Hybrid Fixation in Pediatric Forearm Fractures, does it Predispose to Non-union? A Case Report and Literature Review

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Learning Point of the Article:

Hybrid fixation should be used cautiously in the paediatric age group, where in spite of excellent healing and remodelling potential, non union may still occur.

Abstract

Introduction: Pediatric fracture non-union is rare, with limited published evidence available. Whilst there have been certain predisposing factors identified throughout case reports/series, we present a case, hypothesizing a previously undocumented risk factor for non-union.

Case Report: A 9-year-old boy sustained closed, diaphyseal both bone forearm fractures. He underwent a hybrid fixation (plate fixation of the ulnar and elastic stable intramedullary nail of the radius). Whilst the ulnar fracture healed well, the radial fracture went on to non-union before a second procedure was performed, metalwork removed, and a compression plate utilized. At 2-month post-radial compression plate, there was a union at this site.

Conclusions: There are numerous risk factors for non-union in pediatric fractures which have previously been highlighted throughout literature. We present a case hypothesizing a new risk factor, of hybrid fixation, for pediatric non-union.

Keywords: Case report, Hybrid fixation, Non-union, Orthopedic, Pediatric, Trauma.

Introduction

Non-union in pediatric fractures is rare, with evidence published based on case reports or case series following up a small number of individuals over an extended period of time [1, 2, 3, 4, 5, 6, 7, 8]. Factors contributing to non-union include open fractures and/or reductions, refractures, fracture location, infection, congenital abnormalities, and chronic diseases [3, 4]. We present a case of non-union in a pediatric forearm fracture, hypothesizing that mixing fixation principles contributed to this non-union.

Case Report

A, a 9-year-old male, sustained a closed, neurovascularly intact, diaphyseal radius, and ulnar fracture following a fall during karate (Fig. 1). A closed reduction was initially attempted (Fig. 2) before the decision was made for internal fixation that same day. He went to theater where the radial fracture required an open reduction before a 1.5 mm elastic stable intramedullary nail (ESIN) was inserted. Following this, an attempt was made to pass a 1.5 mm ESIN down the ulnar; however, the ulnar canal was too narrow, and a plate was subsequently utilized instead (Fig. 3). He was seen routinely at 2 weeks, 6 weeks, and 6 months, where radiographs confirmed healing of the ulnar fracture, but not of the radius (Fig. 4). At 11-month post-initial surgery, a computed tomography scan was performed which confirmed non-union at the radial fracture site. The decision was then made to explore the fracture non-union site. At this stage, the initial metalwork was removed, and the radial fracture site was fixed with a compression plate. Samples taken intraoperatively ruled out any infection or bone pathology. At 2-month post-second surgery, there was a fracture union of the

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Author's Photo Gallery


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Figure 1: Initial radiographs post-injury.

Figure 2: Radiograph post-initial closed reduction and immobilization.

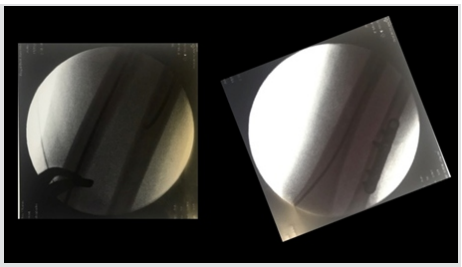

Figure 3: Intraoperative radiographs.

radial site (Fig. 5).

Discussion

Non-union is a term with various definitions. For the purpose of this case report, we have defined this as no bony union at 6-month post-injury. Due to the potential for remodeling, the majority of pediatric forearm fractures can be managed with closed reduction and immobilization. Above the age of 10, the remodeling potential reduces, and there is an increasing trend for unstable forearm fractures to be managed with internal fixation. The ESIN is increasingly becoming the fixation method of choice for treating diaphyseal long bone fractures. Studies have shown that in short to midterm, ESIN has a low complication rate in pediatric long bone shaft fractures [1, 2]. There are also numerous benefits of this system, including limited tissue dissection, insertion of the metal work away from the fracture site, treatment without a cast, and smaller incisions when compared to other operative techniques. These factors can have important outcomes on the risk of non-union. Fernandez et al. identified the following predisposing factors of non-union in pediatric forearm fractures including open fractures, open reductions, refractures, hypotrophic bone healing, middle third of the forearm as a fracture site, unstable osteosynthesis, premature removal of metal, and infections [3]. In their cohort of 592 patients treated with ESIN, six children developed a pseudarthrosis, all examples of which involved the ulna. Di Gennaro et al. identified 15 cases of pediatric forearm non-union [4]. Whilst only one of these cases was managed with ESIN, they highlighted that the most common sites of non-union involved the distal third of the radial diaphysis and the middle third of the ulnar shaft, hypothesizing that this was possibly due to injury to the nutrient arteries to the bones at these respective levels. Injury to these arteries could be secondary to the trauma itself or iatrogenic at the time of surgery. Whilst we could not find any evidence of mixing fixation principles in the pediatric population, Behnke et al. compared fixation of diaphyseal forearm fractures with dual plating versus a hybrid fixation of plating the radius and an intramedullary locking nail on the ulna [9]. Whilst the nail system here is different to the ESIN; in the adult patient, they identified no significant difference in outcomes between the two options. The literature suggests that whilst rare, non-union of the ulna is more common than of the radius is both bone forearm fractures [3, 5]. In the present case, a number of differences are highlighted that may account for the subsequent non-union when compared to literature evaluated. No evidence could be found for hybrid fixation of pediatric forearm fractures in the published literature, however, when comparing this to Behnke et al.'s study, we utilized an ESIN rather than a locking nail, and this was for fixation of the radius rather than the ulnar. The biomechanical principles of the ESIN utilize 3-point fixation and the symmetrical bracing action of the two elastic nails [10]. Therefore, one possibility for non-union of the radius is the lack of the second elastic nail causing suboptimal stabilization of the fracture. This theory may explain why we saw non-union of the radius which is far rarer than that of the ulnar in literature. Samples taken at the time of operation ruled out any underlying infection or bone disease as contribution factors toward non-union. One other factor that may have contributed was the open reduction of the radial fracture, which Fernandez et al. have shown to be a risk factor for non-union.

Conclusion

Non-union in pediatric forearm fractures is rare, with limited evidence available in literature supporting this. Whilst a number of factors have been associated with an increased risk of non-union, we present a case of non-union, hypothesizing a further possible risk factor of mixing fixation principles.

Figure 4: Post-operative radiographs 2 weeks–11 months.

Figure 5: Radiographs following removal of original metal work and fixation of radius with compression plate.

Clinical Message

Non-union in pediatric fractures is rare. Whilst numerous risk factors have been shown to contribute to this, we present a case with a potential new risk factor, hybrid fixation, to avoid when fixing pediatric forearm fractures.

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