Surgical Reconstruction of Severe Patellofemoral Maltracking

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Abstract
Dysfunction of the patellofemoral mechanism presents in many ways. Results from different realignment procedures show great variability in patient outcome. A surgical technique is presented that attempts to correct all the abnormalities of patellofemoral maltracking. The procedure consists of a lateral release, a vastus medialis (obliquus) tendon advancement and a tibial tubercle transfer. Along with being moved medially, the tubercle also is moved distally to correct patella alta and elevated anteriorly to reduce patellofemoral joint reaction forces. One hundred and seven knees in 84 patients were reviewed. Fifty-five percent of patients had frank dislocation. The remainder had anterior knee pain and had abnormal patella tracking on examination. The mean follow-up was 5.6 years. Seventy-nine percent had a good to excellent functional outcome and 84% of patients stated they would have the operation again. Two patients with marked generalized ligamentous laxity had recurrent patella dislocation of the patella.

Introduction

With abnormal patellofemoral tracking most cases of patellofemoral instability can be managed by conservative treatment. [3,8,18] Patients in whom conservative treatment fails usually require some form of surgical realignment procedure. Surgical reconstruction usually reduces the rate of redislocation to between 0% to 40%. [1,2,5,7,10-15,22-25] Improved function of the knee usually is achieved between 53% to 90% of patients. [1,2,5,7,10-15,22-25] The differing degrees of success of surgical realignment are reflected in the number of surgical procedures described.

Patellofemoral instability presents in many ways and its etiology often is multifactorial. It may present as recurrent subluxation or dislocation, habitual dislocation, permanent dislocation, maltracking with anterior knee pain, anterior knee pain with normal tracking and ultimately osteoarthrosis of the patellofemoral joint.[9] The etiologic factors can be classified as external (trauma) or internal.[21] The internal factors can be additionally subdivided into skeletal abnormalities (genu valgum, femoral or tibial torsional abnormalities, patella dysplasia, trochlea dysplasia) and soft tissue abnormalities (deficient medial structures, increased quadriceps angle, tight lateral structures, generalized ligamentous laxity, patella alta). Each patient may have one or any combination of these predisposing factors.

The surgical technique presented in the current study attempts to identify and correct all the etiologic factors present. Some parameters are impossible to correct (generalized ligamentous laxity) or require complex surgical procedures that usually are considered inappropriate (rotational femoral osteotomies). The technique described is extensive but necessary to allow a comprehensive correction of all the possible anatomic abnormalities.

Materials and Methods

One hundred and seven knees in 84 consecutive patients were reviewed. All patients had an initial diagnosis of recurrent dislocation of the patella or clinically abnormal patella tracking with anterior knee pain. Patients with anterior knee pain and normal patella tracking were not considered suitable for the procedure. A conservative rehabilitation program had failed in all the

patients.

All patients were assessed clinically and the factors listed in Table 1 were recorded. Followup also consisted of a questionnaire relating to patient satisfaction, recurrence of symptoms and return to sport (Table 2). At examination each patient also completed a functional assessment according to the Crosby and Insall[8] rating scale. Complications and additional operations were documented.

Preoperative and postoperative radiographs (anteroposterior (AP), lateral and skyline patella view at 45^0) were examined for the presence of osteoarthrosis of the patellofemoral and tibiofemoral joints. This was graded as mild, moderate or severe (modified from the classification of Iwano et al,[17]). Patella height was assessed according to the methods described by Insall and Salvati [16] and Caton et al [6].

Statistical analysis was done using SPSS software, (version 10.0, Chicago, IL) using Fishers exact test and Wilcoxon signed-rank test.

Operative Technique

A thigh tourniquet is inflated with the knee flexed and a lateral skin incision circumventing the patella is made. An intrasynovial lateral release is completed from the musculotendinous junction to the insertion of the patella tendon after coagulation of the lateral retinacular vessels. The fibers of the vastus medialis obliquus are identified and released from the patella. The patella then is everted to allow inspection of the surfaces of the patellofemoral joint. Unstable chondral areas examined with the arthroscopic probe are debrided back to stable tissue. The remainder of the joint is inspected for additional pathologic characteristics.

Soft tissues around the tibial tuberosity are cleared taking care not to enter the anterior compartment of the leg. A bone block containing the attachment of the patella tendon then is cut with a saw and osteotome. The bone block typically measures 1 x 1.5 x 3 cm and is trapezoidal with an external base (Fig. 1). The bone block is predrilled with a 4.5 mm drill and countersunk before harvesting. This then is moved medially 5 to 10 mm (to normalize an abnormal Q angle) and distally so that at 90^0 flexion the distal pole of the patella is 10 mm above the tibial plateau (to correct patella alta if present, Fig. 2). The patella is assessed regularly to ensure central tracking. The tibial tuberosity is elevated anteriorly if significant retropatellar degenerative change is present. A trough approximately 5 mm in depth is cut into the tibia. The bone removed is placed into the original defect as a local bone graft (Fig. 3). This relatively shallow trough moves the tibial tuberosity to an anterior position (Fig. 1). The posterior cortex is drilled with a 3.2 mm drill and the block is secured with a lagged self-tapping 4.5 mm cortical screw inserted perpendicular to the shaft of the tibia. None of the bone blocks were fractured during drilling.

With the knee flexed at 45^0 the vastus medialis obliquus (VMO) muscle is advanced distally and laterally over the front of the patella. This improves the mechanical efficiency of the muscle-tendon unit by increasing tension and obliquity of pull. This also prevents medial subluxation of the patella by preventing the repair being over tensioned. Final patella tracking is checked before the sutures are tied.

The wound is closed over a suction drain and the limb is placed in a hinged knee brace locked in full extension. Isometric quadriceps exercises are begun immediately. The brace is unlocked progressively, commencing at 0^0 to 30^0 degrees at 10 days, and then removed at 6 weeks.

Rehabilitation progresses through closed and open chain exercises with an aim to return to sport at 6 months.

Results

Completed outcome data were obtained for 107 knees in 84 patients (33 males, 51 females). Twenty three patients had bilateral procedures. The mean age was 30 years (range, 11 – 68 years) and the mean followup was 5.6 years (range, 0.6 – 14 years). Fifty-nine (55 %) patients initially presented with dislocation. Forty-eight (45%) patients had patella maltracking and anterior knee pain. The mean preoperative duration of symptoms was 8.6 years (range, 0.5 – 35 years).

Sixteen (15%) knees (15 patients) had previous patellofemoral realignment procedures and 25 (23%) knees (21 patients) had previous arthroscopic debridement procedures. Eighty-three (78%) knees (66 patients) had patella alta, an effusion was seen in 43 (40%) knee (36 patients) and there were no cases of patella baja. Thirty-one (29%) patients had generalized ligamentous laxity. All knees had quadriceps wasting.

At surgery 34 (32%) knees (27 patients) had significant wear (Outerbridge Grade 3 or 4[20]) on the retropatella surface. One hundred and four (97%) knees (81 patients) required medial translation of the tibial tuberosity. Eighty-three (78%) (65 patients) were moved distally and 46 (43%) (37 patients) were elevated anteriorly. All patients had a lateral release and VMO advancement. Twenty-nine (27%) knees (25 patients) required a patella chondroplasty and 22 (21%) (19 patients) required another procedure (such as partial medial meniscectomy).

Findings at followup showed that 22 (21%) knees (21 patients) had an effusion. Twenty-nine (27%) knees (22 patients) had residual maltracking (patella tilt or subluxation in extension). Twenty-four (22%) knees (20 patients) had a positive apprehension sign. There was a mean loss of flexion of 4^0 in the surgically treated leg and 13% of patients had at least 10^0 flexion deficit.

Thirty-two percent of the available preoperative radiographs showed changes of tibiofemoral osteoarthrosis compared with 37% at followup ($p = 0.05$, Wilcoxon signed-rank). Forty percent of preoperative radiographs showed changes of patellofemoral osteoarthrosis compared with 65% at followup ($p = 0.01$). The change of grade of radiologic osteoarthritis is presented in Table 3. The mean preoperative and postoperative Insall-Salvati ratio changed from 1.28 to 1.19 and the mean index of Caton et al[6] changed from 1.45 to 1.1, respectively. The clinical and functional outcome data are presented in Table 4 and Table 5.

Analysis of Results

Two categories of results were created: the successes which were those in which the patients' results were rated good or excellent with the Crosby and Insall[8] rating, and failures were those in which the patients' results were patients rated fair to poor or worse.

Relevant preoperative, operative, radiologic and postoperative variables were analyzed by Fisher's exact test to find predictors of a good or poor functional outcome (Table 6). The patient outcome questionnaire was analyzed according to the two main preoperative diagnosis groups: patellofemoral subluxation or dislocation and anterior knee pain with maltracking (Table 7).

Review of Poor Outcomes

There were five patients with results in the worse category. These patients all had significant

anterior knee pain. Although their patellofemoral instability had been resolved their overall knee function was worse than before surgery.

Discussion

The current study is a mid-term review of outcome after a combined proximal and distal realignment procedure. The mean followup of 5.6 years is relevant as deterioration of outcome 2 years after realignment procedures has been previously reported.[12] The procedure was developed to correct most of the abnormalities of the patellofemoral mechanism in an individualized way.

As there are many presentations of patellofemoral instability it is important to analyze outcome with regard to different groups. In the current study, 78% of patients overall obtained a good to excellent outcome (Table 5). If these patients are subdivided into patients with dislocation and patients with anterior knee pain and maltracking the good to excellent outcome results are 80% and 71% respectively. These differences are not significant (Table 6). Similar results are found when analyzing the patient outcome questionnaire (Table 7). Therefore it seems that the procedure is equally effective in both groups of patients. Previous studies have considered these two groups together [5,12] and some authors have reported a poor outcome in patients with anterior knee pain.[1] Patients with anterior knee pain and normal tracking were not considered suitable candidates for realignment in the current study.

Patients with significant patellofemoral degeneration seen radiographically or at surgery did as well in final outcome compared with patients without degeneration (Table 6). This is reassuring as these patients can be offered a reasonably optimistic prognosis after surgery. In the current surgical procedure the patella is elevated anteriorly if there are significant degenerative changes on the retropatellar surface. Some authors are concerned that this may increase the instability of the patella in patients with patella maltracking.[4,9] This was not a problem in the current patients as the patella was moved distally and medially to improve the Q angle and bring the patella down farther into the trochlear groove. The authors found that these patellae were worn distally and so moving the patella distally brings normal cartilage back into contact with the trochlea.

There was a significant increase in radiologic patellofemoral osteoarthrosis at followup in the patients. There also was deterioration in radiological grade (Table 3). The improvement in the severe category probably is because of the anterior displacement of the tibial tuberosity, which can lead to an apparent increase in joint space. Most of the new changes were peripatellar osteophytes. Such changes did not predict a poor outcome. The progression of radiologic degenerative changes may represent the normal delay between loss of articular cartilage and the onset of radiologic changes of osteoarthrosis or alternatively may represent new joint degeneration after the procedure. An increase in patellofemoral osteophytes has been seen previously after surgical realignment.[2,3] However it also is known that unstable patellae have a greater risk of degeneration than stable patellae.[19] The current procedure does not protect from radiologic degeneration of the patellofemoral joint, but it may protect from the natural history of untreated patellofemoral instability. This could be confirmed only by a randomized controlled trial with a long term followup.

Return to recreational sport is restricted significantly by anterior knee pain (Table 7, $p = 0.04$). Postoperative anterior knee pain seems to predict a poor clinical outcome (Table 6, $p = 0.04$). All of the patients in the current study with the worse functional outcome category had degenerative anterior knee pain. This is a consistent cause of poor results in all realignment studies. [1,2,5,7,10-15,22-25]

Six patients required a manipulation under anesthesia for knee stiffness. These patients all had an uneventful recovery. This was described previously after realignment procedures [22,23] and probably is attributable to suprapatellar adhesions. Thirteen percent of patients had lost at least 10^0 of knee flexion by the most recent followup. This was caused by quadriceps tightness as a result of the distal displacement of the tibial tuberosity. Fifteen patients required removal of metalwork for persistent pain over the tibial tuberosity. This improved but did not completely resolve their symptoms.

Two patients had recurrent dislocation and six patients had occasional subluxation of the patella. The two patients with recurrent dislocation both have significant ligamentous laxity. The others have no obvious clinically discernable cause for their persistent symptoms, which seems to be sport-related. Residual postoperative instability did not predict a poor functional outcome. These rates compare favorably with rates reported in the literature [1,2,5,7,10-15,22-25] (5% mean rate of dislocation; range, 0% to 40%) especially as 15% of the current patients had previous realignment procedures elsewhere. Such a procedure is a highly significant predictor of a poor clinical result (Table 6, $p = 0.01$).

The current study showed that if a comprehensive patellofemoral reconstruction is tailored to each patient then a good to excellent result can be achieved in 78% of cases. This is true for patients with recurrent subluxation or dislocation and for patients with anterior knee pain and maltracking, although the latter may not achieve as good results as the former. Patients with anterior knee pain but without maltracking should not be considered suitable candidates for a realignment procedure. Patellofemoral wear does not preclude a good result but may be a cause for persistent anterior knee pain at midterm followup. Patients should be warned about a possible postoperative restriction of flexion and the need for removal of metalwork. A previous realignment procedure predicts a poor result so every effort should be made to make the first procedure a definitive one.

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TABLE 1. Clinical Features Recorded on Each Patient

Preoperative diagnosis
Recurrent patella dislocation
Recurrent patella subluxation
Anterior knee pain with maltracking
Patellofemoral osteoarthritis
Duration of symptoms
Right/left/bilateral
Prior operations on knee
Examination findings
Effusion
Quadriceps circumference difference
Patella tilt
Patella subluxation
Patella apprehension
Lateral facet tenderness
Patella alta
Patellofemoral crepitation
Range of motion
Generalized ligamentous laxity

TABLE 2. Patient Outcome Questionnaire

Is patient satisfied with outcome?	Yes/No
Details	
Did the operation improve or abolish their symptoms?	Yes/No
Details	
Would they have the same procedure again?	Yes/No
Details	
Have they had a recurrence of their symptoms?	Yes/No
Details	
Have they resumed sport/activity?	Yes/No
Details	
Does the patient have any residual symptoms?	Yes/No
Details	

TABLE 3. Changes in Radiologic Grading of Osteoarthrosis on Preoperative and Postoperative Radiographs (%)

Radiologic Grade	**Preoperative Patellofemoral**	**Postoperative Patellofemoral**	**Preoperative Tibiofemoral**	**Postoperative Tibiofemoral**
Normal	60	35	69	63
Mild	1	11	6	10
Moderate	19	46	25	26
Severe	20	8	0	1

TABLE 4. Results of the Patient Outcome Questionnaire

Question	**Number**	**Percent**
Satisfied?	86	80.4
Symptoms improved or resolved?	98	91.6
Have procedure again?	90	84.1
Recurrence of symptoms?	48 (4 dislocation, 6 subluxation, 19 anterior knee pain, 19 other)	44.9
Returned to sport?	75 (of 102)*	73.5
Residual symptoms?	77 (2 dislocation, 5 subluxation, 36 anterior knee pain, 33 other)	71.9

* Total number engaged in sporting activities

TABLE 5. Results of the Functional Categorization Scale (Crosby and Insall[8])

Functional Category	**No**	**Percent**
Excellent	26	24.3
Good	58	54.2
Fair to poor	18	16.8
Worse	5	4.7

TABLE 6. Analysis of Variables in Each Group by Fisher's Exact Test

Variable	**Success**	**Failure**	**Significance**
Preoperative diagnosis-ant knee pain	15	6	p = 0.40
Preoperative diagnosis–dislocation	68	17	p = 0.40
Preoperative effusion	33	10	p = 0.80
Generalized ligamentous laxity	22	8	p = 0.40
Previous realignment procedure	7	9	p = 0.01*****
Preoperative patellofemoral OA on radiograph	13	6	p = 0.50
Postoperative patellofemoral OA on radiograph	45	13	p = 0.80
Significant patellofemoral wear	24	9	p = 0.50
Postoperative anterior knee pain	28	16	p = 0.04*****
Postoperative subluxation or dislocation	6	5	p = 0.06
Postoperative effusion	14	8	p = 0.08

* = Significant result, OA = Osteoarthritis

TABLE 7. Analysis of Results of the Patient Outcome Questionnaire in Comparison With the Preoperative Diagnosis.

Question	**Anterior Knee Pain With Maltracking**	**Dislocation**	**Significance**
Satisfied?	16	69	p = 0.60
Symptoms improved or resolved?	19	78	p = 1.00
Have procedure again?	19	71	p = 0.70
Recurrence of symptoms?	12	35	p = 0.20
Returned to recreational sport?	11	64	p = 0.04*****
Residual symptoms?	13	64	p = 0.30

***** = Significant result

Figure Legends

Fig 1. Diagrammatic representation shows the bone block move medially and anteriorly**.**

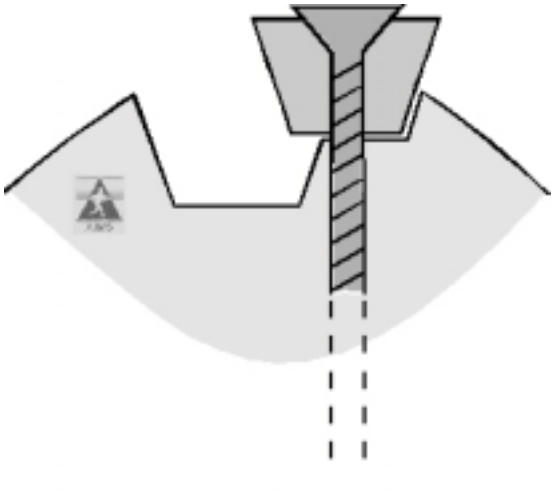

Fig 2 A-B. Radiographs show patella location (A) before and (B) after surgery. Fig 2A shows patella alta before surgery, and, Fig 2B shows improved patella height.

Fig 3 A-D. Representation of the tibial tubercle osteotomy showing medial and distal moves with the use of local bone graft. 3A shows the tibial tuberosity is predrilled and bone block is created. 3B shows the trough that is created to accept the bone block with (3C) the tibial tuberosity being transfer to the new position and the removed bone inverted and replaced in the defect. 3D shows the tuberosity fixed in its new position.