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Evaluation of the Carrying Angle of the Elbow Joint in Adolescents and its Correlation with BMI, Gender and Dominant Side

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Abstract: ***Introduction: The evolution of carrying angle in apes is related to the need to bring the center of mass of body beneath the supporting hand during suspensory locomotion. Increased carrying angle may lead to conditions like Elbow instability, decreased elbow ROM and increased risk of elbow Dislocation. Aim: To study the carrying angle of the elbow joint in adolescents and its correlation with bmi, gender and dominant side. Material and methods: A cross-sectional study was conducted on 120 Adolescents (63 Males and 57 Females) in DVVPF'S COPT Ahmednagar and individuals with history of fractures around the elbow and shoulder joint and congenital condition were excluded. Result: There was a significant positive correlation between dominant side carrying angle and BMI with r=0.144 and p<0.05 and there was a significant positive correlation between non –dominant side carrying angle and BMI with r=0.017 and p<0.05.Conclusion: This study concluded that Age, Sex, BMI and dominant side are important factors that affect the value of the carrying angle .The BMI of Adolescents has an impact on Carrying angle of Elbow joint.***

Keywords: Body mass index (BMI), Carrying Angle, Adolescents

1. Introduction

Apes and humans distinguished from other primate species in possessing carrying angle at the elbow. The evolution of carrying angle is related 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 [1]. Role of carrying angle in the sex determination & cause of formation is a debated issue in Anatomy and Anthropology. The carrying angle of the elbow is defined as the angle formed by the long axis of the arm and the long axis of the forearm in the frontal plane when elbow is fully extended and forearm is supinated. In such a position, the forearm does not lie in one line with arm, but it deviates lateral to arm axis forming this angle [2].

The angle is neutralized when the forearm is flexed or pronated from extended or supinated position [22]. It is said that carrying angle is greater in females than in males and difference has been considered to be due to ligamentous laxity at the medial elbow or asymmetrical bone growth. The angle is formed as a result of trochlear groove being vertical anteriorly but on the posterior aspect it runs obliquely distally and laterally. These results in formation of carrying angle in extension when posterior aspect of the oblique groove makes contact with the trochlear notch of ulna and the angle is marked during flexion when trochlear notch lies on vertical groove in the anterior aspect [2]. However, Sharma K et.al reported no significant difference in carrying angle of males and females of any age group. Studies have shown that there is a gradual increase in the carrying angle with skeletal maturation. It has been found that the carrying angle of the elbow changes from infancy to adulthood in a predictable manner [3].The apparent difference in gender may be due to increased joint laxity in females permitting a greater degree of extension [2]. Variation in carrying angle among age groups, gender and race has been reported in literature. The average value of the carrying angle is 12.5 ±0.57 degrees in male and 15.26 ±0.45 degrees in females [23]. Anatomically, the carrying angle in human adults is approximately 10_ in men and 13_ in Women [24].

Body mass index (BMI) a measure of weight adjusted for height. It is calculated as weight in kilograms divided by the square of height in meters. Obesity has been primarily diagnosed by using the BMI. Excess adipose tissue (obesity) is deleterious for multiple body organ systems through thrombogenic, atherogenic, oncogenic, haemodynamic and neuro-humoral mechanisms and is linked to multiple medical conditions, such as diabetes, heart disease and several types of cancer [4]. Obesity is presently the number one killer worldwide replacing smoking. So this study will help in determination of impact of BMI on Carrying Angle and how these two domains are connected with each other.

2. Materials and Methods

Study design: Cross-sectional study

Sampling method: Convenience Sampling Technique

Inclusion criteria: Male and Female of age group 16-26 years

Exclusion criteria: Male and Female
1) With Restriction of Elbow ROM
2) With Cubitus Varus Deformity secondary to Fracture.
3) With Congenital Deformity of elbow

Material: Goniometer, Marker

3. Methodology

This is a cross-sectional study carried out in DVVPF College of Physiotherapy Ahmednagar. 120 healthy young adolescents were selected with convenience sampling. Institutional Ethical Committee approval was obtained from the IEC prior to beginning of the study. Detail importance and benefits of the study was explained to the participants. They were informed verbally and written consent is signed by the participants.

Demographic data of participants was documented .The individual asked to stand and fully extend and supinate the forearm. Placement of Goniometer - 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. Measurement of carrying angle was done on the left side as well as on the right side to find out difference on both sides Stature meter was used to measure the height. Height was measured in standing, erect, anatomical position from vertex to hill with bare foot. Weight of the patient taken by the digital weighing machine. Body Mass Index(BMI) measured using formula Quetelets Index BMI=Weight(in Kg)/(Height in cm)^2 .

Data Analysis
Analysis was done by Microsoft Excel 2010. It will be done by demographic variable, mean and standard deviation

4. Results

Table 1: Frequency distribution of participants by gender

Gender	Frequency	Percentage
Male	63	52.5%
Female	57	47.5%
Total	120	100%

Table 2: MEAN & SD of age, BMI and carrying angle

	No.	AGE	BMI	CA Dominant	CA Non-Dominant
Male	63	21.68±1.61	24.85±3.73	12.85±2.13	11.85±2.22
Female	57	20.47±2.18	21.82±3.72	13.75±2.06	12.64±2.61
Total	120	21.27±1.94	23.36±3.87	13.39±2.17	12.31±2.45

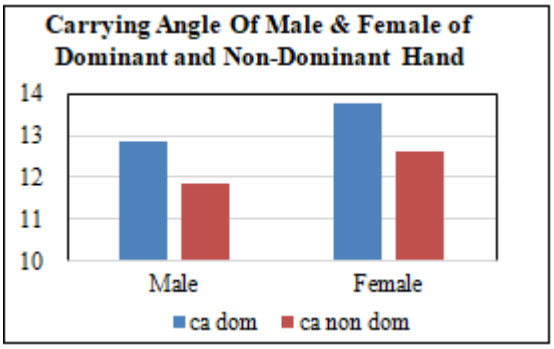

Figure 1: Gender Distribution of Subjects

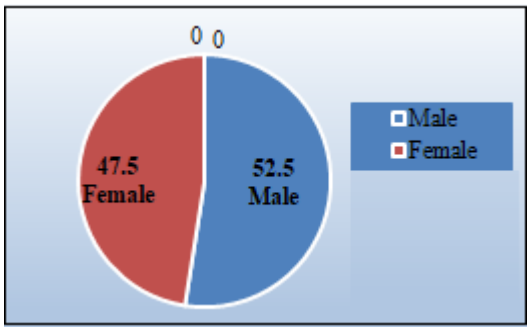

Figure 2: On comparing the carrying angle in Females and Males there was significant difference between them (p<0.0001) with 13.75±2.06, 12.85±2.13 on dominant side and 12.64±2.61, 11.85±2.22 on Non-Dominant side respectively.

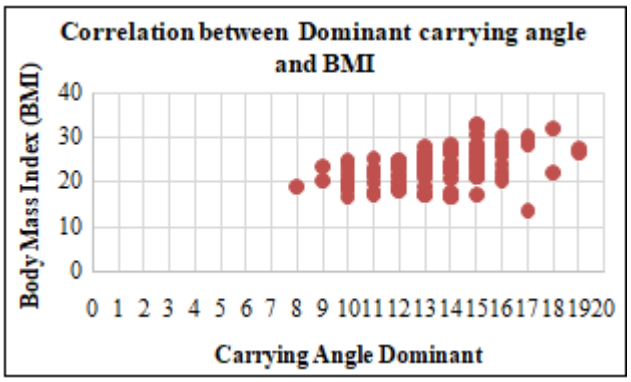

Figure 3: Correlation between Dominant carrying angle and BMI irrespective of gender.

There was a significant positive correlation between dominant side carrying angle (M=13.39, SD=2.17) and BMI (M=23.36, SD=3.87), with r=0.4509 and p<0.0001.

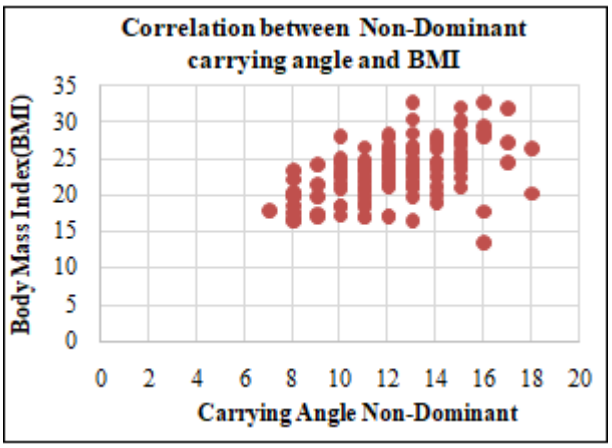

Figure 4: Correlation between Non-Dominant carrying angle and BMI irrespective of gender and there was a significant positive correlation between non-dominant side carrying angle (M=12.31, SD=2.45) and BMI (M=23.36, SD=3.87), with r=0.4713 and p<0.0001.

There is a significant difference in carrying angle of both sides of the upper limbs both in males and females and a significant greater carrying angle was found in females. It was observed that the carrying angle of Dominant limb was greater than Non Dominant limb in both sexes.

5. Discussion

The carrying angle of the elbow is defined as the angle formed by the long axis of the arm and the long axis of the forearm in the frontal plane when the elbow is fully extended and the forearm is supinated. It exhibits considerable individual variation and is generally said that carrying angle is greater in females than in males [2]. Body mass index [BMI, weight kg/height m2] is presently the most often used and widely satisfactory methods of distribution of body weight.

The current study shows the relationship between BMI and carrying angle of Adolescents in DVVPF"s COPT, Ahmednagar has a mean BMI (M=23.36, SD=3.87) , mean Dominant Carrying Angle (M=13.39, SD=2.17) with r=0.4509 and p<0.0001 and mean Non Dominant Carrying Angle (non-dominant side carrying angle (M=12.31, SD=2.45), with r=0.4713 and p<0.0001 which is significant and on comparing the carrying angle in Females and Males there was significant difference between them (p<0.0001) with 13.75±2.06 , 12.85±2.13 on dominant side and 12.64±2.61 , 11.85±2.22 on Non-Dominant side respectively which indicates the carrying angle is Greater in Females than in Males and also Greater in Dominant hand than in Non-dominant hand.

A Study conducted by Paraskevas G *et al*] reported that carrying angle was significantly greater in the right upper limb than the left in both sexes, 12.20±3.80 in right and 11.46±3.20 in left upper limb in males and 16.52±4.230 in right and 15.36±3.230 in left upper limb in females. They also reported that in right-handed subjects angle was significantly greater in right upper limb in both sexes and in left-handed subjects, it was significantly greater in left upper limbs in both sexes which is similar to the current study. This difference in the carrying angles of the dominant and non-dominant sides may be due ligamentous laxity at the elbow.

A Study conducted by **Dr. Shiva Prakah SS,** et al on 120 children's 60 male and 60 female concluded that there is a positive correlation between carrying angle and height, Body Mass Index (BMI) which is significant in the current study

A study by Anibor Ese et.al on 384 volunteers between the age group of 10 to 19 years revealed that there was a weak positive correlation between right carrying angle (M=12.411, SD=1.719) and BMI (M=18.730, SD=2.613), with r=0.144 and p<0.05 and a weak positive correlation between left carrying angle (M=12.480, SD=1.787) and BMI (M=18.730, SD=2.613), with r=0.017 and p<0.05 which is similar to the results of the current study.

6. Conclusion

This study concluded that Age, Sex, BMI and dominant side are important factors that affect the value of the carrying angle. The BMI of Adolescents has an impact on Carrying Angle of Elbow Joint.Carrying angle increases with age and is greater in females than in males.

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