Injury, Int. J. Care Injured 46 (2015) 2181–2184

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Influence of obesity on surgical outcomes in type III paediatric supracondylar humeral fractures

Chia-Hsieh Chang [a,b,c,*,1], Hsuan-Kai Kao [a,b,c,1], Wei-Chun Lee [a,b,c], Wen-E. Yang [a,b,c]

[a] Department of Orthopaedics, Chang Gung Memorial Hospital, Taoyuan, Taiwan
[b] College of Medicine, Chang Gung University, Taoyuan, Taiwan
[c] Bone and Joint Research Center, Chang Gung Memorial Hospital, Linkou, Taiwan

ARTICLE INFO

Article history:
Accepted 6 September 2015

Keywords:
Child
Elbow
Humeral fractures
Obesity

ABSTRACT

Introduction: Obesity was associated with poor treatment outcome in paediatric supracondylar humeral fractures. It is controversial about the association is related to more severe fractures in obese children or obesity directly affects treatment. The purpose of this study was to evaluate the influence of obesity on surgical outcomes after control of fracture severity.

Patients and methods: This is a retrospective comparative study of 107 children treated for type III supracondylar humeral fractures between January 2009 and December 2013. Children were classified according to sex-specific body mass index (BMI)-for-age growth chart into 4 groups: underweight group ($n = 10$); normal-weight group ($n = 71$); overweight group ($n = 13$); and obese group ($n = 13$). Clinical outcomes were assessed using the Flynn criteria. Radiographic evaluation included the Baumann angle and the lateral humerocapitellar angle. Loss of reduction was defined by Skaggs' criteria.

Results: The mean age, sex, and Flynn criteria were comparable among the four BMI groups. Obese children were more likely to develop a varus change in the Baumann angle ($p = 0.017$) and loss of reduction in varus ($p = 0.059$) postoperatively. The risk for pin-related complications was significantly higher in overweight and obese children ($p = 0.013$).

Conclusions: Obesity was associated with more postoperative varus deformation and pin-related complications after surgical fixation for type III supracondylar fracture. These findings underline the importance of stable fixation and close post-operative monitoring in obese children.

Introduction

Childhood obesity is an epidemic that has increased worldwide over the past decades. In the United States, 16.9% of children are classified as obese and 31.7% of children are classified as overweight [1]. In developed countries, 23.8% of boys and 22.6% of girls were reported to be overweight or obese in 2013. In developing countries, this proportion has increased from 8.1% to 12.9% in boys, and from 8.4% to 13.4% in girls since 1980 [2]. Obesity is a recognized risk factor for cardiovascular disease, diabetes and cancers [3–6]. In an immature skeleton, obesity also contributes to many musculoskeletal disorders, such as Blount disease and slipped capital femoral epiphysis [7–9].

Supracondylar humeral fractures are the most common elbow fractures in children [10,11]. The typical mechanism of fracture is falling on an outstretched hand with hypertension of the elbow joint. The Gartland classification system is most often used to describe the severity of displacement and guide treatment [12]. Type I injury is a non-displaced fracture; type II is a hinged fracture with the posterior cortex intact; and type III is a completely displaced fracture without cortical contact. Surgical fixation using percutaneous Kirschner wires (K-wires) is the standard treatment for Gartland type II and III fractures [13–16].

Obesity is now being recognized as a factor that could affect clinical outcomes of supracondylar humeral fractures in children. Sun et al. reported that a higher BMI was associated with higher risk of failure of closed reduction for children's supracondylar humeral fractures [17]. Seeley et al. reported that obesity is associated with more complex supracondylar humeral fractures, and greater risk for nerve palsies and postoperative complications [18]. However, it is controversial whether the association between obesity and poor treatment outcomes is related to more severe fractures in obese children or whether obesity directly affects

* Corresponding author at: Department of Orthopaedics, Chang Gung Memorial Hospital, No. 5, Fusing St., Gueishan Dist., Taoyuan City 33305, Taiwan, ROC. Tel.: +886 3 3281200x2423; fax: +886 3 3289582.
E-mail address: chiahchang@gmail.com (C.-H. Chang).
[1] Chang and Kao are co-first author.

http://dx.doi.org/10.1016/j.injury.2015.09.004
0020–1383/

fracture treatment. The purpose of our study was to evaluate the influence of obesity on surgical outcomes between children with different BMI after controlling fracture severity.

Patients and methods

After approval of the institutional review board of the authors' hospital, we retrospectively reviewed medical records and radiographs of patients treated for paediatric supracondylar humeral fractures between January 2009 and December 2013. The inclusion criteria were skeletal immaturity, a Gartland type III supracondylar fracture and follow-up of more than 1 year. Exclusion criteria included skeletal maturity, previous upper limb fractures, open fractures, flexion-type supracondylar fractures, fractures requiring neurovascular exploration, and absence of documented height and/or weight in the medical records.

The BMI is defined as the ratio of weight in kilograms divided by height in meters squared. The BMI has been the standard screening tool for weight status. According to the sex-specific BMI-for-age growth chart provided by the Ministry of Health and Welfare in Taiwan (http://www.hpa.gov.tw), patients were stratified according to their BMI into the following four groups: underweight, normal-weight, overweight and obese [19]. Demographic data, including age, gender, side of injury, number of pins, days of pin retention, preoperative associated injuries, postoperative complications and length of follow-up were recorded.

All the children with Gartland type III supracondylar fractures underwent closed reduction and internal fixation using percutaneous K-wires within 24 h after arriving at the emergency department. No case required open reduction. All interventions were performed by attending paediatric orthopaedic surgeons or orthopaedic trauma surgeons. All surgeons had prior experience with both lateral-entry pin and crossed-pin fixation techniques. Pin size, pin construct, and number of pins were selected subjectively at the time of surgery.

Clinical outcomes were assessed using the criteria of Flynn et al., based on the carrying angle and the range of elbow motion [20]. Radiographic evaluation included the Baumann angle, measured on anteroposterior radiographs, and the lateral humerocapitellar angle, measured on lateral radiographs [21,22]. These angles were calculated by measurement tools that were provided by GE Centricity PACS (picture archiving and communication system). We did the measurements 3 times and calculated the average values. Intraoperative fluoroscopic images, obtained after K-wire placement, were compared with the 3-month postoperative radiographs. According to the criteria reported by Skaggs et al., a loss of reduction was defined by a change in the Baumann angle of more than 12° or when the line of the anterior humeral cortex no longer intersected the ossification centre of the capitellum on the lateral radiograph [13]. Postoperative complications such as pin migration, pin site infection requiring hospitalization, postoperative nerve palsy, and the need for additional surgery were also recorded.

The Fisher exact test was used to compare categorical data among the groups with different weight status. For numerical data, one-way analysis of variance (ANOVA) was used for between-group comparisons. Comparison of the magnitude of angle change between the groups was evaluated using repeated measures ANOVA. The significance level was set at $p < 0.05$. Statistical analyses were performed with SPSS software (version 17.0, SPSS Inc., Chicago, Illinois).

Results

One hundred and forty children with Gartland type III supracondylar humeral fractures were identified in the study period. Thirty-three children were excluded: 2 with previous upper limb fractures, 3 with flexion-type fractures, 1 with an open fracture, 1 with vascular exploration, 1 with skeletal maturity and 25 who did not have complete weight or height recorded. The final study group comprised 107 patients, 37 girls and 70 boys, with a mean age at the time of surgery of 6.2 years (range 1.2–12.8 years). These participants were classified into 4 BMI groups: underweight ($n = 10$), normal-weight ($n = 71$), overweight ($n = 13$), and obese ($n = 13$). There were no significant differences in age, sex, injured side, fracture displacement, number of pins or duration of pin retention among the 4 BMI groups (Table 1).

The final range of elbow motion, the Flynn criteria, mean Baumann angle and mean lateral humerocapitellar angle were not different among the 4 groups (Table 2). However, the change of Baumann angle from operation to post-operative 3 months was different among the 4 BMI groups ($p = 0.017$). Obese children had a tendency for varus displacement, and the other groups had a tendency for valgus deformation. The 2 cases who had loss of reduction in varus by more than 12 degrees were responsible of the tendency of varus deformation in obese children (Table 2).

Table 1
Descriptive data of the patient group.

	Underweight	Normal	Overweight	Obese	*p*-Value
Number of patients[a]	10	71	13	13	
Mean age (years)[b]	7.1 ± 3.4	6.3 ± 2.5	5.8 ± 3.0	5.5 ± 3.2	0.525
Male/female[a]	7/3	46/25	10/13	7/6	0.341
Side[a]					
Right	5	33	8	3	0.123
Left	5	38	5	10	
Displacement[a]					
Posterolateral	4	27	3	4	0.422
Posteromedial	3	30	7	5	
Posterior	3	14	3	4	
Number of pins					
2	6	33	7	9	0.078
3	4	38	6	3	
4	0	0	0	1	
Pin retention (days)[b]	31.6 ± 5.1	33.1 ± 6.7	34.5 ± 4.7	33.8 ± 7.3	0.726

[a] The values are given as the number of patients.
[b] The values are given as the mean and standard deviation.