

Comparative Study of Goniometric and Radiographic Carrying Angle in Human

Amit Kumar Srivastava¹, Sohel Solanki²

^{1,2}Lecturer, Department of Anatomy, Shekhulhind Maulana Mehmood Hasan, (Govt.) Medical College Saharanpur, U.P India

Abstract: **Background:** The Carrying Angle of the elbow is defined as the angle between the long axis of the extended forearm as it lies lateral to the long axis of the arm. It may change with skeletal growth. Clinically carrying angle increases with age up to 15 years, after which there was a slight decrease in the angles. **Aims:** To measure obliquity of fore arm on arm (carrying angle). This is done in both the aspects; the radiological aspects as well as the living objects **Materials and Methods:** The present study consists of 250 living objects and 40 radiographs. All these objects are been carefully taken with normal elbow and any deformity, neuropathy, any fractured condition of the elbow is been excluded from study **Conclusion:** The carrying angle is significantly greater in females than in males, so it can be considered as a secondary sex character. The recorded measurements might be helpful in management of disorders of the elbow and its reconstruction after fractures. Moreover, the proposed method in this study is simple, easy and accurate as it alleviates the effect of any deviation of long bones of the arm and forearm in the measurements. Therefore, it measures the actual angulations at the elbow.

Keywords: Carrying angle, Goniometer, Radiograph

1. Introduction

The Carrying Angle of the elbow is defined as the angle between the long axis of the extended forearm as it lies lateral to the long axis of the arm. It may change with skeletal growth. Range of motion of the elbow and carrying angle increase with age to skeletal maturity.

Clinically carrying angle increases with age up to 15 years, after which there was a slight decrease in the angles. Potter (1895)^[1] was the first to carry out a quantitative investigation on the carrying angle in man i.e., the angle of obliquity between the upper arm and the fully extended and supinated forearm. The obliquity of the forearm is more pronounced in women than in men. However, the line of the upper arm and forearm becomes straightened out when the forearm is in the usual working position of almost full pronation (McMinn, 1994)^[2]. The carrying angle permits the forearms to clear the hips in swinging movements during walking and important when carrying objects (Chen, 2007)^[3]. Snell (2004)^[4] recorded angle measurements of 170° and 167° for males and females, respectively. The difference in the carrying angle between male and female and considering it as a secondary sex character as well as its role in the sex determination are long debated issues in anatomy and anthropology researches (Khare et al., 1999)^[5], Purkait and Chandra, 2004^[6]. The main reasons for this controversy are differences in the definition of the angle and the variations in the measuring methods (Zampagni et al., 2008a)^[7]. The role of carrying angle in the sex determination & its cause of formation is a long debated issue in Anatomy & Anthropology.

Anatomically, the carrying angle in human adults is approximately 10° in men and 13° in women. Increasing the carrying angle may lead to elbow instability and pain during exercise or in throwing activities of sports, may reduce function of elbow flexion, predispose to risk of elbow dislocation, and increase evidence of elbow fracture when

falling on the outstretched hand and fracture of the distal humeral epiphysis Entrapment neuropathy of the ulnar nerve at the elbow has been reported in patients with elbow deformities, including cubitus varus after supracondylar humeral fracture. The carrying angle may also be defined as the acute angle made by the median axis of the arm and that of fully extended & supinated forearm & thus it measures the lateral obliquity of the forearm.

2. Material and Methods

Present study consists of 250 living objects and 40 radiographs. All these objects are been carefully taken with normal elbow and any deformity, neuropathy, any fractured condition of the elbow is been excluded from study. These objects are the patients attending o.p.d. of Teerthanker Mahaveer Medical College & Research centre and hospital, Moradabad U.P.,

The Standard Deviation (S.D) for both the aspects is as follows;

$$\text{Mean} = \frac{\sum X}{n} \dots \dots \dots \text{Equation 1}$$

$\sum X$ = Sum of observations

n = total no. of observations

$$\text{S.D. } (\sigma) = \sqrt{\frac{\sum (X-X)^2}{n}} \dots \dots \dots \text{Equation 2}$$

S.D. = Estimated Standard Deviation

n = Number of observation

X-X = Deviation of each value from arithmetic mean

Measurements were taken using:-

Goniometer, Radiographs, Measuring scale and Protractor . Carrying angle was investigated by an improvised goniometer of which fixed arm is placed on median axis of arm and movable arm is placed on median axis of forearm and angle is been calculated on goniometer. Bicipital groove, biceps brachii tendon and Palmaris longus tendon are conceded as anatomical landmark to identify the median axis of arm and forearm respectively (fig.1). While for radiographic carrying angle is measured by the help of

protractor. It was measured between a line passing through the mid-axis of the lower third of humerus and a line along the mid-axis of the upper third of forearm between radius and ulna on the anteroposterior view.

The two lines were extended to meet at the mid-point of Trans-Epicondylar Distance (TECD). The line of mid-axis of forearm was taken to pass from the point midway between the radius and ulna in the upper third of forearm to the mid-point of trans-epicondylar distance, passing through the superior radio-ulnar joint(fig.2).

3. Result

We summarize the means and standard deviations of the carrying angle in living objects. The result showing in (Table-1).

Table 1: Sowing carrying angle in living
 Carrying Angle in Living

	Male		Female	
	Right	Left	Right	Left
Mean	11.21	10.69	14.80	14.27
S. D.	2.63	2.86	2.31	2.65

And also summarize the means and standard deviations of carrying angle in radiographs. The result shown below (Table-2).

Table 2: showing radiological carrying angle

	Radio graphical Carrying Angle			
	Male		Female	
	Right	Left	Right	Left
Mean	12.95	10.75	18	16.05
S. D.	1.93	2.14	1.21	1.39

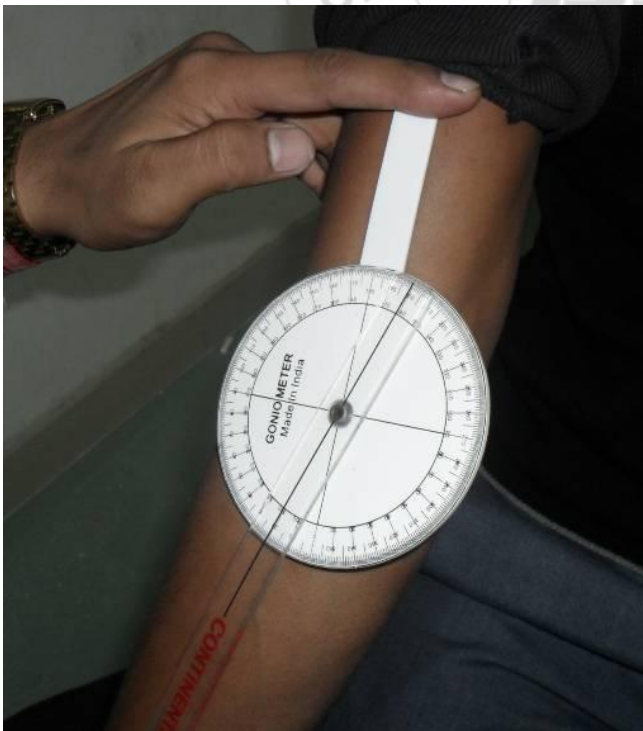


Figure 1: Showing the observation of normal carrying angle

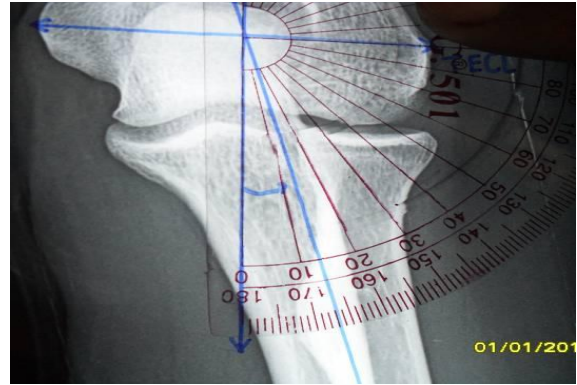


Figure 2: Showing observation of radiological carrying angle.

4. Discussion

Carrying Angle in living persons is been assessed with previous studies which are as follows Braune and Kyrklund et al. 1879 found a mean carrying angle of 166.64 (16°) in 11 anatomical preparations.

Von Mikulicz et al. [1879]- found a mean carrying angle of 164 (17°) in 20 upper limbs of cadavers (after extraction of the muscles). The range of the carrying angle was 157–178(5-24°). Potter et al. (1895) - observed that the carrying angle in women (mean 167.35) (16°) than in men (mean 173.17) (9°).

C.Hubscher et al.[1899]- found that in girls aged 13–17 years the range of the carrying angle was 165–170(10-15°), while in adult women the range was 155–165(5-15°).

Atkinson et al. [1945] - reported a mean carrying angle of 165.6(15.6°) in men and 163.8(18°) in women. G. Harbauer et al. [1958]- found a mean of 167.7(12°) in men and 165.9(15°) in women. Bernardo Barcellos Terra; Bruno Costa Mello Silva et al (2009) - The mean value of the carrying angle was 12.78° ± 5.35 for the females and 11.20° ± 4.45 for the males in the population studied. Mohammad omar alsubael and abdelmonem awad m. Hegazy, (2010).- In males, it ranged from 5° to 17° with a mean of 9.29±2.98°, while in females it ranged from 10° to 27° with a mean of 18.47±4.12°. Bernardo barcellos terra, bruno costa mello silva, henrique bella et al. (2011)- The average of the elbow carrying angle was 12. 78 ± 5.35° for females and 11. 20 ± 4. 45° for males Terra BB, Silva BCM, Carvalho HBF, Dobashi ET, Pinto JA, Ishida A. (2011)- The average of the elbow carrying angle was 12.78 ± 5.35° for females and 11.20 ± 4.45° males; whereas in present studies we found the carrying angle in men right mean ± S.D. 11.21±2.63 and left mean ± S.D 10.68±2.86° while in female right mean ± S.D. 14.79±2.31° and left mean ± S.D. 14.27±2.65°. While In respect with Radio graphical Carrying Angle of persons is been assessed with previous studies which are as follows Punia RS et al.(1994)- conducted study on 50 males and 50 females from Northern States of India using radiographs, according to them mean carrying angle was 164.40(15°) in males and 162.860(17°) in females. Shetty S(2004)-conducted study using radiographs on 52 subjects in South India and found that mean carrying angle in the left upper

limb in males was 158.90(22°) and in females 158.70(21.70°) with the mean difference of 0.2. In right upper limb, mean angle in males was 160.50(20°) and in females it was 160.20(20°) with the mean difference of 0.3. B. Kumar, shakunthala pai, biswabina ray, snigdha mishra, siddaraju k s, a. K. Pandey, binu s (2010)- Among 54 radiographs examined, the mean carrying angle in males was 17.023±1.93° and in females 17.77 ±2.13° whereas in present studies we found the radiographical carrying angle in men right mean ± S.D. 12.95±1.93° and in left mean ± S.D. 10.75±2.14 while in female radiographical carrying right mean ± S.D 18±1.21° and in left mean ± S.D 16.05±1.39°

5. Conclusion

To conclude, carrying angle study reveals that difference between right and left hand the mean value in male 11.21° & 10.69° and S.D. value 2.63° & 2.86°(Table no.) respectively and in female the mean value in right and left hand 14.80° & 14.27° & S.D. value 2.31° & 2.65° respectively is same as previous study^[16,25,26]. While the mean value of radiological carrying angle in right and left hand 12.95° & 10.75° and S.D. value 1.93° & 2.14° respectively and in female in right and left hand 18° & 16.05° and S.D. value 1.21° & 1.39° respectively is same as previous study.^[27]

References

- [1] Potter HP (1895) The obliquity of the arm of the female in extension. *J Anat Physiol* 29:488–491
- [2] McMinn, R.M.H., 1994. *Lasts Anatomy Regional and Applied*. 9th Edn., Churchill Livingstone, London, ISBN: 0-443-04903-3, pp: 53-143.
- [3] Chen, A.L., 2007. Carrying angle of the elbow-excessive-Overview. University of Maryland, Medical Center. <http://www.umm.edu/ency/article/002316.htm>.
- [4] Snell, R.S., 2004. *Clinical Anatomy*. 7th Edn., Lippincott Williams and Wilkins, New York, London, ISBN: 0-7817-4315-X, pp: 455-590.
- [5] Khare, G.N. and S.K. Rai, 1998. Carrying angle in boys and girls of eastern part of India. *Ind. J. Orthop.*, 32:7-14.
- [6] Purkait, R. and H. Chandra, 2004. An anthropometric investigation into the probable cause of formation of carrying angle: A sex indicator. *JIAFM*, 26:14-19.
- [7] Zampagni, M.L., D. Casino, S. Martelli A. Visani and M. Marcacci, 2008. A protocol for clinical evaluation of the carrying angle of the elbow by anatomic landmarks. *J. Should Elbow Surg.*, 17: 106-112.
- [8] Braune W, Kyrklund (1879) Cubitus valgus. *Arch Anat Physiol*
- [9] Mikulicz J von (1879) Cubitus valgus. *Arch Klin Chir* 29:767
- [10] Hu" bscher C (1899) Der Ellbogenwinkel. *Dtsch Z Chir* 53:445
- [11] Mall FP (1905) On the angle of the elbow. *Am J Anat* 4:391– 404
- [12] Fischer E (1906) Der Armwinkel. *Z Morphol Anthropol* 9:147
- [13] Fick R (1911) *Handbuch der Anatomie und Mechanik der Gelenke*. Fischer, Jena
- [14] Atkinson W, Elftman H (1945) The carrying angle of the human arm as a secondary sex character. *Anat Rec* 91:49–52
- [15] Aebi H (1947) *Der Ellbogenwinkel, seine Beziehungen zu Geschlecht, Ko" rperbau und Hu" ftbreite*. Thesis, University of Basle
- [16] Harbauer G (1958) Beitrag zur Statistik des Armwinkels und Beobachtungen u" ber die Mechanik des Ellenbogengelenkes. *Anat Anz* 105:241
- [17] Steel F, Tomlinson J (1958) The "carrying angle" in man. *J Anat* 92:315–317
- [18] Morrey B, Chao E (1976) Passive motion of the elbow joint. A biomechanical analysis. *J Bone Joint Surg* 58:501–508
- [19] Chao E, Morrey B (1978) Three-dimensional rotation of the elbow. *J Biomech* 11:57–73 Youm Y, Oryer R, Thambyrajah K, Flatt A, Sprague B (1979)
- [20] Biomechanical analyses of forearm pronation-supination and elbow flexion-extension. *J Biomech* 12:245–255
- London J (1981) Kinematics of the elbow. *J Bone Joint Surg Am* 63:529–535
- [21] Shiba R, Sorbie C, Siu D, Bryant T, Cooke T, Wevers H (1988) Geometry of the humeroulnar joint. *J Orthop Res* 6:897–906
- [22] Habernek H, Ortner F (1992) The influence of anatomic factors in elbow joint dislocation. *Clin Orthop* 274:226–230
- [23] Minn R (1990) *Last_s Anatomy, regional and applied*, 8th edn. Churchill Livingstone, Edinburgh, pp 84–85
- [24] Nicholas J, Hershman E (1995) *The upper extremity in sports medicine*, 2nd edn. Mosby, St. Louis
- [25] Terra BB, Silva BCM, Carvalho HBF, Dobashi ET, Pinto JA, Ishida A. Evolution of the carrying angle of the elbow: a clinical and radiographic study. *Acta Ortop Bras.*[online]. 2011;19(2):79-82
- [26] Paraskevas G, Papadopoulos A, Papaziogas B, Spanidou S, Argiriadou H, Gigis J, et al. Study of the carrying angle of the human elbow joint in full extension: a morphometric analysis. *Surg Radiol Anat* 2004;26:19-23.
- [27] Punia Rs, Sharma R, Usmani Ja, The carrying angle in an Indian population, *J Anat Soc India*, 1994, 43(2):107–110
- [28] Shetty S, Carrying angle of human upper limb: a radiographic study, *Anatomica Karnataka*, 2004, 1(5):85–89.

Author Profile



Amit Kumar Srivastava did his MSc. Medical Anatomy from Teerthanker Mahaveer Medical college, Moradabad, U.P and Presently he is working as Lecturer in Department of Anatomy at Govt. Medical College, Saharanpur, U.P.



Soheli Solanki did his B.H.M.S. from J.R.N.R.V. Homeopathic Medical College Udaipur, Rajasthan and MSc. Medical Anatomy from Teerthanker Mahaveer Medical college, Moradabad, U.P and Presently he is working as Lecturer in Department of Anatomy at Govt. Medical College, Saharanpur, U.P.