Joints

Extensor mechanism realignment procedures in the treatment of patellofemoral instability

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Abstract

Patellar instability is one of the most common conditions treated in the field of orthopedics. A diagnosis based on clinical and instrumental tests allows proper treatment planning.
The techniques at the disposal of the surgeon – arthroscopic, arthroscopically-assisted and open – are numerous, and extensor mechanism realignment procedures are among the ones most frequently used. The choice of the most appropriate technique must be made case by case, considering the peculiarities of the individual patient.

Key Words: tibial tuberosity transposition, realignment, extensor mechanism, patello-femoral instability.

Introduction

Patellar pain is one of the most frequent reasons for consulting an orthopedic specialist.
The term patello-femoral malalignment (PFM) was introduced in 1979 by Insall (1) and it covers a considerable breadth of disorders, ranging from patellofemoral (PF) maltracking leading to altered loading of the cartilage surfaces, to patellar subluxation and even acute and recurrent patellar dislocation.
Another well-known classification is that of Dejour et al. (2), which divides this condition into three different grades: an initial painful patella syndrome, typically seen in adolescents and individuals who play sport; potential patellar instability, in which patellar pain is present in the absence of specific anatomical abnormalities; and objective patellar instability, characterized by a history of at least one dislocation of the patella and the presence of predisposing factors.
Patellar pain has a very high incidence and affects both active and sedentary individuals, predominantly females. To diagnose this disorder correctly, it is essential to have good knowledge of the conformation of the PF joint, of the ligament and tendon structures contributing to the knee extensor mechanism, and of the neurovascular structures present in this area.

Anatomical and biomechanical considerations

The patella is a sesamoid bone with seven facets on its articular surface with which it interfaces with the femoral trochlea. Its biomechanical function is to improve the efficiency of the quadriceps, by increasing the lever arm of the extensor mechanism and thus the patellar tendon moment of force.
The conformation of the patella is variable, as described by Wiberg (3), who proposed a classification (**Fig. 1**). It is vascularized by branches of the geniculate arteries and innervated by cutaneous nerve endings.
The position and stability of the patella at rest and in flexion-extension movements of the knee result from the interaction of numerous elements, both active and passive, which, schematically, are arranged in a cross shape. Unexpectedly, given the complex mechanics of this system, any condition leading to alteration of even just one of its components (patellar malformations; morphological defects of the femoral condyles; abnor-

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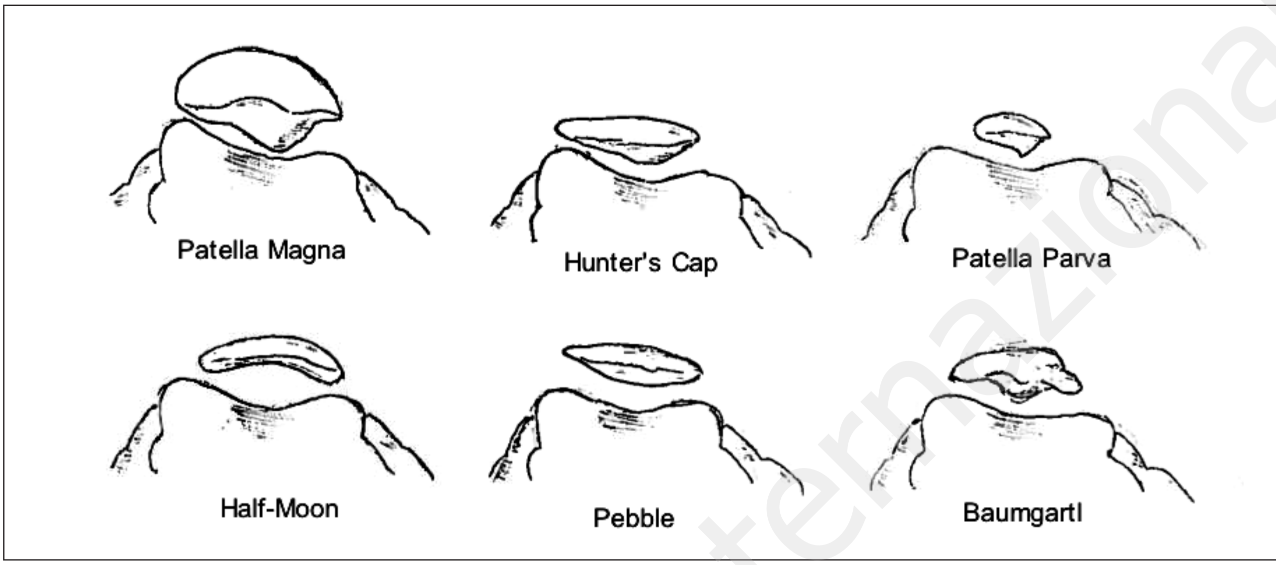

Fig. 1. Wiberg's classification of different patella types (ref. 26).

mal patellar positioning; abnormalities of the extensor mechanism; muscular deficits; abnormal tibial torsion) can interfere with correct patellar tracking in the trochlear groove.

Clinical assessment

The patient will generally present with a clinical history of knee pain, joint weakness and/or locking, and even dislocations.
Very important, in addition to careful history taking, is the general physical examination in which we examine the conformation of the lower limbs and the femoral-tibial axis, and also assess PF tracking using specific clinical tests, such as: grind test, patella apprehension test, Clarke's test, Fairbank's test, patellar glide test and Basset's sign (to detect acute dislocation).

Imaging

Imaging plays an extremely important role in the diagnosis of PFM. The following plain film X-rays are used: anterior-posterior and lateral projections with the knee extended and the condyles overlapping or with the knee flexed to 30°, and axial projections of the patella with the knee flexed to 45° (**Fig. 2**).
On conventional radiographs it is necessary to evaluate the height of the patella, the extent of trochlear dysplasia, the sulcus angle, and the angle of congruence.

The overall assessment of the alignment of the extensor mechanism is performed by measuring the Q angle, which is the angle formed by the intersection between the line of pull of the quadriceps tendon and the axis of the patellar tendon. The factors that influence this angle most are: femoral anteversion, the position of the patella in the femoral groove, the position of the anterior tibial tuberosity, and tibial torsion. Changes in the Q angle alter the moment of the load on the articular cartilage and this, in time, leads to deterioration and progression of symptoms and joint damage.
Computed tomography (CT) and magnetic resonance imaging (MRI) studies are also very important. A tra-

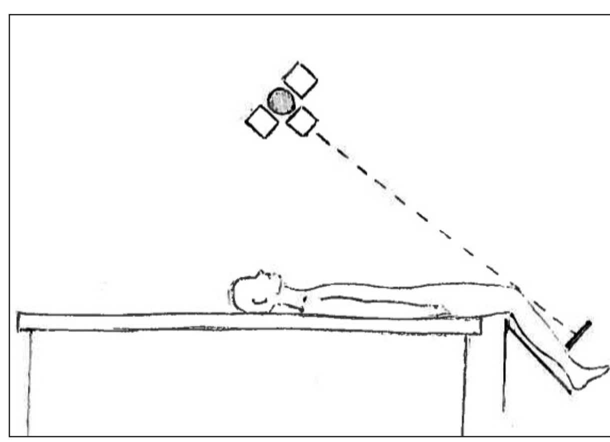

Fig. 2. Position of the patient during the taking of axial radiographs of the patella.

ditional CT will show, with greater clarity, all the possible alterations or deformations of the bone structures involved. Using the Lyon method with superimposition of the images between the trochlear groove and the tibial tuberosity, certain parameters can be calculated, such as the TT-TG, sulcus angle, congruence angle and patellar tilt, which are basic elements for proper planning of surgical treatment.
Using MRI, it is possible to perform a careful study of the cartilage and soft tissues and the technique can also show chondral defects.

Surgical treatment

Considering all the various treatment options for PF disorders, it should be noted that surgical treatment is suitable for a limited number of patients and open surgery for fewer still. The aim of these procedures is to obtain soft tissue correction, bone tissue correction, or both.
Arthroscopic interventions generally involve a diagnostic stage, which includes assessment of patellar tracking and of any chondral defects, synovial plica removal, lateral retinacular release and medial capsular reefing, through to medial patellar femoral ligament (MPFL) reconstruction.
Lateral retinacular release (**LRR**) is probably the most widely used arthroscopic technique and it is indicated in cases of lateral retinacular retraction and persistence of symptoms in spite of conservative treatment. Taking care not to damage the fibers of the vastus lateralis, it is performed using an arthroscopic radiofrequency device starting 5 mm from the lateral edge of the patella and proceeding distally to cut the patello-tibial ligament and the distal insertion of the retinaculum.
Reconstruction of the MPFL, i.e. anatomical reconstruction of the ligament using an autologous tendon graft, is a more recent technique. It can be performed in isolation or combined with arthroscopic or anterior tibial tuberosity realignment procedures.
The literature contains descriptions of numerous soft tissue procedures for realignment of the extensor mechanism, which can be performed via arthrotomy or partial arthrotomy. These include quadricepsplasty (4) and the technique described by Insall et al. (5, 6). The first entails transfer and reefing of the vastus medialis with or without LRR; in the second, a "tube realignment" procedure, the lateral border of the quadriceps tendon is sutured to a medial flap to achieve realignment and partial proximalization of the patella.

The procedures for realignment of the bony components (distal realignment) are interventions involving transposition of the anterior tibial tuberosity – medialization (Elmslie-Trillat), anteromedialization (Fulkerson), elevation (Maquet) – or multiplanar osteotomies with medialization and distalization (**Fig. 3**).
Briefly, these procedures, regardless of the surgical technique used, aim to:
- reduce patellar pressure;
- increase patellar stability;
- reduce the stress on the lateral stabilizers and strengthen the dynamic medial stabilizers;
- improve the Q angle and therefore the biomechanical efficacy of the extensor mechanism;
- improve congruence, by eliminating the excessive lateral pressure.

The **Elmslie-Trillat technique** was first described by Roux in 1888 (7) and subsequently revived by Elmslie in England and Trillat in France (8, 9). It is indicated in cases of recurrent patellar subluxation and dislocation in adults with malalignment of the extensor mechanism.
The surgical procedure involves making a lateral parapatellar incision as far as the anterior tibial tuberosity. LRR is then performed with the knee flexed. An osteotomy of the anterior tibial tuberosity, extending 4-6 cm, is then made, preserving its distal attachment. The tuberosity is then rotated medially by about 1 cm and secured in position with one or two screws (**Fig. 4**).
The Fulkerson procedure is a more aggressive technique, indicated in cases of lateral subluxation and dislocation of the patella in adults with patellofemoral

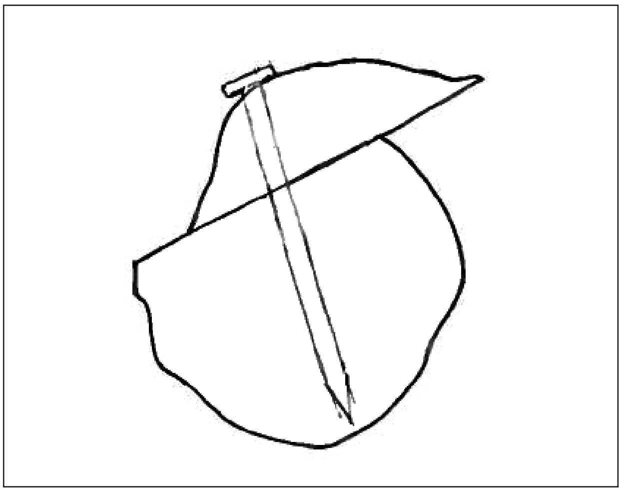

Fig. 3. Medializing effect of osteotomy of the anterior tibial tuberosity.

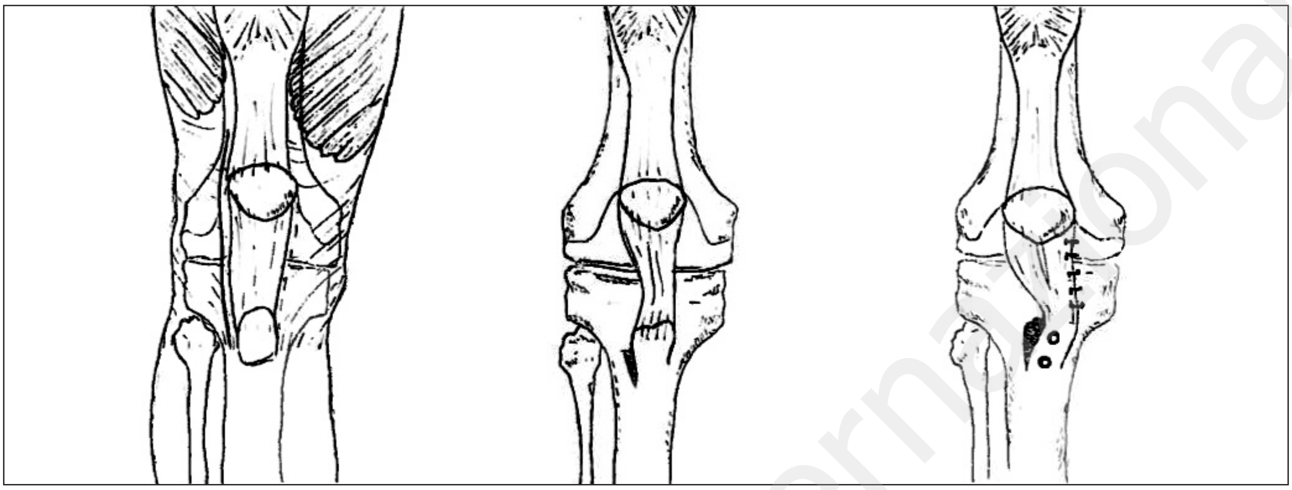

Fig. 4. Stages in the Elmslie-Trillat procedure.

pain and malalignment of the extensor mechanism (10-12).
The surgical procedure involves making a lateral parapatellar incision, ending at a point 5-8 cm distal to the tibial tuberosity. Lateral retinacular re-lease is then performed with the knee flexed. The osteotomy line is marked and the cut performed, completely detaching the tibial tuberosity. The tibial tuberosity is then moved anteriorly and medially by no more than 1-2 cm and fixed with screws. This procedure needs more post-operative immobilization and is more indicated in cases of anterior knee pain on account of the detensioning resulting from the elevation (**Fig. 5**).
The **Hugston-Walsh technique** (13, 14) is indicated in cases of failure of conservative treatments, dislocations associated with osteochondral fractures, patellofemoral instability associated with ligamentous instability, severe PF changes and congenital dislocation of the patella.
The surgical procedure involves making a lateral parapatellar incision. The Q angle is measured intra-operatively. Lateral retinacular release is then performed with the knee flexed. Osteotomy of the anterior tibial tuberosity is then performed and the transfer site prepared. The displacement (less than 1 cm) is then performed in a medial and inferior direction. Fixing is again with screws. The last step is lateralization and advancement of the vastus medialis obliquus (**Fig. 6**).
Finally, the **Maquet technique** (15, 16) is indicated in cases of patellofemoral chondral damage (17, 18). The surgical procedure involves making a lateral parapatellar incision extending 10-12 cm below the tibial tuberosity. The osteotomy line is first marked with a drill and the osteotomy, extending 10-12 cm from the anterior tibial tuberosity, is made parallel to longitudinal tibial axis. Using the distal portion of the osteotomy as a hinge, the tuberosity is elevated and anteriorized, and then fixed with screws. This technique also involves grafting bone into the osteotomy site (**Fig.** 7).
Whatever the chosen surgical technique, it is essential that the osteotomy site be well exposed so as to allow accurate intra-operative measurements of the movements to be performed. In addition, osteotomies should preferably be performed using wide-bladed osteotomes to avoid excessive damage to bone and to vascular supply.
As regards the choice of fixation method, it is always

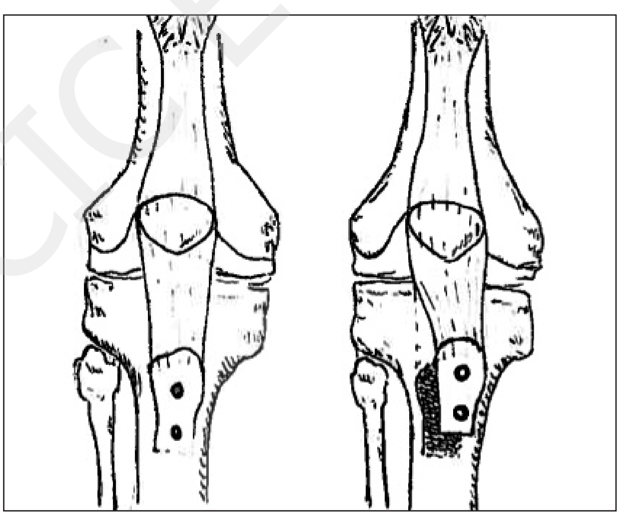

Fig. 5. Stages in the Fulkerson procedure.

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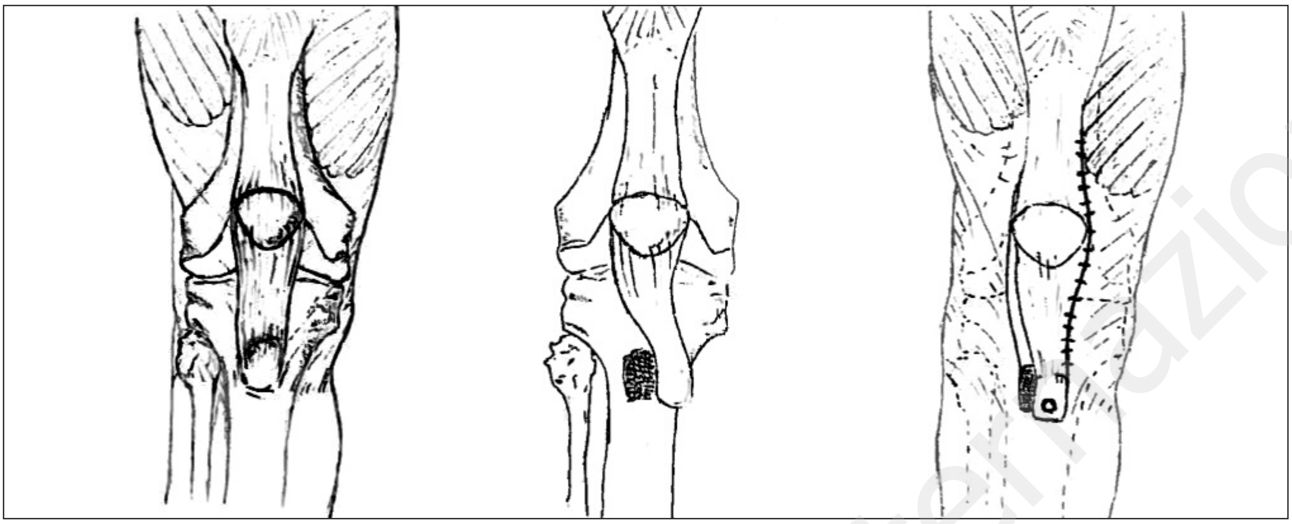

Fig. 6. Stages in the Hughston-Walsh procedure.

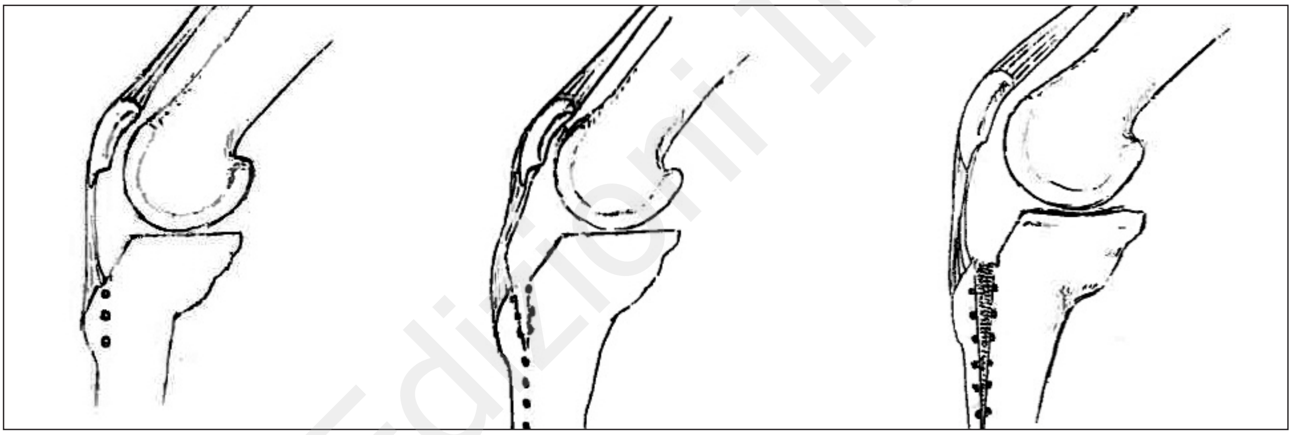

Fig. 7. Stages in the Maquet procedure.

advisable to use at least two cortical screws of adequate dimensions, verifying their length with an image intensifier. At the end of the procedure it is advisable to perform a dynamic evaluation, possibly arthroscopic, to verify the correctness of the patellar tracking and the centering with the knee extended and flexed to 30°, also testing manually for possible patellar subluxation.

In addition to these techniques, whose aim is to realign the extensor mechanism, there are others designed to be used in special cases.

These include **osteotomy of the patella** (19), indicated for recurrent dislocations in PF dysplasia, and **periarticular osteotomies**, indicated in patients in whom there is also a neurological component (e.g. congenital deformity or secondary to spastic palsy).

Finally, in the presence of anatomical abnormalities, **trochleoplasty**, by "recreating the tracks", can be a means of obtaining a conformation that will allow correct patellar tracking.

Conclusions

Patellofemoral instability is an insidious multifactorial disorder, which is difficult to diagnose and requires

careful clinical and instrumental examination. The assessment of the patient must correlate etiology, anatomy, joint condition and type of treatment.
Careful evaluation of imaging data is extremely important in the diagnostic work-up. The data provided by CT scans should guide the surgeon's actions with regard to the medialization, elevation or lowering of the anterior tibial tuberosity.
The choice of the most appropriate treatment must be made "case by case" given that there exists no one procedure suitable for all patients. The decision must take into account the pain symptoms, the patient's level of activity and the outcome he is expecting in terms of his/her sporting and daily activities, remembering that the right physiotherapy treatment can, in many patients, be sufficient to resolve the symptoms.

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