



THE “ TROIS POINT OSSEUX ” RELATIONSHIP OF THE ELBOW : A CLINICAL DATA SURVEY AND ANALYSIS.

Orthopaedics

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ABSTRACT

Introduction : A meticulous and detailed clinical examination of the elbow joint, is an important constituent of the clinical evaluation of any clinical elbow case, either by an Undergraduate or by a Postgraduate medical student in Orthopaedics. An unequivocal opinion on the relationship between the three bony points in the published textbooks and literature in Orthopaedics, does not, unfortunately exist.

Aim : To assess the “Trois Point Osseux” relationship of the elbow joint in a healthy adult.

Materials and Methods : All adult subjects in the age span of 21 to 60 years, with no past history of any elbow pathology or trauma were included for this study. Informed consent was obtained from all the patients, included in this study.

Result : The imaginary triangle shape, as conceptualized by joining the three elbow bony tips, were all a scalene triangle, in all the 500 recruits (1000 elbows).

Conclusion : This study concluded that in all the 500 subjects (1000 elbows), no margins of the imaginary triangle so formed, were equivalent. Thus they all were of the scalene triangle variant.

KEYWORDS

Elbow joint, three bony point relationship, scalene triangle, isosceles triangle.

INTRODUCTION :

A meticulous and detailed clinical examination of the elbow joint, is an important constituent of the clinical evaluation of any elbow case, either by an Undergraduate or as a Postgraduate medical student in the surgical specialty of Orthopaedics. An unequivocal opinion on the correlation between the three bony points, in the published textbooks and literature in Orthopaedics, does not, unfortunately exist. Mandeep S Dhillon et al; was among the first Indian authors in 2014 to publish his results on a case series of 200 patients (400 elbows)^[1]. His team explained that the triangle so formed was infact a scalene triangle. This is despite the fact that it is common to be taught in medical schools, for it to be an isosceles triangle in a healthy adult^[1]. The authors authenticated this factual data by their clinical study, in 200 patients (400 elbows). The purpose behind this “etude prospective” was also to establish a concurrence with or otherwise of, by evaluating a population, selected from an urban center, in a tertiary referral hospital, in Chengalpattu district, of Tamil Nadu.

Methodology :

The study included clinical assessment and mensuration of 500 healthy recruits (1000 elbows), who have had no previous elbow related pathology, at Chettinad Hospital and Research Institute, over a period of 4 months of time frame. This study was endorsed by the Institutional Research and Ethical Committee. “Consentement éclairé” was taken from all the patients included in this study. Two consultants, of which one is the corresponding author and the other is the first author of this manuscript, had individually performed this subjective study of mensuration, on all subjects, to negate the inter-observer error. In the event of any discrepancy in their data entries, the average of the two recorded readings was concluded to be the final.



Fig 1 : Tools used for measurements : Geometric box divider and a transparent scale of geometric box.

The measurements were done using a simple geometric box divider and a transparent measuring scale (Fig 1). The measuring scale had a fixed range from 0.0 cm to 15.0 cm, with a least count of 1 mm.

Inclusion Criteria :

1. An evaluation of 500 subjects (1000 elbows) in adults of both sexes aged between 21 to 60 years.

Nutritional status	BMI (kg/m ²)
Underweight	<18.5
Normal range	18.5-22.9
Overweight	23-24.9
Obese I	25-29.9
Obese II	>30

Figure 2 : WHO Asian BMI Classification^[2].

Exclusion Criteria :

- Any existing or prior metabolic bone disease or any active or corrected endocrinological disorder under treatment.
- Past history of any of the elbow trauma and surgeries, congenital deformities or infection of the upper limb.
- Obesity of either sexes, with a Body Mass Index(BMI) conforming and falling under the category of Obese class I to II of WHO (Fig 2) and as modified for the Indian adult scales of obesity by S. Behl et al; in 2017 (i.e. a BMI ≥ 25 kg/m²)^[3].

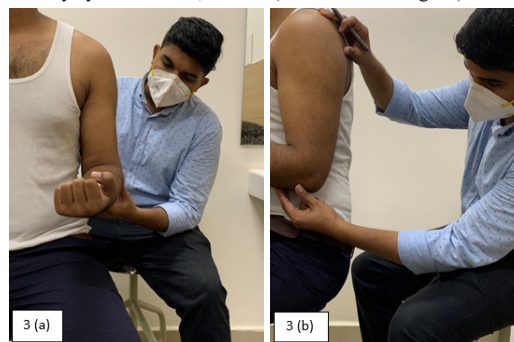


Fig 3(a and b) : Patient's elbow at 90 degrees of flexion, being examined by the examiner being seated behind the patient and by keeping the subject's shoulder in a neutral position.

The medial epicondyle, the lateral epicondyle and the “ pointe d'olecrane ”, were first recognized and marked with the elbow joint, at an elbow's right angle of flexion^[4]. The shoulder was kept in a neutral position and the examiner sat behind the patient (Fig 3: a and b) and the precise lengths in “mm” were jotted down.



Fig 4 : Three bony landmarks of elbow joint marked and labelled as points A, B and C with elbow at 90 degrees flexion.

The lateral supracondylar edge was palpated and followed downwards. The apex of the most prominent lateral bony landmark was palpated and was marked as the lateral epicondyle (Point A). The forearm was supinated and pronated alternately to affirm if the radial head, was the next most prominent bony landmark, distal to it. Similarly, by palpating and tracking down the medial supracondylar ridge, the apex of the medial epicondyle (Point B) was marked. The subcutaneous border of the ulna was then palpated proximally and the most prominent bony mark was marked as the “pointe d'olecrane” (Point C).

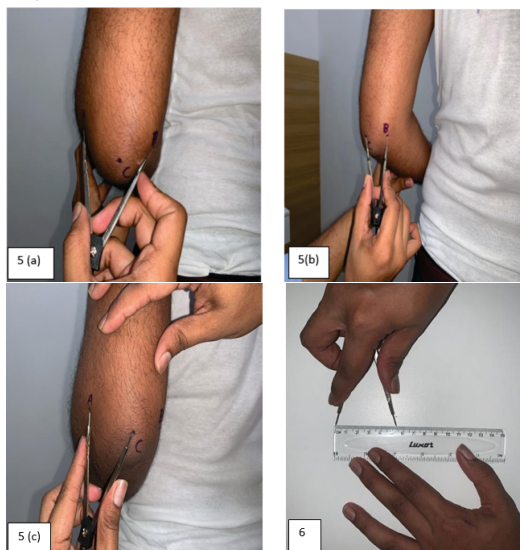


Fig 5(a, b and c) and 6 : Measurement of sides AB, BC and CA of triangle ABC and its measurement on the transparent scale.



Figure 7 : Triangle ABC formed by joining the points A, B and C.

The three marked points were labelled as A, B and C respectively (Fig 4). These labelled points were then joined with a marker pen to form a triangle (Fig 7) and the interval between the marked bony points were precisely measured with the help of a divider and a transparent measuring ruler (Fig 5a, b and c, Fig 6).

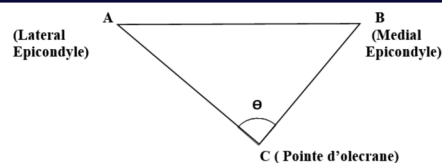


Fig 8 : Imaginary triangle ABC drawn joining the osseous elbow point and the internal angle θ (angle BCA of triangle ABC).

The angle so formed at the “pointe d'olecrane” (angle BCA of triangle ABC) was measured and angle θ was noted (Fig 8). The two authors recorded their readings, of which, one was the corresponding author. The readings were measured upto three times and an average of the readings was recorded individually, by both the screeners (i.e. $3 \times 2 = 6$ readings). This process precluded any inter- observer error, as each had their average earmarked. In the very rare instances ($n = 40$ elbows, 4 percent), a fourth reading was taken by another senior orthopaedic faculty member and the concurrence with his readings and data recorded was entered and taken to be the final reading.

RESULTS :

Table 1 : Mean Readings in millimeters of side AB, BC and CA of triangle ABC and angle θ (angle BCA of triangle ABC) in various age groups.

S. No.	Total subjects/ Elbows (n/n ₁)	Age Groups (in years)	Mean AB (in mm)	Mean BC (in mm)	Mean CA (in mm)	Mean Angle θ (in degrees)
1	157 / 314	21 - 30 years	52 mm	31 mm	37 mm	101
2	198 / 396	31 - 40 years	58 mm	32 mm	42 mm	102
3	75 / 150	41 - 50 years	57 mm	32 mm	41 mm	101
4	70 / 140	51 - 60 years	56 mm	31 mm	39 mm	103
5	500 / 1000	AVERAGE OF AVERAGES	55 mm	31 mm	39 mm	101

Out of the 500 subjects ($n = 1000$) in the study, 265 subjects ($n = 530$, 53%) were males and 235 subjects ($n = 470$, 47%) were females. The central value of the set age of the recruited subjects was 36.6 years. The study population was then divided into 4 age groups viz; 21 to 30 years, 31 to 40 years, 41 to 50 years and 51 to 60 years. In each age group, the mean distance between the points A, B and C were calculated and mean estimate of angle θ (angle BCA of triangle ABC) was estimated. As summarized in Table 1, the mean distances among all age sub-groups were as follows : AB = 55 mm, BC = 31 mm, CA = 39 mm. Further the mean value of the angle ‘ θ ’ (angle BCA of triangle ABC) was 101 degrees.

This study concluded that in all the 500 subjects (1000 elbows), no margins of the triangle were found to be equivalent. The triangle shape so formed, was found to be a scalene triangle, in all the 500 subjects (1000 elbows).

DISCUSSION :

The “ articulation du coude ” is an observable joint in the upper appendicular extremity. Posteriorly when we visualize, the “trois point osseux” stand out prominently^[5]. These three bony subcutaneous landmarks with the elbow in full extension lie on a horizontal line named “ line of Heuter”(Fig 9, 11 and 12). Similarly in a normal adult elbow, when the 90 degrees of elbow flexion is achieved, it forms an imaginary “Heuter triangle”(Fig 10, 11 and 12), which in 2006, was reported by Ross and Lamperti^[5] to simulate an equilateral triangle. Our study of 500 subjects (1000 elbows), revealed that the three bony point relationship formed in the elbow joint, was a scalene triangle, as in the ISAKOS 2020 conclusion^[6].

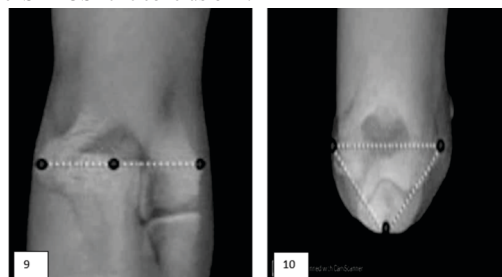


Fig 9 And 10: Line Of Heuter And Heuter's Triangle^[5].

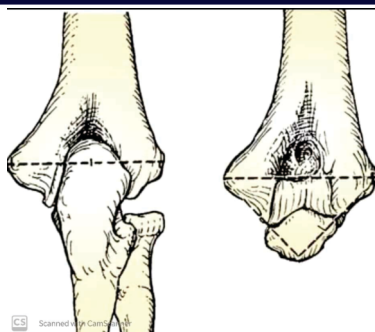


Fig 11 : Heuter's Line And Heuter's Triangle^[7].

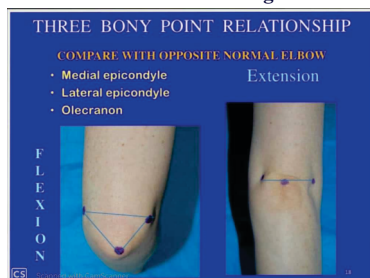


Fig 12 : Three Bony Point Relationship Of Elbow In Flexion And Extension^[8].

Table 2 : Study comparing our results to that of Dhillon M. et al;^[1].

Parameter	Mean measurement in "mm" between medial epicondyle and the tip of the olecranon.	Mean measurement in "mm" between lateral epicondyle and the tip of the olecranon.	Mean measurement in "mm" between medial epicondyle and lateral epicondyle.
Dhillon's Study	45	51	63
Our Study	31	39	55
Deficit percentage in our study	31.2%	23.6%	12.7%

Table 3 : State-wise Distribution Of Average Height(in Cm) In Indian Population^[9].

	MEN	WOMEN
PUNJABI	169 cm	154.5 cm
TAMILIAN	164.5 cm	152.4 cm

Table 4 : Publications And Studies With a Confusing Outlook For The Shape of the "Heuter's Triangle".

S. No.	Geometric nature of the Heuter's Triangle	Publications and Studies
1.	An Equilateral triangle	Gray et al ^[10] ; Kulkarni N. et al ^[11] ; Ebnezar J et al ^[12] ; Mc Rae R. et al ^[13] ; Reider B. et al ^[14] ; and Dumontier C. et al ^[15] .
2.	An Isosceles triangle	Kulkarni N. et al ^[11] ; Warwick D. et al ^[16] ; Magee DJ. et al ^[17] ; Maheshwari J et al ^[18] ; and Pandey . et al ^[19] .
3.	A Scalene triangle	Das S. et al ^[20] ; Dhillon MS. et al ^[1] and our present study.

This can be explained, on the basis of the average Aryan race Punjabi body build being more robust and tall, in comparison to the average Dravidian race Tamilians (Table 2,3). Furthermore, it is in total concordance with what Maheshwari has quoted, viz; that the medial side of the Heuter's triangle is by far the shortest^[18].

The orthopedic manuals reading material despite everything are not unified in their ideas with respect to this. Twelve standard references were compiled and contrasted (Table 4). Apley^[16], Magee^[17], Maheshwari^[18] and Pandey^[19] labelled it as an isosceles triangle. Gray^[10], Ebnezar^[12], Mc Rae^[13], Reider^[14] and Dumontier^[15] labeled it as an equilateral triangle. On the contrary, Das has mentioned it to be a scalene triangle^[20]. However, none of these authors have cited any cross reference to legitimize their claim. A similar study of 200 subjects (400 elbows) was conducted three years back by Nekkanti et al; and the

conclusion of the study was similar to our study^[21]. This study was taken to invalidate the findings of the past research.

However, the authors find this study resonating the outcome of the previous study^[1,20,21]. The present authors, despite everything, see that there is an authentic absence of accord in the latterly published standard textbooks and the clinical manuals of Orthopedics on this basic concept. The draw backs of this study are the very minimal possibilities of inter-observer error between the authors as a result of minor changes in the level of flexion of the elbow. Use of probably a fixed point flexion elbow braces could minimize this error^[21]. A parallax error can't be precluded. This study reveals more lucidity and additional evidence to the concept in question; to put to rest all other unsubstantiated arguments, our next study shall be CT based measurement with fixed angle elbow brace.

CONCLUSION :

In conclusion, the distances of "pointe d'olecrane" (Point C) from the lateral epicondyle (Point A) and the medial epicondyle (Point B), as evaluated in our series of 500 subjects (1000 elbows), found it to be of the scalene triangle pattern, wherein all the three measured margins of the imaginarily formed triangle, were of unequal lengths.

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