Acta Medica Alanya

RESEARCH ARTICLE

ARAŞTIRMA

Acta Medica Alanya

2020;4(2):126-131

DOI:10.30565/medalanya.663618

Are modified Gartland Type IV supracondylar humerus fractures different from Type III fractures? A retrospective clinical study

Modifiye Gartland Tip IV Suprakondiler Humerus Kırıkları, Tip III Kırıklardan Farklı mıdır? Retrospektif Klinik Çalışma

Duran Topak[1*], İsmail Kadir Dere[1], Fatih Doğar[1], Burak Kuşçu[1], Ökkeş Bilal[1]

1.Kahramanmaras Sutcu Imam University, Faculty of Medicine Department of Orthopaedic and Traumatology, Kahramanmaras, Turkey

ABSTRACT

Aim: The present study investigates whether surgical treatment of modified Gartland Type IV supracondylar humerus fracture is radiologically and clinically different from the treatment of Type III fractures.

Methods: The medical charts of 197 patients who underwent surgical treatment for pediatric supracondylar humerus fracture in our clinic between 2012 and 2015 were retrospectively reviewed, and 76 patients humerus Gartland Type III and unstable Type IV fractures regardless of neurovascular injury (49 males, 27 females) were included in the study as randomize. The patients were divided into two groups as patients with modified Gartland Type III (n=36) and patients with Type IV fractures (n=40). The mean age of the patients was 5.88±3.29 (1-15) years, and the mean duration of follow-up was 19.80±4.83 (12-29) months. All patients underwent surgery within the first 24 hours and closed reduction was first attempted. Posterior open reduction was performed in patients with failed attempts of closed reduction. The functional and cosmetic outcomes of the patients were evaluated according to the Flynn criteria. The Baumann's angle was measured on the X-rays obtained in the last control visit.

Results: The comparison of functional outcomes between the two groups revealed that satisfactory outcomes were obtained in 97.3% of patients in the Type III fracture group and 87.5% of patients in the Type IV fracture group; however, the difference was not statistically significant (p=0.509). The comparison of cosmetic outcomes showed that satisfactory outcomes have been obtained in 100% and 97.5% of the patients, and no significant difference was found between the two groups (p=0.495). There was no statistically significant difference between the two groups in terms of the need for open surgery, nerve injury, and Baumann's angle (p=0.776, p=0.108, p=0.069, respectively).

Conclusion: Modified Gartland Type IV pediatric supracondylar humerus fractures can be treated successfully just like Type III fractures with anatomical reduction, stable fixation and early initiation of joint movements.

Keywords: Supracondylar fractures of the humerus, pediatric fractures

ÖZ

Amaç: Bu çalışmada; modifiye Gartland tip IV suprakondiler humerus kırığı cerrahi tedavisinin klinik ve radyolojik olarak tip III kırıklardan farklı olup olmadığını araştırdık.

Yöntemler: 2012-2015 yılları arasında kliniğimizde çocuk suprakondiler humerus kırığı tanısıyla cerrahi tedavi uygulanan 197 hastanın dosyaları retrospektif olarak incelenip, nörovasküler yaralanma olup olmadığı bakılmaksızın 76 hasta (49 erkek, 27 kadın) randomize olarak çalışmaya dahil edildi. Modifiye Gartland Tip III (n=36) ve tip IV (n=40) olarak iki gruba ayrıldı. Yaş ortalaması 5.88±3.29 (1-15) yıl olan hastalar, 19.80±4.83 (12-29) ay süreyle takip edildi. Hastaların tamamı ilk 24 saat içinde ameliyata alındı ve kapalı redüksiyon öncelikli olarak denendi. Kapalı redükte edilemeyen hastalara posteriordan açık redüksiyon uygulandı. Hastaların fonksiyonel ve kozmetik sonuçları Flynn kriterlerine göre değerlendirildi. Son kontrollerindeki röntgenlerinden Baumann açısı ölçüldü.

Bulgular: İki grubun fonksiyonel sonuçları karşılaştırıldığında, tip III grubunda %97.3, tip IV grubunda ise %87.5 tatminkar sonuç elde edildi, aradaki fark istatistiksel olarak anlamlı bulunmadı (p=0.509). Kozmetik sonuçlar karşılaştırıldığında sırasıyla %100 ve %97.5 tatminkar sonuç elde edildi, iki grup arasında anlamlı fark bulunamadı (p=0.495). İki grup arasındaki açık cerrahiye gereksinim, sinir lezyonu ve Baumann açıları arasında istatistiksel olarak anlamlı fark bulunamadı (p değerleri sırasıyla, p=0.776, p=0.108, p=0.069).

Sonuç: Modifiye Gartland tip IV pediatrik suprakondiler humerus kırıkları, tip III kırıklar gibi anatomik redüksiyon, stabil tespit ve erken eklem hareketlerine başlanarak başarılı bir şekilde tedavi edilebilir.

Anahtar kelimeler: Suprakondiler humerus kırıkları, çocuk kırıkları

Received: 31.01 2019 Accepted: 06.04.2019 Published (Online): 12.07.2020

*Corresponding author: Duran T., Kahramanmaras Sutcu Imam University, Faculty of Medicine,Department of Orthopaedic and Traumatology, Kahramanmaras/ Turkey, Phone: +90 344 300 3331 E-mail: drdtopak@gmail.com

ORCID: 0000-0002-1442-3392

To cited: Topak D, Dere İK, Doğar F, Kuşçu B, Bilal Ö. Are modified Gartland Type IV supracondylar humerus fractures different from Type III fractures? A retrospective clinical study. Acta Med. Alanya 2020;4(2):126-131. doi:10.30565/medalanya.663618

INTRODUCTION

Pediatric supracondylar humerus fractures are classically defined as fractures proximal to the condyles of distal humerus that involve the olecranon fossa [1]. Supracondylar humerus fractures account for 16.6% of all fractures in children, 50% of elbow fractures in children and 85% of pediatric fractures requiring surgical therapy [1, 2]. It is usually more common in the 3-10 years age group and in males [2]. Typically, these fractures occur as a result of falling with the elbow extended while the hand is in open position [1, 3]. The main objective of therapy in such fractures is to obtain a functional joint through anatomical reduction, stable fixation and early initiating joint movements [4]. Pediatric supracondylar humerus fractures were first classified by Gartland et al. in 1959 and then modified in various ways [1]. Leitch et al. defined unstable fractures in flexion and extension as Type IV fractures [5].

The present study investigates whether surgical treatment of modified Gartland Type IV supracondylar humerus fracture is different from Type III fractures, in terms of clinical and radiological outcomes and the need for open surgery.

METHODS

The medical charts of 197 patients who underwent surgical treatment for pediatric supracondylar humerus fracture in our clinic between 2012 and 2015 were retrospectively reviewed, and 76 patients humeral Gartland Type III and unstable Type IV fractures regardless of neurovascular injury (49 males, 27 females) were included in the study as randomize. The patients were divided into two groups, namely as patients with modified Gartland Type III (n=36) and patients with Type IV fractures (n=40). The mean age of the patients was 5.88±3.29 (1-15) years, and the mean duration of follow-up was 19.80±4.83 (12-29) months. Age, side, etiological cause, treatment method, pin configuration, presence of nerve lesion, and fracture type were retrieved from the medical charts; the Baumann's angle was measured on the latest anteroposterior radiographs in the last control visit; and functional and cosmetic outcomes were recorded from the examination data in the patient files.

All children who were found to have supracondylar humerus fractures after admission to the emergency room underwent long arm splint applications with elbow flexed up to 110-120 degrees after traction, and then hospitalized in our clinic (Figure 1a, 1b). The limb was kept in an elevated position while continuing cold application, and patients underwent surgery at the earliest opportunity in a fasted state, after completion of preoperative preparation. All patients underwent surgery within the first 24 hours and, initially, closed reduction was attempted. Posterior open reduction was performed in patients with failed attempts of closed reduction. After the posterior exposure, the fracture line was reached at the medial and lateral sides of the triceps muscle. Fifty-eight patients underwent percutaneous pinning after closed reduction and eighteen patients underwent percutaneous pinning after open reduction (Figure 2a, 2b). The patient was evaluated as an unstable fracture in the operating room under lateral fluoroscopy with the elbow flexed, the anterior of the capitellum glenohumeral line and the posterior with the elbow extended. Patients with instability in all sides during surgery were classified as having Type IV fracture and this was noted on the patient chart. After the operation, all fractures underwent immobilization with a long arm splint for three weeks after which the splint was removed and joint movements were initiated. The K-wires were removed at the end of six weeks after surgery and joint movements were continued (Figure 3a, 3b).

The patients were classified according to the Modified Gartland classification system described by Leitch et al [6]. Cosmetic and functional evaluation criteria defined by Flynn et al. were used to evaluate the functional and cosmetic outcomes in the groups [7].

Patients with missing data in the medical charts, Type II fractures (n=18), metabolic bone sicks, accompanying another multiple fracture, patients (n=103) who were not noted as Type III or Type IV postoperatively, and those who did not regularly attend control visits within a 1-year period, were excluded from the study. The study was approved by the ethics committee of Kahramanmaras Sutcu Imam University Clinical Research. (Session:2018\15, Date:29.08.2018, Decision:23)

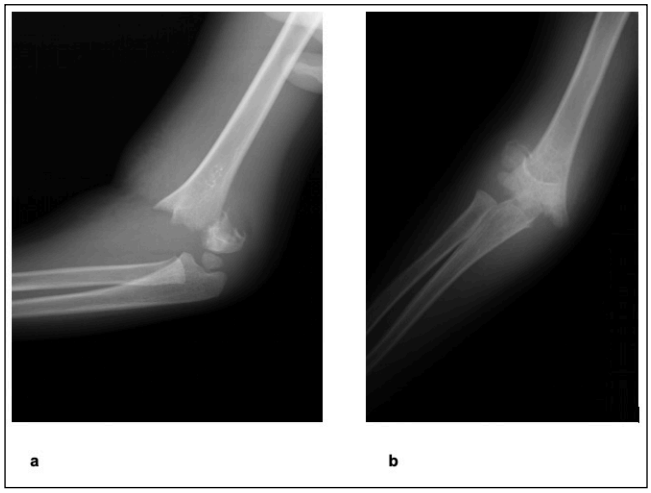

Figure 1a: Preoperative A-P radiography of pediatric supracondylar humerus fracture, b: Preoperative lateral radiography of pediatric supracondylar humerus fracture.

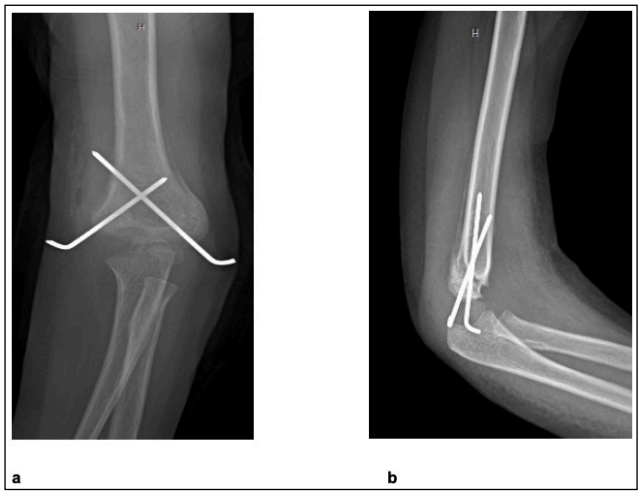

Figure 2a: Early postoperative A-P radiography of pediatric supracondylar humerus fracture, b: Early postoperative lateral radiography of pediatric supracondylar humerus fracture.

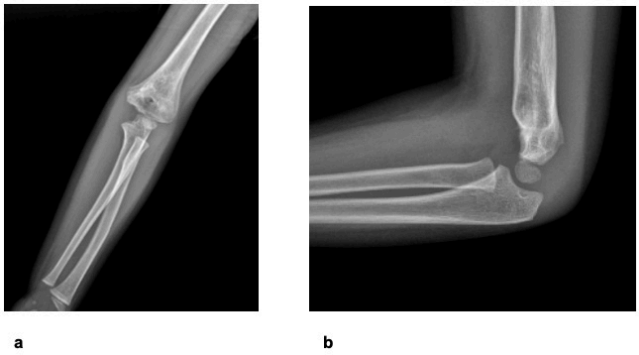

Figure 3a: A-P radiography of pediatric supracondylar humerus fracture three years later, b: Lateral radiography of pediatric supracondylar humerus fracture three years later

Statistical analysis

The data obtained in the study was analyzed using the SPSS (Statistical Package for Social Sciences) for Windows 25.0. The data collected from the patients was interpreted using descriptive statistics (frequency, percentage, mean and standard deviation). A Q-Q plot was used to evaluate fitness to normal distribution. Accordingly, age and Baumann's angle were found to have normal distribution.

A Chi-square test, independent samples T-test and F-test were used to evaluate whether the groups showed similar distribution or if there was a difference between the groups. The error rate was determined in all tests and a P-value of less than 0.05 was considered statistically significant.

RESULTS

Nerve lesion was detected in 11.8% (n=9) of patients, while the mean Baumann's angle was 72.96±7.63 degrees. In terms of functional outcomes, excellent outcomes were achieved in 59 patients, good outcomes were achieved in 11 and satisfactory outcomes were achieved in 70 patients (92.1%). The cosmetic outcome was excellent in 73 patients (96.1%). The demographic data of the patients participating in the study are shown in Table 1.

When the two groups are compared in terms of functional outcomes, the rate of satisfactory outcomes was 97.3% in the Type III fracture group and 87.5% in the Type IV fracture group, and the difference was of no statistical significance (p=0.509). A comparison of cosmetic outcomes showed that satisfactory outcomes were achieved in 100% and 97.5% of the patients, showing no significant difference between the two groups (p=0.495). There was no statistically significant difference between the two groups in terms of the need for open surgery, nerve lesion and Baumann's angle (p=0.776, p=0.108, p=0.069, respectively). The data for the comparison of the groups is shown in Table 2.

An improvement was noted in all patients within 6 weeks. Pin-track infection occurred only in three patients who recovered with oral antibiotherapy, and one patient underwent repeat closed reduction

with percutaneous pinning due to re-fracture after three months.

Table 1. Demographic characteristics of the patients participating in the study (n=76)

Specifications		Number	Percent
Age (year)		5.88±3.29 (1-15)	
Gender	Male	49	64.5
	Female	27	35.5
Side	Right	44	57.9
	Left	32	42.1
Etiology	Falls	69	90.8
	MVI	7	9.2
Fracture Type	Type III	36	47.4
	Type IV	40	52.6
Treatment	CRPP	58	76.3
	ORPP	18	23.7
Nerve lesions	Absent	67	88.2
	Median	1	1.3
	Radial	3	3.9
	Ulnar	5	6.6
Pin configuration	M1/L1	23	30.3
	M1/L2	42	55.3
	L2 or L3	11	14.5
Functional outcome	Excellent	59	77.6
	Good	11	14.5
	Moderate	2	2.6
	Poor	4	5.3
Cosmetic outcome	Excellent	73	96.1
	Good	2	2.6
	Poor	1	1.3
Baumann's Angle (degree)		72.96±7.63 (52-85)	
Following time (month)		19.80±4.83 (12-29)	

Abbreviations: MVI; Motor Vehicle Injury, CRPP; Closed Reduction Percutaneous Pinning, ORPP; Open Reduction Percutaneous Pinning, M1/ L1; Medial one pinning / Lateral one pinning, M1/L2; Medial one pinning / Lateral two pinning, L2 or L3; Lateral two pinning or Lateral three pinning.

DISCUSSION

In 1959, Gartland proposed a simple classification system based on the type of injury to emphasize the underlying principles of treatment in patients with supracondylar humerus fracture, and this system was later embraced as a practical and effective system [1].

In 2006, Leitch et al. proposed an additional Type IV injury that can be defined during, which they believed pose challenges in the treatment due to lack of a durable periosteal connection and presence of instability in multiple sides. They suggested that, despite their rare occurrence, these fractures are less stable than Type III fractures due to displacement of the fracture during flexion and extension [5].

Table 2. Data for the comparison of groups

Characteristics		Type III (n=36)	Type IV (n=40)	
Age (year)		4.69±2.93	6.95±3.26	t= -3.162 p=0.002
Side	Right	18 (50.0)	26 (65.0)	X2=1.746 p=0.186
	Left	18 (50.0)	14 (35.0)	
Treatment	CRPP	28 (77.8)	30 (75.0)	X2=0.081 p=0.776
	ORPP	8 (22.2)	10 (25.0)	
Nerve Lesions	Absent	34 (94.4)	33 (82.5)	X2=2.589 p=0.108
	Present	2 (5.6)	7 (17.5)	
Pin	M1/L1	11	12	X2=2.374 p=0.112
	M1/L2	21	21	
	L2 or L3	4	7	
Functional Outcome	Excellent	29 (80.6)	30 (75.0)	X2=2.905 p=0.509
	Good	6 (16.7)	5 (12.5)	
	Moderate	0 (0.0)	2 (5.0)	
	Poor	1 (2.8)	3 (7.5)	
Cosmetic Outcome	Excellent	36 (100.0)	37 (92.5)	X2=2.374 p=0.495
	Good	0 (0.0)	2 (5.0)	
	Poor	0 (0.0)	1 (2.5)	
Baumann's Angle (degree)		74.64±6.68	71.45±8.19	t=1.848 p=0.069
Duration of Follow-up (month)		21.97±4.80	17.38±3.59	t:-2.386 p:0.892

Abbreviations: CRPP; Closed Reduction Percutaneous Pinning, ORPP; Open Reduction Percutaneous Pinning, M1/ L1; Medial one pinning / Lateral one pinning, M1/L2; Medial one pinning / Lateral two pinning, L2 or L3; Lateral two pinning or Lateral three pinning.

The energy of injury is higher in Type IV fractures than in Type III fractures. The reduction of such fractures is difficult and they often require open surgery due to the presence of more extensive soft tissue injury. The complication rate after treatment is higher [8]. In our study, the rate of complications was numerically higher in the Type IV fracture group than in the Type III fracture group, but the difference between the groups was not statistically significant. Recent studies recommend conservative therapy in non-displaced or minimally displaced fractures (Type I, II). There is a tendency towards performing surgery in all displaced fractures (Types II, III, IV). There was no statistically significant difference between the

two groups in terms of the need for open surgery, but it was higher in the Type IV fracture group than in the Type III fracture group.

When Leitch et al. first identified Type IV fractures, 297/9 Type IV fractures were detected. However, it was stated that open fractures were not included in the study [5]. Stuart et al. compared 159 Type III and 39 Type IV fractures [9]. The reason why Type IV fractures in our study are more than Type III fractures; We think that we included open fractures in the study and accepted all high-energy supracondylar humerus fractures with vascular and nerve injuries from other medical centers.

Epidemiological studies revealed that the rate of such fractures increases in parallel to the activity level in the playgrounds, and the rate is higher in summer season, in the afternoon, at the weekends, in boys, and the majority occurs as a result of falls [10]. Similarly, in our study, these fractures were more common in boys who are physically more active and the fracture occurred after a fall in most cases.

Type IV supracondylar humerus fractures were seen in older age group than Type III fractures. We think that this may be due to the skeletal maturation resulting in decreased bone flexibility.

Nerve injuries are the most important complication of pediatric supracondylar humerus fractures, with a reported prevalence rate of 10-23%. The most commonly injured nerve is the anterior interosseous nerve, and the rate of neurological damage increases with increasing energy of trauma [8,11,12]. Consistent with the literature, neurological damage was also observed in the present study. Neurological damage was more frequent in the Type IV fracture group than in the Type III fracture group, but the difference between the groups was not statistically significant.

Although various open (open, medial, or lateral mini-open) and closed surgery and pinning methods have been described for surgical treatment of pediatric supracondylar humerus fractures, most studies have not shown superiority of one method to another [3,13-15].

The aim of surgical therapy in displaced pediatric supracondylar humerus fractures is to achieve functional recovery by performing anatomical reduction, stable fixation and initiating early joint movements. The studies have reported satisfactory outcomes (excellent-good) with closed reduction and percutaneous pinning in 88%, with medial mini-open technique in 94% of the patients, with anterior mini-open technique in 93% of the patients, with posterior open technique in 97% of patients, and with closed reduction followed by lateral or medial-lateral cross pinning in 99% of the patients. The results of the present study were found to be compatible with the literature, for both groups. [16-19].

In previous studies, it was stated that reduction of Type IV fractures is more difficult, more open surgery is needed and it is associated with worse clinical results [5, 9, 20]. Although Type IV fractures involve a higher energy trauma than Type III fractures, there was no statistically significant difference in functional and cosmetic outcomes in our study. The authors consider that the difference between the two groups would disappear with increasing team experience, good reduction, stable fixation and early initiation of range of joint motion exercises.

Limitations

Apart from retrospective study design, the present study is also limited by the small number of patients and the fact that operations were performed by two different surgeons.

CONCLUSION

Modified Gartland Type IV pediatric supracondylar humerus fractures can be treated successfully, just like Type III fractures, with anatomical reduction, stable fixation, and early initiation of joint movements. However, the authors believe that this observation must be supported by large case series and randomized trials.

Thanks: The authors thank Enago – https://www.enago.com.tr/ceviri/ for their assistance in manuscript translation and editing

Funding sources: There is no source of funding or financial interest in this study.

Conflict of Interest: The author has no conflict of interest related to this article.

REFERENCES

1. Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynecol Obstet. 1959;109:145–54. PMID: 13675986
2. Shrader MW. Pediatric supracondylar fractures and pediatric physeal elbow fractures. Orthop Clin North Am. 2008;39(2):163-71. DOI: 10.1016/j.ocl.2007.12.005
3. Yaokreh JB, Gicquel P, Schneider L, Stanchina C, Karger C, Saliba E, Ossenou O, Clavert JM. Compared outcomes after percutaneous pinning versus open reduction in paediatric supracondylar elbow fractures. Orthop Traumatol Surg Res. 2012;98(6):645-51. DOI: 10.1016/j.otsr.2012.03.021
4. Fayssoux RS, Stankovits L, Domzalski ME, Guille JT. Fractures of the distal humeral metaphyseal-diaphyseal junction in children. J Pediatr Orthop. 2008;28(2):142-6. DOI: 10.1097/BPO.0b013e3181653af3
5. Leitch KK, Kay RM, Femino JD, Tolo VT, Storer SK, Skaggs DL. Treatment of multidirectionally unstable supracondylar humeral fractures in children: a modified Gartland Type-IV fracture. J Bone Joint Surg Am. 2006;88:980–5. DOI: 10.2106/JBJS.D.02956
6. Skaggs DL, Flynn JM, Supracondylar Fractures of the Distal Humerus. In: Beaty JH Kasser, eds. Rockwood and Wilkins' Fractures in Children. Philadelphia, PA: Lippincott Williams & Wilkins; 2010:487–582.
7. Flynn JC, Matthews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. Sixteen years' experience with long-term follow-up. J Bone Joint Surg Am. 1974;56(2):263-72. PMID: 4375679
8. Ladenhauf HN, Schaffert M, Bauer J. The displaced supracondylar humerus fracture: Indications for surgery and surgical options: a 2014 update. Curr Opin Pediatr. 2014;26(1):64-9 DOI:10.1097/MOP.0000000000000044
9. Mitchell SL, Sullivan BT, Ho CA, Abzug JM, Raad M, Sponseller PD. Pediatric Gartland Type-IV Supracondylar Humeral Fractures Have Substantial Overlap with Flexion-Type Fractures. The Journal of Bone and Joint Surgery 2019;101(15):1351–1356. DOI: 10.2106/JBJS.18.01178
10. Aparicio Martínez JL, Pino Almero L, Cibrian Ortiz de Anda RM, Guillén Botaya E, García Montolio M, Mínguez Rey MF. Epidemiological study on supracondylar fractures of distal humerus in pediatric patients. Rev Esp Cir Ortop Traumatol. 2019;63(6):394-9. DOI: 10.1016/j.recot.2019.07.001
11. Campbell CC, Waters PM, Emans JB, Kasser JR, Millis MB. Neurovascular injury and displacement in Type III supracondylar humerus fractures. J Pediatr Orthop. 1995;15:47-52. DOI: 10.1097/01241398-199501000-00011
12. Muchow RD, Riccio AI, Garg S, Ho CA, Wimberly RL. Neurological and vascular injury associated with supracondylar humerus fractures and ipsilateral forearm fractures in children. J Pediatr Orthop. 2015;35:121-5. DOI: 10.1097/BPO.0000000000000230
13. Erçin E, Bilgili MG, Baca E, Başaran SH, Bayrak A, Kural C, Avkan MC. Medial mini-open versus percutaneous pin fixation for Type III supracondylar fractures in children. Ulus Travma Acil Cerrahi Derg. 2016;22(4):350-4. DOI: 10.5505/tjtes.2015.20268
14. Aslan A, Konya MN, Ozdemir A, Yorgancigil H, Maralcan G, Uysal E. Open reduction and pinning for the treatment of Gartland extension Type III supracondylar humeral fractures in children. Strategies Trauma Limb Reconstr.2014 Aug;9(2):79-88. DOI: 10.1007/s11751-014-0198-7.
15. Gopinathan NR, Sajid M, Sudesh P, Behera P. Outcome Analysis of Lateral Pinning for Displaced Supracondylar Fractures in Children Using Three Kirschner Wires in Parallel and Divergent Configuration. Indian J Orthop. 2018;52(5):554-60. DOI: 10.4103/ortho.IJOrtho_462_17
16. Nayak AR, Natesh K, Bami M, Vinayak S. Is closed manipulative reduction and percutaneous Kirschner wiring of supracondylar humeral fracture in children as day care surgery a safe procedure? Malays Orthop J. 2013;7(2):1-5. DOI: 10.5704/MOJ.1307.006
17. Li M, Xu J, Hu T, Zhang M, Li F. Surgical management of Gartland Type III supracondylar humerus fractures in older children: a retrospective study. J Pediatr Orthop B. 2019;28(6):530-5. DOI: 10.1097/BPB.0000000000000582
18. Su Y, Nan G. Evaluation of a better approach for open reduction of severe Gartland Type III supracondylar humeral fracture. J Invest Surg. 2019;12:1-7. DOI: 10.1080/08941939.2019.1649766
19. Sahin E, Zehir S, Sipahioglu S. Comparison of medial and posterior surgical approaches in pediatric supracondylar humerus fractures. Niger J Clin Pract. 2017;20(9):1106-11. DOI: 10.4103/njcp.njcp_104_16
20. Pei X, Mo Y, Huang P. Leverage application on Gartland Type IV supracondylar humeral fracture in children. Int Orthop. 2016;40(11):2417-22. DOI: 10.1007/s00264-016-3206-3