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TO DETERMINE IMPORTANCE OF ANTERIOR HUMERAL LINE FOR SUCCESSFUL ANATOMICAL REDUCTION IN THE SURGICAL TREATMENT OF PAEDIATRIC SUPRACONDYLAR HUMERAL FRACTURES

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Abstract
When treating a juvenile supracondylar humeral fracture surgically, the anterior humeral line (AHL) and tilting angle (TA) are employed to evaluate the sagittal plane alignment of the paediatric elbow. There aren't many research that compare the reliabilities of these metrics, though. This study aims to ascertain if radiographic parameter measures are accurate and helpful in attaining anatomical reduction. In contrast to TA, we showed in the present work that determining the AHL location requires a straightforward and accurate measurement. Finding AHL during surgery is a sign that anatomical reduction has been achieved.

Introduction

The radiographic evaluation of paediatric supracondylar humeral fractures must include both lateral (sagittal) and anteroposterior (coronal) radiography images[1]. The majority of research on child supracondylar humeral fractures focusses on coronal plane malalignment. One Since hyperextension deformity is often assumed to be repaired with development, the decrease on the sagittal alignment has not gotten as much attention as that on the coronal alignment[2]. Nonetheless, a number of findings reveal that patients with a sagittal plane supracondylar fracture that is underreduced nonetheless have radiographic abnormalities and restricted elbow flexion until skeletal maturity.[2, 3] Orthopaedic surgeons should thus be more exacting when reducing the sagittal alignment since they are aware of this potential consequence[3].

On the sagittal plane, as opposed to the coronal plane, there are many in-depth studies examining the impact of several radiological parameters on reduction[4]. When evaluating sagittal plane alignment in paediatric supracondylar humeral fractures, the anterior humeral line (AHL) is a useful radiographic tool. [4,5,6] The AHL extends distally via the capitellum on the elbow's lateral projection after being traced along the anterior humeral cortex. In healthy elbows, AHL travels via the middle portion of the capitellum. The application of this measurement in the surgical management of juvenile supracondylar humeral fractures has only been covered in a few number of published papers. , 8. Additionally, distal fragment rotation[6] may produce conflicting intraoperative interpretation of AHL placement, and there is little evidence on capitellum orientation.[7]

A further indicator of sagittal plane alignment after paediatric supracondylar humeral fractures is the tilting angle (TA). The anterior tilt of the capitellum with regard to the humerus' long axis in the

sagittal plane is known as TA[8,9]. Several techniques have been used to quantify this relationship, and it has been called by several names in the literature, including humerocondylar angle, lateral capitellohumeral angle, capitellar angle, humerocapitellar angle, and capitellar angle[8,9,10,11]Although the techniques for measuring TA are very straightforward, they are insufficient on their own to make final judgements for the treatment of paediatric supracondylar humeral fractures due to the large individual variances[11]. Although TA can demonstrate the distal humeral fragment's anteroposterior displacement, it is insufficient to assess rotation[12,13].

The clinical utility of radiographic measures is contingent upon their repeatability and dependability. Changes in a value may indicate measurement error rather than clinical reality if it cannot be assessed with good reliability and reproducibility. The purpose of this study was to ascertain if radiographic parameter measures in the elbow sagittal plane are accurate and helpful in attaining anatomical reduction. Orthopaedic surgeons with different degrees of expertise evaluated intra- and inter-observer agreement in the measures of the fractures on radiographs.

Materials and Methods

This study was approved by the institutional review board before it started. ERA'S Lucknow Medical College and Hospital, *Sarfarazganj Hardoi Raod, Lucknow*'s ethics committee gave its approval for this study. Every patient consented to the study's conditions. Between 2008 and 2013, patients who had a displaced supracondylar humeral fracture treated at our institutions with closed reduction and percutaneous K-wire fixation had radiographs obtained right after surgery. Patients having a history of fractures or other upper extremity fractures were not included. Additionally, we did not include any individuals for whom a genuine lateral radiograph was not available. According to Skibo and Reed's finding, the distal piece of the humerus should show superimposed posterior supracondylar ridges on the true lateral radiograph.[7,8,9,12] The mean patient age at the time of the fracture was 9 years (range 4-14 years), and 60 individuals out of the total population participating in this study satisfied these criteria.

To ascertain the intra- and inter-rater reliabilities, three observers were divided in 4 groups randomly and advised to measure three radiographic parameters: the AHL location, TA, and Baumann's angle (BA). After removing any identifiable patient information, the radiographs were randomly assigned to the three observers. In order to prevent recollection bias, the observers took identical measures on each of the 44 radiographs at least two weeks after the first evaluation. The outcomes of their initial assessment were hidden from them. An independent researcher (a board-certified orthopaedic surgeon with four and fourteen years of experience) collected and analysed the data, blinded and randomly assigned the patients, and disassociated themselves from the measuring procedure[13,14].

Measurement in Radiography [7,8,12]

The AHL extends distally via the capitellum on the elbow's lateral projection after being traced along the anterior humeral cortex. By splitting the capitellum into three equal halves and drawing a second line from the front to the posterior side, the AHL location was determined. The assessment was based on the link between the anterior middle third, middle third, and posterior middle third of the capitellum and AHL.

Two transverse lines linking the anterior and posterior cortices of the radius were drawn across the humerus to measure TA. The long axis of the humerus was then determined by drawing a line down the humerus that connected the midpoints of the two lines. Additionally, a second line was drawn along the humeral diaphysis' long axis. Lastly, the angle formed by the two lines was used to calculate TA[2,6,9].

BA is the angle created by the line along the humeral shaft axis and the capitellar physis. Two transverse lines linking the medial and lateral cortices of the radius were drawn across the humerus to measure BA. The long axis of the humerus was then determined by drawing a line down the humerus that connected the midpoints of the two lines. Lastly, the angle formed by the two lines was used to calculate BA.

Statistical analysis

Since the AHL location is a categorical variable, both intra-rater and inter-rater reliabilities were tested using the kappa statistic with 95% CIs. According to Landis and Koch, a kappa statistic of 0 to 0.20 indicates little agreement, 0.21 to 0.40 indicates reasonable agreement, 0.41 to 0.60 indicates moderate agreement, 0.61 to 0.80 indicates significant agreement, and >0.80 indicates almost perfect agreement, even though there is no standard threshold for acceptability.
In the elbow sagittal plane, BA was also examined for any associations with the radiographic characteristics. The Student's t-test was used to assess the relationship between the AHL location and BA. The Pearson product-moment correlation coefficient (r) was used to evaluate the relationship between TA and BA. SPSS software (version 22.0; SPSS Inc., Chicago, IL) was used to analyse the data.

Fig-1

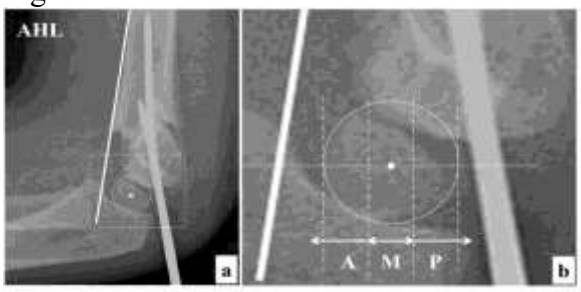


Fig 2

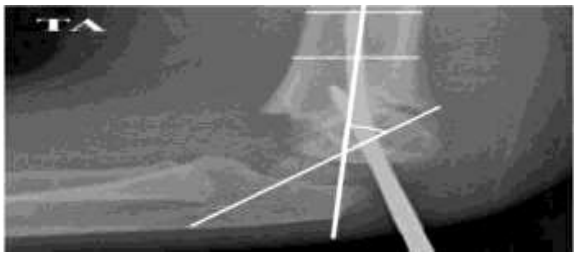
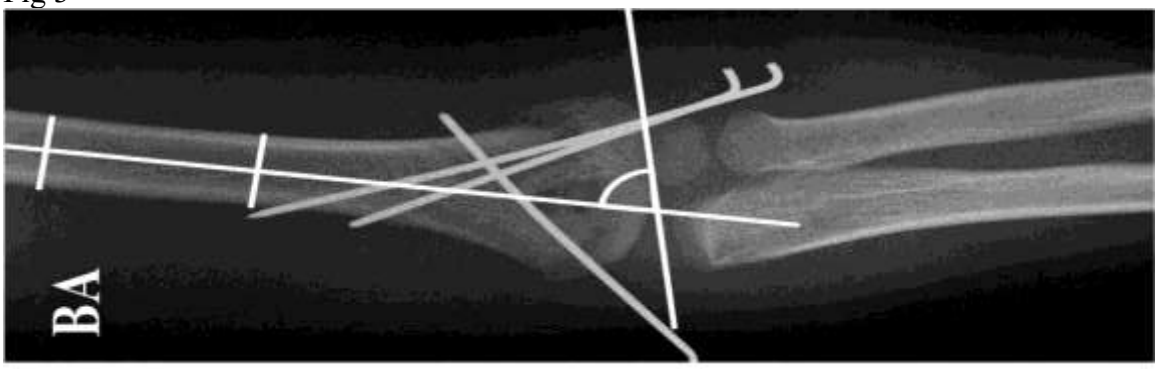


Fig 3



Results

In 68% of cases, AHL went via the anterior middle third, 32% through the middle third, and 0% through the posterior middle third. The average temperature was 39 ± 11 degrees for TA and 73 ± 8 degrees for BA. Significant inter-rater reliabilities (0.78), as well as strong intra-rater reliabilities (0.76-0.98), were seen at the AHL sites. Significant intra-rater (0.68-0.79) and modest inter-rater (0.52) reliabilities were demonstrated by TA. BA had significant inter-rater reliabilities (0.65) and high intra-rater reliabilities (0.58-0.87) that were close to ideal. The anterior humeral line (AHL) was depicted in Figure 1. The tilting angle (TA) and Baumann's angle (BA) were displayed in Figure 2 and Figure 3, respectively, while the connection between the AHL and capitellum was categorised as anteriorly loss (A), middle third (M), and posteriorly loss (P). Orthopaedic surgeon 1's mean BA at the AHL site differed statistically significantly between the anterior middle third (77 ± 9 degrees) and the middle third (71 ± 6 degrees) ($p < 0.05$). Orthopaedic surgeon 1's TA and BA did not significantly correlate, according to the Pearson product-moment correlation coefficient ($r = 0.07$, $p > 0.05$).

Discussion

According to the current investigation, the AHL location exhibited significant inter-rater and intra-rater reliabilities that ranged from considerable to almost flawless. Although TA's intra-rater reliability was significant, its inter-rater reliability was far worse. According to these findings, TA has a poorer

inter-observer reliability but may be assessed consistently by a single observer. When comparing the results of radiographic treatments from several surgeons, TA is a helpful tool. Similar to the current study, prior research has shown that the intra-rater and inter-rater reliabilities for TA vary from 0.67 to 0.87 and 0.37 to 0.60, respectively.Among some surgeons, determining the AHL position is an easy and accurate measurement. It is now a helpful technique for treating paediatric supracondylar humeral fractures by attaining precise anatomical reductions.

According to researchers in their study showed that the extensional and rotational abnormalities are present in 80% of patients with a cubitus varus deformity.According to their findings, treating paediatric supracondylar humeral fractures also required reducing extensional and rotational malalignment[5,9]. Even while TA displays the distal humeral fragment's anteroposterior displacement, it is insufficient to assess rotation. The proximal fragment's intraoperative anterior bony spike showed the remaining rotational and extensional malalignments[8]. TA is unable to account for the anterior bony spike in the measurement, though. AHL, on the other hand, can evaluate any remaining rotational and extensional malalignments and reflect the anterior bony spike. There was a statistically significant difference in the mean BA between going through the middle third and crossing the anterior middle third at the AHL site in the current investigation. Varus malalignment is caused by the residual extensional and rotational malalignments, especially when there is an oblique fracture line in the sagittal plane from anterior to posterior[6,8]. For a satisfactory anatomical reduction in both the sagittal and coronal planes, the intraoperative reduction with AHL going through the middle part of the capitellum was crucial.

With the examination of all radiographs, regardless of age, Herman et al. showed that the kappa value of AHL varies from 0.56 to 0.68; their results were smaller than those of the current study. We believed that these variations were connected to the humerus's modest posterior bending, an anatomical characteristic. There is limited information on how to create a line along the humerus' anterior cortex that accounts for bending while measuring AHL[10]. To get rid of the bending effect, we only measured AHL on the anterior edge of the proximal segment, which is the distal third of the humerus. The dependability findings may be connected to the measurement discrepancies between the current study and Herman et al. Our measuring technique can lower AHL reliability errors.

There are many restrictions on the current investigation. First, we didn't look at whether the middle part of the capitellum is traversed by the AHL site on the unaffected side. According to Ryan et al., the AHL passes through the middle part of the capitellum in all individuals older than five years, but in 25% of patients younger than five years, the AHL falls outside of this region[4,7]. The AHL site in our data was deemed to pass through the middle third of the capitellum since all of the radiographs were older than five years. However, compared to the current study's findings, the AHL location's reliability may be poorer in skeletally immature patients younger than five years. Second, we looked at the relationship between BA and the AHL location in two-dimensional assessments. Three-dimensional assessments allow for a more accurate assessment of the association. The 2-dimensional examination, on the other hand, represents typical postoperative pictures that could be more clinically significant. Lastly, we just contrasted TA and the AHL location. For a sufficient decrease, Turhan et al. suggested combining a few radiological criteria in the sagittal plane. Even in individuals with skeletal immaturity, reliability may be increased by combining the position of the AHL with additional sagittal plane radiological parameters. Future research should examine if the AHL position in conjunction with a few other radiological parameters in the sagittal plane enhances the anatomical reduction[9].

In conclusion, as compared to TA, determining the AHL location is a trustworthy measurement. According to the correlation between the AHL position and BA, intraoperative determination of the AHL site is a reliable predictor of elbow deformity following surgery. When treating a juvenile supracondylar humeral fracture, it is crucial to reduce the distal fragment with AHL that passes through the middle third of the capitellum in order to establish anatomical alignment.

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