ORIGINAL ARTICLE

Is long arm splinting sufficient in the nonsurgical follow-up of pediatric Type I and Type IIa supracondylar humerus fractures?

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ABSTRACT

BACKGROUND: This study aims to compare the radiological and functional outcomes of long arm casting versus splinting in the nonsurgical treatment of pediatric supracondylar humerus fractures classified as Modified Gartland type I and IIa.

METHODS: Between January 2021 and January 2024, 112 pediatric type I and IIa supracondylar humerus fractures (SCHFs) treated nonoperatively with long arm splinting or casting were evaluated. Baumann angle and lateral capitellohumeral angle (LCHA) were measured pre-reduction, post-reduction, and at weeks 1 and 4. Outcomes were compared using Flynn's criteria.

RESULTS: Of the 112 patients, 55 had type I (49%) and 57 had type IIa (51%) fractures (mean age: 7.51 years; 69 males, 43 females). Fractures were equally distributed between the right and left sides (n=56 each). Fifty-eight patients were treated with long arm splinting and 54 with long arm casting. Follow-up durations were similar between groups. In the splint group, the mean Baumann angle was 72.1° pre-reduction and 73.2° at week 4; in the cast group, it was 70.7° and 73.4°, respectively. Mean LCHA increased from 43.9° to 50.8° with splinting and from 42.4° to 50.1° with casting. A statistically significant difference was not observed for loss of reduction between the splinting and casting groups ($p=0.475$). No statistically significant differences were observed in LCHA ($p=0.175$), Baumann angle values ($p=0.485$), or Flynn scores ($p=0.768$) pre- and post-reduction in type I and type IIa SCHFs.

CONCLUSION: Splinting and casting yielded comparable clinical and radiological outcomes in nonsurgically managed Modified Gartland type I and IIa supracondylar humerus fractures. However, splinting stands out as a strong alternative due to its ease of application and lower complication rates.

Keywords: Supracondylar humerus; fractures; elbow; reduction; pediatric.

INTRODUCTION

Supracondylar humerus fractures (SCHFs) occur primarily before 10 years of age,[1] accounting for 3% to 18% of all reported pediatric fractures.[2-5] The instability observed in cases of Modified Gartland types IIb and III SCHFs generally necessitates surgical treatment.[6-8] While there is widespread consensus on the most appropriate treatments for types I, IIb, and III SCHFs, treatment approaches for type IIa remain controversial.[9] The American Academy of Orthopaedic Surgeons published updated clinical practice guidelines in 2011 for treating pediatric SCHFs.[7,10] Treatment of type IIa SCHFs with the application of closed reduction and percutaneous pinning was moderately recommended. Nevertheless, many pediatric orthopedists would still argue that the application of closed reduction followed by immobilization is sufficient for the treatment of pediatric patients with type IIa SCHFs.[11-15] In the present study, closed reduction was first applied for

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types I and IIa fractures, and the patients were subsequently followed with long arm splinting or casting.

Immobilization of stable types I and IIa fractures for 4 weeks generally yields satisfactory functional results. As soon as the fracture has healed, movement of the limb should begin.[16] Conservatively managed fractures may be addressed with various immobilization strategies, including long arm casting or splinting. With both of these strategies, the elbow is immobilized in flexion at a 90° angle, with the forearm held in supine neutral positioning.[3,17] The most widely utilized treatment approach entails the application of a circular cast with immobilization for 3 to 4 weeks.[18,19] However, based on their review of the literature, Cuomo et al. suggested that long arm splinting may also constitute a viable treatment approach, especially for type I SCHFs.[20] No research has been reported in the literature to date comparing the effectiveness of long arm splinting and long arm casting for SCHFs of type I and type IIa. The present study is the first to be conducted on type I and especially type IIa fractures in this context. We aimed to evaluate and compare the long-term functional and radiographic results and complication rates of pediatric cases of types I and IIa SCHFs treated with long arm splinting or long arm casting.

MATERIALS AND METHODS

The study was approved by the Ethics Committee of Erzurum City Hospital (Approval No: 34926-08.01.2025) and was conducted in accordance with the principles of the Declaration of Helsinki.

A total of 112 patients who were followed with nonsurgical long arm splinting or casting between January 2021 and January 2024 were retrospectively examined in this study. All patients had a minimum of 6 months of follow-up. For patients with type I fractures, reduction was achieved without manipulation of the current positioning. For patients with type IIa fractures, closed reduction manipulations were applied before casting or splinting.

Demographic data on age, sex, and affected side were collected. The evaluated radiographic parameters comprised the Baumann angle (BA) and lateral capitellohumeral angle (LCHA) (Figure 1).[21-22] These values were measured after the injury, immediately after reduction, and on radiographs obtained at 1 and 4 weeks of follow-up. All of these radiographic measurements were made simultaneously by two experienced pediatric orthopedic surgeons. Elbow joint ranges of motion and carrying angles were measured, and functional and cosmetic evaluations were performed based on Flynn's criteria. These functional and cosmetic evaluations, along with measurements of elbow joint range of motion and carrying angle, were performed at specific follow-up intervals, primarily at 1 week, 4 weeks, and 6 months post-treatment. Although the minimum clinical follow-up was six months, radiographic evaluations were primarily performed at the first and fourth weeks, as subsequent imaging at six months did not demonstrate significant differences in fracture healing compared to earlier assessments.

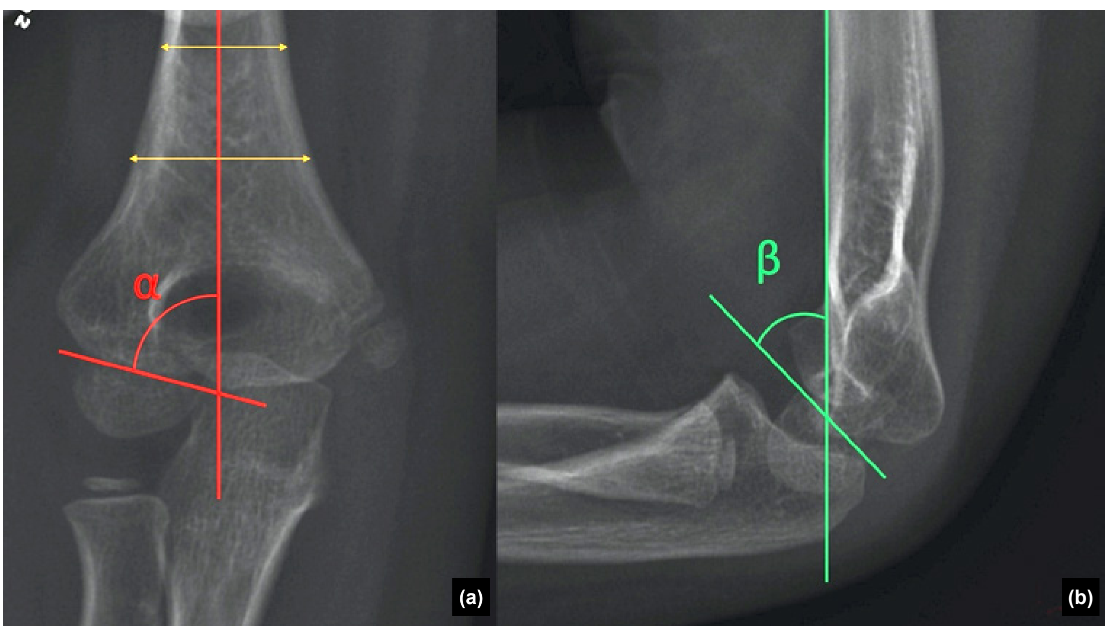

Figure 1. X-ray images show the 3-year follow-up of an 8-year-old male patient with a right elbow Type I fracture. **(a)** demonstrates the Baumann angle on an anteroposterior X-ray. The Baumann angle (α) is defined as the angle between the longitudinal axis of the humeral shaft and a line tangential to the lateral condylar physis (the red line). **(b)** shows the lateral elbow X-ray of the same patient. It demonstrates the Lateral Capitellum Humeral Angle (LCHA), (β) which is defined as the angle between the anterior axis of the humeral shaft and the proximal margin of the capitellum (the green line).

Statistical Analysis

For all obtained data, statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Variables were examined for compliance with normal distribution using both visual (probability graphs and histograms) and analytical (Shapiro–Wilk and Kolmogorov-Smirnov tests) approaches. For comparisons of qualitative variables between two independent groups, chi-square tests or Fisher's exact tests (in the event that values observed in cells did not satisfy chi-square test assumptions) were used. For comparisons between two independent groups, the independent-samples t test was utilized for parametric variables, and the Mann-Whitney U test was performed for nonparametric variables. The Wilcoxon test was applied for comparisons of nonparametric variables between two dependent groups.

Radiological measurements were repeated by two orthopedists at 2-day intervals, and the data obtained from these four measurements were graded radiologically. The agreement between the radiological gradings of the four measurements was evaluated with the kappa test, and measurements were confirmed to be consistent between the two observers ($p<0.05$). Subsequently, the mean values of the measurements of the two observers were calculated and used in the data analysis.

RESULTS

Sixty-nine of the analyzed patients were male and 43 were female. The average age was 7.51 years. Splinting was applied for 31 (63.4%) cases of type I SCHF, and casting was applied for 24 (44.4%) cases. Splinting was applied for 27 (46.6%) cases of type IIa SCHF, and casting was applied for 30 (55.6%) cases. A statistically significant difference was not observed in the distribution of Modified Gartland fracture classifications of patients with SCHFs treated with closed reduction and casting or splinting ($p=0.341$).

No statistically significant differences were detected in LCHA and BA values or Flynn scores calculated before and after reduction for type I and type IIa SCHFs followed with casting or splinting (Table 1).

Since the assumptions of normality were not met by the data, multivariate analysis of variance could not be performed. The mean differences in vertical displacement amounts immediately after reduction and at 4 weeks were compared for both groups using the Wilcoxon test, which is utilized for data that do not comply with a normal distribution. A statistically significant difference was found between LCHA values after reduction and those obtained at 4 weeks for all patients, reflecting an increase over time ($p=0.002$). When the differences in LCHA and BA values obtained after reduction and those obtained at 4 weeks were compared between the groups, no statistically significant difference was found (Table 2).

Loss of reduction was observed in 6 patients followed with splinting and 8 patients followed with casting. Eight of these patients subsequently underwent percutaneous pinning, while the other 6 once again underwent closed reduction and conservative follow-up. A statistically significant difference was not observed for loss of reduction between the splinting and casting groups ($p=0.475$). In one patient who was followed with casting, edema developed due to pressure from the cast, and in another patient, a wound developed due to pressure from the cast. In both cases, the cast was removed, and the patients continued follow-up with splint-

Table 1. Comparison of splinting and casting follow-up in terms of radiological, functional, and cosmetic outcomes

	Treatment Method		
	Splinting, n=58	Casting, n=54	p
BA before reduction (°)	72.1 (60-4.2)	70.7 (57.3-83.2)	0.623[1]
BA after reduction (°)	73.3 (67.3-80)	75.2 (67.1-78.1)	0.864[1]
BA, week 1 (°)	74.2 (68.3-80.1)	74 (66-78.9)	0.449[1]
BA, week 4 (°)	73.2 (68.9-80)	73.4 (69-77.1)	0.809[1]
LCHA before reduction (°)	43.9±11.9	42.4±12.2	0.504[2]
LCHA after reduction (°)	49.2 (46.8-54.7)	48 (46.6-50.4)	0.074[1]
LCHA, week 1 (°)	50.3 (46-55)	49.1 (47.6-51)	0.522[1]
LCHA, week 4 (°)	50.8 (47.8-55)	50.1 (48-53)	0.365[1]
Flynn elbow score - functional	4 (4-4)	4 (4-4)	0.955[1]
Flynn elbow score - cosmetic	4 (3-4)	4 (3-4)	0.768[1]

[1]: Mann-Whitney U test, with data given as median (25th-75th percentile) values. [2]: Independent samples t-test, with data given as mean ± standard deviation values.

Table 2. Comparison of changes in LCHA and BA values obtained after reduction and at the 4th week of follow-up

	Conservative follow-up of types I and IIa SCHFs after closed reduction		
	Splinting, n=58	**Casting, n=54**	**p**
BA before reduction (°)	74.2	68.36	0.623[1]
BA after reduction (°)	75.08	71.99	0.864[1]
BA, week 1 (°)	74.98	72.49	0.449[1]
BA, week 4 (°)	75.11	70.79	0.809[1]
LCHA before reduction (°)	47.31	39.24	0.504[2]
LCHA after reduction (°)	49.67	48.77	0.074[1]
LCHA, week 1 (°)	50.61	47.75	0.522[1]
LCHA, week 4 (°)	51.39	48.2	0.365[1]
Flynn score – functional	3.93	3.67	0.955[1]
Flynn score – cosmetic	3.85	3.49	0.768[1]

[1]: Mann-Whitney U test, with data given as median (25th-75th percentile) values.

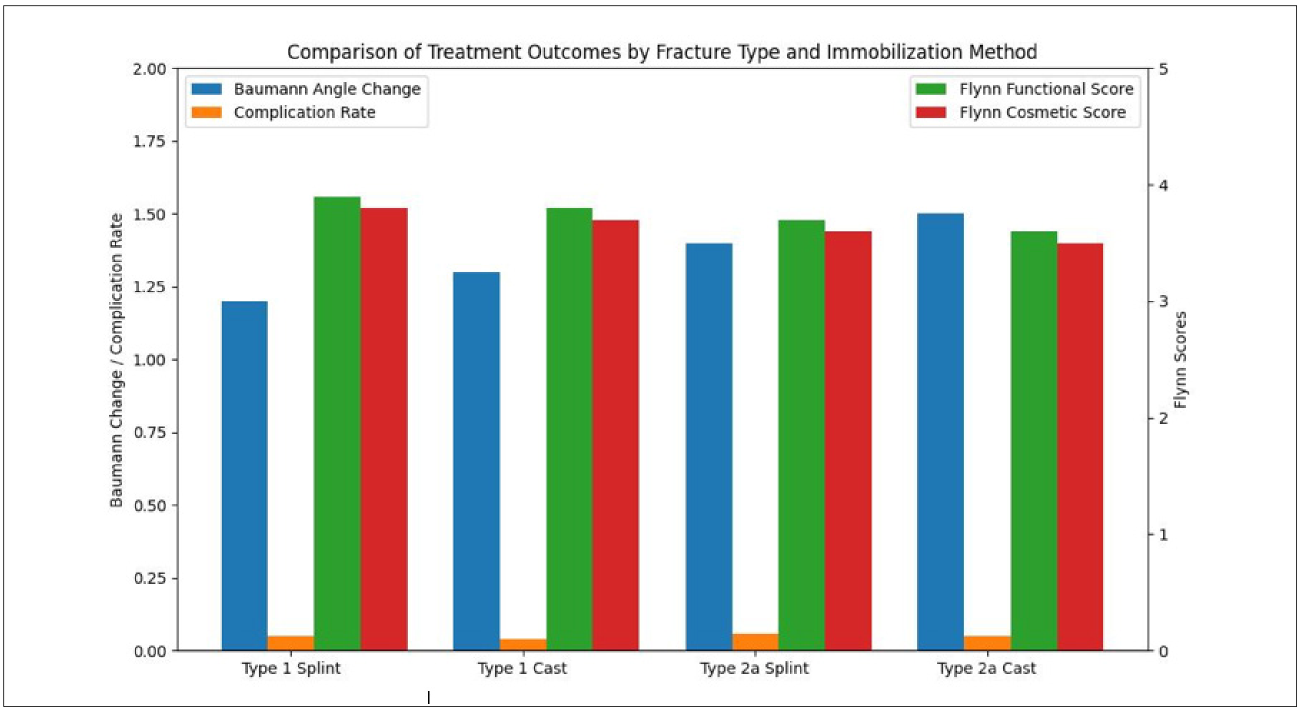

Figure 2. Treatment outcomes by fracture type and immobilization method (Type 1 Splinting, Type 1 Casting, Type 2a Splinting, Type 2a Casting). Differences in Baumann angle change, complication rates, and Flynn scores are shown. Data are mean±SD. Statistical significance indicated where applicable.

ing. Additionally, subgroup analysis dividing patients into four groups based on fracture type and immobilization method (Type I splinting, Type I casting, Type IIa splinting, Type IIa casting) was performed. This detailed subgroup comparison revealed significant differences in reduction loss and other treatment outcomes, enhancing the reliability of the results (Figure 2).

Additionally, subgroup analysis based on the Gartland classification demonstrated significant differences between type I and type IIa fractures. The post-reduction Baumann angle ($p=0.0087$), Baumann angle at the 4th week ($p=0.0157$), and pre-reduction lateral capitellohumeral angle ($p<0.0001$) were all significantly higher in patients with type I fractures compared to those with type IIa fractures (Table 3).

Table 3. Comparison of radiological and clinical parameters between Modified

Parameter	Type I Mean	Type IIa Mean	p-value
BA before reduction (°)	74.2	68.36	0.6231
BA after reduction (°)	75.08	71.99	0.8641
BA, week 1 (°)	74.98	72.49	0.4491
BA, week 4 (°)	75.11	70.79	0.8091
LCHA before reduction (°)	47.31	39.24	0.5042
LCHA after reduction (°)	49.67	48.77	0.0741
LCHA, week 1 (°)	50.61	47.75	0.5221
LCHA, week 4 (°)	51.39	48.2	0.3651
Flynn score – functional	3.93	3.67	0.9551
Flynn score – cosmetic	3.85	3.49	0.7681

Gartland type I and IIa fractures. Values are means. Mann–Whitney U test was used. BA: Bauman angle, LCHA: Lateral capitello-humeral angle. Significant results: BA after reduction (p=0.0087), BA week 4 (p=0.0157), LCHA before reduction (p<0.0001).

DISCUSSION

While there is consensus on the application of nonsurgical methods in treating type I fractures, the treatment of type IIa fractures is still debated.[9] Hadlow et al.[12] and Parikh et al.[13] both described the successful treatment of type IIa fractures with closed reduction and casting, with surgery being required in 23% and 28% of cases, respectively. In the present study, surgery was deemed necessary for 10.3% of type IIa fractures followed with splinting and 14.8% followed with casting. For both types of immobilization, the rate of progression to surgery was lower than the rates reported in the literature, and this rate was also lower for patients followed with splinting compared to casting. Akgülle et al.[23] reported that in operatively treated patients, casting was superior to splinting in preventing loss of reduction. However, in our patient cohort, there were no fractures with instability severe enough to require surgical intervention.

Children who have experienced type IIa SCHFs treated with closed reduction and long arm splinting must be monitored carefully, both clinically and radiographically, for possible loss of reduction or alignment. It has been recommended that the first follow-up evaluation in these cases be performed within 7 days after reduction.[9] Furthermore, it is crucial that the parents or guardians of children with fractures fully comply with the treatment protocol by attending all scheduled follow-up appointments. Noncompliance with follow-up X-rays can lead to malunion and possible cosmetic deformities, in association with surgery-related expenses and potential complications.[3,13] In our study, patient follow-up was carried out weekly based on radiological measurements while checking the strength and positioning of the splints and casts.

A difference of less than 5° in BA has been observed by several authors to predict less reduction loss and satisfactory cosmetic results.[24,25] In our study, it was determined that patients with loss of reduction (14/112) had differences of 6.8° to 19.7° in BA values, with these differences being higher compared to patients without loss of reduction. In this sense, there is a significant relationship between reduction loss and BA differences. However, in this study, we did not find any significant differences between the groups for the change in BA or Flynn's cosmetic criterion.

A previous study stated that surgical fixation was required for type IIa fractures if the LCHA difference was 18° or more.[25] In our study, we observed loss of reduction in two patients with respective LCHA differences of 28.2° and 27°, for whom closed reduction with percutaneous pinning was applied. The treatment of the other 17 patients with differences of ≥18° ended after closed reduction, regardless of the application of splinting or casting. These findings align with the observations of Ariyawatkul et al.,[26] who reported that surgical intervention may not be necessary in type IIa fractures with angular differences below 18°. We argue that surgery should not be directly recommended to patients solely based on LCHA values and that such patients should initially be managed with closed reduction and long arm splinting.

In this study, none of the Modified Gartland type I SCHFs treated with long arm splinting necessitated a switch in treatment to casting and/or surgical intervention. There was a loss of reduction in only one of those cases; an increase in LCHA and BA was observed, the patient underwent closed reduction again, and the treatment was completed with splinting. Among the cases of type IIa fractures, loss of reduction was observed in 8 (7.14%) of the patients followed with casting, while loss of reduction was observed in 5 (4.4%) of the patients followed with splinting. Thus, splinting had a numerically superior rate of success. These data suggest that long arm splinting is a viable alternative to long arm casting in the conservative follow-up of both type I and type IIa SCHFs. There are increasing findings in the literature suggesting that minor pediatric fractures do not require more than a splint.[27-30] These studies have shown that splints offer better functioning and are a preferred treatment option compared to casting. Furthermore, splinting was reported to be cost-effective in treating minor ankle fractures and minimally angled distal fractures of the radius.[30]

CONCLUSION

No significant difference was observed in this study between the radiological and clinical results of splinting and casting in the nonsurgical treatment of pediatric type I and type IIa SCHFs. However, splinting offers additional benefits, such as increased ease of application, greater comfort, lower complication rates, and improved hygiene. We advocate splinting as an appropriate alternative in the nonsurgical treatment of type I and type IIa fractures.

Ethics Committee Approval: This study was approved by the Erzurum Medical Faculty Scientific Research Ethics Committee for Clinical Research Ethics Committee (Date: 08.01.2025, Decision No: 34926).

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Pediatrik Tip I ve Tip IIa suprakondiler humerus kırıklarının cerrahi dışı takibinde uzun kol atel uygulaması yeterli midir?

AMAÇ: Bu çalışma, pediatrik, değiştirilmiş Gartland tip I ve IIa suprakondiler humerus kırıklarının cerrahi dışı tedavisinde uzun kol alçı ve atel uygulamalarının radyolojik ve fonksiyonel sonuçlarını karşılaştırmayı amaçlamaktadır.
GEREÇ VE YÖNTEM: Ocak 2021 ile Ocak 2024 tarihleri arasında, uzun kol alçı veya atel ile cerrahi dışı olarak tedavi edilen 112 pediatrik tip I ve IIa suprakondiler humerus kırığı (SCHF) retrospektif olarak değerlendirildi. Bauman açısı ve lateral kapitellohumeral açı, redüksiyon öncesi, sonrası, 1. hafta ve 4. haftalarda ölçüldü. Klinik ve radyolojik sonuçlar Flynn kriterleri kullanılarak karşılaştırıldı.
BULGULAR: Çalışmaya dahil edilen 112 hastanın 55'inde tip I (%49), 57'sinde tip IIa (%51) kırık mevcuttu (ortalama yaş: 7.51 yıl; 69 erkek, 43 kız). Kırıklar sağ ve sol dirseklerde eşit dağılım gösterdi (n=56). Elli sekiz hasta uzun kol atel ile, 54 hasta ise uzun kol alçı ile tedavi edildi. Takip süreleri her iki grupta da benzerdi. Atel grubunda ortalama Bauman açısı redüksiyon öncesi 72.1°, 4. haftada 73.2°; alçı grubunda ise sırasıyla 70.7° ve 73.4° olarak ölçüldü. Ortalama lateral kapitellohumeral açı atel ile 43.9°'den 50.8°'ye, alçı ile 42.4°'ten 50.1°'e yükseldi. Atel ve alçı uygulanan gruplar arasında redüksiyon kaybı açısından istatistiksel olarak anlamlı bir fark gözlenmemiştir (p=0.475). Tip I ve tip IIa SCHF olgularında, redüksiyon öncesi ve sonrası LCHA (p=0.175), BA değerleri (p=0.485) ile Flynn skorları (p=0.768) arasında istatistiksel olarak anlamlı bir fark bulunmamıştır.
SONUÇ: Cerrahi dışı tedavi edilen değiştirilmiş Gartland tip I ve IIa suprakondiler humerus kırıklarında atel ve alçı uygulamaları benzer klinik ve radyolojik sonuçlar vermektedir. Ancak atel, uygulanabilirliğinin kolaylığı ve daha düşük komplikasyon oranı nedeniyle güçlü bir alternatif olarak öne çıkmaktadır.

Anahtar sözcükler: Dirsek; kırık; pediatrik; redüksiyon; suprakondiler humerus.

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