A Review Paper

Proximal Tibial Stress Fractures Associated With Primary Degenerative Knee Osteoarthritis

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Abstract

Tibial stress fractures are not rare—they have been extensively studied in young athletes and soldiers and in elderly people with rheumatoid arthritis, osteoporosis, Paget's disease, pyrophosphate arthropathy, and hyperparathyroidism—but they seldom occur in patients with severe primary degenerative knee osteoarthritis. The etiology, diagnosis, and optimal treatment of these fractures remain a challenge.

In this article, we review the English-language literature on the symptoms, diagnosis, treatment options, and final outcomes of these fractures, and we report 2 new cases of proximal tibial stress fractures in elderly women with severe primary degenerative knee osteoarthritis.

Tibial stress fractures are not rare. They have been extensively studied in young athletes and soldiers[1] and in elderly people with rheumatoid arthritis,[2,3] osteoporosis,[4] Paget's disease,[5] pyrophosphate arthropathy,[6] and hyperparathyroidism.[7] They have been also recognized after total knee arthroplasty (TKA)[8] and in people who play sports incompatible with their age.[9] Tibial stress fractures, however, seldom occur in patients with severe primary degenerative knee osteoarthritis (OA). The etiology, diagnosis, and optimal treatment of these fractures remain a challenge.

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In this article, we review the English-language literature on the symptoms, diagnosis, treatment options, and final outcomes of these fractures, and we report 2 new cases of proximal tibial stress fractures in elderly women with severe primary degenerative knee OA.

Patients and Methods

Patient 1

A 63-year-old woman (case 32 in Table) presented to our service 4 months after exacerbation of left knee pain. She had a 3-year history of primary degenerative knee OA that had been treated conservatively with anti-inflammatory drugs and analgesics.

The patient initially visited her physician for sudden aggravation of pain after long-distance walking. Weight-bearing anteroposterior and lateral radiographs showed nothing more than the already known osteoarthritic changes (Figure 1). The pain was attributed to exacerbation of her primary disease, and she was advised to rest and continue her medication. Two months later, she returned to her physician with a complaint of persistent pain. New radiographs showed a fracture in the proximal third of the left tibia in the phase of callus formation (Figure 1), and the recommended treatment was crutch-walking and partial weight-bearing, which led to increased varus alignment of the left knee.

When the patient visited our hospital for the first time (4 months after symptom onset), the left knee had 15° varus alignment and the right knee 10° varus alignment. Clinical examination revealed a decrease in range of motion of both knees and no signs of swelling or inflammation. In palpation, both knees were tender in the medial side and in the area of the patellofemoral joint. In addition, there was generalized pain in the tibial and femoral condyles. Routine biochemical analysis revealed no alteration in calcium and alkaline phosphate levels, and inflammation markers were within normal limits. Six months earlier, the patient's bone mass density was slightly lower than the normal expected for her age.

Surgery was recommended for both fracture and arthritis, but the patient refused this treatment because of respiratory problems and family considerations. She was then advised to continue crutch-walking and partial weight-bearing. At 8-month follow-up, there was a complete cal-

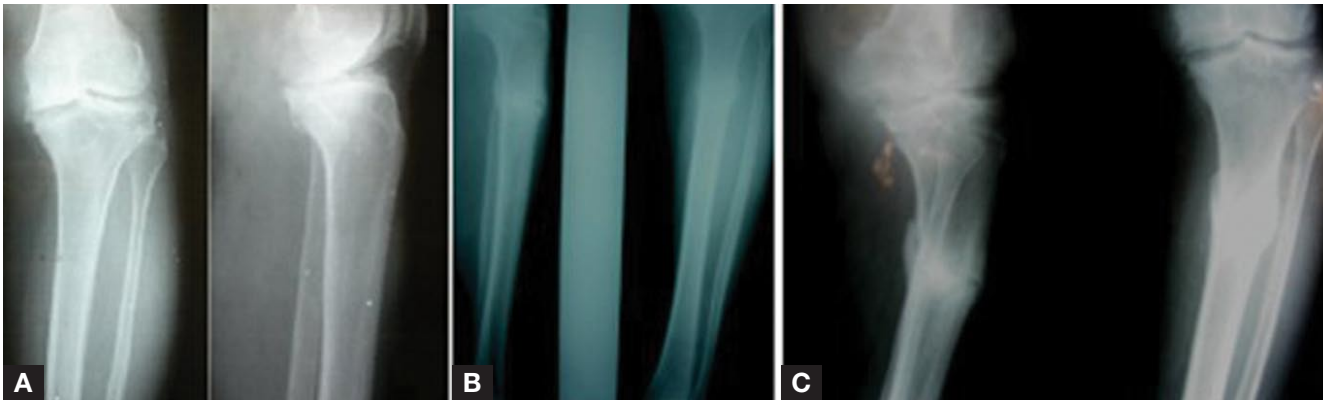

Figure 1. (A) On initial radiographs, tibial stress fracture was not apparent. (B) Radiographs obtained 2.5 months later show nearly healed tibial stress fracture. (C) Four months later, radiographs show valgus knee alignment aggravated by nonprotected weight-bearing.

lus in the fracture site (Figure 1). Then, 3.5 years after the stress fracture, the varus deformity of the knee was worse, and the tibia was subluxated. The patient underwent successful surface TKA (Figure 2).

Patient 2

A 72-year-old woman (case 33 in Table) presented to our service with severe primary OA of the right knee. For 8 months, she had been unable to walk because of aggravated knee pain, being treated conservatively with painkillers. Clinical examination revealed severe tenderness during palpation of the medial and lateral sides of the knee and in the proximal third of the tibia. In addition, knee range of motion had decreased 10° to 95°. Standard anteroposterior and lateral radiographs showed severe OA, valgus malalignment (20°) of the knee, and fracture of the proximal third of the tibia and fibula (Figure 3).

The patient underwent TKA. Bridging of the fracture site with a long-stem St. George endoprosthesis led to complete fracture healing and excellent knee range of motion and pain relief (Figure 4).

Literature Review and Discussion

Tibial stress fractures are rare in patients with primary knee OA, and their exact incidence is unknown. Searching the literature back to 1972, we found only 31 cases of tibial stress fractures in elderly patients with primary degenerative knee OA (Table).[6,10-24] The patients in all these cases were women. Mean age was 71.2 years (range, 53-84 years). Type of knee malalignment was reported in 29 cases (24 in varus, 5 in valgus).

Explanatory Theories

By 1958, Devas[25] had already suggested that stress fractures in young athletes with tibial bowing resulted from traction of the muscles attached to the proximal third of the tibia. In 1961, Wheeldon[26] first reported 3 cases of patients with rheumatoid arthritis and tibial stress fractures and underlined the role of abnormal load bearing as a causative factor. Reynolds[19] in 1972 argued that this line of thinking cannot be valid for elderly people with OA and knee malalignment. He presented 4 cases of tibial stress fractures in elderly women with knee malalignment either in varus or in valgus. Only 1 patient had primary OA of the knee; the other 3 had rheumatoid arthritis. Reynolds focused on the fact that varus or valgus knee deformity caused by degenerative arthritis increases tibial loads and results in stress fractures. Most authors[3,6,10,12-14,16,18,24,27,28] who have described these fractures have agreed with Reynolds.

Tomlinson and colleagues[6] suggested that the deformity caused by the fracture is in the same axis as the existing knee deformity and that, in these patients, osteoporosis and knee stiffness caused by arthritis are important causative factors. Martin and colleagues[14] agreed with these suggestions and underlined the role of joint stiffness in the development of the fracture and the importance of correcting the axis deformity to allow fracture healing and avoid recurrence.

Kobayashi and colleagues[12] conducted biomechanical studies of the tibia as an elastic body and proposed that fracture occurs in the central metaphysis when the knee side is fixed and a force is applied to the ankle side and that it occurs in the distal metaphysis when the ankle joint is stable. Furthermore, Papachristou[29] conducted a photoelastic study of the loads applied to the knee before and after osteotomy and concluded that excessive knee valgus

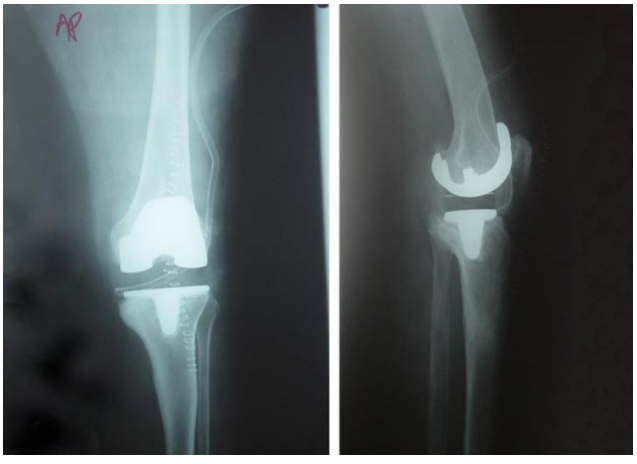

Figure 2. Three and a half years after fracture, patient underwent successful uncemented surface total knee arthroplasty.

Table. From the Literature, 33 Cases of Tibia Stress Fracture in Elderly Patients (All Women) With Primary Degenerative Knee Osteoarthritis

Case	Study	Age (y)	Varus/Valgus	Diagnosis Delay	Diagnosis Method	Initial Therapy	Final Therapy
1	Reynolds (1972)[19]	84	Varus	3 weeks	Radiographs	Cast immobilization	—
2	Resnick & Guerra (1981)[18]	70	Varus	—	Radiographs, bone scan	No weight-bearing	—
3	Satku et al (1987)[20]	72	Varus 20°	4 weeks	Radiographs	No weight-bearing	—
4		53	Varus 5°	8 weeks	Radiographs	No weight-bearing	—
5		60	Varus 10°	—	Radiographs, bone scan	No weight-bearing	—
6	Martin et al (1988)[14]	76	Varus 17°	8 weeks	Radiographs	Protected weight-bearing	—
7		66	Varus 30°	24 weeks	Radiographs	Restricted activity	Plate + TKA
8		79	Varus 17°	—	Radiographs	TKA	TKA
9	Learmonth & Grobler (1990)[13]	79	Varus	No delay	Radiographs	Bone grafting	Casting
10	Gacon et al (1990)[11]	81	Varus	18 months	Radiographs	Plate + fibular osteotomy	—
11		74	Varus 25°	—	Radiographs	Plate + TKA	—
12		83	Varus 40°	—	Simple tomographs	TKA	—
13	Cameron (1993)[10]	59	Varus	No delay	Radiographs	Plate + osteotomy	—
14		64	Varus	3 years	Radiographs	Plate	—
15	Molderez et al (1994)[15]	65	Varus 23°	—	Radiographs	Intramedullary nailing	—
16	Templeton et al (1995)[24]	80+	Varus	—	Radiographs	Long-stem TKA	—
17		80+	Varus	—	Radiographs	Long-stem TKA	—
18	Tomlinson et al (1995)[6]	75	Varus 20°	8 weeks	Radiographs	—	Long-stem TKA + graft
19		84	Valgus 25°	6 weeks	Radiographs	Intramedullary nailing + TKA	—
20		84	—	—	Radiographs	Casting	Long-stem TKA
21	Sy et al (1995)[23]	59	Varus 40°	5 months	Radiographs	Plate + fibular osteotomy	—
22	Nabors et al (1995)[17]	62	Valgus 22°	1 week	Radiograph, bone scan, CT	Casting	TKA
23		70	Varus 25°	2 weeks	Radiograph, bone scan, CT	Knee immobilization	TKA
24	Seral et al (1997)[22]	72	Varus	6 months	Radiographs	TKA	—
25		75	Varus	8 weeks	Radiographs	Protected weight-bearing	—
26	Kobayashi et al (1998)[12]	67	—	4 weeks	Radiographs	Conservative treatment	—
27	Sawant et al (1999)[21]	84	Valgus 18°	—	Radiographs	Casting	Long-stem TKA
28		64	Valgus 14°	—	Radiographs	Casting	Long-stem TKA
29		68	Valgus 15°	—	Radiographs	Long cast	Plate + TKA
30	Moskal & Mann (2001)[16]	71	Varus	—	—	Casting + electrical stimulation	Long-stem TKA + plate
31		74	Varus	—	Radiographs	Casting	Long-stem TKA + plate
32	Present study (2009)	63	Varus 15°	8 weeks	Radiographs	Protected weight-bearing	—
33		72	Valgus 20°	12 weeks	Radiographs	Restricted activity	Long-stem TKA

Abbreviations: CT, computed tomography; TKA, total knee arthroplasty.

increases the loads applied to the lateral condyles and predisposes to proximal tibial stress fractures.

Clinical Presentation and Diagnosis

The typical clinical presentation of patients with stress fractures is pain, usually of sudden onset, which is aggravated with activity and relieved during night rest. There is no history of trauma. Clinical examination reveals swelling, increased local temperature, and tenderness in palpation.[4]

In elderly patients with OA, the diagnosis of stress fracture is often difficult to set. Of the 31 patients described in the literature (Table), 16 had a diagnosis delay, which ranged from 1 week to 3 years. There are several reasons for this delay. First, in most cases, patients and their physicians attribute the aggravation of pain to existing OA and do not consider stress fracture. Second, despite careful assessment of radiographs, stress fracture (especially during its early days) can be missed.[20,24,30] Often it is missed at the initial radiologic evaluation because plain radiographs do not include the entire tibia[30] or because the fracture is concealed by the severe osteoarthritic changes. Third, symptoms are often attributed to femoral or tibial condyle osteonecrosis, degenerative meniscal tear, or a loose body inside the joint.[20] Fourth, in the past, many stress fractures were treated as cellulitis, thrombophlebitis, or malignancy.[19]

Plain radiographs were used to set the diagnosis of stress fracture in 25 of the 31 patients described in the literature (Table). Further evaluation was necessary in 6 patients:

Figure 3. Two months after aggravation of pain, radiographs show combined tibial–fibular stress fracture.

bone scan in 4 patients[17,18,20] and computed tomography (CT) in 2 patients.[17] Gacon and colleagues[11] used simple tomographs to confirm the diagnosis of stress fracture.

Bone scan can be useful in evaluating stress fractures.[4,31,32] Martin and colleagues[14] and Nabors and colleagues[17] suggested that the diagnosis of stress fracture in patients with OA can be easy to make with bone scan. In patients with severe OA, however, this method is often false-positive. Resnick and Guerra[18] noted that a negative scan almost precludes the diagnosis of stress fracture, whereas a positive scan is suggestive though not specific for this pathology.

Combined tibial–fibular stress fractures are rare. Only 4 cases have been reported in the contemporary literature[6,13,20]; we report a fifth case (patient 2) in this review. It is possible that a fibular stress fracture might result from delayed diagnosis during treatment of a tibial stress fracture.[20] Resnick and Guerra[18] reported the case of an isolated fibular stress fracture in a patient with knee OA and axis deformity.

Treatment

Treatment of these stress fractures is either conservative or surgical. Of the 31 cases described in the literature plus the 2 new cases we present in this article (Table), 19 were initially treated conservatively, with no-weight-bearing alone,[14,16,18,20] cast immobilization,[6,17,19,21] cast immobilization and electrical stimulation,[21] or knee immobilization.[17] Only 9 had successful fracture healing; the other 10 subsequently underwent surgery.[6,14,17,21]

Conservative treatment requires long-term immobilization of the knee joint and is sufficient mainly in patients with minimal axis deformity and in patients who cannot undergo surgery because of general health problems.[6,19,21] Long-term immobilization causes knee stiffness to worsen and does not resolve the pain and symptoms caused by OA.[6,14] In addition, pseudarthrosis of the fracture is more common in patients who have been treated conservatively, and the persistent axis derangement can lead to a new fracture in the same extremity[14,19,21] or to further aggravation of OA.

Figure 4. Successful treatment with fracture-bridging long-stem total knee arthroplasty.

Twenty-four of the 33 patients (Table) underwent surgery as final treatment. The surgical treatments were internal fixation with plates, osteotomy for correction of axis deformity and plate fixation,[11,23] TKA and non–weight-bearing until fracture healing,[11,12,14,17,22] long-stem TKA for fracture bridging,[6,12,24] autologous bone grafting and cast immobilization,[13] intramedullary nailing,[15] and TKA and intramedullary nailing.[6]

Although rare, pseudarthrosis or delayed fracture union can occur, mainly in cases diagnosed late or treated conservatively.[6,11,12,14,15,23] Such a complication makes definitive treatment even more difficult. Surgical treatments for pseudarthroses were internal fixation and bone grafting combined with TKA and postoperative electrical stimulation[14]; internal fixation with plate, bone graft application, and fibular osteotomy[11]; internal fixation with plate and bone graft application[23]; intramedullary nailing[15]; internal fixation with plate and surface TKA[21]; fracture bridging with long-stem TKA[21]; and combined long-stem TKA and internal fixation with plate and bone grafting for rotary stability and fracture bridging.[16]

Conclusions

Tibial stress fractures associated with primary knee OA are rare. Over the past 3 decades, only 31 cases have been described.[6,10-24] Their exact incidence is not known and may be higher than reports indicate.[6,14,20] The diagnosis of these fractures is often delayed or missed because patients and physicians do not suspect them and do not request radiologic evaluation.[2,21,24,30]

Cast immobilization is a conservative treatment that often leads to knee joint stiffness, aggravation of osteoporosis, and malunion.[11,12,14,20] In addition, it does not provide relief from osteoarthritic pain and does not correct the axis deformity, which may then cause a new fracture.[6,11,19,21]

Conservative treatment should be proposed only for patients whose general health does not permit surgical treatment and who have a minimal axis deformity.[6]

We agree with Cameron,[10] Sawant and colleagues,[21] and Moskal and Mann[16] that the first goal of surgical treatment should be to correct the axis deformity. Using a plate for internal fixation of the fracture can lead to fracture healing but does not correct the deformity and does not provide relief from osteoarthritic pain. Long-stem TKA, which addresses both the knee deformity and the osteoarthritic symptoms, seems to be the optimal treatment.[6,10,16,21,24] Moreover, the load-sharing long stem favors fracture healing.[16] In cases of pseudarthrosis, long-stem TKA can be combined with osteotomy and plating to prevent rotary deformities at the fracture site.[16]

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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