Patellofemoral Pain Disorders: Evaluation and Management

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Abstract

Patellofemoral pain disorders can be difficult to diagnose. Careful attention to the history and physical examination is central to accurate diagnosis. Standardized office radiographs are sufficient in most cases. Computed tomography of the patellofemoral joint (precise midpatellar transverse images through the posterior femoral condyles with the knee at 15, 30, and 45 degrees of knee flexion) will provide valuable objective information regarding subtle abnormalities of patellar alignment. Magnetic resonance imaging and radionuclide scanning may be helpful in selected cases. By differentiating between rotational (tilt) and translational (subluxation) components of patellar malalignment, the clinician will be better able to prescribe appropriate treatment. It is also extremely important to localize and quantitate articular and retinacular abnormalities. While nonoperative treatment is usually successful, surgery is sometimes required. Lateral release will relieve tilt and associated pain in the lateral retinaculum. Realignment of the extensor mechanism, usually at the level of the tibial tubercle, is necessary to control lateral tracking (subluxation) of the patella. If there is lateral or distal medial articular damage related to chronic lateral tilt and/or subluxation, shift of the tibial tubercle will help to unload damaged cartilage while realigning the extensor mechanism.

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Patellofemoral pain can present a diagnostic and therapeutic challenge. Accurate diagnosis requires specific knowledge of the anatomy, biomechanics, and functional behavior of the patellofemoral joint.[1] Because the joint is superficial and prone to injury, worker's compensation, litigation, and secondary gain are commonly involved. Optimal patient management, therefore, requires careful attention to the history and physical examination and an awareness of the various personality and socioeconomic factors that may affect treatment outcomes.

History

There is a tendency to attribute most anterior knee pain to chondromalacia. Many patients, however, do not have a patellofemoral cause for their symptoms.

The events accompanying the onset of anterior knee pain often will suggest a likely diagnosis. If there has been trauma, it is important to know the position of the knee at impact, whether there was direct blunt trauma, whether there was a dislocation or subluxation, and whether the patient believes the injury is compensable.

Information about pain should be elicited. Is the pain dull or sharp? Is it intermittent or constant? Does it radiate up or down the leg? Does it occur only at night? Is there associated crepitation or swelling? Is there a feeling of instability? Does the patella slip out of place? Is the pain related to position? Does the pain occur only with squatting, or is it constant throughout the full range of motion of the knee? Knowing where the pain occurs in the flexion arc of the knee will be useful in locating a specific articular lesion. Sometimes the position in which pain occurs coincides with the position in which the original injury occurred.

If swelling is present, is it constant or intermittent? Does swelling occur only after activities? The presence of effusion suggests intra-articular, rather than peripatellar, pathology.

Because knee pain can be associated with systemic disease, it is important to ask questions such as the following: Are other joints affected? Does the patient have a history of gout? Is there a family history of rheumatoid arthritis? Has a rash been observed? Does the patient have multiple aches and pains?

One should determine whether the specific dysfunction prevents

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the patient's usual employment or athletic participation. This information helps in projecting a long-term prognosis and in establishing whether the nature of the problem is sufficient to cause the limitation of function described by the patient. The examining physician should find out whether there is litigation or compensation involved. The physician should also try to gain insight into the patient's personality. A history of the patient's response to treatment and attitudes toward life, work, family, and physicians may provide additional insight. A formal psychological evaluation, such as the Minnesota Multiphasic Personality Inventory, may be extremely useful in some cases.

The nature of all previous treatments and surgery should be elicited. If physical therapy has been tried, was it a comprehensive program including stretching of the hamstrings and extensor mechanism? Was there objective strength gain? If taping or bracing was tried, what was the result? If there has been previous surgery, did the pain become better or worse after surgery?

A frequently overlooked and useful approach is to ask the patient to point to the location of the pain. Many patients can literally put a finger on the origin of pain, particularly if the pain has a retinacular or tendon origin. Some patients point to a previous arthroscopy portal, suggesting that a portal neuroma is the cause of pain. If the patient points to the distal quadriceps, the clinician may recognize that there is an overuse problem or a quadriceps compartment problem, particularly in an athlete involved in vigorous repetitive exercise (such as bicycling). This frequently overlooked part of the history may make a seemingly complicated problem easy to treat.

Physical Examination

The basic principles of musculoskeletal examination apply to the patient with anterior knee pain. Here I will describe those parts of the knee examination specific to patellofemoral syndromes.

The patient is observed for attitude, anxiety level, facial expression, and interaction with the physician and family members. With the patient standing, the examiner can assess the varus/valgus and rotational alignment and how this might impact on patellar tracking. Some indication of patellar tracking can be gained by having the patient slowly bend the knees. As the patient walks, additional information can be garnered regarding excessive lateralization of the patella and other gait-related factors that cause the patella to ride out of the trochlea, such as extreme internal rotation of the hips during gait due to excessive femoral anteversion. If the patient is using orthotic devices, do they improve patellar tracking?

The appearance of the skin may indicate a vasomotor problem, such as reflex sympathetic dystrophy. All scars and bruises around the anterior aspect of the knee should be examined, and the presence of muscle wasting should be evaluated.

Specific maneuvers of examination are then performed. Excessive tightness of the quadriceps extensor mechanism is determined by placing the patient prone, with the knees flexed as far as is tolerable while the pelvis is stabilized. Normally, symmetric flexion is possible, and each heel can be brought to or near the buttocks on full flexion. The inability to flex fully is important in designing a subsequent rehabilitation program. No patient should be left with a tight extensor mechanism after rehabilitation.

With the patient prone, one can palpate the patellar tendon while the knee is flexed and examine the tibial tubercle and the origin of the patellar tendon. The knee should be palpated carefully to identify any discomfort while stretching the extensor mechanism. The presence or absence of effusion can also be determined.

With the patient supine, the knee is flexed and extended to observe whether the patella enters the trochlea promptly or whether there is a lag during which the patella jumps abruptly from a lateral position into the trochlea. The examiner should place posteriorly directed pressure on the patella and actively and passively flex and extend the knee fully to see whether there is crepitation at any point in the flexion arc. The location of crepitation and whether it is associated with pain should be noted. It is particularly important to note at what point in the knee-flexion arc the pain occurs; this will give insight into the location of a possible articular lesion on the underside of the patella. Articular lesions on the distal patella will be more manifest in early knee flexion; more proximal lesions will be notable farther into the flexion arc.

With the extremity in full extension and the patient lying supine, the examiner should palpate all structures of the anterior knee, starting with the quadriceps muscle, to identify any muscular or ligamentous tenderness. The iliotibial band should be examined with the knee in extension and during flexion and extension to see whether pain can be localized to the iliotibial band. The entire lateral retinaculum should then be palpated carefully. The examination should proceed to the patellar tendon, and the exact location of tenderness should be docu-

mented. The medial and lateral infrapatellar tendon spaces must be palpated carefully with particular attention to any arthroscopy portals, to see whether pain can be reproduced. Palpation of the medial retinaculum and the vastus medialis may reveal the exact location of any tenderness.

Another maneuver is for the examiner to sit on a chair to the side of the patient with his eyes at the level of the patella to see whether it is possible to elevate the lateral facet to the neutral, horizontal plane. This is best accomplished by stabilizing the medial patella with the fingers of both hands while using the thumbs to pull up on the lateral patella as if raising it out of the trochlea. Is there excessive mobility of the lateral retinaculum? Is the patella tethered laterally by a tight lateral retinaculum? Normally the lateral patellar edge should rise to the horizontal plane or slightly past it when the lateral patella is lifted while the knee is kept passively extended on the examination table. Can the patella be displaced laterally out of the trochlea? Does this cause apprehension?

The examiner should evaluate the quadriceps angle with slight knee flexion and at 90 degrees of flexion. While abnormality of the quadriceps angle may help establish that there is malalignment, it is inappropriate to make decisions regarding surgical treatment based on the quadriceps angle alone.

In addition to those parts of the examination specific to patellofemoral pain, the knee examination should include all of the tests necessary to establish the presence or absence of other pathologic conditions, such as meniscal lesions and ligamentous instability.

The clinical examination is not complete until other possible sources of pain have been explored, such as referred hip and back pain, pain that originates proximally in the quadriceps or hamstring muscles, and intraosseous causes, such as tumor and infection. Evaluation of the hip for pain or limitation of motion followed by a straight leg raise and assessment of any radicular sensory loss or muscle group weakness in the lower extremity should take only a few seconds and will reveal referred pain in some patients. My examination generally concludes with a quick screening for general ligamentous laxity by dorsiflexing the fingers of the patient's hand and then bringing the thumb toward the volar aspect of the forearm.

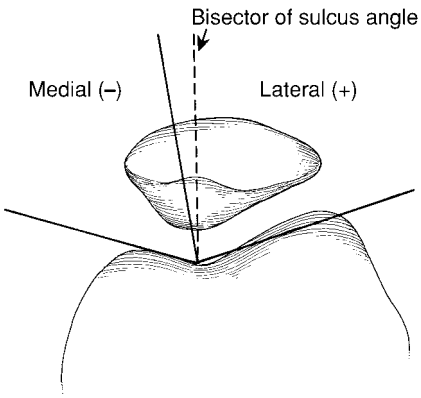

Fig. 1 The congruence angle on a standard Merchant view should normally demonstrate that the patellar apex is medial to the bisected trochlea.

Radiographic Evaluation

At the initial evaluation, I obtain standard weight-bearing anteroposterior (AP) and lateral radiographs and a Merchant axial view.[2] A standardized axial view will reveal significant malalignment and is a useful, relatively inexpensive screening tool. Some clinicians may prefer another axial view, but it is useful to choose one standard axial view and obtain that same projection in all patients.

The Merchant view is well standardized. It is taken with the knee flexed 45 degrees and the x-ray beam projected caudad at an angle of 30 degrees from the plane of the femur. The same techique may be used to take a 30-degree knee-flexion axial view. The normal patella is well engaged in the trochlea and has no tilt or subluxation once the knee is flexed beyond 15 to 20 degrees. On the Merchant view, the central ridge of the patella should lie at or medial to the bisector of the trochlear angle (Fig. 1). If the ridge is lateral to the bisector, the patella is displaced laterally.

Tilt is more difficult to evaluate on the Merchant axial view than subluxation (lateral translation) is, and objective criteria have not been well defined. The patella may be centered in the trochlea (no subluxation) but tilted if the medial facet is elevated away from the medial trochlea. I have found this simple observation to be useful in evaluating Merchant axial views for tilt, but gaining confidence has required the appraisal of many normal Merchant axial views along with axial views of patients with clinical evidence of tilt. Unfortunately, these observations are potentially misleading if there is any abnormality of medial patellar morphology. Dejour et al[3] and Grelsamer and Tedder[4] have pointed out the importance of evaluating trochlear morphology on the lateral knee radiograph. If occult subluxation (lateral translation) or tilt is suspected despite normal axial radiographs, the clinician may wish to order computed tomography (CT).

The Laurin view may offer greater sensitivity but is difficult to obtain reproducibly.[5] With this axial radiograph, the knee is flexed only 20 degrees. A line is drawn along the lateral facet, and a second line is drawn across the condyles of the trochlea anteriorly. The angle determined by drawing these lines will normally be open laterally (Fig. 2,

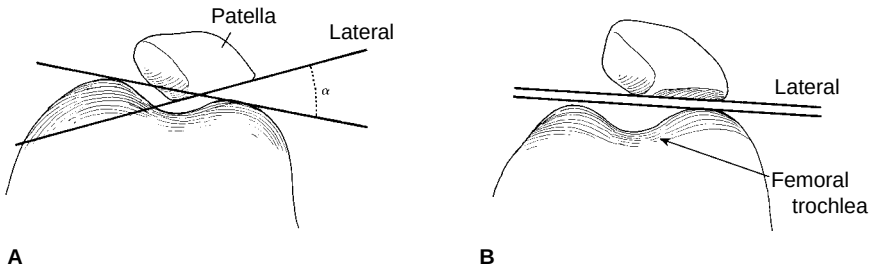

Fig. 2 Diagrammatic representations of Laurin axial radiographs, which are obtained with the knee flexed 20 degrees. These views are useful in determining whether the patella is tilted. **A**, Normally the patella will be centered in the trochlea with the lateral facet angle (α) open laterally. **B,** If the lateral facet is parallel to the anterior trochlea or if the angle formed by the lateral facet and the anterior trochlea is open medially, the patella is tilted.

A). If the angle is open medially or if the lines are parallel, the patella is probably tilted (Fig. 2, B).

Because of the lack of sensitivity of axial views, the clinician should remain open to the possibility of significant malalignment despite normal findings on axial radiography. Occasionally, CT of the patellofemoral joint at 15, 30, and 45 degrees of knee flexion will demonstrate an abnormality otherwise undetectable on axial radiographs.

Evaluation of standard standing AP and 30-degree-flexion lateral radiographs of the knee will indicate whether there is patella alta or baja. A simple screen for these possibilities is to note whether the patellar tendon length is more than 1.2 times the height of the patella on a lateral radiograph, which suggests patella alta.[6] This is not uniformly reliable, however, and obtaining a true lateral view (posterior condyles superimposed) in full extension and with quadriceps contracted may provide a better means of examining the relationship of the patella to the proximal trochlea (Dupont JY, personal communication, 1994). One can gain some sense on the AP view of whether the patella appears lateralized (or abnormally medial in a postoperative patient). Subchondral sclerosis, cyst formation, bone mottling (as in a patient with reflex sympathetic dystrophy), tumors, osteochondritis dissecans, bipartite patella, osteoarthritis, rheumatoid arthritis, loose bodies, and other disorders associated with anterior knee pain are usually apparent on AP or lateral radiographs.

Other Imaging Studies

If a thorough clinical evaluation followed by carefully performed standardized axial radiography fails to confirm the suspected diagnosis, further diagnostic imaging may be justified. However, these more sophisticated and expensive imaging techniques can be misleading and cannot be considered to supersede the careful clinical evaluation.

Computed tomography is an excellent imaging modality for evaluation of patellar alignment and intraosseous pathologic changes in the patella and trochlea[1,7] (Fig. 3), but the need to obtain this study is relatively uncommon. The technical details of positioning a patient for patellofemoral CT have been described in detail.[1]

It is important to obtain precise midpatellar transverse images, with the tomographic plane extending directly across both posterior femoral condyles, to define a reference plane of distal femoral orientation. If the plane of imaging is correct, the relationship between the trochlea and that portion of the patella that articulates with it will be well defined. Midpatellar transverse images should be obtained at 15, 30, and 45 degrees of knee flexion in the position of the patient's normal standing alignment. This alignment is determined by taking measurements between the medial femoral condyles and the medial malleoli while the patient is standing. These measurements are duplicated once the patient has been placed in the CT gantry. It is imperative that the technician reproduce the standing rotational alignment of the lower extremities in order to obtain meaningful patellofemoral CT studies.

The normal pattern of patellar tracking is for the patella to enter the trochlea but not be tilted by 15 degrees of knee flexion and then to stay within the trochlea throughout further flexion of the knee. This pattern of patellar tracking in the normal knee can be easily reproduced with properly performed CT.[1] Deviation from this pattern indicates malalignment. By drawing lines along the lateral facet of the patella and along the posterior condyles of

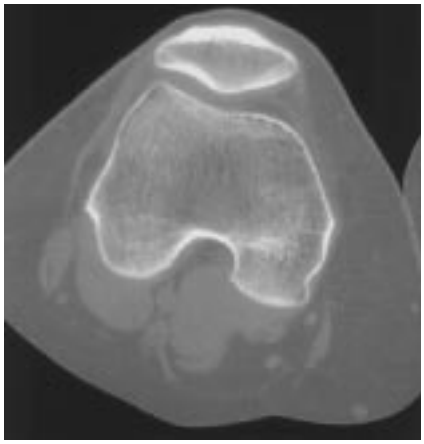

Fig. 3 Imaging the patellofemoral joint with CT can give excellent information regarding patellofemoral alignment without image overlap or distortion.

the femur, one can determine the patellar tilt angle, which is the angle formed by these two lines. The angle will be greater than 12 degrees in patients with normal alignment, as determined on 15- and 30-degree-flexion CT images. Again, it is important to emphasize that one must be certain that the midpatellar transverse plane is reproduced on the CT scan.

One can also evaluate these images for evidence of subluxation by determining Merchant's congruence angle, which is measured in the same way on CT as on radiography (Fig. 1). On 15- and 30-degree-flexion midpatellar transverse images, the midpatella should be at or medial to the bisected femoral trochlea. However, one must be particularly careful about the diagnosis of medial subluxation. We recently obtained patellofemoral CT scans of 20 asymptomatic volunteers and found that a congruence angle of –20 to –27 degrees (i. e., the central apex of the patella forms an angle of 20 to 27 degrees medial to the bisected femoral trochlea) occurs commonly in a normal population (Legeyt M, Fulkerson JP, unpublished data, 1993). The "normal" pattern of patellar tracking, in fact, generally keeps the central apex of the patella well medial to the bisected trochlea.

We also found that tilting of the patella can cause medial rotation of the central ridge of the patella as the lateral retinaculum pulls down on the lateral aspect of the patella and the patella rotates out of the coronal plane. This pattern, although suggestive of medial subluxation, actually indicates a tight lateral retinaculum with tilt.

One must be extremely cautious, therefore, in rendering a diagnosis of medial subluxation based on tomographic imaging. The history and clinical examination will generally clarify the nature of the problem. In my practice, I have yet to see a patient with medial subluxation of the patella except when there has been previous surgery.

I have found magnetic resonance (MR) imaging less helpful than CT in evaluating patellofemoral alignment and thus do not use it for that purpose. However, MR imaging may give insight into bone or cartilage lesions and may be useful in localizing an articular lesion or identifying an intraosseous or intra-articular problem, such as osteochondritis dissecans, meniscus tear, or ligament disruption. Cinematic MR imaging is interesting but has not been proved to yield any useful information beyond that which one can achieve with the less expensive CT.

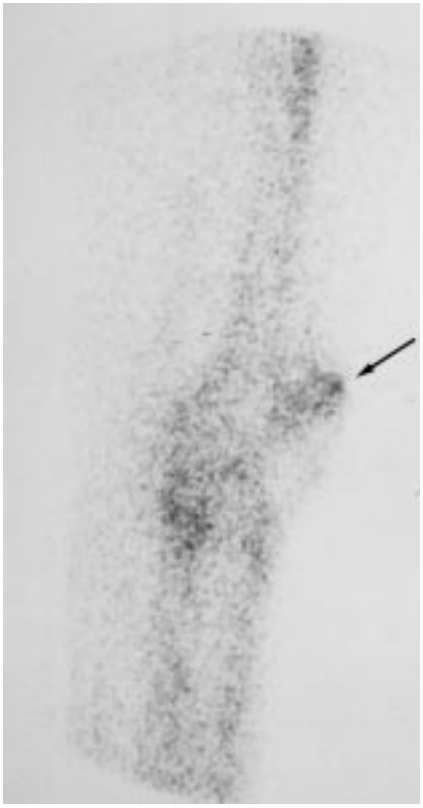

Fig. 4 A radionuclide (technetium 99m) scan can reveal specific locations of increased bone activity in the patella or trochlea (arrow), which may correlate with a source of pain.

Radionuclide scanning of the patellofemoral joint may be very useful in selected patients (Fig. 4). Dye and Boll[8] have provided considerable insight into the indications and utility of this imaging technique. Radionuclide scanning of the patellofemoral joint is helpful in identifying intraosseous pathologic changes, such as occult fractures, following trauma to the anterior knee. In a dashboard injury or direct blow to the patella, the radionuclide scan often will show increased uptake if there is an occult patellar fracture. The radionuclide scan may reveal a patellar lesion or demonstrate a bone lesion on the trochlear side of the patellofemoral joint, which might otherwise escape detection. Chronic proximal patellar tendinitis may cause increased uptake in the distal patella. Similarly, occult tumors may become evident on bone scan. The radionuclide scan may also show diffuse uptake suggestive of reflex sympathetic dystrophy, which can be very important in planning treatment for patients with chronic pain.

Nonoperative Treatment

The first approach to patients with patellofemoral dysfunction is nonoperative, tailored to the specific clinical diagnosis. A nonsteroidal anti-inflammatory medication may help with pain relief, but most patellofemoral dysfunctions do not involve significant inflammation. Reassurance is important for these patients and is an important part of the treatment.

Simple bracing with an elastic patellar cut-out brace may be helpful to some patients. McConnell[9] has recommended a patellar taping technique to help control tilting or subluxation in order to reduce anterior knee pain. Patients can learn to apply the tape at home.

Simple exercises that can be done at home are very useful. The clinician should show the patient how to stretch the quadriceps mechanism while lying in the prone position. Manual stretching of the lateral retinaculum is often important, particularly if there is tightness and tilt of the patella. Straight-leg exercises with weights on the ankle form the basis of a simple strengthening program for the quadriceps. Patients can learn these exercises in the orthopaedic surgeon's office. At present, it is not clear whether there is any advantage to either closed-kinetic-chain exercises (low-resistance exercise bicycle) or open-chain exercise (leg lifts against resistance). Isokinetic exercise in general is less appropriate in patients with patellofemoral disruption, as there is a significant risk of overloading the patellofemoral articular surfaces, particularly at lower speeds. This concern is most acute regarding eccentric isokinetic exercise, which causes particularly high articular cartilage pressures. I consider eccentric isokinetic exercise appropriate only in the treatment of patellar tendinitis. General aerobic conditioning is desirable for patients with patellofemoral pain.

Regardless of the exercise chosen, it should be prescribed in a pain-free arc and should be individualized. Management of chronic anterior knee pain is more difficult and requires comprehensive pain management, particularly if the diagnosis is reflex sympathetic dystrophy.

Vocational rehabilitation is important for some patients, and functional work capacity assessment may become necessary in patients with chronic anterior knee pain who need to define a level of work capability. There is a growing understanding of the importance of returning a patient to gainful employment as soon as possible, to prevent chronic disability.

Operative Approaches

The decision to perform surgery is based on the diagnosis, adherence of the patient to nonoperative treatment, and the surgeon's and patient's assessment of the benefit to be derived.

Arthroscopy and Lateral Release

Indications

Occasionally, a patient who has sustained a pure traumatic articular lesion with frank flaps of articular cartilage may benefit from isolated debridement when there is no malalignment to correct and there is no sign of reflex sympathetic dystrophy. Most patients, however, have malalignment leading to articular disruption, and this should be corrected at the time of patellar debridement. One may consider malalignment to be the cause and the articular breakdown to be the effect in such cases; it is important to treat both cause and effect whenever possible.

There is substantial evidence that lateral retinacular release is effective for patients with patellar tilt and no or minimal articular involvement. Lateral release does not significantly improve subluxation, but in a patient with tilt and subluxation, lateral release may relieve the tilt component of malalignment.[7,10] Lateral release, however, is not appropriate for all patients with anterior knee pain. If objective evidence of tilt is not present, the patient may get worse following lateral retinacular release. Furthermore, lateral release will benefit fewer than 25% of patients with more severe articular breakdown at longer follow-up.[11]

Lokietek et al[12] have noted that the results of lateral release are better in patients with a medial congruence angle. This is consistent with CT findings that a medial congruence angle may result from tilting of the patella. A small number of patients, estimated to be less than 10%, will experience pain as a result of increased pressure on an area of articular softening at the distal medial facet of the patella after lateral release.

Technique

Preliminary arthroscopy is performed using portals that permit complete evaluation of the patellofemoral joint as well as the remainder of the knee. The quadrant in which the articular cartilage lesion is located is ascertained, and the exact nature of the lesion is described, including whether there is softening alone, partial- or full-thickness fibrillation, or exposed bone (Fig. 5). The Outerbridge classification[13] has proved helpful. In this classification, grade 1 is cartilage softening alone, grade 2 is fibrillation measuring less than 0.5 inch in diameter, grade 3 is fibrillation measuring more than 0.5 inch in diameter, and grade 4 is exposed bone.

The location and degree of involvement determine whether the release will relieve or aggravate the lesion. Unfortunately, lateral release alone may cause greater contact on the distal medial facet, a common location for articular lesions, which may explain why some patients report increased clicking and popping after release. When a patient has had dislocation of the patella accompanied by substantial articular damage to the medial patellar facet, lateral release may actually bring greater contact with the deficient medial patellar facet. If, however, there is tilting of the patella, grade 1 softening, or early breakdown of the lateral patellar facet, lateral release will probably reduce contact on the lateral facet and provide very satisfactory results.

Arthroscopy of the patellofemoral joint may be performed through distal or proximal portals. With the use

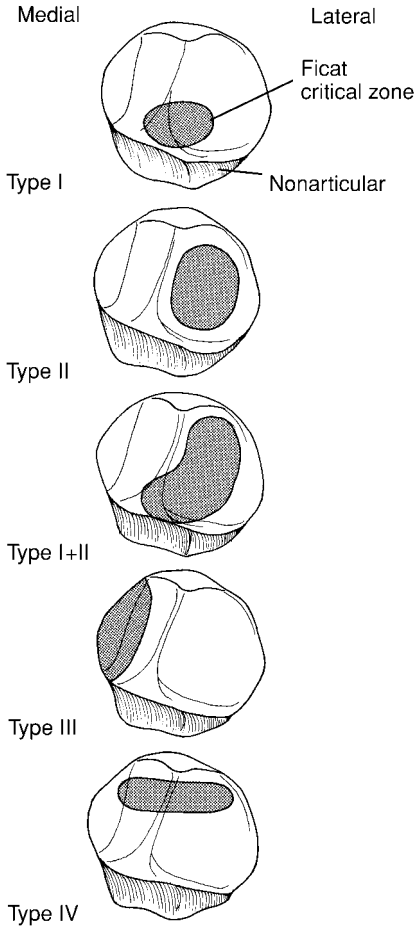

Fig. 5 Treatment of articular lesions of the patella. Type I is a distal midpatellar midline or medial lesion caused by chronic tilt and/or subluxation. Treatment is alignment by lateral release and possibly anteriorization or anteromedialization of the tibial tubercle. Type II is excessive lateral pressure syndrome caused by chronic lateral tilt and/or subluxation, usually long-standing. Treatment is alignment by lateral release and anteromedialization of the tibial tubercle. Type I+II is a combination of types I and II. Treatment is anteromedial tibial tubercle transfer with lateral release. Type III is a medial-facet shear fracture sustained on forceful reduction of a dislocated patella. Treatment is alignment, debridement, and replacement of the fragment. Medial imbrication and overmedialization must be avoided. Type IV is the result of direct trauma to the patella in a flexed-knee posture (e.g., a dashboard injury), which causes proximal patellar articular injury. Treatment is to wait and then debride loose flaps of cartilage if necessary.

of a distal portal, either a medial or a lateral peripatellar approach allows good arthroscopic visualization of the patellofemoral joint. The trochar is placed along the patella to avoid damage to the patellar or trochlear cartilage. The patella is then evaluated with the knee in extension, moving through an arc of flexion to 60 degrees, and then returning to full extension. I prefer the proximal superomedial approach described by Schreiber,[14] which allows visualization of patellar articular lesions and tracking.

At the time of lateral release, significant articular lesions are debrided.[15] Basket forceps and a power shaver are efficient means of removing cartilage flaps and fibrillations, but normal cartilage should not be violated, and beveling of intact cartilage should be avoided. During the procedure, the rest of the knee should be examined thoroughly to establish the presence of other intra-articular lesions.

The lateral release can be done arthroscopically or through a short lateral incision, which has the advantage of ensuring a complete release as well as obtaining complete hemostasis. Hemarthrosis is a common postoperative complication and can impair the ability to gain easy motion and compromise the quality of the result. In particular, small vessels in the fat pad are commonly overlooked.

The release includes the entire lateral retinaculum,[16] the vastus lateralis obliquus,[17] and any tethering bands of the thickened retropatellar tendon fat pad. Care must be taken to avoid the patellar tendon and the main tendon of the vastus lateralis. If an incision is made, very complete closure of subcutaneous tissue should be done.

Following lateral release, one should encourage early motion and quadriceps strengthening. Preoperative and postoperative antibiotics are appropriate for patients who undergo a lateral retinacular release because of the possibility of hemarthrosis and the associated increased risk of infection.

Tibial Tubercle Realignment

Medial transfer of the tibial tubercle remains the treatment of choice for the skeletally mature patient with a lateral quadriceps mechanism vector and recurrent subluxation and/or dislocation.[18-20] Because medial retinacular imbrication alone increases the risk of contact stress on the commonly deficient medial facet, a straight medial tibial tubercle transfer[18] or anteromedial tibial tubercle transfer[21,22] appears to have the important benefit of minimizing aggravation of articular cartilage lesions. If patella alta is present, the surgeon may also want to move a tibial tubercle distally a few millimeters.

When there is little or no articular damage, a straight medial tibial tubercle transfer, such as the Elmslie-Trillat procedure, may be most appropriate.[18-20] Koskinen et al[23] have reiterated the importance of lateral release and tibial tubercle transposition for correcting subluxation. Most patients, however, have articular cartilage lesions at the distal medial or central lateral facet as a result of long-standing malalignment; in such cases, anteromedial tibial tubercle transfer is advised.[1,22] The anterior displacement unloads the distal and lateral facets of the patella while moving the tibial tubercle medially, which improves the quadriceps extensor mechanism vector (Fig. 6). This procedure should include a lateral retinacular release.[1,21,22]

A successful outcome for anteromedial tibial tubercle transfer requires some preservation of proximal—particularly proximal medial—articular cartilage on the patella. Because this procedure moves the

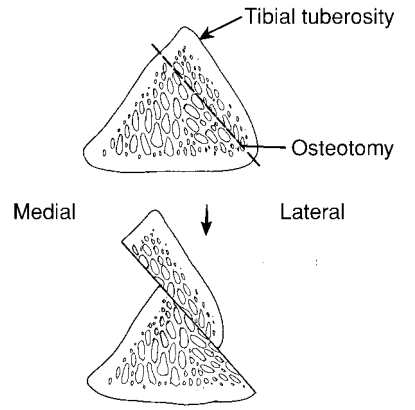

Fig. 6 Anteromedial tibial tubercle transfer relieves loading of the distal patellar articular surface and lateral facet when combined with lateral retinacular release.

tibial tubercle anteriorly and medially, loads are transferred onto the proximal medial patella. If this area is damaged (e.g., in a dashboard or flexed-knee type of injury), tibial tubercle transfer is less likely to be successful.

In some cases, direct anterior transfer of the tibial tubercle is necessary to shift load onto the proximal patella and off distal articular lesions without medializing the patella. A 5-mm local bone graft is inserted behind the tibial tubercle following an anteromedial oblique osteotomy (Fig. 7). The tubercle is placed straight anteriorly by neutralizing the medial displacement that occurs with transfer of the anteromedial tibial tubercle obtained with an oblique osteotomy. Thus, straight anteriorization can be achieved with less bone graft than has been traditionally thought necessary.

Patellectomy or Resurfacing

When there is extensive articular damage to the patella and unremitting pain associated with significant functional limitation, patellectomy or patellar resurfacing may be necessary. If the patellar articular cartilage is extensively damaged and tibial tubercle transfer is unlikely to be successful, a patellectomy may be the only alternative. This situation may result from a crushing (dashboard-type) injury to the patella, fracture, osteoarthritis, or advanced deterioration related to chronic malalignment. Before considering this surgery, all other possible treatments should be considered.[24] The patella must be satisfactorily aligned without any significant retinacular source of pain. There is substantial loss of strength following patellectomy, and the symptom of "giving way" is common. Therefore, the patient must understand the essential importance of postoperative rehabilitation.

Prosthetic resurfacing of the patella is another option when there is extensive articular damage. This procedure has intrinsic appeal when both the patella and the trochlea are diffusely damaged but the remainder of the knee has no evidence of degenerative change. The results with resurfacing are inconsistent, however.[25] Cartier et al[26] have reported 85% good or excellent results with complete patellofemoral resurfacing at a 2- to 12-year follow-up. It is imperative that the patella be normally aligned prior to the resurfacing procedure and that the extensor mechanism be properly balanced in order to avoid problems of instability and prosthetic loosening.

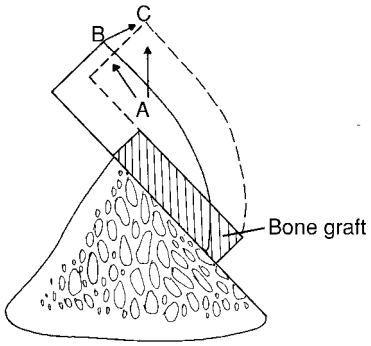

Fig. 7 An offset bone graft placed in the osteotomy will neutralize medialization and permit straight anteriorization with a relatively small bone graft. **A** represents the original location of the tibial tubercle; **B,** position after oblique osteotomy on shift; **C,** position after addition of a bone graft into the osteotomy.

Other Soft-Tissue Surgery

When a patient has undergone prior surgery, neuromata, painful scars, and chronic patellar tendinitis may be a problem. Some scars or neuromata are amenable to surgical treatment.

Chronic patellar tendinitis may require a limited resection of a small amount of the patellar tendon. I believe that resection of less than 25% of the patellar tendon (only the longitudinal segment that is painful) is reasonable for patients who have chronic, well-documented, unremitting pain related to patellar tendinitis that can be localized to a specific segment of the patellar tendon. A 6- to 9-month course of nonoperative management, including quadriceps stretches in the prone position, should be completed before surgery is considered. The painful area is usually at the proximal pole of the patellar tendon. The extent of involvement can sometimes be determined with MR imaging. Although histologic examination should demonstrate inflammatory or degenerative changes, some patients experience excellent pain relief from partial tendon excision even though their resected tissue shows no evidence of pathologic change.

In patients with a well-documented, localizable source of retinacular pain that is relieved by local lidocaine injection, resection of the painful nidus of soft tissue may be curative. An uncommon cause of local pain is a hemangioma of the quadriceps muscle[1]; if confirmed with MR imaging, this can be cured by local excision.

Another indication is patella baja in which the patella is tethered distally. This condition is usually related to fibrosis in the fat pad deep to the patellar tendon. Adhesions should be released, usually through a short lateral incision. A postoperative continuous-passive-motion program may be effective.

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