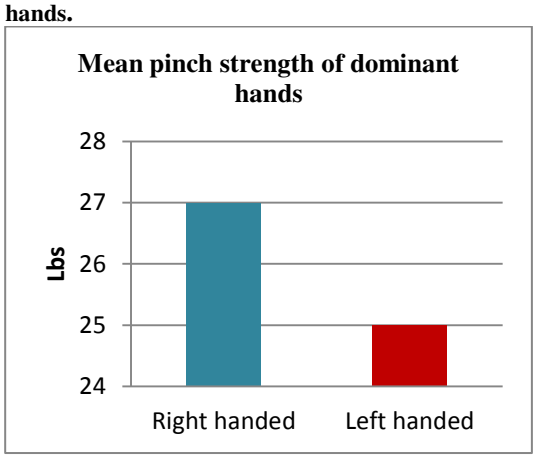

Figure 9. Showing the mean pinch strength of dominant hands in which Mean±SD of Righthanded was 27.04 ±4.2.Whereas,for left hand it was 25.4±2.9.Here,p>0.05(Not significant)

Table1.Showing mean pain pressure threshold of non-dominant hands.

	Right hand Mean ± SD	**Left hand Mean ± SD**	**Unpaired "t" test**
PPT(Kgs/ cm^2)	5.91± 0.670	5.90 ±0.328	Not Significant (p > 0.05)

Table 2. Showing mean grip strength of non-dominant hands.

	Right hand Mean ± SD	**Left hand Mean ± SD**	**Unpaired "t" test**
Grip Strength (Kgs)	25.73 ± 4.25	25.46 ± 4.20	Not Significant (p > 0.05)

Table 3. Showing mean pinch strength of non-dominant hands

	Right hand Mean ± SD	Left hand Mean ± SD	Unpaired "t" test
Pinch Strength (lbs)	26.8±2.6	25.3±2.6	Not Significant ($p > 0.05$)

4. Discussion

The superior performance of the preferred hand over the non-preferred hand in most tasks has been documented extensively. In particular, the preferred hand is faster and more accurate than the non-preferred one. This superiority has been attributed to cerebral laterality. Rationale of assessing was to identify which differences are "typical" and obtain reliable measurements of these would provide useful baseline performance values. These could be

applied in both the diagnosis and treatment of impaired hand function [1,3,5].

The loss of the sensibility of pain and proprio-receptors caused by sarcopenia, decreases the speed and quality of nervous propagation. Recently, some studies have reported that in elderly participants, molecular, cellular, nutritional and hormonal mechanisms are at the basis of sarcopenia and are responsible for a progressive deterioration in skeletal muscle size and function. For whole muscle, in addition to changes in neural drive, alterations in muscle architecture and in tendon mechanical properties, exemplified by a reduction in tendon stiffness, have been shown to contribute to this reduced pain threshold in older participants [2].

Hand grip is an important component of human function. It involves grasping of objects between any two surface of the hand [1]. And it is a unique feature in human and primates. It enables human to perform activities ranging from fine motor activities to carrying heavy loads and manipulating objects. In older population grip strength is used for evaluation of chances of fall, fracture, bone mineral density and function of skeletal muscle [3,7].

It is a simple measure which is easy to perform and is less time consuming but provides valuable information regarding health and disability in elderly. Grip and pinch strength test are easy to understand by patients with demonstration. These tests do not cause any harm to the patient and it indicates the functional status and strength of the entire upper limb and also any motor and neurological deficits. As these deficits are common in elderly a measure of hand grip strength will help to evaluate and quantify the gradual progression of neurological and motor conditions.[15]

Remarkably lower grip strength (31% to 52%) in older participants might be due to the muscle weakness, which was caused by the diseases (arthritis or stroke).Some studies suggested that decreased muscle strength of the upper and lower extremities as well as trunk has been repeatedly reported in arthritis patients. The percentage of decrease in strength might depend on the degree of severity of the abnormality. Studies reported that arthritis caused a 90% decrease in grip strength compared to healthy persons. [3,15]

In addition to that the physically strong persons usually perform more physical work than the older adults. The relative disuse of muscles in older persons might cause atrophy of the same. Other workers also showed that the patients with osteoarthritis had muscle weakness and possessed lower grip strength than that of normal participants. Gender is another important factor which showed a large difference in grip strength among the participant . Also found considerable differences in hand-grip strength between young male and female adults. The male participants of the present study possessed appreciably greater grip strength (28% to 39%) than that of the female participants both in cases of older adults. The gender difference in hand grip strength was likely due to higher levels of androgenic hormones, greater muscle mass and greater height and weight in boys and men. Further, the activity level might be another factor related to the gender difference in grip strength [7,15,16].

Assessing the manual performance using parameters (hand grip strength, pain pressure threshold and pinch grip) in dominant and non-dominant hands of self-reported right- and left-handers, and comparing within and between these groups. [1,2]. The results showed clear PPT asymmetry in the right-handed participants, whereas no such finding was observed in the left-handed group. It was noted higher sensitivity in the non-dominant hands of right-handed participants, but no PPT asymmetry in the left-handed group [12].

The dominant and non-dominant hand strength in both right- and left-handed participants was compared. The grip strength was reported to be higher in dominant hand with right handed participants, but no such significant differences between sides could be documented for left handed people. As they tend to use their dominant hand in the day to day activity compared to non dominant hand which does not contribute to much force generation in daily activity [2].

Inter-group comparisons revealed no significant differences between the dominant hands of right- and left-handed participants with respect to grip strength , pain pressure threshold and pinch grip. However, the dominant hands of the right-handed participants were significantly faster than the dominant hands of the left-handed participants. These results may be partially explained by left-handed people living in a world designed for right-handers. This requires a left-handed person to use the right (non-dominant) hand for many tasks that would naturally be done by the dominant hand of right-handers [13].

Understanding the extent of manual performance asymmetry is very important in many respects. In this study, right-handers exhibited dominant hand superiority in grip strength whereas left-handers showed no such differences. It was also observed asymmetry of pain sensitivity in the right-handed group but not the left-handed group. Defining and quantifying such dominant hand differences in specific tasks is important as a baseline for diagnosing and treating hand injuries [7,11,12].

5. Conclusion

PPT, grip strength and pinch strength of the dominant hand of right handed person is greater than compared to Left handed. PPT, grip strength and pinch grip strength are independent of dominance of participant between these three groups.

6. Acknowledgement

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