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The three bony point relationship of the elbow- Why is there still a lack of consensus?

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ABSTRACT

Introduction: There is a definite lack of agreement in the orthopedic community regarding the three bony point relationship of the elbow. It is known that the lateral epicondyle, medial epicondyle and the tip of the olecranon acquire a "triangle" orientation when the elbow is flexed and form a straight line of extension. However, there is no clarity as to what is the nature of the triangle formed. Our review of the literature shows only one study to answer this question.

Objective: We attempt to either refute the survey published or to support it by conducting a separate investigation in our population.

Patients and Methods: An online poll was conducted to test the experienced orthopedic surgeon about their opinion regarding the nature of the triangle formed. We included 400 normal elbows in our study. The three bony points were marked and the distances measured using vernier calipers and the angles measured using a goniometer. The results were documented.

Results: The survey conducted that the orthopedic surgeons gave mixed responses to our poll. The study also revealed that the triangle formed in all the elbows included in our study was that of a triangle of unequal sides and angles.

Conclusion: Our study confirms the results of the previous research. This study forms an addition to the database to prove the same.

Key words: *Clinical examination, elbow joint, three bony point concept, scalene triangle*

Introduction

The clinical examination of the elbow joint is an essential part of the training of undergraduate MBBS Students and the postgraduate residents in Orthopaedics. A definite consensus on the three bony point relationship of the elbow does not exist. Mandeep S Dhillon et al. described this problem first in 2014 and published the results of their study of 200 elbows [1]. They explained that the triangle formed was a scalene triangle although it was a common teaching practice to describe it as an isosceles triangle [1]. The authors of this study believed that there continues to be a lack of consensus

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in the orthopedic community. The authors decided to test this study by conducting prospective research on 400 elbows. The reason for doing a similar investigation was to either refute the published research or to provide an additional database to the existing data to prove the same. There have been no updates in the standard textbooks of orthopedics or the clinical manuals despite the results of the same being published three years back.

Patients and Methods

The study was initiated by conducting an online poll about the opinion of the orthopedic community. The responses collected were analyzed. The subsequent part of the study involved an evaluation of 400 elbows in JSS Medical College and Hospital over a three month period. This study was approved by the Institutional Review Board of our university. All adult patients above 18 years of age with no previous elbow pathology were considered for this study. Informed written consent was taken from all the patients included in this study. Any patient with a congenital deformity, surgery, infection of the upper limb were excluded from this study. Two senior most authors conducted the study and supervised the entire study. Two authors including one senior author performed the study in all patients to negate inter-observer error. The mutually agreed upon values were entered.

The measurements were done using an Aerospace Digital Vernier Caliper, Range: 150 Mm vernier calipers. It had a range filter of 0-150 mm, Least Count Filter: 0.01 mm. It had an Accuracy Filter of +/- 0.02 mm (<100mm) and +/-0.03mm (>100mm). The repeatability error was less than 0.01mm. The measuring speed was 1.5m/sec. It was fitted with a stable microprocessor and had a 4 Way measurement Inside, outside, depth, step with thumb lock and bezel. The Company identification number was U30008DL2006PTC151557 (Figure 1).

The bony landmarks were first identified and marked with the elbow flexed at 90degrees. The shoulder was in neutral position, and the examiner sat behind the patient and measured the distances and angles (Figure 2). The lateral Supracondylar ridge was palpated and tracked downwards. The apex of the most prominent lateral bony landmark palpated was marked as the lateral epicondyle. The forearm was supinated and pronated alternately to confirm if the radial head was the next most prominent bony point distal to it. Similarly, the medial supracondylar ridge was palpated, tracked down, and the apex of the medial epicondyle was marked. The subcutaneous border of the ulna was traced proximally, and the most prominent bony mark was marked as the tip of the olecranon. The three points were joined with a marker pen to form a triangle, and the distance between the bony points was meas-

Figure 1. Vernier Calipers used to measure the distances.

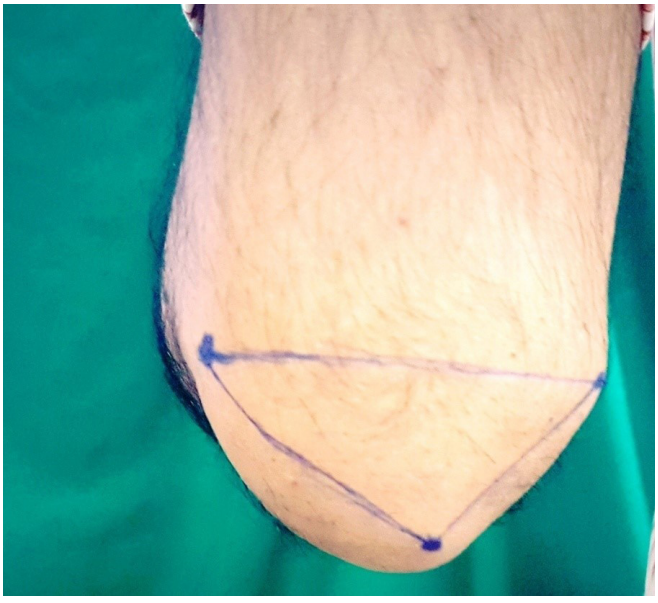
Figure 2. Photograph to demonstrate the triangle drawn.

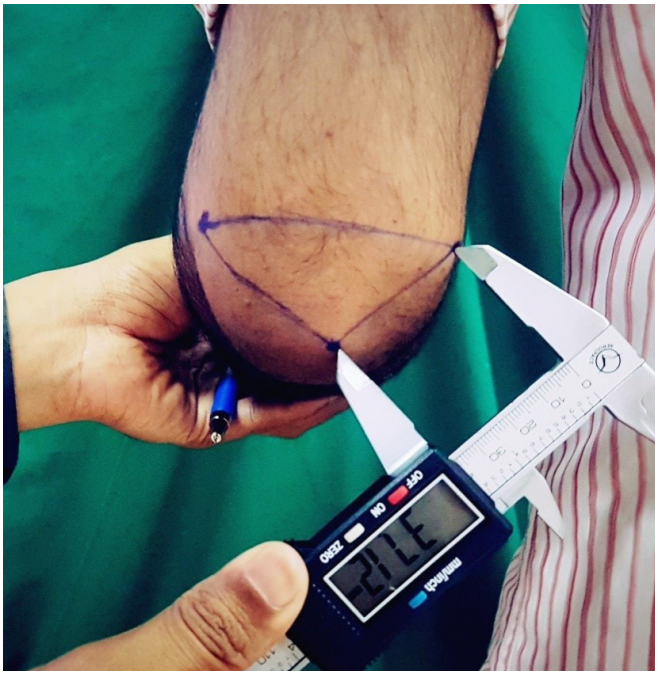

Figure 3. Photograph is demonstrating the distance measured between two points.

ured using the vernier calipers (Figure 3).

Two authors confirmed the readings, one of them always being the senior author. The readings were measured three times, and an average of the readings was recorded in our charts. Two authors including one senior author measured the readings independently, and the mutually agreed value was entered. This ruled out any inter-observer variability error.

Results

The study revealed that there was a definite lack of clarity among the senior professors as well as the post-graduates residents who participated in the poll. About 151 surgeons participated in the survey, out of which 88 surgeons voted for a scalene triangle, and 62 surgeons marked isosceles triangle in their answers.

Out of the 200 participants in the study, 111 participants were males,and89 participants were females. The mean age of the subject population was 23.78 years. The mean value of the distance between the tip of the olecranon process and the medial condyle of the humerus was 41.57mm. The mean value of the distance between the tip of the olecranon process and the lateral condyle of the humerus was 49.04 mm. The mean value of the distance between the tip of the medial condyle and the lateral condyle of the humerus was 52.62 mm. The mean values of the angles Alfa, beta and gamma, were 48.52, 37.47 and 94.04 degrees respectively.

This study concluded that in all the 400 elbows, the no two sides of the triangle were the same nor were any two angles measured were equal in any of the patients. The triangle formed was a scalene triangle in all the 400 elbows. There was a difference in the measurements in between the two elbows of one subject. This reason for this variation is unclear.

Discussion

This study revealed that the three bony point relationship formed in the elbow joint was a scalene triangle. The orthopedic manuals and textbooks still are not unified in their concepts in regards to this [2-13]. Nine standard reference books were studied. Apley, Magee, and Pandeylabelled it as an isosceles triangle [4,8,11]. Ebnezar, Mc Rae, Reider, and Dumontierlabeled it as an equilateral triangle [6,7,10,12]. Das is the only standard book which has explained it to be a "triangle of unequal sides" [5]. However none of these authors have cited a reference to justify this. A similar study of 200 elbows has been done three years back, and the results of their research are similar to ours [1].

This study was taken to refute the findings of the previous research. However, the authors find this study resonating the results of the former. The current authors still observe there is a genuine lack of consensus in the latest editions of the standard textbooks and the clinical manuals of orthopedics on this concept.

The limitations of this study are the small possibility of inter-observer error between the authors because of minor changes in the degree of flexion of the elbow. Usage of fixed angle flexion elbow braces could negate this error. A parallax error cannot be ruled out. Lastly, a human error of measurement could exist. The manual measurement could lead to interobserver error. However, the senior author supervised every patient. Although this error is not

negligible, efforts have been taken to minimize it.

This study reveals more clarity and additional evidence to the concept in question. This concept is frequently tested among undergraduates and postgraduate orthopedic residents in all universities. Clarity in these concepts is warranted among the orthopedic teaching community. Inter-examiner disagreement is a problem for the student taking the exam due to apparent confusion in providing the correct response. The authors thus feel that this study provides a suitable database of evidence-based medicine to be practiced. This study can help us define goals of successful surgery during management of intercondylar fractures of the humerus, isolated pediatric medial or lateral condyle fractures and fracture-dislocations of the elbow joint.

Conclusion

In conclusion, all the elbows in our study revealed a scalene triangle pattern. There is a variation in the measurements of the two elbows joints of the same subject. The reason is unclear.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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