

Comparison of Treatment Results for Fractures of the Distal Humerus in Children According to the Indication for Conservative or Surgical Solution

Sead Buturovic¹, Ferid Krupic²

General Hospital Konjic, Konjic, Bosnia and Herzegovina¹

Department of Orthopaedics, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Sweden²

Corresponding author: prof. Sead Buturovic, MD, PhD. General hospital Konjic, Konjic, Bosnia and Herzegovina. E-mail: sean@gmail.com

ABSTRACT

Introduction: Records about the fractures of the distal humerus could be found in the scriptures written long before Christ (Hippocrates 300 to 400 BC). During the twilight of science development and of any scientific work (the Middle Ages), little has been written about this problem. Between the 1700 and 1800 much was discussed about the controversies between the correct position and immobilization. In the early twentieth century view on the treatment of fractures of the distal humerus begins to change dramatically, from the former passive to active surgical treatment. The sudden turnaround followed thanks to the intensive development of technology, especially new imaging technology. **Material and methods:** We observed a period of 4 (four) years (1998 to 2002), and only hospital patients of certain age. As database are used the histories of the disease. The patients were followed for one year and at the same time, we analyzed (clinical) early complications after three (3) months and late complications (X ray), after a year. Among the early complications we observed most often lower motility and contraction, and of late we have followed the morphological deformation—cubitus varus and valgus. **Results:** Using x-ray images, we measured Baumann's (en face) and lateral condylar angle (profile) after one year in the operated group and the group treated conservatively SPDH type III in children. We calculated the arithmetic mean (\bar{x}) and a standard deviation (SD) in both groups. Using chi square and t-test, with the probability of 95%, we showed that there is a significant difference between operative and conservative treatment of SPDH type-III in children, according to Gartland. **Conclusion:** All humerus fracture type-III by Gartland in children should be surgically treated. Surgery should be undertaken in a time frame of 6 hours. Surgery should be done in these cases by the specialized institutions (Clinical Hospital Centre). The success of treatment in such institutions corresponds to the results achieved in the world (93.0%). We must be sure to adopt and implement a scheme of treatment of fractures of the distal humerus in children. Required is faint trial, OPF, lateral (Kaplan) approach, exceptionally for some articular fractures posterior approach by Campbell, fixation with two or more Kirchner's needles, usually cross-set at an angle of 30°, vacuum drainage with cast immobilization.

Keywords: fractures of distal humerus, treatment modalities, children.

1. INTRODUCTION

About the fractures of the distal part of the humerus wrote Hippocrates (300 to 400 BC). In the classics of medical literature not much has been written about this problem. Between the 1700 and 1800 much was discussed about the controversies between the correct position and immobilization (1). In the early twentieth century view on the treatment of fractures of the distal part of the humerus begins to change dramatically, from the former passive to active surgical treatment. The sudden turnaround followed thanks to the intensive development of technology. Intensive development of radiology and the use of new imaging technology (C-arc), strongly changed possibility

to achieve and maintain an adequate reduction, which led to a drastic reduction in the incidence of complications.

Until recently, many doctors believed that conservative treatment is the optimal solution for the treatment of fractures of the distal humerus. In 1937 Eastwood describes so called "Bag of bones" technique, which involves the manipulation of the compressive distal fragment, elbow immobilization in flexion of 120° and a neck cuff (2).

Evans warns that, despite the relatively satisfactory mobility in the joints, often the final result of conservative treatment of fractures of the distal humerus in children "weak and unstable elbow." (2)

In 1943 Watson and Jones, commenting on surgical treatment, point out that, despite the ideal anatomical reconstruction, joint mobility is lower and the results are worse than the results with conservative treatment. For this reason, they recommend a closed reduction or limiting surgical repositioning and stabilization with Kirchner's wires (2). Lambotte, in 1960 was first who described surgical technique for stable osteosynthesis of fractures of the distal humerus, forming the AO-ASIF (2).

Risebourgh and Radin in 1969 year warned about restrictions of surgical intervention for fractures of the distal part of the humerus (2).

Today it is considered that the operative reduction and internal fixation of fractures of the distal humerus with displacement in children "gold standard" for most patients.

2. GOALS

Identify the results of treatment of fractures of the distal humerus in children by conservative and surgical treatment, and give recommendations for an optimal method of treating the individual stages of the surgery today.

3. MATERIAL AND METHODS

The research was conducted as a retrospective (using the disease history from the Clinic for Orthopedic Surgery, Clinical Center of Sarajevo University and Konjic General Hospital outpatient records or protocols), descriptive, clinical, comparative. The injured mainly came to the clinic accompanied by a parent.

On the basis of medical history or heteroanamnestic data, injuries have occurred mostly in the course of the game, a small number as a result of traffic accidents (the majority of the patients came directly to the clinic, and a slightly smaller number of through Clinic of Emergency Medicine, and the least number from other institutions. At 53.1% of the injured had transport immobilization. Among patients from the time of injury, up to the moment of arrival at the clinic, there was no neuro-vascular problems, nor open fractures.

Baumann's angle is today the best indicator for assessing post reduction alignment. It is measured in the AP projection and is defined as the angle which makes fiseal line of the lateral condyle and the longitudinal axis of the humerus—the line that divides the humerus in two equal parts in the longitudinal direction.

We compared two groups of children aged patients with fractures in supracondylar region in children of type III. Group A consisted of 23 patients who were treated surgically. Group B consisted of 10 patients who were treated conservatively.

4. RESULTS

In our material, we used standard statistical analysis, arithmetic mean, SD, and to compare the qualitative and quantitative characteristics and the chi square and t test (Student's t test). We analyzed a group of patients who had type III SPDH by Gartland-in (total 39, of which 29 were operated). Observed complications related to the time period in which the surgery is performed (limit 6 hours). N1=11—patients operated on within the first 6 hours; N2 = 18—patients operated or after 6 hours. We observed two phenomena: Lower mobility—25% expected (EX) Contracture - 40% expected (EX).

By statistical analysis, using chi square test we demonstrated that there is a significant difference in the outcome of the surgery, which was conducted as the first 6 hours after injury and

	<i>observed</i>	<i>expected</i>	<i>observed - expected</i>	$\frac{(OB - EX)^2}{EX}$
Poor mobility	4	3	1	0.3
Contracture	2	6	-4	0.6
	<i>observed</i>	<i>expected</i>	<i>observed - expected</i>	$\frac{(OB - EX)^2}{EX}$
Poor mobility	11	4	7	12,25
Contracture	8	7	1	0,14
	<i>observed</i>	<i>expected</i>	<i>observed - expected</i>	$\frac{(OB - EX)^2}{EX}$
Cubitus varus	1	14	-13	0.9
Cubitus valgus	2	3	-1	0.3
	<i>observed</i>	<i>expected</i>	<i>observed - expected</i>	$\frac{(op - oč)^2}{oč}$
Cubitus varus	4	3.2	0.8	2
Cubitus valgus	2	0.7	1.3	2.4

Table 1. Observed and expected complications in our sample

after 6 hours of injury (the time frame of 6 hours).

$$\sum X_2^2 = 12.4$$

Morphological complications of supracondylar fractures of the distal humerus in children by Gartland type III treated conservatively and surgically: N = 39 type III; N1 = 29 surgical; N2 = 10 were treated conservatively; Method of treatment: surgical; Method of treatment: conservative.

By statistical analysis, using H-square test demonstrated that there is a significant difference in SPDH by Gartland type III in children treated conservatively.

Baumann's angle: Group SPDH type III, treated surgically (Group A); N₁=29; x₁' - approximate mean. Group SPDH type III, treated conservatively (group B); N₂=10; x₂' - approximate mean.

In this interval, with the certainty of 95% are persons with their mean values. T test (Student's t test) showed there are significant differences in the limits for the degree of freedom of the above values, if we accept the error to 5%:

Lateral condylar angle: Group SPDH type III, treated surgically (Group A); N₁=29; x₁' - approximate mean; Group SPDH type III, treated conservatively (group B); N₂=10; x₂' - approximate mean (Figure 1).

By statistical analysis (mean, SD, chi square test, Student's t test) used in our work, we have shown that there is a significant difference between conservative and operative treatment in supracondylar fractures of the distal humerus of type III in children, which directly confirms our hypothesis.

5. DISCUSSION

Fractures of the supracondylar region of the distal humerus are common in children and constitute 86.4% of all fractures of the ulna in the elbow region. These are fractures of "immature skeleton" and primarily occur in the first decade of life. There are two peaks for their occurrence, usually between 4 and 5, and between 5 and 8 years of age. These data are published in their contemporary world literature dealing with this problem (15).

In our sample, the occurrence incidence of fractures of the ulna in children in the elbow region on an annual basis is 1.7%, of which supracondylar region humerus fractures are more common and make up 84% of all fractures of the ulna in the elbow region. Worldwide incidence of occurrence of elbow fractures is 3% annually.

At the General Hospital Konjic, with one team, led by an



Figure 1. Lateral condylar angle

experienced surgeon, we have handled, in an emergency, all types of supracondylar fractures in children. In fact, the results we have achieved in the treatment of supracondylar fractures in children of type-I and II are almost identical to results of the authors achieved at the Clinic, while the results we have achieved in the treatment of supracondylar fractures in children of type III and IV, were burdened with a high complication rate.

Based on the results that were obtained in this research, we prefer a scheme to resolve the fracture of the distal part of the humerus in children at all levels, taking into account the current organization of health care system (Law on health care, 1997).

Comparing the data that we have encountered in our work with the results published in the relevant, world literature on this problem (fractures of the distal part of the humerus in children), we can say that the incidence of occurrence, related to sex, side, cause, seasonal occurrence and type of fractures are very similar.

From the data that we have stated clearly that in our material, we did not have complications of surgical treatment such as myositis ossificans, which so far published in the world literature, occurs in a large percentage (50%). Perhaps the reason is meticulous surgical technique combined with pale trail.

Average treatment success fits into average published in the world literature (according to Henley-in and authors is 92.0%) (2).

In SPDH in childhood type I and II, in our study, 38.2% is treated conservatively, at the level of general hospitals (Hospital Konjic) without complications. These cases can be resolved on outpatient basis, if possible with permanent control of the neuro-vascular status, otherwise it is required shorter hospitalization (several days). SPDH in childhood of type III and IV must be treated in specialized institutions at the clinical level, to avoid the problem of the development of chronic complications, which lead to functional and morphological deformities permanent character (Figure 2).

According to the results that we obtained by processing the data from the Clinic and the General Hospital Konjic, we prefer a scheme for the treatment fractures of the distal humerus in children, according to the current organization of health care system. Fractures of the distal humerus in children, especially the humerus region of type I and II may be treated at the level of general hospitals (general well-organized, and the cantonal hospital). Treatment is purely conservative by adequate plaster

immobilization, the position depending on the type of fracture. The results thereby obtained are approximately the same as the results achieved in the clinic.

Hastings and Graham describe the functional classification of ectopic ossification of the elbow, drawing or helping clinical evaluation, treatment, operational planning, functional limit (3).

Preventive measures include non-steroidal antirheumatics drugs, low-dose radiation and continuous passive and active exercise in the mild range. The proposed single doses 600-700 Gy, within 72 hours of injury. Non-steroidal analgesics (indomethacin), two tablets a day for three weeks (5).

In our sample, we had no cases of n. ulnaris infringement, nor for the preventive reasons performed front ulnar transposition.

According to the literature, elbow joint instability after distal humerus fractures in children is rare.

With comminuted, intra-articular fractures is often impossible to perform reconstruction of ligament structures, which could lead to joint instability. McKee and the authors used articulated external fixator with joint postero-lateral instability (6).

In our sample, we had two cases of radial nerve functions damage. These were humerus fractures of the distal humerus in the region of the fourth degree (Pucker sign). By monitoring the spontaneous recovery.

The literature describes a brachialis injury, especially with the type of extension fractures (38%).

In our material we had one case of iatrogenic lesions and a brachialis vein. The second day was done reoperation (resection of the damaged portion of the artery, vein graft substitute, ligation of the veins. Was used allograft from vein saphenae magna.

The American Society for Plastic Surgery, authors Lewis, Harry Kennedy, Peter Herbert, Kevin J., describing the advantages of v. basilicae as replacements for the establishment of continuity in a brachialis SPDH requiring arterial reconstruction. V. basilicae anatomically a bit of lateral branches and is the ideal size for a replacement of the brachialis. Cut for taking venous graft from the medial side, access is relatively direct, which reduces operating time and which is not unimportant, preserves great saphenous vein for eventual management of atherosclerotic disease (5-21).

Dormans and Cramer described in their studies a high incidence of hearing function nerve interoseus anterior with supracondylar fractures of the distal humerus. They found the incidence of nerve injury in 9.5 % of cases. Damage to radial nerve often with fractures of the distal humerus and posterior medial displacement of the distal fragment and damage of median nerve is often the in postero-lateral displacement of the distal fragment (2). In our sample we did not notice the specified difference.

Analysis of surgical technique shows that 40% of bone lack of healing occurs in "Chevron osteotomy", although quite a few authors complained that poor technique is causing these complications. Contributing factors are malposition, infection, broken metal implants, intramedullary fixation, and fixation screws. With strength exercises should be started 10 weeks after surgical intervention.

In patients treated at the Clinic for Orthopedic Surgery, Clinical Center of Sarajevo University of SPDH I-III, in 95.6% of cases, the methods used was open reposition and application of Kirchner's needles (OPF—open pinning fixation), and only



Figure 2. Example from the war period - General Hospital Konjic (contractures, bone transformation of the joint cavity)

in two cases is used closed reduction and percutaneous Kirchner's needles under the control of the C-arch (PP—percutaneous pinning).

Review of the contemporary literature about manner of treatment of fractures of the distal part of the humerus in children, a lot of authors believe that the PP is quite effective and satisfactory method of treatment SPDH type III in children. Biomechanical studies have shown that two Kirchner pins, set crossed, with a crossing over the fracture line, providing satisfactory rotator stability (17, 18, 19).

6. CONCLUSION

All humerus fracture type-III by Gartland in children should be surgically treated. Surgery should be undertaken in a time frame of 6 hours. Surgery should be done in this case by the specialized institutions (Clinical Hospital Centre). The success of treatment in such institutions corresponds to the results achieved in the world (93.0%). We must be sure to adopt and implement a scheme of treatment of fractures of the distal humerus in children. Required is faint trail, OPF, lateral (Kaplan) approach, exceptionally for some articular fracture the posterior approach by Campbell, fixation with two or more Kirchner's needles, usually cross-set at an angle of 30°, vacuum drainage with cast immobilization.

CONFLICT OF INTEREST: NONE DECLARED

REFERENCES

1. Rockwood CA, Wilkins KE, Beaty JH. Fractures in Children (Volume 3) Lippincott-Raven, Philadelphia-New York. 1996; 655-752.
2. Edward Y, Madhav K. Distal Humerus Fractures, Department of Orthopedic Surgery. University of Michigan, 2003.
3. Cekanauskas E, Deglute R, Kalesinskas RJ. Treatment of supracondylar humerus fractures in children, according to Gartland classification, Medicina (Kaunas). 2003; 39(4): 379-383.
4. De Buys Roessingh AS, Reinberg O. Open or closed pinning for distal humerus fractures in children? Swiss Surg. 2003; 9(2): 76-81.
5. Diri B, Tomak Y, Karaismailoglu TN. The treatment of displaced supracondylar fractures of the humerus in children (an evaluation of three different treatment methods), Ulus Travma Derg. 2003 Jan; 9(1): 62-69.
6. Powell RS, Bowe JA. Ipsilateral supracondylar humerus fracture and Monteggia lesion: a case report. J Orthop Trauma. 2002 Nov-Dec; 16(10): 737-740.
7. Scola E, Jezussek D, Kerling HP, Yedibela S. Dislocated supracondylar humerus fracture in the child. Surgical technique and outcome with dorsal approach. Unfallchirurg. 2002 Feb; 105(2): 95-98.
8. Kumar R, Trikha V, Malhotra R. A study of vascular injuries in pediatric supracondylar humeral fractures. J Orthop Surg (Hong Kong). 2001 Dec; 9(2): 37-40.
9. Gordon JE, Patton CM, Luhmann SJ, Bassett GS, Schoenecker PL. Fracture stability after pinning of displaced supracondylar distal humerus fractures in children. J Pediatr Orthop. 2001 May-Jun; 21(3): 313-318.
10. Koudstaal MJ, De Ridder VA, De Lange S, Ulrich C. Pediatric supracondylar humerus fractures: the anterior approach. J Orthop Trauma. 2002 Jul; 16(6): 409-412.
11. Von Laer L, Gunter SM, Knopf S, Weinberg AM. Supracondylar humerus fracture in childhood - an efficacy study. Results of a multicenter study by the Pediatric Traumatology Section of the German Society of Trauma Surgery - II: Costs and effectiveness of the treatment, Unfallchirurg. 2002 Mar; 105(3): 217-223.
12. Houshian S, Mehdi B, Larsen MS. The epidemiology of elbow fracture in children: analysis of 355 fractures, with special reference to supracondylar humerus fractures. J Orthop Sci. 2001; 6(4): 312-315.
13. Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children, J Pediatr. Orthop B. 2001 Jan; 10(1): 63-67.
14. Srivastava S. The results of open reduction and pin fixation in displaced supracondylar fractures of the humerus in children. Med J Malaysia. 2000 Sep; 55 Suppl C: 44-48.
15. Kumar R, Malhotra R. Medial approach for operative treatment of the widely displaced supracondylar fractures of the humerus in children. J Orthop Surg (Hong Kong). 2000 Dec; 8(2): 13-18.,
16. Sobotta, J. Atlas of human anatomy, Vol. 1. Head, neck, upper limbs, skin, Printed in Germany by R. Oldenbourg, Munich. 1989: 238-240.
17. Scola E, Jezussek D, Kerling HP, Yedibela S. Dislocated supracondylar humerus fracture in the child, Surgical technique and outcome with dorsal approach: Unfallchirurg. 2002 Feb; 105(2): 95-98.
18. Cramer KE, Devito DP, Green NE. Comparison of closed reduction and percutaneous pinning versus open reduction and percutaneous pinning in displaced supracondylar fractures of the humerus in children. J Orthop Trauma. 1992; 6(4): 407-412.
19. AS de Buys Roessingh, O Reinberg. Open or Closed Pinning for Distal Humerus Fractures in Children? Department of Pediatric Surgery, Lausanne, 2003.
20. Shahab-ud-Din, Israr Ahmed. Percutaneous Crossed Pin Fixation of Supracondylar Humeral Fracture in Children, Department of Orthopaedic, Hayatabad Medical Complex, Peshawar, Original Article. 2003; 17(2): 184-188.
21. Lewis, H, Morrison C, Kennedy P, Herbert K. Arterial Reconstruction Using the Basilic Vein from the Zone of Injury in Pediatric Supracondylar Humeral Fractures. American Society of Plastic Surgeons. 2003.
22. Philip Fleurieu-Chateau, William McIntyre, Mervyn Letts. An analysis of open reduction of irreducible supracondylar fractures of the humerus in children. Can J Surg. 1998; 41: 112-118.
23. Banovic D. et al. Traumatologija koštano-zglobnog sistema, Zavod za udžbenike i nastavna sredstva, Beograd, 1998.