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Component Fracture in the Kotz Modular Femoral Tibial Reconstruction System: An Under-Reported Complication

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ABSTRACT

Background: Primary bone tumors of the femur are commonly reconstructed using an endoprosthesis. Different modes of implant failure have been described, including structural failure; although uncommon, this may be an under-reported complication. The purpose of this study is to examine the rates and risk factors for implant fracture of the Kotz Modular Femoral Tibial Reconstruction system (KMFTTR).

Methods: Two hundred twenty-one patients (95 women and 126 men) who underwent a KMFTTR reconstruction were reviewed. Twenty-seven patients (12%) sustained a prosthetic fracture. The mean time to fracture was 7 years postoperatively. The fractured component most commonly involved the distal femur ($n = 21$) and a screw hole in the stem ($n = 12$). In patients with stem fractures ($n = 21$), the mean intramedullary stem diameter was 12 mm and the mean extramedullary component length was 18 cm.

Results: Compared to patients who did not fracture, those with a prosthetic fracture had a significantly smaller stem diameter (12 vs 14 mm, $P = .001$) and a significantly longer extramedullary component length (18 vs 15 cm, $P = .04$). There was no difference between the preoperative and postoperative Toronto Extremity Salvage Scores ($P = .98$), Musculoskeletal Tumor Society 87 ($P = .78$), or Musculoskeletal Tumor Society 93 ($P = 1.0$) ratings for patients with or without a prosthetic fracture.

Conclusion: This study shows that fracture is an under-reported complication associated with the KMFTTR stem. We identified an endoprosthetic component fracture rate of 12%. Patients with smaller stem diameter and longer resection lengths were more likely to sustain a stem fracture. Subsequent revision provides a durable means of reconstruction, with no significant loss of patient function.

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Limb salvage surgery has replaced amputation as the most common surgical procedure for management of primary bone tumors. It has been shown to have the same long-term overall survival, disease-free survival, and local control rate as amputation,

with the benefit of decreased costs and superior function [1–3]. Over the years, many different methods of limb salvage surgery have been described, but endoprosthetic reconstruction is used most commonly. This method is advantageous because patients benefit from early weight bearing, good function, and a faster recovery [4–6]. Over the last 30 years, the 20-year overall survival rate for tumor endoprostheses has increased from 20% to 90% [7,8].

Patients with primary malignant bone tumors are often young and the femur is involved most frequently. With improvements in adjuvant treatment, and subsequent life expectancy, patients undergoing limb-sparing reconstruction after resection of tumors around the knee and hip with an endoprosthesis should expect to have one or more revisions in their lifetime [9]. The 5 principal modes of endoprosthetic failure have been described as soft tissue failure (type 1), aseptic loosening (type 2), structural failure (type 3), infection (type 4); and tumor progression (type 5),

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Ethics: Prior to the start of this study we obtained approval from our Institutional Review Board.

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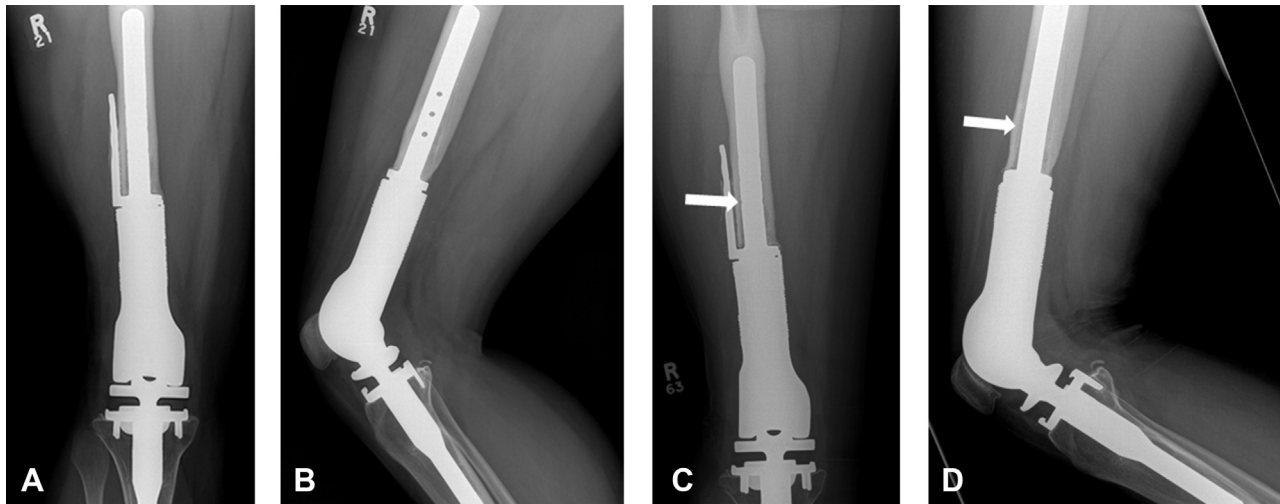


Fig. 1. Anteroposterior (A) and lateral (B) radiographs of a patient 13 years postoperative following excision of a soft tissue sarcoma showing ingrowth of the femoral stem. They presented the next year with increased sensation of instability, without a history of trauma. On anteroposterior (C) and lateral (D) radiographs, a slight step-off (arrows) was observed. Intraoperatively, the patient was found to have a fracture through the screw hole and underwent revision to a larger ingrowth femoral component.

with the most common being aseptic loosening (type 2) [10]. Within type 3, periprosthetic fractures, prosthetic fractures, and deficient osseous supporting structures have been included as modes of structural failure. Currently, the reported fracture rate of implanted endoprostheses ranges from 1% to 8% [3,8–15]; however, this may be under-reported with the improved survival outcome of patients.

The Kotz Modular Femoral Tibial Reconstruction system (KMFTR or Kotz prosthesis) was an early uncemented prosthetic design that featured a cast cobalt chrome stem with a macro-textured madreporic surface. There were side plates that were affixed to the stem component with the intention that cobalt chrome screws would be inserted through both the plate and holes in the stem. Our group initially utilized this prosthesis for reconstruction after resection of sarcomas around the knee and hip. We abandoned the use of screws through the side plates and stem due to a concern about stress shielding, and also because our insertion technique for the KMFTR uncemented stem without screws provides very low rates of aseptic loosening [16–19]. The purpose of this study is to evaluate the rates of prosthetic fracture following endoprosthetic reconstruction using the KMFTR system and to provide a technique for how to remove the well-fixed stem component after fracture.

Methods

After obtaining approval from our Institutional Review Board, we identified all patients ($n = 221$) who underwent an endoprosthetic reconstruction of the lower extremity over a 20-year period (1990–2009) with a KMFTR utilizing our institution's oncology database. This cohort consisted of 82 (46%) women and 97 (54%) men, with a mean age of 38 years (range 13–82) at the time of surgery. The reconstructions included distal femur ($n = 112$, 51%), proximal tibia ($n = 53$, 24%), proximal femoral ($n = 40$, 18%), total femoral ($n = 13$, 6%), and combined distal femur and proximal tibia ($n = 3$, 1%) replacements. For patients with stemmed components, the mean intramedullary stem diameter was 13 mm (range 10–15) and mean extramedullary component length was 16 cm (range 8–34). Chemotherapy was used as a combined neoadjuvant and adjuvant setting in 79 patients, neoadjuvant alone in 31, and adjuvant alone in 20 patients. All surviving patients had reached a

minimum 2 years of clinical follow-up, with a mean follow-up of 10 years (range 2–25). Forty-one (19%) patients expired prior to the 2-year clinical follow-up.

Stem Fracture Cohort

Twenty-seven (12%) patients sustained a fracture of the prosthetic component postoperatively (Fig. 1), and are the subject of this study. These patients consisted of 14 women and 13 men, with a mean age at the time of surgery of 30 years (range 13–63). The pathology at the time of initial tumor resection included osteosarcoma ($n = 16$), malignant fibrous histiocytoma of bone ($n = 4$), giant cell tumor ($n = 3$), chondrosarcoma ($n = 2$), synovial sarcoma ($n = 1$), and lymphoma ($n = 1$). Combined neoadjuvant and adjuvant chemotherapy was used in 13 patients, while neoadjuvant chemotherapy alone was given to 4 patients. No patients were treated with radiotherapy. The mean tumor volume was 313 cm³ (range 8–2128) and the mean tumor diameter was 10 cm (range 4–22).

Prosthetic fractures included the distal femur ($n = 21$), proximal tibia ($n = 5$), and total femur ($n = 1$) components. Excluding the total femoral reconstructions, fixation of the stems were uncemented ($n = 21$) or cemented ($n = 6$). The implant fractured through a screw hole (Fig. 2) in the stem ($n = 12$), stem base ($n = 9$), antirotation lug ($n = 4$), interprosthetic at a modular taper ($n = 1$), and through the tibial hinge component ($n = 1$). The mean intramedullary stem diameter was 12 mm (range 10–14) and the mean extramedullary component length was 18 cm (range 8–34). Screws were placed in the side plate and stem in 10 (37%) patients, including those with fractures of the stem base ($n = 5$), stem screw hole ($n = 4$), and through the tibial hinge ($n = 1$). Five (18%) fractures were associated with a fall, including all 4 patients with the derotation lug failure and the patient with a total femoral replacement modular taper failure. The remaining 22 patients presented with an insidious onset of pain ($n = 16$), pain and instability ($n = 4$), or instability ($n = 2$).

The surgical wounds in the 27 patients with prosthetic fracture were closed primarily ($n = 16$), with a local pedicled flap ($n = 7$) or free tissue transfer ($n = 4$). Follow-up was performed through regular clinical visits which included plain radiographs of the knee and clinical examinations at regular intervals until the time of

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