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Epidemiologic evaluation of torus fractures of radius in Turkey and comparison of different immobilization modalities

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Abstract

Torus fracture of the distal radius is one of the most common pediatric fractures. Though inherently stable, the literature lacks data about the complications or refracture rates after these fractures. The aim of this study was to evaluate the epidemiology of torus fractures of the distal radius in Turkey and to compare rigid and non-rigid immobilization modalities. 598 patients were enrolled in this retrospective study. Medical data such as age, gender, mechanism of the injury, duration and type of treatment were collected as well as the complications during this period. "The Faces Pain Scale – Revised" (FPSR) was used for the assessment of pain before and after the treatment. The mean age was 7.1± 3.6 and the median follow-up was 12 (9-15) months. 181 patients were treated with plaster of paris, 149 with soft casts, 80 with hard casts and 188 with splints. The mean duration of the immobilization was 22.6±5.39 days. FPSR scores before and after the treatment were 2.837(95%CI, 2.686-2.989) and 0.255 (95%CI, 0.186-0.324), respectively (p=0.001). There was no statistically significant difference between the immobilization modalities in terms of FPSR decline before and after the treatment (p=0.403). The overall complication rate was 7.4% among all patients (95% CI, 5.3%-9.5%). Complication rates for each stabilization modality were 13.3% for the plaster of paris, 6.7% for the soft cast, 10% for hard cast and 1.1% for the splint group. The complication rate in the patients treated with splints was statistically significantly lower in the splint group (p=0.001; p=0.033; p=0.002, respectively). The pain was the most common complication (47.8% of all complications). There were 2 refractures during the follow-up period. In conclusion, torus fractures are stable and do not require rigid immobilization. The refracture rate is below 1% and any increase in this rate should be further questioned in order to rule out a misdiagnosis of "green-stick" fracture.

Keywords: Torus, buckle, radius fractures, pediatric trauma

Introduction

Forearm fractures are the most common fractures seen in pediatric population and distal radius account for 85% of these injuries. [1]. Torus or so-called "buckle" fractures constitue the majority of these fractures and they are thought to be "safe" by means of stability and functional outcomes. It is seen most commonly during metaphyseal growth spurt. The mechanism is a low energy trauma which usually occurs through a fall from the same level with the outstretched hand often during sports or play [2]. This results in an axial load to the wrist and creates a damage in one cortex (compression side) of the transitional zone between metaphysis and diaphysis of the bone [3]. Although there is an approximately 2% of refracture rate for the whole forearm fractures in this population, there is not enough data to evaluate the complications or refracture rates after torus fractures in the literature. Orthopedic textbooks usually recommend immobilization for 2 to 4 weeks in a short arm cast as the treatment; however there is still a debate, whether and for how long applying a rigid cast, splint or even a simple bandage is enough for these fractures [4-8].

The objective of this study is to evaluate the demographic properties of torus fractures of the distal radius in Turkey and compare different immobilisation modalities in addition to the complications during and after the treatment. Our hypothesis is that torus fractures have a stable pattern regardless of the treatment modality and non-rigid immobilization would be a suitable option with low complication rates in the treatment of these injuries.

Materials and Methods

This is a retrospective study in which the children with torus fractures in the distal radius admitted to the same clinic between the years 2010 and 2016 are analysed. 252 female, 346 male with a total of 598 patients were enrolled in the study (Figure 1). Patients with ipsilateral upper extremity injury, who were unwilling to attend the study or lost to follow-ups were excluded. Greenstick

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fractures were also excluded. Informed consent was obtained from the parents and ethical committee of the faculty approved the study (approval number: 29062022/127).

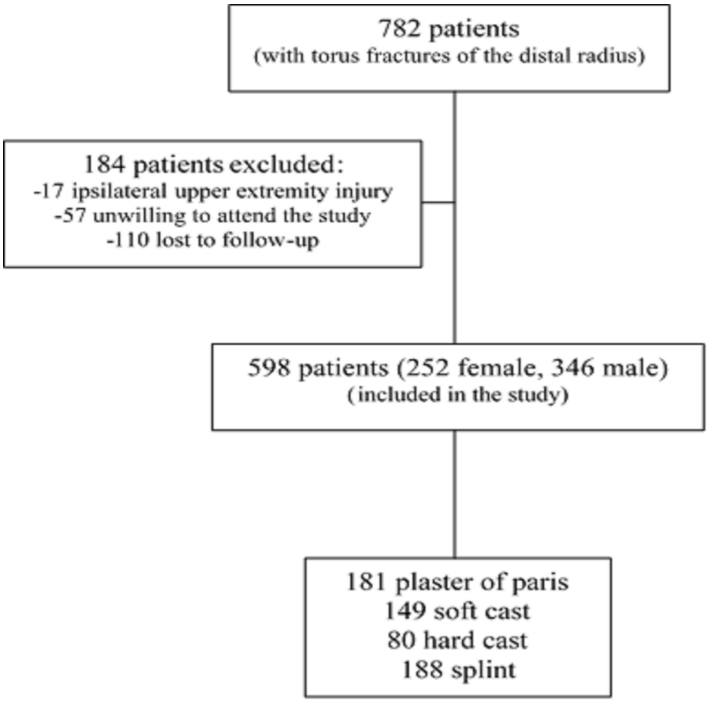

Figure 1. A flowchart showing the number of patients included in the study

Medical records of the patients were examined and data was collected such as age, gender, side and mechanism of the injury, diagnosis method, initial treatment in the emergency room, definitive choice and duration of treatment. Complications seen during the treatment period were also recorded. All patients were asked to complete "The Faces Pain Scale - Revised" (FPSR) forms for pain assessment before and at the end of the treatment [9].

All general practitioners working in the emergency department (ER) were informed about obtaining routine anteroposterior (AP) and lateral forearm radiographs from the children who were admitted to ER with wrist pain after a trauma. Patients diagnosed with torus fractures had a below-elbow splint in neutral position as the initial treatment and were asked to visit the outpatient clinic of traumatology department on the next day for follow-up. Patients who were not diagnosed with any fracture but had a resisting pain in the wrist were also asked to visit the traumatologist in case of any misdiagnosis in the ER.

Patients who visited the outpatient clinic in the following days were all seen by the same traumatologist. The splints were removed and the patients were reexamined for pain, swelling or any other pathology. The radiographs obtained in the ER were reevaluated by the traumatologist and all radiographs were initially reported by the same radiology doctor and then confirmed by another radiologist of the hospital who was experienced for almost 20 years in musculoskeletal radiology. Radiologically, a torus fracture was defined as "the disruption (bulging outward) of one cortex in the compression side of the metaphysis of radius; whereas the cortex in the tension side is intact" (Figure 2). For the definitive treatment, patients were informed about the fracture and asked to have their immobilisation applied either with traditional plaster of paris, splints (NemoaTM Splint, T&L Co., Ltd., Rep. of Korea), synthetic soft or hard casts (ScotchcastTM, 3M, USA) because of the higher price of the novel casting materials. The wrist was held in neutral position and all the cast or splints were below-elbow. No reduction maneuver was applied to any of the patients. The patients were asked to come for a follow-up in the third week after the fracture if there was no urgent situation during the treatment period. The casts were removed during the third week visit. Reexamination was made following the removal of the cast. Patients were asked to fill the pain FPSR forms again after the removal of the cast.

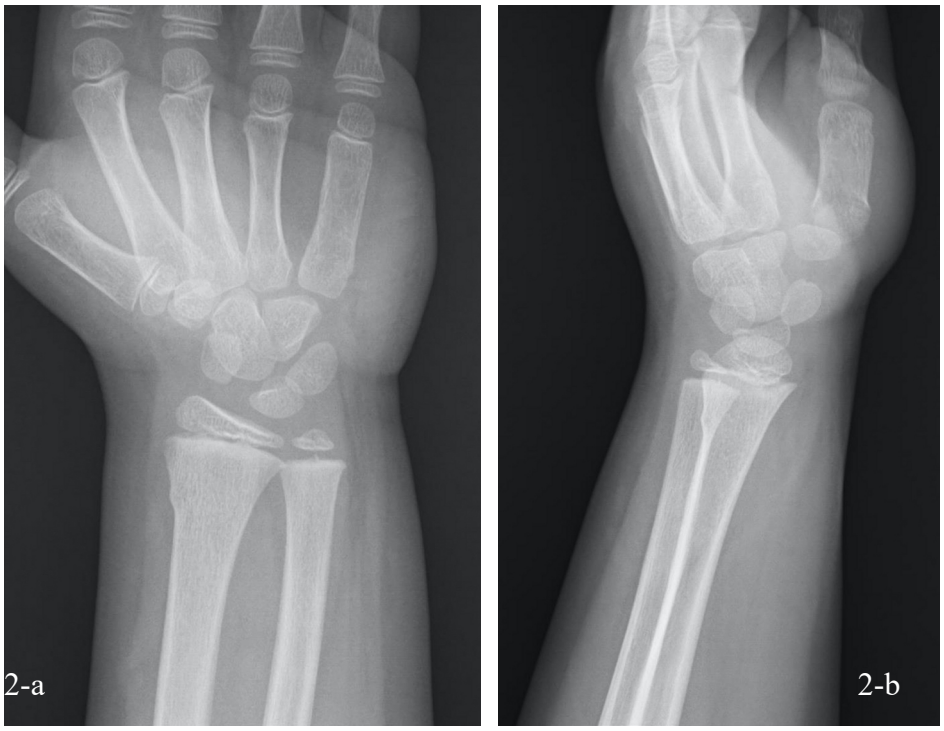

Figure 2. AP and lateral radiographs showing a torus fracture in the distal radius

Baseline data regarding the sample were presented as mean, median and standard deviation, min-max values for continuous variables, as percentages for categorical data. Results of the continous data were disclosed as mean or median together with 95% confidence interval. Independent two group comparison of continous data was analyzed with independent samples t-test (checking equality of variances with Levene's test). For the analysis of more than 2 group comparisons (continous data) ANOVA was performed. In cases of inequality of group variances Welch test was preferred. When ANOVA test was significant, multiple comparisons were performed, namely Hochberg or Games-Howell tests in accordance with the structure of the data. For all comparisons, effect sizes were calculated as Cohen's d (0.20= Small, 0.50= Medium, 0.8= High). Comparative analysis of the categorical data were performed by using contingency tables. Since the sample size was high enough, Pearson Chi-Square test was used to test independence. Cramer's V was utilized to assess effect size (less than 0.10=Small; between 0.10 and 0.25=Medium; over 0.25= High). In case of a significant Pearson Chi-Square test, pairwise comparisons of column proportions were computed (taking into account Bonferroni adjusted p-values). The accepted significance level was 95%. Statistical analyses were performed with SPSS software version 15 (SPSS Inc., Chicago, IL).

Results

598 patients who had distal radius torus fracture were included in the study. The median follow-up period was 12 months (9-15 months). The demographics of the patients and characteristic properties of the injuries were described in Table 1. All of the fractures were diagnosed with routine AP and lateral wrist radiographs as described above. All but three patients were treated with short-arm splints in the ER. Two of these patients (0.33%) were diagnosed with torus fracture in the outpatient clinic, after the general practitioner failed to identify these fractures, resulting in a "misdiagnosis" and one patient (0.16%) did not want a splint application but came to the outpatient clinic two days later because of the resisting pain. In the outpatient clinic, the splints were removed and changed with the definitive immobilisation modality in accordance with the patients' request; 181 patients with plaster of paris, 149 with soft cast, 80 with hard cast and 188 with splint. The duration of the immobilisation period was 22.6±5.39 days. FPSR scores before and after the treatment were 2.837 (95% CI, 2.686-2.989) and 0.255 (95% CI, 0.186-0.324), respectively. There was no statistically significant difference between the immobilisation modalities in terms of FPSR decline before and after the treatment (p=0.403). FPSR scores were significanty higher in patients who were admitted to the ER on the same day of the injury. 21.2% of the patients returned to their daily life right after the application of the cast or splint, while 71.5% returned within 1-3 days and 7.3% returned 3 days after the end of the treatment. Patients with soft casts returned to their daily activities sooner than the other treatment modalities, with a statistically significant difference (p<0.001).

14 of the patients with plaster of paris casts, experienced an unexpected visit to the outpatient clinic during the treatment period, which was statistically significantly higher than the other treatment modalities (Table 2). The overall complication rate was 7.4% among all patients (95% CI, 5.3% - 9.5%). Pain was the most common complication (47.8% of all complications). The other complications and possible reasons for unexpected visits are described in table III. The complication rates were the lowest in the patients treated with splints, which was statistically significant (1.1%) (p<0.001). None of the patients experienced any loss in the range of motion of the wrist joint after the treatment.

There were 2 refractures seen during the follow-up period; one of whom was an 8-year-old boy with a torus fracture in his right radius and treated with plaster of paris for 3 weeks. 2 days after the removal of the cast, he came to ER after falling from the ground level again and diagnosed as refracture. He was treated with closed reduction and above-elbow casting for another 5 weeks until the callus formation had been seen (Figure 3). After the removal of the latter casting, he had a loss of flexion of 20 degrees and loss of extension of 10 degrees, which was completely recovered after range of motion (ROM) exercises for 3 weeks. The other refracture case was a 9-year-old boy who was treated again for right radius torus fracture with hard cast. Just like the other patient, 5 days after the removal of the cast at 3 weeks of treatment, he came to ER after falling down from the ground level and diagnosed as refracture. Unlike the other, this patient did not accept closed reduction and casting treatment and left the ER. After 9 months, the patient was called and asked for a follow-up appointment. It was understood that the patient had gone to another clinic and undergone open reduction and internal fixation with locking plate and screws. 5 months after the operation, he had undergone implant extraction surgery. At the end of 6 months, he had a complete healing of the fracture and there was no loss in wrist ROM. Radiographs obtained from the patient are shown below (Figure 4).

Table 1. Demographics of the patients and characteristics of the injuries

Age (years) ± SD (range)	**7.1 ± 3.6 (1-12)**
Age Groups	**n (%)**
1-3 years	129 (21.6)
4-6 years	110 (18.4)
7-9 years	167 (27.9)
10-12 years	192 (32.1)
Gender	
M	346 (57.9)
F	252 (42.1)
Side of the injury	
Right	297 (49.7)
Left	293 (49)
Bilateral	8 (1.3)
Mechanism of the injury	
Ground-level fall	397 (66.4)
Sports injury	78 (13)
Fall from height	61 (10.2)
Blunt trauma	43 (7.2)
Traffic accident	19 (3.2)
Time of the injury	
Dec - Jan - Feb	77 (12.9)
Mar - Apr - May	281 (47)
Jun - Jul - Aug	174 (29.1)
Sep - Oct - Nov	66 (11)
Application time after the injury	
Within 24 hrs	442 (73.9)
24 - 48 hrs	116 (19.4)
Later than 48 hrs	40 (6.7)

Figure 3. Radiography of refracture case I, treated with conservative methods

Table 2. Unexpected visits and complications among treatment modalities

	n				
	Soft Cast	**Splint**	**Hard Cast**	**Plaster of Paris**	**Total**
Unexpected Visits					
No	140 (94)	186 (98.9)	74 (92.5)	167 (92.3)	567 (94.8)
Yes	9 (6)	2 (1.1)	6 (7.5)	14 (7.7)	31 (5.2)
Complications					
No	139 (93.3)	186 (98.9)	72 (90.0)	157 (86.7)	554 (92.6)
Yes	10 (6.7)	2 (1.1)	8 (10.0)	24 (13.3)	44 (7.4)

Table 3. List of complications

List of Complications	**n (%)**
Pain	21 (47.8)
Dirty cast	9 (20.5)
Broken cast	5 (11.4)
Tight cast	4 (9)
Abrasion during removal	2 (4.5)
Refracture	2 (4.5)
Vascular compromise	1 (2.3)
Total	44 (100)

Figure 4. Radiography of refracture case II, treated with surgery

Discussion

As the bones in pediatric population have a higher collagen ratio, incomplete fracture patterns are more likely to occur; making torus fractures the most common orthopedic injury seen in children [1,2,10]. There is an increasing incidence of pediatric forearm -therefore torus- fractures in recent years as the age for participation in sports activities has decreased [11]. In our study, we saw that spring and summer months were the peak periods for these fractures; as other authors have pointed out a seasonal variation due to long summer holidays and longer daylight hours [11,12]. In addition to this, we saw that there is a male dominancy, which could be explained by the longer hours male children spend outside their homes compared to female children [13].

In our study, we obtained routine AP and lateral radiographs of the forearm before initiating treatment in ER. Recently, there are some studies suggesting ultrasonographic evaluation for torus fractures because of its high sensitivity for cortical disruption and being radiation-free; however, we found out that ultrasonographic evaluation for these kids was difficult to perform in the ER [14]. This was due to both children's discomfort and parents' not wanting to wait for a longer time for the ultrasound to be performed in ER. In such hospitals with lower frequency of patients presenting to an emergency service, ultrasonographic evaluation would be an alternative method for the diagnosis of torus fractures [4]. For the follow-up of torus fractures, Farbman et al. suggested that there is no need to take an additional radiograph unless the orthopedic surgeon has any doubt that the healing is completed and one must definitely rely on the examination findings after the removal of the cast [15]. In our study, we did not obtain forearm radiographs at the third week routinely and we saw that in the patients with persisting pain after cast removal, the control radiographs did not change the treatment plan in any direction. In the literature, it is clearly stated that torus fractures are inherently stable fractures which do not require follow-up and non-union almost never occurs [2,10,16]. In a study by Schranj et al. 7.1% of unicortical dorsal buckle fractures were seen to be displaced, but even with this ratio, it is also agreed that fractures without a cortical breach are stable and any angulation occuring in fractures of distal radius is unlikely to cause any long-term functional disability in children due to high remodeling capacity [17,18]. Therefore, obtaining serial radiographs for the follow-up would be an overreaction for these kinds of fractures. Besides, in the same study by Schranj, the displacement risk of any cortical breach such as greenstick fractures was nearly 30% and especially the dorsal deformites were pointed to have a tendency to displace.

Controversy still exists over the treatment modalities of torus fractures in the literature. In a systematic review and meta-analysis by Jiang et al., it was found that non-rigid immobilisation methods had more advantages than rigid immobilisations in terms of functional recovery, complications and medical costs [19]. Recently, a multi-centre, randomised, controlled trial has been conducted in the UK, which compared non-rigid (bandage) and rigid immobilisation (splint) [20]. There was no statistically significant difference between both groups in terms of pain scores, analgesia use, complications or functional capacity after the treatment, which offered the usage of non-rigid immobilisation for torus fractures of the radius. Findings of our study also support non-rigid immobilisation for torus fractures, as the usage of splints and soft casts had the lowest complication rates and unexpected visits to the clinic, when compared to hard casts and plaster of paris. Besides, non-rigid immobilisation achieved the most rapid return to the daily activities in our study.

There is convincing data in the literature about the stable nature of torus fractures. Choosing the right treatment modality should provide both immobilisation for reducing the pain and enhancing the healing and keeping the immobilisation non-rigid in order to decrease the complication rates. Because the complications in torus fractures are nearly always not related to the fracture itself, but the treatment method instead. Long-term functional compromise or deformities are almost never seen, independently from the treatment [21]. Nevertheless, there is still a lack of data about the refracture rates after these fractures. Plint et al. found 1% of the subjects were refractured during the following year in their study [22]. We had seen 2 cases of refracture in our study (0.33%), both of which were fractured soon after the removal of the casts. Many authors claim that the increasing rate of refracture should be questioned for improper or misdiagnosis of torus fractures. Another variant of incomplete fractures -so called greenstick- are thought to be unstable and more likely to be displaced and refractured [23,24]. Any misdiagnosis of greenstick fractures with torus fractures would be an issue. Claudia M. Vernosij had founded a %13 of misdiagnosis of torus with greenstick fractures [13]. In our study, 9 patients who were referred to our outpatient clinic diagnosed with as torus fractures by the general practicioner in ER were actually not torus but greenstick fractures (%1.5) which required a different treatment plan and were excluded from the study. In a systematic review by Hill et al., it was found that the only concern identified about the stability of torus fractures was being incorrectly diagnosed greenstick fractures which do not possess the inherent stability of torus fractures [24]. Any misdiagnosis may falsely lead to an increase in the refracture rates in different populations.

This retrospective study was limited by its relatively small sample of patients for a fracture pattern seen so often in pediatric age group. As the treatment modalities had been decided upon parents' request, there may have been a selection bias when determining the groups. It would also have been ideal if patients' or parents' satisfaction levels were questioned and included in the study for each treatment group. Further investigations would clarify the benefits of different treatment modalities about adaptation to the treatment, school attendance, satisfaction and social advantages.

Conclusion

In conclusion, regardless of the treatment modalities, torus fractures of the distal radius are inherently stable which do not need a rigid immobilisation or serial radiographic follow-up. The usage of either splints or soft casts would be enough to decrease the complication rates related to the rigid immobilisation modalities. Refracture rate is below 1% in these fractures. Any misdiagnosis of greenstick fractures should be questioned especially if there is an increased rate of complications.

Conflict of interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

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Ethical approval

Haliç University Non-Invasive Clinical Research Ethics Committee, 29.06.2022, Decision No: 127.

References

1. Boyer BA, Overton B, Schrader W, et al. Position of immobilization for pediatric forearm fractures. J Pediatr Orthop. 2002;22:185-7.
2. Solan MC, Rees R, Daly K. Current management of torus fractures of the distal radius. Injury. 2002;33:503-5.
3. Davidson JS, Brown DJ, Barnes SN, Bruce CE. Simple treatment for torus fractures of the distal radius. J Bone Joint Surg Br. 2001;83:1173-5.
4. Pountos I, Clegg J, Siddiqui A. Diagnosis and treatment of greenstick and torus fractures of the distal radius in children: a prospective randomised single blind study. J Child Orthop. 2010;4:321-6.
5. Achten J, Knight R, Dutton SJ, et al. A multicentre prospective randomized equivalence trial of a soft bandage and immediate discharge versus current treatment with rigid immobilization for torus fractures of the distal radius in children: protocol for the Forearm Fracture Recovery in Children Evaluation (FORCE) trial. Bone Jt Open. 2020;1:214-21.
6. Kuba MHM, Izuka BH. One Brace: One Visit: Treatment of Pediatric Distal Radius Buckle Fractures With a Removable Wrist Brace and No Follow-up Visit. J Pediatr Orthop. 2018;38:e338-e42.
7. Oakley EA, Ooi KS, Barnett PL. A randomized controlled trial of 2 methods of immobilizing torus fractures of the distal forearm. Pediatr Emerg Care. 2008;24:65-70.
8. West S, Andrews J, Bebbington A, et al. Buckle fractures of the distal radius are safely treated in a soft bandage: a randomized prospective trial of bandage versus plaster cast. J Pediatr Orthop. 2005;25:322-5.
9. Hicks CL, von Baeyer CL, Spafford PA, et al. The Faces Pain Scale-Revised: toward a common metric in pediatric pain measurement. Pain. 2001;93:173-83.
10. Firmin F, Crouch R. Splinting versus casting of "torus" fractures to the distal radius in the paediatric patient presenting at the emergency department (ED): a literature review. Int Emerg Nurs. 2009;17:173-8.
11. Bell SW, McLaughlin D, Huntley JS. Paediatric forearm fractures in the west of Scotland. Scott Med J. 2012;57:139-43.
12. Rennie L, Court-Brown CM, Mok JY, Beattie TF. The epidemiology of fractures in children. Injury. 2007;38:913-22.
13. Vernooij CM, Vreeburg ME, Segers MJ, Hammacher ER. Treatment of torus fractures in the forearm in children using bandage therapy. J Trauma Acute Care Surg. 2012;72:1093-7.
14. Williamson D, Watura R, Cobby M. Ultrasound imaging of forearm fractures in children: a viable alternative? J Accid Emerg Med. 2000;17:22-4.
15. Farbman KS, Vinci RJ, Cranley WR, et al. The role of serial radiographs in the management of pediatric torus fractures. Arch Pediatr Adolesc Med. 1999;153:923-5.
16. van Bosse HJ, Patel RJ, Thacker M, Sala DA. Minimalistic approach to treating wrist torus fractures. J Pediatr Orthop. 2005;25:495-500.
17. Schranz PJ, Fagg PS. Undisplaced fractures of the distal third of the radius in children: an innocent fracture? Injury. 1992;23:165-7.
18. Symons S, Rowsell M, Bhowal B, Dias JJ. Hospital versus home management of children with buckle fractures of the distal radius. A prospective, randomised trial. J Bone Joint Surg Br. 2001;83:556-60.
19. Jiang N, Cao ZH, Ma YF, et al. Management of Pediatric Forearm Torus Fractures: A Systematic Review and Meta-Analysis. Pediatr Emerg Care. 2016;32:773-8.
20. Perry DC, Achten J, Knight R, et al. Immobilisation of torus fractures of the wrist in children (FORCE): a randomised controlled equivalence trial in the UK. The Lancet. 2022;400:39-47.
21. Riera-Alvarez L, Pons-Villanueva J. Do wrist buckle fractures in children need follow-up? Buckle fractures' follow-up. J Pediatr Orthop B. 2019;28:553-4.
22. Plint AC, Perry JJ, Tsang JL. Pediatric wrist buckle fractures. Should we just splint and go? CJEM. 2004;6:397-401.
23. Randsborg PH, Sivertsen EA. Distal radius fractures in children: substantial difference in stability between buckle and greenstick fractures. Acta Orthop. 2009;80:585-9.
24. Hill CE, Masters JP, Perry DC. A systematic review of alternative splinting versus complete plaster casts for the management of childhood buckle fractures of the wrist. J Pediatr Orthop B. 2016;25:183-90.