Surgical Indications in the Treatment of Osteoarthritis

14

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Introduction

When conservative management of knee arthritis fails, one of the following surgical procedures may be indicated: osteotomy, unicompartmental arthroplasty (UKA), or total knee arthroplasty (TKA). Arthroscopy and lavage as well as arthrodesis will not be described here. The procedure indicated is dependent on the clinical history from the patient, as well as his or her functional complaints, motivations, clinical examination, and the radiological findings.

An overview of the anatomic and clinical parameters is given. The weight of each factor can vary depending on circumstances, and thus there is no true algorithm.

Anatomic factors	*Clinical factors*
Stage of osteoarthritis	Weight
Analysis of the deformity and its reducibility	Age, level of activity, function
Ligamentous status (frontal and sagittal laxity)	Medical conditions (diabetes, rheumatoid arthritis, use of anticoagulants)
Range of motion	Surgical history (including sepsis)

The procedure chosen by the surgeon is also influenced by geographical factors (an osteotomy is more frequently performed in continental Europe than in the UK or USA), cultural factors (osteotomy more frequently in Asian and Muslim countries, arthroplasty more frequently in English speaking countries), educational factors (UKA is not recognized and taught as a treatment option in certain countries), and economical factors. Prostheses are more frequently implanted far from, and osteotomies performed close to the equator. Today fast recovery, short hospital stay, and a wish to return to work may also influence the decision. These influences may originate from a number of sources including the patient, insurers, lawyers, government, or employers.

Patient Expectations

A patient's satisfaction following surgery is the result of the difference between his expectations (expected functional result) and the obtained functional result (Fig. 14.1).

This equation is therefore dependent on informing the patient in detail of the risks, benefits, and expected outcome of the surgical procedure that is to be performed. Importantly, this information must be adapted to the patient's level of understanding. Unrealistic patient expectations can be a common reason for dissatisfaction following surgery.

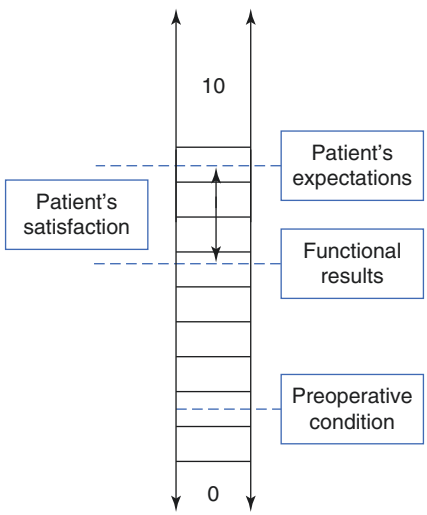

Fig. 14.1 A patient's satisfaction following surgery is the result of the difference between his expectations (expected functional result) and the obtained functional result

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The Concept of the Functional Envelope Applied to Osteoarthritis

Fig. 14.2 shows the concept of the functional envelope, described by Scott Dye. The X-axis represents the frequency of the applied forces/load while the Y-axis represents the magnitude of the applied forces/load. The area under the curve defines the functional envelope of the knee. The upper limit, thus defines the threshold above which a clinical reaction may be observed (discomfort, pain, swelling, stress fracture). The definition of the functional envelope remains a theoretical concept with a large variation between individuals and over time. It thus remains difficult to determine the individual upper and lower threshold.

Nevertheless, the profile of the functional envelope can be modified by medication, surgery, and rehabilitation. Each type of intervention will modify the functional envelope in a specific way. Total knee arthroplasty will change the shape of the curve differently to an osteotomy.

It has to be remembered that:

1. The patient has the possibility to modify his activity (or his body weight) to re-enter the functional envelope.
2. The aim of surgery is to enlarge this envelope, either increasing the potential frequency of load, the magnitude, or both. If the area of the envelope might be reduced by the intervention in one or other way, it has to be clearly explained to the patient. If the patient applies excessive forces, above the threshold, the risk for failure is increased. This concept of a functional envelope, and the scheme, are very useful to explain the situation and therapeutic options to the patient.

Expected Functional Outcomes

The following paragraphs are a simplification of the current common opinion and the literature. This is of course schematic and disputable but understandable by the majority of patients.

After osteotomy

1. Pain: pain free (95%), forgotten knee (80%).
2. Stability (90%).
3. Unlimited walking distance.
4. Normal stair climbing and descent.
5. No limp, no use of crutches, no swelling.
6. All sports (impact and contact) are possible but are not recommended.
7. Full extension, flexion to 145°.
8. Slow recovery: weight bearing is not allowed until 2 months post-surgery, one to 2 days hospitalization, return to home, functional autonomy and driving (75 days), slow adaptation to the modified biomechanics and degree of valgus (4–6 months).
9. Revision total knee arthroplasty is easy (see chapter on TKA after osteotomy).

Survival rate: 70% to 10 years.
Infection rate: less than 0.5%.

After unicompartmental knee arthroplasty

1. Pain: pain free or mild occasional pain (92%), forgotten knee (70%).
2. Stability (98%).

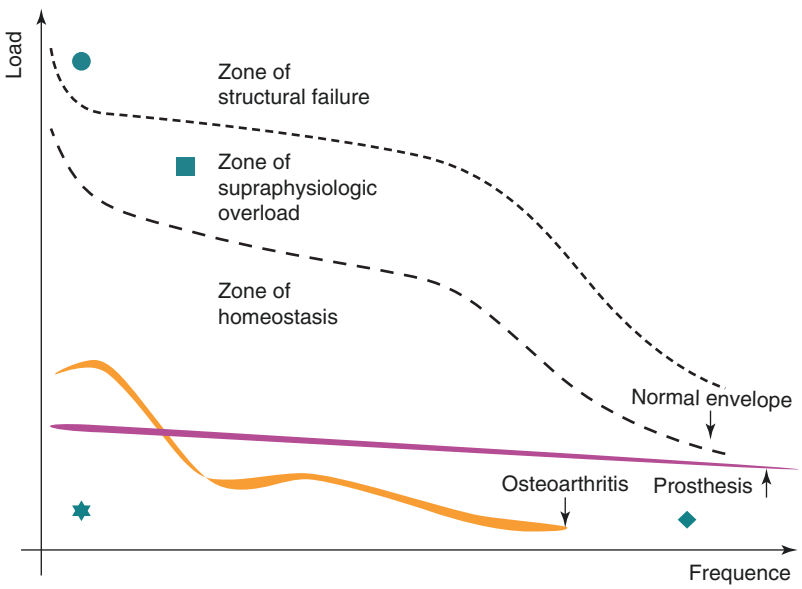

Fig. 14.2 Concept of the functional envelope (described by Scott Dye) applied to osteoarthritis. Situations: Circle, jump from 3 m height; Square, playing basketball; Star, sitting in chair; Diamond: walking 10 km

3. Walking distance of at least 10 km.
4. Normal stair climbing and descending.
5. No limp or use of crutches.
6. No swelling.
7. Walking on uneven terrain, hiking, skiing, tennis are possible.
8. Full extension, flexion of up to 145°.
9. Recovery: immediate weight bearing, 1–2 days hospitalization, return to home or rehab center 2 weeks, functional autonomy and driving of a car possible 30 days postoperatively. Outpatient surgery can be considered in most of cases.
10. Strict surveillance during follow-up (demanding intervention for the surgeon), revision to TKA possible.

Survival curve: 90% at 10 years after medial UKA. 95% after lateral UKA.

Infection rate: 0.5% on the 10 years postoperative period.

After a total knee arthroplasty

1. Pain: pain free or mild and occasional pain (95%), forgotten knee (50%),
2. Stability (98%).
3. Walking distance of at least 5 km.
4. Normal stair climbing.
5. No limping or use of crutches.
6. Swelling of the knee is possible.
7. Hunting, golf, doubles tennis, gardening are expected.
8. Full extension, flexion up to 120°.
9. Slow postoperative recovery for the patient: immediate weight bearing, 2 to 4 days hospitalization (in some specific circumstances an out-patient surgery is proposed), rehabilitation center (3–4 weeks), activities of daily life, and driving of the car possible 30 to 45 days postoperatively.
10. Necessity for long-term follow-up, revision TKA possible.

Survival curve: 90% at 15 years.

Infection rate: 1.5% in the 10 years period postoperative.

Indications

The indication is often a compromise and it should be a choice made by both the patient and the surgeon. For teaching purposes, we would like to remind you that it is not always possible to have ideal indications. Sometimes, one or more criteria will make the indications limited or disputable.

Osteotomy

- Ideal indications.
  - Clinical exam:
    Pain localized to the tibiofemoral joint line.
    Normal range of motion.
    Normal ligamentous status.
    Non reducible deformity (Fig. 14.3a, b).
    No inflammatory arthritis.
    Less than 70 years old.
    No obesity.
  - Radiological findings: (Fig. 14.4a–c).
    Partial or complete joint space narrowing in one compartment.
    No contralateral tibiofemoral joint space narrowing or patellofemoral joint space narrowing.
    Extra-articular deformity more than 5°.
- Disputable indications:
  Patellofemoral arthritis.
  A "cupula"—tibial bone loss in severe osteoarthritis.
  Flexion <100° or fixed flexion deformity.
  Intra-articular deformity.
  Age > 70 years.
  Obese women.

This is the ideal indication in case of true osteoarthritis where a hypercorrection is mandatory. This hypercorrection is adapted to the wear of the severity of the osteoarthritis (between 3 and 6°). The situation is different in case of osteotomy combined with meniscal, cartilage, or ligament injury where the patient wants to return to sports. In this situation, a normo-alignment or a moderate hypercorrection (between 0 and 3°) is performed even if the longevity of the osteotomy is reduced (see Chap. 7 Revision ACL reconstruction).

Unicompartmental Prosthesis

- Ideal indications.
  - Clinical examination: (Fig. 14.5a–c).
    Pain at the tibiofemoral joint line.
    Normal range of motion.
    Normal ligament status.
    Reducible deformity.
    Above 60 years old.
    Weight limited to 80 kg.
    No inflammatory arthritis.
  - Radiological findings: (Fig. 14.6a–c).
    Unicompartmental partial or complete joint space narrowing.
    No contralateral tibiofemoral or patellofemoral joint space narrowing.
    No ligamentous laxity.

Fig. 14.3 (**a**, **b**) Non-reducible deformity

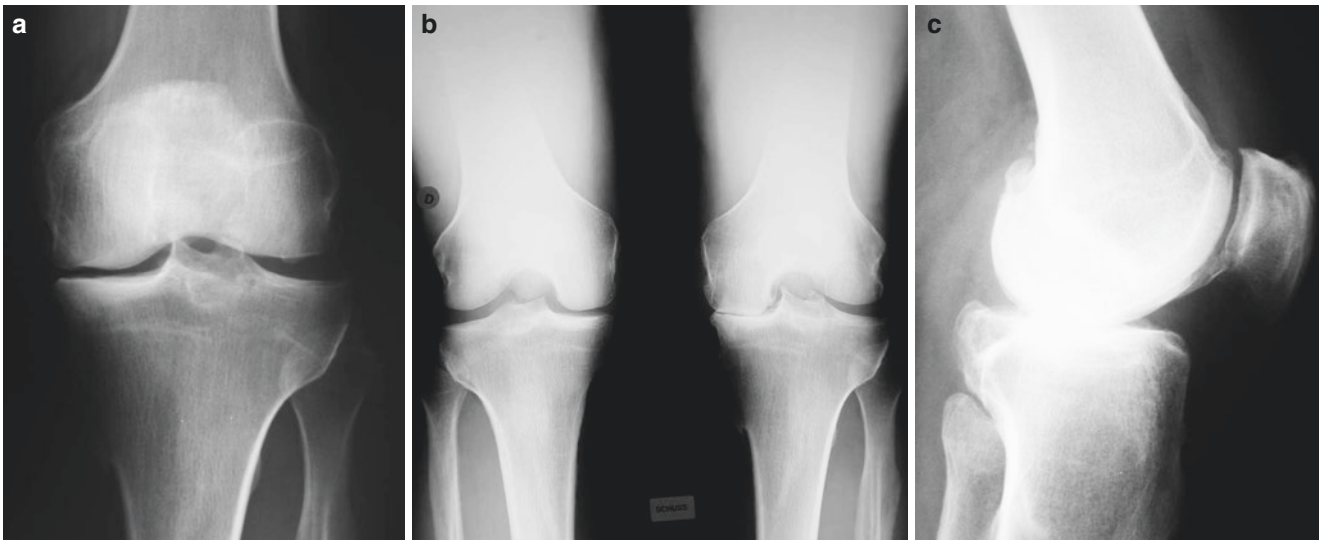

Fig. 14.4 Full weight bearing X-rays. (**a**) AP view. (**b**) Schuss view at 45° of flexion. (**c**) lateral view (30° of flexion)

Reducible deformity without hyper-correction.
No frontal laxity.
Extra-articular deformity <5°.

- Disputable indications:
  Asymptomatic patellofemoral arthritis.
  Flexion <100°.
  Extra-articular bony deformity between 5 and 8°.
  Surgical history including: malunion, HTO, UKA.
  Age < 60 years old.

- Contraindications:
  Inflammatory arthritis.
  Chronic anterior laxity or ligament insufficiency.

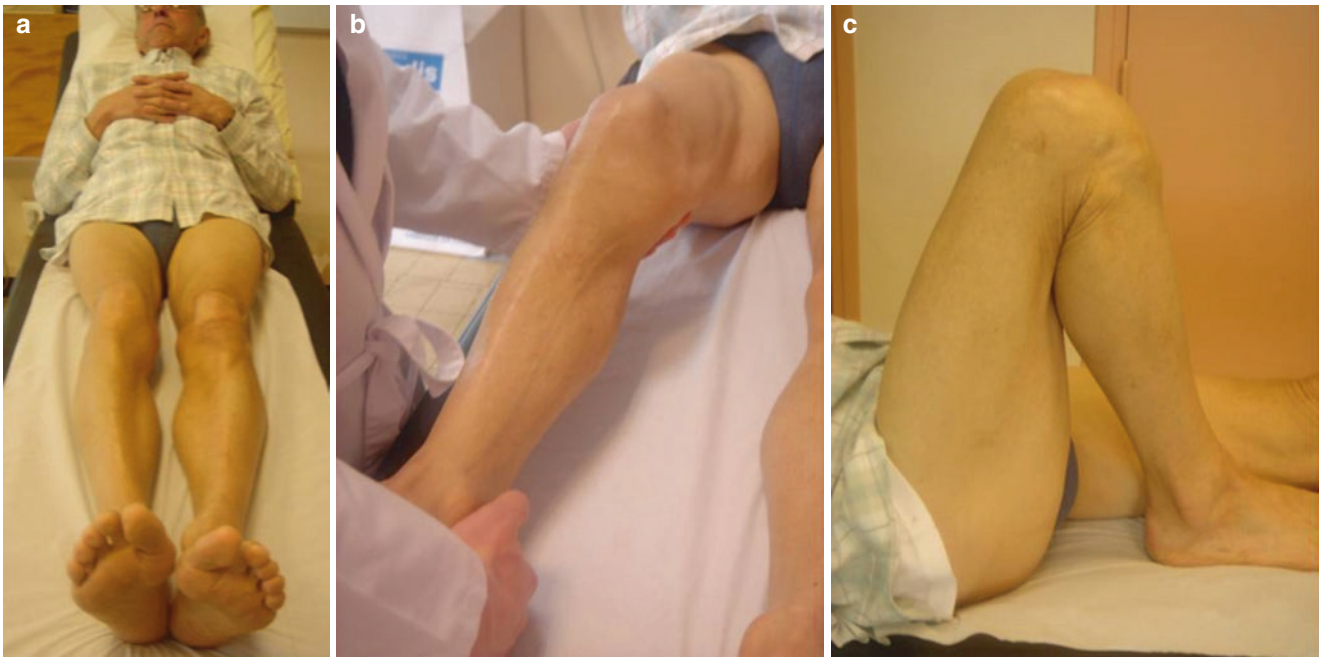

Fig. 14.5 Clinical examination. (**a**) Mild deformity. (**b**) Reducible deformity. (**c**) No flexion stiffness

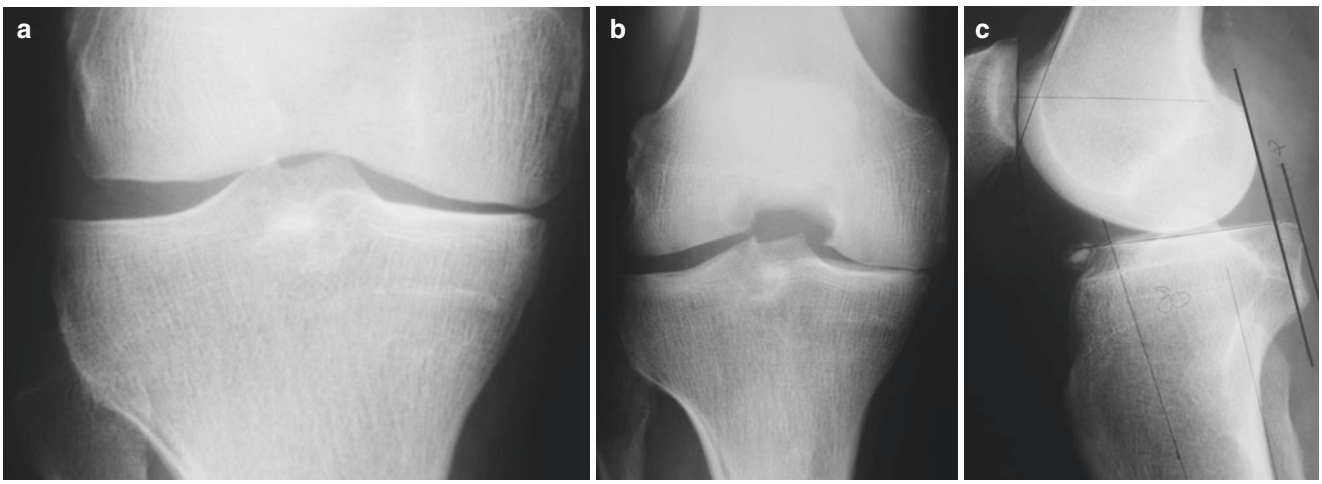

Fig. 14.6 X-ray findings. (**a**) AP view. (**b**) Schuss view. (**c**) Lateral view

Total Knee Arthroplasty

- Indication
  Pain localized to the arthritic knee
  Any deformity, laxity, or range of movement

The basic indication for surgery is reduced quality of life due to the degenerative knee pathology. The decision to proceed to a TKA is the most commonly selected surgical option in the treatment of osteoarthritis, as there are fewer factors that predict a poor outcome. A "monoculture" surgeon is tempted to propose a TKA for the majority of his/her patients. Others will only proceed to a TKA in the presence of contraindications for a unicompartmental arthroplasty or an osteotomy. In our opinion, weight is not a contraindication, and has no influence on wear (Fig. 14.7). Early mobilization and improved preoperative management have minimized the effects of excessive weight.

- Disputable indications.
  Early osteoarthritis, where the joint space is still preserved on plain X-ray. Attempting non-operative treatment methods first will be mandatory.
  Young age: although there is more logic to perform TKA in advancing age, this is unavoidable in certain young patients where other treatment methods are not suitable.

Fig. 14.7 Obesity is not a contraindication to TKA

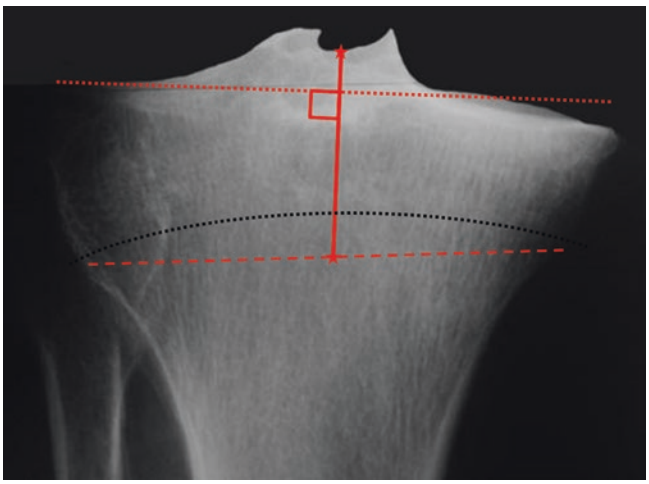

Fig. 14.8 Epiphyseal axis defined by Levigne

Radiological Evaluation

The radiologic evaluation is the same for all three types of intervention (osteotomies, unicompartmental knee, and total knee replacement). It includes:

At the Time of the Consultation (Minimum Work-Up)

- Single leg AP view: type of arthritis, location, presence of osteophytes, cysts, foreign bodies, obliquity of the joint line.
- Single leg lateral view at 30° of flexion: presence of a cupule, patella height, tibial slope, anterior tibial translation, malunion with flexion deformity. This view is the most important view for anti-recurvatum osteotomies.
- Skyline view of the patella in 30° of flexion: to examine the patellofemoral joint.
- Bilateral leg stance at 45° of flexion view (schuss view). This view is excellent to evaluate tibiofemoral joint space narrowing that is frequently underestimated on the AP view.

Prior to an Intervention

Preoperative planning is essential. It includes:

Bilateral full leg view: allows measuring of different angles and axes.

- The mechanical femoral axis is represented by a line connecting the center of the femoral head and the middle of the tibial spines.
- The mechanical tibial axis connects the middle of the tibial spines and the middle of the ankle joint.
- The mechanical lower limb axis represents the overall deformity of the lower limb.

This View Is of Interest:

For osteotomies: it will define the origin of the deformity (at the level of the femur or tibia) and will thus indicate the level to perform the osteotomy, the importance of the overall deformity and the amount of correction that will have to be performed.

Unicompartmental knee prosthesis: will define the deformity and will illustrate reducibility (full leg stress X-rays).

Total knee arthroplasty: will determine the overall deformity, and possible bony defect. It will allow planning of the femoral and tibial cuts, and therefore predict the need for soft tissue release.

Stress radiographs in varus and valgus will illustrate intra-articular laxity and reducibility of the deformity.

Of interest

- Measurement of the constitutional varus.
  - Epiphyseal axis defined by Levigne: line connecting the middle of the tibial joint line and the middle of the line connecting ends of the tibial physeal scar. This axis forms a constant angle of 90°±2° to the lateral tibial plateau (Fig. 14.8). The constitutional deformity of the tibia is defined as the angle between the epiphyseal axis and the tibial mechanical axis (Fig. 14.9).
  - Sometimes it is difficult to determine the middle of the tibial joint line and to perform the measurement. Therefore, we prefer to determine the level of the original tibial plateau by the line tangent to the normal contralateral tibial plateau. Subsequently, the mechanical tibial axis is drawn. The angle between both axes is the angle alpha. The constitutional varus is defined by the complementary angle 90-alpha (Fig. 14.10).
- Measurement of the hip knee femoral angles; this will be discussed in Chap. 25, Steps and Strategies.

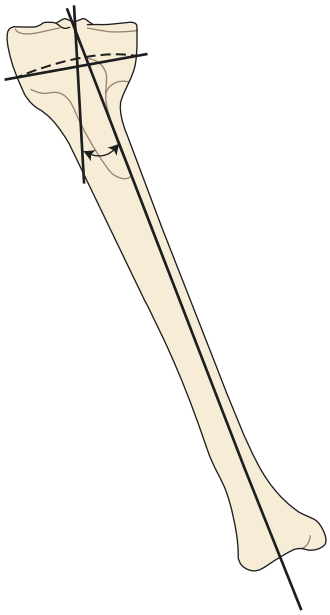

Fig. 14.9 The constitutional deformity of the tibia is defined as the angle between the epiphyseal axis and the tibial mechanical axis

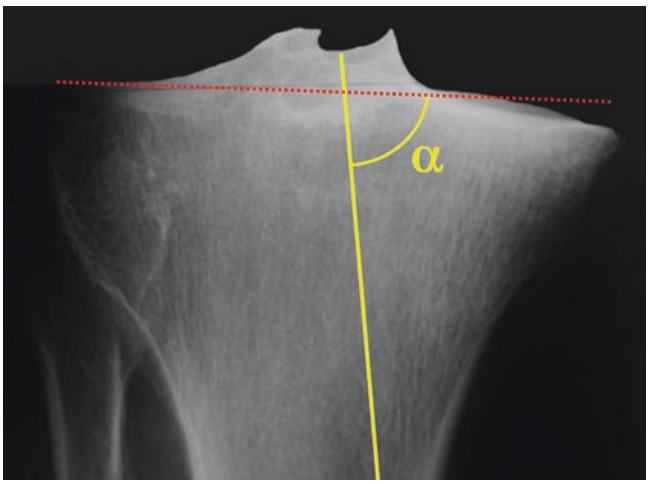

Fig. 14.10 The constitutional varus is defined by the complementary angle 90-alpha

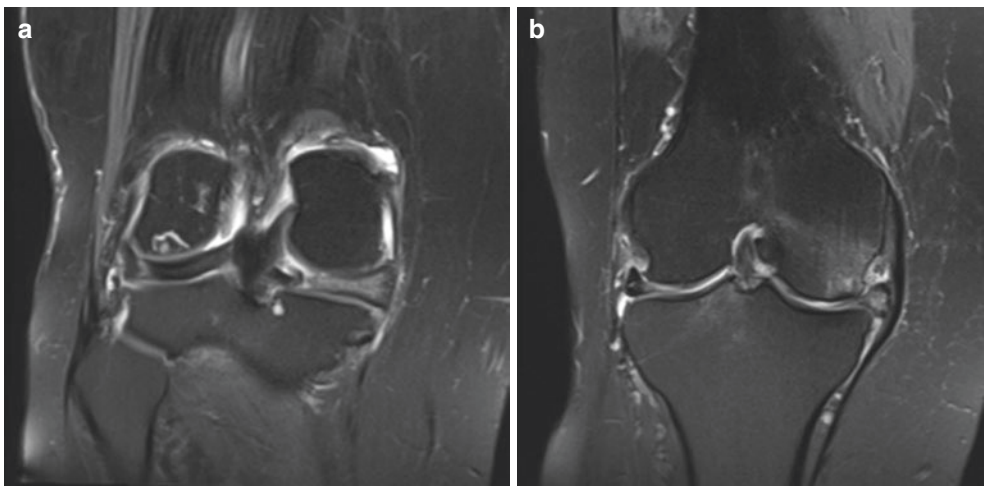

Fig. 14.11 MRI coronal images in the same patient showing (**a**). Posterior horn root tear. (**b**) Meniscal extrusion and subchondral edema

Additional Radiologic Investigations:

For anti-recurvatum osteotomies: two long profile hyperextension views of the lower limb. The femoral recurvatum is the angle defined by the line tangent to the anterior cortex and the line perpendicular to the Blumensaat line. The tibial recurvatum is defined by the tibial slope. For both, see Fig. 14.2a–c, Chap. 20).

CT imaging: this will determine the presence of rotational problems. Certain patients with a frontal valgus or varus deformity develop a unilateral arthritis at the side of the convexity of the malunion. This lateralization of the degenerative process can be explained by the associated rotational problem. An internal femoral rotational deformity will cause lateral tibiofemoral arthritis, while an external rotational deformity will cause medial tibiofemoral arthritis.

We do not use routinely low dose X-rays imaging developed by Charpak and Dubousset (EOS system) but it does allow a precise measurement of the deformities in the three planes.

MRI may be useful in cases of early osteoarthritis to show evidence of AVN or overload from varus deformity, and incompetence of the meniscus secondary to root tear and extrusion (Fig. 14.11). It will thus play a part when the indications appear disputable and guide various surgical interventions including root repair, osteotomy, UKA, or TKA.