International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Effect of Varying Carrying Angle on Grip Strength in Normal Young Individuals

Manisha R Patel[1], Shaswat Verma[2]

[1]Lecturer, Dept of Physiotherapy, DR, B R Ambedkar Medical College, Bangalore.
[2]Assistant professor, Dept of Physiotherapy, Ramaiah Medical College, Bangalore.

Corresponding Author: Manisha R Patel

ABSTRACT

Background: The elbow joint is a loose hinge joint. Carrying angle of the elbow is a clinical measure of varus-valgus angulation of the arm with the elbow fully extended and forearm fully supinated. Generally, carrying angle is more in women than in men secondary to sex characteristics. Increase or decrease in the carrying angle can have the stretching effect on the muscular origin at the elbow i.e. common flexor and extensor origin. This may have an effect on grip strength. Grip strength is an integrated performance of muscles that can be produced in one muscular contraction. Grip strength provides an objective index of the functional integrity of upper extremity.

Objectives:

- To measure carrying angle in normal individuals.
- To check the grip strength in normal individuals.
- To find the correlation between carrying angle and grip strength.

Methods: 200 subjects of the age 18-30 years were included in the study that satisfied the inclusion criteria. Carrying angle was measured by digital goniometer in standing (anatomical) position. Grip strength was measured by hand held dynamometer with the patient sitting on a chair, shoulder in a neutral position, elbow in 90 degree flexion and forearm in mid prone position. Other parameters such as forearm length, height and hand span were also measured. Forearm length was measured by measuring tape in centimeter. Height was measured by stature meter in centimeter. Hand span was measured by the scale in centimeter.

Data Analysis: Correlation between right and left side carrying angle and grip strength was done by using Spearman's correlation test.

Result: There was a negative correlation between carrying angle and grip strength of both right and left side with the r value of -0.494 and -0.551 respectively and 0.01 was the p-value.

Conclusion: This study concluded that as carrying angle increases, the grip strength decreases and vice versa.

Keywords: Carrying angle, Grip strength, Hand-held dynamometer, Digital goniometer, Elbow joint.

INTRODUCTION

The elbow joint is considered as a compound joint which functions as a loose hinge joint. It is formed by lower part of the humerus and upper part of radius and ulna. At the elbow, one degree of freedom is

possible that occurs in the sagittal plane around a coronal axis. The joint has two articulations; a) Humero-radial which is between capitulum of humerus and radial head. b) Humero-ulna which is between trochlea of the humerus and trochlear notch of ulna. [1] Fischer noted that the center of the rotation of the elbow was a very small locus of points near the center of the trochlea. This was confirmed by three-dimensional analysis done by Marrey and Chao et al. However, the concept of a single axis hinged joint has been challenged by Ewald, who theorized that the elbow joint has a constantly changing center of rotation during flexion and extension motion. [2]

Measurement of the angle between the arm and forearm was first done by Potter [3] which was called carrying angle. The carrying angle of the elbow is a clinical measure of varus-valgus angulation of the arm with the elbow fully extended and the forearm fully supinated. [4] The axis of the elbow joint is set obliquely at nearly 84 degree of both the humerus and ulna. This is caused by the obliquity of trochlea to the shaft of the humerus. Kapandji [5] suggest that the angle is formed as a result of the trochlear groove being vertical anteriorly but on the posterior aspect it runs obliquely distally and laterally.

In the frontal plane, the angulation is caused by the configuration of the articulating surfaces at humero ulna joint. The medial aspect of trochlea extends more distally than does the lateral aspect, which shifts the medial aspect of the ulna trochlea notch more distally and results in a lateral deviation of the ulna in relation to the humerus. This normal valgus angulation is called the carrying angle. [6] Carrying angle is neutralized when the forearm is pronated and elbow is in flexion from supinated or extended position. [7] The carrying angle apparently develops in response to pronation of forearm and keeps the swinging upper extremity away from the side of the pelvis during walking. [8]

As a general view, this angle is accepted as a secondary sex characteristic. [3] In most studies, it was shown to be greater in women than in men. [9,10,11] But carrying angle is more in male in the age group of 3-5 years. [8] The average value of carrying angle is 10^0 in male and 13^0 in a female in adults. On the other hand, a study states the average value of carrying angle in male 12.5±0.57 degrees and 15.26±0.45 degrees in female. [8]

The increase in carrying angle may lead to elbow instability and pain during exercise or in throwing activities. [12] Wider carrying angle may reduce the function of elbow flexion, predispose to risk of elbow dislocation. [13] There is increase evidence of elbow fracture when falling on the outstretched hand and fracture of the distal humeral epiphysis in subjects with wider carrying angle. [14]

Carrying angle is measured by universal goniometer or digital goniometer with an elbow in extension and forearm in supination. [15] Digital goniometer has a better validity and reliability compare to universal goniometer. Researcher believed real time display added clinical usability to the devise while reducing reading errors. [16]

The increase in carrying angle, in turn, increases the stretch on long finger flexors near its origin whereas; decrease in carrying angle generates the pull on the common extensor tendons which acts as stabilizers during the grip. Hence, it might affect the grip strength of that particular extremity if there is a variation in the carrying angle. [17]

Many daily functions and sporting events require high activity levels of the flexor musculature of the forearm and hands like flexor carpi radialis, palmaris longus, flexor digitorum profundus, flexor digitorum superficialis, flexor policus longus and brevis. Each of these muscles is active during gripping activity. [17]

Grip strength is often used in medicine as a specific type of hand strength. Many factors influence the strength of the grip, including muscle strength, fatigue, time of the day, age, nutritional status, joint range of motion and pain. [18] Grip strength

is the integrated performances of muscles that can be produced in one muscular contraction. It is widely accepted that grip strength provides an objective index of the functional integrity of upper extremity. [19]

The purpose of testing grip strength is diverse, which include evaluating and comparing treatments, to diagnose disease, to document the progression of muscle strength. It can be used as a measure of fatigue. People are generally limited by their strength when exerting force. Strength is a muscle's capacity to exert maximal effort or resist maximal opposing force. [18]

The American Society of Hand Therapists recommended standardized positioning for grip strength measurement which is patient in sitting position with shoulder adducted and neutrally rotated, elbow flexed at 90^0, forearm and wrist in neutral position. However, Pryce found no significant difference in grip strength with different positions of the wrist joint. De S Sengupta [18] notes that grip strength values are more in standing than any other positions of the body posture.

A variety of instruments are available to measure grip strength. The Jamar dynamometer is recommended as the best measure of grip strength as it perfected to the extent that its sealed hydraulic system is as nearly leak proof as any mechanical appliance can be made. ASHT recommended that the second handle position of the dynamometer be used when evaluating grip strength and the mean of three successive trials be used as the measure of grip strength. [20]

There are several studies which correlate shoulder and elbow angles with grip strength, but scarce studies which correlate carrying angle and grip strength. Hence, the present study aimed at correlating the effects of varying carrying angle on grip strength in normal young individuals.

MATERIALS AND METHODS

Study design:
Cross-sectional study

Sample size:
200 which was calculated based on the study conducted by Jyothinath Kothapalli, et al, it was found that correlation between carrying angle and grip strength was found to be -0.3. In the present study, the sample size was calculated based on power (99%) and α error (5%)].

Sampling technique:
Convenience sampling

Source of data:
Students and employees of Ramaiah Institution, Bangalore.

Inclusion criteria:
- Age: 18 to 30 years.
- Gender: Male and Female.
- Asymptomatic individuals.

Exclusion criteria:
- Pathology around elbow and wrist joints.
- Median, Ulnar and/or Radial nerve palsy.
- Fractures around shoulder, elbow and wrist joints.
- Cervical radiculopathy.

Material used:
- Digital goniometer
- Hand-held dynamometer
- Measuring tape
- Scale

Procedure for data collection:
An ethical clearance was obtained from the ethical committee of Ramaiah Medical College. Subjects who satisfied the inclusion criteria were included in the study. The purpose of the study was explained and informed consent was obtained from subjects. A brief assessment of upper extremity was taken prior to study.

The carrying angle was measured by digital goniometer in standing position with the upper extremity to be measured should be in anatomical position. The arms of the goniometer were kept in straight line and

the goniometer's axis placed at fulcrum (midline of elbow joint) of the elbow. The fixed arm of the goniometer was aligned with the middle of the subject's upper arm. The movable arm of the goniometer was moved along until it lined up along the middle of subject's forearm.

The other parameters such as height, weight, and length of the forearm were also recorded. Grip strength was measured by hand held dynamometer with the subject sitting on a chair, arm unsupported, shoulder in a neutral position, elbow at 90^0 of flexion and forearm in mid prone position. Each subject was instructed to exert their maximum grip strength for 5 seconds. [4] The measurement was repeated 3 times and best of those three values was considered. The length of the forearm was measured from medial epicondyle of the humerus to styloid process of ulna by measuring tape. [3] Hand span was measured in both hands at the maximal width and by measuring the distance separating distal extremes of the first and fifth digits. [9] These measurements were done for both dominant as well as the non-dominant side of the hand. Height was measured by stature meter, from vertex to heel of the individual with barefoot in anatomical position.

Picture 1: Materials required in the study.

Picture 2: Measurement of right CA.

Picture 3: Measurement of left CA.

Picture 4: Measurement of left GS.

Picture 5: Measurement of right GS.

Statistical Analysis:

It was done by using spearman's correlation test.

RESULT

Correlation between carrying angle and grip strength was performed by using SPSS software of version 20. The carrying angle and grip strength showed great variability between the genders at a different age. The data was not distributed normally hence spearman's correlation test was used to analyze the data. Median of the all the category data is shown in tables below.

Table 1: median of demographic data.

	Median
Age	26 years
Height	162 cm
Weight	59.50 kgs

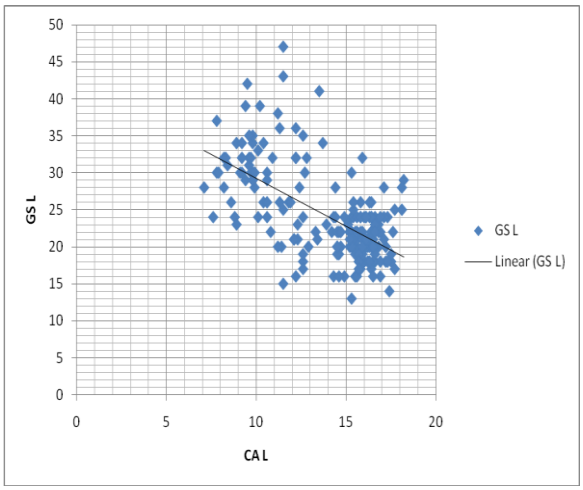
Table 2: median of carrying angle, grip strength and other data.

Contents	Median
Carrying angle (right)	14.9 degree
Carrying angle (left)	15.3 degree
Grip strength (right)	24 kgs
Grip strength (left)	22 kgs
Forearm length (right)	25.5 cm
Forearm length (left)	25.4 cm
Hand span (right)	19.2 cm
Hand span (left)	19.5 cm

Table 3: Spearman's correlation test result.

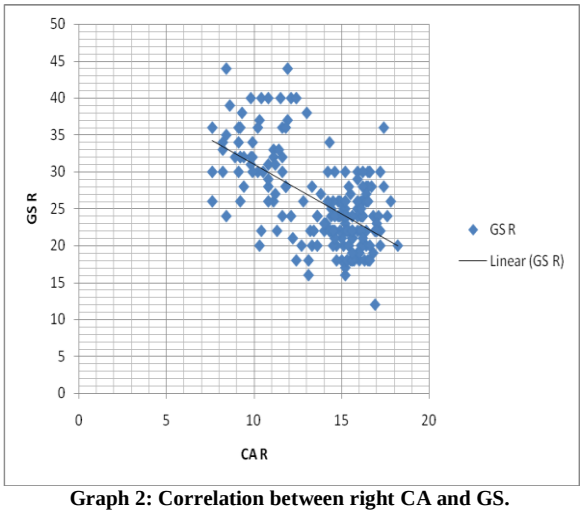
	r value	p value
CA and GS (right)	-0.494	0.01
CA and GS (left)	-0.551	0.01

There is a negative correlation between carrying angle and grip strength of both the sides with the significant value of 0.01. Hence, as the carrying angle increases, grip strength decreases.



Graph 1: Correlation between left CA and GS.

This graph shows a negative correlation of left side carrying angle and grip strength.



Graph 2: Correlation between right CA and GS.

This graph shows a negative correlation between right carrying angle and grip strength.

DISCUSSION

The present study aimed to correlate carrying angle and grip strength in a normal young individual. The result suggests that there is a negative correlation between carrying angle and grip strength which means as the carrying angle increases, grip

strength decreases. This result can be attributed to active insufficiency which states that the muscles which are incapable of producing full action simultaneously at all joints on which they act are said to be actively insufficient. There are three types of insufficiency: Active, Passive and Tonic. [21] Passive insufficiency means that the relaxed muscle cannot allow a full range of reverse movements in all joints under its control. Active insufficiency implies that such a muscle cannot contract to such an extent that maximum range of movement in every joint on which it acts would be possible. Tonic insufficiency means that muscular tension interferes with joint movement. Haines offered the correct basis for understanding the insufficiency of muscles passing over several joints. According to him, muscles acting on more than one joint have short fibers and therefore a smaller range of contraction in comparison with muscles acting only on one joint. [21] Hence, when carrying angle increases, there will be minimal change in length of forearm muscles, mainly from its origin. Previous studies have correlated grip strength with shoulder and elbow angles. However, according to Jason Shea, [17] increase in carrying angle increases the stretch on long finger flexors near its origin. Hence, carrying angle does affect the grip strength. The synergistic action of flexors and extensors muscles and the interplay of the muscle groups is an important factor in strength of the resulting grip. [22] Variation of body joint angles had some effects on grip strength. Mathiowetz et al studied the effect of elbow position on grip strength and found it to be higher with the 90^0 of elbow flexion. [18]

In the present study, there was an incidental finding about the correlation of forearm length and hand span with the grip strength. Forearm length and grip strength had a positive correlation which tells that grip strength increases with forearm length. There was a positive correlation between hand span and grip strength as well. This can be attributed to the study done by Radwin which states that hand span affects the grip strength, grip force, and exertion level. [23] Also Incel et al reported that the hand grip strength is to be higher in dominant hand with right-handed subjects, but no such significant differences between sides could be documented for left-handed people. [18]

However, there was a positive correlation between carrying angle and grip strength in females and negative among males. The reason for including demographic components in the current study is that grip strength can be influenced by multiple variables, not only age, sex, hand dominance and employment but also by height, weight, hand length, etc.

In the current study, carrying angle in female was observed to be more than to male. Potter was the first one to carry out an investigation on the variation of carrying angle in male and female. His observation was the same. [24] Median of grip strength in the female for the right side is 22kg and for left side 21kg which is less than normal values of grip strength in this age group as compared to the normative ranges. Median in men for the right and the left side was 32kg and 30kg respectively which were again reduced as compared to normative data. [25]

Limitations of the present study are following:

1. Subjects included were young individuals; hence results can not apply to children, older adults and older age group populations.
2. Sample size was less in the study.

CONCLUSION

With the negative correlation between carrying angle and grip strength, it was proved that grip strength decreases with increased carrying angle and vice versa. Other factors such as forearm length and hand span showed a positive correlation with the grip strength.

REFERENCES

1. SoumedhikDey, Lopamudra Mandal, BananiKundra, MaitrayeeMondal, Tridib Kumar Sett. Carrying angle of the Elbow: Its change from childhood toadulthood: morphometric study in Eastern India. Indian journal of basic and applied medical research; Sept 2013: issue-8, vol-2, p. 823-830
2. An KN, Morrey BF, Chao EY. Carrying angle of the human elbow joint. Journal of orthopaedic research. 1983 Jan 1;1(4):369-78.
3. Sönmez M, Tattemur Y, Karacan K, Erdal M. The relationship between the carrying angle and the distal extent of the 2nd and 4th fingertips. Folia morphologica. 2012 Aug 31;71(3):173-2.
4. Nwagbo G. Ikechukwu, Emuobo Harrison and Febresima Okocha. A study of carrying angle of an adult Nigerian population. African Journal of Internal Medicine ISSN 2326-7283 Vol. 3 (10), pp. 301-303 November, 2015.
5. Keats TC, Teeslink R, Diamond AE, Williams JH (1996). Normal axial relationship of major joints. Radioilogy 87:904-907
6. Levangie PK, Norkin CC. Joint structure and function: a comprehensive analysis. FA Davis; 2011 Mar 9.
7. Sharma K, Mansur DI, Khanal K, Haque MK. Variation of carrying angle with age, sex, height and special reference to side. Kathmandu University Medical Journal. 2015 Sep 23;11(4):315-8.
8. Lim V, Jacob NA, Ghani MF, Wang DL, Devi KA. An anthropometric study on the carrying angle of elbow among young adults of various ethinicities in Malaysia. Natl J Integr Res Med. 2014 Nov 1;5:20-3.
9. Atkinson WB, Elftman H. The carrying angle of the human arm as a secondary sex character. The Anatomical Record. 1945 Jan 1;91(1):49-52.
10. Purkait R, Chandra H. An anthropometric investigation into the probable cause of formation of 'carrying angle': a sex indicator. Journal of Indian academy of forensic medicine. 2004;26(1):14-9.
11. Yilmaz E, Karakurt L, Belhan O, Bulut M, Serin E, Avci M. Variation of carrying angle with age, sex, and special reference to side. Orthopedics. 2005 Nov 1;28(11):1360-3.
12. Cain EL, Dugas JR, Wolf RS, Andrews JR. Elbow injuries in throwing athletes a current concepts review. The American journal of sports medicine. 2003 Jul 1;31(4):621-35.
13. Habernek H, Ortner F. The influence of anatomic factors in elbow joint dislocation. Clinical orthopaedics and related research. 1992 Jan 1;274:226-30.
14. Khare GN, Goel SC, Saraf SK, Singh GA, Mohanty C. New observations on carrying angle. Indian journal of medical sciences. 1999 Feb;53(2):61-7.
15. Rajesh B, Reshma VR, Jacne RC, Somasekhar IT, Vaithilingam. An evaluation of the carrying angle of the elbow joint in adolescents. Int. journal Med Biomed Res 2013; 2(3): 221-225.
16. Carey MA, Laird DE, Murray KA, Stevenson JR. Reliability, validity, and clinical usability of a digital goniometer. Work. 2010 Jan 1;36(1):55-66.
17. Jason Shea C.S.C.S. The importance of grip strength. 2005; 1-8.
18. De S, Sengupta P, Maity P, Pal A, Dhara PC. Effect of body posture on hand grip strength in adult Bengalee population. Journal of Exercise Science and Physiotherapy. 2011 Dec;7(2):79.
19. Parvatikar VB, Mukkannavar PB. Comparative study of grip strength in different positions of shoulder and elbow with wrist in neutral and extension positions. Journal of Exercise Science and Physiotherapy. 2009 Dec;5(2):67.
20. Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of grip and pinch strength evaluations. The Journal of hand surgery. 1984 Mar 1;9(2):222-6.

21. Lewit K, Čihák R, Lepšíková M. Insufficiency of finger flexors and extensors and its importance for hand function: A clinical and electromyographic investigation. International Musculoskeletal Medicine. 2015 Oct 2;37(4):178-83.
22. Mukkannavar PB, Mohanty U. A Comparative Study of Left and Right Hand Grip Strength in Different Positions of Shoulder and Elbow. Indian Journal of. 2011 Oct;5(4):150.
23. Ruiz JR, España-Romero V, Ortega FB, Sjöström M, Castillo MJ, Gutierrez A. Hand span influences optimal grip span in male and female teenagers. The Journal of hand surgery. 2006 Oct 31;31(8):1367-72.
24. Ruparelia S, Patel S, Zalawadia A, Shah S, Patel SV. Study of carrying angle and its correlation with various parameters. NJIRM; Vol. 1(3). July-Sept. 2010. 28-32
25. Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S. Grip and pinch strength: normative data for adults. Arch Phys Med Rehabil. 1985 Feb 2;66(2):69-74.

How to cite this article: Patel MR, Verma S. Effect of varying carrying angle on grip strength in normal young individuals. Int J Health Sci Res. 2018; 8(8):159-166.

******