Exposure in difficult total knee arthroplasty using coronal tibial tubercle osteotomy

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ABSTRACT
Exposure in a total knee arthroplasty can be challenging regardless of whether it is a difficult primary or a revision. Various techniques both proximal and distal to the patella have been described and implemented to gain exposure and improve knee flexion. When patella eversion is not possible due to previous surgery or severe preoperative knee flexion contracture, a coronal tibial tubercle osteotomy may be utilized.

We present successful results utilizing the coronal tibial tubercle osteotomy procedure. The technique involved in this series is based on that described by Whiteside. It involves the development of a long lateral musculoperiosteal flap incorporating the tibial tubercle and anterior tibia, and leaving the proximal tibial cortex intact. This is extended along the tibia distally for 10 cm. It finishes by gradually osteotomising the anterior surface of the tibial crest. The tibia is reattached with wires at the end of the procedure. This technique minimizes complications that have been associated with the tibial tubercle osteotomy.

The 10 knees in 9 patients, who had total knee arthroplasty with a coronal tibial tubercle osteotomy, were reviewed pre and postoperatively. All knees were assessed using the Hospital for Special Surgery knee score (HSS). The scores averaged 43.6 preoperatively (range, 29–57) and 79.2 postoperatively (range, 67–90), and the mean range of motion was 59.5° preoperatively and 78.0° postoperatively. There were no cases of extension lag. Fixed flexion deformity was present in 3 cases postoperatively. Average time to union at the proximal and distal ends of the osteotomy was 8 and 24 weeks respectively. There was no evidence of nonunion and no other significant complications occurred.

Key words: tibial tubercle osteotomy, total knee arthroplasty, exposure

INTRODUCTION
Exposure of the knee may be difficult in revision total knee arthroplasty (TKA). Other causes of difficult knee exposure include patella baja, previous patellectomy, previous high tibial osteotomy, severe varus deformity, quadriceps contracture, poor flexion and rheumatoid arthritis. The underlying problem is frequently due to adhesion formation in the vicinity of the quadriceps mechanism or quadriceps fibrosis. This makes eversion of the patella difficult and forced eversion may result in patellar ligament rupture which may have serious consequences.

A number of techniques for improving exposure in these difficult situations have been described. These include partial release of the patella tendon, the
Coonse-Allen V-Y quadricepsplasty and modifications thereof, and tibial tubercle osteotomy. Partial release of the patella tendon provides only a limited increase in exposure. The V-Y quadricepsplasty is easy to perform but must be protected from early motion and results in extensor mechanism scarring and weakness. Trousdale measured an average extensor lag, after quadricepsplasty, of 4°. The tibial tubercle osteotomy also has had varying success with Wolff et al. and others reporting a number of complications including avulsion, fracture and wound breakdown. Modifications in technique as described by Whiteside and others have enabled these complications to be avoided. In the following study the results of 10 cases utilising the coronal tibial osteotomy are reported.

MATERIALS AND METHODS

Ten knees were operated on for TKA in 9 patients, utilizing the coronal tibial tubercle osteotomy technique. One patient had bilateral TKA surgery. Patients’ ages ranged from 66 to 78 years. Sex distribution was 8 men and 2 women. Mean follow-up time was 3 years and one month. All the patients had previously had knee surgery. Of these, 8 had a TKA. Of the 2 remaining, one patient had surgery for congenital patella dislocation, and the other patient had a high tibial osteotomy. On average 2.7 procedures had been performed on each knee before the TKA with coronal tibial tubercle osteotomy. Preoperatively all patients complained of pain and disability that affected their daily activities. Initial examination revealed limited joint movement with an average preoperative range of motion of 59.5°, and a mean Hospital for Special Surgery (HSS) knee score of 43.6 (Table 1).

Preoperative radiographic investigation demonstrated aseptic loosening in 5 patients. Two patients required the surgery as the second stage of a revision procedure for septic loosening of an earlier primary total knee arthroplasty. One patient had severe osteoarthritis and a previous patellectomy for congenital dislocation of the patella, and one patient had severe knee osteoarthritis with fixed flexion of 40° and a fused hip above the knee due to previous hip sepsis. Surgery was performed by the senior author and data was collected prospectively.

In each patient the previous surgery and deformity prevented lateral eversion of the extensor mechanism, following a standard medial parapatellar incision. A coronal tibial tubercle osteotomy was thus performed as follows:

The skin incision was extended distally along the anteromedial border of the tibia for 10 to 12 cm. Fine drill holes were used to mark the osteotomy. A fine toothed oscillating saw was then used to make a longitudinal osteotomy of the medial and lateral tibial cortices in the coronal plane through the cancellous bone of the tibial metaphysis. This was extended 10 to

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<th>Preop flexion</th>
<th>Preop HSS*</th>
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Average 2.7 -6.5 66 43.6 -2.5 71 79.2 1.25 0

Average Preop ROM 59.5 Postop ROM 78

* HSS The Hospital for Special Surgery Knee Score
** Patient 5 had both left and right knees operated on
Note: Extension, flexion and deformity are measured in degrees
12 cm distal to the tibial tubercle and was gradually brought to the anterior surface of the tibia. The proximal part of the osteotomy was angled anteriorly above the tibial tubercle to protect the proximal tibial cortical rim. An osteotome was then used to separate the osteotomised segment from the tibia (Fig. 1).

Care was taken not to damage the lateral periosteal and muscular attachments which were left attached to the osteotomised segment. The extensor mechanism was then reflected laterally on the intact musculoperiosteal hinge.

The prosthesis implanted in all cases was the Advantim (Wright Medical) prosthesis. Following implantation of the prosthesis, the tibial tubercle osteotomy was replaced by passing 3 cerclage wires through drill holes in the medial then the lateral tibial cortices, around the tibial tubercle osteotomy but under the anterior compartment muscle. They were then tightened and angled downward under the lateral soft tissue. Three wires were used to hold the osteotomy in all but 2 cases. In one case 4 wires were utilised and in the other case 3 screws were used to fix the osteotomy in place.

The postoperative regime was essentially the same as that for routine primary TKA with range of motion exercises being commenced after 48 hours and the patients being allowed to fully weight bear as tolerated. The only difference in the postoperative regime was that the knee was rested in a knee extension splint between exercises for the first week to prevent undue stress on the wound as most of these patients had multiple scars. One patient with a preoperative fixed knee flexion of 40° had instructions for a plaster of Paris cast in extension to be maintained for the first 3 weeks postoperatively, to ensure that he did not lose full extension.

RESULTS

The results in 10 knees (9 patients) were reviewed clinically and radiographically. Mean preoperative range of motion improved from 59.5° to 78.0°. The Hospital for Special Surgery knee scores (HSS) ranged from 29 to 57 preoperatively (average 43.6), and from 67 to 90 postoperatively (average 79.2).

Fixed flexion deformity (FFD) was present in 3 cases postoperatively (Table 1, column 9). In 2 of these cases fixed flexion was 5° and 15°, however, this was improved from preoperative FFD of 10° and 40° respectively (Table 1, column 4). The patient with eventual FFD of 15° had a fused ipsilateral hip due to previous septic arthritis. An attempt was made to maintain this patient in a plaster cylinder in extension in the 3 weeks immediately after the operation. The patient’s plaster failed after approximately one week and there was 30° of extension loss before the patient represented at 3 weeks. This only partly improved with physiotherapy and accounted for his residual FFD of 15°. A third case with residual FFD had total range of motion increase from 0–30° to 5–75°.

Two cases, in the one patient, were noted to have radiographic evidence of proximal migration of the osteotomy (2.5 cms in each case). The reason for the migration was thought to be due to the osteotomy being much shorter than usual. In one of these cases, the osteotomy migrated proximally after 8 weeks and a prominence was exhibited at the distal end of the osteotomy. The distal end of the osteotomy was bevelled and its accompanying cerclage wire was removed at 5 months as the prominence under the skin was uncomfortable.

Figure 1  Diagrammatic representation of anteroposterior and lateral views of the coronal tibial tubercle osteotomy. (a) Oscillating saw and line of proposed osteotomy. (b) Osteotomy reflected laterally and patella everted.
Average time to union at the proximal and distal ends of the osteotomy was 8 and 24 weeks respectively. This was determined radiographically (Fig. 2). There was no clinical or radiographic evidence of nonunion, tibial fracture, wound breakdown or infection. No other significant complications occurred.

Figure 2  Lateral (a-c) and anteroposterior (d,e) radiographic views of a coronal tibial osteotomy.
DISCUSSION

Extended tibial tubercle osteotomy allows safe and extensive exposure during total knee arthroplasty without compromise to the quadriceps extensor mechanism. Previous studies have shown that stresses are greater across the suprapatellar region of the extensor mechanism than the infrapatellar region. Patients can therefore be mobilised early in their postoperative course with less fear of disruption to the extensor mechanism. This technique also allows the tibial tubercle to be moved to correct abnormalities of patella tracking.

By producing a large musculoperiosteal flap, a well vascularised corticocancellous contact area is created and the risk of nonunion is minimised. The vascular flap minimises the risk of wound necrosis and subsequent wound infection, as reported by Wolff et al. Tension on the wound was also minimised in the first week by resting the knee in an extension splint when it was not receiving supervised range of motion exercises. Normal rehabilitation was undertaken after one week in all but one patient.

This technique is based on the Whiteside procedure. It is our opinion that the use of wires rather than screws for fixation produces less of a stress riser at the anterior tibial cortex.

Whiteside reported one patient out of 71 cases who had radiographic evidence of proximal migration of the osteotomy. We noted a small amount of proximal migration of the osteotomy in 2 cases, both in the same patient, thought to be because the osteotomy was shorter than usual. Nonunion of the osteotomy did not occur in any of the cases.

Fixation failure in tibial tubercle osteotomy and fracture of the tibercle or the tibia itself has been discussed by other authors. Whiteside and Ohl noted the association between fixation failure and the use of a small osteotomy segment. Our results compare favourably with Whiteside’s findings since there was no fracture of the tibercle or tibia in this series.

Exposure of the knee may be difficult in the total knee arthroplasty. We have shown that coronal tibial tubercle osteotomy is a safe and reliable procedure which affords excellent exposure.

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REFERENCES