Learning Point for this Article:
Stress fractures due to deranged mechanical axis in knee osteoarthritis, although rare, need a high index of suspicion for identification from the treating surgeon and can be managed in a single stage.

Introduction: Stress fractures occur due to abnormal increased or repetitive stress on a normal bone. These have been described in sports persons or military personnel involved in strenuous physical activities. Stress fractures occurring as a result of undue stress due to deviated mechanical axis usually involve the proximal tibia and fibula and have rarely been described in the literature.

Case Report: We report a case of the left medial malleolus stress fracture secondary to advanced knee osteoarthritis (OA) with severe varus deformities. Mechanical malalignment like severe genu varus deformity is a risk factor for a stress fracture in knee OA. A single-staged management by the surgical treatment of stress fracture, along with the correction of underlying knee deformity by bilateral simultaneous total knee arthroplasty of this case is discussed. We also describe the pathomechanics involved in this injury in the present case report.

Conclusion: Stress fractures associated with knee OA can be found in the ankle as well. Detailed history and clinical examination can help in diagnosing this condition. It is also important to correct the overall mechanical alignment of the knee to provide an adequate environment for fracture healing.

Keywords: Knee, osteoarthritis, stress fracture, total knee replacement.
Case Report

Case 1

A 78-year-old male presented to us with a history of progressive severe knee pain and deformities over the last 10 years (Fig. 1). The local practitioner managed this case with oral non-steroidal anti-inflammatory medications. However, the pain progressed gradually and led to significant reduction of mobility over the period of 10 years. The patient was forced to use a stick while walking but developed insidious onset swelling and pain in both ankles (left > right) in the past 6 months. The gradual onset of pain in the ankle forced the patient to be immobile and wheelchair-ridden. The patient was also suffering from hypertension and benign prostate hypertrophy, both of which were medically controlled.

On examination, he was in good general condition but had fixed flexion deformity of both knees at 20° and varus deformity of 30°. The knee range of movement was 20°–90° bilaterally. He had diffuse swelling of both medial malleoli. There were a bilateral medial joint line and patellofemoral tenderness. There was palpable crepitus while knee range of motion. There was localized tenderness in bilateral medial malleoli along with a soft tissue swelling.

The long leg hip-knee-ankle (HKA) radiograph showed severe varus deformity to both knees (left > right). There was a gross distortion of mechanical axes on both the sides (Right: 157° and Left: 151°) with lateral deviation of the mechanical axis (Right: 7.15 cm and Left: 8.45 cm) (Fig. 2).

His biochemical blood tests were within normal limits, including serum Vitamin D levels.

The dual energy X-ray absorptiometry scan revealed moderate osteopenia with T scores of −2.0 in the lumbar spine and −1.8 in the hip bones. The plain anteroposterior (AP) and lateral knee radiographs showed severe varus deformity, gross destruction in the medial tibiofemoral and patellofemoral compartments, lateral subluxation of the tibia, and large posterior osteophytes (Fig. 3). Plain radiograph of the ankle showed an ununited fracture of the left medial malleolus with hypertrophic callus at the fracture site (Fig. 4). There was no visible fracture line at the right medial malleolus.

All the routine pre-operative workup was normal along with a normal Dobutamine Stress Echo. The patient was planned for simultaneous bilateral TKA, along with the fixation of the left medial malleolus.

Bilateral simultaneous TKA, under spinal-epidural anesthesia, was done using the modified Insall’s exposure. Intraoperatively after the resection of the proximal tibia, a large medial bone defect was identified, and this was filled up using medial metal wedge augments (5 mm on the right side and 10 mm on the left side). To offload the augments and to compensate for the long-term ligamentous imbalance, semi-constrained posterior stabilized TKA components (Scorpio TS™, Stryker) with tibial stem extenders were used (Fig. 5). The patient was started on thromboprophylaxis in the form of injection enoxaparin 0.4 mg per day starting from the day of surgery and continued for 7 days. The patient had an uneventful recovery and was able to walk independently without support by the time of discharge.
subcutaneously once a day for 3 weeks and DVT stockings for 6 weeks.

The left medial malleolus was exposed, and the hypertrophic callus was cleared. After the freshening up of the fracture ends, it was fixed using two 4 mm 60 mm cancellous screws (Fig. 6). The hypertrophic callus was used as bone graft after the fixation.

Postoperatively, the patient was managed for pain relief and was mobilized using a pneumatic shoe walker for the left ankle on the third post-operative day. The stress fracture united uneventfully in 3 months (Fig. 7). Post-operative HKA radiograph showed restoration of mechanical axes (Right: 179° and Left: 178°) on both the sides (Fig. 8). Both the knees remained pain free and with the good functional outcome, at 1-year follow-up. The knee society score improved from 24 (pre-operative) to 77 (at 1-year follow-up).

Discussion

It is well known that the fractures often result from repetitive abnormal mechanical forces on bone. These are commonly seen in weight-bearing bones, although have been documented in almost all bones [4]. These fractures are more common in younger individuals, especially in athletes and army personnel than in the older population [5]. With increasing life expectancy and more physical activities in an older subgroup, stress fractures are being reported more often. Risk factors for stress fractures can be divided into three groups:

1. Environmental and behavior factors: Heavy exercising, irregular terrain, and inadequate footwear
2. Biomechanical factors: Calf muscle weakness, inequality of limb length, flat or high arched feet, and knee deformities
3. Metabolic factors: Hormonal imbalance, osteoporosis, renal osteodystrophy, nutritional deficiencies, rheumatoid arthritis, and OA [6].

Of all stress fractures of the foot, medial malleolar fractures account for only 10% [3]. Such fracture has been found to be associated with tibia vara with the altered mechanical axis. The possible cause of the stress fracture in our patient was a result of this mechanical alteration following severe genu varum deformity arising from knee OA. We agree with Soni et al. that a combination of an altered weight-bearing axis due to knee OA and associated osteopenia is responsible for the causation of these stress fractures [3]. In individuals with genu varum deformity, there is a greater adduction moment at the knee as compared to healthy individuals. Due to the lateral deviation of the tibial mechanical axis in genu varum, there is an associated compensatory rearfoot pronation to obtain a balanced and plantigrade foot [7]. Soni et al. also suggested a possible consequence of varus angulation at foot strike [3]. They believed that the applied force to the ground is directed more medially, resulting in an increased lateral ground reaction force. We propose that all these factors might have led to an increased stress transmission to the medial malleolus and an eventual stress fracture.

Symptoms may vary in these patients with OA, as in our patient, he had pain and a long history of untreated OA and progressive deformity but only presented for definitive treatment when he developed ankle pain and increased immobility. The treatment of stress fracture should aim to decrease abnormal stresses on the bone to a level within
physiological limits of the bone. It entails identifying and correcting any predisposing factor, which in our case was severe genu varum due to knee OA. We opted for a single-staged management for the surgical treatment of stress fracture, along with the correction of underlying knee deformity by bilateral simultaneous TKA. In our case, there was an isolated stress fracture on the left malleolus and clinically an impending fracture on the right which was prevented by the correction of angular deformity by TKA. The deformity was more on the left side, which had a more severe mechanical deviation leading to an earlier stress fracture. Soni et al. did a two-stage operation with plating of malleolus first then TKA as the second stage [3]. They, however, could not achieve total correction of the varus deformity which was achieved in our case. We also note they used conventional tibial stems (probably due to lesser deformity in their case), while we used lengthened stems to provide additional support to the tibial base plate and the augments which were used for dealing with the tibial defects. The stress fractures eventually unite fast, when the predisposing knee deformity is corrected, and the stress fracture is fixed internally.

**Conclusions**

Cases of stress fracture are well documented in younger athletic adults and older patients with knee OA with osteoporosis, in the proximal tibia. The medial malleolus is a highly uncommon site for these stress fractures. We report the successful management of a bilateral knee OA and a medial malleolar stress fracture in a single-staged operation.

**Clinical Message**

Stress fractures of the tibia although rare, require a high index of suspicion. There are multiple epidemiological factors which may lead to the stress fracture. The identification and treatment of the risk factors are important to achieve good clinical outcome. The presence of malalignment of the lower limb due to knee OA may lead to stress fractures in the tibial shaft and medial malleolus. The correction of the malalignment through total knee replacement and the fixation of the stress fracture can give satisfactory outcomes.

**References**

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