

# Total knee replacement with tibial tubercle osteotomy in rheumatoid patients with stiff knee

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## Abstract

**Purpose** Total knee arthroplasty (TKA) is a well-proven modality that can provide pain relief and restore mobility for rheumatoid arthritis (RA) patients with advanced joint destruction. Patellar ligament avulsion, especially in presence of poor bone quality and knee stiffness, is one of the special considerations that must be addressed in this unique population of patients. This study aimed to determine the functional results in a series of rheumatoid patients with stiff knee and end-stage joint destruction who underwent tibial tubercle osteotomy during TKA.

**Methods** Twenty-three knees in 20 patients (16 women; four men) at a mean age of 54 years with end-stage arthritis and knee stiffness due to RA were operated upon for TKA using tibial tubercle osteotomy as a step during the operation. Patients were reviewed clinically and radiographically with a minimum follow-up of two years. Complications were noted. Hospital for Special Surgery (HSS) score was recorded pre-operatively and at six and 12 months postoperatively.

**Results** Union occurred at the osteotomy site in 21 of 23 cases. One case had deep venous thrombosis (DVT). There was no infection or periprosthetic fracture, and at last follow-up, no patient required revision. HSS score improved from 46 (15–60) pre-operatively to 85 (71–96) post-operatively.

**Conclusion** Tibial tubercle osteotomy during TKA in patients with RA and stiff knee is technically demanding yet proved to be effective in improving post-operative range of movement and minimising the complication of patellar ligament avulsion.

**Keywords** Arthroplasty · Osteotomy · Rheumatoid arthritis · Stiff knee · Tibial tubercle · Total knee

## Introduction

The course of rheumatoid arthritis (RA) varies from mild disease to severe joint destructive variant that progresses rapidly, eventually leading to unremitting pain and joint deformity. The knee is one of the most commonly affected large joints in patients suffering from long-standing RA. Despite recent improvement in biological agents and treatment modalities in the field of rheumatology, progressive joint destruction continues to occur in a subgroup of RA patients, who eventually require joint surgery. Total knee arthroplasty (TKA) has proven to be the most successful intervention, reducing knee pain and improving physical function in RA patients [1, 2]. However, as RA patients carry additional potential for late complications, many important considerations regarding pre-operative evaluation and surgical techniques must be taken into account in order to improve TKA results in this subgroup of patients.

The classic medial parapatellar approach frequently used in TKA proved to be sometimes insufficient in difficult cases like RA [3]. Difficult patellar eversion during surgery may

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lead to iatrogenic lesions of the patellar tendon, with severe functional outcome on the knee [4]. Different techniques, like controlled distal partial disinsertion of the patellar ligament [5], V or Y plasty of the quadriceps tendon [6, 7] and tibial tubercle osteotomy [8, 9] were used to obtain a better eversion.

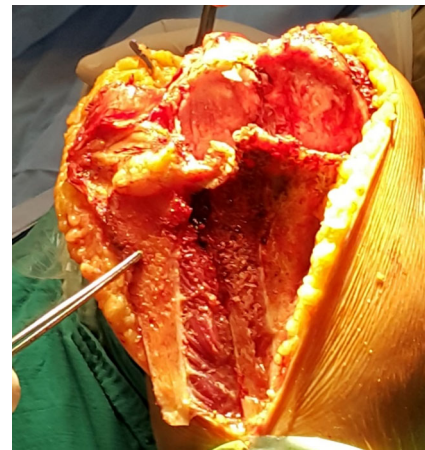
The primary outcome of this study was to determine the functional outcome using Hospital for Special Surgery (HSS) score in RA patients with stiff knees after they were operated upon by TKA, with simultaneous tibial tubercle osteotomy as a routine step during the procedure, and to determine the rate of complications with this technique as the secondary outcome.

## Patients and methods

This was a prospective single-centred, noncomparative, interventional case series. Twenty patients with 23 knees with end-stage arthritis and knee stiffness due to RA were recruited prospectively. All patients (16 women; four men) were operated upon by cemented TKA with simultaneous tibial tubercle osteotomy between 2011 and 2012. All cases were known long-standing RA patients. Average disease duration was ten years (6–14). All patients were being followed up in our rheumatology outpatient clinic with a patient-tailored regimen of standard protocol using combinations between steroids, disease-modifying drugs and biologics, with good control at the time of surgery. All were receiving antiosteoporotic medications in the form of weekly bisphosphonates orally for at least the previous six months preceding the operation. We defined a stiff knee as one having a flexion contracture of  $\geq 15^\circ$  and/or  $< 75^\circ$  range of flexion. The mean age at surgery was 54 years (45–59). All patients were last followed up between two and four years (mean 2.5). Pre-operative radiographic evaluation was conducted on anteroposterior and lateral knee and standing full-leg (hip, knee and ankle) views.

## Operative technique

All procedures were performed by one surgeon (WAN) using tourniquet control. A midline skin incision and standard medial parapatellar approach with 10–12-cm distal extension on the anterior tibial border was used. All cases had tibial tubercle osteotomy in the coronal plane. The osteotomy line was marked using a small drill bit and completed by an oscillating saw. The distal line of the osteotomy was cut first with the oscillating saw between two small drill holes; then the frontal cut was made starting from the medial side passing through the cancellous metaphyseal bone, maintaining lateral soft tissue, and a periosteal hinge aiming for an osteotomised fragment of 7- to 10-cm long and 2–3 cm in width and at least 1-cm thick (Fig. 1). Soft tissue release was done cautiously in a stepwise fashion biased towards under- rather than over-release. Posterior cruciate ligament was excised and synovectomy



**Fig. 1** Tibial tubercle osteotomy should be of adequate length (7–10 cm), width (2–3 cm) and thickness ( $>1$  cm at several points) to increase surface area of contact and withstand fixation of the osteotomised fragment

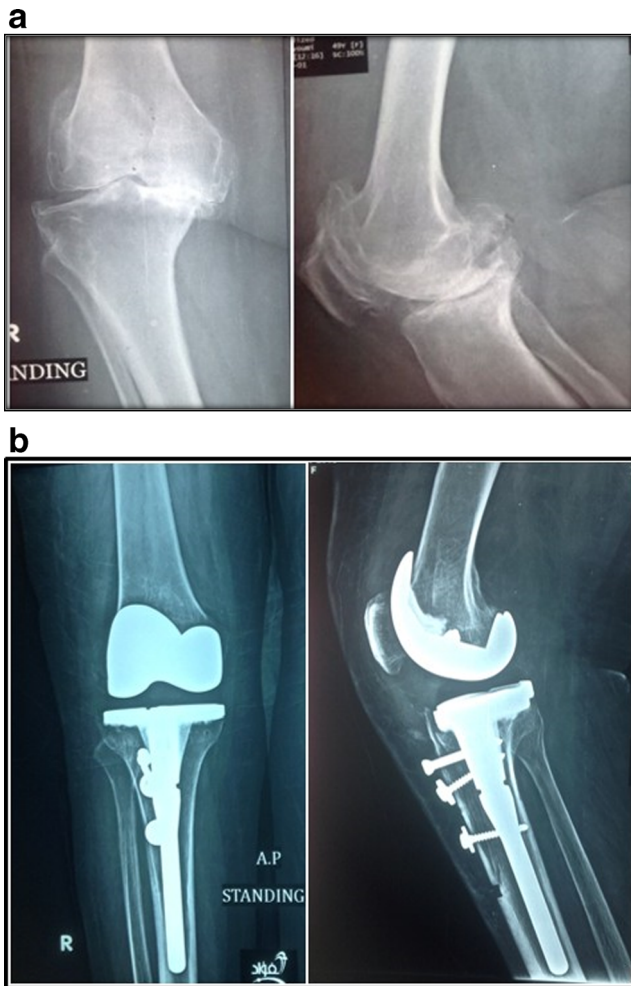
performed. Soft-tissue releases were carried out to correct angular and flexion deformities. Posterior soft-tissue releases were undertaken routinely in all cases.

Determining the level of tibial tubercle osteotomy could also be a problem in RA patients with valgus knee deformities because of possible sinking of the lateral tibial condyle, and in such cases, positioning a 10-mm stylus at the usual highest position of the lateral tibial condyle can result in over-resection. Therefore, we usually adjust the level of cut using the 2-mm stylus side, being biased towards under-resection. A posterior-stabilised cemented total knee prostheses used (Miller-Galante: Zimmer, Warsaw, IN, USA) in all knees. After prosthesis implantation, the tibial tubercle was reattached and fixed with two or three bicortical screws in situ or in a proximal translated position at the tibial metaphyseal bone. Only removal of osteophytes and patellar denervation was performed.

The post-operative rehabilitation program was the same as that followed after using regular approach, with no modifications except for limiting maximum flexion to  $60^\circ$  until three weeks after surgery. No splints or orthosis were required, and progressive weight bearing was allowed and was limited only by pain. Patients were reviewed in the outpatient clinic at six weeks and three, six and 12 months after surgery. HSS score was used as a conventional objective outcome scale [10] and was recorded pre-operatively and at six and 12 months post-operatively. At each follow-up visit, patients were assessed clinically and radiographically by anteroposterior and lateral radiographs (Fig. 2). Osteotomy union and complication rates were recorded.

## Results

Twenty-three primary knees in 20 patients (16 women; four men), mean age 54 years (45–59), were operated upon. The



**Fig. 2** **a** Pre-operative anteroposterior and lateral radiograph in a 45-year-old woman. **b** Four years post-operative showing stable prosthesis with tibial tubercle fixed with three screws in a proximal translated position

mean follow-up period was 2.5 years (2–4). No patient was lost to follow-up. The tibial tubercle was fixed in situ in 12 cases (52.2 %) and translated in a proximal position in 11 (47.8 %) by an average of 1.2 cm (1–1.5 cm); 21 of the 23 tibial tubercle osteotomies united (91.3 %) in a mean 4.5 months (3.5–6). There were three complications (13 %): two cases showed radiological nonunion without translation, and one case was complicated with deep venous thrombosis (DVT). No case required revision at last follow-up. There was no infection or periprosthetic fracture during the follow-up period. HSS score improved from 46 (15–60) pre-operatively to 85 (71–96) post-operatively (Table 1).

## Discussion

Treating patients with RA and end-stage knee destruction necessitating arthroplasty may present a challenge to the orthopaedic surgeon, who thus should anticipate facing some difficulties during the procedure, most commonly poor bone quality

and knee stiffness. Bone quality is generally poor in RA patients due to the combined effect of the inflammatory disease process itself, disuse of the knee and chronic use of steroids [1, 11]. Additionally, prostaglandin released by rheumatoid synovium had been suggested as an additive local deleterious factor because of its direct role in subchondral bone resorption [1]. When poor bone quality is combined with knee stiffness—which is not uncommon in RA patients—the functional range of motion after TKA may be compromised, resulting in post-TKA stiffness that does not improve even with manipulation under anaesthesia [12]. The risk of patellar tendon detachment from its tibial insertion increases with the classic medial parapatellar approach, which can lead to an active extension lag and difficult locking of the knee [13, 14], with subsequent poor functional outcome [4]. To avoid this, different techniques have been used, and the extensor system could be released distally at the tibial tubercle or proximally at the quadriceps tendon [5–9]. The patellar–tendon patella–quadriceps tendon group can be turned down towards the front, with the proximal V sutured in a Y fashion to lengthen the extensor apparatus proximally [7]. Although the V-Y quadriceps plasty was relatively safe and technically undemanding, it delayed functional rehabilitation by impeding postoperative knee mobilisation, with negative impact on range of motion [6]. Partial disinsertion of the patellar tendon did not substantially improve the surgical exposure and could lead to extensor apparatus weakening and complete secondary ruptures [5].

Satisfactory results were gained with the use of tibial tubercle osteotomy, which acted on the distal part of the extensor system to improve exposure [15–19]. Its lateral levering widely freed the joint and facilitated exposure. Modification of the position of the bone fragment aimed at improving patellar position, in particular in terms of height, which proximal release—like V-Y quadriceps plasty—did not provide. In a series of TKAs, Hsu et al. found that the V-Y quadriceps plasty was associated with an inferior clinical outcome when compared with tibial tubercle osteotomy [20]. The purpose of this study was to determine functional outcome of and complications following tibial tubercle osteotomy as a routine step during primary TKA in a series of RA patients with stiff knee. Poor bone quality in RA patients was why our patients received at least six months of antiosteoporotic treatment before the operation. Although excellent long-term results using hydroxyapatite-coated implants have been recorded even in RA patients [21], we preferred to use cemented TKA. We thus used a posterior-stabilized prosthesis in all patients, because the use of posterior cruciate-retaining designs is associated with an increased incidence of posterior instability, recurvatum deformity and increased revision rate [22].

Tibial tubercle osteotomy was done for all cases with the aim of improving exposure during surgery, protecting the patellar ligament from avulsion during retraction and improving

**Table 1** Comparison between pre-operative and post-operative scores of different Hospital for Special Surgery (HSS) parameters

	Pre-operative		Post-operative		Z value	P value
	Range	Median	Range	Median		
Pain on walking	0–5	5	10–15	10	5.16	<0.0001*
Pain at rest	0–5	5	10–15	15	5.16	<0.0001*
Walking	0–10	8	8–12	10	5.16	<0.0001*
Stairs	2–5	2	2–5	5	3.92	<0.0001*
Transfer	2–5	2	2–5	5	4.01	<0.0001*
Range (°)	50–95	80	90–130	100	5.16	<0.0001*
Range (score)	6–12	10	10–15	12	5.16	<0.0001*
Quad strength	4–10	8	8–10	10	4.94	<0.0001*
Walking aids	–3 to 0	0	–1 to 0	0	3.41	0.0007**
Extension lag	–3 to 0	–2	–2 to 0	0	4.01	<0.0001*
Deformity score	–7 to –1	–3	–2 to 0	0	5.16	<0.0001*
Flexion deformity	0–10	8	8–10	10	3.92	<0.0001*
Mediolateral instability	0–10	8	8–10	10	4.78	<0.0001*

Z value = Wilcoxon signed-rank test

\* $P \leq 0.0001$ ; \*\* $P \leq 0.001$

post-operative range through proximal transfer of the tibial tubercle at the end of the procedure, which was significantly different from the pre-operative range in this study group ( $P < 0.0001$ ). However, tibial tubercle osteotomy has some risks that may be encountered: fracture of the proximal tibia may occur, especially during knee mobilisation in the presence of osteoporosis [23, 24]. There were no such occurrences in this series. A short bone fragment increases the risk of failure due to minimal contact surface area and insufficient fixation [16, 25–28]; thus, it is recommended that the bone fragment should be at least 7-cm long, with several points of sufficient thickness ( $>1$  cm) so the fixation does not weaken it. There was no fracture of the osteotomised fragment in this study, yet we encountered two cases (8.7 %) with radiological nonunion, without evidence of displacement. There was no skin necrosis, which is another issue of concern with tibial tubercle osteotomy; it was avoided by meticulous surgical technique without subcutaneous dissection. The osteotomised fragment can be fixed with different methods, like wires, metal cable cerclages [15, 26, 29–32] or screws [33–35]. We preferred screw fixation, as mechanical studies demonstrate the superiority of this method [36]. Fixation was ensured either in situ (12 cases) or by modifying the position in medial or proximal (11 cases) translation to improve post-operative range of movement.

The strength of this study is that all patients had the same diagnosis, which minimised variables. However, there were also some limitations. Firstly, it was a single-centre study, and the number of cases was relatively small: 23 cases with relative short-term follow-up (2–4 years). Secondly, we did not measure extensor apparatus strength; however, clinically, we observed no active extension defect.

In conclusion, TKA in rheumatoid patients with stiff knee may be difficult, and tibial tubercle osteotomy, although technically demanding, may provide adequate exposure and has the advantage of improving patellar tracking if needed, in addition to reducing the risk of patellar tendon rupture. The technique could be considered a routine step when operating on stiff knees such as those in RA patients. Further studies with longer follow-up and randomised controlled trials are warranted to assess the long-term safety and efficacy of the technique relative to other techniques used in RA patients with stiff knees.

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