Correlation Between Bauman’s and Carrying Angle in Children with Supracondylar Fracture of Humerus

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Supracondylar fractures are the result of a fall on outstretched hand in more than 70% of cases, and more common in the non-dominant arm. Bauman’s angle is used to determine the degree of displacement and angulation, and the quality of fracture reduction. Carrying angle is the clinical parameter of varus-valgus angulation with elbow fully extended and forearm completely supinated. Patients and methods: The study was a retrospective-prospective and there were analyzed children under 14 years of age with supracondylar humerus fracture. They were analyzed by X-ray anteroposterior view of injured elbow, made before and after the surgery, with 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 and discussion: The results showed that there is a negative correlation Bauman and carrying angle of injured elbow (r=−0.543, p <0.0001). Analyzing Bauman’s angle deviation from value of 75 ° and the loss of carrying angle there is noticed significant positive correlation between the Bauman angle deviation and loss of carrying angle. Bauman’s angle correlates well with the carrying angle and can be used as an indicator of the potential cosmetic complications. Conclusion: Carrying angle of uninjured elbow measured when reviewing a child who has suffered supracondylar fracture, can serve as a useful parameter in the assessment of real Bauman’s angle, thereby the adequacy of fracture reduction on the injured arm. Keywords: supracondylar fracture, humerus, Bauman’s angle, carrying angle

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1. INTRODUCTION
Supracondylar fractures are the result of a fall on outstretched hand in more than 70% of cases, and more common on the non-dominant arm. Children tend to protect themselves with extending the arm during the fall, thereby explaining the high incidence of fracture of the upper extremity. Supracondylar fractures are the most common cause of hospitalization of children with elbow injury (1, 2). They occur in two basic types: extension, more common type (98%), and less common flexion type (2%). Extension type of supracondylar fracture usually occurs in the fall on the outstretched hand with elbow in hyper extension, and flexion type as a result of the direct effect of force on the back of the elbow. Diagnosis of supracondylar fracture is based on the clinical signs and radiological examinations (3). To determine the degree of displacement and angulation, and the quality of fracture reduction is used Bauman’s angle (4). Bauman’s angle is measured after fracture reduction on the anteroposterior X-ray view, and it is represented by a line that goes along the epiphiseal capitulum and the longitudinal axis of the humerus. Normal value is 75 °, while the increase in value by 5 ° or more indicates varus deformity, a decrease of 5 ° and more valgus deformity (5, 6). Carrying angle is the clinical indication of varus-valgus angulation of the arm with elbow fully extended and forearm completely supinated. This angle is defined by the section of the line that runs along the middle axis of the arm and the line that runs along the middle axis of forearm. There is no significant difference in the carrying angle value in men and women, but there is significant difference based on age. At the age of 0-4 years the value is about 15º and 17.8º in adults. Increasing this angle indicates a valgus deformity, and reducing the varus deformity (7).

2. AIM
The aim of this study was to determine the correlation between Bauman’s angle measured on the anteroposterior X-ray view injured arm after reduction, and carrying angle injured arm after finished treatment.

3. SUBJECTS AND METHODS
The study was a retrospective-prospective and analyzed for children under 14 years of age with supracondylar...
humeral fractures, surgically treated at Orthopedic-Traumatology Clinic of the University Clinical Center Tuzla in the period from January 2005 to September 2010. Including criterion was completely displaced supracondylar fracture of humerus (Gartland type III – extension type), while excluding criterion was an open fracture, as well as the existence of another a fracture on the same hand. The proper medical documentation was used: case histories, X-ray images before and after treatment, and ambulatory protocols. Postoperative testing was performed at least three months after surgery. Random selection method selected 60 subjects who were invited and analyzed as follows:

- The first group (group 1) were patients who were hospitalized for up to 24 hours of the injury and who were immediately treated surgically without attempting closed fracture reduction and cast immobilization. The second group (group 2) were patients who underwent surgery after 24 hours of injuries; surgical treatment after this period was made because the respondents appeared later, or a failed closed fracture reduction with cast immobilization.

- Anteroposterior X-ray views of injured elbow were analyzed, made before and after surgery. Preoperative images were used to confirm the diagnosis supracondylar fractures and determine the degree of dislocation. Postoperative recordings were used to assess the quality of the repositioning of the fracture. Bauman’s angle was measured. Bauman’s angle was measured on the anteroposterior image, and presented to the lines that go to the longitudinal axis of the humerus capitulum and along the epiphysis. The values of this angle 75 ± 5° were considered as anatomical reconstruction.

- After completing the physical therapy clinical examination was performed, which was measured carrying angle of the injured and healthy elbow. Carrying angle was measured using a goniometer, in the full extension of forearm. It is defined by the section of the line that runs along the middle axis of the arm and the line that runs along the middle axis of forearm. Based on data obtained the degree of loss of carrying angle injured compared to healthy elbow was evaluated. For statistical analysis of data was used statistical software SPSS 12. Statistical analysis of data was performed by descriptive statistics to calculate the mean and standard deviation, and t-test and χ² test to calculate the significance of the established results. Statistical analysis was performed with a confidence interval of 95%, a value of p < 0.05 was considered significant.

4. RESULTS
The study involved two groups of 30 patients each. The first group of patients underwent surgery to 24 hours after injury (group 1), there were 20 boys and 10 girls, and the second group underwent surgery after 24 h of injury (group 2) and there were 19 boys and 11 girls (p = 0.37). The average of the first group was 7.16 ± 2.46, and another group of subjects 7.23 ± 2.81 years (p = 0.46). In both groups the largest number of respondents belonged to a life sentenced to six to ten years. Regard to position of the distal fragment in both groups there is higher number of respondents with posteromedial dislocation of the distal fragment (p = 0.14). In both groups more of respondents had a fracture of the left humerus (p = 0.1), which was mostly non dominant. Measurement of Bauman’s angle on the anteroposterior view in both groups showed no statistically significant difference in their values (p = 0.37) (Table 1). In both groups the majority of respondents had a value of Bauman’s angle 70–80° (Figure 1). Increase of Bauman’s angle in both studied groups mostly occurs in posteromedial dislocation (dislocations 1), and decrease in the posterolateral dislocation of the distal fragment (dislocations 2) (Figure 2). The mean carrying angle of the injured elbow after completing physical therapy in group 1 was 11.90 ± 7.80°, and in second group 13.37 ± 6.89° (p = 0.21). The
injured elbow in the first group was 4.30 ± 7.66°, and the second group 5 ± 6.11° (p = 0.35) (Figure 3). In both studied groups there was a negative correlation between Bauman’s and carrying angle of injured elbow (r = -0.543, p < 0.0001) (Figure 4). Analyzing deviation of Bauman’s angle from the value of 75° with the loss of carrying angle a significant positive correlation between the deviation Bauman’s angle and loss of carrying angle was noticed (Figure 5).

5. DISCUSSION

Supracondylar fractures of the humerus are the most common type of elbow fracture in children and adolescents and accounts for 16% of all fractures in childhood. In 60% of cases the fracture is on the left, usually the non-dominant hand (8). Dislocated supracondylar fractures can lead to serious residual deformity if they are not reduced and stabilized in the optimum position. The goal of treatment is to achieve and maintain the anatomic location of the fractured fragments, which leads to rapid recovery with the return of full and unrestricted function with minimal risk of complications. After making the stabilization the goal is to preserve the position of fractured fragments since the loss of reduction leads to changes of carrying angle and to possible occurrence of cubitus varus. Adequacy of supracondylar fracture reduction is observed on anteroposterior and profile view of elbow. Bauman’s angle is a good indicator of the adequacy of repositioning. This is based on the assumption that Bauman’s angle is in constant relation to the carrying angle in dislocated fractures.

Dai conducted a study in 1999 and found a significant correlation between Bauman’s angle that was measured immediately after repositioning and carrying angle that was measured in the postoperative follow-up. He concluded that the measurement of the Bauman’s angle after the repositioning can be used for estimating of the final carrying angle, which is important for the prevention of cubitus varus (9). Silva et al. conducted a study in 2010th and they examined the Bauman’s angle in 35 children with supracondylar fractures. They concluded that the Bauman’s angle is simple, easily measurable and reliable indicator that can be used to assess the outcome of supracondylar fractures in children (10). Besides Bauman’s angle which is used to evaluate the adequacy of fracture reduction, measuring of carrying angle is performed, and it is used to evaluate the success of treatment. Changes in carrying angle after supracondylar fractures occur as a result of inadequate anatomical reconstruction due to loss or repositioning, and may also be due to disturbances in the growth of the distal end of the humerus (11, 12). Worlock conducted a study that examined the correlation of Bauman’s and carrying angle on the uninjured, and the same angle on the injured arm. This study has shown a direct correlation in Bauman’s and carrying angle. With increase of the Bauman’s angle there is decrease in the value of carrying angle on the healthy and the injured arm (13). Measurement of Bauman’s angle after supracondylar fracture reduction is a good indicator of the final value of carrying angle in injured arm, and thus of the potential occurrence the angular deformity.

In our study, in both studied groups, postoperative anteroposterior X-rays of the injured elbow were made and the Bauman’s angle was measured (α). Reciprocal angle (90–α) is approximately equal to the carrying angle, which is measured by goniometer. Correlation of reciprocal angle on the anteroposterior image and carrying angle measured with goniometer was used in our study.

After the carrying angle on healthy elbow was measured, Bauman’s angle on the healthy elbow was assessed, and as a good anatomical reconstruction of the injured elbow fractures considered value of Bauman’s angle 75 ± 5°. Based on the average values we assessed that in both groups adequate anatomical reposition was mostly achieved.

6. CONCLUSION

Bauman’s angle measurement is important for assessing the adequacy of supracondylar fracture reduction. Bauman’s angle correlates well with the carrying angle and can be used as an indicator of the potential occurrence of cosmetic complications. Carrying angle of uninjured arm measured when reviewing a child who has suffered supracondylar fracture, can serve as a useful parameter in the assessment of real Bauman’s angle, and thus the adequacy of repositioning the injured hand.

REFERENCES