



Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: [www.JHSGO.org](http://www.JHSGO.org)

## Case Report

## Opening Wedge Osteotomy for the Treatment of Pediatric Radial Neck Malunion and Anterior Radiocapitellar Dislocation: A Case Report

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## ARTICLE INFO

## Article history:

Received for publication August 20, 2023

Accepted in revised form August 27, 2023

Available online September 22, 2023

## Key words:

Osteotomy

Opening wedge osteotomy

Radial neck fracture

Radial neck malunion

Radiocapitellar dislocation

Radial neck fractures are common injuries of the elbow in the pediatric patient. Surgical intervention is recommended for significant angulation and displacement or mechanical blocks to motion. Radial neck malunion is a rare complication and may result in altered joint mechanics and, if severe, joint incongruity. Dislocation of the radial head has yet to be reported in this population after radial neck malunion. Treatment for radial neck malunions with dislocation varies and can include radial head excision or radial neck osteotomy. Outcomes after radial neck osteotomy is limited to case reports and small cases series. We present a case report of pediatric patient with radial neck malunion and anterior radiocapitellar dislocation treated with joint realignment via opening wedge osteotomy. To our knowledge, this is the first report of a pediatric case with radial head dislocation secondary to neck malunion and the first described report using this technique.

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Radial neck fractures are a common pediatric elbow injury, accounting for 5% to 10% of the pediatric elbow injuries.<sup>1</sup> These fractures often result from a fall on an outstretched, supinated forearm, driving the radial head into the capitellum and subjecting the radial neck to valgus force.<sup>2</sup> Although frequently associated with other fractures, isolated radial neck fractures occur in up to 40% of the cases.<sup>2</sup>

Nonoperative treatment is preferred for fractures with less than 30° of angulation and less than 3 mm of displacement.<sup>3</sup> Operative management is reserved for more severe injuries with unacceptable displacement/angulation, blocks to motion, and those that fail nonoperative treatment. Surgical intervention is typically in the form of closed reduction percutaneous pinning or internal fixation; failure to obtain appropriate reduction may require open reduction.

A rare complication after radial neck fractures is malunion. Untreated malunion alters elbow biomechanics that may lead to pain, diminished range of motion, and elbow instability. Furthermore, altered loading of the articular surfaces increase risk of

cartilage wear and joint degeneration. Optimal treatment strategies addressing malunion of the radial neck relies on restoring joint congruency, typically in the form of osteotomy. Limited literature exists on the outcomes following radial neck osteotomy for radial neck malunion in skeletally immature patients. Most common technique described involves a closing wedge osteotomy with variable outcomes.<sup>4–7</sup>

We present an 11-year-old patient with radial neck osteotomy for treatment of radial neck malunion resulting in radiocapitellar dislocation. To our knowledge, this is the first report of an associated radiocapitellar dislocation with a radial neck malunion in pediatric patient, in addition to the description of a novel technique using an opening wedge osteotomy.

## Case Report

## Case details

An 11-year-old male presented 3 days after a fall on outstretched arm, resulting in a 30° angulated and displaced radial neck fracture (Fig. 1A, B). Provided the degree of angulation, operative treatment was recommended. Two weeks after the injury, the patient underwent closed reduction and internal fixation with flexible nailing using the Metaizeau technique. After surgery, the

**Declaration of interests:** No benefits in any form have been received or will be received related directly to this article.

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<https://doi.org/10.1016/j.jhsg.2023.08.009>

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**Figure 1.** Initial injury PA (A) and lateral (B) radiographs.

patient was immobilized in splint and transitioned to a long-arm cast for a total of 3 weeks. Range of motion at 3 weeks post-operative was limited from 30° of extension to 60° of flexion. Provided the motion deficits, the patient underwent 6 weeks of occupational therapy. At 9 weeks after surgery, persistent limitation was noted in all planes of the elbow including flexion, extension, supination, and pronation. Radiographs demonstrated fracture healing with acceptable radial neck angulation and anterior subluxation of the radial head (Fig. 2A, B). Static progressive splinting was initiated, in addition to continuing occupational therapy. CT scan at 3.5 months after surgery demonstrated a healed radial neck malunion with anterior dislocation of the radial head (Fig. 3A, B). Because of limited motion and joint incongruity, the recommendation was surgical intervention in the form of radial neck osteotomy to restore joint alignment and improve motion. The patient underwent removal of hardware and radial neck osteotomy 5 months after the index procedure.

#### *Surgical technique*

Patient was positioned supine with operative extremity extended on the radiolucent hand table. Removal of hardware was performed via a previous incision at the distal radius. Six to eight-centimeter incision was positioned on the lateral elbow. An interval between the extensor digitorum communis and extensor carpi radialis brevis was developed, posterior interosseous nerve was identified and protected, and arthrotomy was created to expose the radiocapitellar joint. Malunion exposure occurred through extraperiosteal elevation of the supinator muscle off the radial neck. Radial head dislocation occurred with pronation during surgery. Opening wedge osteotomy was performed using an oscillating saw. The far cortex was left incomplete to maintain a hinge, and opening wedge was created to reduce the radiocapitellar joint and correct malunion. The void from the opening wedge was filled with allograft cancellous bone graft. A five-hole T-plate, used for definitive fixation, was placed in the safe zone of the radial neck (Fig. 4A, B). Full passive pronation and supination was observed intra-operatively, with maintained joint alignment throughout the full arc of motion. Annular ligament and extensor tendon mass was repaired with 2–0 Ethibond. Skin was closed using 3–0 Monocryl and 4–0 nylon.

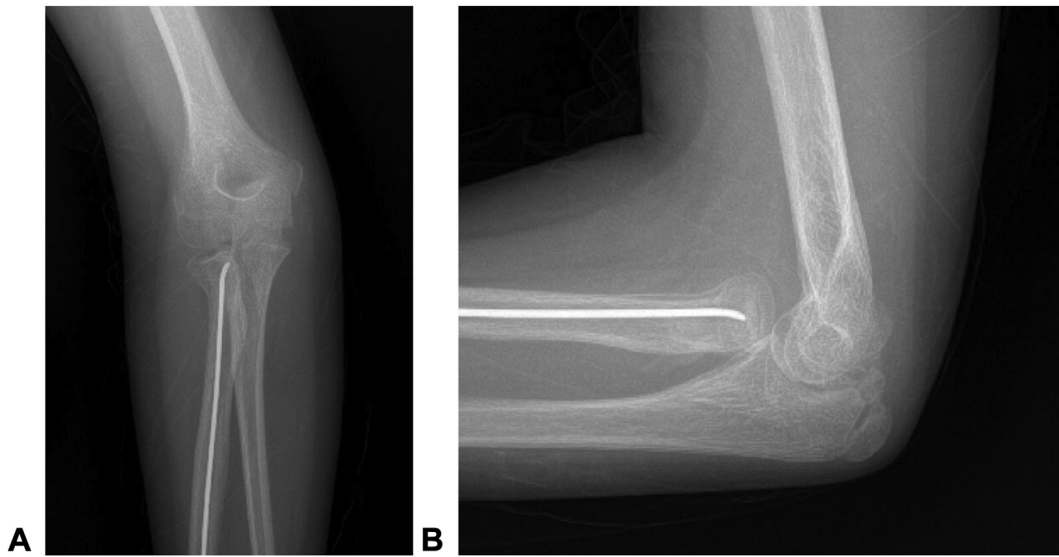
#### *After surgery*

Patient was immobilized for 2 weeks in a splint and was transitioned to a removable long-arm posterior mold brace. Occupational therapy was initiated at 2 weeks after surgery. Therapy was continued at 4 months after the procedure. The patient was asymptomatic at the final follow-up and achieved 20° of extension, 135° of flexion, 70° of supination, and 80° of pronation. Radiographically, the osteotomy site was healed with maintained radiocapitellar alignment at the final follow-up at 4 months after surgery. Written informed consent was obtained from the patient and his guardian for the publication of this case report and accompanying images.

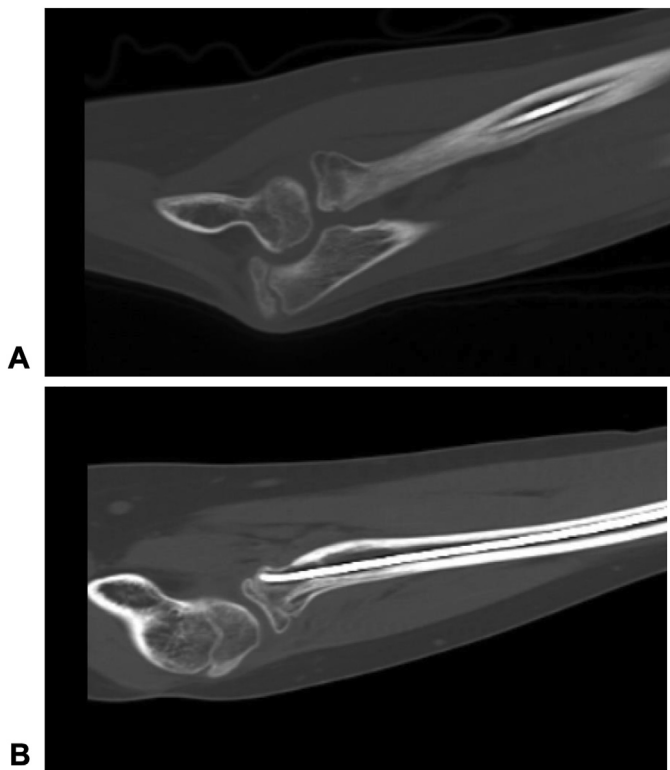
#### **Discussion**

This case describes a rare complication in a pediatric patient after radial neck fracture. Radial neck malunion has been reported in 0.7% to 5.5% after this injury.<sup>8</sup> Treatment for malunion is a highly individualized decision, and the relative indications include pain and loss of motion. Radiographic indications for surgical treatment include joint incongruity. The limited remodeling potential of the proximal radial physis is often insufficient for correcting malunions and restoring physiologic joint mechanics; hence, operative intervention may be required.<sup>4</sup>

Treatment of radial neck malunions with dislocation includes radial head excision or realignment with osteotomy. Observation alone or radial head excision results in a limited range of motion and high complication rates.<sup>5,9</sup> Literature on the surgical treatment for malunions consists of case reports and small case series.<sup>2,5</sup> Waters et al<sup>5</sup> reported that five of the nine patients underwent operative treatment for their nonunion, three of whom were treated with osteotomy. All had improvement in pain and one gained improvement in range of motion; however, one patient's motion did not change and another's declined after surgery. Others have demonstrated appropriate healing and restoration of range of motion after closing wedge osteotomy.<sup>2,6</sup> Weigelt et al<sup>7</sup> described four patients who underwent three-dimensional planned radial head osteotomies with improved angulation—however, all with an asymptomatic diminished range of motion at the time of the final follow-up. Contrarily, Bhashyam et al<sup>4</sup> demonstrated improved range of motion and pain after closing wedge osteotomy in 13



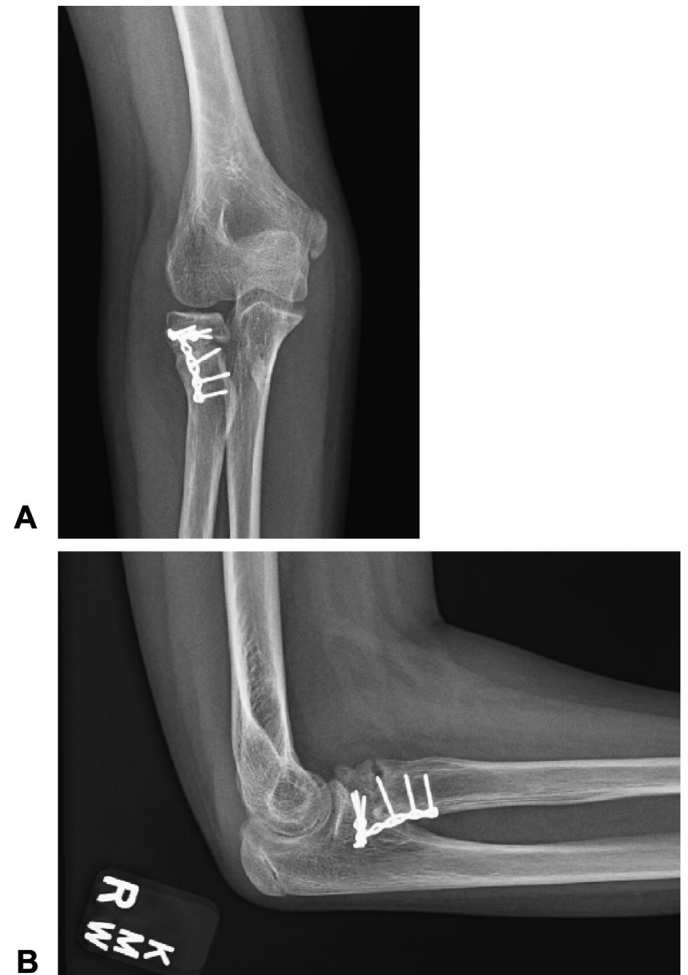
**Figure 2.** Postoperative PA (A) and lateral (B) radiographs demonstrating radiocapitellar dislocation.



**Figure 3.** Representative sagittal CT cuts demonstrating radiocapitellar dislocation (A) and radial neck angulation (B).

patients, only one of whom had resulted in nonunion at the osteotomy site.

Avascular necrosis (AVN) is a potential complication after corrective osteotomy of the proximal radius. The risk of AVN after osteotomy is largely due to the intra-articular and cartilaginous nature of the proximal radial epiphysis.<sup>4</sup> This structure's lack of soft tissue attachment further adds to the risk of osteonecrosis.<sup>4</sup> Therefore, it is crucial that the osteotomy be incomplete and the surgeon preserves soft tissue attachments to maintain adequate



**Figure 4.** Postoperative PA (A) and lateral (B) after radial neck opening wedge osteotomy.

blood supply.<sup>2</sup> Although AVN is a feared sequela of radial neck corrective osteotomy, recent reports suggest that the incidence of necrosis is far lower than what was previously believed.<sup>10</sup>

Great care must be taken so as to not to disturb the proximal radial physis during corrective osteotomy in the pediatric population because subsequent arrest of radial growth may result.<sup>2,4</sup> Premature physal closure is a complication frequently reported in the literature.<sup>4</sup> However, recent reports indicate that premature closure does not result in radial shortening greater than 5 mm and rarely leads to severe cubital valgus.<sup>2,4</sup> Authors have advocated for transphyseal fixation in proximal radial osteotomies despite the risk of premature physal closure to ensure optimal articular congruency and lasting fixation of the articular surface.<sup>10</sup>

The radial head dislocation was a mechanical block to full motion in our patient, and thus, surgical intervention was indicated. The increased range of motion our patient regained following osteotomy was due to improved articular angulation and alignment. Despite these promising outcomes, families and providers alike should retain realistic expectations in range of motion following corrective osteotomy because minor losses in terminal extension and flexion is not uncommon.

This case presents particular novelty, not only in diagnosis but also in surgical treatment. The effect of radial neck fracture angulation and subsequent malunion on joint biomechanics and stability cannot be underemphasized. This case demonstrated that malunions may result in radiocapitellar malalignment, and close monitoring is crucial in identifying the development of this post-injury. If incongruency is suspected, advanced imaging should be obtained to further evaluate the joint and would be an absolute indication for radial neck osteotomy. This finding has yet to be reported in the literature after pediatric radial neck malunions. Furthermore, most described techniques for radial neck osteotomy involve a closing wedge. We present an opening wedge osteotomy, in order to maintain radial neck length. This is important in preserving appropriate proximal radioulnar joint articulation and mechanics. Restoring the length would also be beneficial in the scenario physal closure occurred following the osteotomy. We demonstrated that our patient regained a near full range of motion

with complete healing of the osteotomy site and full resolution of pain with this technique.

## Conclusion

Radial neck malunions can lead to joint incongruency, altered biomechanics, and abnormal articular loading. Surgical intervention is typically warranted in these cases. An opening wedge osteotomy offers pain relief, restores range of motion, and preserves joint integrity following radial neck malunion with radiocapitellar dislocation. Although outcomes in this case were promising, further study is needed to completely assess the role of this procedure in this population.

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