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KNEE REVISION SURGERY

Proximalize osteotomy of tibial tuberosity (POTT) as a treatment for stiffness secondary to patella baja in total knee arthroplasty (TKA)

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Abstract
Introduction Stiffness after a total knee arthroplasty (TKA) is one of the most common post-operative complications. The purpose of this study is the evaluation of the effectiveness of TT proximalization osteotomy of improving a lack of flexion and secondary pain in patella baja (infera) post-TKA.
Materials and methods Between April 2007 and July 2012, TT proximalization osteotomy was performed on 21 patients. The average preoperative flexion was 70° (in a range of 60–80). Clinical pre- and post-operative evaluations were performed with Knee Society Score, Western Ontario and McMaster Universities Arthritis Index scales and a satisfaction survey. Modified Blackburn-Peel index and Portner angle were used to evaluate patellar height.
Results After an average follow-up of 35 months (range 18–48), an average flexion of 100° (range 90–100) and an overall satisfaction were obtained. Clinical scores improved significantly. The Blackburn-Peel index and Portner angle improved significantly from 0.3 (range 0.1–0.5) to 0.4 (0.3–0.5) and from 9 (3–15) to 12 (9–18), respectively. Three patients showed no signs of osteotomy consolidation. However, this was not linked to a lack of extension or an increase in local pain.
Conclusion TT proximalization osteotomy provides satisfactory results in improving a lack of flexion and pain in patella baja post-TKR.

Keywords Tibial tuberosity osteotomy · TKA · Knee stiffness

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Introduction

Total knee arthroplasty (TKA) is a procedure with a success rate over 95 % [1] that, just like any other surgery, is not exempt of complications [2, 3]. Stiffness is one of them, with an approximate incidence of 1.3 % [4]. A flexion deficiency of less than 90° impedes certain routine movements, such as climbing and descending stairs, getting into a car, going to the bathroom, etc., which can seriously hinder basic activities of daily living [5]. Several factors can be involved, one of which is acquired patella baja [6].

Nevertheless, the relation between stiffness and acquired patella baja is infrequent but it can be very incapacitating. Patella baja syndrome is defined as those signs and symptoms associated with a knee that, primarily or secondarily, has the patella displaced from the femoral trochlea, due to the shortening of the patellar tendon (which, according to Sabshin et al. [7], should have an average length of 4.2 cm). This is normally due to trauma or surgery, causing retraction of the tendon [8], affectation of the quadricipital tendon, patella malalignment from the femur [9], excessive soft tissue release, etc., and has been described in different studies with an incidence of 34–65 % post-TKA [10–12]. It should be noted that TKA can lead to a more than 10 % patellar height alteration [13]. On the other hand, not all knees with patella baja are symptomatic.

Although there is literature dedicated to TKA stiffness, there are no studies that refer to the treatment of stiffness secondary to patella baja after TKA. On the contrary, in other studies [8, 14, 15] that evaluate the treatment of acquired patella baja in multiple situations, some patients with TKA are included.

A retrospective series of patients with TKA who have been treated for stiffness due to acquired patella baja by performing a proximalize osteotomy of tibial tuberosity (POTT) is presented in this work. The purposes of this study are to evaluate the effectiveness of the osteotomy in improving mobility range (flexion) and function, and to determine the parameters that are related to any improvement. The initial hypothesis was that POTT is an effective treatment to improve flexion in patients with TKA who have had complications associated with patella baja.

Material and methods

Patient group

22 patients with TKA who had POTT performed between 2007 and 2012 were revised retrospectively. One patient died due to causes unrelated to the knee surgery and was not included in the study, leaving 21 as the final number of patients, fourteen of which were female (66 %). The average age was 67 years (range 64–73) with a average Body Mass Index (BMI) of 31.5 (range 28.7–34.4). POTT was performed in 12 right knees (57.1 %) and 9 left knees. In all cases, surgical indication criteria were post-TKA stiffness (defined as flexion <90°) associated with acquired patella baja, 15 out of the 21 patients having a flexion less than 75°. Acquired pseudo-patella baja were excluded from the study. The average waiting time between surgeries (TKA to POTT) was 28 months (range 23–35). Before surgery, some causes like infection, instability or loosening of components were discarded. The used prosthesis models were: 9 Scorpio (Stryker, Michigan, USA), 7 Profix (Smith & Nephew, Memphis, Tenessee, USA), and 1 Nexgen (Zimmer, Warsaw, Indiana, USA), 1 PFC Sigma (Depuy Synthes, Indiana, USA), 1 Journey (Smith & Nephew, Memphis, Tenessee, USA), 1 W-Link (GmbH & Co, Bavaria, Germany) and 1 Legion (Smith & Nephew, Memphis, Tenessee, USA). The reason for this distribution (predominantly Scorpio and Profix models) was that, in our hospital and in that period, these models were the most frequently used. The revision surgery (POTT) was done by the same surgeon as the one who performed the TKA with a final total of 3 different surgeons involved. Due to incapacitating anterior knee pain, 15 (71.4 %) patients underwent patellar resurfacing simultaneously (SPR).

Surgical technique

Since all the cases were chronic (an average of 28 months between TKR and stiffness surgery), a closed manipulation under anesthesia was not performed. In all cases, after the classic parapatellar approach, an open arthrolysis with synovectomy was performed. After that, a manipulation was done in order to check if there was an improvement in flexion. If the improvement was none or minimal, a POTT was performed at an approximate depth of 1 cm, with a length of 4–6 cm (Fig. 1). An average of 1–1.5 cm of patella proximalization was performed without surpassing these values in order to avoid possible loss of active extension. Patients who presented incapacitating femoropatellar pain underwent patellar resurfacing using a conventional technique of each surgeons' decision. In all cases the fixation of the TT was done with two 1.6 mm wire cerclages (Fig. 2) at an approximate distance of 1.5 cm between them, trying to avoid the breakage of the tibial tuberosity. Patellar tracking and improvement of flexion degrees were tested at the end. Total or partial release of the lateral retinaculum was done when patella maltracking was detected. The closing of both arthrotomies and subcutaneous incisions were done with the knee flexed. The post-op was the same as in a conventional TKA, insisting on immediate mobilization.

Evaluation

In all cases clinical, functional and radiological evaluations were performed before and after POTT by the same person (M.V.), thus avoiding interobserver variations. The data was entered in a Microsoft Excel spreadsheet.

Clinical and functional evaluation

The clinical evaluation was done with a goniometer, by measuring maximum flexion and extension degrees before and after the surgery.

The results were collected using the Knee Society Score Scale (KSS), knee and function sections, and the Western Ontario and McMaster Universities Arthritis Index (WOMAC) for pain, function and stiffness. Patient's satisfaction was evaluated with a visual analogous scale (VAS) between 0 and 10 points, being 0 the value of maximum dissatisfaction and 10 the maximum satisfaction.

Radiological evaluation

AP, lateral and X-rays were taken to 30°. In order to evaluate the patellar height, a modified Blackburn-Peel index was used (Fig. 3) (according to Berg et al. [16]; Seil et al. [17], this index has shown less inter and intraobserver

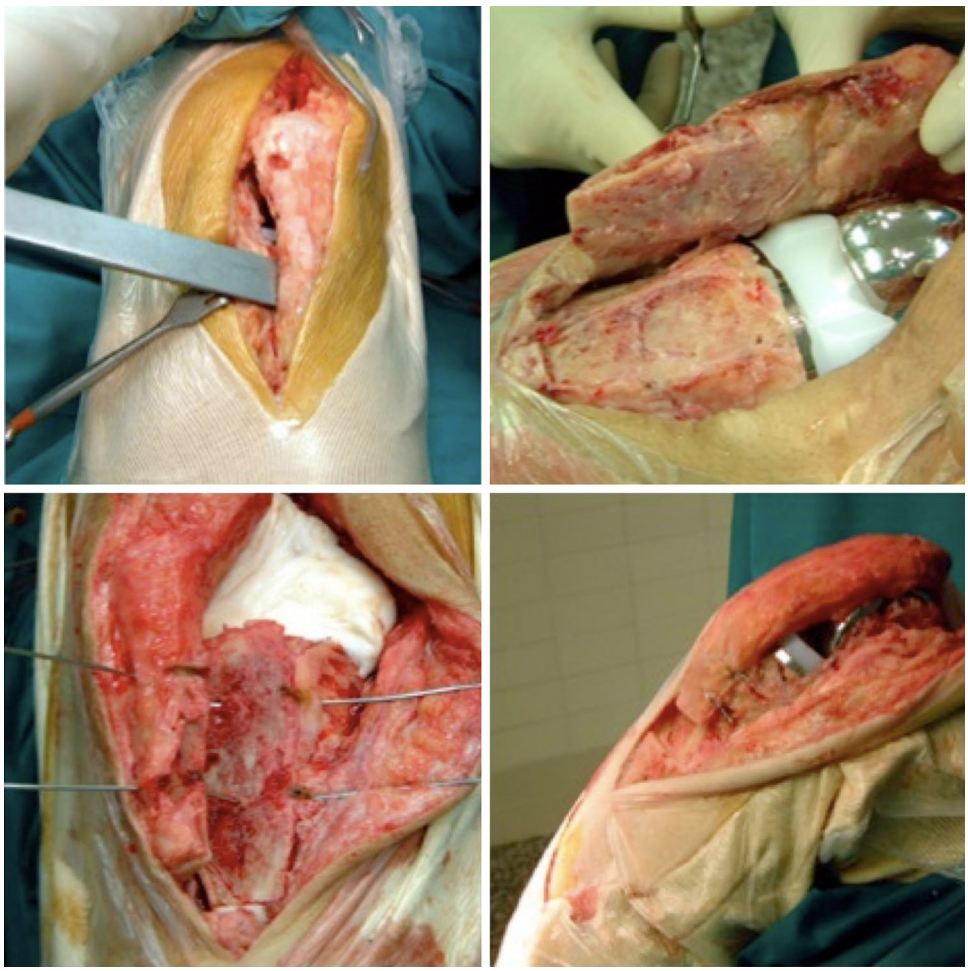

Fig. 1 Intraoperative images during the POTT. *Up-left* TT osteotomy, *up-right* proximal displacement of TT, *down-left* fixation with two 1.6 wire cerclages. *Down-right* final result with a 1–1.5 cm TT proximal displacement. A good patellar tracking is achieved without the need of lateral release

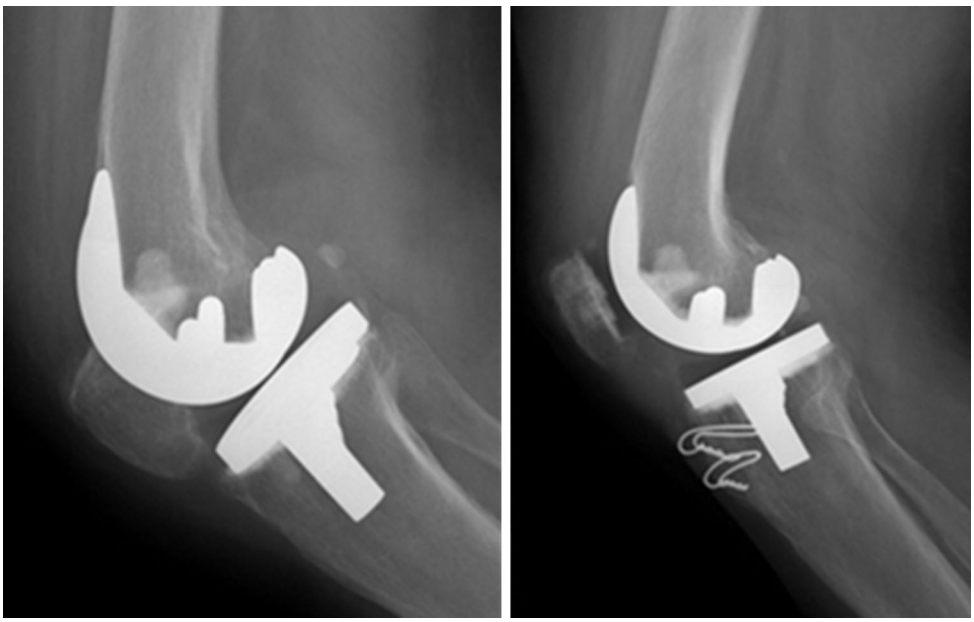

Fig. 2 Pre- and post-op radiological images of POTT fixed with cerclages. In this case SPA was performed

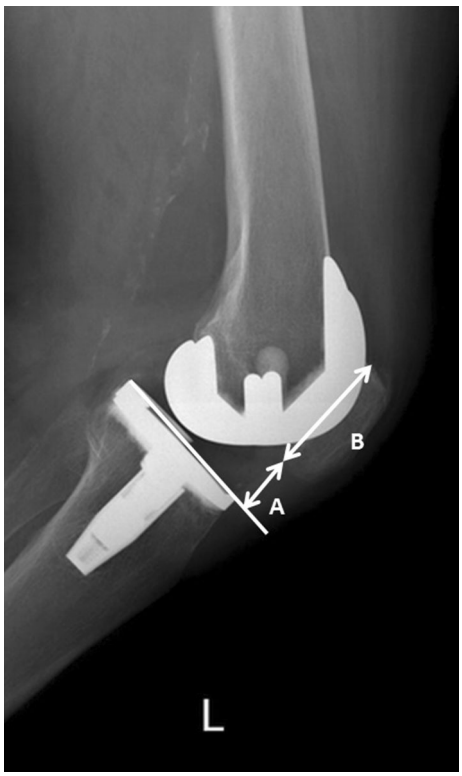

Fig. 3 Modified Blackbourne-Peel index *A*/*B*

Fig. 4 Modified tibial plateau-patella angle described by Portner

variability, thus lowering standard error) and modified tibial plateau-patella angle described by Portner [18] (Fig. 4).

Special care was taken to avoid the confusion between patella baja with pseudo-patella baja [9], which is described as a situation in which the tibial surface is raised towards the distal pole of the patella. This can be due to several causes, such as an excessively proximal femoral condyle osteotomy, an overly large tibial insert, an excessive release of soft tissue requiring the elevation of the articular line to provide stabilization [19], etc.

We have also studied other parameters such as prostheses malalignment or presence of radiolucencies.

Statistical analysis

The variables for each category are described in frequencies and percentages.

Continual variables are described from the average and standard deviation, median and 25 and 75 % percentiles.

In order to evaluate any improvement, a Wilcoxon's non-parametrical test was performed for matching data. So as to compare improvement variables according to the patellar button the non-parametrical Mann–Whitney *U* test was performed, in accordance with the time between surgeries, and the Spearman correlation. Spearman correlations were used to evaluate the relation between the different variables used to measure the improvement.

The level of statistical significance was set to bilateral 5 % and the analysis was performed with SAS statistical software, version 9.3.

Results

Clinical results

With an average follow-up of 35 months (range 18–48), a statistically significant improvement ($P < 0.01$) was obtained in all functional parameters (Table 1). The average flexion went from 70° (range 60–80) to 100° (range 90–100). KSS-F went from 40 (range 35–45) to 80 (range 80–90). KSS-R scales improved from am average of 58 points (range 52–62) to 88 points (range 83–95). The WOMAC scale also presented significant improvements: pain went from 14 (range 12–14) to 9 (range 3–12); function from 42 (range 36–46) to 20 (range 12–36); and stiffness from 3 (range 3–5) to 2 (range 1–4). A positive correlation was found between flexion improvement (our main purpose) and the normalization of radiological parameters (Blackburn-Peel index). The restoration of patellar height showed a statistically noteworthy improvement in knee flexion ($P = 0.02$). We also found a relevant

Table 1 Relationship between the variables and pre/post-operative differences, with *P* value

Variable	Preoperatory	Final	Differences	*P* value
Flexion	70; (60–80)	100; (90–100)	30; (20 to 35)	<0.01
KSS-F	40; (35–45)	80; (70–90)	40; (30 to 50)	<0.01
KSS-R	58; (52–62)	88; (83–95)	28; (25 to 35)	<0.01
Womac pain	14; (12–14)	9; (3–12)	−6; ([−6] to 0)	<0.01
Womac function	42; (36–46)	20; (12–33)	−21; ([−32] to 8)	<0.01
Womac stiffness	4; (3–5)	2; (1–4)	−2; ([−3] to 1)	<0.004
Height	0.3; (0.1–0.5)	0.4; (0.3–0.5)	0.2; (0 to 0.3)	<0.001
Angle	9; (3–15)	12; (9–18)	4; ([−2], 9)	<0.001

Data shown with median (DE). Statistical test done with the Wilcoxon test

Median; (Range)

correlation between KSS-R improvement and the resurfaced patellas, due to the improvement of pain after resurfacing ($P = 0.04$). General satisfaction was an average of 8 (range 6–8), with the procedure being recommended by patients in most cases (80 %) even though, in general, slight residual pain remained.

In spite of general improvement regarding functional, clinical and radiological parameters, a statistically significant correlation could not be established between improvement in functional parameters and demographic data (gender, BMI, laterality), type of prosthesis, time between surgeries and surgeon.

Immediate complications after the surgery were: two acute TKA infections (9.5 %), which were solved by debridement, polyethylene replacement and antibiotic treatment; and a wound dehiscence that required debridement and suture. Regarding late complications, cerclages were extracted in one patient due to intolerance after 1-year of follow-up revision. One patient required a tibial component replacement due to aseptic loosening 2 years after the POTT, although they seemed to be unrelated. Finally, after the 2-year follow-up, another patient required a revision of the TKA due to instability and, as a result, a Rotational Hinge model was placed. Both patients presented consolidation of the osteotomy before their revision.

Radiological results

The average Blackburn-Peel index went from a pre-operative 0.3 (range 0.1–0.5) to a post-operative 0.4 (range 0.3–0.5); the average tibial-patellar angle went from 9° (range 3–15) to 12° (range 9–18), with a statistical significance of $P < 0.01$ in both cases.

Three patients (15 %) showed lack of consolidation of the osteotomy (Fig. 5), without any loss of active extension or other functional alterations. No revision surgery was necessary in these patients.

No malalignment or radiolucencies were found at posterior X-ray controls.

Fig. 5 Image of a nonunion after POTT

Discussion

The most important discovery in this study is the significant improvement of the average flexion of 29.5° using POTT for post-TKA stiffness associated with patella baja, related to restoration of patellar height. Until now there have been no studies centered on POTT for patients with TKA, since most of the research regarding patella baja has been done on patients without TKA. Caton et al. [14] studied 24 patients with patella infera due to mechanical causes, performing TT proximalization with excellent or good results in 80 % of the cases, and, therefore, recommending this process as the standard treatment. Drexler et al. [8] used this osteotomy as a treatment for acquired patella baja in 17 patients, two of which had TKAs, with

good post-operative results. Tabutin et al. [15] described a series of 20 patients where 21 POTTs were performed to obtain medial access in difficult knees, fourteen of these being revisions, while another 7 patients had not previously received a TKA. They showed satisfactory clinical and functional results in all cases. Paulos et al. [20], in a series of 75 non-TKA patients (76 knees) who suffered patella baja associated with a patellar tendon shortening of 8 mm or less, performed POTT in 15 of them. These patients showed an improvement of flexion range.

Both clinical and radiological discoveries had a significant improvement in the study but no significant relevant correlation was detected between them. Although the flexion improvement was substantial (approximately 30° of flexion) the radiological parameters improved in a lower degree. We think that soft tissue release (intraarticular fibrosis if present, lateral retinaculum) and probably patella resurfacing, might be the explanation of this lack of correlation.

In the present study, 15 patients had the patella resurfaced due to retropatellar pain. Several series study secondary patellar resurfacing (SPR) as a treatment for anterior pain in TKA, finding an effective pain reduction in approximately the 50–60 % of cases [20, 21]. Some of these series also found improvements in the range of flexion after the placement of the patellar component. Correia et al. [21] studied 48 patients with bi-condylar knee prostheses, which had had SPR performed. 56.5 % Of them improved their range of movement (though not significantly) and they concluded that, even that not all patients in the study showed improvements, SPR was considered a good procedure to treat femoral-patellar pain. Muñoz-Mahammud et al. [22], in a series of 23 patients treated for anterior knee pain post-TKA, found a significant improvement in flexion in 63 % of cases after the SPR. Since the patella resurfacing improved the retropatellar pain, it might have a small benefit in improving the range of motion, so we think it could be helpful as an extra procedure in stiffness cases.

In the present study, all osteotomies were fixed with two wire cerclages. The radiological was present in 3 cases (15 % rather high percentage) but did not lead to a loss of active extension, probably due to the fibrosis involved in the osteotomy site; only 1 patient required removal of the cerclages due to local discomfort. There is a certain controversy regarding the type of fixation (screws or cerclages); biomechanical studies [23], comparing the fixation of POTT with screws versus cerclages showed that screw fixation could provide a more reliable fixation but the placement of screws around the tibial component could be difficult. Cerclage wires are easier to place and provide solid static fixation, especially with the addition of a proximal stepcut osteotomy [24, 25]. Tabutin et al. [15] described two stress fractures of the immediate proximal part overhanging the TT with no consequences: one case of stiffness and one case of local skin necrosis that had undergone several surgeries. Van de Broek [25] performed fixation with screws in 39 revisional TKAs that required a step-cut osteotomy, finding two TT migrations. Drexler et al. [8] performed all osteotomy fixations (17 knees) with screws, finding complications in 5 knees: two delayed scarring, two persistent pain that required the removal of material and one, stiffness. Della Valle et al. [26], in a series of 126 knee revisions that required TT osteotomy, used three cerclages instead of screws to fix the osteotomy, due to the technical difficulty of placing screws (especially if the revision included a tibial stem) and their high predisposition to cause a fracture. The study did not mention any secondary complications caused by the use of cerclages. The fixation of the tuberosity, with screws or cerclages, is still debatable. In general, surgeons prefer screw fixation.

This study has its limitations. Even though results were favorable, it is a non-comparative retrospective study that does not feature a control group. We were unable to compare whether another type of treatment would have been more efficient. Also, even though the study used a cohort of patients with the same pathology that required surgical intervention (TKA complication), it is an overall small sample of patients. This is due to the fact that the pathology itself is uncommon. This fact, however, does not reduce the validity of this study, since a larger number of patients would favor even more statistical significance over favorable clinical and radiological results. Another limitation is that not all patients used the same prosthesis. Seven different types were used in total, with Scorpio being the most prevalent (9 %) followed by Profix (7 %), and there are no data regarding whether the prosthesis model are related to further post-operative complications or if they encourage the evolution of patella baja themselves. Another arguable fact is that the interventions were not performed by the same surgeon, but rather 3 different ones, thus leading to possible variations in surgeries (personal techniques, releasing of soft tissues, etc.) such as, for example, in the SPA or the sectioning of the lateral retinaculum.

Conclusion

According to the results obtained in this study, POTT is a successful procedure to improve flexion and function in TKAs presenting stiffness and patella baja, with a relatively low rate of complications. The cerclage fixation of tuberosity (although with a high non-union incidence) did not lead into any extension deficit. Even though

radiological improvement was not as significant, both flexion and function improved together with a reduction in post-operative pain.

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