One-stage long-stem total knee arthroplasty for arthritic knees with stress fractures

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ABSTRACT

Purpose. To evaluate the outcome of one-stage long-stem total knee arthroplasty (TKA) for patients with arthritic knees and tibiofemoral stress fractures.

Methods. Records of 11 men and 18 women aged 47 to 78 (mean, 66) years who underwent fixed-bearing posterior-stabilised TKA for osteoarthritis or rheumatoid arthritis of the knee with tibial (n=31) and femoral (n=3) stress fractures were reviewed. All the tibial fractures involved the proximal half. There were 7 associated fibular stress fractures. Of the 31 knees with tibial stress fractures, 26 and 5 manifested varus and valgus deformity, respectively.

Results. The mean follow-up period was 51 (range, 24–96) months. The mean tibiofemoral angle improved from 23.2º to 1.9º varus. The mean Knee Society knee score improved from 38.5 (range, 15–63) to 89.6 (range, 80–95) [p<0.05]. The mean Knee Society functional score improved from 25.5 (range, 0–40) to 86.5 (range, 60–100) [p<0.05]. All fractures were united at the last follow-up. No complications were encountered.

Conclusion. One-stage long-stem TKA restores limb alignment and facilitates fracture healing, with excellent outcome.

Key words: arthritis, rheumatoid; arthroplasty, replacement, knee; femur; fractures, stress; osteoarthritis; tibia

INTRODUCTION

Stress fractures are overuse injuries of bone and associated with military or athletic activities in young people,1–3 and rheumatoid arthritis,4,5 osteoarthritis,6–8 osteoporosis,9 post-traumatic deformity,10 deformed degenerate knees,11 Paget’s disease,12 pyrophosphate arthropathy,13 and knee arthroplasty (unicondylar and navigated)14–16 in elderly people. Stress fractures are usually treated by rest and/or casting6,10,17 and rarely surgery.12,13,17 Treatment for patients with knee arthritis and stress fractures is challenging. Malalignment secondary to osteoarthritis increases the stress at the fracture site, which predisposes to
delayed or non-union. Osteopaenia, corticosteroid use, and abnormalities of calcium metabolism decrease the strength of bone and predispose to non-union. Surgical treatments include internal fixation and second-stage total knee arthroplasty (TKA) and one-stage TKA using long-stem tibial or femoral components. This study evaluated the outcome of one-stage long-stem TKA for patients with arthritic knees and tibiofemoral stress fractures.

MATERIALS AND METHODS

Records of 11 men and 18 women aged 47 to 78 (mean, 66) years who underwent TKA for osteoarthritis or rheumatoid arthritis of the knee with tibial (n=31) and femoral (n=3) stress fractures were reviewed. Five patients had bilateral tibial fractures. All the tibial fractures involved the proximal half. There were 7 associated fibular stress fractures. Of the 31 knees with tibial stress fractures, 26 and 5 manifested varus and valgus deformity, respectively.

Onset of these fractures was insidious and gradual, without trauma. All patients were evaluated using the Knee Society score. The extent of deformity was measured using standing full-length weight-bearing radiographs. When such radiographs were not feasible, pelvic radiographs were used to determine the distal femoral valgus cut. Computed tomography and magnetic resonance imaging were requested to confirm stress and intra-articular fractures. Radiologic indications of stress fractures included periosteal bone formation, horizontal or oblique linear patterns of sclerosis, endosteal callus, and a frank fracture line.

Fixed-bearing posterior-stabilised TKA through the standard midline skin incision with medial parapatellar arthrotomy was performed. The tourniquet was inflated at the beginning and deflated after cementation of the components. Only the tibial base plate and the proximal part of the stem engaging the metaphysis were cemented. Care was taken to ensure that no cement extruded into the fracture site. Intra-articular deformity was corrected using standard bone cuts and soft-tissue releases. Bone defect was filled with cement, bone graft, and/or metal wedges. In patients with larger bone defects, a tibial stem extender was used to reduce the stress at the fracture site.

Extra-articular deformities were classified into 3 groups (Table). Group 1 included correctable or no deformity such as mobile non-unions, for which an intramedullary tibial zig (along with its extramedullary rod) was used. It aligned the tibia and acted as an internal splint to stabilise the fracture so that an appropriate tibial cut could be performed. Sequential cannulated reaming over a guide wire under image intensifier guidance was performed to prevent cortical perforation.

Group 2 included malunions or stiff non-unions with <30º varus deformity of the femur or tibia in the coronal plane, which could be corrected at the joint level. Non-unions that could be corrected after fibular osteotomy were treated as in group 1. Non-union sites were not exposed, as reaming facilitated fracture healing. Long offset stems were used. Correction of the malalignment converted tension stresses to compression forces thus facilitated healing.

Group 3 included malunions or stiff non-unions with >30º varus deformity in the femur or tibia in the

<table>
<thead>
<tr>
<th>Type of stress fracture</th>
<th>No. of patients</th>
<th>Mean tibiofemoral angle</th>
<th>Mean patient age (years)</th>
<th>Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-articular</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femoral</td>
<td>3</td>
<td>21.5º varus</td>
<td>65.5</td>
<td>Total knee arthroplasty (TKA) with bone grafts/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>metal augments with or without stem extender</td>
</tr>
<tr>
<td>Tibial</td>
<td>5</td>
<td>21.5º varus</td>
<td>68.6</td>
<td>TKA with bone grafts/metal augments with or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>without stem extender</td>
</tr>
<tr>
<td>Extra-articular* (all tibial)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>3</td>
<td>Correctible deformity</td>
<td>64.7</td>
<td>Long stem TKA with or without fibular osteotomy</td>
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<tr>
<td></td>
<td></td>
<td>with or without fibular osteotomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>15</td>
<td>23.5º varus</td>
<td>65.8</td>
<td>Long stem TKA with or without fibular osteotomy</td>
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<tr>
<td></td>
<td>3</td>
<td>16º valgus</td>
<td>64.6</td>
<td>Long stem TKA with or without fibular osteotomy</td>
</tr>
<tr>
<td>Group 3</td>
<td>3</td>
<td>35º varus</td>
<td>71</td>
<td>Long stem TKA with tibial osteotomy</td>
</tr>
</tbody>
</table>

* Group 1 denotes correctable or no deformity, group 2 malunions or stiff non-unions with <30º varus deformity, and group 3 malunions or stiff non-unions with >30º varus deformity
coronal plane, which could not be corrected at the joint level without violating the insertion of collateral ligaments. The malunion or non-union sites were approached through a separate longitudinal incision. The fracture was stabilised with a long stem, which acted as an internal splint. No plates were used.

Knee movements and full weight-bearing ambulation with a walking frame were allowed immediately after surgery. A long-leg knee brace was worn for 6 weeks. From 6 to 12 weeks, a hinged knee brace was used during ambulation. Brace and stick were discontinued after bone union. Patients were followed up at week 6, months 3, 6, and 12, and yearly thereafter. Pre- and post-operative Knee Society scores were compared using the paired $t$ test, and the level of significance was set at 5%.

RESULTS

The mean follow-up period was 51 (range, 24–96) months. The mean tibiofemoral angle improved from 23.2° to 1.9° varus. The mean Knee Society knee score improved from 38.5 (range, 15–63) to 89.6 (range, 80–95) [$p=0.032$]. The mean Knee Society functional score improved from 25.5 (range, 0–40) to 86.5 (range, 60–100) [$p=0.02$]. All fractures were united at the last follow-up. No complications such as wound necrosis, infection, loosening, joint instability, or patellar problems were encountered.

DISCUSSION

Stress fractures in elderly people are a combined result of stress and insufficiency fractures related to
abnormal bone (secondary to osteoporosis, pagets disease, or rheumatoid arthritis) under abnormal stresses (secondary to deformities). In our hospital, the incidence of stress fractures was around 1 to 2%.

Management of tibiofemoral stress fractures associated with knee arthritis is a challenge. Conservative treatment using casts and braces is associated with prolonged immobilisation and persistent symptoms, and may result in increased knee stiffness, despite aggressive physical therapy after immobilisation.6,7,13 Stress fractures may become recalcitrant non-unions in the presence of malalignment at the knee joint and fracture site.18,20

Surgical treatment enables realignment of the knee joint and the fracture site so as to alleviate arthritic symptoms and ensure fracture healing. Osteotomy alone can achieve fracture healing and limb alignment.21 Osteotomy with or without second-stage TKA after bone union has achieved good outcome,22 but this involves 2 separate surgeries and prolonged immobilisation and persistent symptoms from knee arthritis, which may increase knee stiffness. In a 2-stage procedure, malunion/non-union at the fracture site can be corrected and fixed with an interlocking nail in the first stage.23 The nail is a load-sharing device that minimises the risk of re-fracture. A plate is not recommended as it has to be contoured and requires extensive dissection at the fracture site, which may lead to wound breakdown and infection. The plate weakens the bone by stress risers and necessitates a removal surgery. In the second stage, TKA is performed with simultaneous removal of the nail. This 2-stage procedure is less technically demanding, but involves 2 separate surgeries and leaves the knee-joint deformity and abnormal mechanical axis untreated initially, which may lead to implant failure and non-union.25

One-stage TKA with internal fixation of the stress fracture involves a single anaesthetic and surgical risk only.20 Nonetheless, the procedure is more extensive and entails separate incisions. A plate rather than an intramedullary nail is used, as the latter may interfere with placement of the tibial component. In patients with a proximal metaphyseal tibial non-union who undergo TKA with long-stem tibial non-union, bone grafting, and supplemental internal fixation (unicortical plate), it may be difficult to maintain rigid rotational stability with only an intramedullary stem, and additional fixation with a unicortical plate may become necessary to minimise motion at the non-union site.20 The diameter of the stem is very small and may be responsible for inadequate fixation.20

One-stage TKA with a long-stem extension of the tibial or femoral component to bypass the fracture site has been suggested.18,19,24,25 This procedure corrects the deformity and the adverse biomechanics at the fracture site, stabilises the fracture, and treats the arthritis in a single stage, while enabling early ambulation.19 In a patient with severe valgus knee deformity with a stress fracture, a fully constrained Guepar hinge prosthesis was used because of severe medial ligament laxity.25 A classification system for stress fractures has been proposed, although femoral stress fractures were not mentioned.24 In our study, extra-articular deformities were classified based on their severity and correctability at the joint level. Osteotomy for all malunited extra-articular fractures has been recommended, irrespective of the degree of the deformity.24 Correction of extra-articular deformity at the joint level achieves similar outcome to that of primary TKA, as it requires no additional incision for the corrective osteotomy, enables earlier rehabilitation, and minimises complications such as non-union, delayed union, failure of internal fixation, and infection of the osteotomy site.

The limitations of this study were its retrospective nature and short follow-up. Preoperative planning is important as the procedure is technically challenging. One-stage long-stem TKA restores limb alignment and facilitates fracture healing, with excellent outcome. Longer follow-up studies are needed.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES


