# Survival of Fassier-Duval Femoral Rods in Pediatric Patients with Osteogenesis Imperfecta

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INTRODUCTION: Pediatric patients diagnosed with Osteogenesis Imperfecta (OI) commonly experience fractures of the long bones secondary to abnormal bony curvature and poor bone quality. Intramedullary (IM) rod fixation is an important aspect of fracture management for patients with OI, specifically through providing additional support for the appendicular skeleton. First introduced around 2001, Fassier-Duval (FD) rods are a telescoping IM rod with “screw-in” fixation in the epiphyses to anchor the ends of the rod to the ends of the long bone as a child grows. Throughout a child’s life, there may be various reasons for rod revision or replacement surgery. However, many rods will last years without requiring reoperation. The primary purpose of this study is to report the revision rate, reason for revision, and survivorship data for femoral FD rods. A secondary purpose of this study is to compare the survivorship of femoral FD rods in younger versus older cohorts of patients, as the authors hypothesize that younger patients will require more rod revisions.

METHODS: A retrospective chart review was performed to identify pediatric and adolescent patients (≤18 years) with Osteogenesis Imperfecta (OI). Patients were included if they underwent a FD rod insertion into the femur. Patients were excluded if they did not have complete charts and radiographic imaging available for review. The total number of FD femoral rod insertions was analyzed. Data retrieved included demographics, medical/surgical history, date of femoral FD rod insertion, date of any femoral RD rod reoperations, and associated complications. A Shapiro-Wilk Test for Normality was performed; therefore, non-normally distributed continuous variables are represented as median and interquartile range (IQR). The overall survival and age-stratified survival of the FD femoral rods was assessed using Kaplan-Meier (KM) survival analysis. For this, FD rod failure was defined as any unplanned surgical intervention that resulted in a replacement of an existing rod. A time point of 10 years following FD rod placement was selected as the censored time for cumulative survival analysis. The median age of at the time of all the rod placements was used to divide the cohort into a younger and older cohort for further analysis.

RESULTS: Of the 111 patients identified, 26 patients met final inclusion and exclusion criteria (48 femurs, 75 FD rods). There were 16 (61.5%) males and 10 (38.5%) females. The median age at femoral FD rod insertion was 6.3 (IQR = 6.4). Of the 75 rods inserted, 27 (36.0%) required a revision of the FD rod. The most common reasons for revision of the rod were a subsequent fracture, a bent rod, and the rod stopped lengthening. The cumulative survival of FD rods at 1-, 5-, and 10-years was 88%, 48%, and 5%. For rods placed in patients younger than 6.3 years, the cumulative survival of FD rods at 1-, 5-, and 10-years was 89%, 35%, and 3%. For patients older than 6.3 years, the cumulative survival at 1-, 5-, and 10-years was 87%, 61%, and 8%. However, it is important to note that many of the rods in this cohort were censored because they are still in place. This means that the KM curves reported in this study are “right-censored” such that the true survival time for the overall cohort and both the younger and older groups is likely greater than what is reported here. This is one of the limitations of KM survivorship analysis. Of our 26 unique patients, 7 (26.9%) had a hip fracture in the ipsilateral side after a femoral FD rod placement (6 unilateral, 2 bilateral) at an average of 3.5 $\pm$ 1.1 years after FD rod insertion.

DISCUSSION AND CONCLUSION: The overall revision rate for FD femoral rods was 35.1%, with the most common reason for revision being refracture of the femur, followed by rod bending and rod not lengthening as the next most common reasons for revision. The KM survivorship curve analysis results demonstrate an 88% survival rate of FD femoral rods 1 year after placement, with about half of the femoral FD rods (48%) still in place at 5 years. Only 5% of femoral FD rods remain after 10 years. When assessing 5-year FD femoral rod survival in younger versus older patients of this cohort, there is a 35% probability of rod survival for the younger group and 61% probability of rod survival for the older group. This demonstrates that FD femoral rods placed in children when they are < 6.3 years have about half the likelihood of lasting 5 years as those rods placed when children are > 6.3 years. This may be a result of younger children being more accident-prone, leading to an increased number of femoral fractures, and thus requiring more revision surgeries. This study demonstrated that the FD rod failing to lengthen is one of the top 3 most common reasons for rod revision surgery, and given that there is a faster rate of growth observed in children from birth to age 5, this may indicate that the rod is unable to keep elongating when the child’s growth rate is increased. Another unique finding is that throughout a child’s femoral FD rod treatment, of our 26 unique patients, 7 (26.9%) had a hip fracture in the ipsilateral side after FD rod placement (6 unilateral, 2 bilateral). In conclusion, FD rods appear to be a safe and effective fixation device for young patients with OI.

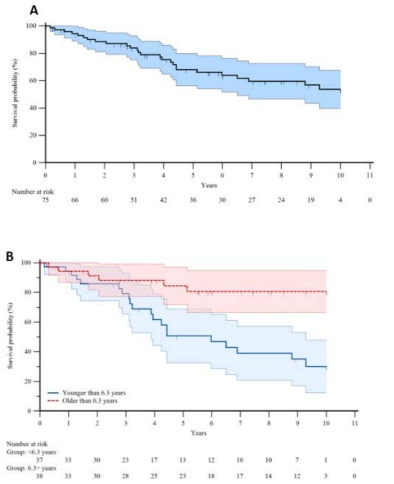


**Figure 1**. A) Kaplan-Meier survivorship curve for all femoral FD rods. B) Kaplan-Meier survivorship curves for femoral FD rods placed in patients < 6.3 years and > 6.3 years

**Table 1.** Survival Probability of Femoral FD Rods.

| Patient cohort | Time since FD rod placement | Probability of rod survival |
|---|---|---|
| All FD rods (n=75) | 1 year | 88% |
| | 5 years | 48% |
| | 10 years | 5% |
| FD rods placed in patients < 6.3 years (n=37) | 1 year | 89% |
| | 5 years | 35% |
| | 10 years | 3% |
| FD rods placed in patients > 6.3 years (n=38) | 1 year | 87% |
| | 5 years | 61% |
| | 10 years | 8% |