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Research Paper

An Evolution of the Carry Angle of an Elbow Joint: A Radiographic Study

Healthcare

KEYWORDS : Carrying angle, trochlear angle, olecranon–coronoid angle, inferior medial trochlear notch.

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ABSTRACT

The aim of this paper is to evaluate the elbow carrying angle of the elbow joint by radiographic examination in normalchildren and adult inorder to determine the range of normality according to age and skeletal maturity proposing a simple and reliable method for measuring it.Carry angle is considered as the secondary sexual character. The distal end of the humerus and the proximal end of ulna plays a major role in the formation of 'Carrying angle' and has been examined for sex difference. The measurements of the humerus (Trochlear angle and Inclination angle of Olecranon fossa) and also the three measurements of the ulna (Olecranon–coronoid angle, length and width of inferior medial trochlear notch) were devised for the study. The humeral angles failed to prove any sexual difference, but the angle and dimensions of ulna exhibited significant result[1]. The present study also devised the correlation of carrying angle with the length of the forearm and the height of the person.The carry angle of the elbow should also be considered in the construction of elbow prosthesis and identification of skeletal remains. This paper aims at using the advanced measurement software in Digital Radiography (DR) and Computed Tomography (CT), the carrying angle being measured on radiographs, the use of the advancedpost-processing software in DR and CT. This paper also aims to provide information that Medical Imaging and Radiography plays significant roles not only in diagnoses of pathologies but also in Forensic Radiography, where radiographs are taken for age, sex determination (for example,medical legal cases, age retirement, adolescence age for marriage etc.).

Introduction

In 1895, Potter was the first person to conduct a quantitative investigation on a human carry angle lateral obliquity of the forearm from the arm when the forearm is supinated and extended is called carrying angle. The carrying angle of the elbow is the clinical measurement of varus-valgus angulation of the arm with the elbow fully extended and the forearm fully supinated [3].The evaluation of valgus deformity or elbow carrying angle and the knowledge of its variations is essential, especially for the handling and monitoring of traumatic lesions that affect the pediatric elbow [2]. In physiological conditions, a number of parameters affect the degree of carry angle according to age, gender, hyperextension of the elbow, dominant upperlimb,anthropometric characteristics, such as height and intertrochanteric distance.According to Chen (2007), the carrying angle apparently develops in response to pronation of the forearm and keeps theswinging upper extremity away from the side of the pelvis during walking.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, and predispose to risk of elbow dislocation. The role of carrying angle in thesex determination and its cause of formation is a long debated issue in Anatomy & Anthropology researches. The main reason for this controversy is the differences in method and calculation of the carry angle (Zampagni et al., 2008a).According to Purkaitand Chandra, olecranon–coronoid angle shows high sexual dimorphism, and it may be one of the causes of sexual difference observed in carrying angle.Therefore, this paper aims at evaluating the elbow carrying angle by radiographic examination in individuals without any trauma or disorders of the musculoskeletal system to determine a normality curve according to ageand also to verify if there is statisticallysignificant correlation of the length of the forearm and the height of an individual with the carry angle of an elbow.

Methodology

Research approach: Evaluative approach

Study design:	Prospective observational study design.
Setting:	TITAN 2000 Phillips, Department of Radiology and Imaging, Kasturba Hospital, Manipal, Karnataka.
Study period:	6 months.
Population:	Patients scheduled for elbow x-ray in DR
Sampling technique:	Non-probability sampling technique

Materials and Methods

Materials used consist of 45 males and 45 female patients who are of different age groups, free from any fractures and musculoskeletal deformities, nutritional disorder were selected. The subjects were divided into groups on the basis of their age and sex for the purpose of study. Radiograph antero-posterior view and lateral view of the elbow and the forearm is taken in Digital Radiography. Using the advanced measurement software,the carrying angle was measured on radiographs by the method described by Beals (1976). On the radiograph, two mid points were marked on the distal humerus, oneat distal metaphysis and the other in the distal third of the diaphysis. Two mid points were marked on ulna, one at the level of radial tuberosity and other at the most proximal ossification of the ulna. Line was drawnthrough points of corresponding bone and the software gives the angle between the two lines. We also measured the length of forearm by taking the medial epicondyle and styloid process of the ulna as landmark. Distance between these two points is recorded as length of forearm(length of ulna). Stature meter is used to measure the height. Height was measured in standing, erect, anatomical position fromvertex to heel with bare foot.All the parameters were measured in centimeters, except the carrying angle was measured in degree.

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Figure I

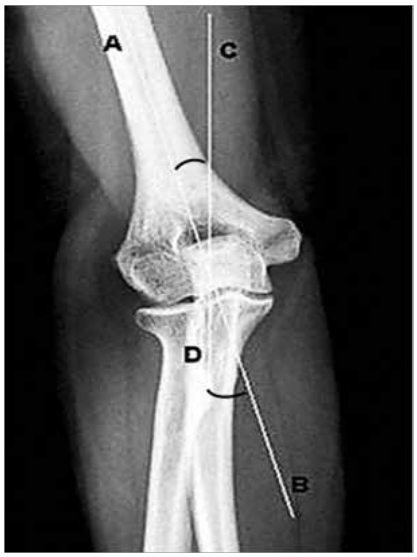

Fig.: Digital representation of the measurement of the elbowcarrying angle by DigitalRadiography.

Statistical Analysis

Table I: Analysis Of Trochlear Angle & Olecranon-Coronoid Angle In Mean And Standard Deviation For Secondary Sexual Character

Angle	Male		Female		Student T-Test
	Mean	SD	Mean	SD	
Trochlear Angle	15.533	4.335	15.066	4.835	0.5
Olecranon-Coronoid Angle	17.044	4.358	16.577	5.114	0.001

Table II: Values In Mean And SD Of Length Of Forearm And Height

Sex	Measurement					
	Carry Angle (Degree)		Length of Forearm (cm)		Height (Feet)	
	Mean	SD	Mean	SD	Mean	SD
Male	16.288	4.3	22.70	1.21	5.38	0.40
Female	15.821	4.9	24.96	1.30	5.11	0.48

Discussion

Even with the advance of technology(CT and MRI),the gold standard for diagnosis of the elbow joint is stillradiography. The present study has been undertakenwith the sole purpose to identify, by anthropometricmeans, the sexually dimorphic features in the bonesof the elbow joint which makes the 'Carrying angle'a sex indicator.Knowledge of the measurement of the elbow carrying angleand of its variations is of significance when evaluating traumatic elbowinjuries in childhood and in adolescenceand other elbowdisorders that require reconstruction or arthroplasties. The main reasons that determine the performance of thisstudy were the fact that we do not have reference values established for the Indian population, as the available literatureis based on international studies(1). According to Martin and Saller in 1957, the carry angle is always positive (more than 90 degrees) implying that the tangent of the trochlear is inclined outward and upward.

An observation by Hooton which became the basis of 'Carrying angle' theory is that the broad shoulders and narrow hips of male allow the arms to hang straight downwards, with long axis of the upper and lower segment approximately in the same straight line. Whereas in the female, the narrower shoulder and broader hips require a splaying out of the forearm axis in order that the hanging arms clear the hips.

The main objective of the present study is to identify the sexually dimorphic features in the bones of the elbow joint which makes the 'Carrying angle' a sex indicator. Hence, the main bones forming the 'Carrying angle' are the distal end of humerus and the proximal end of ulna, which had been critically examined for sex difference.

One of the reasons that determined the performance of this study was the fact that we do not have reference values established for the Indian population, as the available literature is based on international studies.

In the present study, we observed the mean values for the elbow carrying angle of 16.288 degrees +/-4.3 in males and 15.821 degrees +/-4.9 in females.The highest value of this angle in the female gender would be justified by the presence of ligamentous laxity.The maximum extension of the elbow should contribute to the increase of the elbow carrying angle, in conformity with the study by Golden et al. It is mainly influenced by ligamentous laxity. The length of forearm in the male and female is statistically significant; it is also observed that the height and length of forearm are both greater in males than females,whereas the average carrying angle is greater in females than males. The height and length of the forearm are directly related to each other, and the length of the forearm bones values is inversely proportional to the elbow carrying angle.These results showed a greater gender changed in the carry angle of the elbow joint.The use of the radiographic images helps to reduce the differences in measurement due to variation in soft tissue in the upper limb.The current study is useful in management of elbow disorders, and the differences in carry angle value between that of males and females are of significance in forensic medicine as a base for sex determination. The present study also showed that the height of the person is inversely related with the carry angle.

Conclusion

This study aids to determine the carrying angle in adult population by radiological method taking part in formation of human elbow. It also aids to establish data on carrying angle, its sex in South Indian population and it also showed that the height of the person is inversely related with the carrying angle. This study will assist the orthopedic surgeons and manufacturers preparing for elbow replacement implants.Olecranon-Coronoid angle exhibiting highsexual dimorphism may be one of the causes ofsexual difference observed in 'Carrying angle'. The smaller Olecranon-Coronoid angle offemale ulna suggests that the projection ofolecranon process in female may be relativelylarger than in male.More investigations are required on this topicto resolve the issue of 'Carrying angle' beingasex-dominant character and various other factors related to the carry angle.

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