Inkenas Matas
Master of sciences, Lithuanian University of Health Sciences Kaunas Clinics, Department of Orthopaedics and Traumatology, Republic of Lithuania

Cekanauskas Emilis
Doctor of Medical sciences, Professor, Professor of Lithuanian University of Health Sciences Kaunas Clinics, Department of Orthopaedics and Traumatology, Republic of Lithuania

EVALUATION OF COMPLICATIONS BETWEEN TYPE II AND III FRACTURES ACCORDING TO GARTLAND CLASSIFICATION IN PEDIATRIC SUPRACONDYLAR HUMERUS FRACTURE

Abstract. Study goal was to evaluate, to compare treatment outcomes and complications for children with displaced humerus fracture. Distribution of subjects by age, gender, dominant hand and distribution of subjects according to the fracture mechanism and the Gartland classification were evaluated.

Keywords: supracondylar humerus fracture, Gartland classification, pediatric.

The supracondylar humerus fracture is often found in the work of a pediatric traumatologist and is considered to be the most common elbow trauma in pediatric patient. The supracondylar humerus fracture accounts for about 60 percent among all child elbow fractures (1). The most vulnerable children are between 3 and 6 years old (2). Although boys are diagnosed with supracondylar humerus fractures more frequently, the gender distribution is almost the same (48% of girls, 52% of boys) (2,3). Younger children are particularly vulnerable as a result of distal humeral cortex thinning and the interaction between the olecranon and the olecranon fossa in elbow extension during fall (4). The physiological ligamentous laxity also allows the joint to perform hyperextension (5,6). The Wilkins modification of the Gartland classification is currently in use (Table 1).
Table 1

Fracture types according Gartland classification

| Type | Description |
|------|-------------|
| I    | non-displaced fracture |
| II   | partially displaced fracture with intact posterior cortex |
| III  | a completely displaced fracture, without cortex contact, may have a rotational displacement |

Accurate diagnosis is especially important. Misdiagnosed and mistreated dislocated fractures can lead to severe complications. Pain, deformity, impaired function, redness, tenderness in the elbow area are the main symptoms suggesting a supracondylar humerus fracture. Anterior and lateral elbow x-ray must be performed for suspected fractures. Type II and type III fractures are easily seen on X-rays, but type I non-displaced fractures often require indirect signs for diagnosis such as anterior and posterior fat pad sign, sail sign (7, 8, 9). There are several ways to perform percutaneous osteosynthesis for supracondylar fractures, most commonly Gartland type II and III (9,10).

Research goal was to evaluate and compare treatment methods for children with dislocated humerus fracture. The following tasks were to evaluate distribution of subjects by age, gender, dominant hand and distribution of subjects according to the fracture mechanism and the Gartland classification. Also, to review the outcomes and complications.

The study was performed using retrospective data analysis. The case histories of children who underwent supracondylar humerus fracture and were treated in hospital from 2017 to 2020 were examined. The Hospital Information System (LIS) was used to examine case histories and the Meddream system for X-ray images. Research population consisted of 125 patients. Research subjects were evaluated by age, sex, side of injured arm, type of fracture, period of wire fixation and complications.

Epidemiological evaluation of patients has been shown to be consistent with other studies. Of the 124 subjects, 59.68% were boys (n = 74) and 40.32% were girls (n = 50). The most common humeral fracture occurs in children aged 5 to 7 years (2). The study found that the average age of boys was $6.1 \pm 2.5$ years, of girls $5.5 \pm$
2.5 years. L. V. Barr found in a 2018 study that the median age of patients with VGL was 6.1 years and 53% by gender were boys (11). In a 2020 study by Nick I. Pilla and others, 56% were boys and 44% were girls (12). Non-dominant hands are more likely to break. The study found that the left hand broke the most (62.6%, n = 77), which is 1.7 times more common than the right hand. Assessing that right-handedness is the predominant hand dominance, it can be assumed that the non-dominant hand is more often injured. According to other authors, about 58% injured the non-dominant hand (12).

Displaced type II or III supracondylar humerus fracture was found in 119 patients and a flexion type fracture in 1.6% (n = 2). The majority of patients were 5 to 6 years old. Age range from 2 to 11 years. According to the method of reduction, out of 116 patients, 94% (n = 109) of patients underwent closed reduction and 6% (n = 7) - open reduction. Good outcome was 82.7% (n = 86), postoperative neuropathy was performed in 1.9% (n = 2), and contracture was observed in 15.4% (n = 16) of patients.

Supracondylar humerus fracture is often complicated by neurovascular complications, contractures, and deformities (14). According to the Gartland classification, type II fracture was detected in 37.8% (n = 45) of patients and type III fracture in 60.5% (n = 72) of patients. The figure 1 shows the dependence of how complications correlated with the type of fracture according to Gartland.

![Figure 1](image.png)

Fig. 1. Assessment of the relationship between complication and fracture type.

There was a statistically significant difference (p <0.001)
A statistically significant difference was found in the number of complications between Gartland type II and type III fractures. The frequency of neurovascular complications was not statistically significantly different between type II and type III fractures. Good treatment outcomes for type II fractures were 82.4%, with contracture or neuropathy found in 17.6% of patients. Type III good outcomes were 81.5% and contracture or neuropathy was 18.5% of patients. A study conducted in Germany in 2019 found that Gartland's type III fracture and surgical tactics were the main factors leading to a higher number of complications: decreased amplitude, neurovascular damage (15).

After estimating the fixation time (days) according to the type of fracture: Type II according to Gartland - 25.7 ± 4.52 days; Type III according to Gartland - 24.76 ± 6.22 days. The fracture type had no statistical significance for duration of Kirschner wire fixation time (p > 0.05).

In conclusion, boys aged 5-6 are most likely to experience a supracondylar humerus fracture, and the non-dominant hand is injured more often. The most common fracture mechanism is extension-type displaced supracondylar humerus fracture. Two-thirds of the subjects had a type III fracture according to Gartland. Neurovascular complications or contractures were more common in patients with type III fractures.

References:
1. Emery, K., Zingula, S., Anton, C., Salisbury, S., Tamai, J. (2015) “Pediatric elbow fractures: a new angle on an old topic”, Pediatric Radiology, 46(1), pp. 61-66.
2. LiBrizzi, C., Klyce, W., Ibaseta, A., Shannon, C., Lee, R. (2020) “Sex-based differences in pediatric supracondylar humerus fractures”, Medicine, 99(20), e20267.
3. Holt, J., Glass, N., Shah, A. (2018) “Understanding the Epidemiology of Pediatric Supracondylar Humeral Fractures in the United States: Identifying Opportunities for Intervention”, Journal of Pediatric Orthopaedics, 38(5), pp. e245-e251.
4. Brubacher, J.W., Dodds, S.D. (2008) “Pediatric supracondylar fractures of the distal humerus”, Current Reviews in Musculoskeletal Medicine, 1(3-4), pp. 190-196. doi: 10.1007/s12178-008-9027-2.
5. Nork, S., Hennrikus, W., Loncarich, D., Gillingham, B., Lapinsky, A. (1999) “Relationship Between Ligamentous Laxity and the Site of Upper Extremity Fractures in Children”, Journal
6. Gartland, J.J. (1959) “Management of supracondylar fractures of the humerus in children”, Surgery, gynecology & obstetrics, 109, pp. 45–154.

7. Mulpuri, K., Wilkins, K. (2012) “The Treatment of Displaced Supracondylar Humerus Fractures”, Journal of Pediatric Orthopaedics, 32(Supplement 2), pp. S143-S152.

8. Ladenhauf, H., Schaffert, M., Bauer, J. (2014) “The displaced supracondylar humerus fracture’, Current Opinion in Pediatrics, 26(1), pp. 64-69.

9. Prashant, K., Lakhotia, D., Bhattacharyya, T., Mahanta, A., Ravoof, A. (2016) “A comparative study of two percutaneous pinning techniques (lateral vs medial–lateral) for Gartland type III pediatric supracondylar fracture of the humerus”, Journal of Orthopaedics and Traumatology, 17(3), pp. 223-229.

10. Dekker, A., Krijnen, P., Schipper, I. (2016) “Results of crossed versus lateral entry K-wire fixation of displaced pediatric supracondylar humeral fractures: A systematic review and meta-analysis”, Injury, 47(11), pp. 2391-2398.

11. Barr, L. (2014) “Paediatric supracondylar humeral fractures: epidemiology, mechanisms and incidence during school holidays”, Journal of Children's Orthopaedics, 8(2), pp. 167-170.

12. Pilla, N., Rinaldi, J., Hatch, M., Hennrikus, W. (2020), “Epidemiological Analysis of Displaced Supracondylar Fractures”, Cureus, 12(4), pp. e7734. doi:10.7759/cureus.7734

13. Kiran, K. K, Prasad, R. S. (2015) “Volkmann's Ischemic Contracture with Atrophic Non-union of Ulna Managed by Bone Shortening and Transposition of Radial Autograft”, Journal of orthopaedic case reports, 5(1), pp. 65-68.

14. Körner, D., Laux, F., Stöckle, U., Gonser, C. (2019) “Factors influencing the complication rate in pediatric supracondylar humerus fractures”, Orthopedic Reviews, 11(2).