# Outcomes of Pediatric Forearm Intramedullary Nail Removal Versus Retention Following Fracture Union

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INTRODUCTION:

Forearm fractures account for up to 40% of all pediatric fractures. These injuries can generally be treated with closed reduction and casting and achieve high rates of union and good functional outcomes. However, unstable injuries, or those that occur in adolescents nearing skeletal maturity, may require operative treatment in order to maintain acceptable alignment during the healing process. Several implant options exist, however intramedullary fixation is becoming the preferred technique.

Following successful fracture union, surgeons must decide to remove or retain the implant. However, there are no clear guidelines to assist in the decision-making process. While some advocate for the routine removal of implants due to the risks of growth interference, peri-prosthetic fracture, and infection, others advocate against routine removal due to the risk of re-fracture and the risks associated with a second surgery.

Despite this controversy, there is a growing trend toward routine implant removal. Currently, implant removal accounts for 6.2-6.7% of all procedures performed by pediatric orthopaedic surgeons. However, there is limited data supporting this trend, particularly for intramedullary nails. To date, only two studies have been published, reporting re-fracture rates of 3.1% and 16.7%. However, these studies are limited by small sample sizes and short follow-up intervals.

Due to the paucity of data, routine removal of intramedullary nails following pediatric forearm fractures remains controversial. However, this information is helpful in clarifying the outcomes associated with the decision to remove or retain implants, providing appropriate surgical counseling, and managing patient expectations. The purpose of this study is to characterize the complication rates following the decision to remove or retain intramedullary nails after successful union of pediatric forearm fractures.

METHODS:

A retrospective chart review was completed for pediatric patients who underwent intramedullary nailing of a forearm fracture from January 1, 2012 to December 31, 2022. Inclusion criteria included age ≤ 18 and pre-operative diagnosis of midshaft radius and/or ulna fracture. Exclusion criteria included intramedullary nail performed as a revision surgery, chronic non-union, or deformity, and patient lost to follow-up precluding data collection.

A total of 195 fractures were identified; 161 ultimately met inclusion and exclusion criteria and were included in the study. Data collected included demographics, BMI, medical history, implants utilized, date of fracture union, complications and re-operations, and the rates of planned implant removal and planned implant retention. Date of fracture union was determined based on the documented interpretation of a post-operative forearm radiograph by a pediatric orthopaedic surgeon.

RESULTS:

One hundred sixty-one fractures were included. The mean age of our population was 9.45 years. The mean follow-up was 559 days (range 38-3048), and the mean time to fracture union was 114 days. Several intramedullary implants were utilized including: Steinmann pin (41%), titanium elastic nail (35%), Kirschner wire (19%), and rush rod (5%) (figure 1).

Of the 161 fractures treated with an intramedullary nail, 47 were planned to be removed after successful fracture union, and 114 were planned to be retained indefinitely. Prior to implant removal, 10/47 (21%) of planned removals became symptomatic. Additionally, 31/114 (27%) of planned retentions became symptomatic requiring implant removal. In total, 78/161 (48%) of the intramedullary nails were removed, with a mean time to removal of 347 days.

There were several indications for implant removal. Of the 10 planned removals that became symptomatic, 8 (80%) reported persistent pain at the implant site. Two (20%) developed a peri-prosthetic fracture; of note, this was a case of osteogenesis imperfecta wherein peri-prosthetic fracture recurred twice prior to implant removal. Of the 31 planned retentions that became symptomatic, 26 (81%) reported persistent pain at the implant site, 3 (9%) developed a peri-prosthetic fracture, 2 (6%) developed a soft-tissue infection, and 1 (3%) reported persistent stiffness (figure 2).

DISCUSSION AND CONCLUSION:

Routine implant removal following successful fracture union in pediatric forearm fractures remains controversial, with limited evidence to support it. Despite this, routine implant removal is becoming increasingly prevalent amongst pediatric orthopaedic surgeons. In this study, planned implant removal was common, occurring 29% of the time. However, this was dependent on surgeon practice with planned removal rates varying from 0% to 85%.

Ultimately, 78/161 (48%) intramedullary implants were removed with symptomatic hardware being the primary indication in 34/161 (21%) of cases overall including 8/47 (17%) of planned removals. It was also the primary indication for implant

removal in 26/114 (23%) of planned retentions. Retained implants otherwise demonstrated low rates of peri-prosthetic fracture (3/114, 2.6%), infection (2/114, 1.8%), and stiffness (1/114, 0.9%). There appears to be a low complication profile with intramedullary nail retention following pediatric forearm fracture union compared to planned removal.

Overall, studies with larger sample sizes and longer follow-up are needed in order to further delineate the long-term implications of routine implant removal versus retention.

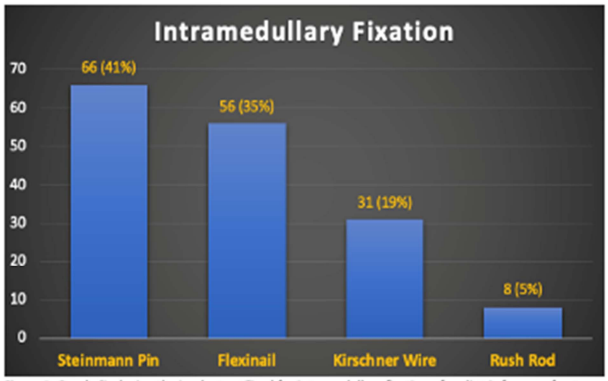


Figure 1. Graph displaying the implants utilized for intramedullary fixation of pediatric forearm fractures

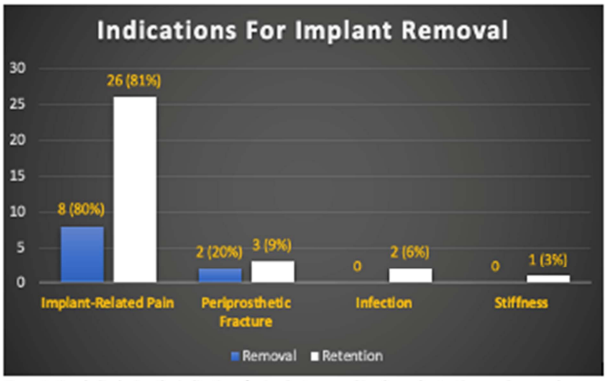


Figure 2. Graph displaying the indications for implant removal in planned retentions and removals