



The Correlative Study Of Carrying Angle And Height Of Body Among Male Population Of Rajasthan

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Article History	Abstract
<p>Received- 15.11.2023 Revised - 1.12.2023 Acceptance- 3.1.2024</p>	<p>Carrying angle is defined as the angle formed by the axis of the arm and the forearm when the elbow is completely extended. It varies between sexes, ages, races and could also show changes with various morphological features.</p> <p>Aim and objectives: To study correlation of degrees of carrying angle and height of body in male sex of RUHS-CMS Students.</p> <p>Materials & Methods: In this cross sectional study, carrying angle of 246 healthy male students of RUHS-CMS, Jaipur between 17- 35 year of age were evaluated. The correlation between carrying angle and height of participants were also done. Carrying angle (in degree) is measured by a manual goniometer with two drawing axes of the arm and forearm in anatomical position at point of measurement. The axis of arm is defined by the lateral border of the cranial surface of the acromion to the midpoint of the lateral and medial epicondyles of the humerus. Standard deviation, t-tests, P- values and correlations were obtained. A p-value $0.05 < P < 0.10$ was considered suggestive significant and p-value $P \leq 0.001$ was considered highly significant.</p> <p>Observation and Result: In the present cross sectional study, the mean bilateral range of 17, 18, 19 and 20-35 years of age participants were $9.91^\circ - 12.39^\circ$, $12.77^\circ - 14.66^\circ$, $13.80^\circ - 13.60^\circ$ and $8.18^\circ - 8.64^\circ$ respectively. The left side of 18 year of age participant's angle was greater and on the right side 19 year of age participant's angle was greater. Bilateral significant difference was observed for the height, right carrying angle (RCA) and left Carrying angle (LCA) (p- value ≤ 0.05). The mean values of RCA and LCA were almost equal without any significant difference while the 17 and 20-35 years of age group found significant differences.</p> <p>Conclusion: The use of simple method to measure carrying angle adopted in this study makes the researcher to recommend it to be used in the actual future researches and clinical practice. Also, the values obtained here might be useful in the management of elbow disorders and the significant difference between females and males might be used in forensic medicine as a basis for sex discrimination.</p>
<p>CC License CC-BY-NC-SA 4.0</p>	<p>Keywords: Angle, Acromian, Gonio, LCA, RCA</p>

Introduction:

Carrying angle is defined as the angle formed by the axis of the arm and the forearm when the elbow is completely extended. It varies between sexes, ages, races and could also show changes with various morphological features [1]. This angle can be measured in vitro by several methods such as use of goniometer, x-rays, Computerized-Tomography(CT) Scan, Magnetic Resonance Imaging (MRI) etc, but few authors accomplish this measurement in vivo [2]. In the anatomical position, it is noted that the upper arm and the forearm do not lie in the same plane, the medial border of the forearm cannot come in contact with the lateral surface of the thigh because it is angled laterally [3]. This lateral deviation of the forearm at the elbow is caused by the trochlea it presents at the lower end of humerus. The carrying angle is caused partly by the medial flange of trochlea edge, about 6mm beyond its lateral edge and partly by the obliquity of the superior articular surface of the coronoid which is not orthogonal to the shaft of the ulna [3]. But get masked by pronation of the extended forearm. The value of carrying angle might vary between the sexes as well as presence with different height. However, when the arm is extended in the anatomical position, the longitudinal axis of the upper arm and forearm form a lateral (valgus) angle at the elbow joint which is the angle of deviation (approximately 50 in males and between 100 and 150 in females) on the medial side [4]. The level of the elbow joint is situated 2cm below a line joining the two epicondyles. Which slopes downward and medially from its lateral extremity and this obliquity produces another angle on the lateral side of the elbow which is also regarded as the carrying angle by many authors [5, 6]. This angle is approximately examined on 165 degrees in the female and 175 degrees in the male [3]. These two angles however disappear on full flexion of the elbow, when the shafts of the ulna and humerus come to lie in the same plane, and is also obscured in full pronation of the forearm. The difference in the carrying angle in male of various age groups is a long debated issue in anatomy and anthropology [7, 8]. Several studies showed variability in carrying angle among different age group of both sexes. Snell [9] obtained carrying angle of 170 degrees and 167 degrees for males and females, respectively. Variability is expected because of the variability of the measurement methods.

Carrying angle apparently develops in response to supination of the forearm and keeps the swinging upper extremity away from the side of the pelvis during walking [10]. Degrees of carrying angle may vary in both the sexes, between 163-175 degrees towards the body. If it is more when measured away from the body it is called as cubitus valgus and if less, it is Cubitus varus [11]. But studies have been mentioned that there is a gradual increase in the carrying angle with skeletal maturation. A more recent study concluded that carrying angle is a suitable secondary sexual characteristic for the individual. The olecranon-coronoid angle shows high sexual dimorphism and it may be one of the causes of sexual difference observed in carrying angle.

The increased carrying angle may lead to elbow instability and pain during exercise due to dislocation, fracture while fall on outstretched hand, and fracture of distal humeral epiphysis an keeping their in mind, attempt has been made to correlate the height of male sexes with degrees of carrying angle in right and left elbows. Fractures or epicondylar diseases, elbow reconstruction can be done efficiently by orthopaedic surgeon. Knowledge of normal degree of carrying angle is a must for radiologist but also for surgeons especially orthopaedicians.

Importance of the study- Knowledge of carrying angle is of considerable importance in clinical Medicine, Anatomy, Surgery (Orthopaedics and Paediatrics units in particular). It is equally relevant in Rehabilitation and Sports medicine. It is related to the type of fractures likely to be sustained especially among the younger population (infants, children, and young adults) e.g. supracondylar fractures are common in children (Park et al., 2003). The type of fracture a child sustains after a fall on outstretched arm is determined by the value of the carrying angle (Park et al., 2003). Hence, this study could help in establishing carrying angle value in this environment which could be relevant in future in establishing any association between carrying angle and pattern of fracture. It is also useful in the management of elbow disorders

Method:

In this cross sectional study, carrying angle of 246 healthy male students of RUHS-CMS, Jaipur between 17-35 year of age were evaluated. The correlation between carrying angle and height of participants were also done.

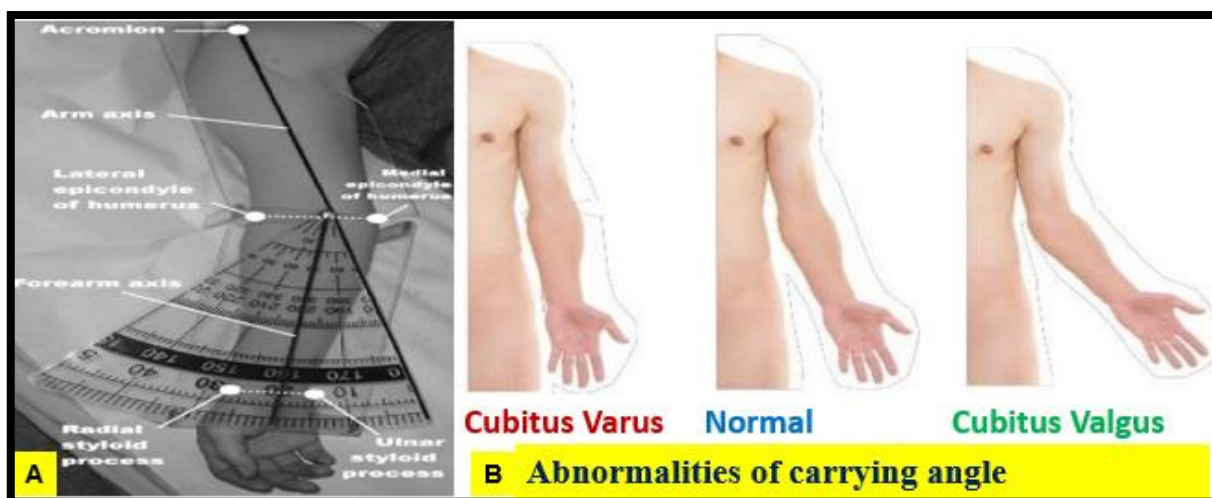
Inclusion criteria: Only healthy male students from 17-35 year of age were included as study participants.

Exclusion criteria: Participants with a history or clinical evidence of fracture of the upper limb bone(s), dislocation on injury to the elbow or any congenital conditions were excluded from the study.

Methodology:

Carrying angle (in degree) is measured by a manual goniometer with two drawing axes of the arm and forearm in anatomical position at point of measurement. The axis of arm is defined by the lateral border of the cranial surface of the acromion to the midpoint of the lateral and medial epicondyles of the humerus. The axis of forearm is defined by the Carrying angle is measured by a manual goniometer with two drawing axes of the arm and midpoint of the lateral and medial epicondyles of the humerus to the midpoint of the distal radial and ulnar styloid processes [12]. Using goniometer is straightforward. first, line up the fulcrum with the subject joint crease between the medial and lateral epicondyles of humerus. Next line up the stationary arm of goniometer along the axis of arm. Moving arm of goniometer is adjusted along the axis of forearm. Now angle is measured. At the same time height was measured in meters from vertex to heel with bare feet. Each side was measured three times and average to reduce bias error.

Statistical analysis: Microsoft-Excel, Microsoft Disk Operating System and SPSS (version 15) were used for the statistical data analysis. Standard deviation, P- values and correlations were obtained. A p-value $0.05 < P < 0.10$ was considered suggestive significant and p-value $P \leq 0.001$ was considered highly significant



Table/Fig 1: A. Manual goniometer with two drawing axes of the arm and forearm in anatomical position at point of measurement, B. various abnormalities of carrying angle

Observation and Result:

In the present cross sectional study, the mean bilateral range of 17, 18, 19 and 20-35 years of age participants were $9.91^\circ - 12.39^\circ$, $12.77^\circ - 14.66^\circ$, $13.80^\circ - 13.60^\circ$ and $8.18^\circ - 8.64^\circ$ respectively. The left side of 18 year of age participant's angle was greater and on the right side 19 year of age participant's angle was greater. Bilateral significant difference was observed for the height, right carrying angle (RCA) and left Carrying angle (LCA) (p - value ≤ 0.05). The mean values of RCA and LCA were almost equal without any significant difference while the 17 and 20-35 years of age group found significant differences. The descriptive analysis for all parameters of heights and right & left carrying has been displayed in Table/ Fig 2, 3 respectively along with P value. Descriptive statistics matrix of various parameters studies population have been exhibited in Table/ Fig 4.

Age	No.	Right		Left	
		Range	Mean \pm SD	Range	Mean \pm SD
17	53	4- 17°	9.91 \pm 3.28 °	5- 21 °	12.39 \pm 3.59 °
18	43	5-20 °	12.77 \pm 3.46 °	7- 22 °	14.66 \pm 3.64 °
19	32	8-25 °	13.80 \pm 4.89 °	4- 20 °	13.60 \pm 5.07 °
20-35	118	1-15 °	8.18 \pm 2.32 °	5- 18 °	8.64 \pm 2.44 °

Table/fig 2: showing range and mean with standard deviation of right and left side carrying angle of various age categories participants.

Age group	Sex	HT(m)	RCA °	LCA °	P- Value
17 year	Male	1.70	9.91	12.39	0.03
18 year		1.72	12.77	14.66	0.5
19 year		1.77	13.80	13.60	0.6
20-35 year		1.72	8.78	8.64	0.001

Table/fig 3: Displaying distribution of average of height, right carrying angle (RCA) and left carrying angle (LCA) of various age groups.

	Age	Height	RCA	LCA
AGE	1.00	.805(**)	.143(**)	.080(**)
Height	.805(**)	1.00	.229(**)	.228(**)
RCA	.143(**)	.229(**)	1.00	.660(**)
LCA	.080(**)	.228(**)	.660(**)	1.00

Table/ fig 4: Pearson's correlation matrix of various parameters studies population.

** Correlation is significant at the 0.01 level (2-tailed).

Age: strongly correlates with all the parameters ($p < 0.01$), Height: show very significant correlation with all parameters ($p < 0.01$), RCA (Right carrying angle): strong correlation exists between RCA and other parameters ($P < 0.01$) and LCA (left carrying angle): strongly correlates with all the parameters ($p < 0.01$).

Discussion:

The angle formed between an arm's long axis and the forearm's long axis is known as the carrying angle. When the forearm is supinated and the elbow is fully extended, the carrying angle is the angle formed between the arm's long axis and the long axis in the frontal plane. When the hand is positioned, it serves as a lever arm and the forearm lever's pivot. In patients using crutches, it functions as a weight bearing joint [13]. Carrying angle apparently develops in response to supination of the forearm and keeps the swinging upper extremity away from the side of the pelvis during walking [14]. Carrying angle is also found even in-utero and is completely developed in a new-born [11]. However, it exhibits considerable individual variations. That comparisons for the carrying angle should be made with the contralateral side rather than with any "normal standard" [15]. Carrying angle formation to the trochlea of the lower end of the humerus [18]. The upper end of the ulna shares in the angle formation [5]. He reported that there is a curved ridge in the deep trochlea notch at the upper end of the ulna. The obliquity of the shaft of the ulna to this ridge accounts for most of the carrying angle at the elbow. The carrying angle may be disturbed by fractures of the lower end of the humerus or by rupture of the collateral ligaments, which act as stays to the bones [19]. The significant difference appears obvious at 17-year-old. After 17 years (18-19 years), the difference became non-significant but became significant again in the young adults (20-35 years) [20]. This trend is due to the fact that the individuals had acquired completely the secondary sexual characteristics before the age of 20 years and above. Average left carrying angle was greater than average right carrying angle as right upper limb length greater than left upper limb length. This therefore still agreed with the fact that the longer the limb, the lesser the carrying angle [21]. It was reported that carrying angles differ according to the sex and age [14]. They observed that carrying angle was higher in adult females than adult males. In the present work, the young adults have lower average carrying angles in

both left and right elbows when compared to the younger population. That is to say that, the study does not agree at this point with Yilmaz et al., 2005 finding. However, high values of standard deviations were obtained at all ages in both sexes. This indicates that there is a great variability at all ages.

The carrying angle of the dominant arm was significantly greater than that of the non-dominant arm [14]. In the present study, out of a total of 246 participants only about 0.2% of the population was found to be left handed. Yet, average left carrying angle was higher than average right carrying angle in males. It would have been expected that the right carrying angle should have been more than the left. Therefore, carrying angle did not correlate with handedness. Hence, this study did not agree with Yilmaz et al, (2005) observation that carrying angle was greater on the dominant arm. At 17,18,19 ages males appear taller. This is to say that, from adolescence and in young adults that the height of females appears less than that of the males and this is statistically significant. Chinonso (1991), noted that two structures which are identical anatomically are usually unequal in size, hence the variations of right carrying angle and left carrying angle. In the present study statistically significant values were however obtained at 17,18, 19-year-old and young adult. This distinct finding corresponds to pubertal developmental period and adulthood [22, 23].

Conclusion:

The use of simple method to measure carrying angle adopted in this study makes the researcher to recommend it to be used in the actual future researches and clinical practice. Also, the values obtained here might be useful in the management of elbow disorders and the significant difference between females and males might be used in forensic medicine as a basis for sex discrimination.

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