68 Knee injury

68.1 introduction

Severe knee injuries may tear the menisci, the collateral or cruciate ligaments, or break the bones that form the joint. As with the ankle, ligamentous injuries are often missed and cause prolonged disability. Occasionally, the patella or even the whole knee may dislocate.

A severe injury makes the knee swell so much that you cannot tell where the fractures are except with a radiograph.

Fortunately, there are adequate closed methods for most knee fractures, and for most soft tissue injuries. *Don't try to operate inside the knee*.

HISTORY

This is vital. If there was a direct injury to the knee, the history is straightforward. If, however, nothing touched it, but instead, the foot locked on the ground and the knee twisted inwards in flexion, and is now acutely painful, ask these questions:

How soon did the knee swell? If it swelled immediately, it is probably full of blood as the result of the rupture of a larger vessel. If it swelled more slowly over 6-8h, a smaller vessel has ruptured, or there is a sympathetic effusion.

If engaged in vigorous activity, such as playing football, is continuing playing feasible?

If the patient: (1) felt a snap or a pop, or (2) has had previous episodes, or (3) has locking and pain on weight bearing, there is probably an injured meniscus.

Where is the pain?

EXAMINATION: LOOK, FEEL & MOVE

Sit the patient on a couch with the knees over its edge, and remove trousers and shoes. Look at and feel the muscles of the thighs. Look for atrophy, and compare both sides. If necessary, compare their circumferences with a tape measure. Extend the leg, and examine the knee for fluid (68.3).

With the knee extended, hold the leg with one hand just above the injured knee, and the other just above the ankle.

With the knee just short of full extension, move the lower leg from side to side. If either collateral ligament is grossly torn, the tibia will wobble on the femur. There is very little movement in a normal knee. Repeat this test in 30° flexion, and always compare with the other knee. *Mobility with varus and valgus stress should be symmetrical if there is no lesion present.*

With the knee flexed in 90°, use both your thumbs to palpate the medial and lateral joint lines. Feel for tenderness anteriorly (anterior meniscus injury), in the mid-joint line (ligament or meniscus injury), and posteriorly (posterior meniscus injury, and for lesions of the hamstring tendons). Feel for the origins and insertions of the medial and lateral collateral ligaments above and below the joint lines.

Now lie the patient flat. Flex and extend the knee fully. The injured knee should extend and flex as much as the normal knee, with the foot touching or nearly touching the buttocks. In a normally built person, you should be able to achieve 140° flexion, and 0° extension with sometimes a physiological hyperextension up to 5° or 10°. Physiological hyperextension is more present in women and should be symmetrical.

Flex the thigh and the knee. Grasp the ankle and rotate it internally and externally, while holding the knee with your other hand (the McMurray test), to see if any meniscal tears are present. Finally, lie the patient prone, with the knee extended, and feel the back of the popliteal fossa. A large effusion of the knee,or a Baker's cyst, may be visible here, because of the capsule bulging out posteriorly.

CAUTION! In any severe knee injury, always examine the hip.

SPECIAL METHODS FOR AN INJURED KNEE

Use appropriate special tests for the following lesions: effusions (68.3), injuries of the patient's collateral ligaments (68.5), tears of the cruciate ligaments (68.6), injuries of the menisci (68.7), and injuries of the quadriceps mechanism (68.11).

RADIOGRAPHS: Take AP and lateral views.

NERVES AND PULSES
Remember to examine the common peroneal nerve (59.1), and the dorsalis pedis and posterior tibial pulses. *This is especially important with tibial condyle fractures*.

DIFFICULTIES WITH AN INJURED KNEE

If there is *varus* or *valgus* instability with the knee fully extended, there is probably a tear in the collateral ligaments, the posterior capsule of the knee, or perhaps the posterior cruciate ligament.

68.2 Plaster knee cylinder

This is the standard treatment for a soft tissue knee injury, and for some fractures. It will protect the injured knee until pain and swelling subside, and may allow walking. *If you are not careful*, it will slip down the leg and press on the Achilles tendon, or on the dorsum of the foot. You can prevent this happening by putting a 3-4cm band of soft foam plastic around the ankle which you incorporate in the lower end of the cast. This way, if the cast slips, the foam plastic will prevent the cast from hurting or creating lesions on the foot or ankle.

Apply the plaster cylinder usually with the knee in 10°, or occasionally in 30 ° or 60° of flexion. Even if you have applied it correctly, the knee is sure to be stiff and extension will be limited when you remove it, so warn about this, and show how to do extension exercises, especially cycling.

INDICATIONS
(1) Soft tissue injuries of the knee.
(2) Postoperative immobilization.
(3) Patellar fractures.

METHOD
Put a 3-4 cm band of plastic foam around the ankle, and attach both ends with a piece of tape. Make sure that it is loose & does not compress any neurovascular structures. Apply a cast from the groin to c.3cm above the malleoli with the knee in 10° of flexion. Mould the lower end of the cast on to the plastic foam band so that it becomes partially incorporated.
Start quadriceps exercises as soon as the cast is dry.

CAUTION! Never apply a plaster cylinder in full extension: the knee will be very painful and osteoarthritis may ensue.

68.3 Knee effusion

A fracture involving the knee surface rapidly fills its cavity with blood which remains liquid for a few days. Aspirating the tensely swollen knee will greatly relieve pain and make moving it much easier. Aspiration is also useful in diagnosing less obvious effusions, and especially in distinguishing between infection (7.18) and haemorrhage. *Careless aspiration can infect a sterile effusion*, so take the strictest aseptic precautions.

ASPIRATE ALL MAJOR KNEE EFFUSIONS

TESTING FOR AN EFFUSION
The first sign is the obliteration of the natural hollow on either side of the patella. Press the fluid from one of these hollows into other parts of the knee, and then, in a good light, slowly watch the empty hollow refill.

Can you 'ballot' the patella (press it down & see it bob up again)? Grasp the thigh between your fingers and thumb just above the knee. Press the effusion distally towards the patella, so as to drive fluid from the suprapatellar pouch down into the knee. Press the patella sharply. If some fluid is present, you can feel the patella tapping on the femur. This sign is absent if there is very little fluid present, or so much that the patella cannot reach the femur. Compare the injured knee with the normal side. If the knee is hugely distended and fixed in flexion, aspirate the effusion, and then re-examine it.

A KNEE EFFUSION

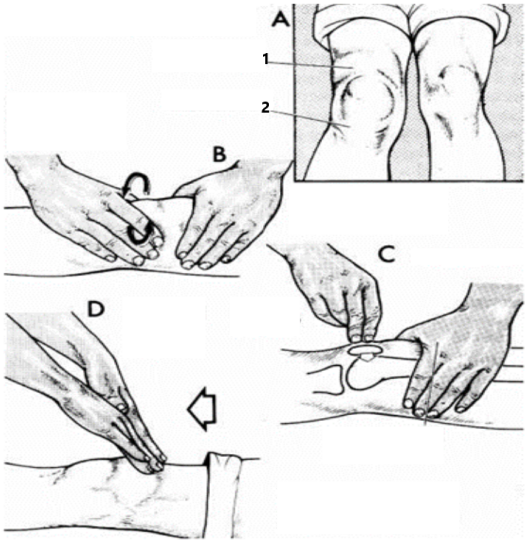

Fig. 68-1 KNEE EFFUSION. A, the 1st sign is obliteration of the peripatellar hollow with swelling in the supra- (1) and infra-patellar (2) pouches. B, shift the fluid from one side of the patella to the other. C, push the fluid in the suprapatellar pouch into the knee & then tap the patella to see if it 'floats'. D, distinguish fluid from a thickened synovium.

KNEE ASPIRATION (GRADE 2.2)

CAUTION! Never aspirate a knee in a minor theatre used for septic cases. This is a procedure for the main theatre, or a clean treatment room with full aseptic precautions. **If you do not have a sterile environment available**, limit aspiration to very acute emergencies, *i.e.* high suspicion of septic arthritis.

There are many techniques to aspirate fluid from a knee. We describe 2 techniques here, one for a knee in extension, the other in flexion. When properly performed, both techniques achieve a 95% success rate to aspirate fluid.

(a) Knee extended
Put both legs in full extension. Get as much relaxation as possible, specifically of the *quadriceps*, so that the patella becomes mobile. *Make sure that the patella is parallel to the table.* **If the leg continues to rotate externally when relaxed**, hold the leg with one hand in the correct position.

Palpate the upper border of the patella, and follow this imaginary line towards the lateral side of the knee. By doing this, you will fall automatically into a 'soft spot'. Introduce your needle in this space parallel with the patella or under a 45° angle (68-2).

KNEE ASPIRATION IN EXTENSION

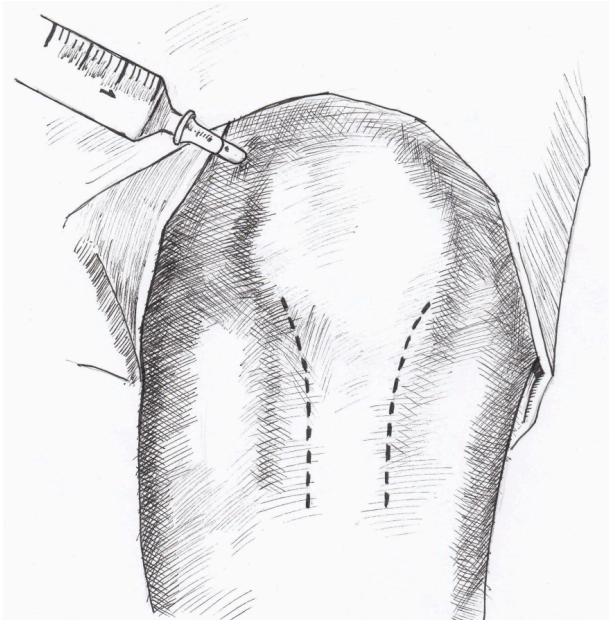

Fig. 68-2 ASPIRATION IN EXTENSION. Find the 'soft spot' at the upper patellar border moving a little laterally round it. Introduce the needle *under strict aseptic conditions* here.

(b) Knee flexed
Let the patient sit slightly above your level, *e.g.* on the side of a table with both legs in 90° flexion. Sit on a chair in front. Fix the knee you wish to aspirate to 90°. Palpate the patellar tendon and the lower border of the patella. If you move down your finger the lateral border of patellar tendon you will find a "soft spot" right between the lower border of the patella and the tibial plateau. Insert your needle here under a 45° angle (68-3).

KNEE ASPIRATION IN FLEXION

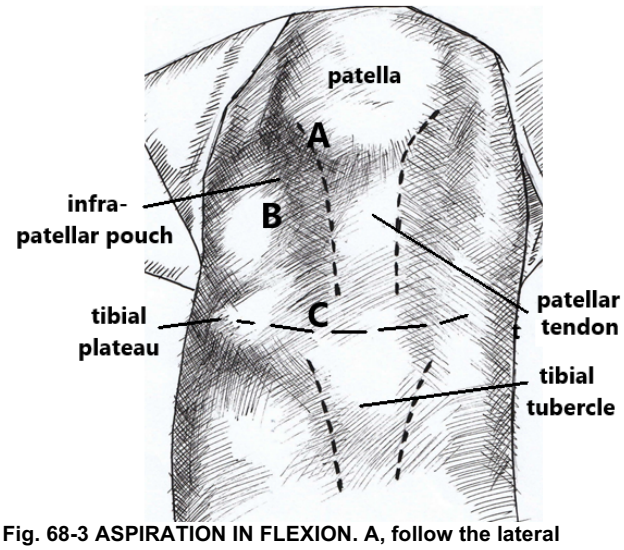

Fig. 68-3 ASPIRATION IN FLEXION. A, follow the lateral patellar border & tendon. B, find the 'soft spot' (between the lower patellar border & the tibial plateau (C). Insert the needle *under strict aseptic conditions* at B.

Examine the fluid carefully:
If it is bloody, let it settle for 5mins and then look at its surface. If fat from an injured marrow cavity is floating on the top, there is an articular fracture. Blood or blood-stained fluid is suggestive for synovial, ligamentous or capsular tears.

If it is clear, amber-coloured, this is suggestive of torn menisci, osteoarthritis, loose bodies, or synovitis.

If it is cloudy, think of septic or rheumatoid arthritis. If there are 'rice bodies' there is probably tuberculous arthritis. If it is frank pus, there is septic arthritis.
In gout, you may see crystals in yellowish fluid.

If possible, send the fluid for culture, in a blood culture bottle.

68.4 Knee swelling after minor injury

When a knee swells after a minor injury the cause can be:
(1) a minor fracture,
(2) a synovial or capsular tear,
(3) a loose body,
(4) a torn cartilage, or
(5) synovitis of obscure origin.

Take a careful history. If the patient has had previous episodes, he may have a chronic ligamentous injury, a loose body, or a torn cartilage.

A history of locking suggests a loose body, or a torn cartilage. An abduction or adduction injury suggests a torn ligament, and a rotational injury a torn cartilage. The absence of any history of force suggests a loose body or 'synovitis'. This has many causes, including rheumatoid arthritis, or infectious disease. If the swelling appeared slowly over 6-12h before producing acute pain, it is probably a haemarthrosis, perhaps from quite a minor injury. Examine the knee (68.1), aspirate it (68.3), and look at the fluid. Remember that repeated haemarthroses may be the first indication of a bleeding disorder.

TREATMENT FOR A MINOR KNEE INJURY
Minor fractures, and synovial and capsular tears Aspirate the knee as necessary. Apply a well-padded dressing, and mobilize it as pain subsides.
Loose bodies. Removing a loose body from the knee is a specialist task.
'Synovitis' Rheumatoid arthritis is responsible for 50% of cases. Treat the underlying cause and make sure you exclude TB.

68.5 Collateral ligament sprain & tear

It is possible to injure the knee while it is extended, or flexed (as when the knee hits the dashboard), and sustain a variety of complex injuries to collateral ligaments, cruciate ligaments, and menisci. Sprains (partial tears) of the collateral ligaments are usually obvious, but you can miss a complete tear because:
(1) It causes less pain than a sprain, so walking may be possible, and likewise movements of the knee.
(2) Blood can escape through the capsule in a complete tear, so that swelling is less.

COLLATERAL KNEE LIGAMENT INJURY EXAMINATION
Tenderness is a good indication as to where a ligament is injured, so feel for it carefully. The collateral ligaments may be tender over their femoral or tibial origins. Narrowly localized tenderness (usually about 2 cm above the joint line) indicates a partial tear. Severe diffuse tenderness suggests a complete rupture.

If the medial ligament is tender at the joint line, the medial meniscus may be injured also.

If you suspect that a collateral ligament may have been ruptured, test the stability of the knee like this. Hold the leg with one hand just above the injured knee, and the other just above the ankle. With the knee just short of full extension move the lower leg from side to side.

KNEE STRESS TESTS

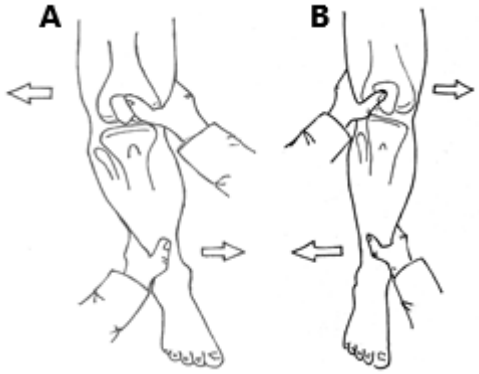

Fig. 68-4 STRESS TESTS ON THE KNEE. A, *varus*: holding the lower end of the femur medially, push the lower leg medially. B, *valgus*: holding the lower end of the femur laterally, push the lower leg laterally. *After Lubowitz JH, Bernadini BJ, Reid III JB. Current Concepts Review: Comprehensive Physical Examination for Instability of the Knee, Am J Sports Med 2008 36: 577*

This manoeuvre is called applying *valgus* or *varus* stress. The former excludes a rupture of the medial collateral ligament and the latter of the lateral collateral ligament (68-4). If either of the collateral ligaments is grossly torn, the tibia will wobble on the femur.

STRESS RADIOGRAPHS OF THE KNEE

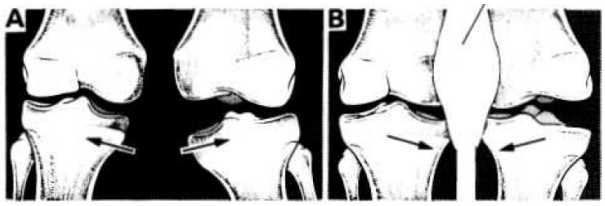

Fig. 68-5 STRESS RADIOGRAPHS OF THE KNEE. A, a medial collateral ligament tear. B, a lateral collateral ligament tear. (In both cases the cruciate ligament was also ruptured) *After Apley AG, Solomon L. Apley's System of Orthopaedics and Fractures. Butterworth, 6th ed.1982 with kind permission.*

CAUTION! (1) the knee must be just a little flexed when you do this test. If it is fully extended, the cruciate ligaments will stabilize the knee and mask tears in the collateral ligaments. (2) A fracture of the tibial plateau can also make the knee unstable and resemble a torn collateral ligament.

STRESS RADIOGRAPHS UNDER GA
Sedate the patient, put a pillow between the ankles, bind the knees together, and take an AP view to compare the joint space between the femoral and tibial condyles on either side (68-5) in 15° of flexion. In extension, the cruciate ligaments can make the leg appear to be stable, even when the collateral ligaments have been torn. With a few degrees of flexion, the cruciates are relaxed and the tears of the collateral ligaments will become more obvious. If the ligament is completely ruptured, you will be able to open the joint space on the affected side by >1cm with your hands when applying *varus* or valgus stress and the tibia will visibly wobble under the femur.

TREATMENT
For incomplete tears, fit a plaster cylinder (68.2) to relieve pain and protect the sprained ligament. After 2wks, if walking is easy without pain, remove the PoP, otherwise leave it for 2wks more, then start active knee exercises.

If *varus* or *valgus* stress causes an opening of <1cm on the side of the knee joint, use a plaster cylinder as above, but apply it in 30° of flexion (to relax the torn ligament) and continue immobilization for 6-8wks. Warn that extension will be slow to return, and encourage progressively increasing extension exercises. This gives as good results as attempts at secondary repair.

If lateral angulation causes an opening of >1cm on one side of the knee joint, the collateral ligament on that side Is torn, and perhaps the meniscus also. Refer immediately for primary repair. This, however, gives only fair results in most cases. If referral is impossible, fit a plaster cylinder as described below.

68.6 Cruciate ligament rupture

(a) The posterior cruciate ligament is attached posteriorly on the proximal surface of the tibia, and anteriorly on the inner part of the medial femur condyle. It tightens when the tibia is pushed backwards on the femur. It can rupture when the tibia hits the dashboard of a car and is driven back on the femur.

(b) The anterior cruciate ligament is attached anteriorly on the proximal surface of the tibia, and posteriorly on the inner part of the lateral femur condyle. It tightens when flexing the knee at 30° and as such, by mobilizing the tibia forward on the femur. It can rupture if the foot remains on the ground, and the femur is driven backwards by some twisting injury. This is a typical sports injury and happens frequently playing football.

Anterior are much more common than posterior cruciate ligament injuries.

HISTORY
A rotatory mechanism of injury is suggestive for an anterior cruciate ligament tear, while a direct impact on the tibia on a flexed knee (*e.g.* a car accident) is suggestive for a posterior cruciate ligament tear.
Ask additionally about complaints of instability or pain with certain movements or activities to exclude possible additional lesions.

EXAMINATION
In a very recent injury, examine under GA. Otherwise, with the patient sitting up, bend the knee to 90°, and sit on the foot. Take hold of the proximal end of the tibia with both hands, and move it forcibly backwards and forwards (the posterior & anterior drawer tests). There should be very little movement.

SIGNS OF CRUCIATE LIGAMENT RUPTURE

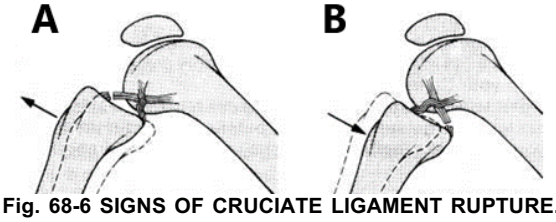

Fig. 68-6 SIGNS OF CRUCIATE LIGAMENT RUPTURE. A, forward movement of the tibia implies the anterior cruciate is torn. B, backward movement of the tibia suggests the posterior cruciate is ruptured. *Kindly contributed by John Jellis.*

Now with the normal knee in the same position, look at the outline of both the knees from the side. Observe especially the relative positions of the tibial tuberosities and the patellae. Compare the normal with the injured knee. If you see 'tibial sagging', meaning that the tibia is relatively posterior in relation to the patella (68-6B), this is suggestive of a posterior cruciate ligament tear.

Isolated posterior cruciate ligament rupture is rare, but can easily go unnoticed even when the knee is examined under GA because of swelling.

N.B. Aspirate an effusion when testing for a posterior cruciate ligament tear to have full range of movement in the knee.

If you suspect a posterior cruciate ligament tear, always examine for additional lesions. These may be:
(1) A popliteal artery injury.
- check the distant pulses.
(2) Posterolateral ligament injury
- **if there is >10mm movement in a knee**, this suggests an additional lesion of the capsule and the ligaments in the posterolateral corner of the knee. Confirm this with the patient prone; flex both knees to 90°, and take the left foot in your left hand and the right foot in the right hand. Turn both feet outwards. The range of rotation on one side will be larger than on the other side.
(3) Avulsion fractures of the tibial plateau
- always get a radiograph of the knee

O'DONOGHUE'S UNHAPPY TRIAD
This triad in football players includes a torn anterior cruciate ligament, a torn medial collateral ligament (68.5) and a meniscal tear (68.7). Refer such a patient for further treatment.

TREATMENT
Treat isolated anterior and posterior cruciate ligament tears conservatively with a plaster cast.
For the anterior cruciate ligament tear, rest in bed for 5days until most of the pain has gone. Then start active *quadriceps* exercises. Hypertrophy of the *quadriceps* can compensate with complete return of function.
For the posterior cruciate ligament tear, immobilize the knee in 60° of flexion for 6wks.

68.7 Meniscus damage

A footballer playing on hard ground can easily injure the menisci. The pressure of the femoral condyle against the tibia may split one of them, so that a piece becomes loose at one end and may lock the knee. A history of injury to a flexed loaded knee is highly suggestive, especially if it sometimes locks. The *quadriceps* will often already have started to waste, there may be an effusion, and the knee joint line will be tender. Most patients learn how to move their knees so as to unlock them.

If a patient has repeated episodes of locking with effusion, refer him for meniscectomy. This suggests the presence of a large tear which will eventually cause osteoarthritis.

EXAMINATION
Tests for injuries to the menisci are not reliable, so place great importance on the history of the injury (flexion of a loaded knee) and a history of locking.
(1) Sit the patient down and extend the knee. With the tip of your fingers press firmly over the joint line just medial to the patellar tendon. Now, still pressing hard, flex the knee and at the same time rotate the tibia to and from on the femur several times. You may feel the torn meniscus click and move under your finger, or roll against the head of the tibia, showing that it is displaced.
(2) Press with your thumb close beside the patellar tendon over the anterior horn of the medial meniscus. Flex and extend the knee passively. Do the same thing with the anterior horn of the lateral meniscus. Compare the tenderness with that of the normal leg. Significant tenderness in one place suggests that the meniscus under it is injured.
(3) Lie the patient prone. Hold the foot, and flex the knee, until the heel almost reaches the buttock. Rotate the foot externally as far as it will go and then extend it. If you feel a 'click' while you do this, the posterior horn of the medial meniscus is probably torn.

TREATMENT
Late meniscectomy results are poor.
If the knee is locked, and you cannot refer, manipulate the knee under GA. Use combinations of flexion, extension, rotation, abduction, and adduction. You may be able to unlock it, temporarily at least.

68.8 Knee dislocation

A violent injury such as a road accident can dislocate the whole knee. This is not the same as a patella dislocation (68.9); rather it is dislocation of the tibia off the femur. It can dislocate in any direction: posteriorly, anteriorly, medially or laterally. There is an extremely high risk of concomitant soft tissue lesions: torn cruciate ligaments, menisci (one or both), patellar tendon, capsule, *quadriceps* tendon or one or both collateral ligaments. The popliteal neurovascular bundle may also be damaged.

KNEE DISLOCATION REDUCTION
(GRADE 1.3)
Reduction is usually easy, but the easier it is, the more likely the knee is to be unstable afterwards. If the knee is completely dislocated, it is unlikely to function normally again. An injury severe enough to dislocate the knee may also injure the hip, so check that too.

If the patient presents with a highly unstable, but undislocated knee after a violent injury, be very suspicious. It may have dislocated knee during the trauma, but reduced spontaneously. Treat it as a dislocated knee, even though you haven't witnessed the dislocation and reduction yourself.

A DISLOCATED KNEE IS A TRUE ORTHOPAEDIC EMERGENCY!!

Check the circulation distally in the leg. Reduce the dislocation as quickly as possible, and, if necessary, aspirate the knee. If there is a skin wound, toilet it.

If you cannot refer, apply a plaster cylinder with the knee flexed to 90°, and split it to allow for swelling. Leave it on for 3-4wks. Then remove it and start gradual extension exercises. It will take several months to regain normal movements. Start *quadriceps* exercises from the beginning. Allow weight bearing in the cast as soon as lifting the leg is possible.

If reducing the dislocation does not restore the circulation to the leg, the popliteal artery is probably injured. You will not have time to refer, so get what help you can and explore the popliteal space (49.4h). If you cannot restore arterial flow, a knee level amputation will result.

68.9 Patellar dislocation

A sudden uncoordinated movement of the leg may dislocate the patella outwards, and rotate it so that its articular surface lies against the outer side of the femur. The fibres of *vastus internus* tear, and the knee fills with blood. There is great pain; the knee is flexed and immobile. It has an abnormal shape, with the patella obviously out of place.
A less serious movement may cause a subluxation, which is more common in women.

SKYLINE VIEW OF THE KNEE

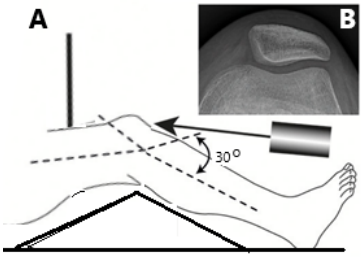

Fig. 68-7 SKYLINE VIEW A, with a support under the knee, keep it at 30^0 of flexion. Get the patient to hold the cassette (if you cannot keep it fixed in a holder) but *make sure it stays vertical & does not fall backwards. Also make sure the toes do not get in the way of the rays!* . B, clear space between patella and tibia.

Always get a post-reduction radiograph to exclude any avulsion fractures. If possible, take a skyline view (68-7) and look for displaced bony fragments free in the joint.

Early after injury, you may be able to reduce a dislocation spontaneously by extending the flexed knee slowly. Pressure on the lateral side of the patella may flick it back into the midline. If there is too much discomfort, use sedation.

The medial attachment of the *quadriceps* to the patella may be torn, so fit a plaster cylinder (68.2) for 2-3wks, and encourage straight leg raising and *quadriceps* exercises.

If the dislocation recurs, or if there is a history of recurrence since childhood, try to get adapted physiotherapy and *vastus medialis* exercises.
N.B. Surgical repair of the medial patella-femoral ligament has mixed results.

68.10 Extensor mechanism injury

If there is a fall on the leg whilst the powerful *quadriceps* tendon is in contraction, any of these injuries may result (68-7):
(1) Ruptured extensor expansion
(2) *Quadriceps* disruption
(3) Patellar fracture
(4) Patellar tendon disruption
(5) Patellar tendon rupture
(6) Patellar tendon avulsion

***QUADRICEPS* MECHANISM RUPTURE**

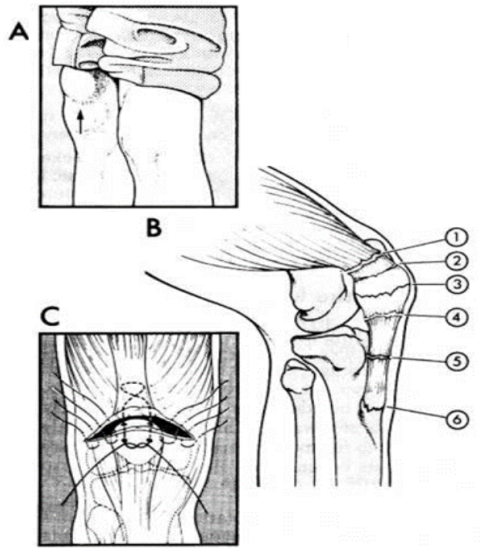

Fig. 68-8 POSITIONS OF *QUADRICEPS* MECHANISM INJURY. A, the patella is displaced upwards. B, of all these injuries, the patellar fracture (3) is by far the most common. An inferior laceration (6) needs suture repair C, exposure of the patellar tendon & its repair with at least 7-9 figure-of-8 sutures.

The results are all similar: full knee extension is impossible, with dragging of the leg on walking, difficulty climbing stairs, or going up a slope. Apart from fracture of the patella, all these other injuries are rare. Repairing them involves open joint surgery, with the risk of infection, so refer the patient if you can.

As with the olecranon (62.8), the proper management of these injuries, especially patellar fractures, depends on whether the extensor mechanism is intact or not. This is the mechanism which extends the knee.

TESTING THE EXTENSOR MECHANISM
(1) Feel the patellar tendon between the lower margin of the patella and the tibial tuberosity; ask the patient to lift the leg gently off the couch. Pain may prevent this, but if you can feel the patellar tendon tightening, you can be sure the *quadriceps* extension is sufficiently intact to justify closed treatment.
N.B. This test may be difficult.
(2) Palpate the *quadriceps* tendon, the patella, the patellar tendon, and its insertion. Feel for a transverse crack in the patella with your thumb nail.
(3) Put your hand on the patella and ask the patient to flex and extend the knee. If the surfaces of the patella and femur are rough, you may feel crepitations as they slide over one another.

(a) Undisplaced patellar fractures
Fractures of the patella resemble those of the olecranon, but are more often missed.

TYPES OF PATELLAR FRACTURES

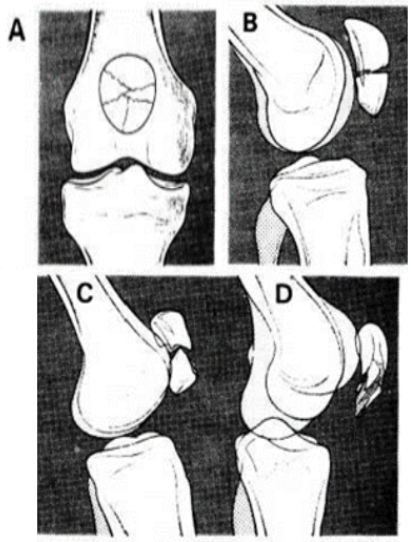

Fig. 68-9 PATELLAR FRACTURES. A, stellate fracture from a direct injury. B, undisplaced midline horizontal patellar fracture. C, displaced patellar fracture. D, comminuted patellar fracture. The important feature is whether the *quadriceps* mechanism is intact. *Kindly contributed by John Stewart.*

A common mistake with disastrous results is to suture a knee laceration overlying a patellar fracture and so, an open knee injury. Such an injury needs careful wound toilet and exploration under GA.

The patella fractures in 2 ways:
(1) A direct injury causing a stellate fracture leaving the extensor mechanism intact (68-9A). The *quadriceps* remains intact.
(2) A fall whilst the *quadriceps* are contracting, typically someone >40yrs who misses a step, hears something snap in the knee, and then falls to the ground. There is subsequent difficulty walking.
The injury has split the patella horizontally into two halves, separated them, and torn the patellar *retinacula*. This is the tough fibrous capsule of the knee on either side of the quadriceps tendon, the patella, and the patellar tendon. In both kinds of fractures, the knee swells with blood making it impossible to extend.

INDICATIONS FOR CLOSED METHODS
An intact extensor mechanism as tested (68.10), with:
(1) A nondisplaced fracture of the patella,
(2) A nondisplaced fracture with a lesion of the extensor mechanism in zone 3 (68-7B),
(3) A vertical split fracture of the patella,
(4) Fragments separated ≤3mm or with an intra-articular step-off >2mm.

TREATMENT
There will be blood in a painful swollen knee, so aspirate it under strict sterile conditions.

If pain and swelling are mild, mobilize with crutches (66.1).

If pain is moderate, bandage the leg from the ankle to the groin with alternate layers of cotton wool and crepe bandage, making 4 layers in all. Maintain bedrest until control of the knee is regained. Then allow standing with active knee movements within the limits of the bandage. After 2wks, remove the bandages and add knee flexion exercises.

If the extensor mechanism is torn in zone 3 or if pain and swelling are severe, fit a plaster cylinder (68.2).

(b) where the *quadriceps* mechanism is torn, and there is a displaced patellar fracture, repair is mandatory for otherwise knee extension beyond the final 20° will not be possible, although walking may.

If the skin over the patella is normal, operate as soon as is practical.

If it is bruised, operate immediately and toilet the wound.

If it is infected, wait for 7-10days until infection subsides and treat the infection in the meanwhile.

N.B. These interventions are all truly intra-articular, with a risk for post-operative septic arthritis. Consider carefully if the patient has a better option being referred or being treated locally.

Reduce and fix the patella if it is displaced, so that you obtain a smooth posterior surface. The fracture may be in the middle of the patella, in which case it will be in two halves, or it can be at the top or bottom of the patella, in which case there may be one large fragment and one small one.

QUADRICEPS MECHANISM REPAIR (GRADE 3.1)
Use a GA or spinal anaesthetic and apply a tourniquet. Make a longitudinal skin incision, centred on the patella. Be sure that the incision goes far enough to visualize the upper and lower poles of the patella clearly. If an area of skin is bruised, avoid it, or excise it. Reflect the skin proximally and distally to expose the whole anterior surface of the patella, the patellar tendon, & the *quadriceps* tendon. Inspect this medially and laterally. Remove any small detached fragments of bone.
The knee will be full of blood; wash out all the clots 7 & débris. Use a litre bag to squirt saline under high pressure into all its recesses, until the fluid comes out clear.

SUTURING THE EXTENSOR EXPANSION

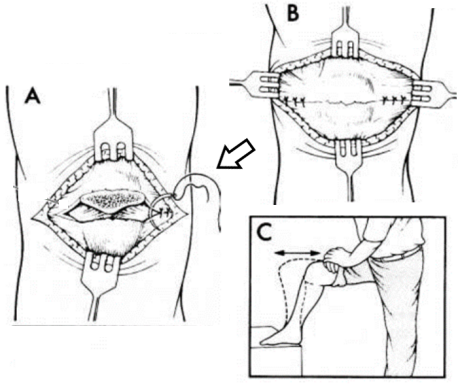

Fig. 68-10 SUTURING THE EXTENSOR EXPANSION. A, expose the whole torn extensor expansion. B, having brought the expansion together, wire the patella together. C, encourage postop knee exercises. *Kindly contributed by John Stewart.*

QUADRICEPS REPAIR (GRADE 3.1)
Repair the tendon from outside inwards using strong slowly absorbable suture.

If the *quadriceps* tendon has torn away from the patella, drill some holes for sutures through its edge (68-8C). Otherwise use strong slowly absorbable suture to bring the ends together.

If the injury is an old one, and the *quadriceps* muscle has retracted, pass a Steinmann pin through the *quadriceps* tendon, apply traction, and when, after some days, the muscle has lengthened sufficiently, suture the tendon.

HORIZONTAL PATELLAR FRACTURE FIXATION (GRADE 3.2)

If the patella is in 2 halves, and the extensor expansion is torn, sew it up from the sides towards the centre with strong monofilament sutures, (68-10A). Put 2 K-wires of 1.6-2mm diameter from proximally to distally to keep the fragments stabilized. Bend the upper ends so they do not cut through the skin when flexing the knee; put a 'figure of 8' tension band wire around the K-wires (68-11).

TENSION BAND WIRING

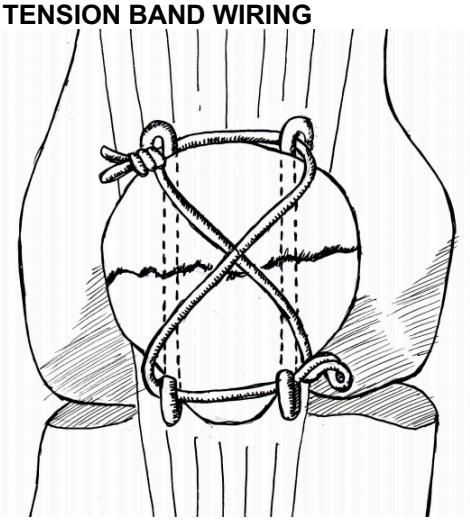

Fig. 68-11 TENSION BAND WIRING for a simple horizontal patellar fracture.

COMMINUTED PATELLAR FRACTURE FIXATION (GRADE 3.3)
Bring together the different fragments as well as you can using the tension-band wiring technique (68-11). Then encircle the patella with 1mm stainless steel wire, preferably using a large Gallie needle, or alternatively, threading it through a large intravenous needle. Pass the wire in and out of the *quadriceps* expansion, taking big bites very close to the patella. Pass all around the superior and lateral borders and straight through the patellar tendon, close to the patella itself.

Finally, bring the ends together and twist them tight. This circumferential wiring prevents the fragments separating.

Place this wire superficially in the patella, so that when the knee flexes, the posterior aspects of the fragments are brought together in compression. *The wire must lie close to the patella, particularly above and below,* or it will cut out when the knee flexes (68-12).

If there are still several widely separated fragments, remove the entirely loose fragments.

WIRE CERCLAGE

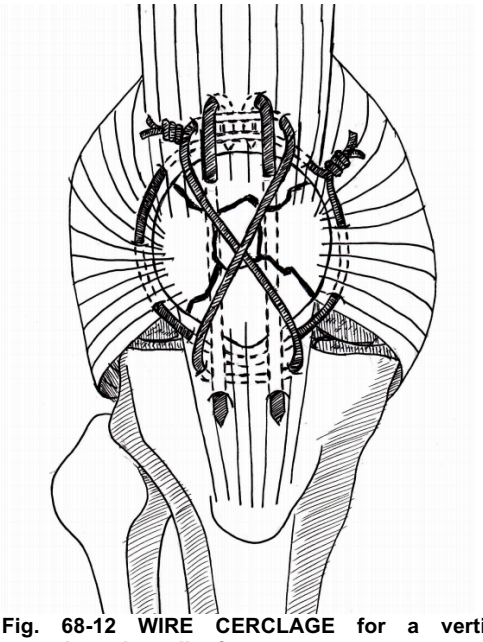

Fig. 68-12 WIRE CERCLAGE for a vertical or comminuted patellar fracture.

PATELLAR EXCISION (GRADE 3.3)
This treatment is rarely needed, and should only be considered if you do not have any other treatment option available. Get advice before you proceed!

If the patella is in several widely separated small fragments, use a very sharp scalpel to cut them out of the tendon. Keep the edge of the scalpel close to the bone all the time. Change the blade frequently as it blunts, and preserve the soft tissue coverings of the excised fragments. Excise all fragments except for a small anterior chip in both proximal & distal tendons. Preserve as much tendon as you can.

Repair the medial and lateral tears in the *quadriceps* expansion with interrupted sutures of thick slowly absorbable sutures, beginning at the sides of the knee and working towards the gap created by removing the patella.

Pass a purse string suture around the edges of this gap and pull them together. If one purse string does not seem to be enough, put in another one.
Don't worry if you have a gap in the middle where the patella was.

If the *quadriceps* expansion is torn at the sides of the knee, be sure to repair it.

PATELLAR TENDON REPAIR (GRADE 3.1)
Suture the torn ends of the patellar tendon with strong slowly absorbable sutures. If necessary, drill some holes through the lower pole of the patella to hold the sutures. If the patellar tendon has pulled away from the tibia, drill some holes in it to hold wire sutures, or hold the patellar tendon in place with a screw.

If the injury is old and the patella is much retracted, push the skin upwards and the patella downwards. Pass a K-wire through both sides of the patellar tendon and exert traction for ≥2wks. Keep the wire in place and incorporate it (without its tensioner) in a long leg plaster cylinder (68.2). Then operate and repair the tendon.

POSTOPERATIVE CARE FOR OPERATIONS ON THE EXTENSOR MECHANISM
Dress the wound with gauze, cover this with plenty of cotton wool from 10cm above the knee to 5cm below it. Hold this firmly with 2 15cm crepe bandages. Apply a cast cylinder (68.2). Allow immediate weight-bearing, with the protection of 2 crutches.

After 12days, remove the cast and dressings. If the wound is clean and dry, take out the sutures. Apply a new plaster cylinder.

At 4wks bi-valve the cast and start non-weight bearing extension exercises under supervision. Abandon the cast when flexion to 90° and extension against resistance are possible. This is usually after 6-8wks. At 6wks start gentle active flexion exercises, and at 8wks, begin the passive flexion exercises shown (68-10C).

Gradually increase the exercises, provided active full extension is present. *If this ceases, don't allow flexion of the knee any further until active extension resumes*.

Expect the recovery of flexion to be slow. Full flexion takes 4-6months.

DIFFICULTIES WITH PATELLAR FRACTURES
If the knee is stiff, continue progressive active movements. *Don't try forcible manipulation under GA*, or you may rupture the repair, tear the ligaments, or break the lower end of the femur.

68.11 Supracondylar femoral fracture

A direct impact on the knee above the femoral condyles, may cause a fracture. Usually, there is little displacement, but it may be severe (68-13A). Occasionally, the *gastrocnemius* flexes the proximal end of the distal fragment, so that the shaft of the femur displaces anteriorly. The distal fragment may then press on the popliteal vessels and occlude circulation in the leg.

DISTAL FEMORAL FRACTURES

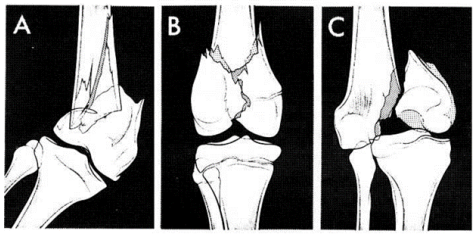

Fig. 68-13 DISTAL FEMORAL FRACTURES. A, supracondylar fracture with severe angulation. B, T-shaped fracture. C, rotated condylar fracture. *Kindly contributed by John Stewart.*

MILD DISPLACEMENT
If the distal fragment is only mildly angulated and the peripheral pulses are normal, apply Perkins traction (67.3) but with the hip and knee flexed, (68-14). Encourage movements of the knee. Ignore lateral displacement, and flexion of the distal fragment on the radiograph. Concentrate on getting good antero-posterior alignment.

PERKINS TRACTION

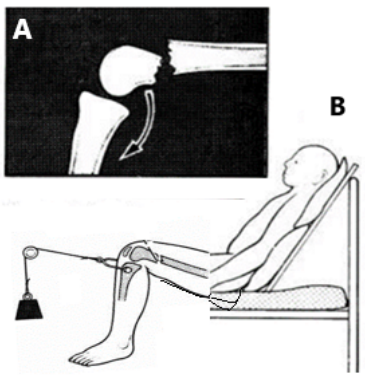

Fig. 68-14 PERKINS TRACTION FOR SUPRA-CONDYLAR FEMORAL FRACTURE. A, mildly angulated fracture. B, knee flexion helps to compensate flexor pull of *gastrocnemius*. *Kindly contributed by Peter Bewes*

SEVERE DISPLACEMENT

If the distal fragment is severely flexed, under ketamine, insert a Steinmann or Denham pin through the upper tibia (70.11, 78.4). If there is lateral displacement, try to push medially to effect reduction. Then apply traction in a Böhler-Braun frame (68-14).

BÖHLER-BRAUN FRAME

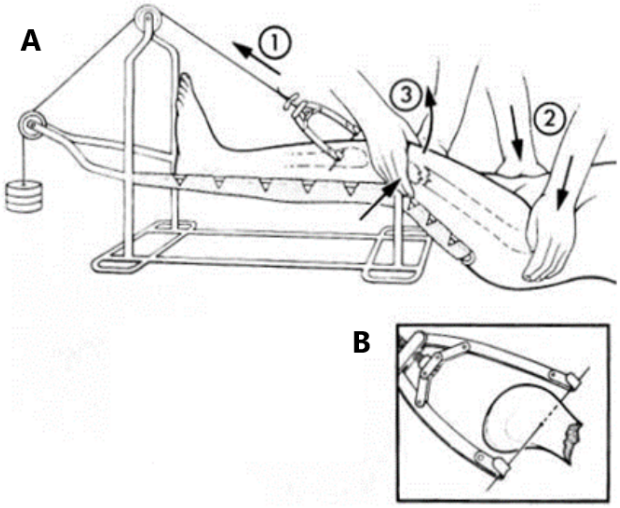

Fig. 68-15 REDUCTION OF A SEVERELY ANGULATED SUPRACONDYLAR FEMORAL FRACTURE ON A BÖHLER-BRAUN FRAME. A, under suitable anaesthesia, having inserted a proximal tibial pin and attached the weights (1), reduce the fracture (3) whilst an assistant holds the pelvis down (2). B, you may occasionally need to insert a pin through the distal femoral fragment to get adequate traction.

Exert traction in the line of the femur (68-15A). Ask another assistant to hold the iliac crests (68-15B). When the femoral length is corrected, grasp its distal end with both hands, and bring it forward (68-15C). Leave the patient on a Böhler-Braun frame for 10days, until the bone ends have become sticky, before starting Perkins traction, as for a fracture of the femoral shaft (67.3).

If reduction fails, pass a K-wire or Steinmann pin through the anterior margin of the distal fragment, and pull on it anteriorly and distally.

N.B. A disadvantage of this method is that you have to insert the pin or wire through the joint capsule with the risk of infecting the knee. So, remove it as soon as the fracture is stable, usually c. 3wks, and continue with Perkins traction, with the knee in 90° flexion.
Alternatively, you may be able to get the distal fragment into a suitable position by putting a padded block under it.

CAUTION! As always in fractures of the lower limb, correct rotation (78-3).

LATER CARE
Maintain traction until there is clinical union, usually c. 8wks. After 2wks more, allow non-weight bearing with crutches (67.1), then after 2wks more, if radiographs show solid union, start protected weight bearing. *Don't allow unprotected weight bearing until the fracture has consolidated*. The knee is likely to be stiff for a long time, and will need continued exercises to help extension.

Alternatively, at 4-6wks, apply a long leg cast while standing, keep this on until the fracture has consolidated, usually after 2-4wks more. This is a poor alternative to continued Perkins traction.

If you still cannot achieve satisfactory reduction, refer him for open reduction.

If there is a T-shaped fracture into the knee joint (68-13B), the 2 condyles are separated. Any or all fragments may be displaced, angled or rotated. Perkins traction usually reduces the displacement satisfactorily.

If one of the fragments has turned through 180° open reduction is essential, so refer him.

If there is a single lateral femoral condylar fracture (68-13C), Perkins traction is satisfactory if there is little displacement.

However, when there is failure of reduction (usually owing to severe angulation, displacement or rotation), operative intervention will be necessary. You may be able to use an X-fix across the knee (69.5) temporarily but this risks the knee becoming stiff.