



Correlation of Radiographic Parameter with Functional Outcomes in Pediatric Supracondylar Humerus Fractures (SCHF) Treated with Close Reduction and Percutaneous Pinning (CRPP)

Rahadyan Magetsari, Irsan Kesuma*, Yudha Mathan Sakti

Department of Orthopaedics and Traumatology, Sardjito General Hospital / Faculty of Medicine, Universitas Gadjah Mada.

*Corresponding Author: Irsan Kesuma

Abstract

Background Humerus supracondylar fracture is one of the most common elbow injuries and this injury approximately includes 16.6 % of all fractures in children⁽¹⁾. Until now, one of the current treatment for a displaced supracondylar humeral fracture is closed reduction of the fracture is using the percutaneous skeletal fixation⁽⁴⁾. The Baumann angle and Carrying angle of the humerus has been a commonly used as an outcome measure for supracondylar fractures in children^(6,7). The aim of this study was to evaluate the radiographic parameter with functional outcomes in pediatric Supracondylar Humerus Fractures (SCHF) treated with CRPP. Materials and Method This was a cross sectional observational study conducted on a consecutive series of supracondylar humerus fracture patients. It involved patients in Sardjito General hospital that were diagnosed as supracondylar humerus fracture treated with close reduction percutaneous pinning. Several parameters were reviewed, including Bowmann angle, Carrying angle, age at injury, sex, right or left extremity, Gartland fracture type, mechanism of injury, operative or nonoperative treatment intervention. Then, the functional outcome of the subjects in this study was measured using QuickDASH score which is the short form of DASH score. Chi Square test and Independent T Test was using as the statistical analysis for this study. Result This study included 78 out of 104 supracondylar humeral fractures. 26 patients were excluded from this study. Out of 78 patients, 25 (32%) were in girls and 53 (68%) were in boys. The mean duration of follow-up all patients was 35 months. During the first data-collection, the mean Baumann angle of the humerus was found to be 72.76 ° (range 55.00 ° to 87.00 °, SD 6.17 °) . This was not significantly different from the data obtained during the second data-collection (mean 72.98 °, range 65° to 80 °, SD 6.21 °). Carrying angle pre operatively was found (mean 10.80 °, range 2 ° to 17°, SD 3.12 °). And not significantly different from post operatively (mean 10.94 °, range 2° to 18 °, SD 3.23 °). There was no functional interference with normal social activities, sports performing, and a activities of daily living, and no functionally limiting symptoms Conclusion This study showed that good functional outcome with better carrying angle was achieved in patient with SCHF patients treated with CRPP.

Introduction

Humerus supracondylar fracture is one of the most common elbow injuries and this injury approximately includes 16.6 % of all fractures in children[1]. 5-30 % of these fractures are associated with vascular and neural injury [2,3]. The current treatment for a displaced supracondylar humeral fracture is closed reduction of the fracture with the use of percutaneous skeletal fixation [4].

The indication treatment of Open Reduction in cases of closed reduction is the occurrence of neurovascular injuries. Nondisplaced fractures are typically treated with a cast.

Temporary elbow stiffness that is noted could be happen after the treatment of a supracondylar humeral fracture, and this is often concern. Return of elbow motion after treatment of supracondylar humeral fracture in children has been well documented in the literature [5]. The Baumann angle and Carrying angle of the humerus has been a commonly used as an outcome measure for supracondylar fractures in children[6,7].

However, there is limited information about the reliability of this measurement. The return of elbow range of motion and function

is usually measured as an objective parameter, such as a return of normal range of arc motion in the sagittal plane (flexion and extension) [5].

Long-term functional outcome using standardized tools has not been well documented in the literature. One study analyzed the correlation between the values of a modified Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and change of elbow function after SCHF of the humerus[8]. The aim of this study was to evaluate the radiographic parameter with functional outcomes in pediatric Supracondylar Humerus Fractures (SCHF) treated with CRPP.

Materials and Method

This was a cross sectional observational study conducted on a consecutive series of supracondylar humerus fracture patients. It involved patients in Sardjito General hospital that were diagnosed as supracondylar humerus fracture treated with close reduction percutaneous pinning who were younger than 17 years at the time of injury, agreed and consent to be included to the study (obtained from parents).

The exclusion criteria more than 17 year old at the time of injury, polytrauma, ipsilateral injury requiring surgery, reinjury to the same elbow within the study period, metabolic bone disease, condyle fractures, epicondyle fractures and physeal fractures. After patients gave consent to be enrolled to this study, the researcher asked them to do an interview using QuickDASH. Then the

several parameters were reviewed, including Bowmann angle, Carrying angle, age at injury, sex, right or left extremity, Gartland fracture type, mechanism of injury, operative or nonoperative treatment intervention. Carrying angle was measured using goniometer clinically (Fig. 1). The carrying angle was measured on both the elbows by a goniometer with forearm in extended and supinated position, normally this is an acute angle (approximately 14° in males [range 2° - 26°] and 16° in females [range 2° - 22°] [12,13]. This study reviewed the radiographs and grouped the patients according to the Gartland classification [2].

In the Gartland classification system, type I fractures are nondisplaced. Type II fractures are displaced with a variable amount of angulation, but the posterior cortex of the humerus is intact. Type III fractures are completely displaced, with no cortical continuity (Fig. 2). The radiological parameter used in this study was Baumann angle (Fig. 3).

The angle formed by the intersection of a line drawn down the humeral shaft axis and a line drawn along the physeal line of the lateral condyle has been commonly described as the Baumann angle of the humerus. Normal values of the Baumann angle in the paediatric population have been reported to range between 70° and 75° [10,11]. A quick DASH questionnaire was administered by the parents of the patients. If they were old enough, the patients completed the questionnaire themselves but under a parent's supervision.

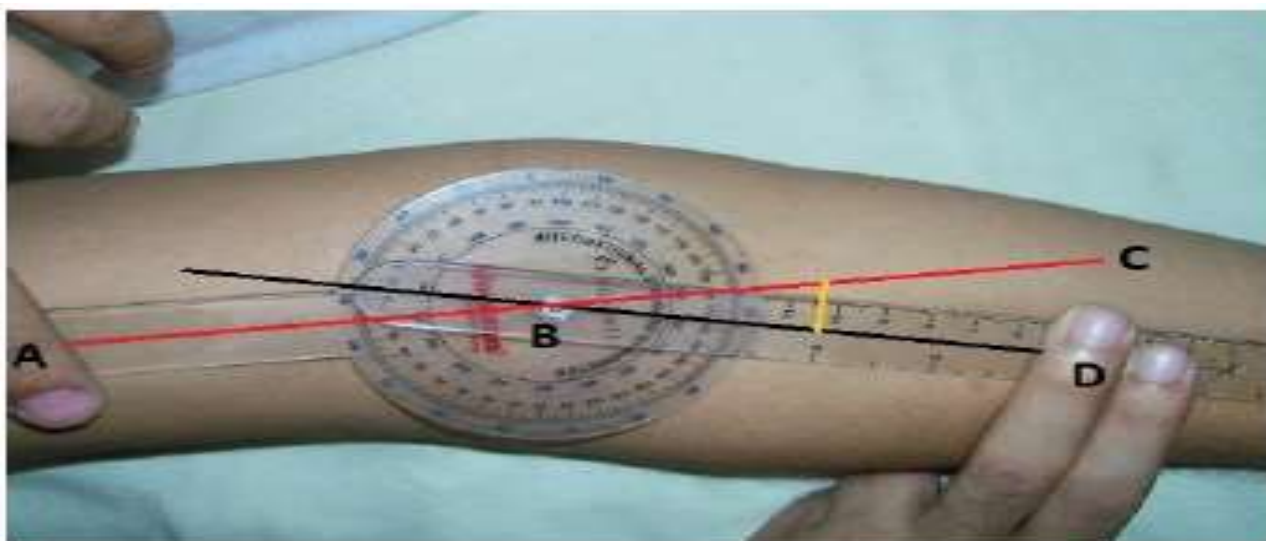


Fig.1: Measurement of carrying angle with goniometer. A is the midpoint of the line joining anterior axillary fold and maximum width over deltoid, B denotes midpoint of the interepicondylar line C is a point where line joining AB is extended; D is the midpoint of the interstyloid process



Fig. 2. Types of supracondylar fractures. A) type I supracondylar fracture with a posterior fat pad sign. B) type II supracondylar fracture with an intact posterior hinge. C) type III supracondylar fracture with no cortical continuity. Arrows delineate fracture lines



Fig. 3: Baumann angle: (A) Angle between long axis of humeral shaft and (B) growth plate of lateral humeral condyle

The functional outcome of the subjects in this study was measured using QuickDASH score which is the short form of DASH score. It is a subjective patients based score that contains 11 questions about the ability of subjects to do daily activities[8]. Quick DASH score was calculated by adding up all the assigned values for each responses divided the number of items [8], then subtracted by one, and multiplied by 25.

The range of the result between 0 to 100. The disability is indicated by higher QuickDASH score and the other way around good physical function and symptom is indicated by lower QuickDASH score. In this study, the score result was divided into 4 categories as follows 75-100 means severe disabilities, 50-74 means poor, 25-49 means fair, and 0-24

means good. Chi Square test and Independent T Test was done as the statistical analysis of this study.

Result

This study included 78 out of 104 supracondylar humeral fractures (**Fig. 4**). 26 patients were excluded from this study. Out of 78 patients, 25 (32%) were in girls and 53 (68%) were in boys. The mean age of the patients (and standard deviation) was ± 7.64 years (range, 1.0 to 17 years), and the mean duration of follow-up was 35 months. Of the 78 fractures, 55 (70.5%) were on the left and 23 (29.5%) were on the right, 5 (6.4%) were flexion type, and 73 (71.2%) were extension type, all of patients were further intervention by operatively with CRPP.

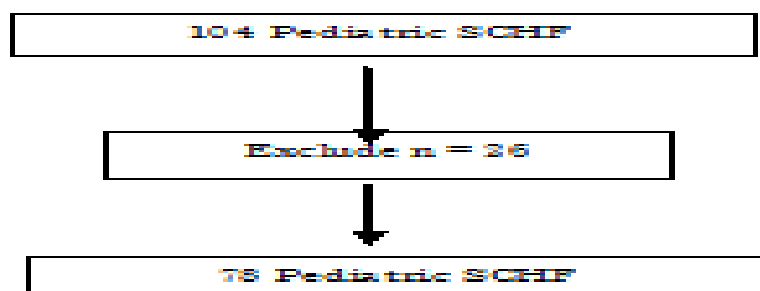


Fig. 4: Enrolment of eligible patients. SCHF = supracondylar elbow fractures

Of the 78 fractures, 19 (24.3%) were type I, 33 (42.3%) were type II, and 26 (33.4%) type III. A multiple linear regression analysis was performed to determine the significance of the clinical parameters as they related to the quick DASH score for functional outcome. During the first data-collection, the mean Baumann angle of the humerus was found to be 72.76 ° (range 55.00 ° to 87.00 °, SD 6.17°) . This was not significantly different from the data obtained during the second data-collection (mean 72.98 °, range 65° to 80 °, SD 6.21 °). Carrying angle pre operatively was found (mean 10.80 °, range 2 ° to 17°, SD 3.12 °). And not significantly different from post

operatively (mean 10.94°, range 2° to 18 °, SD 3.23°). In this study, we performed an abnormality test using Saphiro-wilk on Dash sore preoperatively and post operatively as seen in Table 1. There was a normal distribution of data with p value < 0,05. Then, we used Wilcoxon test to assess whether those parameters were significantly difference. This study showed that there were significant differences in carrying angle post operatively. Most patients had been reported no functional interference with normal social activities, sports performing, and a activities of daily living, and no functionally limiting symptoms.

Table 1: the statistical analysis of carrying angle, Baumann angle, and quick DASH score in Pediatric Supracondylar Humerus Fractures (SCHF) treated with CRPP

Variable	n	Mean ± SD	p Value (normality test)	Mean diff	p value
CA	Pre	10.21 ± 3.34	0,004	Z = -2.506	0,012
	Post	10.93 ± 3.25	0,009		
BA	Pre	72.76 ± 6.17	0,015	Z = -0.344	0,731
	Post	72.98 ± 3.82	0,002		
Quick DASH	Pre	5.62 ± 2.37	0,378	0,26154	0,351
	Post	5.88 ± 2.31	0,128		

Discussion

A supracondylar humerus fracture is a fracture of the distal humerus just above the epicondyles. Supracondylar humerus fractures are caused by direct or indirect low-kinetic energy traumas, such as falls, which makes the occurrence of comminution, bone exposure or association with other fractures less frequent [14].

Supracondylar fractures mostly occur between the ages of 5 and 10 with the peak incidence occurring between 5-8 years of age (after this, dislocations become more frequent) [15]. At this age, the supracondylar area is undergoing remodeling and is typically thinner with a more slender cortex, predisposing this area to fracture[16].

This injury occurs during this time period due to greater likelihood of falls, general ligamentous laxity, weak bone structure at the supracondylar region, and a joint position of hyperextension.

Supracondylar fractures are more common in males (2.6 times more often than the girls) and on the non-dominant side 67%) [1, 7]. There are two types of supracondylar fractures of humerus in children i.e. extension type (97%) and flexion type (3%) [17]. Supracondylar fracture classification is based on the degree and direction of displacement, and the presence of intact

cortex. It applies to extension supracondylar fractures rather than the rare flexion supracondylar fracture. Classification is based on the Gartland system. The pediatric orthopedic surgeons in our tertiary care centre treated patients either operatively or non-operatively based on the degree of angulation and displacement [18]. The treatment goal in displaced supracondylar humerus fractures in children is anatomic reduction. If an anatomic reduction cannot be achieved with closed reduction, open reduction is indicated [19].

A Baumann angle within 5° of the uninjured side was considered acceptable. This was the radiographic measure of coronal plane deformity. The normal physiologic tilt of the capitellum on the humerus is about 30° anteriorly; reduction was not required if this physiologic angulation was 20°. Type I fractures were treated nonoperatively. Type II fractures were treated operatively or nonoperatively depending on the amount of angulation and displacement. Type II fractures that failed closed reduction based on the radiographic parameters mentioned previously were treated operatively.

All type III fractures were treated operatively. Patients who were managed

operatively underwent closed reduction and percutaneous pinning using Kirschner wires under fluoroscopy. If reduction could not be

obtained with closed reduction, open reduction and percutaneous pinning was performed[18]. Return of elbow motion after treatment of supracondylar humeral fracture in children has been well documented in the literature. However, the return of elbow range of motion and function is usually measured as an objective parameter, such as a return of normal range of arc motion in the sagittal plane (flexion and extension).

Long-term functional outcome using standardized tools has not been well documented in the literature. One study analyzed the correlation between the values of a modified Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and change of elbow function after SCHF of the humerus [18].

The DASH Outcome Measure is a 30-item, self-report questionnaire designed to measure physical function and symptoms in people with any of several musculoskeletal

disorders of the upper limb. The tool gives clinicians and researchers the advantage of having a single, reliable instrument that can be used to assess any or all joints in the upper extremity.

The DASH score is scaled between 0 and 100. Higher scores indicate worse function, and lower scores indicate better function relating to upper-extremity disability[18]. In this study, we were found no significant outcome in patient with SCHF between preoperatively and follow up postoperatively with measurement of DASH score. All of patient had good functional outcome after operatively, and no significant parameter radiologic (Baumann angle and Carrying angle) between pre and postoperative.

Conclusion

This study showed that good functional outcome with better carrying angle was achieved in patient with SCHF patients treated with CRPP.

References

1. Cheng JCY, Shen WY (1993) Limb fracture pattern in different pediatric age groups: a study of 3,350 children. *J. Orthop. Trauma.*, 7(1):15-22.
2. Brown IC, Zinar DM (1995) Traumatic and iatrogenic neurological complications after supracondylar humerus fractures in children. *J. Pediatr. Orthop.*, 15(4):440-3.
3. Shaw BA, Kasser JR, Emans JB, Rand FF (1990) Management of vascular injuries idisplaced supracondylar humerus fractures without arteriography. *J. Orthop. Trauma.*, 4(1):25-9.
4. Omid R, Choi PD, Skaggs DL (2008) Supracondylar humeral fractures in children. *J Bone Joint Surg Am.*, 90:1121-32.
5. Spencer HT, Wong M, Fong YJ, et al (2010) Prospective longitudinal evaluation of elbow motion following pediatric supracondylar humeral fractures. *J. Bone Joint Surg Am.*, 92:904-10.
6. Williamson DM, Coates CJ, Miller RK, Cole WG (1992) Normal characteristics of the Baumann (humerocapitellar) angle: an aid in assessment of supracondylar fractures. *J. Pediatr. Orthop.*, 12:636-639.
7. Balasubramanian P, Madhuri V, Muliylil J (2006) Carrying angle in children: a normative study. *J. Pediatr. Orthop. B.*, 15(1):37-40.
8. Colovic H, Stankovic I, Dimitrijevic L, et al. The value of modified DASH questionnaire for evaluation of elbow function after supracondylar fractures in children. *Vojnosanit Pregl* 2008;65:27-32.
9. Gartland JJ (1959) Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet.*, 109:145-54.
10. Keenan WN, Clegg J (1996) Variation of Baumann's angle with age, sex, and side: implications for its use in radiological monitoring of supracondylar fracture of the humerus in children. *J Pediatr Orthop.*, 16:97-8.
11. Camp J, Ishizue Gomez M, Gelberman R, Akeson W (1993) alteration of Baumann's angle by humeral position: implications for treatment of supracondylar humerus fracture. *J. Pediatr. Orthop.*, 13:521-5.
12. Khare GN, Goel SC, Saraf SK, Singh G, Mohanty C (1999) New observations on carrying angle. *Indian J. Med. Sci.*, 53(2):61-7.
13. Kapandji IA (1986) The physiology of joints, Vol 2, lower limb. New York:

- Churchill.Livingstone. Krogmann
WM,ISCAN, 564-582.
14. Carvalho, Roni Azevedo Filho, Nelson Franco (2012) Supracondylar Fracture of the Humerus in Children Fixation with Two Crossed. Brazil: Rev Bras Ortop, Vols., 47(6):705-9.
 15. Lord B, Sarraf KM (2011) Paediatric Supracondylar Fractures of the Humerus: Acute Assessment and Management.: British Journal of Hospital Medicine, 72(1): M8-M111.
 16. Brubacher, Jacob W, Dodds, Seth D (2008) Pediatric Supracondylar Fractures of the Distal Humerus. Curr Rev Musculoskelet Med, 1(3-4): 190-196.
 17. J Bayisenga, R Ssebuufu (2013) Early Outcome of Delayed Management of Supracondylar Humeral Fractures in Children in Rwanda. East and Central African Journal of Surgery, 18.
 18. Isa, Ahaoiza Diana, Furey Andrew (2014) Functional Outcome of Supracondylar Elbow. St. John's, Nfld : Canadian Medical Association, 57: 4.
 19. Alam, Wakar, Rehman, Sha ur and Jan, Roohullah (2014) Outcome of open reduction and internal fixation of Supracondylar fractures of humerus in children with lateral approach. Pak. J. Surg., 30 (2): 146-149.