Total Knee Arthroplasty in a Patient With Skeletal Fluorosis

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abstract

Published reports on patients with skeletal fluorosis undergoing total knee arthroplasty are rare. Skeletal fluorosis is a chronic condition that occurs secondary to the ingestion of food and water that contain high levels of fluoride. Although fluorosis may be described as osteosclerotic and marble-like in appearance, features may also include characteristics of osteomalacia and osteoporosis.

This article describes the case of a 67-year-old man with skeletal fluorosis who underwent total knee arthroplasty complicated by fracture. An intramedullary guide was used for the proximal tibia and distal femoral bone cuts intraoperatively. Following the completion of the femoral bone cuts, it was noted that the drill used to open the femoral canal had breached the medial femoral cortex. Multiple fractures were seen in both femoral condyles. A revision femoral stem was chosen to complete the total knee arthroplasty but, after further manipulation of the femur, it appeared that the fracture had displaced. A LISS plate (Synthes, West Chester, Pennsylvania) was used to ensure fracture reduction and implant stability. The remainder of the procedure was completed without complication. One year postoperatively, functional knee range of motion was limited to 70° of flexion. Radiographs showed signs of healing and satisfactory implant position.

This case highlights the importance of the preoperative examination and the need to fully appreciate the bone quality of patients prior to undertaking an orthopedic procedure. Variation from the use of intramedullary guides should be considered in patients with questionable bone quality undergoing total knee arthroplasty.

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Skeletal fluorosis is a chronic condition that occurs secondary to the ingestion of food and water that contain high levels of fluoride. Chronic fluoride intoxication is often observed in areas where the water supply contains fluoride in concentrations in excess of 4 parts per million. Typically, skeletal fluorosis is described as osteosclerotic and marble-like in radiographic appearance. However, features of this disease include osteomalacia and osteoporosis.

To the current authors’ knowledge, no published reports described total knee arthroplasty (TKA) in patients with skeletal fluorosis until recently. The current article describes the case of a patient who underwent TKA with ensuing complications. To the authors’ knowledge, this is the first report in the literature describing the technical challenges of performing a TKA in a patient with skeletal fluorosis.

**Case Report**

A 67-year-old man initially presented with severe right knee pain (Figure 1). His medical history was significant for hypertension, hypercholesterolemia, type 2 diabetes mellitus, and depression. The patient was born and raised in the New England region of the United States. To his knowledge, he had not been exposed to foreign drinking water. Although his medical and social history presented no long-standing risk factors, the patient recalled possibly ingesting fluoride over a 2-week period as a child, which may have contributed to this condition. Standard preoperative evaluation was completed, and laboratory testing revealed no further abnormalities. No further imaging was obtained, and the patient subsequently underwent TKA.

A standard midline incision was made, and a medial parapatellar approach was used. Intramedullary guides were used for the proximal tibia and distal femoral bone cuts. The femur was initially prepared by opening the femoral canal in the traditional manner. The femoral bone cuts were created using the femoral intramedullary alignment guide, anterior and distal resection guides, and 4:1 cutting block. However, after these bone cuts were made, it was noted that the drill used to open and define the femoral canal had breached the medial femoral cortex, creating a femoral shaft fracture. At this point, no displacement of the fracture was noted. Furthermore, intraoperative imaging confirmed multiple fractures in both femoral condyles (Figure 2).

Due to the fracture and placement of the femoral intramedullary alignment guide through the breach in the medial femur, the distal femoral cuts were made with significant valgus. The guides were then repositioned, and the cuts were corrected. A revision femoral stem was used to complete the TKA. After further manipulation of the femur, it appeared that the femoral shaft fracture had displaced. A LISS plate (Synthes, West Chester, Pennsylvania) was used to ensure fracture reduction and implant stability (Figure 3).

The remainder of the operative course was without complication. In the immediate postoperative course, the patient was instructed to maintain touchdown weight bearing for 6 weeks. Deep vein thrombosis prophylaxis consisted of 40 mg of enoxaparin subcutaneously daily for 2 weeks. The patient progressed steadily with physical therapy. At discharge on postoperative day 4, he ambulated approximately 25 feet with the use of an assistive device.

Following completion of outpatient physical therapy and compliant use of a dynasplint 4 months postoperatively, he reported pain with ambulation, especially on stairs, and he ambulated with an antalgic gait with no assistive device. Knee range of motion (ROM) was limited to 70° of flexion with 5° of flexion contracture. At 1-year follow-up, knee radiographs demonstrated signs of fracture union (Figure 4). Clinically, ROM declined to 60° of flexion with a 10° flexion contracture. The patient ambulated with a limp but reported no pain.

**Discussion**

Fluorine is a common element found in water, soil, and rocks worldwide. Some areas have higher concentrations than others due to increased activity of flowing gas and rock. India, Africa, and China have previously been documented in field studies regarding fluorosis and associated health concerns. Chronic fluoride intoxication commonly causes developmental tooth enamel defects that were initially called the Colorado brown stain.
However, the regulated fluorination of water in the United States is often regarded as an achievement in public health due to the prevention of dental caries.⁰¹

Although fluorinated water has benefited the population, discrepancies exist concerning the allowable concentration. Currently, the Environmental Protection Agency lists the maximum contaminant level goal at 4 mg/L and the secondary maximum contaminant level at 2 mg/L of fluoride in drinking water.¹² It was found that even 2mg/L of fluoride in drinking water could be associated with stage 2 and 3 skeletal fluorosis.¹³ Therefore, joint stiffness and arthritis may be experienced. Reversing skeletal fluorosis after removing the source of toxicity may take decades. Also, no specific treatments are currently available.¹⁴

To the authors’ knowledge, few reports have been published of using TKA in a patient with skeletal fluorosis. Nevertheless, a relationship has been reported between knee osteoarthritis and endemic fluorosis.¹⁵ This study reviewed clinical and radiographic features of endemic fluorosis in Turkish patients. Key radiographic features included osteopenia, membranous and ligamentous calcification, exostoses, coarse trabecular pattern, diaphyseal widening, and intermittent growth lines.¹⁵

The current case highlights the need for appreciation of bone quality prior to undertaking orthopedic procedures, especially TKA. Although sclerotic in appearance on radiographs, the bone crumbled with minimal force. This characteristic was most evident with the use of an intramedullary guide when entering the femoral canal. To prevent this in the future, an extramedullary device may be used.¹⁶,¹⁷ Furthermore, the use of full-length leg preoperative radiographs may have been useful in planning the placement of the cutting guides.

Histologically, surgical challenges have been noted with skeletal fluorosis. A larger osteoid perimeter and osteoid width exist, but bone formation defects, including decreased osteoblast function, are present.¹⁸ In one study, mineral maturity and the mineral crystallinity index of fluorotic bone was measured. Although the crystallinity index was elevated, the mineral maturity was decreased.¹⁹ Through the incorporation of fluoride into the crystalline lattice of hydroxyapatite, the lattice is more stable but less soluble. This may result in brittle bone. Bone must be somewhat flexible to absorb energy. Without this ability, the bone may be susceptible to fracture.²⁰

**CONCLUSION**

The current case presented a unique set of challenges. Bone quality should be an area of attention prior to all TKAs, which is especially true in the setting of skeletal fluorosis. It is possible that the use of extramedullary guides may have assisted in the prevention of intraoperative fractures. In the future, variation from the use of intramedullary guides, full-length lower-extremity radiographs to aid in preoperative planning and cutting guide placement, and avoidance of dull cutting instruments to decrease shear stress on the bone could all be considered in patients with questionable bone quality undergoing TKA.

**REFERENCES**

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