

Soft-Tissue Realignment for Adolescent Patellar Instability

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Summary: Patellar malalignment or instability is a frequent problem in adolescents. Patients with persistent symptoms require operative correction with procedures often requiring osteotomies of the tibial tubercle. Insall described a soft-tissue procedure to correct instability in adults, and others have used this in adolescents. Short-term results have seemingly been satisfactory in the skeletally immature population. A long-term outcome study was performed to evaluate the effectiveness of soft-tissue realignment for patellar instability in adolescents.

From 1980 to 1996, 54 patients (65 knees) underwent Insall proximal-distal soft-tissue realignment. No concomitant bony or other soft-tissue procedures were performed. Follow-up averaged 6 years (range, 2-15 years), assessing stability, strength, range of motion, and congruence angle on the Merchant's view. Eighty-seven percent had a good to excellent result; 8%, a fair result; and 5%, poor results. **Key Words:** Adolescent—Patellar malalignment—Skeletally immature—Soft-tissue realignment.

Patellar malalignment or instability is recognized as one of the most common causes of anterior knee pain in the adolescent, perhaps due to more vigorous and athletic activities in this age group (12,13,15). Patellofemoral instability represents a broad spectrum from mild, abnormal patellar tilt to pathologic patellofemoral dissociation. The terms malalignment, maltracking, and instability have been used interchangeably in the literature. Malalignment represents an abnormal static relationship between the patella and associated soft-tissue envelope within the bony femoral boundaries. Maltracking may occur secondary to malalignment but represents a dynamic event in response to static malalignment. Instability is a dynamic clinical state with loss of normal patellofemoral congruity within a discrete arc of motion (17).

Instability secondary to mild rotational and translational abnormalities may be difficult to diagnose. Initial treatment is conservative, with only patients not responding being considered for surgical correction. More than 100 surgical procedures have been proposed to correct patellar instability, achieving realignment through either (a) releasing an abnormal tethering vector, (b) providing a balancing medial vector, (c) distal realignment of the patellar mechanism, or (d) a combination of these (3). Normally, soft-tissue procedures are appropriate in the skeletally immature adolescent, and success has been achieved with both lateral retinacular releasing and medial reefing procedures, reefing being accomplished by capsular imbrication with or without vastus medialis

obliquus transfer (4,13,18). Unfortunately, no long-term studies of soft-tissue medial augmentation procedures have been reported. The purpose of this article is to report a long-term study evaluating the effectiveness of soft-tissue realignment for patellar instability in adolescents.

METHODS

The charts of all patients undergoing patellar realignment procedures between 1980 and 1996 were reviewed. Only patients undergoing soft-tissue realignment were included in this study. Fifty-four patients with a total of 65 knees underwent a modification of Insall's proximal-distal soft-tissue realignment. No additional concomitant bony or other soft-tissue procedures such as the Roux-Goldthwait procedure were performed in these knees. Malalignment secondary to neuromuscular causes, congenital ligamentous laxity, congenital dislocation, or severe bony rotational deformities was excluded. The average age at surgery was 12 years (range, 10-16 years) with an average follow-up of 6 years (range, 2-15 years).

Patellar malalignment included maltracking, subluxation, or dislocation, diagnosed by clinical and radiologic evaluation. Definitive diagnostic clinical findings included anterior knee pain, especially with flexed-knee activities, and increased Q-angle and a positive Fairbanks apprehension sign. Suggestive symptoms included retropatellar crepitus and pain, medial retinacular tenderness, "giving way," and effusion. Moderate femoral anteversion associated with mild external tibial torsion was occasionally noted.

Orthoroentgenographic evaluation included anterior/posterior, lateral, and Merchant's views of the involved

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knees. The Merchant's view was used to evaluate both patellar tilt and the congruence angle. The congruence angle is the relationship of the patellar articular ridge at the intracondylar sulcus (Fig. 1). If the apex of the patella is lateral to the zero line, the angle is recorded as positive; if medial to the zero line, the angle is negative. A normal congruence angle is -6° , with a standard deviation of 11° . Any congruence angle $>+16^\circ$ was considered abnormal (15). A positive radiographic diagnosis consisted of the presence of either an abnormal patellar tilt or an abnormal congruence angle or both.

All patients underwent a 4- to 6-month trial of conservative treatment consisting of quadriceps rehabilitation, salicylates or nonsteroidal antiinflammatory drugs, if tolerated, and activity restriction. Approximately 80% of patients responded to conservative therapy alone.

Persistence of symptoms was basis for operative intervention, either a lateral retinacular release alone or a soft-tissue realignment procedure. Symptomatic knees with a normal Q-angle, normal radiographs, and normal congruence angle or just with patellar tilt underwent lateral retinacular release alone and were excluded from this study. Soft-tissue realignment was performed in symptomatic knees with an abnormal Q-angle and evidence of patellar tilt and abnormal congruence angles on radiographs, as well as those with failed previous lateral retinacular releases.

Technique

The operative technique is similar to that described by Insall et al. in 1976 (11) and McCall and Gavioli (13) in 1981. The approach to the knee is through a lateral parapatellar skin incision, avoiding possible damage to the infrapatellar branch of saphenous nerve and exposing the lateral aspect of the capsule and patellar tendon. A lon-

gitudinal incision is then made through the patellar tendon beginning at the level of the tibial tubercle at the junction of the medial one third and lateral two thirds of the tendon and extending proximally across the patella into the quadriceps tendon. The medial third of the patellar tendon is sharply dissected from the patella, leaving undisturbed the attachment of the tendon at the tibial tubercle. This allows the interior of the joint to be inspected. The only consistent finding in this series was the presence of chondromalacia, and no other operative procedures were performed. A lateral release is begun at the level of the tibial tubercle, passing along the lateral edge of the patella into the quadriceps tendon, leaving the synovium intact laterally.

The medial one third of the patellar tendon is advanced laterally, with the lateral edge being sutured into the lateral third of the patellar tendon by using a pants-over-vest repair (Fig. 2). This statically transposes the patella medially and tethers it. A medial portion of the quadriceps tendon proximal to the patella is likewise advanced and reefed, thus moving the insertion of the vastus medialis obliquus laterally and distally on the patella. The distal patellar tendon is also slightly reefed. The knee is brought through a full range of motion to evaluate patellar tracking, and if it is satisfactory, closure is begun. The patient is immobilized in a cylinder cast with the knee fully extended, the cast being removed at 10-14 days, followed by physical therapy for range-of-motion and quadriceps-strengthening exercises.

Physical therapy is begun the day of cast removal and consists of isometric and isotonic quadriceps exercises. Isometric quadriceps exercises are done with the knee in extension, and progressive resistance quadriceps exercise is done through the last 30° of extension, to avoid increased patellofemoral loading that can occur with exercises performed through a full 90° range of motion. Hamstring exercises can be isometric or isotonic.

Initial follow-up was 6 weeks postoperatively and then every 3 months, the patient being seen both by physician and therapist for evaluation of manual muscle testing and range-of-motion measurements, Cybex testing not being available at our institution. The Merchant's view was repeated at 6 months and compared with the preoperative radiographs for evaluating changes in patellar tilt and congruence angle.

RESULTS

The follow-up included assessment of patellar stability, muscle strength, range of motion, and measurement of both the congruence angle and patellar tilt on radiograph. Postoperative assessment of patellar function was rated as excellent: no complaints, pain, or instability, with normal function; good: mild pain, no instability, and normal function; fair: moderate pain, feeling of instability, mildly limited function with partial improvement of preoperative condition; and poor: moderate to severe pain, instability that limits function, and no change in preoperative condition. Of 65 knees, 57 (87%) had good to excellent results; five (8%), fair results, all with

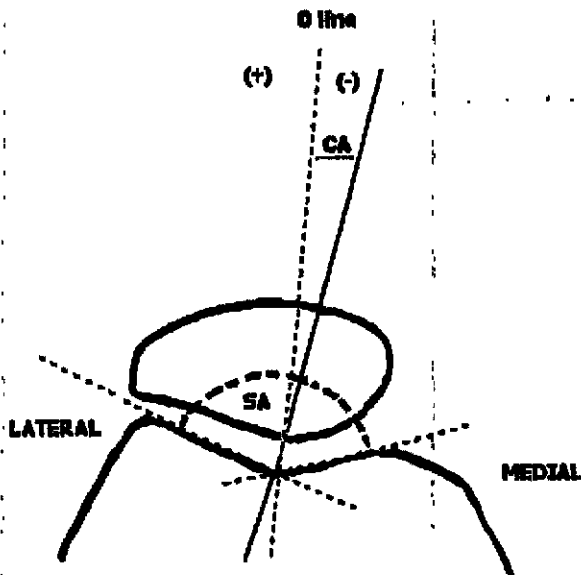


FIG. 1. Congruence angle formed by bisecting sulcus angle (SA) to establish 0 line and a line from apex of sulcus to lowest point on articular ridge of the patella.

ADOLESCENT PATELLAR SOFT-TISSUE REALIGNMENT

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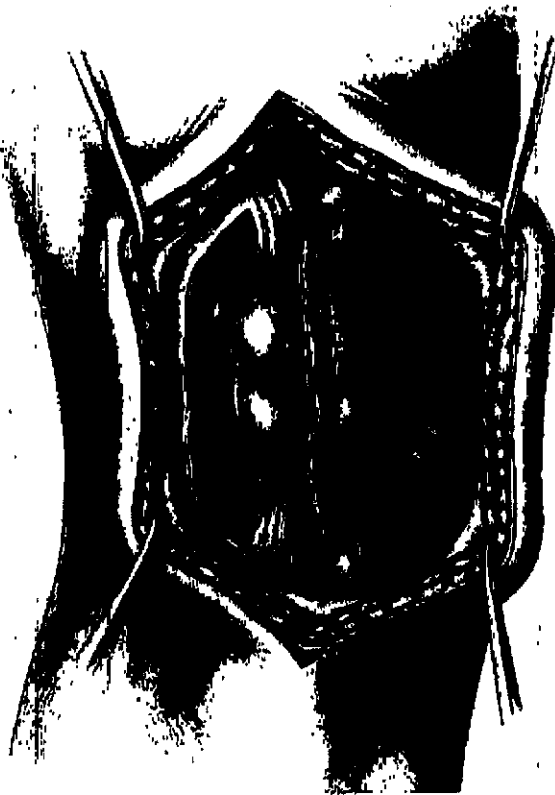


FIG. 2. Postoperative appearance of the knee after the retinacular release and medial advancement. Note that the medial third of the patellar tendon with extension into the quadriceps tendon and down into the patellar tendon itself has been advanced laterally almost to the lateral edge of the patella. A pants-over-vest repair has been performed.

asymptomatic residual subluxation; and three (5%), poor results with symptomatic residual subluxation. The three patients with symptomatic residual subluxation underwent tibial tubercle transfers after bony maturity with eventual good results. No surgical complications occurred in this series.

Postoperative radiographic evaluation demonstrated improvement in the patellar tilt and congruence angle in all patients in the good and fair categories, with less improvement in patients with residual subluxation. It was thought that postoperative radiographic evaluation was important in documenting improvement but did not always accurately reflect the degree of clinical improvement.

DISCUSSION

Patellar subluxation and transitional abnormalities may be very difficult to diagnose. Accuracy in diagnosis and evaluation of patellofemoral dysfunction is essential to prevent inappropriate treatment, which could result in further damage to the joint or persistence of malalignment. Typically, the onset of symptoms occurs in adolescence, with girls predominating (8,18). Symptoms secondary to patellar malalignment are diffuse, aching pain, usually anteromedial, occurring during a flexed-

knee activity or in association with a new sports activity (9,11). The patient may also complain of crepitus, "giving way," pseudolocking of the knee, or intermittent effusions around the joint (7,9). Worsening of symptoms may be due to further quadriceps weakness secondary to either poor compliance with rehabilitation programs, persistent anatomic abnormality of the knee, or deficiency of the extensor mechanism (12).

Clinical examination consists of evaluation of the entire lower extremity to assess deficiencies affecting the extensor mechanism and anatomic factors such as tibial torsion, lateral insertion of the patellar tendon, genu valgum, patella alta, or femoral abnormalities. Structural abnormalities are evidenced by an abnormal Q angle, angles $>20^\circ$ being suggestive of maltracking (6,7). Assessment during active flexion and extension of the knee helps reveal medial or lateral shift of the patella, and visual assessment while standing evaluates the position of the patella in relation to the long axis of the leg (5). Two major clinical signs of malalignment are retropatellar pain elicited by applying firm pressure against the lateral part of the patella, causing direct compression of the patella against the femur (5,10), or a positive Fairbanks apprehension test (12).

Radiographic imaging is essential in confirming the diagnosis of patellar malalignment. Standard anterior/posterior and lateral radiographs may reveal joint disorders such as osteoarthritis but do little to identify patellar dysfunction. Tangential or "sunrise" views have been used to assess the patella, but these methods have difficulty in being technically consistent, making analysis arbitrary (5). The Merchant view allows consistent evaluation and determination of patellar tilt, sulcus angle, and congruence angle (14). Recently, use of both computerized tomography (CT) and magnetic resonance imaging (MRI) have been advocated, the advantage being that they offer better evaluation of the cartilaginous surfaces of the patella, which are not well seen with standard orthoroentgenographic views. Unfortunately, normative data concerning the patellofemoral angular relationships by using these techniques have yet to be accumulated (14,17). Arthroscopic assessment of instability is subjective, dependent on a number of variables including joint position, amount of joint distention, and arthroscopic telescope portal choice (17).

The initial approach to patellar malalignment should be conservative management for a minimum of 4-6 months, with $>80\%$ of the patients responding to therapy (1,5,6,13). Attention should be paid to both quadriceps strengthening and hamstring stretching. Multiple surgical procedures have been advocated for the remaining symptomatic segment, procedures consisting of either (a) lateral retinacular releasing procedures, (b) medial augmentation procedures, (c) bony realignment procedures focusing either on the tibial tubercle or osteotomies of the distal femur and proximal tibia to correct malalignment, or (d) a combination of these.

Lateral retinacular release procedures appear to be very effective in patellar-tilt syndromes but less effective in subluxation or dislocation (4,18). The most effective

procedures for maltracking are those that involve either soft-tissue or distal bony realignment procedures. Procedures involving the tibial tubercle are not appropriate for the skeletally immature adolescent. Distal femoral/proximal tibial derotational osteotomies are indicated only in the patient with the so-called "miserable malalignment syndrome" (2), in which the malalignment is secondary to a combination of significant femoral anteversion and external tibial torsion (16).

Consequently, only soft-tissue realignment procedures are indicated in the skeletally immature adolescent, consisting predominantly of medial augmentation or reefing-type procedures involving realignment of the vastus medialis obliquus or the patellar tendon such as the Roux-Goldthwait procedure or a combination of the two. In 1981, McCall and Gavioli (13) reviewed 33 patients, a total of 35 knees, undergoing modified Insall proximal-distal soft-tissue patellar realignment with 91% good results and 9% fair results. There were no poor results, wound infections, or other complications. Follow-up was only 18 months.

A report by Vahasarija et al. (18) reviewed soft-tissue realignment performed on 57 knees in adolescents. Three different techniques (lateral release, lateral release with medial reefing, and the Roux-Goldthwait patellar tendon transposition) were used, medial reefing being performed in 29 cases alone. Follow-up time was 4 years, but the results were not broken down into specific groups as to surgical procedures, although the authors did suggest that lateral release alone was appropriate for mild malalignment, but soft-tissue realignments were indicated for more severe degrees of malalignment.

In a report to the Pediatric Orthopaedic Society (Chambers et al. Results of proximal soft tissue realignment for adolescent patellar instability. Presented at the Pediatric Orthopaedic Society of North America Annual Meeting, Banff, Alberta, Canada, May 17, 1997) reviewed 18 patients, with a total of 22 knees. The surgical procedure consisted of the Insall proximal-distal realignment in all patients, with the addition of the Roux-Goldthwait procedure in five. Follow-up was short, 77% of patients having good to excellent results, but no distinction was made between the patients having the Insall procedure and those with the Insall procedure plus the Roux-Goldthwait.

In our series, 54 patients with a total of 65 knees underwent a modification of the Insall proximal-distal realignment procedure. No concomitant bony or other soft-tissue procedures were performed. Eighty-seven percent of the knees demonstrated good to excellent results, with an average follow-up of 6 years; the longest follow-up was 15 years. Eight percent of the knees demonstrated fair results, and 5% demonstrated poor results. The Insall soft-tissue realignment transposes the patella medially and tethers it statically by a combination of lateral release and medialization of the patellar tendon both proximally and distally, and dynamically by advancing the vastus medialis obliquus during the reefing of the quadriceps tendon (11). This procedure results in immediate postoperative stability, allows early immobi-

lization of the knee, and does not interfere with the patellar tendon attachment to the tibial tubercle.

CONCLUSION

Patellar malalignment can be a significant problem in the adolescent population. Ten percent of patients will not respond to conservative management, and operative intervention will become necessary. Because of skeletal immaturity, malalignment cannot be addressed with bony procedures. Soft-tissue patellar realignment procedures such as the Insall proximal-distal realignment with a lateral release and medial reefing appears to be well suited for this particular patient population. Mild malalignment appears to respond to lateral retinacular release alone, but more severe malalignment, including subluxation and dislocation, requires soft-tissue realignment for correction and stabilization. In our study of 65 knees treated with the modified Insall procedure, 87% demonstrated excellent to good results, 8% demonstrated fair results, and only five results demonstrated poor results. Soft-tissue patellar realignment by medial reefing and lateral retinacular release appears to be an excellent surgical procedure for addressing patellar malalignment in the adolescent population.

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