CASE REPORT

Clinical Insights and Management of Pediatric Bennett-Equivalent Fractures: Case Report and Literature Review

Daniel A. Nemirov, MD; Pedro K. Beredjiklian, MD; Gregory G. Gallant, MD

Research performed at Rothman Orthopaedic Institute, Philadelphia, Pennsylvania, USA

Received: 28 February 2025 *Accepted: 17 May 2025*

Abstract

Pediatric Bennett-equivalent type fractures represent an uncommon yet consequential source of morbidity and diagnostic complexity. Despite the remarkable remodeling potential and resiliency of the pediatric patient population, if managed inappropriately, these injuries are associated with multiple sequelae such as residual deformity, pain, functional limitations, and prospective accelerated arthrosis. Given the paucity of literature and absence of prospective, rigorous trials, the optimal management of these injuries remains contentious. The present study exhibits the authors' experience with two pediatric Bennett-equivalent fractures, one managed conservatively and one operatively, highlighting the necessity for provider vigilance and attentiveness in recognizing and treating these injuries.

Level of evidence: IV

Keywords: Bennett fractures, Hand, Injury, Management, Pediatric

Introduction

Hand fractures are exceedingly common in the pediatric population, second only to distal radius fractures in frequency.[1,2] Fractures of the metacarpals are more commonly seen in adolescent populations, whereas phalangeal fractures typify injuries suffered by children and toddlers.[1–4] Predominantly, these injuries involve the fifth metacarpal neck and go on to heal without significant burden or lasting sequelae.[2–4] Although rare, first metacarpal base fractures in the pediatric population represent an injury of consequential morbidity with residual ramifications if inappropriately identified and managed.

In adults, displaced, partial intra-articular fractures of the first metacarpal with a palmar ulnar fragment and an associated carpometacarpal dislocation are eponymously known as Bennett's fractures.[5] These fractures are inherently unstable and occur secondary to an axial force while the thumb is held in a flexed position.[2,5] Although optimal management for these injuries remains controversial,[6–10] the epidemiology, incidence, prognostic factors, and outcomes associated with these injuries are well elucidated.[6–9,11–14]

However, in the pediatric population, metacarpal base fractures are highly uncommon.[2] In a retrospective epidemiological investigation by Mahabir et al., only two out of 185 pediatric hand fractures recorded over a five-year interval involved the physis at the thumb metacarpal base.[3] Pediatric thumb metacarpal fractures are predominantly classified into four groups.[2,15] Metaphyseal fractures are classified as Type A.[2,15] Type B and C fractures are Salter-Harris II physeal injuries of the metacarpal base with lateral or medial angulation, respectively.[2] Type D fractures are Salter-Harris III or IV injuries, considered pediatric Bennett fracture equivalents.[2] Traditionally, when displaced, these Type D injuries have been managed with closed versus open reduction and fixation to achieve anatomic articular and physeal alignment.[2,15,16]

Given the scarcity of literature and infrequency of these cases, the optimal management, complications, and lasting consequences of Type D pediatric first metacarpal fractures are unknown. Furthermore, in the setting of open physes and barriers to physical examination, misdiagnosis often plagues the management of these injuries.[17] We present here our experience with two pediatric Bennett-equivalent basilar thumb metacarpal fractures to highlight the importance of recognizing and

Corresponding Author: Daniel A. Nemirov, Rothman Orthopaedic Institute. Philadelphia, Pennsylvania, USA

Email: Daniel.Nemirov@rothmanortho.com

THE ONLINE VERSION OF THIS ARTICLE ABJS.MUMS.AC.IR

appropriately treating these rare injuries.

Case presentation

Case I

A left-hand-dominant eleven-year-old female presented to the outpatient orthopaedic hand specialist following a fall on an outstretched hand during a soccer game the previous weekend. The injury occurred to her dominant thumb and was accompanied by immediate pain, swelling, and subjective popping and instability. On examination, the patient was found to have pain with palpation over the thumb metacarpal base, without any gross appreciable dislocation or subluxation. The remainder of her examination was benign.

PA, lateral, and oblique radiographs of the left thumb were obtained at a regional emergency department at the time of the injury, which demonstrated a displaced, Type D pediatric metacarpal base injury with an avulsion of the radial trapezium [Figure 1]. Carpometacarpal joint subluxation was notable at the time of the injury. Given the fracture's clinical picture and inherent instability, the decision was made to pursue operative intervention with closed reduction and percutaneous pinning.

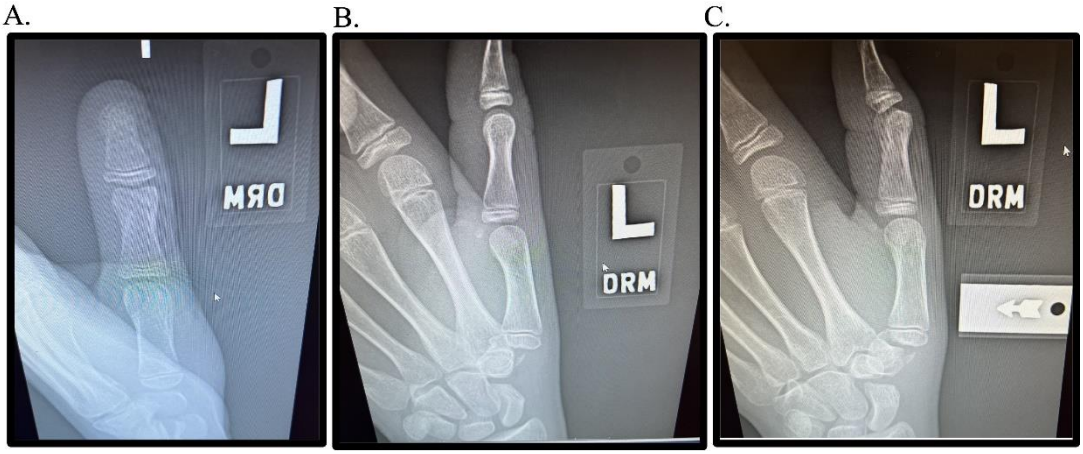

Figure 1. PA (A), lateral (B), and oblique (C) series of the left thumb in a skeletally immature individual at the time of injury demonstrating a displaced, pediatric Bennett-equivalent metacarpal base injury with an avulsion of the radial trapezium and associated carpometacarpal instability

First, closed reduction was performed through traction, extension, and pronation using three-view fluoroscopy of the thumb. Once satisfied with the alignment, four smooth Kirschner (K-wires) were utilized to hold the reduction. Three pins were placed through the epiphysis, which managed to avoid the growth plate [Figure 2]. The fourth pin served as a blocking pin, traveling along the apophysis and engaging the trapezium to counter the dorsally directed dislocation vector present preoperatively. Following pin placement, no instability remained at the carpometacarpal joint, and they were bent and cut outside the skin. The patient was placed in a thumb spica cast. The patient tolerated the procedure well without any immediate complications.

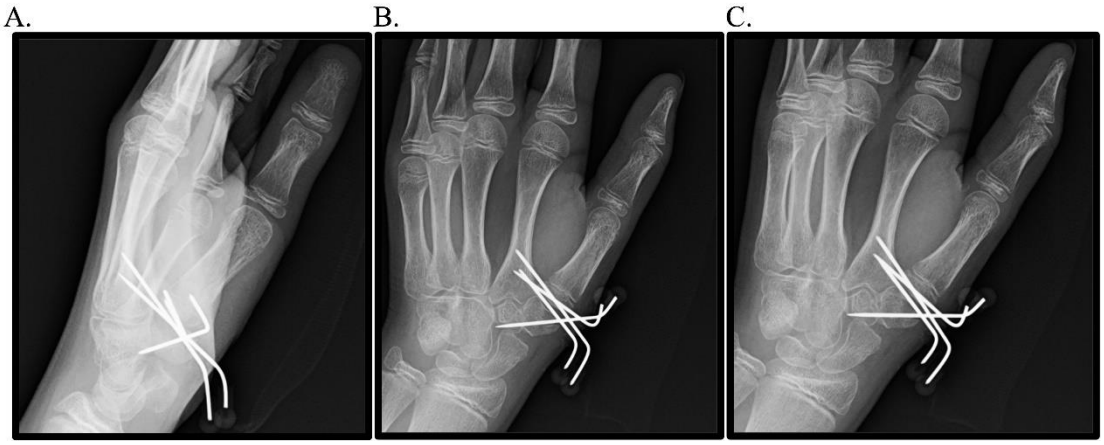

Figure 2. PA (A), lateral (B), and oblique (C) series of the left thumb in a skeletally immature individual obtained postoperatively at the four-week follow-up out of the thumb spica cast. Reduction was well maintained, and K-wires were removed at this time

Four weeks postoperatively, radiographs were taken following cast removal, and therapy was begun. The remainder of the patient's postoperative course was unremarkable, and radiographs obtained at 8 weeks postoperatively demonstrated appropriate interval healing and a well-reduced thumb carpometacarpal joint [Figure 3].

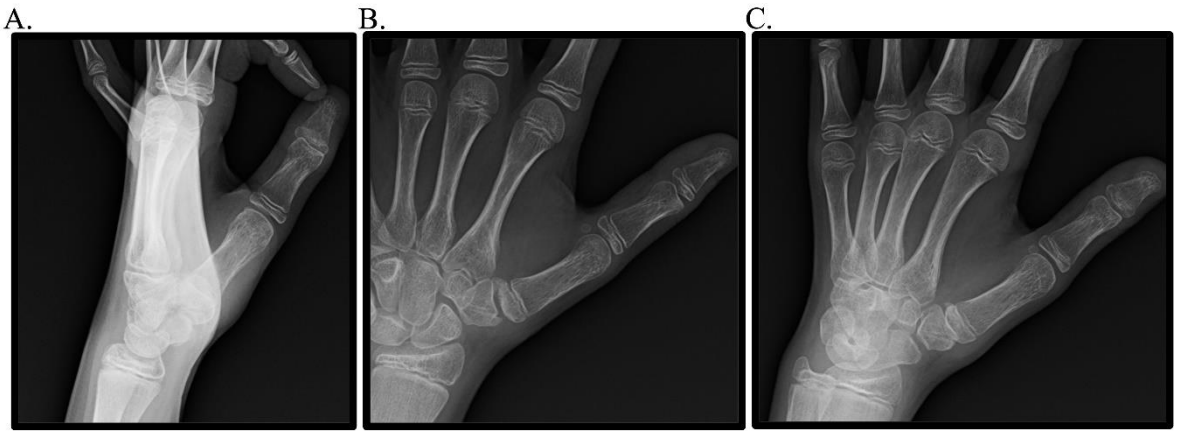

Figure 3. PA (A), lateral (B), and oblique (C) series of the left thumb in a skeletally immature individual obtained at the eight-week follow-up appointment demonstrating interval healing of the pediatric Bennett-equivalent fracture with maintained reduction and carpometacarpal congruity

Case II

A right-hand-dominant eleven-year-old female presented to the outpatient orthopaedic hand specialist following a fall on an outstretched hand, leading to an injury to her right thumb. The injury occurred three days prior to her presentation, and her chief complaint was pain at the base of the right thumb.

PA and lateral radiographs of the right thumb were obtained on the day of the injury at an urgent care facility that demonstrated a minimally displaced Type D pediatric thumb metacarpal base fracture without associated dislocation or subluxation of the carpometacarpal joint [Figure 4]. On examination, no subtle subluxation or dislocation was elicited.

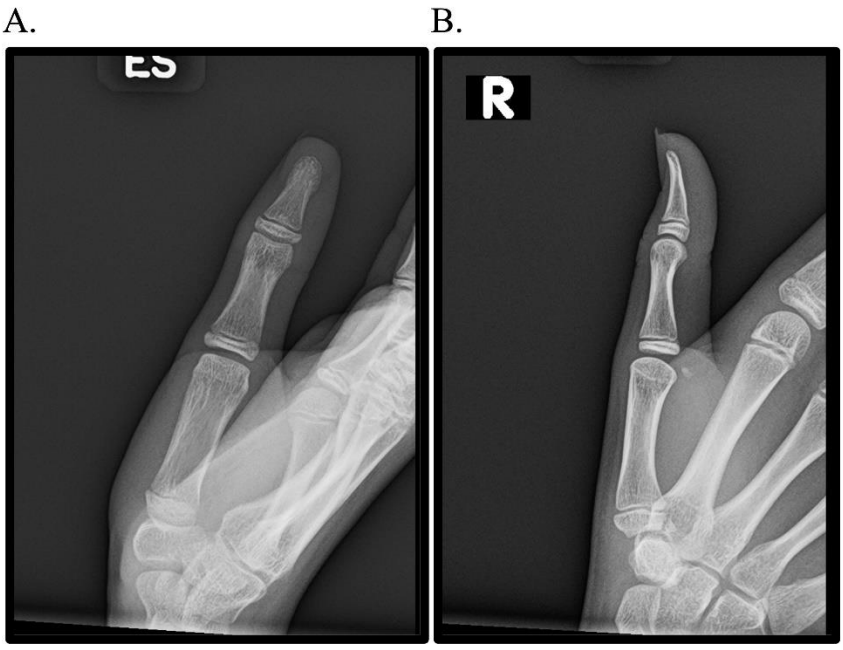

Figure 4. PA (A), lateral (B) radiographs of the right thumb in a skeletally immature individual demonstrating a minimally displaced Bennett-equivalent metacarpal base fracture without associated dislocation or subluxation of the carpometacarpal joint

Given the clinical examination, radiographic findings, and remodeling potential of the patient, the decision was made to pursue nonoperative management. The proposed plan included using a short arm thumb spica cast for three weeks, with interval radiographs obtained out of the cast one week from the patient's initial presentation.

PA, lateral, and oblique X-rays of the right thumb were obtained one week later, which were negative for interval displacement, redemonstrating a well-reduced carpometacarpal joint. Four weeks after the patient's initial injury, final radiographs were obtained out of the cast, demonstrating interval healing and a well-aligned first carpometacarpal joint [Figure 5]. The cast was discontinued at this time, and the patient progressed to full activity without formal, guided therapy.

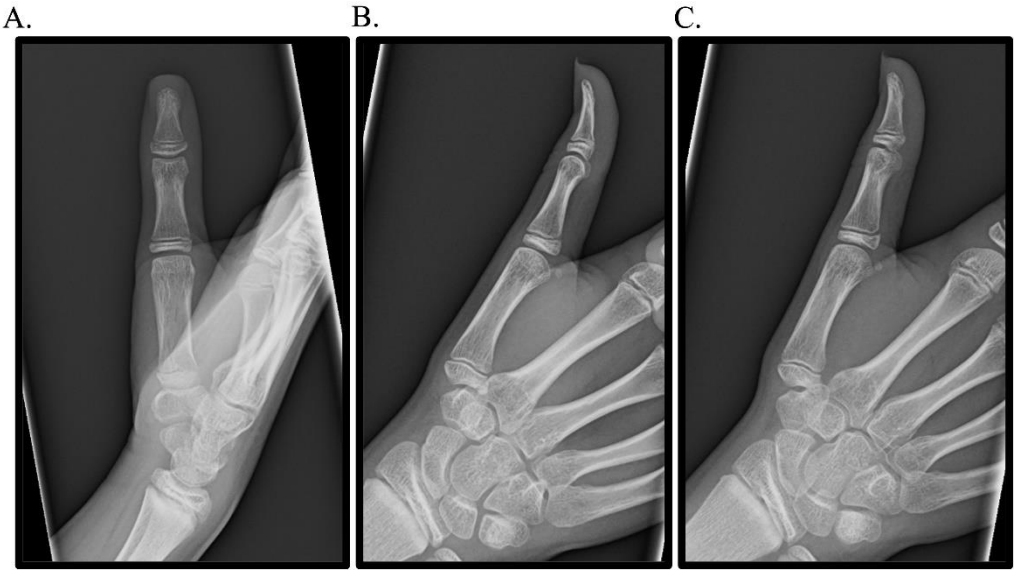

Figure 5. PA (A), lateral (B), and oblique (C) radiographs of the right thumb in a skeletally immature individual, obtained four weeks post-injury, demonstrating interval healing of a previously minimally displaced Bennett-equivalent metacarpal base fracture with preserved carpometacarpal joint congruity

Discussion

The present case reports examine the operative and nonoperative treatment of pediatric Bennett-equivalent fractures to emphasize the importance of proper recognition and management of these uncommon injuries. Although well-researched in the adult population, the epidemiology, incidence, and optimal management of pediatric Bennett-equivalent fractures are less established.[2,6–8,12,15,17] Despite the unique treatment obstacles intrinsic within the pediatric population, the present study demonstrates that, when properly indicated, both operative and nonoperative regimens represent viable courses in managing these injuries.

In adults, Bennett's fractures necessitate formal reduction and operative fixation, as cast immobilization alone is associated with subsequent fracture displacement and a resultant loss of function.[6–12,15] Therefore, recent research has focused on comparing outcomes and complications of closed reduction and percutaneous pinning (CRPP) versus open reduction and internal fixation (ORIF) in the setting of these injuries. In a meta-analysis of adult Bennett fractures, Daher et al. found that ORIF was associated with increased pinch and grip strength, increased carpometacarpal flexion and extension, and smaller residual adduction deformity of the thumb.[13] However, the clinical implications of these discrepancies are unclear, and patients undergoing ORIF have been found to have increased postoperative complications compared to their CRPP counterparts across several studies.[6,8–11,13,18,19] A major theoretical advantage of ORIF is the ability to recognize and address any significant fracture gapping or articular step off intraoperatively,[10] yet the causality between persistent postoperative deformity and resultant arthrosis has not consistently been demonstrated in previous studies.[7–9]

To the authors' knowledge, there are no prospective or large cohort retrospective studies investigating the management of Bennett-equivalent fractures in the pediatric population. Furthermore, the injury itself is scarcely reported, contributing to the lack of concordance surrounding its management.[2,15,20] Although focusing on Rockwood and Wilkins' Type C (RWC) pediatric metacarpal base fractures (Salter-Harris II physeal injuries of the metacarpal base with medial angulation), the retrospective investigation performed by Qiao et al., reached several pertinent conclusions likely applicable to Rockwood and Wilkin's Type D injuries (pediatric Bennett-equivalent fractures), while factoring in the additional necessity to restore articular and joint congruity.[20] In a series of 30 patients with severely displaced RWC fractures collected over six years, the authors found comparable, favorable outcomes with both CRPP and

open reduction and pinning modalities.[20] However, patients in the CRPP cohort experienced a decreased incidence of mild complications, shorter operative times, and a shortened recovery interval, leading the authors to designate CRPP as their preferred method for treating these fractures.[20]

Given the lack of any algorithmic guideline when treating pediatric Bennett-equivalent type fractures, an individualized approach should be undertaken for each case, factoring in fracture morphology, radiographic and clinical instability, remodeling potential, and the forgiving nature of the basilar thumb to accommodate multiplanar motion.[2] These injuries are reduced through traction, extension, and pronation, as highlighted in Case I. Although implant selection should also be determined on a case-by-case basis, smooth K-wires (as utilized in Case I) are advantageous in curbing iatrogenic injury to both the physis and articular cartilage surface.[2] The overarching goal of treatment is to preserve or reestablish the anatomic congruity of the joint and physis.[2] As previously exhibited, this can be achieved through operative or nonoperative means, depending on initial displacement and instability. CRPP is favored over ORIF when feasible to mitigate operative time, surgical footprint, and postoperative complications.[20] Both patients in the present manuscript went on to achieve clinical and radiographic union by 5 weeks and could return to pre-injury functionality without lasting limitations.

Several clinical and radiographic obstacles arise when treating pediatric Bennett-equivalent fractures, often precipitating misdiagnosis and mismanagement.[17] In a retrospective review conducted by Chew et al., a misdiagnosis rate of 8% was found among emergency and family physicians referring suspected pediatric hand fractures to outpatient specialists.[17] Their study's leading cause of misdiagnosis stemmed from a misinterpretation of the epiphysis.[17] Furthermore, physical examination limitations often inherent to the pediatric patient population routinely limit the ability to correlate clinical and radiographic findings. When addressing pediatric first metacarpal base fractures, a hyper-pronated view of the thumb may help counteract these hurdles, which can accentuate the carpometacarpal joint.[2] Diligence is critical for the physician to discern radiographic subtleties that may represent persistent joint incongruity or instability that would portend a poor prognosis for Bennett-equivalent fractures managed with cast immobilization in isolation.

Conclusion

Pediatric Bennett-equivalent fractures are an uncommon injury, which, if misdiagnosed, may be associated with lasting pain, impediments to motion, and accelerated arthrosis. Although traditionally managed via closed reduction and operative stabilization in the adult population, the present series highlights the importance of managing these cases individually and the utility of both operative and nonoperative approaches. Given the lack of prospective, randomized investigations regarding the optimal management of these injuries, this empirical data is advantageous in furthering the discussion surrounding these injuries. Moreover, given their propensity to be missed and proclivity for secondary displacement if inappropriately immobilized, pediatric Bennett-equivalent fractures represent an injury necessitating vigilance and attentiveness from managing providers.

Acknowledgement

N/A

Authors Contribution: Daniel Nemirov: Collected the data, Performed the analysis, Wrote the paper/ Pedro Beredjiklian: Conceived and designed the analysis, Paper Review/ Greg Gallant: Conceived and designed the analysis, Collected the data, Wrote the paper, Paper Review

Declaration of Conflict of Interest: The author(s) do NOT have any potential conflicts of interest for this manuscript.

Declaration of Funding: The author(s) received NO financial support for the preparation, research, authorship, and publication of this manuscript.

Declaration of Ethical Approval for Study: Our institution possesses a waiver for reporting individual cases/cases series and does not require individual ethical approval.

Declaration of Informed Consent: There is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

Daniel A. Nemirov MD [1]
Pedro K. Beredjiklian MD [1]
Gregory G. Gallant MD [1]

1 Rothman Orthopaedic Institute. Philadelphia, Pennsylvania, USA

References

1. Hastings H, Simmons BP. Hand fractures in children. A statistical analysis. Clin Orthop Relat Res. 1984;(188):120-130.
2. Kluwer W. Fractures and dislocations of the hand and carpal bones in children. In: Rockwood and Wilkins' Fractures in Children. 9th ed. Water PM, Skaggs DL, Flynn JM, eds. Lippincott Williams & Wilkins; 2020.
3. Mahabir RC, Kazemi AR, Cannon WG, Courtemanche DJ. Pediatric hand fractures: a review. Pediatr Emerg Care. 2001;17(3):153-156. doi:10.1097/00006565-200106000-00001.
4. Liao JCY, Chong AKS. Pediatric Hand and Wrist Fractures. Clin Plast Surg. 2019;46(3):425-436. doi: 10.1016/j.cps.2019.02.012.
5. Dial WB, Berg E. Bennett's fracture. Hand. 1972;4(3):229-235. doi:10.1016/S0072-968X(72)80006-8.

6. Rivlin M, Fei W, Mudgal CS. Bennett Fracture. J Hand Surg Am. 2015;40(8):1667-8. doi: 10.1016/j.jhsa.2015.05.017.
7. Leclère FMP, Jenzer A, Hüsler R, et al. 7-year follow-up after open reduction and internal screw fixation in Bennett fractures. Arch Orthop Trauma Surg. 2012;132(7):1045-51. doi: 10.1007/s00402-012-1499-2.
8. Lutz M, Sailer R, Zimmermann R, Gabl M, Ulmer H, Pechlaner S. Closed reduction transarticular Kirschner wire fixation versus open reduction internal fixation in the treatment of Bennett's fracture dislocation. J Hand Surg Br. 2003;28(2):142-147. doi:10.1016/s0266-7681(02)00307-8.
9. Goru P, Haque S, Verma GG, Mustafa A, Ebinesan A. Bennett's Fracture Management: A Systematic Review of Literature. Cureus. 2022;14(11):e31340. doi:10.7759/cureus.31340.
10. Kamphuis SJM, Greeven APA, Kleinveld S, Gosens T, Van Lieshout EMM, Verhofstad MHJ. Bennett's fracture: Comparative study between open and closed surgical techniques. Hand Surg Rehabil. 2019;38(2):97-101. doi:10.1016/j.hansur.2018.11.003.
11. Langridge B, Griffin M, Akhavani M, Butler PE. Bennett's Fracture Repair-Which Method Results in the Best Functional Outcome? A Retrospective Cohort Analysis and Systematic Literature Review of Patient-Reported Functional Outcomes. J Hand Microsurg. 2021;13(2):81-88. doi:10.1055/s-0040-1703412.
12. Levy V, Mazzola M, Gonzalez M. Intra-Articular Fracture of the Base of the First Metacarpal Bone: Treatment Through a Volar Approach. Hand (N Y). 2018;13(1):90-94. doi:10.1177/1558944716685828.
13. Daher M, Roukoz S, Ghoul A, Tarchichi J, Aoun M, Sebaaly A. Management of Bennett's fracture: A systematic review and meta-analysis. JPRAS Open. 2023;38:206-216. doi:10.1016/j.jpra.2023.09.010.
14. Middleton SD, McNiven N, Griffin EJ, Anakwe RE, Oliver CW. Long-term patient-reported outcomes following Bennett's fractures. Bone Joint J. 2015;97-B(7):1004-1006. doi:10.1302/0301-620X.97B7.35493.
15. Griffiths JC. Bennett's fracture in childhood. Br J Clin Pract. 1966;20(11):582-583.
16. Gedda KO. Studies on Bennett's fracture; anatomy, roentgenology, and therapy. Acta Chir Scand Suppl. 1954;193:1-114.
17. Chew EM, Chong AKS. Hand fractures in children: epidemiology and misdiagnosis in a tertiary referral hospital. J Hand Surg Am. 2012;37(8):1684-1688. doi:10.1016/j.jhsa.2012.05.010.
18. Brüske J, Bednarski M, Niedźwiedź Z, Zyluk A, Grzeszewski S. The results of operative treatment of fractures of the thumb metacarpal base. Acta Orthop Belg. 2001;67(4):368-373.
19. van Niekerk JLM, Ouwens R. Fractures of the base of the first metacarpal bone: results of surgical treatment. Injury. 1989;20(6):359-362. doi:10.1016/0020-1383(89)90014-4.
20. Qiao F, Shang X, Jiang F. Open vs. closed reduction with pinning for displaced Rockwood and Wilkins' type C thumb metacarpal base fractures in children. Front Pediatr. 2024:12:1394853. doi: 10.3389/fped.2024.1394853.