



## ORIGINAL RESEARCH PAPER

Anatomy

### CORRELATION STUDY OF CARRYING ANGLE IN CENTRAL RAJASTHAN WITH HAND DOMINANCE, CORELATION WITH WAIST HIP RATIO

KEY WORDS:

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#### ABSTRACT

Carrying angle is produced as a result of the configuration of trochlea of humerus and coronoid process of ulna. When the upper extremity is in the anatomic position, the long axis of the humerus and the long axis of the ulna form an acute angle medially at the elbow which is called the carrying angle [02]. This angle is marginally greater in female than in male. The knowledge of carrying angle is highly significant in the management of various types of fractures of the elbow. **AIMS AND OBJECTIVES** The present study will discuss the following aspects: 1. To estimate the gender dominant handedness difference in the carrying angle of males and females. 2. To study variation in carrying angle with waist to hip ratio. **MATERIAL AND METHOD** The sample size for study is 500. The carrying angle of both the limbs was measured while keeping the elbow completely extended. The angle was measured in three trials and then the average of the three trials was taken as the final carrying angle. **Results-** Carrying angle found in female is To conclude, carrying angle study of 500 individuals 289 males and 211 females mean carrying angle of right side in males is  $10.05 \pm 1.28$  and in females is  $14.06 \pm 1.96$ . On left side carrying angle in males and females are  $9.21 \pm 1.29$  and  $13.27 \pm 2.02$  respectively. Average of both sides in males and females are  $9.63 \pm 1.25$  and  $13.67 \pm 1.97$  respectively.

#### Introduction

Apes and humans are distinguished from other primate species in possessing carrying angle at the elbow. The evolution of carrying angle in apes is related to the need to bring the centre of mass of the body beneath the supporting hand during suspensory locomotion as seen in lower limbs of humans in which the valgus knee brings the foot nearer the centre of mass of the body during the single limb support phase of walking [01].

#### Brief anatomy of the elbow joint [02]

The elbow is a complex synovial joint formed by the articulations of the humerus, the radius and the ulna. The elbow joint is made up of three articulations Radio-humeral: capitellum of the humerus with the radial head Ulno-humeral: trochlea of the humerus with the trochlear notch (with separate olecranon and coronoid process articular facets) of the ulna Radioulnar: radial head with the radial notch of the ulna (proximal radioulnar joint) In full flexion, the coronoid process is received by the coronoid fossa and the radial head is received by the radial fossa on the anterior surface of the humerus. [03] In full extension, the olecranon process is received by the olecranon fossa on the posterior aspect of the humerus.

#### Movements

The elbow is a trochoginglymoid (combination hinge and pivot) joint.

I. The hinge component (allowing flexion-extension) is formed by the ulno-humeral articulation

II. The pivot component (allowing pronation-supination) is formed by the radio-humeral articulation and the proximal radioulnar joint.

#### Joint capsule

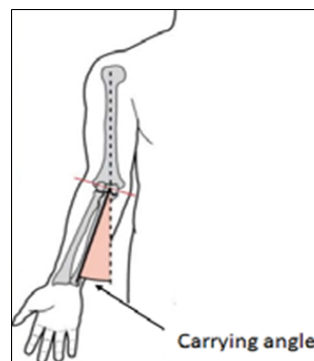
The joint capsule has two layers, deep and superficial, and attaches proximally to the radial, coronoid and olecranon fossae. Distally, it attaches to the annular ligament of the radius and coronoid process of the ulna. The volume of the joint capsule is 24–30 mL.

#### Carrying Angle

Carrying angle is produced as a result of the configuration of trochlea of humerus and coronoid process of ulna. Medial flange of trochlea is 6 mm deeper than lateral flange. Superior

articular surface of coronoid process of ulna is oblique to the long axis of ulna. These two factors produce normal valgus angulation between arm and forearm. Carrying angle disappears in full flexion and during pronation. Carrying angle permits the arm to swing without contacting hip. Women on average have wider pelvis hence Carrying angle is more in females. Dominant limb in both sexes have more Carrying angle than non-dominant limb suggesting that natural forces acting on elbow modify the Carrying angle.

When the upper extremity is in the anatomic position, the long axis of the humerus and the long axis of the ulna form an acute angle medially at the elbow which is called the carrying angle [02]. This angle is marginally greater in female than in male. The average angle in men is about  $5^\circ$  whereas in women it is about  $10^\circ$  to  $15^\circ$  ( $170^\circ$  in males and  $163^\circ$  -  $167^\circ$  laterally) [02]. This angle is important in walking, swinging, and carrying objects. The angle is greater in the dominant limb than in the non-dominant limb of both sexes, suggesting that natural forces acting on the elbow modify the carrying angle. [41, 45] Developmental, ageing and possibly racial influences add further to the variability of this parameter. [8, 10, 14] An increase in the carrying angle is abnormal, particularly if it occurs unilaterally. If the angle is increased beyond the average, it is called cubitus valgus. [11, 15] The knowledge of carrying angle is highly significant in the management of various types of fractures of the elbow. [15]



Knowledge of measurement of carrying angle of the elbow and its variations is important when evaluating traumatic elbow injuries in childhood and in adolescence and other

elbow disorders that require reconstruction arthroplasties<sup>[22]</sup>. The type of fracture a child sustains after fall on outstretched hand is also determined by the value of the carrying angle.

The increase in carrying angle may lead to elbow instability and pain during exercise or in throwing activities<sup>[24]</sup>. Wider carrying angle may reduce the function of elbow flexion, predispose to risk of elbow dislocation<sup>[25]</sup>. 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<sup>[26]</sup>.

It is well documented that the women on an average have smaller shoulders and wider hips than men, which may be one reason for more acute carrying angle in them. This intersex disproportionate nature of the carrying angle is popular among researchers and is regarded as one of the promising secondary sexual characteristic<sup>[24]</sup>. Furthermore, the clinical anatomy of the carrying angle is related to handling and monitoring of traumatic lesions that affect the paediatric elbow, increased carrying angle may lead to elbow instability, pain during exercise, reduce elbow flexion, dislocation and fractures. It is also important anthropologically for sex differentiation in skeletal remains and reduction of fractures complication of supracondylar fracture and may result in cosmetic deformity and for designing total elbow prosthesis<sup>[28]</sup>.

Hence, the present study aimed to determine the basal values of the clinical carrying angle in specific age groups and to study the difference in carrying angle between genders (i.e., Male and female) and to find out any correlation of carrying angle with different parameters like dominance, waist circumference, hip circumference and waist circumference and hip circumference ratio.

The results of the study may be useful to orthopaedic surgeons for correction of cubitus Varus deformity occurring after malunited supracondylar fracture of humerus.

## AIMS AND OBJECTIVES

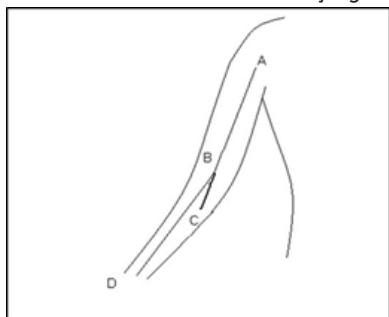
The present study will discuss the following aspects:

1. To estimate the gender dominant handedness difference in the carrying angle of males and females.
2. To study variation in carrying angle with waist to hip ratio.

## MATERIAL AND METHODS

The present study was conducted in the department of Anatomy, J.L.N. Medical College, Ajmer. The inclusion criteria were age group from 15 to 35 years of either sex. Individuals with history of fractures or other pathology around the elbow and shoulder joint and with any congenital condition of elbow and shoulder were excluded from the study. The sample size for study is 500.

Carrying Angle - The carrying angle of both the limbs was measured while keeping the elbow completely extended. The angle was measured in three trials and then the average of the three trials was taken as the final carrying angle.



An improvised instrument Goniometer was used for measurement of carrying angle. The fixed arm of which could

be placed on the median axis of the upper arm, the movable arm adjusted as to lie on the median axis of forearm & the angle read on the goniometer. Bicipital groove, biceps brachii tendon at its insertion and palmaris longus tendon at the wrist were palpated and marked as anatomical landmarks to demarcate the median axes of the arm and the forearm respectively.

**Waist circumference (in centimetres):** This measurement was carried out with the subject standing erect, both feet together and abdomen relaxed. The waist circumference was then read at the end of gentle exhaling and recorded to the nearest 0.1 cms.

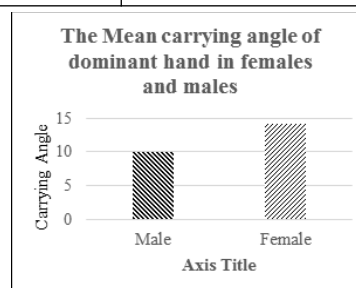
**Hip circumference (in centimetres):** This was measured over the maximal protrusion of the buttocks and took my reading around the trunk at the greatest protrusion of the buttocks to the nearest 0.1 centimetre

## Observations

Distribution according to gender	
Male	289
Female	211
Total	500

Distribution according to carrying angle elbow in degree									
	Right			Left			Average		
	Both (Male & Female)	Male	Female	Both (Male & Female)	Male	Female	Both (Male & Female)	Male	Female
Mean	11.74	10.05	14.06	10.93	9.21	13.27	11.34	9.63	13.67
Median	11.00	10.00	14.00	10.00	9.00	13.00	10.50	9.50	13.50
SD	2.55	1.28	1.96	2.59	1.29	2.02	2.55	1.25	1.97
Minimum	5.00	5.00	6.00	5.00	5.00	7.00	5.00	5.00	6.50
Maximum	18.00	12.00	18.00	17.00	12.00	17.00	17.50	11.50	17.50
Range in Degree	Both (Male & Female)	Male	Female	Both (Male & Female)	Male	Female	Both (Male & Female)	Male	Female
4-6	11	10	1	23	23	0	9	9	0
6-8	17	17	0	15	6	9	18	17	1
8-10	165	156	9	242	236	6	156	147	9
10-12	121	106	15	76	24	52	130	116	14
12-14	116	0	116	87	0	87	111	0	111
14-16	48	0	48	43	0	43	48	0	48
16-18	22	0	22	14	0	14	28	0	28
Total	500	289	211	500	289	211	500	289	211

The Mean carrying angle of dominant hand in females and males	
Gender	Carrying Angle ( in degree )
Male	10.00346
Female	12.48095



Average angle values Distribution according to sex and dominance of the limb

Gender	Dominant Arm (degrees)			Non Dominant Arm (degrees)		
	Mean	±	SD	Mean	±	SD

Male	10.00	±	1.32	9.26	± 1.28
Female	14.17	±	1.96	13.17	± 1.97

## Discussion

The carrying angle, which is found even in utero and is completely developed in a new-born is an outward angulation of the supinated forearm with the elbow extended<sup>[90]</sup> It exhibits considerable individual variation. Comparisons for the carrying angle should be made with the contralateral side rather than with any "normal standard<sup>[91]</sup>." The broad shoulders and narrow hips of the males, allow the arms to hang straight downwards with the long axis of the upper and lower segment approximately in the same straight line. Whereas in the females, the narrower shoulders and broader hips require a splaying out of the forearm axis in order that the hanging arms clear the hips.

In the present study, of the 500 individuals are included mean carrying angle on right side was  $11.74 \pm 2.55$  and on left side was  $10.93 \pm 2.59$ . The mean carrying angle in females and males was  $14.06 \pm 1.96$ ,  $10.05 \pm 1.28$  on right side and  $13.27 \pm 2.02$ ,  $9.21 \pm 1.29$  on left side respectively. The difference between males and females carrying angle was statistically significant ( $p < 0.05$ ).

Paraskevas G *et al.*,<sup>[21]</sup> studied carrying angle in 600 living individuals from Greece, aged 18–28 years. They measured supplementary angle using goniometer. In the age group of 19–28 years, carrying angle was significantly greater in females. Carrying angle was  $12.23 \pm 0.30$  in males and  $15.77 \pm 0.410$  in females.

Steel FLD and Tomlinson JDW<sup>[10]</sup> investigated the left upper limb of 100 European adults using radiographs to measure carrying angle and obtained no statistically significant difference (males  $19.280$  and females  $18.380$ ).

According to Khare GN *et al.*,<sup>[26]</sup> the carrying angle does not help in keeping the forearm away from the side of pelvis during walking as during walk the forearm is pronated and carrying angle disappears in pronation of forearm. They found that carrying angle is inversely related to the height of a person, since the average height of females is lesser than the average height of males so average carrying angle is greater in females than males.

## Clinical significance of carrying angle

Knowledge about measurement of carrying angle and its variation is important during evaluation of traumatic elbow injuries and other elbow disorders that requiring reconstruction or arthroplasty<sup>[59]</sup>.

Therefore, present study was performed to estimate the gender dominant handedness difference in the carrying angle of young adult population of India.

## Summary & Conclusion

Carrying angle found in female is To conclude, carrying angle study of 500 individuals 289 males and 211 females mean carrying angle of right side in males is  $10.05 \pm 1.28$  and in females is  $14.06 \pm 1.96$ . On left side carrying angle in males and females are  $9.21 \pm 1.29$  and  $13.27 \pm 2.02$  respectively. Average of both sides in males and females are  $9.63 \pm 1.25$  and  $13.67 \pm 1.97$  respectively.

According to the study, the carrying angle of the females ranked higher than males and that of the dominant arm was found to be significantly higher than the non-dominant arm in both sexes. Greater carrying angle in female is considered as secondary sex characteristic. This study demonstrated that age, sex, waist circumference, hip circumference, waist to hip circumference ratio and dominant side are important factors that affect the value of the carrying angle.

This study will assist the orthopaedic surgeons and

manufacturers preparing for elbow replacement implants. Our observation of carrying angle can be used to assess traumatic elbow injuries and as an adjunct to identification of skeletal remains in forensic practice in this population.

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