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Research Article

Relationship Between Baumann's Angle and the Trochleocapitellar Index in Pediatric Supracondylar Fracture of Elbow

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Abstract

Introduction: Baumann's angle is an important radiographic tool used in the assessment of the quality of reduction of humeral supracondylar fractures in children. It plays a vital role in the prevention of varus malunion in these fractures by providing a good estimate of the carrying angle of the elbow.

Objective: To assess the relationship between Baumann's angle and the trochleao capitellar index in pediatric elbows.

Methods: The retrospective-prospective study was carried out at the Department of Orthopedic Surgery, Private Clinics at Khulna, Bangladesh from March 2018 to February 2023. Total of 45 children were analyzed under 14 years of age with supracondylar humerus fractures. They were analyzed by X-ray anteroposterior view of injured elbow, made before and after the surgery, by measuring Bauman's angle. Clinical examination was performed after completing physical therapy, when was measured carrying angle of the injured and healthy elbow using a goniometer. Results: A mean value of Baumann's angle of 72.4o was determined with a reference interval of 64° to 80°. The mean trochlea capitellar index was found to be 0.48 with a reference interval of 0.25 to 0.85. Baumann's angle and the trochlea capitellar index did not vary with age or sex. The trochlea capitellar index was found to positively correlate with Baumann's angle. The correlation coefficient and the coefficient of determination values for the linear relationship between the two measurements were 0.589 and 0.347 respectively.

Conclusion: We concluded that Baumann's angle and the trochlea capitellar index do not vary with age, sex, or race. There is a positive correlation between Baumann's angle and the trochlea capitellar index. Further studies on the role of the trochlea capitellar index in the assessment of the final carrying angle of pediatric elbows need to be conducted.

Keywords: Humeral Supracondylar Fracture; Trochlea Capitellar Angle; Baumann's Angle; Carrying Angle

Introduction

Baumann's perspective is an essential radiographic device used in the evaluation of the best reduction of humeral supracondylar fractures in children. It plays a crucial position in the prevention of varus malunion in those fractures by imparting a good estimate of the wearing attitude of the elbow [1]. It could be used both intraoperatively to assess the satisfactory discount of these fractures and in the postoperative follow-up length to evaluate for lack of discount after surgical treatment. The reference interval for the perspective stages among of 64o and 80o with a median price of 72o. Values of the attitude no longer range with age or intercourse [2]. Supracondylar humeral fractures are not unusual accidents in children [3-5]. The outcome of supracondylar fractures in this population has been commonly determined by clinical and radiographic parameters including, among others, the Baumann's angle of the humerus [4,6,7]. Despite its wide use, Baumann's angle has some limitations. It can only measure fracture displacement in the coronal plane despite the fact that these fractures may also exhibit sagittal plane and rotational displacement [8]. This calls for a need for an alternative radiographic tool that could address the limitations of the angle. Normal values of the Baumann's angle in the paediatric population have been reported to range between 64° and 80° [4,6,9]. Multiple factors that could explain the wide range in the normal value of Baumann's angle have been investigated [5,10]. However, to our knowledge, there is limited or no information about the reliability of the measurement of Baumann's angle. The Trochleocapitellar Index (TCI) was described by [8] as a potential alternative to Baumann's angle [8]. It is an index calculated from the ratio between two angles, the trochlear and the capitellar. Both of these angles are potentially disrupted in humeralsupracondylar fractures. Research on the index is still atits early stages. This study attempts to describe the normal values of the index and to study its relationship with Baumann's angle.

Methods and Materials

The retrospective-prospective study was carried out at the Department of Orthopedic Surgery, Private Clinics at Khulna, Bangladesh from March 2018 to February 2023. A total of 45 children were analyzed under 14 years of age with supracondylar humerus fractures. They were analyzed by X-ray anteroposterior view of the injured elbow, made before and after the surgery, by measuring Bauman's angle. Clinical examination was performed after completing physical therapy when was measured carrying angle of the injured and healthy elbow using a goniometer.

The humeral capitellar and the trochlear or alternative trochlear lines were digitally drawn on the x-rays. The Baumann's, trochlear, and capitellar angles were measured digitally using Image J® software and the trochlea capitellar index (TCI) was calculated for each radiograph based on the method used by [8]. Figure 1 demonstrates the technique used for the determination of the TCI and Baumann's angle.

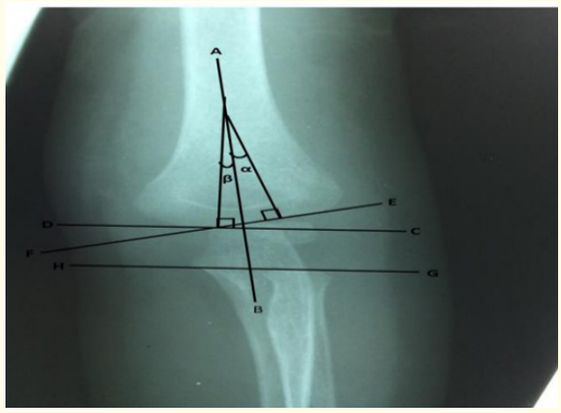

Figure 1: A radiograph showing the technique used for determining the TCI. AB humeral line, CD trochlear line, EF capitellar line, GH alternative trochlear line, α capitellar angle, β trochlear angle.

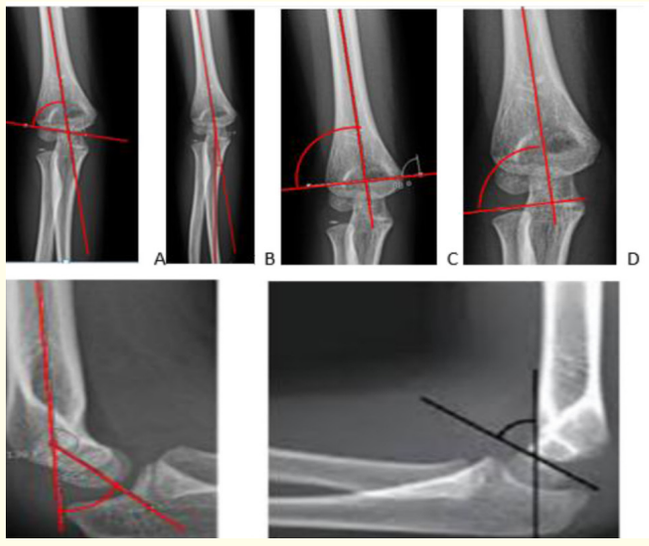

Figure 2: A: Baumann's angle, 1 B: Humero-ulnar angle (HUA), 1C: Metaphyseal-diaphyseal angle (MDA), 1D: Radial epiphyseal angle (REA), 1 E: Shaft condylar angle (SCA), 1 F: Lateral capitellohumeral angle (LCHA).

Radiographic relationships

Knowledge of normal radiographic relationships within the pediatric elbow is important for diagnostic evaluation. Assessment of the radio capitellar joint is performed by drawing a line down the middle of the radial neck or shaft on standard anteroposterior (AP), oblique, and lateral radiographs. This line should intersect

the capitellum at approximately its middle third on all radiographic views. Baumann's angle (or the humerocapitellar angle) is another radiographic measurement that may be used to assess the normal relationships of the distal humerus and is measured on the AP projection of the elbow. It is used to evaluate for the presence of a supracondylar or other types of distal humerus fracture. Drawing a line parallel to the longitudinal axis of the humeral shaft as well as a bisecting line parallel to the lateral condylar physis creates Baumann's angle. A normal angle is 70°-75° or within 5° of the contralateral elbow [11]. This measurement is also useful both during operative fixation and during follow-up evaluations to assess for any residual varus or valgus malalignment [12].

Data was analyzed using Statistical Package for Social Sciences SPSS software version 21. Proportions and means were used to summarize the different variables. Paired t-test was used to comparethe mean Baumann's angle and the TCI across age groups and patients sexes. The correlation between Baumann's angle and the TCI was assessed using Pearson's Correlation. A p-value of less than 0.05 was considered for statistical significance.

Results

The study enrolled 45 children. 28.9% of them were under 6 years of age and 33.3% were females. The mean Baumann's angle in the study group was 72.4° with a reference interval of 64° to 80°. Patients less than 6 years of age had a mean angle of 72° while patients aged 6 years or more had a mean angle value of72.5°. The mean Baumann's angle values in male and female patients were 72.2° and 72.6° respectively. The variation in the values of Baumann's angle across age groups and sex was not statistically significant. The mean TCI value was 0.48 with a reference interval of 0.25 to 0.85. Patients aged less than 6 years had a mean TCI value of 0.46 while those aged 6 years or more had a mean TCI of 0.49. The mean TCI values for male and female patients were 0.49 and 0.47 respectively. There was no statistically significant difference in the mean TCI based on age or sex. The relationship between Baumann's angle and the TCI was assessed using Pearson's Correlation. There was a statistically significant positive correlation between the two variables with a Pearson's Correlation Coefficient (r) value of 0.589 ($p < 0.001$). The coefficient of determination (r^2) for the linear relationship between Baumann's angle and the TCI was 0.347. The linear relationship between the TCI and Baumann's angle is shown in a scatterplot in figure 2.

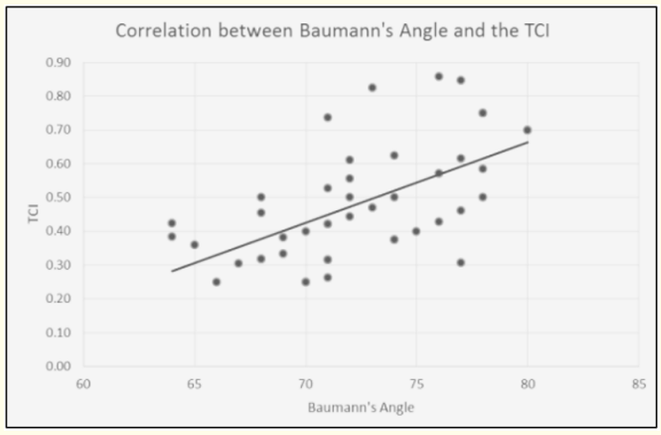

Figure 3: A Scatterplot demonstrating the relationship between Baumann's angle and the Trochleocapitellar index.

Discussion

The angle however has some limitations. Its values can vary among individuals as well as with whether the x-ray examined is a true anteroposterior view of the elbow [6]. The TCI was proposed as a potential alternative to Baumann's angle. This study attempted to define the normal values of both Baumann's angle and the TCI and to examine the relationship between these two parameters in our setting. Prevention of the complications associated with pediatric humeral supracondylar fractures is an important management aspect of these injuries. Varus malunion, the commonest of these complications could be effectively prevented through ensuring adequate reduction of these fractures by restoration of the normal Baumann's angle of the elbow. Williamson., *et al*. evaluated the normal values of Baumann's angle and its variation with age and sex on 114 Australian children. They reported a mean value of 72 o with a reference interval of 64o to 80o. The values of the angle in their study did not vary with age or se [2]. In Asia, Ko., *et al*. conducted a baseline normative study to determine the values of the angle in Chinese children. The study determined a mean value of 70o for the angle that does not vary with age or sex. They reported a mean angle value of 71.78 o. This study provided only the second independent scientific inquiry on the normal values of the TCI. Gorelick., *et al*. in Israel, published the first paper that described the index [8]. They described a mean TCI value of 0.4 and a reference interval of 0.25 to 0.8. These values did not significantly vary from those described in this study. This similarity in the TCI values in the two studies was expected. The capitellar angle that is used in the determination of the TCI is, in essence, a variation of Baumann's angle [7]. Since Baumann's angle value does not vary with race, we also expect the same for the TCI since it is at least partially influenced by the values of the angle. This study provides the first inquiry into how the TCI relates to Baumann's angle in normal pediatric elbows. The findings concluded a statistically significant, moderately positive correlation between the two measurements. A coefficient of determination value of 0.347 for the linear relationship between Baumann's angle and the TCI tells us that 34.7% of the variability in the values of the TCI could be explained by the changes in the values of Baumann's angle. Baumann's angle

is known to be an important tool to determine the carrying angle of the elbow. Worlock., *et al*. stated that the angle inversely correlates with the carrying angle of the elbow [1]. Based on the positive correlation between Baumann's angle and the TCI, we can safely conclude that the TCI is also inversely correlated with the carrying angle of the elbow.

Conclusion

The study supports the assertion that Baumann's angle does not vary with race, age, and sex. Because the TCI is influenced by the values of Baumann's angle, and based on the findings of the study, we can also conclude that TCI values do not vary with age, sex, or race. The TCI may have a potential role in assessing the carrying angle of the elbow in children. Further studies with larger sample sizes and appropriate sampling techniques are however required to confirm this finding.

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