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DELAYED UNION IN PEDIATRIC BENNETT'S FRACTURE TREATED WITH OPEN REDUCTION AND INTERNAL FIXATION USING KIRSCHNER WIRE: A CASE REPORT

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ABSTRACT
Bennett's fracture is a fracture-subluxation of the thumb carpometacarpal joint, occasionally seen in pediatric patients. Despite the frequency of metacarpal fractures, limited data exist on outcomes and complications in children. Optimal surgical treatment remains unclear. This case report aims to describe a rare instance of delayed union in a pediatric Bennett's fracture treated with Kirschner wire fixation and to contribute to the limited evidence guiding its management. This is a descriptive case report. Data were collected through clinical examination, surgical records, and serial imaging, and were analyzed descriptively to assess healing progression and function. A 14-year-old boy presented three weeks post-injury with persistent thumb pain after a karate trauma. Imaging confirmed a Bennett's fracture. He underwent open reduction and internal fixation (ORIF) using Kirschner wires. Although initial recovery was uneventful, delayed union was noted at three months, requiring prolonged observation. Complete union occurred at five months, with good functional outcome. Delayed union can occur in pediatric Bennett's fractures, even with stable fixation. This report emphasizes the need for accurate reduction, extended monitoring, and further documentation to inform pediatric surgical protocols.

Keywords: bennett's fracture; delayed union; kirschner wire; open reduction; pediatric

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INTRODUCTION

The hand is the most common site of injury that resulted in an emergency visit in the pediatric and adolescent population. Metacarpal bones fractures accounts for 10% of all fractures and 40% of all hand fractures with a lifetime incidence of 2.5% (Bouaicha et al., 2022; Goru et al., 2022; Kreutz-Rodrigeus et al., 2022). Due to its anatomical structure and location, the thumb is very prone to trauma such as fractures. Where Bennett's fracture is the most encountered fracture type of the thumb, but without a definite epidemiological data in the pediatric populations. Bennett's fracture named after Edward Hallaran Bennett, is a fracture-subluxation of the carpometacarpal joint (CMCJ) of the thumb with a palmar anterior marginal fracture fragment (Bouaicha et al., 2022; Goru et al., 2022).

Early return to daily leisure and academic activity is the end goal of every treatment, more so in the pediatric population. And early recognition and prompt diagnosis with treatment is key in achieving that satisfactory outcome. Operative fixation such as closed reduction and percutaneous fixation, open reduction and internal fixation (ORIF), or arthroscopically assisted fixation are commonly used to treat Bennett's fracture. However, the optimal surgical treatment is still controversial, with scarce literature comparing the results of those various surgical techniques, leaving surgeons with no clear guidelines on the treatment of Bennett's fracture. Surgicals techniques aside, even the acceptable reduction parameters (such as articular gap, step-off, and displacement level) in Bennett's fracture are still not clear, with some sources stating that up to 2mm of displacement is still acceptable (Yeh & Dodds, 2009; Guss et al., 2016).

Recent literature by Daher et al., review the management and outcomes of Bennett's fracture in various populations. Higher grip and pinch strength along with better extension and flexion of the carpometacarpal joint, and a smaller mean adduction deformity of the thumb were found in patients treated with ORIF. However, they also noted that complications associated with ORIF such as persistent pain, paresthesia, loss of strength and malunion must also be considered (Daher et al., 2023). We report a case of a 14-year-old boy with Bennett's fracture on the left hand treated with ORIF.

METHOD

This study is a single-subject descriptive case report focusing on a pediatric patient diagnosed with a Bennett's fracture of the thumb. The study was conducted in accordance with institutional ethical standards, and written informed consent was obtained from the patient's guardian for both treatment and publication of the case. The subject of this report is a 14-year-old male who sustained a thumb injury during a martial arts event. The sample in this study consists of this individual patient, chosen due to the rare presentation of delayed union in pediatric Bennett's fracture treated with open reduction and internal fixation (ORIF) using Kirschner wires.

Data were collected through a combination of direct clinical examination, imaging studies (including plain radiographs and computed tomography), surgical documentation, and follow-up evaluations. Clinical parameters assessed included range of motion, pain levels, functional outcomes, and radiographic signs of bone healing. Surgical technique details and intraoperative findings were recorded at the time of operation. The data were analyzed descriptively, emphasizing the chronological progression from diagnosis to final recovery. Radiographic images were reviewed for fracture alignment, callus formation, and signs of union at multiple time points post-operatively (2 weeks, 1 month, 3 months, and 5 months). Functional outcomes were qualitatively assessed based on thumb mobility, strength, and patient-reported function during daily activities. The presence of delayed union was determined radiographically by the absence of sufficient trabecular bridging at 3 months post-operatively, requiring extended follow-up until confirmed union. This case is presented to highlight diagnostic, surgical, and postoperative considerations in the treatment of rare complications such as delayed union in pediatric Bennett's fractures, thereby contributing to clinical decision-making in similar orthopedic scenarios.

CASE REPORT

A 14-year-old boy presented to the outpatient clinic with pain on the base of the left thumb for 3 weeks before hospital admission, after punching his opponent's knee in a karate championship. He was only given pain relief medication by his family and did not seek any medical attention. Due to persistent pain, he came to our outpatient clinic in for further examination and treatment.

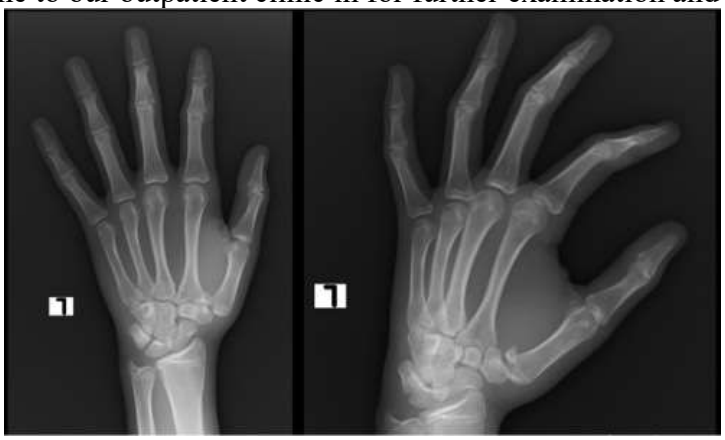

Figure 1. Pre-operative Left Hand Plain Radiograph

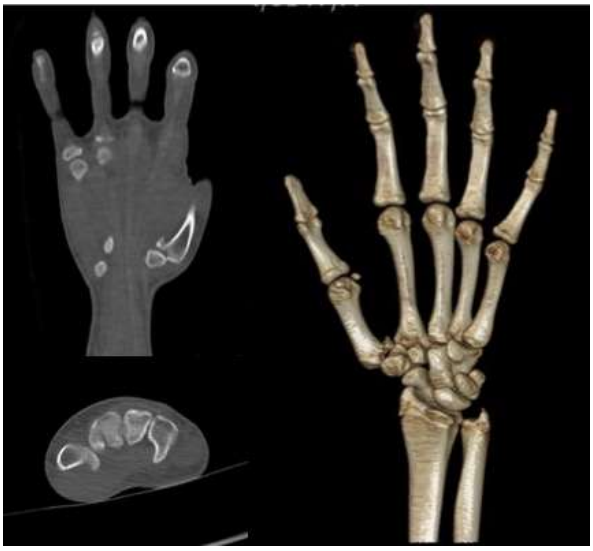

Figure 2. Pre-operative Left Hand Computed Tomography

On physical examination, there was tenderness at the first carpometacarpal joint with limited abduction and flexion on the left thumb. The neurovascular status was normal. Radiological examination revealed that he had intraarticular fracture on the base of first metacarpal with the fracture fragment consisting of the volar-ulnar corner of the proximal metacarpal suggesting for Bennett's fracture. Both plain radiograph and computed tomography (CT) scan were obtained for evaluation (Figure 1 & Figure 2).

Figure 3. Surgical Approach and Exposure

Figure 4. Fracture Reduction and Fixation

The patient was planned for surgical treatment. Under general anesthesia, a tourniquet was applied on the left arm and the hand was placed supine on the table. A wagner approach was used to exposedthe fracture. An incision was made on the dorsal-radial aspect of the thumb CMC joint, at the junction of the glabrous and nonglabrous skin, and curved in a volar direction toward the distal wrist crease to the flexor carpi radialis (FCR) tendon sheath. The thenar muscles were elevated subperiosteally from the CMC joint and a longitudinal capsulotomy was made to expose the joint and the fracture fragments. The fracture site was cleaned from hematoma and soft callus formation (Figure 3). Reduction of fracture site was carried out by inserting a 0.8 Kirschner wire into the shaft of the first metacarpal as a joystick. After manipulation and reduction was achieved, another Kirschner wire 0.8 was inserted from the radial side through the ulnar fragment. Due to small size of ulnar fragment and limitation of the implant choices, we decided to add another Kirschner wire 0.8 in convergent manner between one another as a definitive fixation. Anatomic reduction of the articular surface was verified under fluoroscopy (Figure 4).

Two weeks after surgery, the suture was removed. A month after, he came to our outpatient clinic for evaluation and x-ray examination revealed that fracture reduction was still in place and small amount of callus was formed. Active and passive movement of the thumb was allowed.

Figure 5. Post-operative Thumb Movements

The patient was re-evaluated at 3 month after surgery. From physical examination, there was no any functional limitation from the hand function and the patient had satisfactory outcome (Figure 5). Otherwise, the plain radiograph follow-up showed lack of bone healing progression (Figure 6). We decided to oberve for another months to see if there is any improvement. No additional measures was taken for the patient. Functional outcome at this stage was still satisfactory.

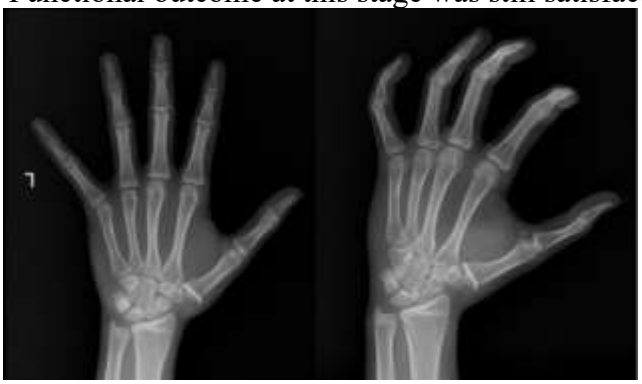

Figure 6. 3-month Post-operative Left Hand Plain Radiograph

The patient control again to our outpatient clinic and underwent plain radiograph examination of the left hand five months after the surgery. It showed a complete union of the fracture. It was then decided to remove the implants. After surgery, the patient showed no complication with satisfactory functional results.

DISCUSSION

Fractures in children differs in various ways from fractures in adult. This is mainly because of the differences in the anatomy, phyisiology, and biomehanics of the bone results in a different fracture patterns, healing process, and ultimately management of the fractures in pediatric patients. In children, fractures of the upper limbs are more commonly encountered if compared to lower limb fractures. Where specific fractures such as fracturs of the hands are commonly encountered (Lau et al., 2022). Most hands fractures do well with immobilization alone, with approximately 10% requires surgical intervention for metacarpal fractures. Two patterns were associated this metacarpal fractures that needed surgery. First is midshaft fractures with either an oblique or transverse pattern where 20.7% of them required operative intervention. The Second one is fracture of the base of metacarpal which require surgery in 9.5% of the time. These fractures most commonly affect the first and fifth metacarpal, coined Bennett's and Baby Bennett's fracture respectively. These fractures are inherently unstable, which is why they needed fixation using K-wires, tension band wiring, lag screws, T-plates, external fixator, or an arthroscopic screw fixation (Hartley et al., 2020; Graham et al., 2023; Langridge et al., 2021). In Bennett's fracture, One should be familiar with the deforming forces responsible for displacement of the fracture fragment. Actually, the fragment maintains its relationship to the trapezium as they are attached by the strong anterior oblique ligament (beak ligament). The radial articular fragment and the remaining first metacarpal shaft classically displace dorsally and radially due to the deforming forces applied. The abductor pollicis longus (APL) proximally imparting a radial force; the adductor pollicis resulting in first metacarpal adduction; and the extensor pollicis longus leading to dorsal translation (Graham et al., 2023).

Surgical fixation is therefore critical in preventing functional impairment of the thumb in Bennett's fracture. However, there is still no consensus on the optimal fixation method for it. A 11-year retrospective cohort analysis and a systematic literature by Langridge et al. showed that Closed reduction with percutaneous K-wire fixation should be the first-choice surgical method, given excellent, long-term functional outcomes, and low risk of complications. ORIF should be utilized where closed reduction is not achievable; however ultimately, the current evidence does not support one method of ORIF above another (Langridge et al., 2021). As such, the optimal surgical management of Bennett's fractures remains controversial. Newer fixation methods such as percutaneous headless compression screw and suspensory fixation might offers advantages over older, more conventional methods but there is still more solid evidence needed. Further studies are needed to investigate the biomechanical characteristics and outcomes between available treatment modalities (Graham et al., 2023).

We reported a delayed union at 4 months post-operative follow up. While this finding is relatively rare, it is still a possibility. In pediatric fracture care, the vast majority of phalangeal and metacarpal fractures are minimally displaced, stable fractures. The thick periosteal covering and ability of the bone to plastically deform afford a great deal of stability in incomplete fractures.. Most fractures complete bony healing in 3-4 weeks, with the scaphoid being a notable exception. While it is true that most of fractures sustained by healthy children and young adults can often be successfully treated with closed reduction and cast immobilization, there are some that need surgical intervention. A small but significant percentage of fractures can result in delayed union (4-6 months) or even nonunion (9-12 months) (Liu et al., 2024; Nellans & Chung, 2013). An article by Langridge et al, reported delayed union can presents as a complication in 6% of patients treated with ORIF with screw and K-wire fixations. Multiple factors are associated with the development of nonunion or delayed union, such as injuries caused by a high energy loading which results in displaced or comminuted fractures. An accurate reduction, longer immobilization and a thorough follow-up are required under these circumstances. But overall data regarding the factors involved in non-union of Bennett's fracture are still very limited (Haj Zargarbashi et al., 2018).

CONCLUSION

We presented a case of 14 year old boy with a Bennett's fracture treated by internal fixation using k-wire with a delayed union. Delayed union in Bennett's fracture in a pediatric is always a possibility regardless of the surgical technique. But here we presents a case report with hopes to contribute to the limited data on surgical outcomes for Bennett's fractures in pediatric patients, emphasizing the importance of accurate reduction, appropriate immobilization, and diligent follow-up to optimize functional results.

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