Management of Tibial stress fracture in Osteoarthritic deformed Knee with Total Knee Arthroplasty

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Abstract: Stress fractures of the tibia which occurs due to the osteoarthritic deformities are rare and pose a great challenge in management. We managed three such patients with stress fractures of proximal tibia with deformed osteoarthritic knee. All patients had established osteoarthritis of the knee; one patient with genu valgus deformity and the other two with genu varus deformity. All of them underwent a total knee replacement with a long tibial stem extension, and subsequently, their fractures united on followup. All three patients recovered uneventfully with good functional range of movements restored. Correction of extra-articular deformities with the restoration of normal knee mechanics and joint lines along with reduction of tension stresses on the bone and stabilisation of the associated stress fractures and replacement of the arthritic joints can all be done effectively with long stemmed modular total knee arthroplasty implants.

Key words: Stress fracture, Deformity, Osteoarthritis Knee, Total Knee Arthroplasty

I. Introduction

Stress fractures of the tibia are commonly observed in the young and the causes can be varied. Most often, where abnormal repetitive stresses are placed on normal bone (fatigue fracture), and are usually associated with military or athletic activities. Although less common, stress fractures are also observed in elderly patients, where normal stresses that are placed on abnormal bone result in fracture. The associations of stress fractures include rheumatoid arthritis (RA), osteoarthritis (OA), osteoporosis and Paget's disease. Pyrophosphate arthropathy and renal osteodystrophy are other rarer causes. Such fractures arise from repeated, cyclical, low magnitude forces exerting upon a weakened bone over a considerable period of time. (1-6)

Stress fractures are often managed conservatively without surgery; in such cases, adequate rest, analgesia and reduced activity often allow the patient to return to a fully functional state after a period of time. Occasionally, casting is done to further protect the fracture site. (6,14,16) However, if the fractures have resulted in a malunion or non-union, it would present as a more complicated clinical problem, and surgery may be indicated.

Stress fractures can occur at many different sites in the body, but the tibia accounts for almost 50% of such fracture incidences. (7) Within the tibia, the majority of the fractures occur at the junction of the middle and the distal third, where the curvature of the bone, and hence the greatest stress, occurs. (8)

II. Case Report

We describe three cases of tibial stress fractures secondary to deformed arthritic knees. All patients were of the elder age group with the age at the range of 56-63 years. All of them presented with minimum of four weeks of knee pain with a history of increasing deformity in the knee. Examination revealed genu valgus deformity in one and the other two patients with genu varus deformity.

Radiographic evaluation revealed a grossly osteoarthritic knee joint in all three patients with stress fracture in the proximal third of the tibia. Two of them underwent a modular total knee prosthesis with a long tibial stem extension while the other one was initially treated conservatively but the fracture failed to unite so she was subsequently treated surgically with total knee arthroplasty with long tibial stem component. All of their fractures united at an average of 18 weeks and one-year follow-up examination revealed that the knees were free of any pain and range of motion of 0-100 degrees possible in all of them. The period of follow-up of these cases ranged from 13 months to 24 months.
III. Discussion

Stress fractures result from repetitive abnormal mechanical loading on normal bone, or normal mechanical loading on abnormal bone. The causes of these fractures are varied, and insults on the bone are usually chronic and of low intensity, thus resulting in a fracture which is often not acute. Stress fractures of the tibia in the elderly are well described, although uncommonly. The associations of stress fractures include RA, OA, osteoporosis and Paget's disease. Pyrophosphate arthropathy and renal osteodystrophy are other more uncommon causes.\(^{16}\) These fractures are rare, possibly because a TKA would have been performed for the patient who has a very symptomatic painful knee before gross deformity and subsequent fracture have time to occur.\(^{17}\) Advances in osteoporotic treatment with new drugs could also be a contributing factor, as such treatments help to increase the strength of the bone.

IV. Mechanism Of Stress Fracture

Severe extra-articular tibial deformity secondary to OA, as observed in our patients, results in the shifting of the mechanical axis of the lower limb. This causes abnormal forces and load to be placed onto the tibia. Eccentric forces result in tension stresses on the convex side of the bone, and compression places stress on the concave side. Large valgus or varus malalignment would thus severely affect the bone, leading to its gradual weakening and hence, a stress fracture ascends into the picture.\(^{18}\) Callus and new bone formation would generally be initiated, and fracture repair carried out. However, this would not lead to fracture union, as the abnormal mechanical axis from the severe tibial extra -articular deformities are still present.

V. Clinical Features

The physical signs of a stress fracture would be localised tenderness over the fracture site. Sometimes, there might be a bony callus that is palpable as the fracture begins to heal. Severe deformity is rarely observed, and unless a complete fracture occurs, it is not usually visible.\(^{19}\) Radiographs may reveal the stress fracture or malunion/non-union at the site of the fracture. If a stress fracture is not visible, a repeat radiograph may be conducted at a suitable interval, which might show up the fracture site; alternatively, a technetium -99 m bone imaging can be performed.\(^{10}\) The fracture site would then be illuminated on imaging, and subsequently identified.

VI. Management

Stress fractures can be treated conservatively or surgically. In most cases of stress fractures, rest, reduction of weight-bearing activity level and analgesia result in bone healing, and also allow a patient to return to full function after some time. However, if a patient presents with stress fractures secondary to severe deformity with concomitant OA, as in our case studies, surgery is often indicated.\(^{17}\) Surgery can be used to treat the fracture and OA with genu varus or valgus deformity at a single shot. The mechanical axis can also be re-aligned and the abnormal stresses on the tibia removed.

In all our patients we managed to correct the deformity with the tibial cuts without any augment in the form of blocks or grafts. A modular TKA was used to replace the arthritic joint and to restore a good range of movement and better kinematics for the patient's knee. This helped to realign the mechanical axis, and converted the tension stresses across the proximal tibia into compression forces.

Correction of the alignment both at the knee joint and at the fracture site is necessary to restore the mechanical axis of the limb to normal and facilitate fracture healing. Osteoporosis resulting in lower fatigue strength of the bone and stiffness of the adjacent joint due to arthritis are undoubtedly important etiologic factors.\(^{11-13}\)

Non-operative measures may achieve union in patients with minimal limb malalignment, but there is a high rate of failure in mal-aligned limbs and symptoms derived from the arthritic knee will persist.\(^{14}\) Operative realignment and grafting of the fracture with or without fixation will usually result in union of the fracture, but the arthritic joint remains malaligned and may be painful. Further stress fractures may occur more distal to the fixation device.\(^{15}\)

Knee joint arthroplasty with a stemmed tibial implant, although not without possible complications, has the advantages of restoring fracture and joint alignment and treating the arthritic joint in one procedure, thus allowing the fracture to unite in a biomechanically favourable situation.\(^{16}\) It also allows immediate mobilization of the patient without the need for cumbersome casts or splintage. The procedure can be technically demanding and open reduction of the fracture site may be necessary.

It is important to use a long enough tibial stem to bypass the fracture site and provide stable fixation of the fracture in the correct alignment. The use of a modular prosthesis allowed the extension of the tibial stem to bridge both the fracture and osteotomy sites, acting as an intramedullary splint, and to provide greater stability to the construct.\(^{17}\) To avoid any potential stress risers, the tibial stem was extended beyond the distal tibial plate,

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which provided additional stability and support to the entire tibia, while reducing the potential for any future fractures.\(^{(18)}\)

Similarly, the use of a modular stemmed prosthesis in our second patient allowed us to correct the extra-articular tibial deformity, restore the joint line and replace the arthritic knee. The intramedullary fixation thus provided gives more ideal conditions for fracture healing.

*Figure shows the Pre Op X ray with proximal tibial stress fracture in a varus deformed osteoarthritic knee which was managed with total knee arthroplasty with long stem tibial component addressing both fracture and deformity in single surgery.*
VII. Conclusion

Although our series of three cases is too small to allow recommendation of this technique as standard treatment for stress fractures below arthritic knee joints, our experience suggests that there is a place for this technique, particularly when angular deformity at the joint or at the fracture site makes union unlikely and when delayed or non-union has occurred after unsuccessful nonoperative treatment. Range of movement and knee mechanics of the patient greatly improved. All three patients went on to do well and recovered uneventfully, and are presently able to walk unaided with minimal symptoms. These cases serve to highlight the various options that are available to the surgeon in cases of tibial stress fractures.

Correction of extra-articular deformities, restoration of normal knee mechanics and joint lines, reduction of tension stresses on the bone, stabilisation of the fractures and replacement of the arthritic joints can all be done effectively with stemmed modular TKA implants.

References