

# Comparison of conservative and surgical treatment in Gartland Type IIB fractures in pediatric patients

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**Abstract. – OBJECTIVE:** In this study, our aim was to compare conservative treatment and surgical treatment radiologically and clinically in the treatment of pediatric Gartland type IIB SCHF, which is a controversial issue in the literature.

**PATIENTS AND METHODS:** This retrospective study included 86 patients with a Gartland type IIB humerus fracture. Forty-three patients were treated conservatively, and 43 patients were surgically treated. Radiological results were evaluated according to the Baumann angle and anterior humerus line. The Mayo Elbow Performance Score (MEPS) and Flynn's criteria were used to assess the functional evolution.

**RESULTS:** The mean MEPS was 94 for the conservative treatment group and 93 for the surgical treatment group. According to Flynn's criteria, 31 (72.09%) excellent results were obtained in patients who were treated conservatively, and 26 (60.46%) excellent results were obtained in the surgical treatment group.

**CONCLUSIONS:** The conservative and surgical treatment of Gartland type IIB SCHF is not superior to each other if anatomic reduction is achieved. Complications of each treatment can be prevented by following strict treatment principles.

*Key Words:*

Supracondylar humerus fracture, Gartland classification, Mayo Elbow Performance Score.

## Introduction

Supracondylar humerus fractures (SCHF) constitute approximately 60% of elbow fractures and 85% of fractures requiring surgery in the pediatric age group<sup>1</sup>. It is more common in individuals aged 3-10 years and of male sex<sup>2</sup>. Many classifica-

tion systems have been proposed for SCHF. The Gartland classification modified by Wilkins is the most frequently used classification system for extension Type SCHF<sup>3</sup>. Type I fractures, according to the Gartland classification, are either not or minimally displaced (<2 mm). Type II fractures are displaced (>2 mm), but the posterior cortex is intact. Type IIA and type IIB subgroups were determined according to whether there is rotation or not in Type II fractures<sup>4</sup>. Type III fractures are completely displaced fractures<sup>5</sup>. The treatment of Gartland Type I and Type IIA SCHF are conservative, while the treatment of type III fractures is surgical. However, there is no definite consensus for Type IIB fractures<sup>6</sup>. Inadequate reduction and rotation in SCHF cause various deformities in the elbow<sup>7</sup>. While France et al<sup>8</sup> state that inadequate reduction may cause problems after conservative treatment, Hadlow et al<sup>9</sup> state that surgical treatment is unnecessary in Type II fractures and may cause some complications.

In this study, our aim was to compare conservative treatment and surgical treatment radiologically and clinically in the treatment of pediatric Gartland Type IIB SCHF, which is a controversial issue in the literature.

## Patients and Methods

### Study Design

Our study was prepared retrospectively in accordance with the ethical standards of the Local Ethics Committee and the 1975 Helsinki Declaration revised in 2013, and the Ethics Committee of the Haseki Education Research Hospital approval was obtained (Decision No: 2020-26, 26/02/2020). Pediatric patients admitted to the

Emergency Department and treated for supracondylar humeral fractures between December 2007 and December 2018 were screened using hospital digital records and patient files. The Gartland classification was used to classify the supracondylar humerus fracture<sup>10</sup>. Patients with Gartland type I, type IIA and type III fractures and other accompanying trauma were excluded from the study. 86 children (50 males, 36 females) with Gartland type IIB fractures (only the patients agreed on to be type IIB by all researchers), with pre-reduction and post-reduction control films, and at least 24 months of clinical follow-up, who were treated conservatively and surgically were included in the study. Blount technique (closed reduction and immobilization) was used as a conservative treatment method<sup>11</sup>. Closed reduction and osteosynthesis with K-wires were used as surgical treatment. Demographic characteristics of the patients were noted. During the follow-up, the development of neurovascular complications and compartment syndrome was checked using digital hospital records and patient files.

### **Postoperative Management**

The cast was removed after three weeks in patients treated conservatively. In patients who underwent surgery, the cast was removed three weeks later and the K-wires in the 4th week. After treatment, patients immediately began physical therapy. According to our SCHF follow-up algorithm all patients were advised to continue follow-up examinations for 24 months after treatment for residual deformity, loss of ROM or avascular necrosis. Although radiologic evaluation was carried out by early post-operative, 1 month, sixth month and every sixth months then, up to 24 months, for the study standard anteroposterior and lateral radiographs on the 6th month follow-up are used to evaluate residual deformity without remodelization. Complete fracture healing was defined as a full return to activities of daily living. The Mayo Elbow Performance Score (MEPS) and Flynn's criteria for SCHF were used to assess the functional evaluation.

### **Radiological Assessment**

Two researcher physicians evaluated pre-and post-reduction x-rays of the patients through the image archiving system of our hospital. Baumann angle and anterior humeral line were used in radiological follow-up. Normal value was determined as  $72 \pm 4$  as the Baumann angle.  $10^\circ$  rotation in the humerus causes  $6^\circ$  change in the

Baumann angle. For this reason, a change greater than  $6^\circ$  in post-reduction and final x-ray was considered as a severe loss of reduction. Changes between  $6^\circ$ - $12^\circ$  were noted as mild, changes greater than  $12^\circ$  were noted as severe reduction loss. On the lateral x-ray, capitellum was divided into three equal zones and where the anterior humeral line intersected the capitellum was noted. Middle 1/3 zone was considered normal. A one-zone change was considered a mild, two-zones change during follow-up was considered a severe loss of reduction.

### **Statistical Analysis**

For statistical analysis, SPSS 15.0 for Windows was used. Regarding descriptive statistics, number and percentage for categorical variables, mean and standard deviation, and the minimum, maximum, and median for numerical variables were calculated. The rates in the groups were compared using the chi-square test. When the normal distribution condition was met, independent 2-group comparisons of numerical variables were conducted with the t-test, and with the Mann-Whitney U test when the normal distribution condition was not met. For all analyses,  $p < 0.05$  was considered statistically significant.

## **Results**

86 patients were included in the study. 43 of the patients were treated conservatively and 43 were treated surgically. The mean age of the patients included in the study was  $5.86 \pm 2.61$  (4-9). Of the 86 patients, 50 were male and 36 were female. Neurovascular deficit and compartment syndrome were not observed in any of the patients. Postoperative radiological evaluation was performed using the Baumann angle and anterior humeral line. The Baumann angle measured on follow-up radiographs at postoperative 24 months was similar in both groups without significant statistical differences. In 43 patients treated conservatively, the anterior humeral line crossed the anterior 1/3 of the capitellum in 35 (81.39%) patients and the middle 1/3 of the capitellum in 8 (18.60%) patients. In 43 patients treated surgically, the anterior humeral line crossed the anterior 1/3 of the capitellum in 33 (76.74%) patients and the middle 1/3 of the capitellum in 10 (23.25%) patients. (Table I).

When the success of preserving the reduction obtained in the coronal plane in the conservative

**Table I.** Changes in the radiographs, Baumann angle and anterior humeral line-capitellum intersection in the conservatively and surgical group before, after reduction and at the third week follow-up.

	Pre-reduction				Post-reduction			
	Baumann angle	Anterior humeral line			Baumann angle	Anterior humeral line		
		Middle 1/3	Anterior 1/3	Anterior to the capitellum		Middle 1/3	Anterior 1/3	Anterior to the capitellum
Conservative	69.97 ± 7.41	2	26	15	69.86 ± 5.85	8	35	0
Surgical	70.39 ± 5.55	2	22	19	70.02 ± 5.00	10	33	0

\*No difference between groups in repeated measurements in Baumann angles ( $p:0.287$ ).

and surgical groups was compared with the Baumann angle, no significant difference was found between the two groups ( $p=0.743$ ) (Table II). Reduction was preserved in 67 patients (77%) and severe reduction loss was found in only two patients (2.3%). Reduction loss in the sagittal plane was evaluated by the anterior humeral line. There was no significant difference between the conservative and surgical groups in maintaining the reduction achieved in the sagittal plane ( $p=0.161$ ) (Table II).

Pressure sore developed in one of 43 patients treated with closed reduction and cast, and reduction loss in two. The pressure sore resolved with a simple course of topical antibiotics. It was determined that reduction loss affected the functional outcome negatively in those two patients. Of 43 patients treated with closed reduction and internal fixation with Kirschner wire, three had pin-tract infection, one had transient posterior interosseous nerve lesion, and one had reduction loss. Pin-tract infections resolved with a simple course of parenteral antibiotics. Neuropraxia was managed non-operatively and resolved spontaneously within eight months (Table III).

The mean MEPS for conservatively treated patients was 94 with 38 (88.4%) excellent outcomes, 5 (11.6%) good outcomes, and no moderate or

bad outcomes. The mean MEPS for the closed reduction/Kirschner wire group was 93, with 36 (83.7%) excellent results, 7 (16.2%) good results, and no or poor results. According to Flynn criteria, 31 (72.09%) patients treated conservatively had excellent results, 7 (16.27%) good results, 5 (11.62%) moderate and no bad results. In the surgically treated patient group, 26 (60.46%) excellent, 13 (30.23%) good and 4 (9.30%) moderate results. There were no patients with poor results (Table III).

## Discussion

The treatment of type II SCHF (especially type IIB) remains controversial despite many studies targeting the issue. This may confuse the orthopedic surgeon in the treatment planning process<sup>12</sup>. While the susceptible nature of the fracture for loss of reduction and the potential poor functional and cosmetic results incites the surgeon for surgical treatment<sup>8</sup>, complications such as neurovascular damage, infection, and pin migration favors a conservative treatment<sup>9</sup>.

Although Wilkins modification to Gartland classification (IIA-IIB) is considered as a decision easier for treatment choices, it is shown with a low

**Table II.** Comparison of the anterior humeral line and Baumann angle measurements with the measurements of the after reduction.

		Conservative n/%	Surgical n/%	p-value
<b>Anterior humeral line</b>	Reduction Preserved	33 (76.7%)	34 (79.06%)	0.161
	Minimal Reduction Loss	10 (23.25%)	8 (18.6%)	
	Severe Reduction Loss	0 (0.00%)	1 (2.3%)	
<b>Baumann angle</b>	Reduction Preserved	39 (90.7%)	37 (86%)	0.743
	Minimal Reduction Loss	4 (9.3%)	4 (9.3%)	
	Severe Reduction Loss	0 (0.00%)	2 (4.7%)	

**Table III.** Demographic data and MEPS results.

		Total n = 86		Technique				P
				Surgical n = 43		Conservative n = 43		
		N	%	N	%	N	%	
Sex	Male	50	58.13%	24	55.81%	26	60.46%	0.662
	Female	36	41.86%	19	44.18%	17	39.53%	
Side	Right	48	55.81%	26	60.46%	22	51.16%	0.515
	Left	38	44.18%	17	39.53%	21	48.83%	
Complication	Pressure Sore	1	1.16%	0	0%	1	1.16%	0.611
	Loss of Reduction	2	2.32%	0	0%	2	2.32%	
	Pin Tract Infection	1	1.16%	1	1.16%	0	0%	
	NVD	3	3.48%	3	3.48%	0	0%	
Age Mean ± SD Median (Min-Max)		6 (4-10)	6 (4-10)	6 (4-8)	0.324			
MEPS Mean ± SD Median		93.5 ± 9.8	93 ± 10.6	94 ± 7.2	1.000			

MEPS; Mayo elbow performance score, NVD; neurovascular deficit.

interobserver reliability for rotational deformities since posterior cortex remains intact<sup>13</sup>. However in a recent study by Teo et al<sup>14</sup> intraobserver reliability for type II SCHF was found to be moderate to excellent and interobserver reliability was found to be substantial. Therefore treatment decision contraversion is thought to depend on surgeon preferences rather than classification variability.

Above mentioned studies and many other more targeting to clarify treatment options of Gartland type II SCHF states that studies with randomized treatment options are needed to define the treatment of choice<sup>13-15</sup>. Thus, to avoid surgeon's treatment selection bias, only patients whom the researchers collectively agreed to be type IIB were included in this study.

The most common complications for SCHF include pin migration, infection, and nerve palsy for surgical treatment<sup>16</sup>, and recurvatum deformity and joint stiffness for conservative treatment<sup>17</sup>. Varus/valgus deformity and malunion can be seen in both treatment modalities with suboptimal reduction<sup>18</sup>. Regarding the prevention of complications in each treatment modality, basic principles of casting and surgery must be followed, such as avoiding hyper flexion casting to prevent compartment syndrome of the forearm and being cautious about the K-wire length and position to avoid neurovascular compromise.

Outcomes of SCHF depend on the range of motion (ROM), functionality, and cosmetic results. Although there are studies that evaluate the functionality with ROM or DASH questionnaire, we think that ROM alone cannot represent the functionality, and DASH is not a useful tool in the

pediatric population, and it is also not validated in the pediatric population. Therefore, we used the Mayo Elbow Performance Score and Flynn's criteria since when both are combined, the functionality can be assessed more thoroughly and objectively.

The most common complication of SCHF is varus deformity<sup>19</sup>. Changes in Bauman's angle are strongly correlated with changes in the carrying angle; an increase in Baumann's angle indicates a medial tilt of the distal fragment, contributing to cubitus varus deformity and studies have shown highly statistically significant correlations between changes in the humerocapitellar angle and changes in elbow flexion<sup>12,20</sup>. In the assessment of SCHF treatment radiologic outcomes, anterior humeral line is a crucial factor since recurvatum-hyperextension is a common complication, especially with the conservative treatment<sup>8</sup>. We therefore evaluate the anterior humeral line alongside the Bauman and humerocapitellar angles.

One of the major advantages of the conservative treatment of SCHF is the shorter hospital stay<sup>18</sup>. With the following of strict elevation, early (24-48 h) follow-up, and neurovascular examination rules, conservative treatment can be carried on an outpatient basis. Patients and parents should be informed about early signs of compartment syndrome. In our study, we did not experience any compartment syndrome or need for cast removal.

In our study, there was no statistically significant difference for functional and radiologic outcomes in all patients, regardless of the treatment modality. The same was also demonstrated with

other parameters, such as sex, side, treatment technique, and age. All these criteria showed no correlation with functional and radiologic outcomes.

Our study has some limitations. Although there are more patients involved in our study than in most studies in the literature, the sample size was still small compared to the prevalence of type IIB SCHF. The retrospective design is another limitation since we could not include other parameters such as the reduction technique. However, with 24 months of follow-up duration, it is one of the longest in the literature. This allows to evaluate the effect of early remodeling on functional and radiological outcomes. Sample size could be increased with shortening the inclusion criteria for follow-up, but we thought seeing the outcome of treatment with a greater angle including remodeling will be much beneficial for treatment decision process for type IIB SCHF.

One of the most important parameters affecting the outcome after supracondylar humeral fractures is the remodeling potential of the distal humerus. The potential for remodeling of the distal humerus gradually decreases with age<sup>21</sup>. For this reason, comparative studies are needed among patients with a narrower age range, as this will have a direct effect on the result.

### Conclusions

The conservative and surgical treatment of Gartland type II-B SCHF is not superior to each other if anatomic reduction is achieved. Complications of each treatment can be prevented by following strict treatment principles. Further prospective, randomized controlled studies with larger but specific age, fracture type and treatment modalities are needed to overcome the controversy.

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### Conflict of Interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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