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Long-Term Clinical Outcome of the Tibial Tuberosity Osteotomy in Patients with Patellar Instability

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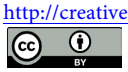

Abstract

Background: Surgical management of patellofemoral instability involves various procedures, including tibial tubercle osteotomy (TTO), aimed at improving patellar tracking and reducing stress on the patellar articular cartilage. This study focuses on the long-term outcomes and patient satisfaction following TTO, particularly the Trillat procedure, performed as a standalone surgical intervention for patellofemoral instability. Methods: A retrospective analysis was conducted on patients who underwent the Trillat procedure between 2000 and 2012 at Aalborg University Hospital. Clinical evaluations were performed, including range of motion assessment, stability tests, and functional scoring using the Kujala Anterior Knee Pain Scale, International Knee Documentation Committee score, and Lysholm Knee Scoring Scale. Additionally, patients reported subjective satisfaction and perceived sensations of recurrent patellar dislocation or subluxation. Results: Fifty-three patients (54% of the initial cohort) with a mean follow-up of 9.8 years were included. The average subjective satisfaction score (SANE) was 6.5 out of 10, with over 60% reporting a score above 5 and expressing willingness to undergo the procedure again. Functional scores indicated fair outcomes, with a mean Kujala score of 66.8 and a mean Lysholm score of 67%. However, 36% of patients reported sensations of recurrent patellar subluxation or dislocation postoperatively. Clinical signs of cartilage defects were observed in 43% of knees, with associated tenderness and crepitus in some cases. Conclusion: TTO, specifically the Trillat procedure, demonstrates mixed outcomes in the long term for patellofemoral instability. While it can prevent most cases of recurrent dislocations, its effectiveness as a standalone surgical treatment is limited. Careful consideration should be given to patient selection, and TTO should be reserved for cases where patellar stability cannot be ensured by alternative procedures such as MPFL reconstruction.

Subject Areas

Orthopedics

Keywords

Knee, Tibial Osteotomy, Patella instability, Luxation, Knee Pain

1. Introduction

Recurrent patellofemoral instability is a prevalent issue in sports medicine, with an incidence of 0.3 to 1.2 per 1000 in children aged 9 to 15 years. [1] [2] [3] This condition is often associated with underlying pathoanatomical abnormalities, including bony conformation issues like trochlear dysplasia, [4] lower limb mal-alignment syndromes such as tibial extra-rotation, [5] and soft tissue abnormalities like patella alta. [6] Due to its multifactorial nature, managing recurrent patellofemoral instability can be challenging, without appropriate treatment, patellar dislocation can lead to recurrent patella dislocations painful instability, anterior knee pain, and patellofemoral degeneration. [2] [7] [8]

Although TTO no longer is the first choice of treatment in patients with patellar instability it is still of great importance as a way to modify the knee joint biomechanics to improve patellar alignment, tracking, and stability, thereby alleviating symptoms and reducing the risk of complications associated with patellofemoral instability. Several pathoanatomical risk factors such as patella alta, trochlear dysplasia and elevated TT-TG have been suggested to decrease the effect of an isolated treatment strategy. (Migliorini 2021)

The Tibial tubercle osteotomy (TTO) is one of the surgical methods in which repositioning of the tibial tubercle will be done to improve the tracking of the patella and reduce stress on the patellar articular cartilage. [9] [10] The most favored approach is anteromedialization (AMZ), which relocates the tibial tubercle anteriorly and medially to address both instability and pain. Another method is only medialization (MZ), which shifts the tibial tubercle medially to manage instability. While satisfactory clinical and functional outcomes have been documented, the occurrence of early postoperative complications after TTO has been reported to be as high as 46%. [11] Raising the question of how satisfied these patients will be at long-term follow-up. It has been indicated that the risk of persistent patellar morbidity over time is as high as 33.8% after patellar stabilizing surgery such as TTO. Persistent patellar morbidity was defined as a new contact with the healthcare system more than a year after surgery. This was significantly higher compared to reconstruction of the Medial Patellofemoral Ligament at eight years of follow-up. [12] There is a lack of knowledge on long-term consequences of how well patients are doing after TTO with only recurrent patellar instability as the primary indication compared to recent studies with more subgroups and specific surgical criteria.

In the period from 2000 to 2012, TTO was the only surgical treatment of choice offered for patients with patella instability at Aalborg University Hospital. The aim of this study is to assess the clinical outcome and satisfaction in those patients, to achieve the best possible results when choosing TTO as a treatment for patellofemoral instability.

2. Materials and Methods

The inclusion criteria were: 1) chronic patellar instability, described as two or more patellar dislocations, with a persistent apprehension sign after a rehabilitation protocol applied for 3 months; 2) closed growth plate. Exclusion criteria were: 1) concurrent ligament (e.g., anterior cruciate ligament [ACL] and posterior cruciate ligament [PCL]) or meniscus injury; 2) history of knee surgery; and 3) fracture around the knee.

2.1. Patients

In this pragmatic retrospective study, the outcome of the TTO procedure was examined at a single follow-up session. Patients with recurrent patella luxation after conservative treatment were included. Data was retrieved by systematically reviewing charts of all patients who underwent TTO procedure between 2000 and 2012 at Aalborg University Hospital (Aalborg UH). All patients were initially treated non-operatively using tape, braces, quadriceps and gluteal muscle strengthening, and supervised physiotherapy rehabilitation with insufficient effect. Insufficient conservative treatment was defined as repeated symptomatic luxation or subluxations after at least three months of rehabilitation.

The charts of the patients included were reviewed to validate the diagnosis, the surgical procedure, and clinical findings, and to specify the indication of the procedure. All patients who underwent the TTO procedure were included. Informed consent was obtained from all patients included and ethical approval was acquired from the local ethical committee.

2.2. Clinical Evaluation

Patients were clinically evaluated at Aalborg University Hospital by one of the authors (CE), who had not been involved in the surgery or rehabilitation. Patients unable or unwilling to attend consultation were interviewed by phone. The clinical examination included: range of motion, thigh muscle circumference, assessment of patellar stability and lateral apprehension test [13] as well as Q-angle measurements [14]. The affected knees were compared to the opposite side. Outcome measures were reported using Kujala Anterior Knee Pain Scale [15], International Knee Documentation Committee score (IKDC) [16], Lysholm Knee Scoring Scale [17], and the following question: "How would you rate your knee today as a percentage of normal (0 to 10 scale with 10 being normal)?" (SANE). [18]

2.3. Surgical Methods

Arthroscopy of the knee was performed ahead of the osteotomy to document

patella maltracking and chondral damage. An incision was made on the lateral side of the tibial tubercle. The subcutaneous tissue was separated from the deep fascia and the patellar tendon was identified. The periosteum of the tibial tubercle was elevated around the lateral margin of the patellar ligament. An oblique, upward-sloping osteotomy was made from the lateral side extending 8 cm down the tibial shaft, maintaining the bone tongue connection with the shaft.

The tubercle was then displaced medially by max. 10 mm. This displacement was fixed with two 4.0 mm fully threaded screws with washer. Hemostasis was controlled, the wounds were closed, and the dressing was applied after injection of local anesthesia. All the patients were operated as a daily operation. Initially, patients were mobilized while their knee was protected in a range of movement brace locked at 0 - 30 degrees for two weeks, 0 - 60 for two weeks, and 0 - 90 for two weeks. The patients were instructed in full weight-bearing with fully extended leg during the first six weeks until the osteotomy united. Patients were present at two weeks follow-up when the brace was adjusted, and six weeks post-operative follow-up for removal of the brace after an x-ray control ensured healing of the osteotomy. None of the patients had concurrent medial patellofemoral ligament (MPFL) reconstruction at the time of surgery.

3. Results

3.1. Demographic Data

A total of 53 out of 99 patients (54%) were included at the time of follow-up. There were 40 females and 13 males. Five patients had bilateral TTO surgery. There were 28 right knees and 30 left. Age ranged from 18 to 32 years of age. The average age at the time of the procedure was 21.5 years (SD = 5.1 y). The mean follow-up was 9.8 years (SD = 3.6 y). (See Table 1)

Table 1. Demographic details of the study population.

Variable	n
Total patients	53
Total procedures	58
Patient characteristics	
- Sex, male	13
- Sex, female	40
- Affected knee, right	28
- Affected knee, left	30
Follow-up characteristics	**years**
Age at time of procedure, mean	21.5
Follow-up period, mean	9.8

3.2. Clinical Outcome

At the time of follow-up, the average SANE score on a scale of 1 - 10 was 6.5 (SD = 2.8) indicating moderate subjective satisfaction among patients. Further, 60.4% of patients had a satisfaction score (SANE) above 5 and would re-do the procedure.

The Kujala score scale of anterior knee pain was rated as excellent in three cases (5%), good in 14 cases (24%), fair in 21 cases (36%), and poor in 20 cases (34%). The mean Kujala score was 66.8 (SD = 20.3) displaying overall fair results regarding functional limitations and subjective symptoms of the patients. (See Figure 1)

The Lysholm Knee Score reported, eight cases (14%) as excellent, 10 cases (17%) as good, 13 cases (22%) as fair, and 27 cases (47%) as poor. The overall average Lysholm score was 67% (SD = 21.5), indicating fair results. Average IKDC score was 56.2 (SD = 20.6). (See Figure 2)

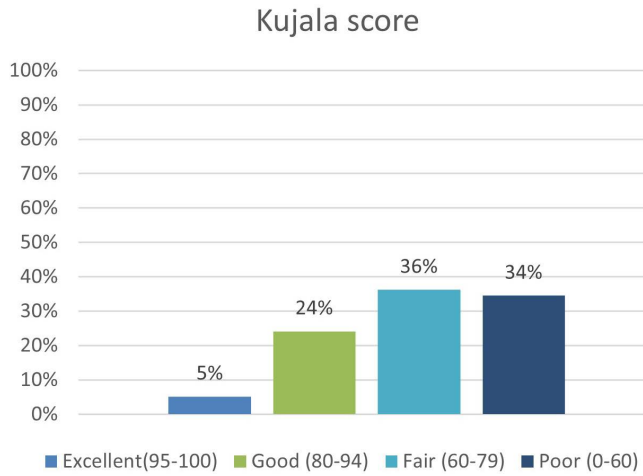

Figure 1. Percentage of excellent, good, fair, and poor results regarding the Kujala Score of Anterior Knee Pain.

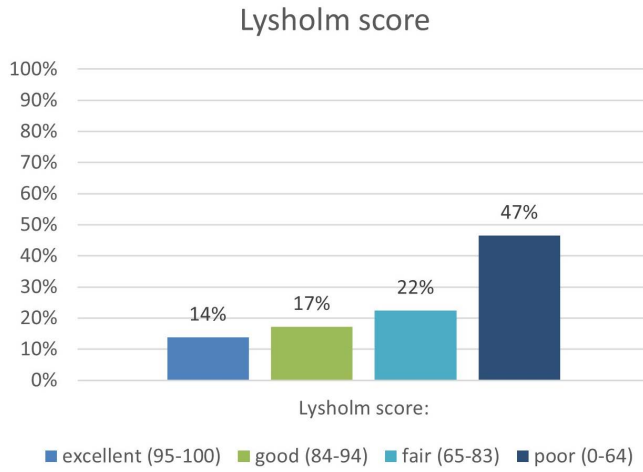

Figure 2. Percentage of excellent, good, fair, and poor results regarding the Lysholm Knee Scoring Scale.

Self-reported sensation of recurrent patellar dislocation or subluxation after the procedure was registered in 36% of patients. Clinical signs of cartilage defects in the patellofemoral joint were observed in 43% of the knees, 26% of patients had experienced retro patellar tenderness, and 16% of patients experienced retropatellar crepitus postoperatively.

4. Discussion

The rate of self-reported recurrent patellar subluxation or dislocation after isolated TTO treatment in this study was relatively high (36%) at a mean follow-up of 9.8 years. Nevertheless, more than 60% reported that they would take the surgery again if they were given the chance.

Previous re-dislocation rates in older studies have been ranging between 7% and 21% with a follow-up time ranging from 12 to 26 years [19] [20] [21] [22] [23]. A study from Arnbjörnsson *et al.* [19] compared TTO on one knee with non-operative management on the contralateral knee and found Lysholm scores of 69 for the operated knee compared to 85 for the non-operative treatment. The findings of the present study found a mean Lysholm score of 67, indicating a similar outcome. Arnbjörnsson *et al.* also showed a higher incidence of osteoarthritis on the operated side, suggesting this was due to the surgical procedure. Other similar studies have also found deterioration of the clinical outcome [20] [22] [23].

Kuroda *et al.* in a cadaver study described that TTO changes the intra-articular load distribution despite normal Q-angles with significantly increased pressure in the medial tibiofemoral joint compartment with medialization of the tuberosity [24]. Furthermore, Saranathan A. *et al.* demonstrated a 35% increase in medial contact pressure at 80˚ of flexion in a cadaver study [25]. These results might suggest that TTO changes the load under the patellar surface, increasing the incidence of osteoarthritis in the long term, thereby affecting the clinical outcomes, however, repeated patellar dislocation will also increase risks of serious patellofemoral cartilage injuries, leading to patellofemoral osteoarthritis.

A recent study has shown a decline in the number of TTO procedures in Denmark and a rapid increase in the number of medial patellofemoral ligament (MPFL) reconstructions over the past 10 years [12]. The first follow-up studies have shown good clinical results with MPFL with eight to 10 years of follow-up, as well as low levels of osteoarthritis [26] [27]. A systematic review with a minimum follow-up of 12 months has shown high satisfactory rates measuring the Kujala score from 16 case series with mean scores of 87.77 compared to 51.6 preoperatively [28]. This is a remarkably better Kujala score than the 66.8 points with TTO in the present follow-up with a comparable age group and follow-up time. However, we have presented the results of an isolated treatment strategy with only a few inclusion and exclusion criteria. This means that Q-angle, patellar height and tibial external rotation angle were not part of the surgical in-or exclusion criteria. MRI was not part of the assessment, and it is therefore most likely that patients

with trochlea dysplasia and osteochondral damage were treated with TTO.

A large Danish cohort study revealed that the risk of Persistent Patellar morbidity (PPM) was significantly lower with MPFL-R compared to other patella-stabilizing surgeries, such as TTO [12]. PPM was defined as a new contact to the healthcare system more than a year after surgery registration for either Patellar Dislocation (DS83.0) or Recurrent Patellar Dislocation (DM22.0). Nevertheless, persistent experience of subluxation was described by 39% of the patients in a large single-clinic study on MPFL-R [29].

While both TTO and MPFL reconstruction are surgical interventions for patellar instability, they target different anatomical and biomechanical aspects of the patellofemoral joint. TTO aims to correct the alignment and biomechanics of the extensor mechanism by altering the position of the tibial tubercle, while MPFL reconstruction aims to restore the primary soft-tissue restraint to lateral patellar displacement by reconstructing the torn or insufficient MPFL. The criteria for each procedure reflect these differences in their biomechanical targets and goals of treatment. The decision for TTO, MPFL reconstruction, or both should be individualized based on the patient's specific anatomical abnormalities, clinical presentation, and functional demands. A classification by Frosch *et al.* from 2016 [30] describes five subgroups of patellar instability of which 4 of 5 need surgical treatment. Nevertheless, TTO was only indicated in one subgroup and not as a stand-alone surgical procedure. This seems to be in line with our results with a relatively high prevalence of recurrent patellar subluxation or dislocation. A consensus statement from the American Orthopaedic Society for Sports Medicine revealed that the majority of the group would not consider medialization unless the TT-TG is >20 mm and there is evidence of lateral patellar translation on axial imaging up to 45degrees of flexion and some members would never include medialization in surgery for patellar instability. [31]

5. Weakness and Limitations of the Study

There are several limitations of this study, one of which is the variations of the surgical methods used in the literature, varying from isolated TTO surgery in the present study to Roux-Elmslie-Trillat used in other studies. This might result in a bias during the comparison of the clinical outcome.

Tibial tuberosity to trochlear groove distance (TT-TG) is a reliable and valid method to evaluate alignment of the knee [32] and can now be assessed by MRI or CT scanners. However, an increased external tibial rotation during scanning might still lead to an overestimation of TT-TG distance and thereby an excessive medialization [33]. None of the patients Q angel in the present study was assessed by MRI or CT. Malalignment was estimated based on a clinical evaluation of Q-angle, which has a relatively poor reliability and validity [14].

Other weaknesses of the study are a relatively low compliance of 54% with the risk of selection bias and the assessment of the surgical indication, and the operation which were carried out by five surgeons. There was no radiological assessment of the patella-femoral joint pre-operatively. Since it is a retrospective

study, there were no clear inclusion or exclusion criteria at the time of surgery.

Finally, no radiological assessment of the patella-femoral arthritis at the time of the follow-up was carried out so the estimation of the degree of arthritis and/or the presence of trochlear dysplasia is unknown.

6. Conclusion

The TTO procedure has generally been proven to prevent most cases of recurrent patellar dislocations, but it is not a sufficient surgical treatment. The procedure should therefore be chosen with caution and primarily be reserved for patients in whom patellar stability cannot be assured by MPFL reconstruction alone. MR scanning should always be done before the procedure to assure the correct indication for medicalization and/or distalization to avoid an unnecessary increased contact pressure in the patellofemoral joint.

Conflicts of Interest

The authors declare no conflicts of interest.

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