CHAPTER 20

Disorders of the Knee

Osteochondritis Dissecans

Osteochondritis dissecans of the knee is characterized by the presence of an area along the femoral articular surface consisting of cartilage and bone that may be softened or may become loose and separated from the rest of the femoral condyle. Most lesions are located on the lateral side of the medial femoral condyle and range in size from a few millimeters to a centimeter or more in diameter. The osteochondral fragment may remain in place or may loosen and become an intra-articular loose body. The disorder was first described by Sir James Paget, who called it "quiet necrosis."[147] The term *dissecans* should be used, as it implies a cutting loose (the term is often misstated as *desiccans*, which means a dry lesion).

ETIOLOGY

Mechanical. The exact etiology of the osteochondral lesion has not been determined. A recent biomechanical study of the distal femur using finite element analysis showed that as loads are applied to the distal femur, the stresses on the subchondral bone are greatest in the medial femoral condyle. These stresses arise from loading forces in the mediolateral direction and from compression forces generated by the patella and tibia in the anteroposterior (AP) direction, and are the greatest in 60 degrees of flexion.[186] Rehbein was able to produce experimental lesions similar to those of osteochondritis dissecans by repeated forced hyperextension of the knee combined with force placed on the femoral condyles through the patella.[157]

Langenskiöld postulated that cartilage fractures in childhood result in osteochondritis lesions. He excised a segment of hyaline cartilage from the articular surface of the distal femur of rabbits, leaving a synovial tissue attachment. The fragment was then replaced in its crater. Several months later the fragment had developed an osseous nucleus similar to that seen in the disorder in humans.[104] Tallqvist repeated the experiment, with similar results.[182]

Mechanisms that have been shown to cause osteochondral fractures of the femoral condyle include impingement from a tall tibial spine, direct blows causing compaction, rotary forces, and joint compression forces.[51,96,163,172,173] Nonunion of an osteochondral fracture produces a lesion that is identical to that of osteochondritis dissecans.[119,163,172,173,190] Most osteochondral fractures are noted immediately after a traumatic event, occur when the knee is acutely loaded, often in a flexed position, and may be accompanied by a loud snap.[163] It may be that lesser injuries which are unnoticed, or at least unreported, result in osteochondritis dissecans lesions.[96] Only one in five patients with osteochondritis can recall a specific injury.[79]

Juvenile and adult lesions behave differently and may well have different etiologies. Smillie suggested that the juvenile form represents a disturbance of epiphyseal development, with small accessory islets of bone being separated from the main osseous nucleus of the epiphysis.[174] He attributed the adult form to trauma.

Hereditary. A number of reports in the literature suggest that osteochondritis is a familial condition. Some of these reports lump osteochondritis lesions of different joints together, which may confound the findings. Wagoner and Cohn reported osteochondritis of the knee in a boy, his father, a paternal uncle, and his two brothers.[192] Petrie, on the other hand, reviewed the family members of 34 patients with typical osteochondritis, most of the knee, and found no evidence for a familial etiology.[153]

There are cases of multiple joint involvement in the same patient, which suggests some type of predisposition.[192] There are also cases associated with dwarfism, which implies either a genetic predisposition or a mechanical etiology based on abnormal joint configuration.[198]

Ischemia. Primary ischemia has been proposed as a cause of osteochondritis dissecans, perhaps due to some embolic phenomena.[9] However, this theory has been refuted by Rogers and Gladstone, who described a rich blood supply to the lower end of the femur and the lack of end arteries in the region.[162]

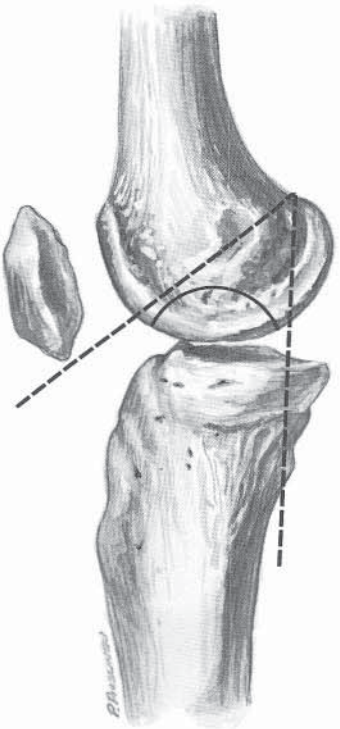

FIGURE 20–2 Drawing of true lateral projection of knee showing method of topographic location of osteochondritis dissecans of the medial femoral condyle. The weightbearing area of the medial femoral condyle is within the boundaries of two intersecting lines, one projected from the posterior femoral shaft and the second projected across the femoral groove.

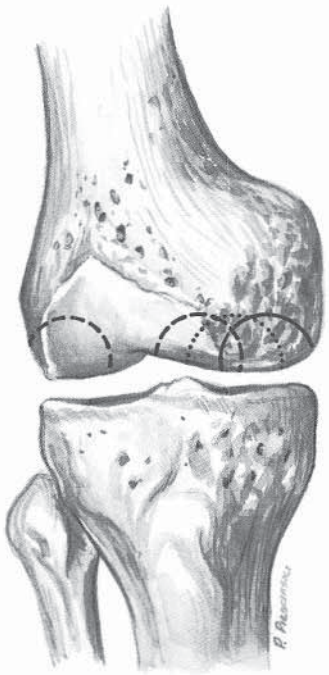

FIGURE 20–3 Possible topographic locations of osteochondritis dissecans in the femoral condyles.

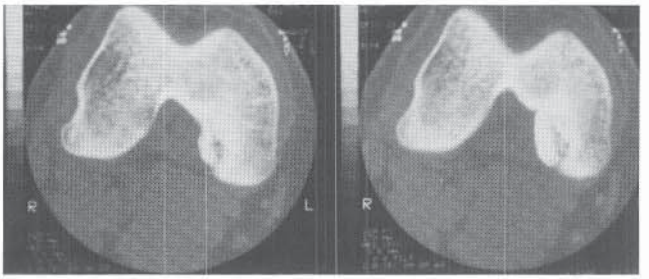

FIGURE 20–4 CT scans of the knee showing osteochondritis dissecans of the medial femoral condyle. Note the clear delineation of the extent of the lesion; the fragment is partially detached.

the location and extent of the lesion. The degree of detachment of the lesion may also be evident on CT (Fig. 20–4).[203]

Magnetic resonance imaging (MRI) is useful in determining the stability of the osteochondritic lesion. De Smet and co-workers found that a high-signal-intensity interface between the lesion and the femur indicated that the fragment was unstable.[43] Kramer and co-workers performed contrast-enhanced MR arthrography using intra-articular gadolinium and were able to diagnose separation of the fragment in almost all cases.[101]

Radionuclide scintigraphy with technetium may also be helpful in determining the state of the fragment. Paletta and colleagues found that if the scan showed increased activity in a patient with open physes, the lesions healed spontaneously. This was not the case if the physes were closed.[148] Litchman and colleagues quantified blood flow on technetium scans and found that in patients with symptoms for more than 2 months, an increase in blood flow favored spontaneous healing and a decrease in flow favored failure to heal.[111]

Arthrography has limited use in evaluating the stability of a lesion. The classic finding of contrast agent surrounding the lesion is rarely demonstrated even when the lesion is loose. Arthroscopy is the most reliable method of evaluating the status of the lesion.

TREATMENT

Nonoperative Treatment. The initial management of osteochondritis in children with open growth plates entails observation with enough activity restrictions to allow the symptoms to resolve. Most stable lesions spontaneously heal over several months. If symptoms persist or if the patient cannot be convinced to reduce activities, a short period of immobilization in a cast or brace may be tried. The knee should be in a position that does not produce weightbearing across the lesion.[68] After 4 to 6 weeks a gradual return to activities is allowed. If symptoms persist or worsen, further evaluation may be necessary. Bone scanning, CT, or MRI may demonstrate an unstable lesion that requires arthroscopic evaluation and treatment.

Arthroscopy. Arthroscopy is indicated in patients in whom nonoperative treatment fails and in those with signs and symptoms and other studies suggestive of an unstable lesion. Arthroscopy is usually performed in children under general anesthesia, but it may be done with regional techniques as well. After a complete knee examination has been performed

crater from which the loose body has detached. The "salvageable" type has a fresh crater with smooth edges, while the "unsalvageable" type is filled with fibrous tissue with irregular edges.[69]

An intact lesion may remain in place or may be drilled to promote healing. Drilling is usually done with a small K-wire. Antegrade drilling results in healing in most skeletally immature patients but is less successful in those with closed physes.[2,5]

In the early-separated lesion, in situ pinning is preferred. Two or more divergent 0.062-mm Kirschner wires are driven through the lesion and brought out through the femoral condyle. The pins should be withdrawn until they are flush with the articular surface. Multiple drill holes are made in the fragment down to bleeding bone to promote healing. Any fibrous tissue should be excised. The pins are left just beyond the femoral condyle to allow removal. Other fixation devices that have been used with good results include Herbert screws, biodegradable pegs, autogenous bone pegs, and cannulated screws.[36,42,158,185,191]

When the lesion is partially detached, or when it is fully detached with a fresh crater, the fragment may be replaced and pinned (Fig. 20–5). The bed of the crater should be curetted down to bleeding bone and cleared of all fibrous tissue. When replaced, the fragment should be flush with the condylar surface.

If the bed is not salvageable, the crater may be managed in one of several ways. Spongialization, the preferred technique, involves removing all fibrous tissue and underlying subchondral bone down to bleeding cancellous bone. An alternative technique is trephining, in which the edges of the defect are cut at right angles to the articular surface. This enhances uniform ingrowth of fibrocartilage into the defect without interfering with the normal articular surface. Saucerization, in which the edges of the defect are tapered, is not recommended (Fig. 20–6). Currently chondrocyte culture with reimplantation to fill articular defects is being investigated in a number of centers.* Periosteal implantation has also been proposed for restructuring defects.[103,112,160,193] Angermann and co-workers reported failure of periosteal transplantation to fill articular defects in a series of 14 cases.[6] These techniques may be tested and refined sufficiently to become part of future methods for replacing lost articular cartilage.

Patellofemoral Instability

Instability of the patellofemoral joint may manifest as acute patellar dislocation, recurrent patellar subluxation or dislocation, habitual dislocation (dislocation each time the knee is flexed), and chronic dislocation. Another condition, congenital dislocation, which is present at birth, represents a developmental error rather than a form of instability.

RECURRENT PATELLAR DISLOCATION

Recurrent patellar dislocation is defined as more than one episode of dislocation of the patella documented by an observer or clearly described by the patient. The dislocations are almost always to the lateral side of the femur. The history of a dislocation should include a description of a period during which the knee appeared deformed and then suddenly was restored to a normal appearance either spontaneously or by manipulation. Events described as slipping of the knee that instantly resolves without visible distortion of the appearance of the knee should be considered subluxations.

Incidence. The incidence of acute patellar dislocation has been estimated at 43 per 100,000 children under the age of 16.[137] Recurrent subluxation is more common in girls than in boys.[22,65,78,96,117] In one series, 40 of 46 patients were females,[117] while another series reported a 3:1 female-male ratio.[89]

Etiology. The most common etiologic factor in recurrent patellar dislocation is lateral malalignment of the quadriceps mechanism. Ligamentous laxity, lateral soft tissue contractures, external tibial torsion, a shallow intercondylar notch of the femur, patella alta, and vastus medialis insufficiency may be contributing factors.

QUADRICEPS MUSCLE. There is general agreement that the quadriceps is oriented in such a way that the patella is displaced laterally in patients with recurrent patellar dislocation. This lateral movement, often called the J sign, is seen just as the knee begins to flex. There has been much controversy concerning the role of various components of the quadriceps muscle, and especially the vastus medialis, in patellar instability. The quadriceps muscle strength is estimated to consist of 35 percent contribution from the rectus femoris and vastus intermedius, 40 percent from the vastus lateralis, and 25 percent from the vastus medialis.[52] The vastus medialis is most active between 30 degrees of flexion and neutral alignment, at which time the vastus lateralis is also contracting.[14] Lieb and Perry showed that the electrical activity of the vastus medialis was twice that of the other quadriceps muscle components in isometric testing. They found the activity of all components of the muscle to be unchanged through varying degrees of flexion.[109] In one study there was reduced electromyographic activity of the medialis in patients with recurrent patellar dislocation which returned to normal after surgical realignment.[118]

LATERAL TETHERING. It has also been proposed that recurrent dislocations are caused by a contracture of the structures lateral to the patella. Whether that is a primary cause or a secondary finding, the lateral patellar retinaculum and patellofemoral ligament are often very taut and prevent medial movement of the patella. At times the vastus lateralis is contracted with a low insertion. Hallisey and co-workers found that the vastus lateralis obliquus was variable in its insertion pattern among individuals and had a different orientation in women than in men.[73] They suggested that only the small obliquus portion of the lateralis be released in realignment procedures. In other cases, strands of ligament from the iliotibial band attach to the lateral border of the patella and may cause lateral patellar dislocation as the knee flexes.[89,139,173]

*See references 10, 24, 25, 27, 60, 64, 86, 91, 95, 128, 155, 166, 168, 193.

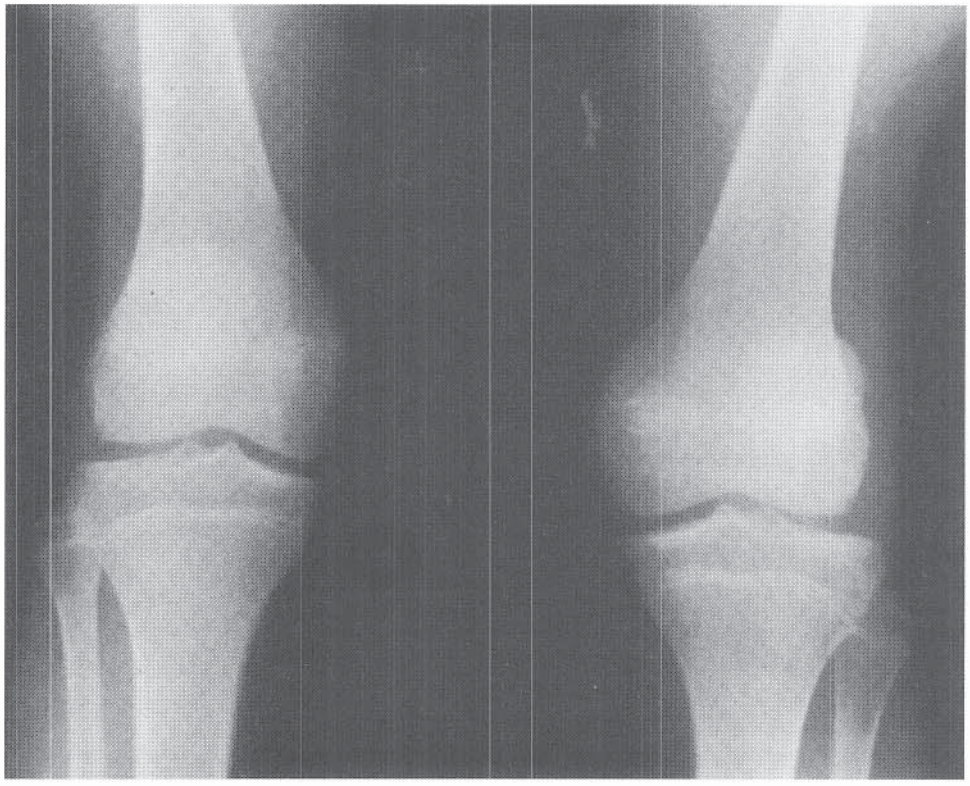

FIGURE 20–8 AP radiographs of both knees in a child with recurrent dislocation of the left patella, which is located in an abnormally lateral position.

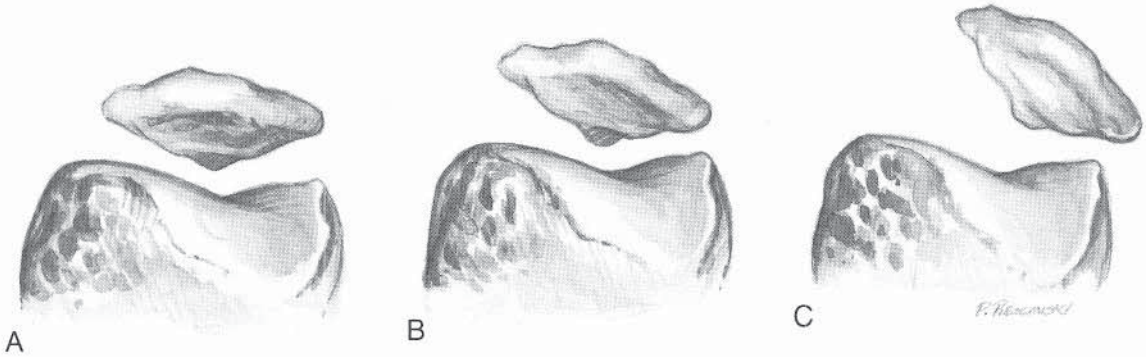

FIGURE 20–9 Laterally tilted and subluxated patellae. **A,** Normal. **B,** Laterally tilted patella. The space between the medial face of the patella and the medial femoral condyle is increased, and the space on the lateral side is decreased. **C,** Laterally subluxated patella. The lateral edge of the patella is displaced lateral to the femoral condyle, and the apex of the patella does not point directly into the intercondylar notch.

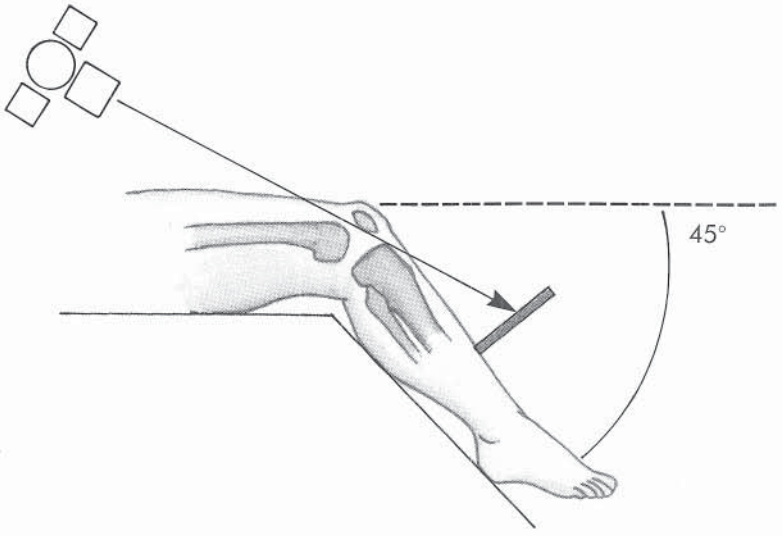

FIGURE 20–12 Laurin technique for infrapatellar axial or tangential projection. (Redrawn after Laurin CA, Levesque HP, Dussault R, et al: The abnormal lateral patellofemoral angle: a diagnostic roentgenographic sign of recurrent patellar subluxation. J Bone Joint Surg 1978;60-A:55.)

alta. A lateral radiograph obtained with the knee in 30 degrees of flexion will disclose patella alta. In this position the patella should lie between the anterior projection of the intercondylar notch line and a line drawn through the central portion of the distal femoral physis (Fig. 20–17).[19,78]

CT is also useful to study the patellofemoral relationship. Guzzanti and co-workers have described performing CT with and without quadriceps contraction. With this technique, lateralization and tilting were more easily seen when the quadriceps was contracting.[71] MRI studies may occasionally be indicated. Using MRI, Sallay and co-workers were able to identify disruption of the medial patellofemoral ligament, bruising of the lateral femoral condyle, bruising of the patella, and retraction of the vastus medialis muscle.[167]

Treatment. An initial dislocation of the patella should be treated with immobilization in a knee immobilizer for comfort. In the first few days the patient should begin straight leg raising to strengthen the quadriceps. As tenderness resolves, more vigorous strengthening exercises are done, focusing on the vastus medialis. A knee sleeve or patellar stabilizing orthotic may be useful in the recovery period.

The initial management of recurrent dislocation of the patella should be nonoperative. A patellar stabilizing orthosis may be useful, although the mechanism of action and the efficacy of these devices are uncertain. Strengthening the vastus medialis is important and may reduce the frequency of dislocation. Both closed- and open-chain quadriceps-strengthening exercises are recommended. High-torque exercises may cause high articular cartilage pressures and should be avoided.[20]

Continued episodes of dislocation require surgical management. In growing children the tibial tubercle is part of an important growth plate that must not be surgically injured. Damage to this apophysis will result in a progressive recurvatum deformity of the proximal tibia. Thus, the surgical approaches to growing children focus on realigning the quadriceps mechanism, usually in combination with a lateral release and the creation of a medial patellar restraint. Redirection of the quadriceps may be accomplished by altering the muscle itself, changing its insertion into the patella, or altering the attachment of the patella to the tibia. Medial repair should focus on the deep portion of the medial patellofemoral ligament, as this is the major medial patella stabilizer.[76]

We prefer the Dewar-Galeazzi procedure for patients with recurrent dislocation of the patella.[11,44] This operation has several components, including a lateral retinacular release, medial advancement of the vastus medialis, and—a unique component—transfer of the semitendinosus to the patella. The semitendinosus provides a medially directed realignment of the tibial insertion of the quadriceps mechanism without interfering with the tibial tubercle (Plate 20–1). If the patella appears malrotated after the semitendinosus tendon is transferred, the lateral portion of the patellar tendon may be detached and resutured beneath the medial portion of the patellar tendon, the Roux-Goldthwait procedure. Sev-

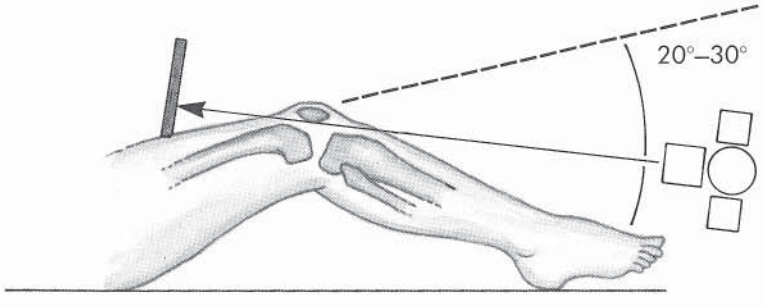

FIGURE 20–13 Merchant technique for radiography of the patellofemoral joints in axial projection. (Redrawn after Merchant AC, Mercer RL, Jacobsen RH, et al: Roentgenographic analysis of patellofemoral congruence. J Bone Joint Surg 1974;56-A:1391.)

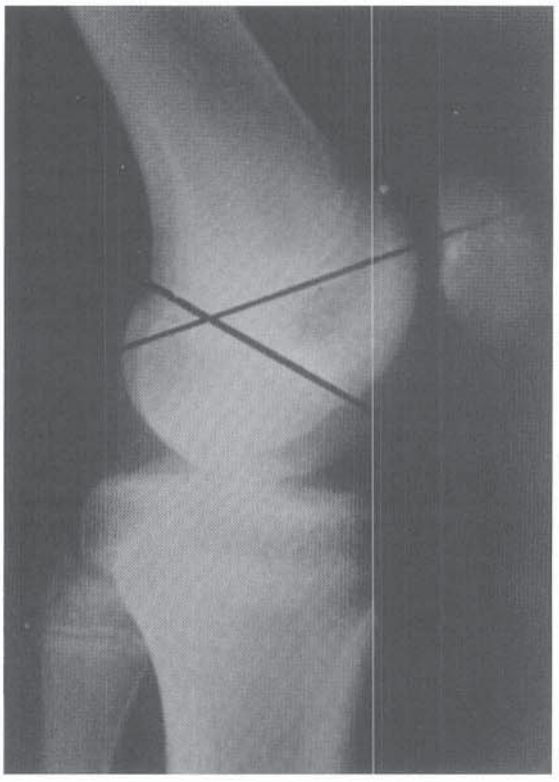

FIGURE 20–17 Normal resting position of the patella as seen on a lateral radiograph of the knee obtained with the knee in 30 degrees of flexion. Note that the patella is between the anterior projections of the intercondylar notch line and the metaphyseal plate line (central part of the physis). (From Hughston JC: Subluxation of the patella. J Bone Joint Surg 1968;50-A:1013.)

had no further dislocations on a mean follow-up of 4 years.[39] We believe that realignment is indicated in most if not all children and adolescents with recurrent dislocation.

Some pessimism is necessary regarding the long-term prognosis for patients with recurrent dislocation of the patella. Arnbjornsson and colleagues followed 21 patients for a mean of 14 years after various realignment procedures. Six operated knees and four nonoperated knees continued to have recurrent dislocations. Patellofemoral arthritis was present in 75 percent of operated knees but in only 29 percent of nonoperated knees. They concluded that surgery provided some short-term benefits but was not a long-term solution.[8]

RECURRENT PATELLAR SUBLUXATION

While recurrent patellar dislocation is rather easily defined, the syndrome of patellar subluxation is often poorly defined, confused with other causes of knee pain, and may be accompanied by complex psychological overtones.

Clinical Presentation. The patient presents with a number of complaints which, when considered together, suggest the diagnosis of recurrent patellar subluxation. For unknown reasons, adolescent girls are the most frequently affected. This may be related to the fact that the female pelvis is wider than the male pelvis and there is a greater degree of valgus at the knee, which results in a laterally directed force on the patella. Pain is the most frequent symptom and is usually poorly localized to the parapatellar area. The pain is aggravated by running, jumping, cutting, and stair climbing. There may be generalized soreness in the knee following activities. Swelling is a common complaint but usually does not imply a joint effusion and is rarely accompanied by objective findings. Crepitance or grinding is often noted. Some patients note that the patella seems to be slipping out of place. In others, giving way, popping, or locking are noted. The giving way occurs during activities and is momentary and not usually associated with a fall. The locking descriptions are not that the knee cannot be extended but rather that it is briefly difficult to extend. Hughston's description in 1968 is hard to improve upon: "Careful histories revealed that locking, popping, and giving out were different descriptions of the same disorder. The locking was not a true sustained limitation of extension of the knee, but rather a momentary and involuntary stoppage of the excursion of the knee toward full extension."[78] He hypothesized that these symptoms were the result of the subluxated patella slipping into the patellofemoral groove during forceful activities.

Physical findings are similar to those noted in patients with recurrent dislocations. The patella can be seen to track laterally before entering the intercondylar notch of the femur, especially when the examiner drops the leg just as the knee is beginning to flex. This is the J sign, as the patella alters its course from lateral to medial in order to enter the notch. Generalized ligamentous laxity may be present in the form of hyperextensible fingers, elbows, and genu recurvatum. The apprehension test (Fairbank's sign) is characterized by anxiety and guarding as the patella is pushed laterally by the examiner with the knee slightly flexed. The patella is more easily displaced laterally than normal. There may be tenderness around the patella, especially along the medial border, and the patella may be tilted in the femoral notch. Although there is not marked quadriceps atrophy, the vastus medialis is usually smaller and weaker than normal. Other occasional findings are external tibial torsion, increased femoral anteversion, genu valgus, and patella alta.

Diagnostic Studies. The same radiographic studies used for recurrent dislocation are also used to identify patients with recurrent subluxation. It should be emphasized that the diagnosis is made from clinical findings, and radiographs should be considered as supplying confirmatory evidence. Tilting or subluxation of the patella on a tangential view with 30 degrees of knee flexion has been reported to be a confirmatory finding (see Fig. 20–9).[78]

Treatment. The first line of treatment is conservative and focuses on relieving symptoms and subsequently on conditioning of the knee. Symptoms may be relieved by reduction of activities, nonsteroidal anti-inflammatory drugs (NSAIDs), and the use of a patellar stabilizing orthosis.[149,115] A well-designed physical therapy program should be instituted with straight-leg raising and isometric exercises until the tenderness resolves. Subsequently a full quadriceps rehabilitation is begun with an emphasis on the vastus medialis. Both closed- and open-chain quadriceps-strengthening exercises have been recommended. High-torque exercises may cause high articular cartilage pressures and should be avoided.[20]

Certain patients have subjective knee complaints that are related to major psychological disturbances. Some of them develop reflex sympathetic dystrophy, and in these patients

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PLATE 20–1. Semitenodesis for Recurrent Dislocation of the Patellofemoral Joint

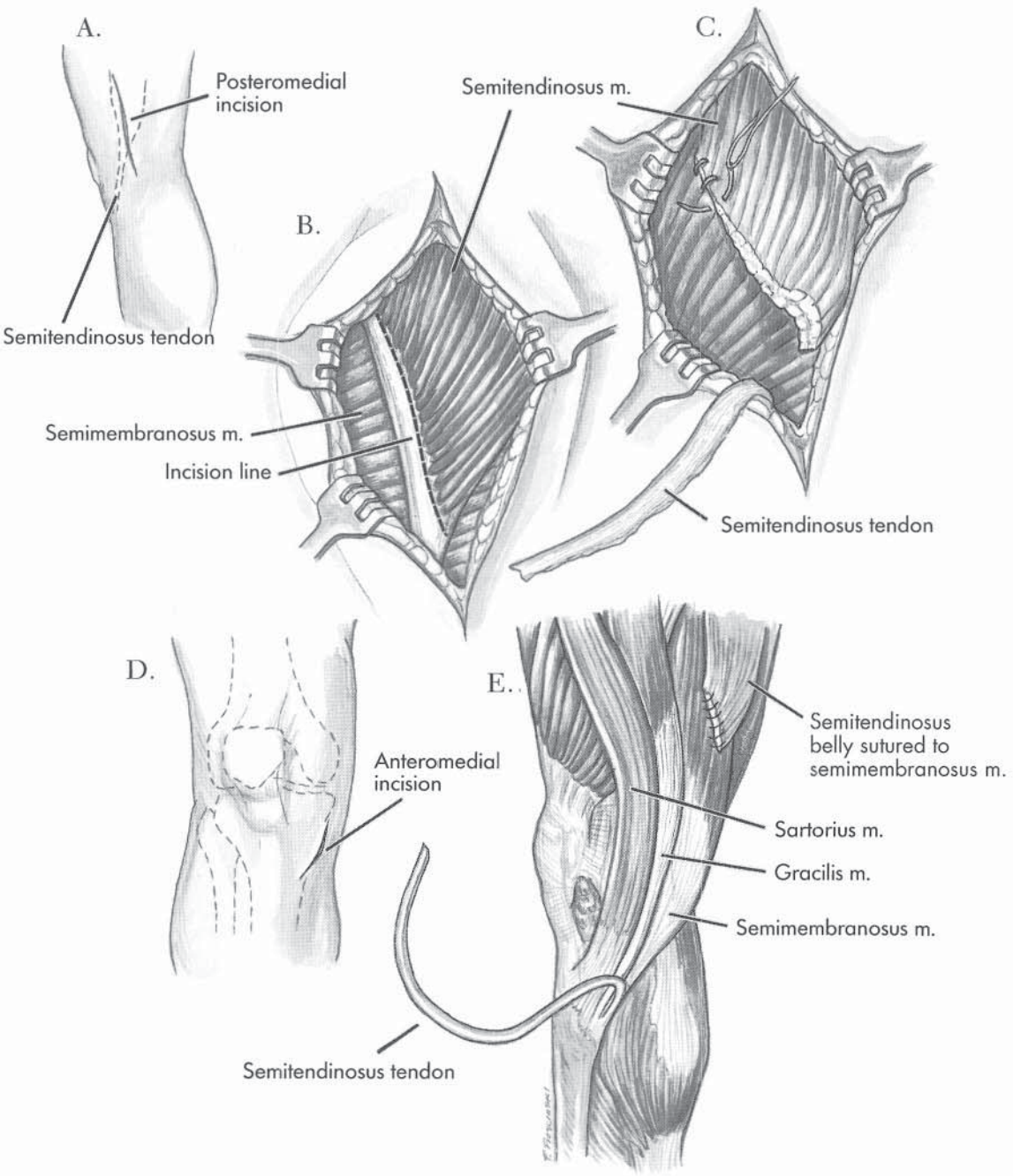


PLATE 20–1. Semitenodesis for Recurrent Dislocation of the Patellofemoral Joint

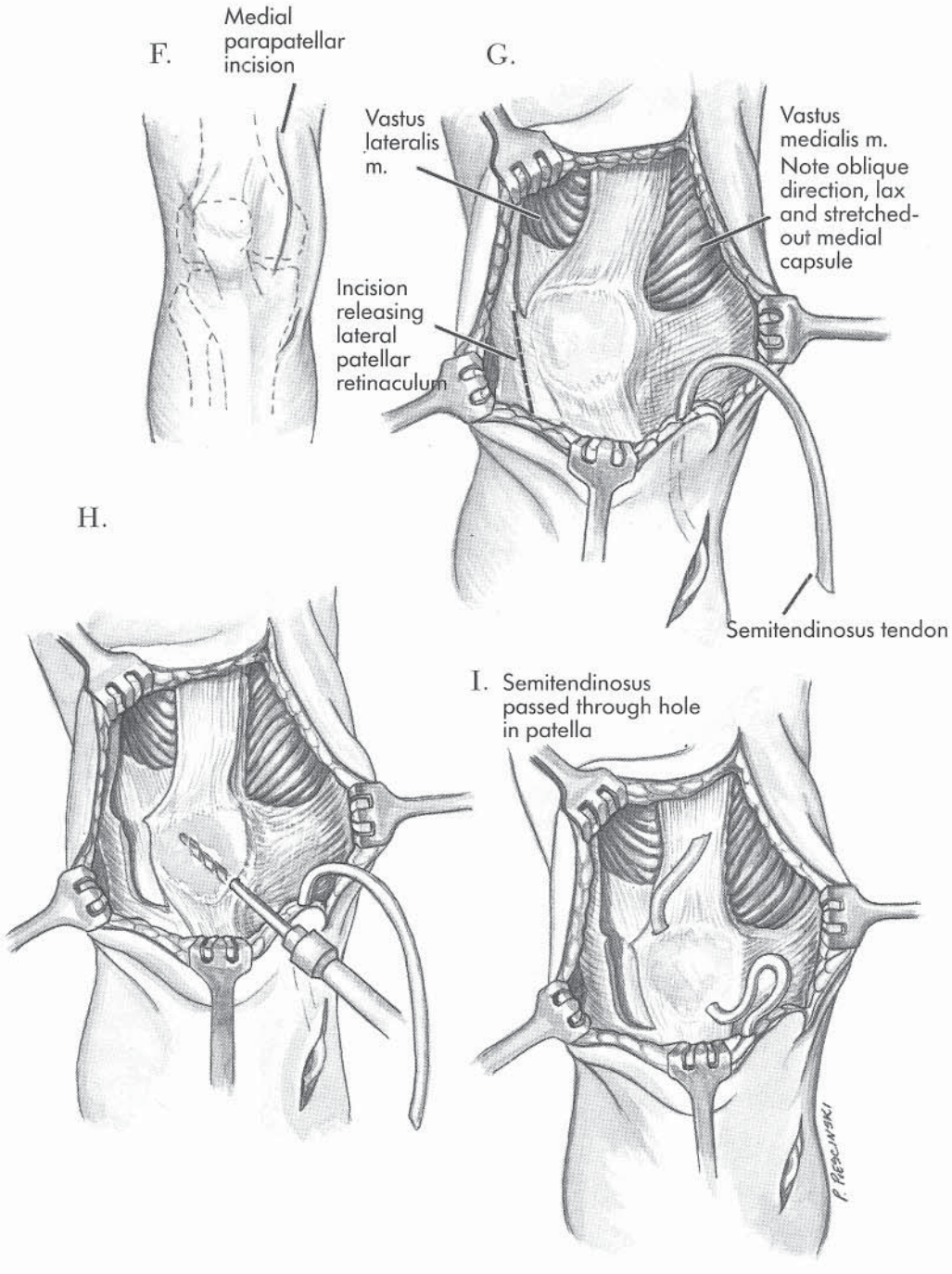


PLATE 20–1. Semitenodesis for Recurrent Dislocation of the Patellofemoral Joint

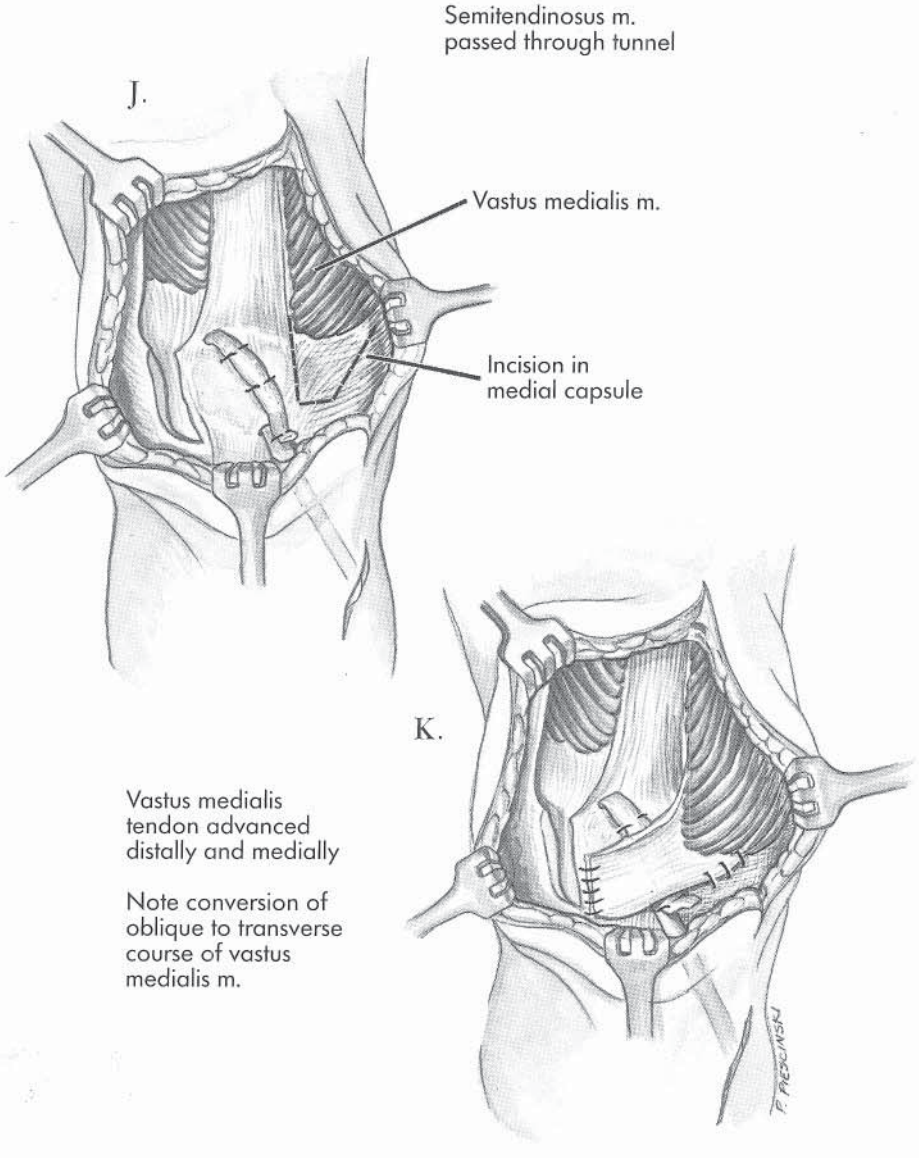


PLATE 20–2. Quadricepsplasty for Recurrent Dislocation of the Patella (Green)

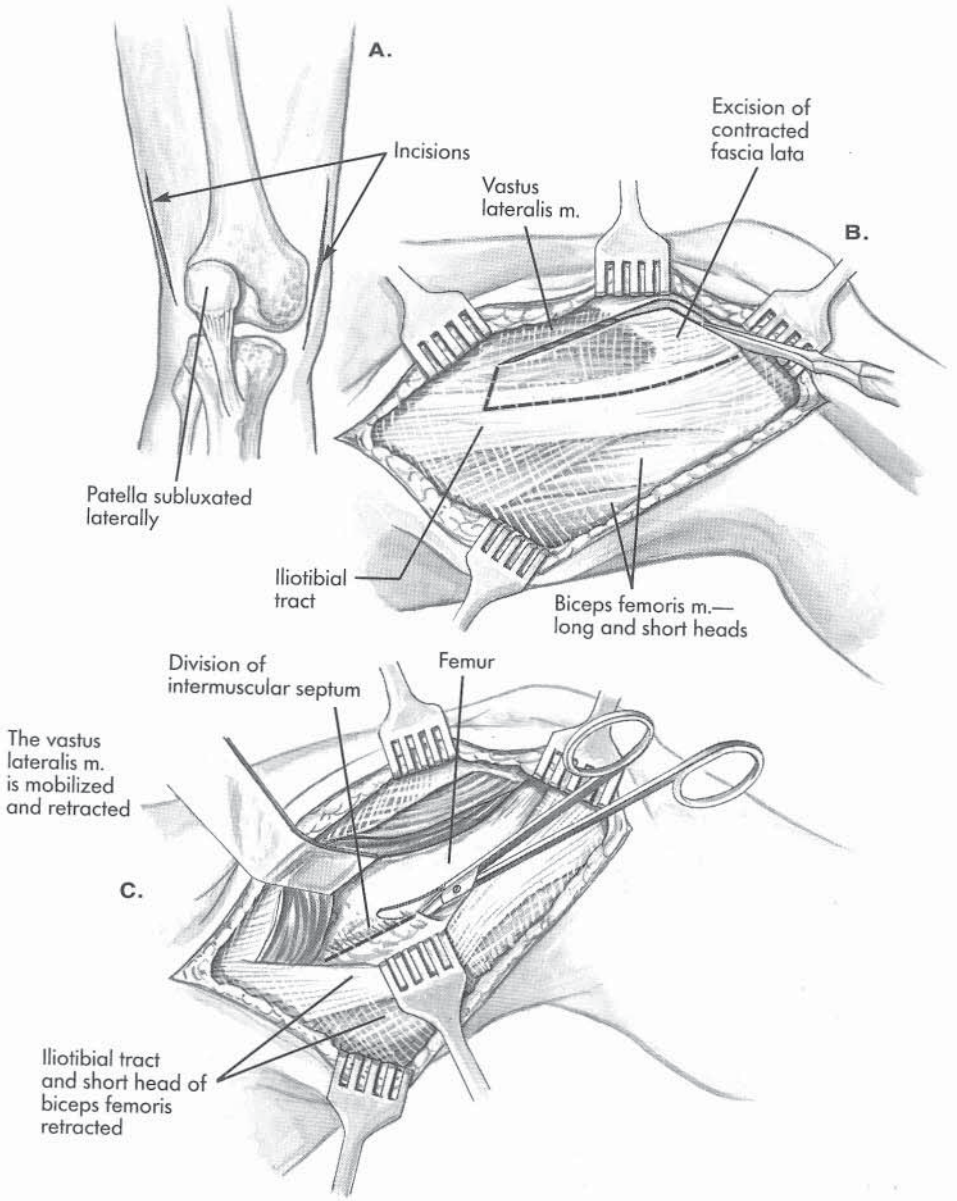
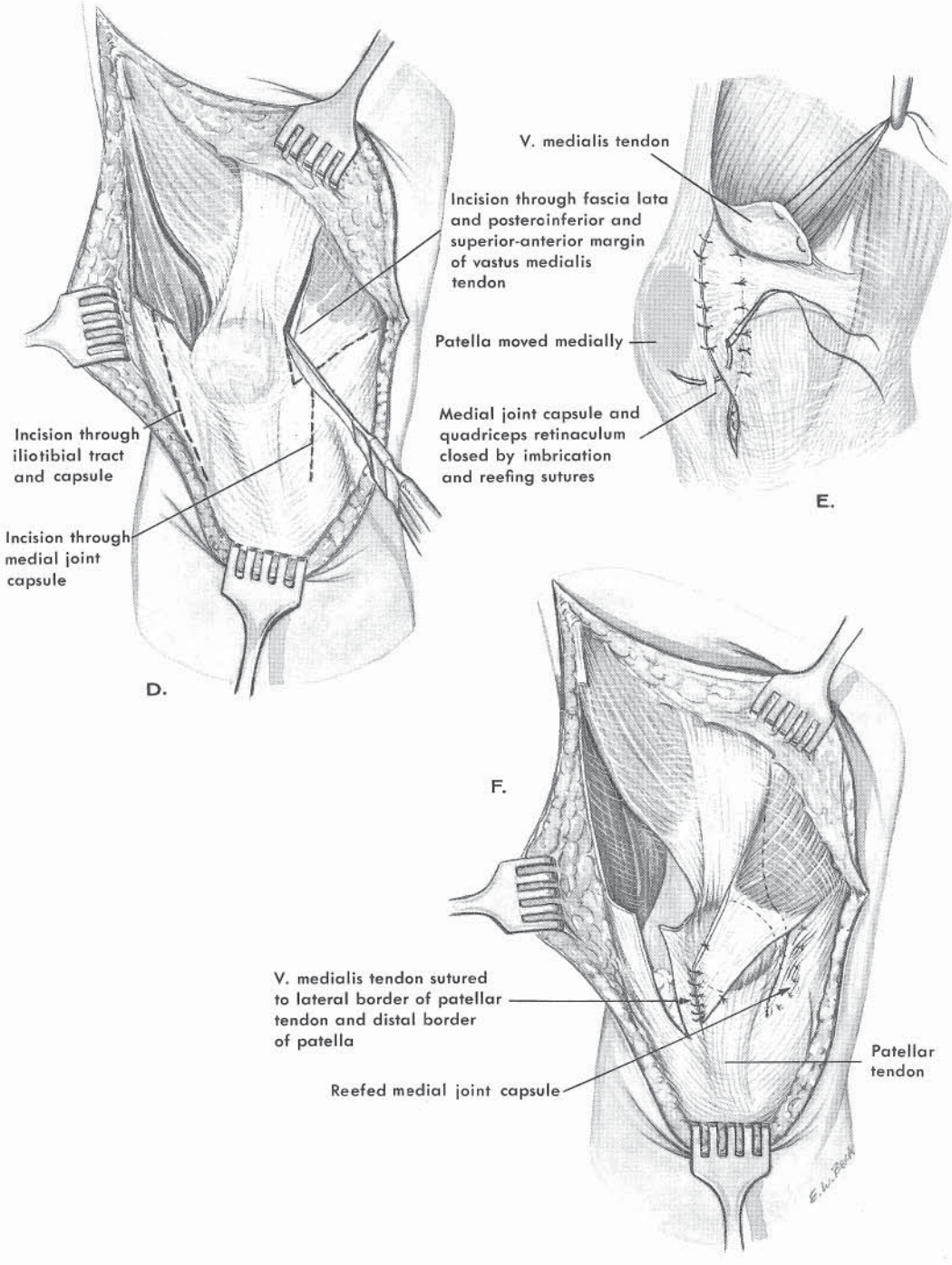


PLATE 20–2. Quadricepsplasty for Recurrent Dislocation of the Patella (Green)



One case has been reported of a large medial plica that caused a 40-degree flexion contracture in a 15-month-old child.[98]

DIAGNOSTIC STUDIES

There are no definitive diagnostic studies for the plica syndrome. Radiographs are normal. Arthrography can demonstrate a plica with reasonable accuracy.[113] MRI has been shown to be effective in demonstrating the presence and extent of plicae.[134] At arthroscopy a thickened band with a corresponding area of fibrillation on the femoral condyle is diagnostic. However, arthroscopic evaluation may also be equivocal. Strover and co-workers have described an arthroscopic technique that can demonstrate the plica and its impingement on the medial femoral condyle.[179] The diagnosis should be considered after other causes of knee pain have been excluded.

TREATMENT

Treatment should begin conservatively with rest, reduction of activities, and muscle rehabilitation.[48] In one study 40 percent of patients responded fully to conservative measures.[4] Simple release of the plica may be followed by recurrence, and arthroscopic resection of the plica usually relieves the symptoms.[48,59]

Bipartite Patella

The patella normally forms from one ossification center. Occasionally there are two or more centers of ossification, and if they fail to fuse, a bipartite or tripartite patella results. In three-quarters of the cases the accessory patellar portion is on the superolateral pole, in 20 percent of cases it is on the lateral margin, and in 5 percent it is on the inferior pole.

A bipartite patella is often asymptomatic and may be an incidental radiographic finding in about 2 to 3 percent of normal people.[34] Trauma may cause the fragment to separate through a fibrous union, which may then result in patellar pain. The pain is aggravated by squatting, stair climbing, and other activities that load the patellofemoral joint.

Plain radiographs reveal a separate fragment of patella with a lucent line between it and the remainder of the bone. If there is doubt as to the source of symptoms, a technetium bone scan may be helpful. Increased uptake on the scan indicates a recent fracture or separation likely to be the source of symptoms.[34,83] Another technique to evaluate mobility of the patellar fragment is to obtain skyline views of the knee with the patient squatting. In symptomatic patients the space between the fragments of patella will increase in the squatting position.[84]

TREATMENT

Painful bipartite patella in children rarely requires surgical treatment. Initial treatment should consist of reduction of activities, the use of NSAIDs, and, if necessary, immobilization in a knee immobilizer or cast for 3 to 4 weeks. Chronic and persistent symptoms that restrict activities may indicate a need for surgical treatment. Small fragments may be excised.[67,143,197] Bourne and Bianco reported relief of symptoms in 15 of 16 adolescents after fragment removal.[21]

Lateral release has also been advocated for the painful bipartite patella. Mori and colleagues reported on 16 knees and found that the separated fragment united with the patella after lateral release was performed.[132] Ogata described a modified technique in which the vastus lateralis is freed from the fragment subperiosteally while the continuity of the insertion of the lateralis tendon to the remainder of the patella is maintained. Unstable fragments are removed and stable fragments are left in place. He reported excellent results in 11 of 13 patients.[141]

Larsen-Johansson Disease

Larsen-Johansson syndrome is a condition characterized clinically by pain and tenderness over the inferior pole of the patella and radiographically by fragmentation of the pole. The cause is traction tendinitis with calcification in the attachment of a patellar tendon that was partially avulsed. Most patients seek medical attention after pursuing athletic activities, and the pain is aggravated by running, jumping, climbing stairs, and kneeling.[122]

The diagnosis is usually made from plain radiographs, which demonstrate calcification at the inferior pole of the patella (Fig. 20–18). Four stages are identified. In the first stage findings are normal, in the second stage there is irregular calcification at the inferior pole of the patella, in the third stage there is coalescence of the calcification, and in the fourth stage the calcification is incorporated into the patella.[122] Ultrasound has been used to make the diagnosis as well.[40]

Treatment is symptomatic, with most patients becoming asymptomatic with rest and anti-inflammatory medications. Occasionally Osgood-Schlatter disease is found in the same knee.

Congenital Dislocation of the Patella

Congenital dislocation of the patella is a distinct entity in which the patella is dislocated at birth.

CLINICAL PRESENTATION

The newborn with a congenital dislocation of the patella often has a deformity of the knee. There is a fixed flexion contracture of the knee and an apparent valgus deformity. On careful palpation, a tiny dislocated patella can often be felt just lateral to the lateral femoral condyle. At the same time the intercondylar notch feels empty. The knee usually cannot be fully extended actively or passively and the patella cannot be reduced.[66] If the child is untreated, there will be a loss of extension in gait, and there may be a progressive valgus deformity of the knee.

TREATMENT

Surgical realignment is indicated for congenital dislocation of the patella. We prefer to perform the procedure at about

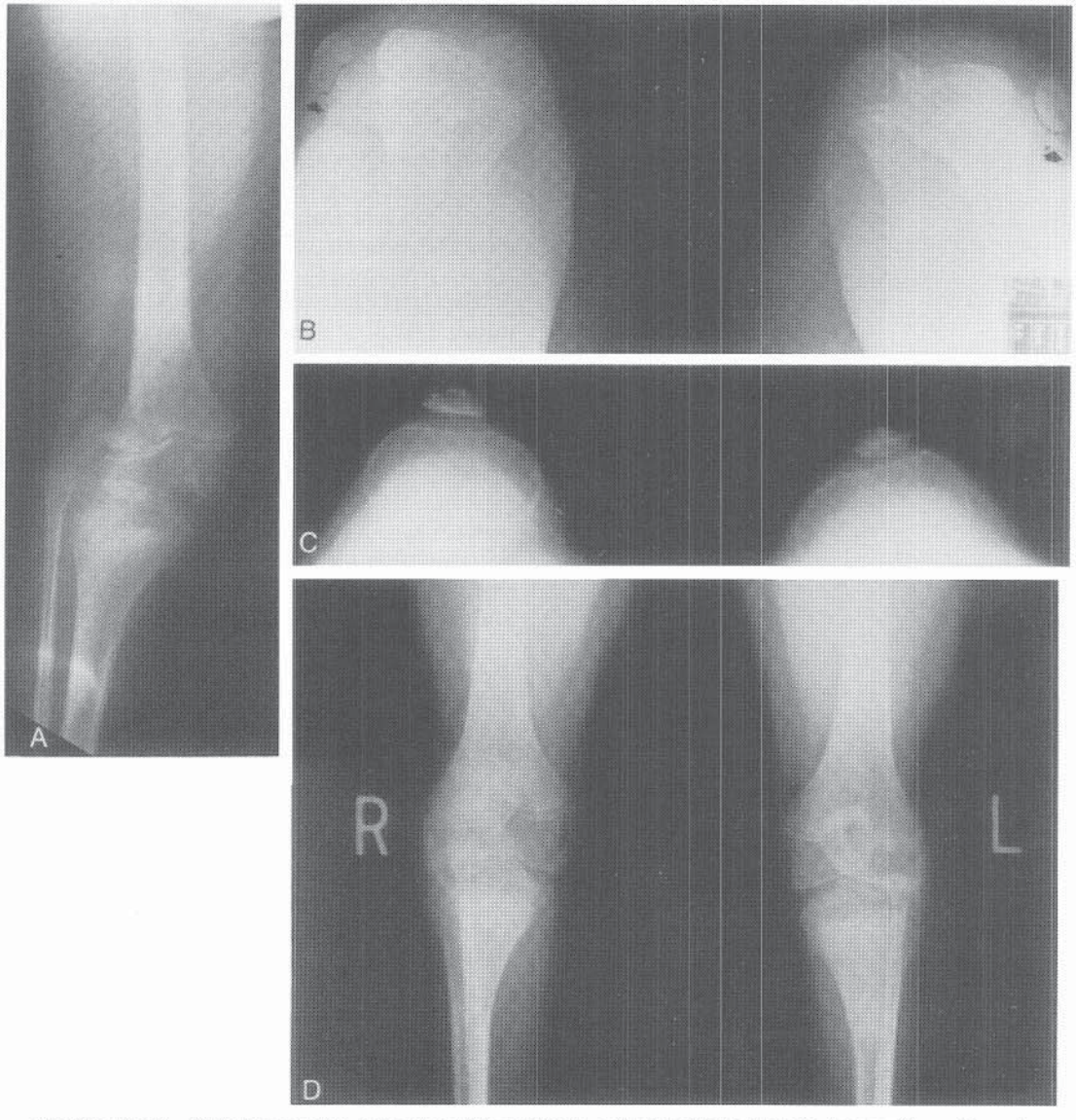


FIGURE 20–19 Bilateral congenital dislocation of the patellae in an 8-year-old girl. **A** and **B,** Preoperative radiographs showing complete lateral dislocation (*arrows*). **C** and **D,** Postoperative radiographs showing reduction.

mentary ossification of the tibial tubercle, which is often a normal variant. In late cases ossicles may form on the undersurface of the patellar tendon just as it reaches the tubercle. One study has shown an association of patella alta with Osgood-Schlatter disease (Fig. 20–20).[7]

TREATMENT

The treatment of Osgood-Schlatter disease should be conservative and expectant. Reassurance is important, as some parents fear that the swollen tubercle may be a sign of malignancy. Activity limitations should be left up to the child and family, with the understanding that this is not a progressive or crippling disorder. Thus, the activity that can be done with tolerable discomfort should be recommended. NSAIDs may be helpful, and a knee immobilizer may be used for a few weeks in severe cases.

Removal of ossicles from the tubercle may rarely be necessary in patients with persistent, disabling symptoms.[18,161] Mital and co-workers reported good results in 14 of 15 patients so treated.[129] Prominence of the tubercle has been the major complication after surgical management.[100] Trail followed patients for 5 years after removal of ossicles and found no benefit compared to conservative measures. In addition, postoperative complications included a marked bony prominence of the tubercle that at times required further surgery, the development of genu recurvatum, and wound healing problems.[184]

COMPLICATIONS

Early closure of the tibial tubercle with severe genu recurvatum has been reported with untreated Osgood-Schlatter disease.[88,114,178]

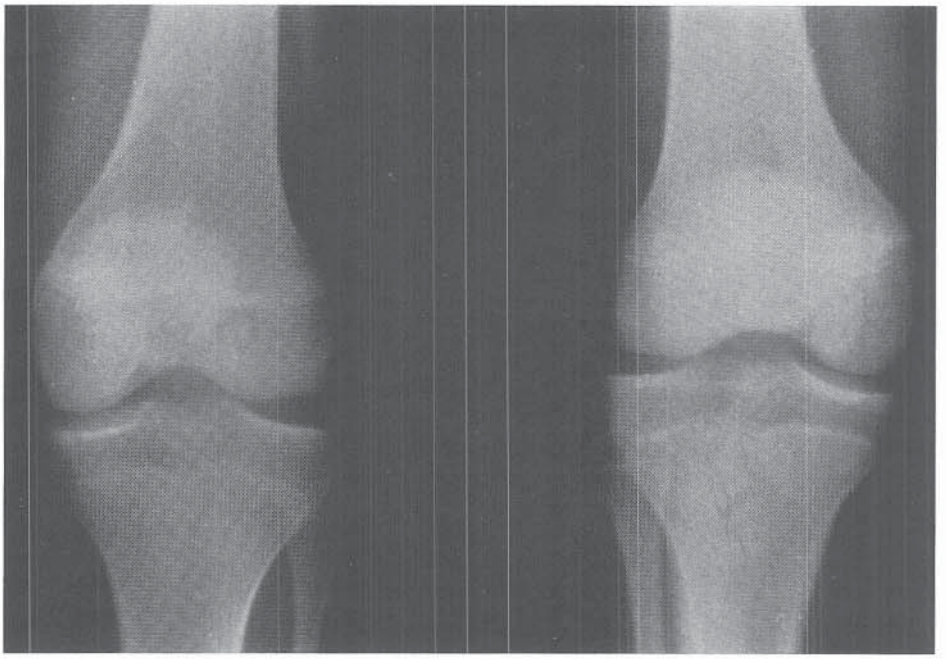


FIGURE 20–22 Widening of the lateral joint space of the right knee as a result of a thick discoid lateral meniscus.

extends. Along the lateral joint line the examiner feels a bulge as the meniscus seems to protrude beyond the margin of the tibia. As the knee moves, the meniscus snaps into the intercondylar notch and the bulge disappears.[92] There may be lateral joint line tenderness.

In some cases the knee may be locked and lack full extension. This implies a torn discoid meniscus.[16] Marked tenderness, locking, and an effusion also suggest a torn meniscus.

DIAGNOSTIC STUDIES

Plain radiographs may show widening of the lateral joint space. Widening is most easily seen when both knees are imaged on the same radiograph for comparison (Fig. 20–22). Other findings include flattening of the lateral femoral condyle (giving a squared-off appearance) and cupping of the lateral aspect of the tibial plateau.[50] Double-contrast arthrography has long been used to delineate the meniscus and possible tears. More recently MRI, when available, has replaced arthrography. Several studies have shown that MRI can demonstrate a discoid meniscus and most tears.[35,74,177] However, one group found that MRI had a low predictive value for tears (57 percent) compared with arthroscopy.[74]

TREATMENT

Many children with discoid meniscus require no treatment. The snapping and popping may be present for many years without pain or limitation of function. These children should be followed and treated only if pain or loss of motion or function occurs.

Excision of the meniscus should be considered when locking, swelling, loss of motion, inability to run, or inability to participate in sports occurs. The choices of treatment include open complete meniscectomy and—more commonly today—arthroscopic meniscectomy. Most authors agree that the Wrisberg type requires total meniscectomy (Plate 20–3). Arthroscopic meniscectomy may be partial, removing a torn fragment, or subtotal, leaving a small rim of meniscus, or total. The reported results of these procedures have varied. Pellacci and co-workers reported better results with partial than with total arthroscopic meniscectomies.[151] Vandermeer and Cunningham reported 55 percent good to excellent results, 30 percent fair results, and 15 percent poor results in a series of 25 knees treated by partial meniscectomy (Fig. 20–23).[189] On the other hand, Hayashi and co-workers in a series of 46 cases reported better results with total and subtotal removal of the meniscus.[77]

Long-term follow-up studies have shown mixed results following lateral meniscectomy. Washington and coworkers found no evidence of osteoarthritis in a 17-year follow-up of 18 patients after open total meniscectomy.[194] Raber and co-workers, on the other hand, found that 10 of 17 patients followed for 20 years had symptoms and radiographic findings of osteoarthritis after total meniscectomy.[154] Wroble and others found in a 21-year follow-up of medial and lateral meniscectomies that 71 percent of patients reported pain, 68 percent reported stiffness, 54 percent reported swelling, and only 27 percent were free of symptoms. The results were worse in those followed longer than 26 years. Few differences were noted between medial and lateral meniscectomies.[201] These findings reinforce the recommendation that one should not remove the relatively asymptomatic discoid meniscus.

Congenital Dislocation of the Knee

Congenital dislocation of the knee was first described by Chanssier in 1812 and Chatelain in 1822.[17,156] It is a rare disorder with a prevalence estimated at 0.017 per thousand,

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PLATE 20–3. Excision of a Discoid Lateral Meniscus by a Direct Lateral Approach

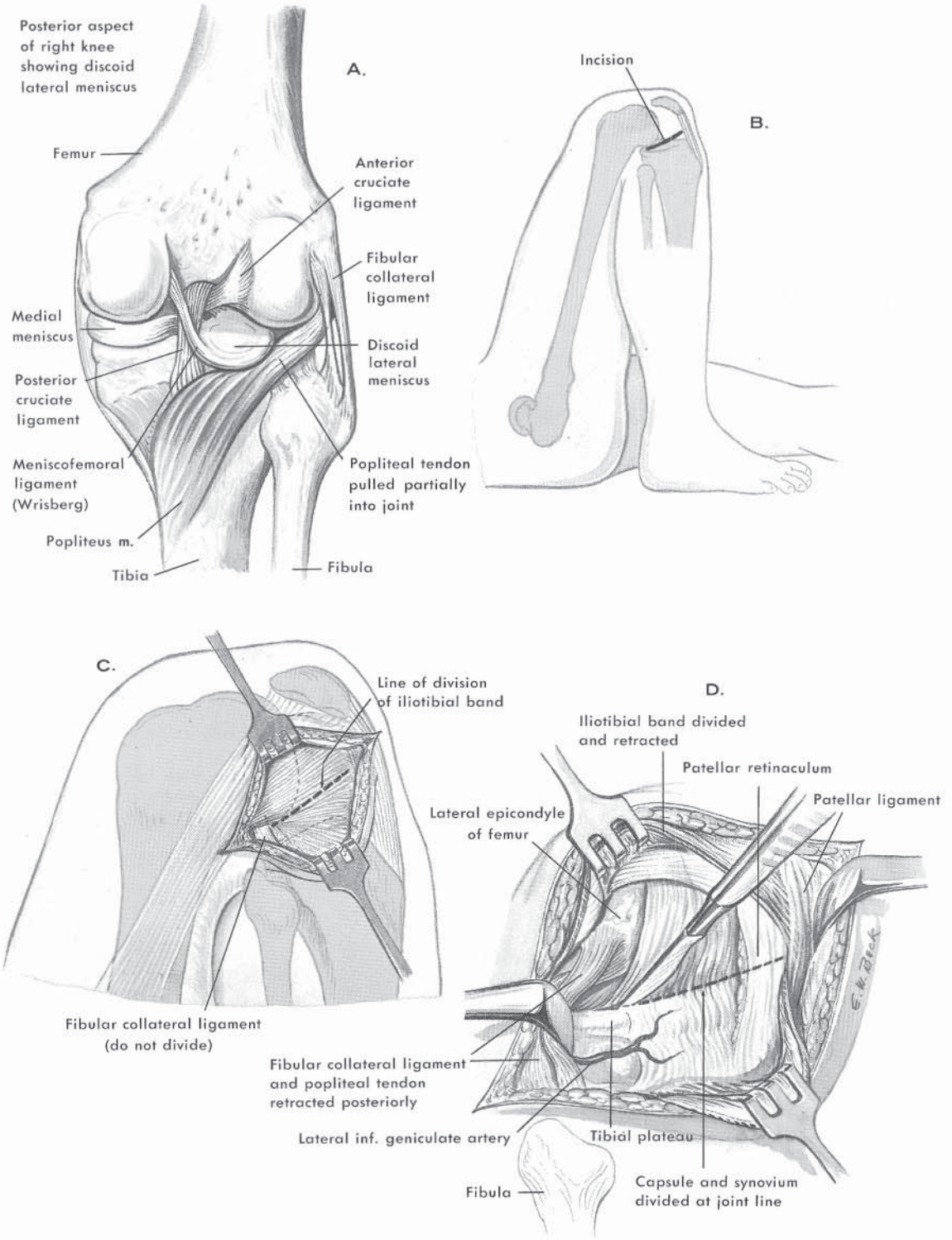


PLATE 20–3. Excision of a Discoid Lateral Meniscus by a Direct Lateral Approach

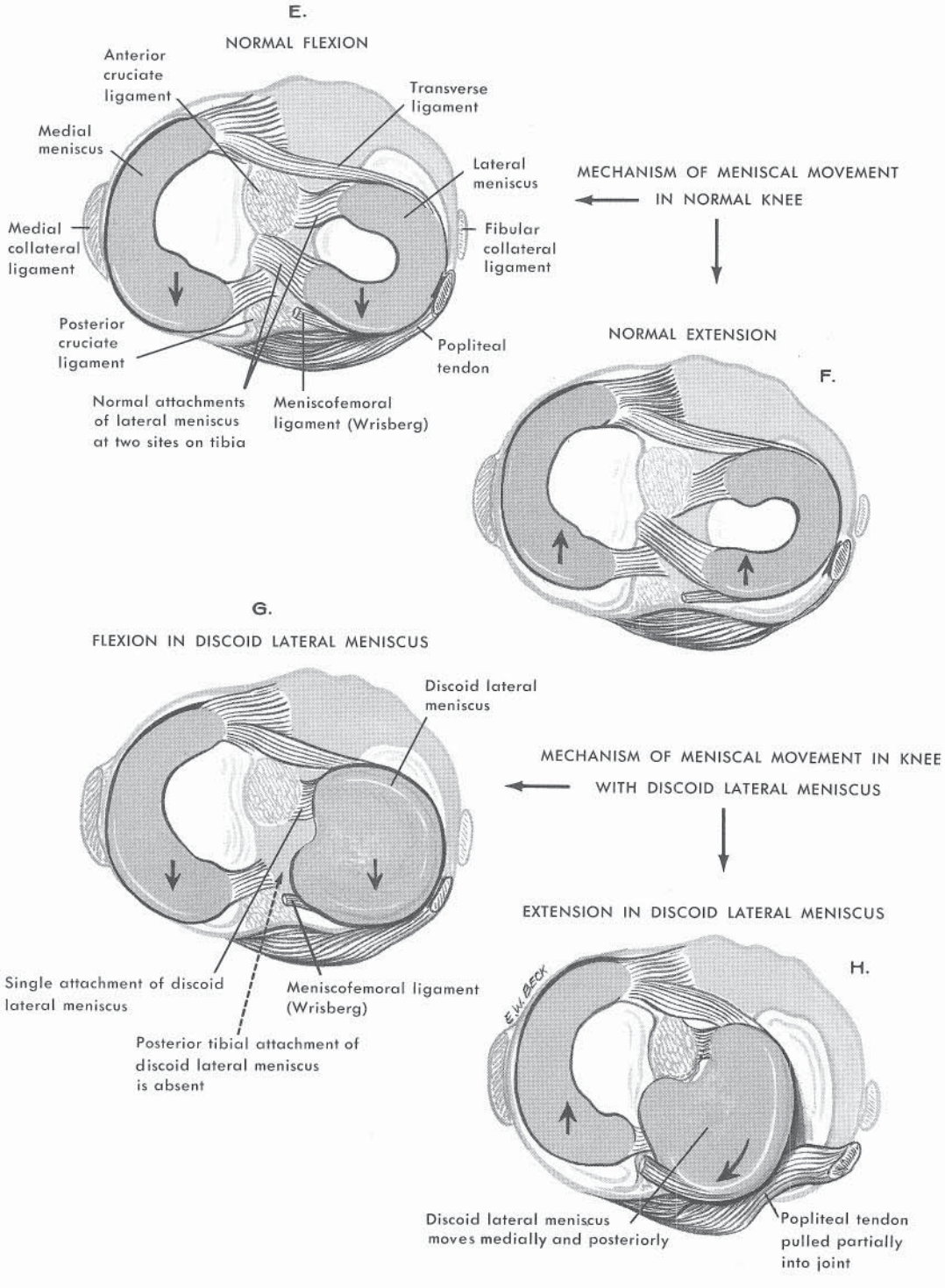
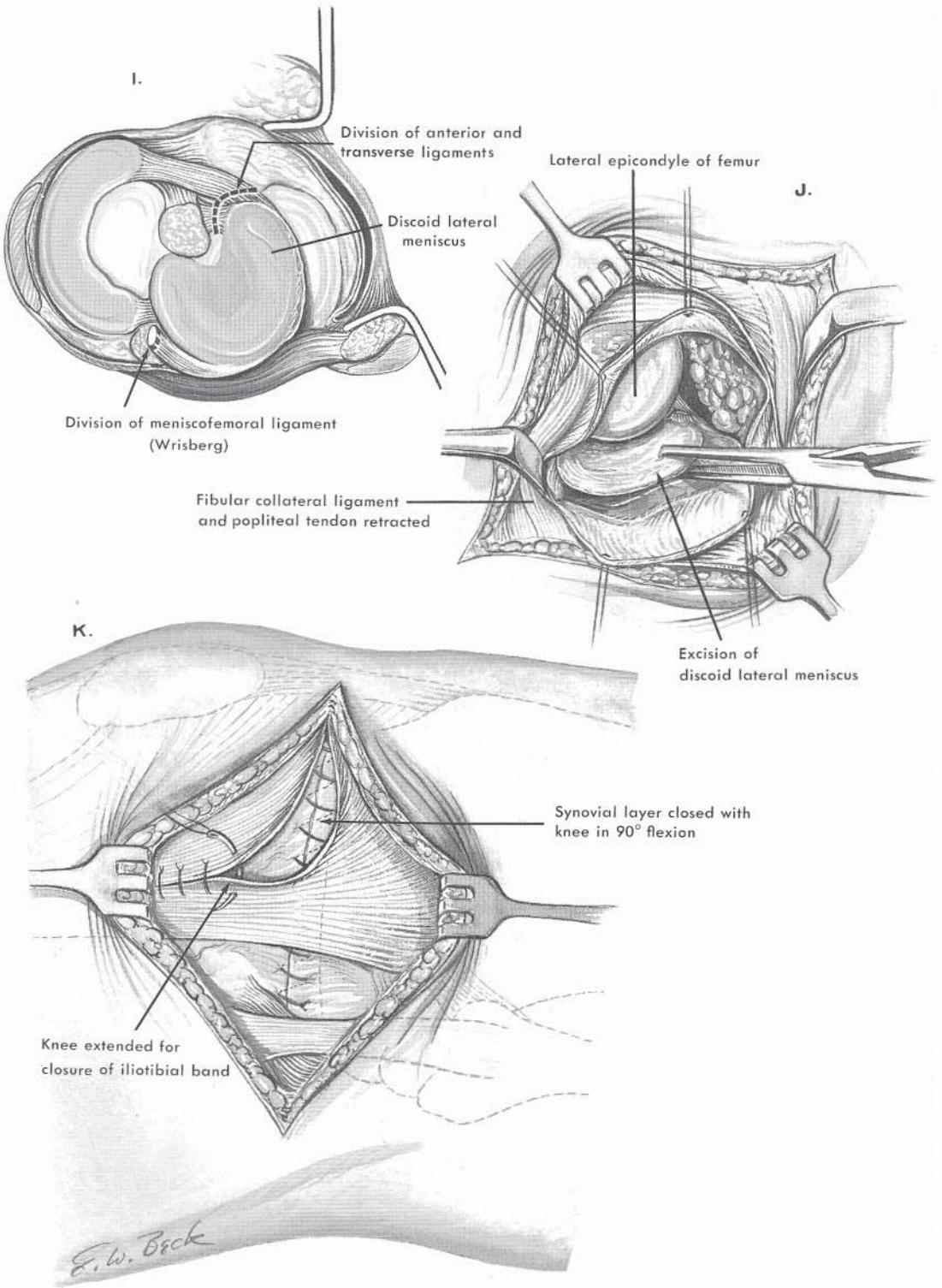


PLATE 20–3. Excision of a Discoid Lateral Meniscus by a Direct Lateral Approach



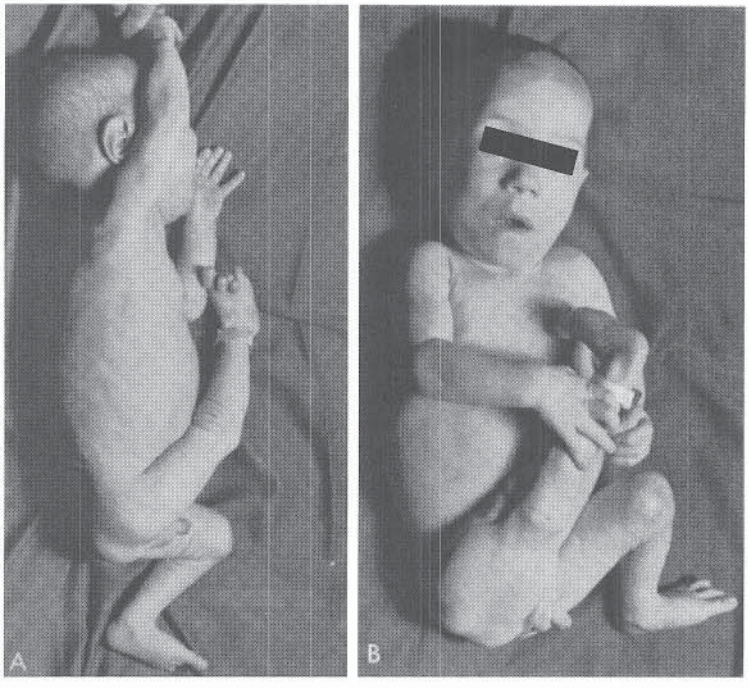


FIGURE 20–25 Congenital dislocation of the right knee in a newborn infant. **A** and **B,** Clinical appearance of the deformity. Note the prominence of the femoral condyles posteriorly in the popliteal area and the transverse skin folds and creases in the anterior aspect of the knee joint.

Illustration continued on following page

mity is possible, but the knee cannot be brought into flexion. In severe cases with dislocation of the tibia, the tibial plateau can be palpated anterior to the femur and cannot be reduced. The patella may be palpable, and the quadriceps is usually atrophic.

The clinical appearance is alarming, and has been described as "knees on backwards." The frightened parents should quickly be reassured that the condition is treatable, with good functional and cosmetic results.

ASSOCIATED DISORDERS

Congenital dislocation of the knee is found in Larsen's syndrome, myelodysplasia, Ehlers-Danlos syndrome, Streeter's syndrome, and arthrogryposis.[90] Ipsilateral congenital dislocation of the hip is present in 70 to 100 percent of cases.[17,37,90,93]

Bensahel and co-workers reviewed 56 cases treated at nine centers and found that 21 were bilateral, in 48 there was dysplasia or dislocation of the hip, and 30 had clubfeet.[17] In 46 cases anomalies of the hands, elbows, face, spine, or urogenital or gastrointestinal system were present. Johnson and co-workers found a 30 percent incidence of breech delivery, a 70 percent incidence of hip dysplasia, and a 41 percent incidence of clubfoot.[90]

DIAGNOSTIC STUDIES

Initial radiographs demonstrate the position of the tibia relative to the femur and allow classification. The ossification centers of the distal femur and proximal tibia in a full-term infant are usually present. The patella is not ossified in infancy but is usually present. In older children radiographs may show hypoplasia of the intercondylar eminence of the tibia, hypoplasia of the tibial plateau, abnormal femoral condyles, patellar hypoplasia, patellar elongation, femoral hypoplasia, proximal tibial bowing, genu valgus, absent patella, and absence of the proximal fibula.[70,90]

PATHOLOGY

Common findings include fibrous contracture of both the quadriceps and fascia lata. The quadriceps is atrophic and, along with the patella, has fibrous adhesions to the femur.[17,37,90,187] There is often absence of the suprapatellar pouch and anterior dislocation of the hamstring tendons. The anterior cruciate is markedly elongated or even absent.[37,93,145]

CLASSIFICATION

Leveuf and Pais classified the disorder into three groups,[108] with grade I being severe genu recurvatum, grade II subluxation of the tibia, and group III complete dislocation (Fig. 20–26).

TREATMENT

Nonoperative treatment should be started as soon as possible. With the baby as relaxed as possible, manual traction is applied to the tibia to stretch the contracted quadriceps muscle. As the quadriceps stretches, the tibia is felt to engage the femoral condyles. Only after the tibia reaches the distal femur can flexion of the knee be attempted. In cases with simple hyperextension some flexion may be possible at the outset. In complete dislocations the knee can be flexed only after prolonged efforts at stretching. In a few cases we have used local anesthesia to block the femoral nerve, which may allow enough quadriceps relaxation to flex the knee. After the period of stretching a long-leg cast is applied with the knee in as much flexion as possible.

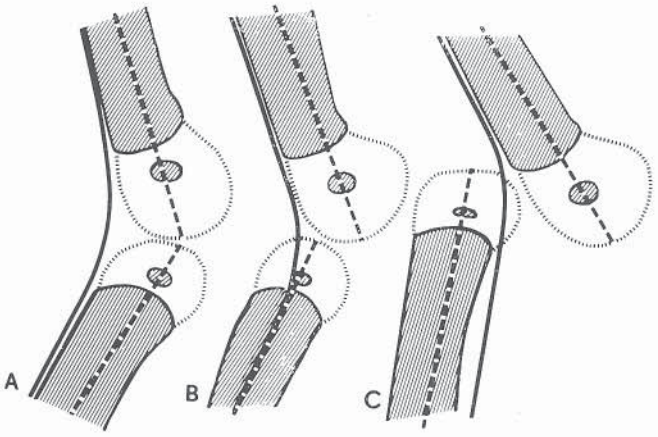


FIGURE 20–26 **A,** Congenital hyperextension of the knee. **B,** Congenital subluxation of the knee. **C,** Congenital dislocation of the knee. (From Curtis BH, Fisher RL: Congenital hyperextension with anterior subluxation of the knee: surgical treatment and long-term observations. J Bone Joint Surg 1969;51-A:255.)

In children with developmental dislocation of the hip, treatment of the hip cannot be started until after some flexion of the dislocated knee is achieved.[145] When the knee can be flexed, the baby can be placed in a Pavlik harness, which facilitates the treatment of both the hip and knee.[85,138] In those with clubfeet, corrective casts may be applied along with the casts used to treat the knees.

Surgical treatment is indicated after an initial trial of stretching and casting or splinting has failed. Early surgery offers the best possibilities of remodeling and is best started at around 6 months of age.[15,17] A progressive release is performed and will vary, depending on the severity and location of the contractures. Usually the fascia lata must be sectioned. The vastus lateralis is released from the intermuscular septum and from the femur. The patella and quadriceps tendon are released from the femur. The tendon of the quadriceps is lengthened by V-Y-plasty to allow 80 to 90 degrees of knee flexion. Some recommend shortening of the hamstrings to stabilize the knee.[15,17,54,90] At times a femoral shortening may facilitate reduction.

RESULTS

Nonoperative treatment usually results in better stability, range of motion, and quadriceps strength than operative treatment.[17] (Because more severely affected knees must be treated operatively, this may be a self-fulfilling prophecy.) Most surgically treated knees gain satisfactory range of motion, and quadriceps strength varies with the degree of initial quadriceps fibrosis and atrophy.[17]

Congenital Tibiofemoral Subluxation

Congenital tibiofemoral subluxation, also called congenital snapping knee, is an extremely rare disorder that is usually noted in children with other skeletal dysplasias (Fig. 20–27). It is characterized by anterior subluxation of the tibia on the femur when the knee is extended and reduction of the subluxation with the knee in flexion. The affected child either walks with the knee flexed to avoid the subluxation or walks with the knee extended and the tibia subluxated.

The first description was by Curtis and Fisher in 1970.[38] They reported findings in ten knees in five patients, all of whom had features of skeletal dysplasias with positive family histories. Two had Larsen's syndrome, one had chromosomal abnormalities, and one had otopalatodigital syndrome. Ferris and Jackson reported findings in six knees in four children; the associated conditions included Larsen's syndrome, Catel-Manzke syndrome, and congenital short tibia (Fig. 20–28).[56] We have also seen this condition in patients who have undergone surgery for congenital dislocation of the knee (see Fig. 20–27).

CLINICAL FINDINGS

The presenting complaint is a snapping knee and an odd physical appearance. In some cases the child walks with the knees flexed. On examination the tibia subluxates forward as the knee is extended. This happens at about 30 degrees of knee flexion and may be accompanied by an audible snap. With flexion the tibia returns to a reduced position with another snapping sound. Some children walk with the knee extended and subluxated; others walk with the knee flexed. The anterior drawer test and Lachman's test are markedly positive.

RADIOGRAPHIC FINDINGS

Plain radiographs demonstrate anterior subluxation of the tibia when the knee is in extension. There is often flattening of the anterior portion of the femoral condyles and the posterior portion of the tibial plateau.

PATHOLOGY

Curtis and Fisher explored several knees and found hypertrophy of the iliotibial tract, intermuscular septum, and biceps femoris. They found normal cruciates, but other authors have found elongated or absent anterior cruciate ligaments.[38,55]

TREATMENT

Curtis and Fisher performed a release with sectioning of the iliotibial band and distal portion of the intermuscular septum. They released the insertion of the biceps tendon and sutured it to the vastus lateralis. Their patients did well, without recurrence of the subluxation.[38]

Acquired Genu Recurvatum

Genu recurvatum may develop in a growing child by several mechanisms. In paralytic disorders, genu recurvatum is initiated by muscle imbalances in gait that force the knee into hyperextension in stance phase. For example, when there is spasticity of the gastrocsoleus that exceeds the spasticity of the hamstrings, the tibia is drawn backward as the gastrocnemius plantar flexes the foot against the floor. In poliomyelitis with quadriceps paralysis the knee is passively

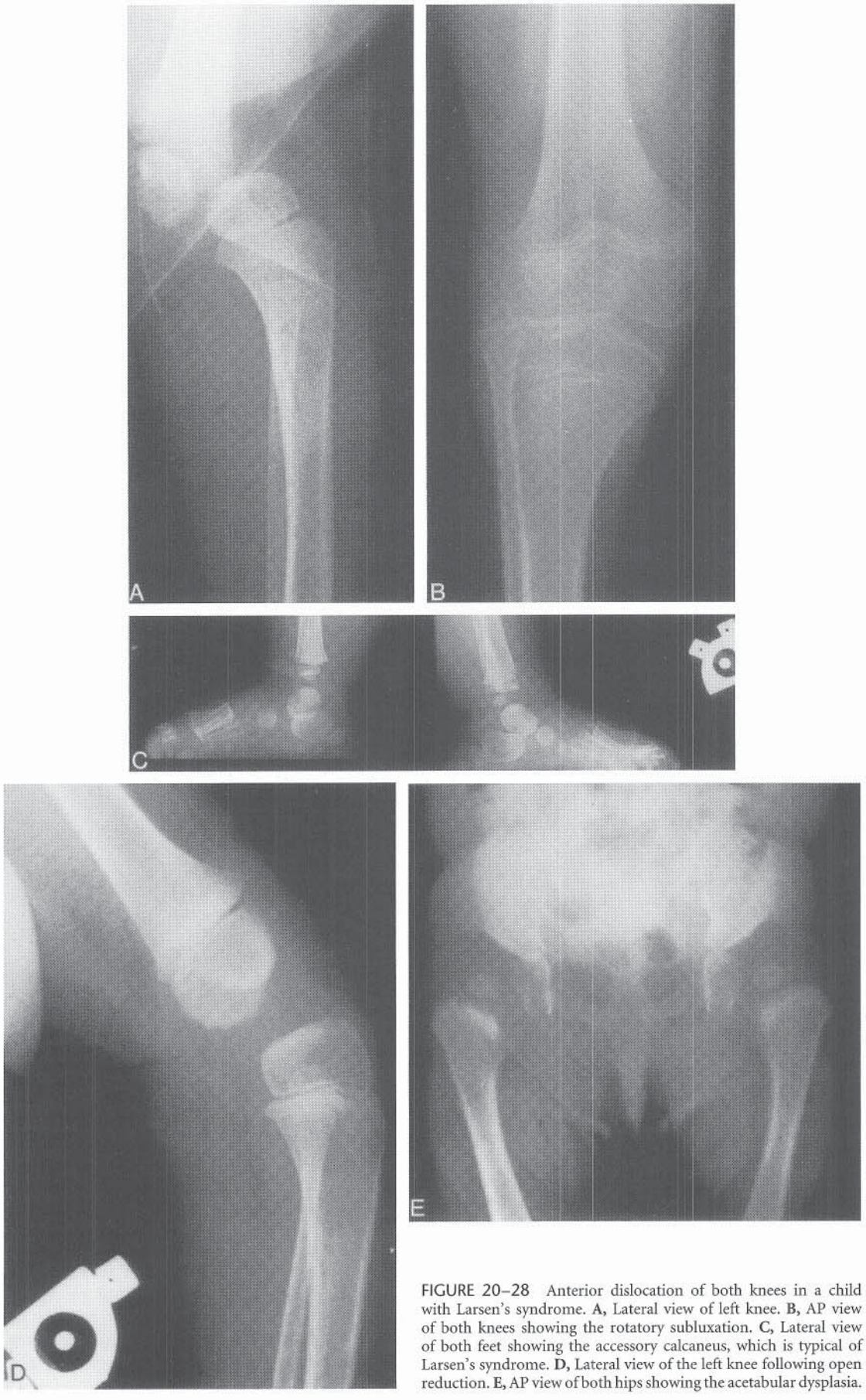


FIGURE 20–28 Anterior dislocation of both knees in a child with Larsen's syndrome. **A,** Lateral view of left knee. **B,** AP view of both knees showing the rotatory subluxation. **C,** Lateral view of both feet showing the accessory calcaneus, which is typical of Larsen's syndrome. **D,** Lateral view of the left knee following open reduction. **E,** AP view of both hips showing the acetabular dysplasia.

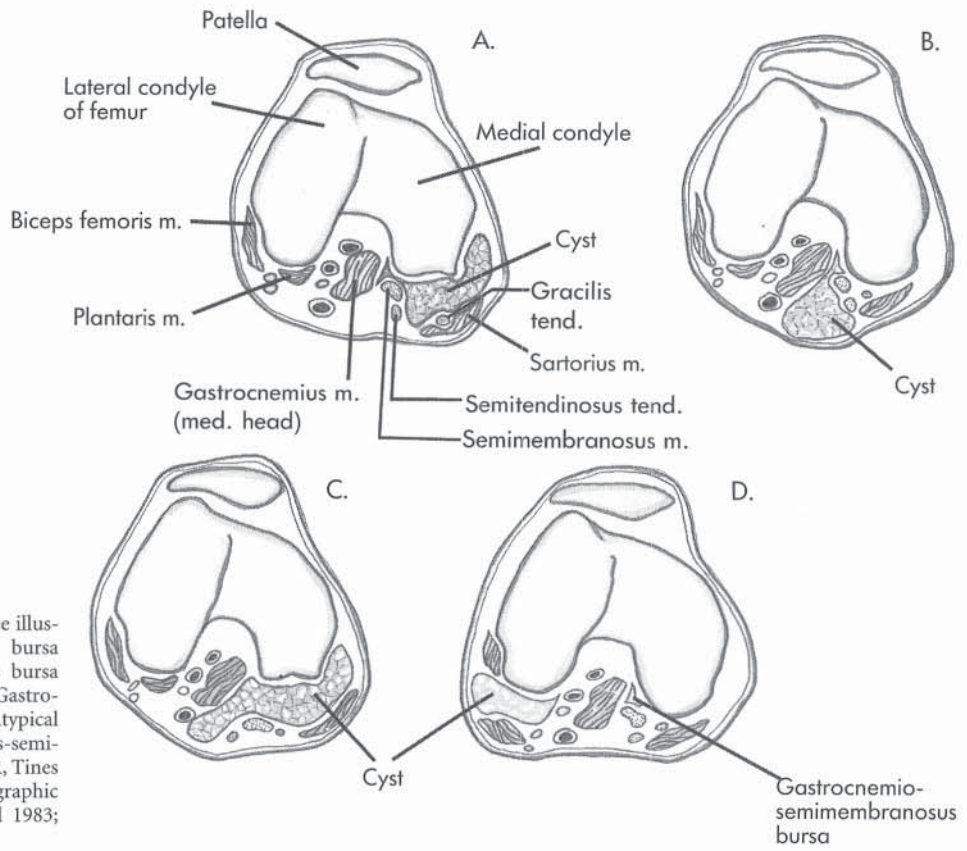


FIGURE 20–30 Cross-sections of the knee illustrating gastrocnemius-semimembranosus bursa and popliteal cyst. **A,** Semimembranosus bursa cyst. **B,** Gastrocnemius bursa cyst. **C,** Gastrocnemius-semimembranosus bursa cyst. **D,** Atypical popliteal cyst and normal gastrocnemius-semimembranosus bursa. (Redrawn after Lee KR, Tines SC, Price HI, et al: The computed tomographic findings of popliteal cysts. Skeletal Radiol 1983; 10:26.)

If significant growth remains, a contralateral epiphysiodesis should be considered. If the recurvatum exceeds 10 degrees and if there are noticeable cosmetic and gait deviations, a corrective osteotomy is indicated. Operative options include opening wedge osteotomy of the tibia with or without transfer of the tibial tubercle,[133] gradual anterior opening osteotomy with callotasis,[140,152] and posterior closing wedge osteotomy of the tibia.

Recurvatum that is primarily due to soft tissue abnormalities or muscle imbalances should be treated by appropriate muscle and soft tissue balancing procedures. With established bony deformity these also may require corrective osteotomies.[124]

Popliteal Cysts

Cystic masses filled with gelatinous material develop in the popliteal fossa in children. They are usually minimally symptomatic and not related to intra-articular pathology. Spontaneous resolution is the usual course. They have also been called Baker's cysts.

CLINICAL PRESENTATION

The usual presenting complaint is that of a mass behind the knee. It often arises gradually and may be fairly large when first noticed. Occasionally it is found after an injury. Complaints of pain are unusual, and unlike in adults, there are no symptoms of internal derangement of the knee.

Physical examination reveals a firm cystic mass in the popliteal fossa, often medially located and usually distal to the popliteal crease. It is most prominent when the knee is hyperextended and the patent is prone (Fig. 20–29).

DIFFERENTIAL DIAGNOSIS

Popliteal cysts are common with arthritic disorders, with 61 percent of children with arthritis having popliteal cysts in one series.[180] Chronic infectious processes may also produce popliteal cysts. Pigmented villonodular synovitis may also present as a popliteal mass.[123] Other tumors such as lipoma, popliteal artery aneurysm, enlarged lymph nodes, synovial sarcoma, and osteosarcoma have been mistaken for popliteal cysts.

PATHOLOGY

The commonest site of origin is the bursa of the gastrocnemius and semimembranosus. This bursa extends proximally around the inner border of the origin of the medial head of the gastrocnemius, partially covering the muscle superficially. It extends transversely over the deep surfaces of the gastrocnemius and semimembranosus muscles and then reflects onto the articular capsule over the upper part of the medial condyle of the femur.[200] The cysts often arise in the bursa deep to the medial head of the gastrocnemius. Some may arise laterally, and any may elongate to extend down into the calf. In one study about half the cysts arose from bursae (Fig. 20–30).[26] Another site of origin, accounting for about a third of the popliteal cysts, is a herniation through the posterior joint capsule of the knee.

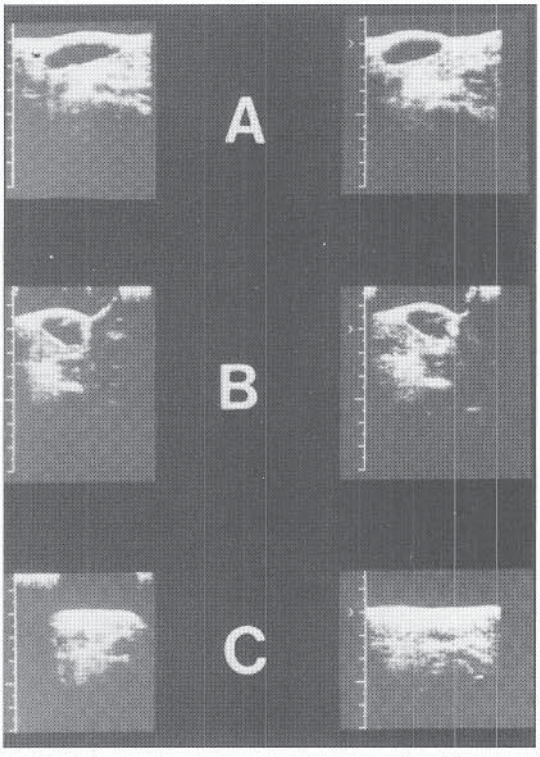


FIGURE 20–32 Sonograms of both knees showing a popliteal cyst on the right. **A** and **B,** Sagittal images showing a large echo-free mass in the popliteal fossa of the right knee. **C,** The normal left knee.

Histologically the cysts are classified as fibrous, synovial, inflammatory, or transitional (Fig. 20–31). Fibrous cysts have a well-defined fibrous wall with a glistening inner surface of hyalinized fibrous tissue. Rice bodies may be found along the surface of these cysts. Synovial cysts have a thicker wall with a villous lining. The lining cells resemble synovial cells. Inflammatory cysts have an even thicker wall and an adherent fibrinous exudate composed of an inflammatory infiltrate. Transitional cysts are intermediate in character. It is likely that these types are not indicative of different conditions but rather are variations on a similar process.

DIAGNOSTIC STUDIES

A simple diagnostic test is transillumination of the cyst. The cystic nature can be confirmed by darkening the examination room and placing a flashlight against the cyst. A cyst brightly transilluminates; a solid tumor does not. Ultrasound is also useful in distinguishing a solid mass from a cystic lesion.[1,180] In one study 11 of 13 popliteal cysts were correctly diagnosed with ultrasound.[1] Ultrasound, however, cannot be used to unequivocally rule out the presence of a soft tissue component lining a cyst wall (Fig. 20–32). Plain radiographs should be obtained in order to detect other lesions such as osteochondromas, osteochondritis dissecans, and malignancies.

MRI clearly defines the cyst, and it also has a good chance of delineating more aggressive soft tissue components.

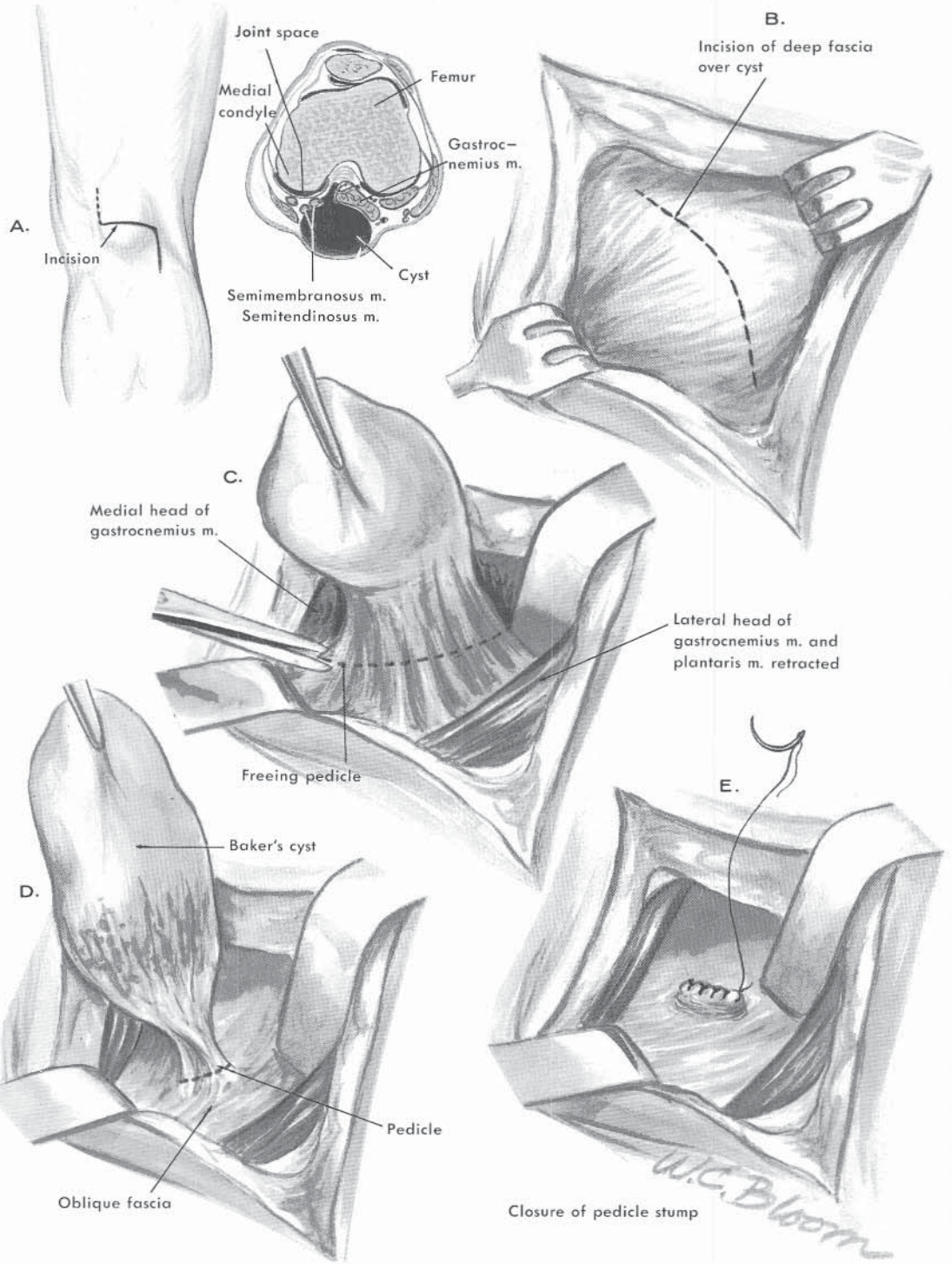
TREATMENT

In the vast majority of cases, popliteal cysts should be left alone. When the features are typical and plain radiographs are normal, further diagnostic studies are not indicated. The cyst will usually resolve over a period of months to a few years.[41,116] In addition, surgical removal is often fraught with recurrence of the cyst. Dinham followed 120 popliteal cysts in children. Over 70 percent of untreated cysts spontaneously resolved over a mean of 20 months, while 42 percent of surgically treated cysts recurred. Three children underwent more than one additional operation, and in one child the cyst persisted after five operations.[47]

Surgical excision of a popliteal cyst is indicated only when symptoms are severe and limiting and have not resolved with at least several months of follow-up. The operative technique is illustrated in Plate 20–4. If any solid mass is present within the cyst, a frozen section should be obtained in the operating room.

Surgical biopsy is indicated when there is evidence of some other pathologic entity, and should be performed within the guidelines for biopsy of possibly malignant lesions. Clinical indicators of possible malignancy include systemic signs such as weight loss, night pain, rapid enlargement. The presence of a solid mass detected on examination or MRI indicates exploration.

PLATE 20–4. Excision of a Popliteal Cyst



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