

Clinical Outcomes of Tibial Tubercle Transfer for Anterior Knee Pain and Patello-femoral Instability

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Abstract

Anterior knee pain and patellofemoral instability have a multi-factorial aetiology and are therefore difficult to treat. A variety of surgical treatment options have been proposed for such patients. Tibial tubercle transfer is one such option and has been described using different surgical techniques. There is however a paucity of literature regarding the procedure itself and its clinical outcomes.

Purpose: This study describes the clinical efficacy and outcome of a Tibial Tubercle Transfer (TTT).

Study Design: Case series.

Methods: 86 consecutive patients who underwent TTT for anterior knee pain and/or patellofemoral instability were studied prospectively. All patients received the same rehabilitation protocol postoperatively. Clinical outcome was measured using the Kujala knee score pre-operatively and at follow-up. Patients were also asked to rate their satisfaction with the procedure. Mean duration of follow up was 1.7 years (6 months to 3 years).

Results: 94% of patients were satisfied with their decision to undergo the operation at the latest follow up. The mean Kujala score pre-operatively was 46 points with a Standard deviation (SD) of 14.35. At 6 months the mean Kujala score had improved to 70 points with a standard deviation of 20.25. Patients with patella-femoral instability alone showed greater improvement of Kujala scores compared to patients with anterior knee pain alone or pain plus instability.

Conclusion: Our experience suggests that tibial tubercle transfer provides a safe and effective surgical treatment option for patients with anterior knee pain and patellofemoral instability. Patients with patellofemoral instability pre-operatively derived the most benefit.

Keywords: Patellofemoral disorders; Anterior knee pain; Tibial tubercle transfer

Introduction

Anterior knee pain and patello-femoral instability have a multi factorial aetiology and hence have a reputation for being difficult to treat [1]. Factors involved include soft tissue imbalance, bony abnormality and patellofemoral malalignment or any combination of these [2]. Patellar tracking is complex and results from the interaction between soft tissues and bony structures. Patients with patellofemoral disorders commonly present with anterior knee pain, patellofemoral instability, crepitus and limping gait [2,3]. Surgical management can be considered if symptoms persist despite optimal non-operative treatment [4,5]. Numerous operative procedures have been described to treat patellofemoral pathology. These include lateral retinacular release, reconstruction of vastus medialis, medial patellofemoral ligament reconstruction, trochleoplasty and tibial tubercle transfer (TTT) but results vary [1,6-8]. There is no consensus on the indications for these various procedures. Recently literature reports suggest that TTT could be an effective treatment for anterior knee pain

and address patella-femoral pathology [9,10]. The principle of TTT is to realign the extensor mechanism at the level of the tibial tubercle and hence offload the lateral patellar articular facet and centre the patella within the trochlear groove [11]. Different surgical techniques have been described in the literature for performing TTT and results vary considerably [12-17]. In our centre we have performed tibial tubercle transfer by a technique which involves medial rotation of the proximal tibial tubercle around an intact distal cortical bridge. This avoids concerns regarding the amount of bony tibial tubercle resection, degree of translation and subsequent bone healing. It also seeks to minimise the likelihood of post-operative avulsion of the tubercle. We report the clinical outcomes of a prospective series of 86 consecutive patients treated with this technique.

Materials and Method

Patients who present with symptoms of anterior knee pain, patellofemoral instability or both are assessed in a standardised fashion involving detailed history taking, clinical examination and investigations including minimally flexed skyline patello-femoral X rays and MRI scanning with axial slices. If the symptoms, signs and

radiological investigations indicate that a trochlear groove is present but that the patella is not centered correctly within it and this is likely the cause of their symptoms then patellar re-alignment is considered. All patients who underwent tibial tubercle transfer between May 2011 and Jan 2014 were included in the study. The surgical procedure was performed or directly supervised by the senior author scrubbed in all cases. All patients received standard specific rehabilitation protocol (Table 1) postoperatively. The average length of follow up was 81 +/- 9.5 weeks. Patients were evaluated using the Kujala patello-femoral score questionnaire which is a reliable and a widely used measuring tool for patella-femoral disorders [18]. Patients were also questioned regarding their overall experience and satisfaction after undergoing the procedure. SPSS version 20 was used to analyse the data, descriptive statistic, 2 tail dependent t-test and chi square test were used. Multi-regression analysis was performed to identify stratified factors.

Operative technique

Under general anaesthetic with the patient supine and a high thigh tourniquet inflated, an initial arthroscopic examination of the patellofemoral articular surface, alignment and tracking of the patella is performed (Figure 1). If the articular surfaces are intact but the patella is mal-aligned whilst the knee is cycled through a range of movement, the decision is made to proceed. The arthroscope is withdrawn and the infero-lateral arthroscopy portal incision is extended distally over the tibial tubercle (Figure 2). The margins of the patella tendon are defined and the periosteum on either side of the tibial tubercle is incised longitudinally for 3 to 4 cm to mark out the osteotomy.

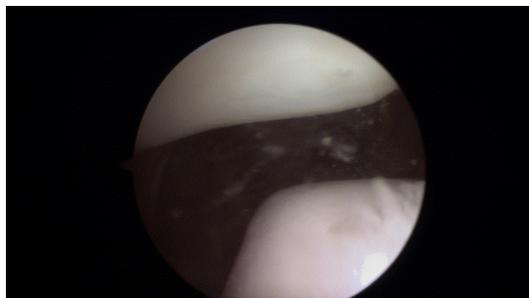


Figure 1: Arthroscopic evaluation of patella instability.



Figure 2: Extension of lateral portal incision.

The osteotomy is then performed horizontally with a micro sagittal saw and particular care is taken to avoid recessing the tubercle. A small

bridge of distal cortex is left intact (Figure 3). After completing the osteotomy, the tibial tubercle is swung medially on its distal osteo-periosteal hinge. The medial displacement of the proximal end of the tubercle is around 50% of its width (8 - 12 mm) and depends on the patient's anatomy and the size of the tubercle footprint. A temporary k-wire is used to hold the tubercle in the new position (Figure 4).



Figure 3: Tibial tubercle cut.



Figure 4: Rotational transfer of tibial tubercle.

Two cortical small fragment screws are lagged and countersunk securing the osteotomy. The K wire is then removed (Figure 5). Patella tracking is assessed at this stage and an extra articular lateral release is performed leaving the synovium intact if the lateral structures are tight and resisting the medial correction. A knee brace is applied in full extension after wound closure and is worn for all weight-bearing for 6 weeks. The patient is encouraged to be fully weight bearing as soon as possible post operatively.



Figure 5: Rotated tibial tubercle post fixation.

Quadriceps rehabilitation is commenced at 2 weeks post operatively under the supervision of the physiotherapy department (Table 1). Patients are encouraged to remove their brace whilst seated to perform static quads straight leg raise and seated knee curl exercises. All

patients were reviewed for radiographic assessment at 2 weeks and 6 weeks. Clinical outcome was measured at 6 months post operatively using the Kujala score and patient satisfaction assessment.

Post Op Rehabilitation:
First 2 weeks: Straight knee brace, Full weight bearing encouraged. Crutches for balance.
2 - 6 Weeks: Straight knee Brace for all weight bearing. Encouraged to remove brace when seated to perform SLR and knee curls.
6 weeks+: Knee brace off. Formal Quadriceps rehabilitation regimen.

Table 1: Post-operative rehabilitation plan.

Results

The mean age of the 86 patient included in the study was 31 years (14-60), 38% (n=33) were male and 62% (n=53) were female. The mean Kujala score pre- operatively was 46 points with a Standard deviation (SD) of 14.35. 14% (n=12) presented with anterior knee pain in isolation. 10% (n=8) presented with instability only and 76% (n=66) reported both instability and anterior knee pain. Mean operating tourniquet time was 28 minutes S.D +/- 5 min. Superficial wound infection was encountered in 3 patients post operatively, each was treated successfully with oral antibiotics. Six patients reported prominent metal work after the surgery and requested removal of the screws after a minimum of 6 months post-operative. One patient fell directly on to the knee whilst mobilising without their brace at 4 weeks post-operative contrary to their post-operative instructions. This resulted in fixation failure at the osteotomy site. Revision fixation was required through the original incision. There were no thromboembolic or other complications. There were no fractures of the osteo-periosteal bridge at the distal end of the osteotomy.

At 6 months the mean Kujala score had improved to 70 points with a standard deviation of 20.25. At the latest follow up with a mean of 1.7 years, 94% of the patients were satisfied with their decision to undergo the operation. On further analysis of the sub categories within the Kujala score, the instability symptom was most improved, followed by pain and stair climbing ability post operatively.

Multi-regression analysis suggested that preoperative anterior knee pain, instability and previous dislocation did not influence patient satisfaction. Only female gender and older patient age had a statistical significant (p=0.0136) negative impact on the patient satisfaction. All 5 patients who were dissatisfied with the procedure were females.

The average pre-op Kujala score for females was 43.6 (S.D +/-15.2) compared to 50.9 (S.D +/- 13.8) for males. The average post-op Kujala score for females was 66.3 (S.D +/-22.7) compared to 75.3 (S.D +/-18.58) for males (Table 2). Patients age 30 or younger (n=47) had significantly better outcome with only 2% having unsatisfactory results compared to 10% in the 31 years and above group (n=39). The average improvement of the Kujala Scores was 26 points in the under 30 group compare to 20 points improvement in the over 30 group. There were no cases of recurrent patella dislocation.

On analysis of sub groups of pre-operative symptoms, 12 patients had isolated anterior knee pain without subjective instability or recurrent dislocation. In this sub group there was a 23 points mean improvement of the Kujala score post-operatively. In the sub group of patients with subjective instability but no pain (n=8) there was a mean

of 27 points improvement of the score. This difference was statistically significant (p=0.043) (Table 3).

	Males (n=33)	Females (n= 53)
Kujala Scores(Mean):		
Preoperative	50.9	43.6
Postoperative	75.3	66.3*
Mean Improvement in scores:	24.4	22.7
(*p<0.05)		

Table 2: Mean pre and post-operative functional knee scores in male's vs. females.

Kujala Scores(Mean)	Ant. Knee Pain only (n=12)	Instability only (n=8)
Preoperative	40.3	53.6
Postoperative	63.5	80.8*
Improvement in scores:	23.2	27.2
(*p<0.05)		

Table 3: Mean pre and post-operative functional knee scores.

Discussion

The treatment of anterior knee pain is controversial with multiple proposed procedures and mixed reported outcomes. Wang et al. reported on 62 knees describing a triple positioning oblique osteotomy for the tibial tubercle transfer, with 78.9% overall patient satisfaction [13,19,20]. In Holland, Koeter et al. [21], report a similar technique in treating lateral tracking of the patella and instability for 60 patients who underwent a preoperative CT scan showing similar results [21]. All patients in our cohort underwent dynamic arthroscopic study of the patellofemoral joint prior to TTT instead of CT scan. Arthroscopy offers the opportunity to perform an assessment of the patellar tracking throughout the range of knee movement and we believe that this is more representative than static CT imaging and avoids the radiation exposure.

In 2007 Pritsch et al. described a technique named Tailored Tibial tubercle osteotomy, which was performed on 69 knees [22]. The

osteotomy was performed by medialisation and anteriorisation of the tibial tubercle using a bone graft [22]. Koeter et al. [21] also suggests anteriorisation of the osteotomy in similar fashion in order to relieve the cartilage pressure [12]. Our TTT technique does not involve anteriorisation of the tibial tubercle which can lead to symptomatic prominence of the tubercle.

The desired magnitude of medial tibial tubercle transfer is controversial and with no consensus in the literature. Fulkerson described a tibial tubercle transfer with satisfactory results reported to be ranging from 38% to 93% of the width of the tubercle. The technique consisted of a fixed 14.8 mm anterior and 4.8 mm medial transfers of the tibial tubercle to reduce the patellofemoral contact pressure [11,15]. Surgical correction using fixed magnitudes of tibial tubercle transfer is undesirable because of variation in the degree of patellofemoral malalignment, different etiological factors and size and shape of the knee. With rotational TTT a range of different angles can be achieved with minimum compromise of the original anatomy. Several studies have demonstrated promising results for reconstruction of the medial patello-femoral ligament (MPFL) for patients with patellar instability [23]. This procedure usually involves harvesting of a hamstring tendon to form the neo-ligament with associated donor site morbidity and is a relatively demanding procedure requiring intra-operative radiology. Our technique avoids the need for a tendon graft and can be performed open with a short tourniquet time and a low complication rate.

Our cohort of patients included those presenting with anterior knee pain, patella-femoral instability or both. Our results show that distal patellar re-alignment achieved reliable results in all three of these groups. Patients presenting with instability alone had a greater improvement in their Kujala scores post-operatively than those who presented with anterior knee pain in isolation. In our study, patients aged less than 30 years improved more post-operatively than those over 30. Our experience suggested that males present less commonly but have better clinical outcomes compared to females. This could be due to the narrower male pelvis and larger tibial tubercle footprint resulting in a greater bio mechanical correction effect to the Q angle with this TTT technique.

Osteoarthritis remains a long-term risk in patients with objective patellar instability whether the patient has undergone surgery or is continuing to be treated non operatively [24]. The incidence of damage to articular cartilage after patellar dislocation is estimated to be as high as 8.4% [25]. Our hope is that early stabilisation of the patella will prevent further damage and could reduce the risk of late patello-femoral osteoarthritis. Longer follow-up of patients undergoing going TTT surgery will be required to evaluate whether this reduction can be achieved.

Conclusion

Tibial tubercle transfer is a technique for medialisation of the patella with a patient satisfaction rate of 94% in our series. The procedure has low complication rate and is effective for patients with anterior knee pain, patella-femoral instability or both. Best results were achieved in younger male patients and those with pure instability. Longer term follow-up will be required to demonstrate whether late patella-femoral osteoarthritis can be avoided using this technique.

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