

## COMPARATIVE STUDY OF CARRYING ANGLE IN SOUTH INDIAN POPULATION

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### ABSTRACT

**Introduction:** Carrying angle (CA) is the acute angle made by the median axis of the arm with that of the fully extended and supinated forearm. Studies conducted to compare the differences between radiologically and clinically measured carrying angle are only few and mostly showing contradictory results. Furthermore, there is a dearth of evidence in the literature regarding differences between the CA in both sexes depending upon the ossification of arm and forearm bones.

**Aim:** To compare the data obtained by measuring CA by manual and radiographic methods in age group 16 - 25 years.

**Materials and Methods:** CA was measured in 100 individuals of both sexes by clinical and radiological methods using manual goniometer.

**Results:** The present study shows significant gender difference and no significant difference between the clinical and radiological methods.

**Conclusion:** Unnecessary exposure of X-rays to children, young adults and pregnant women can be avoided, by measuring CA by clinical methods.

**KEY WORDS:** CA, Post-Pubertal Age, Clinical & Radiological Methods, Elbow Prostheses.

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### INTRODUCTION

Carrying angle (CA) is the acute angle made by the median axis of the arm with that of the fully extended and supinated forearm which disappears when the elbow is pronated and flexed. Earlier reports [2-7] on CA were based on the clinical measurement of CA and comparing them with that of the differences in age groups, sex and height of the individuals. But, change in

CA with advancement in age has not been reported so far.

Only few studies were conducted to compare the differences between radiologically and clinically measured CA. Furthermore, there exists no clear data regarding differences between the CA in both sexes depending upon the ossification of arm and forearm bones. Hence the current study was under taken to

explore the differences between clinically and radiologically measured CA in age group 16 - 25 years and also in both sexes.

## MATERIALS AND METHODS

Descriptive study was conducted in 100 school and college students aged between 16 - 25 years from a Govt. High School located in Ariyankuppam, Puducherry and SriVenkateswara Medical College Hospital and Research Centre, Puducherry, India.

The study was approved by Institutional Ethical Committee (IEC) and Ethical Clearance was obtained before the commencement of the study. Prior to the conduct of the study, informed consent was obtained directly from the subjects if they are major or from Parents/Guardian in case of minor.

**Inclusion criteria:** Normal & healthy individuals without any congenital anomalies and without any history of fractures around elbow joint.

**Exclusion criteria:** Individuals with congenital deformities of extremities, surgeries around the elbow joint, fractures around the elbow joint, endocrine disorders affecting skeletal systems and bone disorders due to Vitamin deficiencies.

**Materials Used:** Measuring Scale, measuring Tape, marker pen, clinical goniometer 180°-NISCO (INDIA), electronic Digital Vernier Caliper – INSIZE (JAPAN), X-ray machine–SEIMENS-Klinoskope–H 800mA Image Intensifier TeleVision (IITV), X-ray-Cassette Scanner FCR CAPSULA XL-II, Fujifilm, X-ray film-Dry Pix 7000 Fujifilm.

**Methods:** A thorough clinical examination of the elbow region was done by following all the inclusion and exclusion criteria. Among the subjects thus included, CA was measured using both clinical and radiological methods.

**Measurement of CA - Clinical method:** Cases of 16 – 25 years of age were subjected to measurement of CA in both the upper limbs by clinical method [2-5].

Points were made 5cm above and below in line with the medial epicondyle in the front of arm and forearm. Width of the arm, forearm and wrist were measured with the help of the Digital Vernier Caliper, with the prongs of the caliper just touching the skin without giving any pressure

to derive their midpoints. Two axes were drawn, one from acromian process meeting the midpoint in front of arm, another in forearm joining the midpoints in front of forearm and wrist (Figure 1). Extend both the lines so that they intersect nearly in front of the elbow joint and the angle thus formed in the medial aspect represents the internal CA (Figure 2,3) which was measured by clinical goniometer.

**Measurement of carrying angle - radiological method:** Cases of 16 – 25 years of age group were subjected to measurement of CA in both the upper limbs by radiological method as described in literature [6,7].

Width of the shaft of the humerus was measured and midpoint was marked in the X-ray film obtained. Two bony points one at the proximal part of the radial tuberosity and the other at highest point at the superior radio ulnar joint, were marked and two vertical lines were drawn along the long axis passing through the midpoints marked earlier. Both the lines intersect nearly in front of the elbow joint and the angle thus formed in the medial aspect represents the internal CA (Figure 4) which was measured by clinical goniometer

After obtaining the CA through both the above said methodology, comparisons were made between the two methods with reference to sex.

**Statistical analysis:** The continuous parameters were expressed as mean with standard deviation using Independent Student's t-test. All statistical analysis were carried out at 5% level of significance and p-value < 0.05 was considered as significant. The analysis was done using "Graph pad 6".

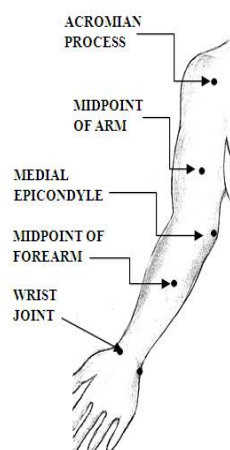


Fig. 1

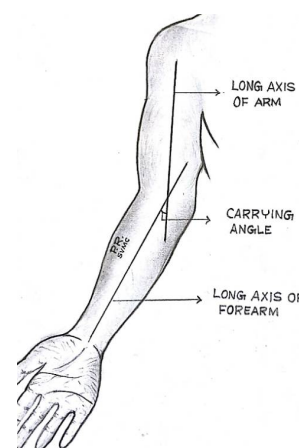


Fig. 2

Fig. 3

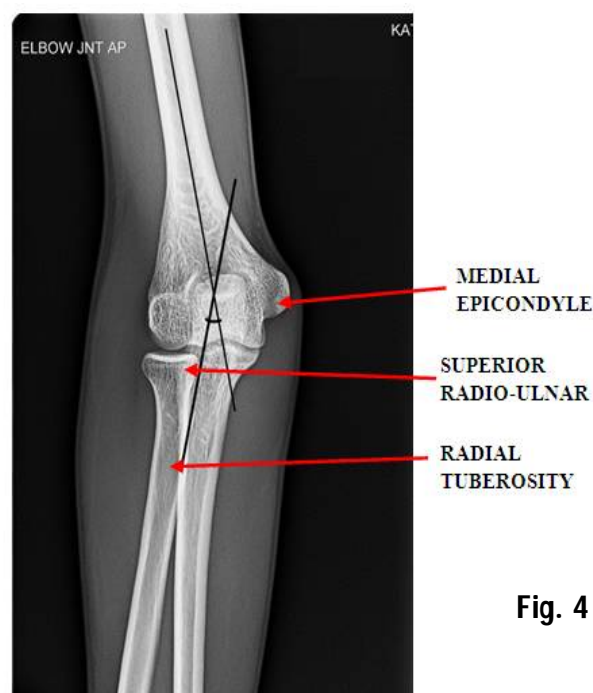
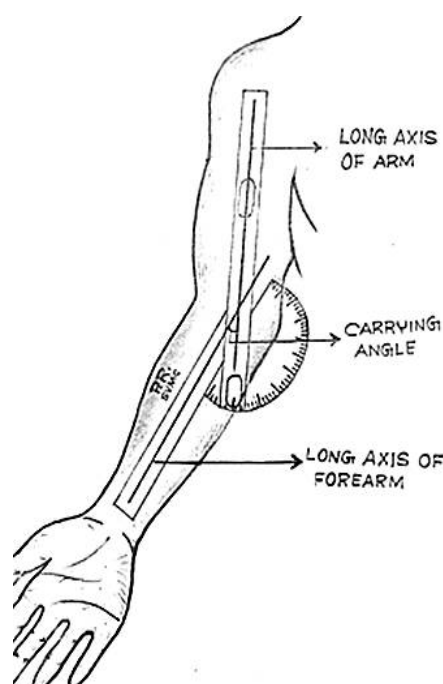


Fig. 4

## OBSERVATIONS AND RESULTS

**Comparison of CA between clinical and radiological measurements:** Comparison between clinically and radiologically measured CA of right and left upper limbs in males, did not show increase or decrease in CA with p-value of 0.753 and 0.653 which is statistically not significant. (Table 1)

**Table 1:** Comparison of CA in right and left upper limbs between clinical and radiological methods in male subjects.

Right				Left			
Clinical (Mean $\pm$ SD)	Radiological (Mean $\pm$ SD)	t-test	p-value	Clinical (Mean $\pm$ SD)	Radiological (Mean $\pm$ SD)	t-test	p-value
12.00 $\pm$ 1.29	12.08 $\pm$ 1.95	0.315	0.753	10.80 $\pm$ 1.39	10.92 $\pm$ 1.25	0.451	0.653

Comparison between clinically and radiologically measured CA of right and left upper limb in females, did not show increase or decrease in CA with p-value of 0.921 and 0.880 which is statistically not significant. (Table 2)

**Table 2:** Comparison of CA in right and left upper limbs between clinical and radiological methods in female subjects.

Right				Left			
Clinical (Mean $\pm$ SD)	Radiological (Mean $\pm$ SD)	t-test	p-value	Clinical (Mean $\pm$ SD)	Radiological (Mean $\pm$ SD)	t-test	p-value
14.90 $\pm$ 2.06	14.94 $\pm$ 1.95	0.1	0.921	13.76 $\pm$ 1.99	13.70 $\pm$ 1.98	0.151	0.88

## DISCUSSION

Measurement of CA becomes imperative in conditions involving fracture of bones forming the cubital articulations. The knowledge of CA and its variations becomes essential for preoperative surgical planning in trauma management and also in correction of congenital deformities influencing the elbow joint. It plays a significant

role in the treatment of epicondylar diseases and in the designing of elbow prosthesis in case of replacement.

Several studies have measured the CA in various age groups ranging from in-utero, neonates, infants, childhood, adolescence and aged individuals among different populations and reported its age changes and sexual dimorphism. Conventionally, CA had been measured

clinically using methodologies involving full circle goniometer, clinical goniometer, universal goniometer, protractor goniometer and electrogoniometer. Radiological methods had also been employed in the measurement of carrying angle with the help of Plain X-ray, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). In this study, CA was measured clinically by using goniometer and was compared with the CA measured from the radiological images taken by using plain digital X-rays.

**Comparison of CA between clinical and radiological measurements:** Few authors conducted studies to measure CA by both clinical and radiological methods and concluded that there was very minimal difference of  $\pm 1^\circ$  or no significant difference in CA between both the methodologies [8-10].

In the present study, no significant difference was observed in CA in 16- 25 years while comparing clinical and radiological methods in both sexes. Our study is the first of its kind from the Indian subcontinent to evaluate the difference between clinical and radiological measurement of CA. From our results, we found no difference between clinically measured CA vs. radiologically measured CA in both genders belonging to 16- 25 years. Our findings are consistent with few studies done by others [8-10]. The difference in CA values was reported which could possibly be explained by the different methodology adopted by the authors in deriving the CA [1].

For the design of resurfacing and semi constrained elbow replacement implants, detailed knowledge of elbow joint geometry and CA are of utmost importance. So, the changes in dynamics and the CA of elbow joint should be taken into consideration before designing the elbow prostheses. Therefore the measurement and application of CA is very essential and should be taken into account in designing the artificial limb implants.

## CONCLUSION

The study was designed to measure and compare the CA clinically and radiologically for the age group 16 - 25 years depending upon the ossification of arm and forearm bones in both

sexes. The premise of the study was based on the available literature. The measurements obtained by the above methods were subjected to various statistical analysis and the results derived from the present study, shows significant gender difference and lack of difference between the clinical and radiological methods. Hence it could serve as reference values for CA in South Indian population before designing the elbow prostheses.

**Conflicts of Interests: None**

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