Study Of Carrying Angle And Its Correlation With Various Parameters

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Abstract: The role of carrying angle in the sex determination and its cause of formation is a long debated issue in Anatomy and Anthropology. Most studies have focused on the question of cause of formation of carrying angle, difference in sex and age but little attention has been given to correlate the carrying angle with various parameters. Hence, an effort has been made to find out correlation of carrying angle with height, and length of forearm. For present study, total 333 (173 female & 160 male) asymptomatic, healthy students of Nursing School, Homeopathic Medical College, Ayurvedic College and Medical College belonging to various regions of Gujarat were selected. There ages ranged between 17 to 22 years. An improvised instrument goniometer was used for measurement of carrying angle. Height was measured in standing, erect, anatomical position from vertex to heel with bare foot. Vernier caliper of 12" was used to measure the length of forearm. According to the present study, height and length of forearm of the person are inversely related with the carrying angle. Greater carrying angle in female is considered as secondary sex characteristic. Knowledge of the carrying angle helps in paediatric elbow surgery. It also helps orthopedic surgeon for correction of cubitus varus deformity occurring after malunited supracondylar fracture of humerus.

Key words: Carrying angle, height, length of forearm, puberty

INTRODUCTION: The carrying angle is 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. The role of carrying angle in the sex determination & its cause of formation is a long debated issue in Anatomy & Anthropology.

According to Mall[1] the axis of the elbow joint is set obliquely at nearly 84° of both the humerus & ulna which is also agreed upon by Jones[2]. Langer[3] was of the opinion that the obliquity of trochlea to the shaft of the humerus is the cause. Kapandji[4] explained that the angle is formed as a result of trochlear groove being vertical anteriorly but on the posterior aspect it runs obliquely distally & laterally. This results in formation of carrying angle in extension when posterior aspect of the oblique groove makes contact with the trochlear notch of ulna & the angle is marked during flexion when trochlear notch lies on the vertical groove in the anterior aspect. Last[5] suggested is that in the ulna a curved ridge joins the prominence of the coronoid & olecranon process which fits the groove in the trochlea of the humerus. The obliquity of the shaft of ulna to this ridge accounts for most of the carrying angle at elbow. Decker[6] gave the same reason pointing out that the inner lip of trochlea of humerus is a ridge (groove) which is much deeper distally anteriorly so that ulna (with the forearm) is deflected in full extension by this ridge. William et al[7] considered the medial edge of trochlea of humerus party responsible as it projects nearly 6 mm below the lateral edge & the obliquity of the superior articular surface of the coronoid process which is not set at right angle to the shaft of ulna.

Most studies have focused on the question of cause of formation of carrying angle, difference in sex and age but little attention has been given to correlate the carrying angle with various parameters. Hence, an effort has been made to find out correlation of carrying angle with Height, and length of forearm.

MATERIAL & METHODS: In present study total 333 (173 female & 160 male) asymptomatic, healthy students of Nursing School, Homeopathy College, Ayurvedic College and Medical College belonging to various regions of Gujarat were selected. There ages ranged

between 17 to 22 years. Medical & paramedical students of this age group were selected as subject because of easy availability.

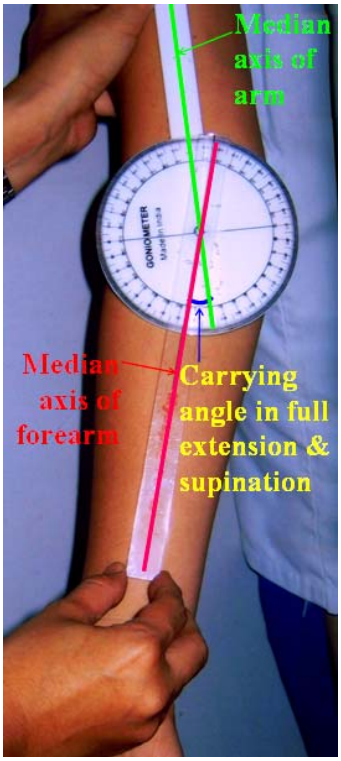

Figure-1 Shows carrying angle measurement

An improvised instrument goniometer is 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 & palmaris longus tendon at the wrist were palpated & marked as anatomical landmarks to demarcate the median axes of the arm & the forearm respectively. Measurement of carrying angle was taken on the left side as well as on the right side to find out difference on both sides if any (Figure-1). Stature meter is used to measure the height. Height was measured in standing, erect, anatomical position from vertex to hill with bare foot. Vernier calliper of 12" is used to measure the length of forearm. Medial epicondyle & styloid process of the ulna are used as landmark. Distance between these two points is recorded as length of forearm (length of ulna).

All the parameters were measured in centimetres except the carrying angle was measured in degree. Three consecutive readings were taken and the mean was recorded.

OBSERVATION & RESULTS: Cross sectional study of 333 was conducted at medial college, Bhavnagar. Out of them 173 students are female & 160 students are male. Obtained data are shown in Table-1 and 2.

Table-1 Shows values in range mean and standard deviation of carrying angle, length of forearm and height

Sex	Side	Measurement					
		Carrying Angle (in degree)		Length of forearm (in cm)		Height (in cm)	
		Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Male	Right	5-11	6.90±1.25	19-27	22.70±1.21	150-177	166.87±5.28
	Left		6.78±1.38		22.69±1.22		
Female	Right	6-18	11.85±2.27	20-28	24.96±1.30	140-173	153.94±5.84

DISCUSSION: A study of Carrying angle and its value in relation to the age has been carried out by many workers. Most other studies have focused on the question of carrying angle difference in sex. Potter[8], Atkinson & Elftman[13] and R Purkait & H Chardra[14] started that the carrying angle is greater in females than in males & this difference has been considered to be a secondary sex characteristics. The present study deals with the observation on carrying angle and its correlation with height and length of forearm.

Table-2 Shows comparison of average carrying angle in male and female by workers and present study

Study by	Carrying angle – Male	Carrying angle – Female
Potter[8]	6.83°	12.65°
Baughman et al[9]	11.0°	15.0°
J Rai et al[10]	13.26°	17.91°
Keats et al[11]	11.0°	13.0°
G. N. Khare[12]	13.56°	16.92°
Present Study	6.9°	11.8°

Table-1 shows values in range, mean and standard deviation of the carrying angle, length of forearm and height. The average carrying angle of male is 6.9° and of female is 11.8° in present study. Results obtained in present study are quiet comparable with results of other workers study.

Results obtained by Potter[8] and present study are almost similar. From the above study we have observed that the carrying angle in female is greater than male. In the present study 63.3 percent of female height ranges between 150–160 cm, average 153.9 cm, where as major population among male students (61.3%) height vary form 160 – 170 cm, average 166.8 cm.

Average Right forearm length is 24.96 cm in male and 22.70 cm in female whereas on the left side this value is 24.96 cm in male and 22.68 cm in female. Difference of the length of forearm of right and left side is statistically insignificant, whereas difference in the length of forearm in the male and female is statistically significant. From the present study, it is observed that the height and forearm length both are more in males than females. In contrast to this average carrying angle is more in females than males. We have proposed a new explanation for greater carrying angle in females than in males. When the forearm is pronated the proximal part angulates. The medial part of the trochlear notch moves more away from the humeral articular surface than the lateral part. Therefore the medial flange of trochlea is not compressed & grows more than lateral flange.

If the height of a person & therefore length of ulna is lesser, then because of shorter lever arm, the proximal end has to angulate more in order to bring the hand in pronated position for routine work. Therefore in a shorter person the medial part of trochlear notch of ulna goes more away from the medial flange of trochlea which can now grow more than in a person with longer forearm, leading to greater carrying angle.

The carrying angle develops in response to the pronation & is dependent on the length of the forearm bones greater the length of the forearm bone lesser is the angulation of proximal articulation of proximal articular surface, therefore lesser is the carrying angle (Figure-2). From the present study it is clear that the height & length of the forearm are directly related to each other. Length of the forearm in female is 22.7 cm on right side and 22.6 cm on left side where as in male this value is 24.9 cm on both sides which is inversely related to the carrying angle (Figure-3).

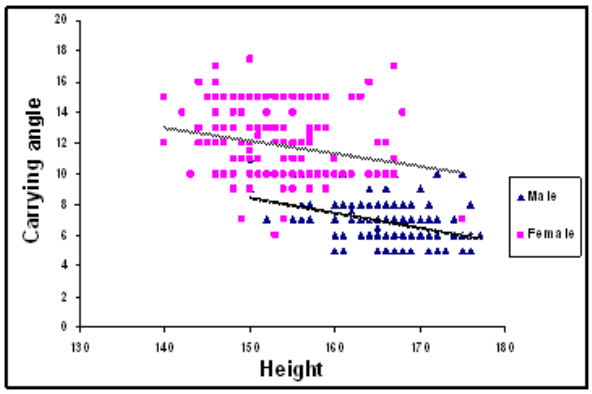

Figure-2 Scattered diagram showing correlation between height and carrying angle

Olecranon-coronoid angle exhibiting high sexual dimorphism may be one of the causes of sexual dimorphism observed in carrying

angle. Distal part of the humerus particularly trochlea & proximal part of the ulna play major role in the causation of carrying angle.

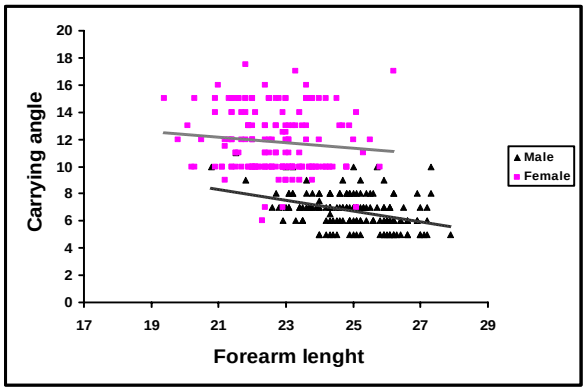

Figure-3 Scattered diagram showing correlation between forearm length and carrying angle

Carrying angle helps in keeping the forearm away from the side of the pelvis when the upper limb swing during walking is also wrong. The carrying angle is only formed when the forearm is fully supinated & extended at elbow. It disappears in pronation or flexion at elbow. Therefore if the carrying angle is not present & does not help in any way in keeping the forearm away from the side of the pelvis during walking. Present study has no data to compare the obtained results. It may be considered as secondary sex characteristics in female because according to the study of some workers there is no difference in the carrying angle in male & female up to the puberty. But in the female, it is increased after puberty.

CONCLUSION: According to the present Study, Height of the person is inversely related with the carrying angle. Average height of female is 153.9 cm and in male it is 166.8 cm. There is significant difference between male & female carrying angle, in female it is 11.8 degree and in male it is 6.9 degree. Greater carrying angle in female is considered as secondary sex characteristic. From the present study it is clear that the height & length of the forearm are directly related to each other. Length of the forearm in female is 22.7 cm on right side and 22.6 cm on left side where as in male this value is 24.9 cm on both sides which is inversely related to the carrying angle. It may be considered as secondary sex characteristics in female because according to the study of some workers there is no difference in the carrying angle in male & female up to the puberty. But in the female, it is increased after puberty.

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