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Current Concepts in Trochleoplasty for Major Trochlear Dysplasia

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Although technically demanding, trochleoplasty can be useful as a primary procedure for primary trochlea dysplasia or as a salvage procedure in cases of failure after previous patellar alignment surgery.

Introduction

The importance of a dysplastic trochlea as a component of patellar instability (especially recurrent dislocation or habitual dislocation) has been recognized for many years. It is usually combined with other static or dynamic abnormalities, such as genu recurvatum, patella alta, patellar tilt, increased Q angle, and bone torsional abnormalities.

Major trochlear dysplasia is characterized by the combination of flat and/or prominent trochlea with a convex shape that is proud of the anterior femoral cortex, rather than a concave geometry, which offer inadequate tracking during flexion and lead to patella subluxation, respectively [1,2].

Many surgical techniques have been proposed for the treatment of patellar instability. Trochleoplasty has been described as corrective treatment for bony abnormalities for many years, with the goal of restoring normal anatomy. Correcting the trochlear depth abnormality plays a major role to stabilizing the patella because it facilitates proper entrance of the patella into the groove of the trochlea. In our experience, restoration of the trochlea groove by trochleoplasty prevents future patellar dislocation and is effective in reducing anterior knee pain.

Elevation of the lateral trochlear facet was first described by Albee [3] in 1915, followed by deepening trochleoplasty, [2,4-12] which tries to create a new sulcus by removing subchondral bone. Recently, Goutallier [13] proposed an easier concept, termed recession trochleoplasty, in which the bump is solely corrected with the trochlea remaining flat. This has now been adopted as our preferred technique [14].

Trochleoplasty is considered to be a demanding technique and may be avoided by many surgeons due to a lack of familiarity. However, it can be a useful addition to the surgical armamentarium of the patellofemoral surgeon and has precise indications.

Trochleoplasty can be proposed as a primary procedure for primary trochlea dysplasia or as a salvage procedure [13] in case of failure after previous patellar alignment surgery, principally anterior tibial tubercle transfer (ATTT).

In most cases, trochleoplasty is performed in association with other procedures (bony procedures such as ATTT transfer, or soft tissue procedure such as medial patello femoral ligament [MPFL] reconstruction). This combined procedures follows the concept of à la carte surgery described by Henri and David Dejour [1,7], which attempts to address all abnormalities during one surgical intervention.

Principles

The first trochleoplasty involved the elevation of the lateral trochlea facet, as described by Albee [3]

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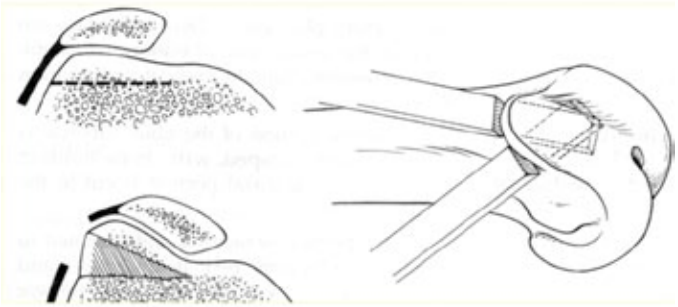


Figure 1. Elevation of the lateral facet, according to the Albee technique.

(Figure 1), addressing a flat trochlea by increasing the trochlear prominence. This method is now generally considered to be erroneous as it increases the patellar constraints, leading to secondary osteoarthritis. As a result, lateral trochlear elevation has fallen out of favor.

The second method is the deepening trochleoplasty. In 1966, surgery to correct the abnormality by deepening the sulcus was introduced by Masse [4]. He suggested the removal of subchondral bone and to impact the articular cartilage with a punch to recreate a central sulcus. This technique was later modified by Henri Dejour [2], who performed an osteotomy of both femoral condyles to create a V-shaped trochlear groove.

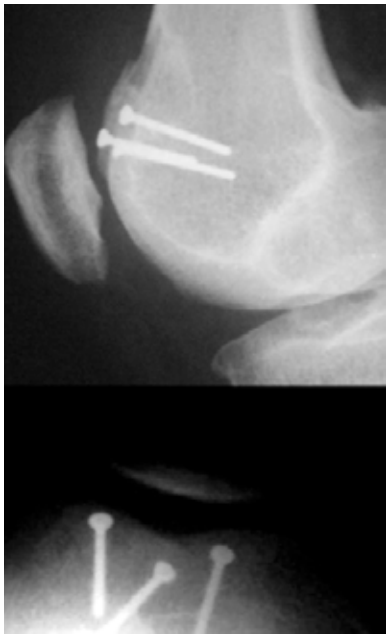


Figure 2. Deepening throchleoplasty. The trochlear groove has been restored but note the incongruency between the flat patella and the deepened trochlea.

Von Knoch et al [5] described another technique known as "the Bereiter technique," in which an osteochondral flap was raised from the trochlea and a bony sulcus was fashioned using burrs. The flaps were then depressed, making a smooth groove, and fixed by vicryl tape. This technique has been later described under arthroscopic control by Blønd and Schottle [6].

Deepening trochleoplasty, by any of these methods, is logical because it reduces the flatness and the prominence and attempts to restore a normal anatomy (Figure 2). There are several key points to be considered when performing deepening surgery:

- Where should the trochlea sulcus be located when the trochlea is flat?
- What about the congruency between a flat dysplastic patella on a deepened trochlea? (Figure 2)
- What is the morbidity of this demanding technique, particularly bone healing and the risk of subchondral bone or cartilaginous necrosis?

The third type of trochleoplasty has been described by Goutallier et al [13], who performed a recession-type trochleoplasty. In this procedure, the prominent dome-shaped anterior surface of the distal femur was recessed to the level of the anterior femoral cortex without deepening the groove itself. The aim was not to fashion a groove, but to reduce the prominent bump without modifying the patellofemoral congruence. This procedure is technically less demanding than a deepening trochleoplasty (Figure 3).

Figure 3. Recession trochleoplasty. There is a reduction of the prominence but the flat trochlea remains (crossing sign).

Recession trochleoplasty diminishes the trochlear bump, which improves patellar tracking, reduces lateral subluxation, and decreases patellofemoral constraint by increasing the angle between the quadriceps muscle force and the patellar tendon force. This has now become our preferred technique and we have reported the outcome of 24 cases of recession trochleoplasty performed between 2004 and 2009 [14] (mean age: 25; 12 primary procedures and 8 salvage procedures). Recession trochleoplasty was always performed with an additional procedure: 16 ATT transfers, 8 MPFL reconstructions.

Preoperative Imaging

Preoperative imaging forms the key to determine when trochleoplasty is indicated. We have established a standard protocol of plain radiographs for visualisation of the patello-femoral joint. These con-

sist of AP view, lateral view at 20° of flexion, lateral view in full extension with quadriceps contraction, and skyline views at 30° in neutral rotation of the leg [15] and in external rotation (in order to demonstrate an eventual lateral subluxation). Additional bone imaging is provided by computed tomography (CT) [16].

The projection of the lateral radiograph is critical. By ensuring that the posterior aspects of the medial and lateral femoral condyles are superimposed, the bony anatomy of the trochlea can be compared. A number of key measurements and lines have been described based on this true lateral projection [1]:

- The Crossing Sign described by Walch characterizes the trochlea flatness.
- The trochlear bump or prominence is measured by the distance between a line tangential to the anterior femoral cortex, and a line parallel to this through the trochlear groove. A bump > 5 mm characterizes a major dysplasia (Figure 4)
- Patellar height may also be determined to consider an ATTT distalization procedure. We prefer to use the Caton Deschamps [17] index > 1.2

The lateral view in complete extension with quadriceps contraction allows assessment of the patellar tilt. (Figure 5) The "thick patella sign" characterizes a tilted patella, which appears thickened front to back.

CT scanning confirms the trochlear flatness and the trochlear prominence on sagittal sections, which can also be measured (Figure 6) according to Dejour's classification [7]. It is important to consider that the dysplastic trochlea is lateralized compared to the center of the femoral epiphysis. This lateralization must be taken into account during trochleoplasty procedure.

The CT scan also measures the distance between tibial tubercle and the trochlear groove (TTTG). This is the traditional image-based determination of an increased Q angle [16]. Finally, CT scan permits assessment of the patellar tilt in extension: A tilt of more than 20° may be considered as an indication for additional soft tissue reconstruction.

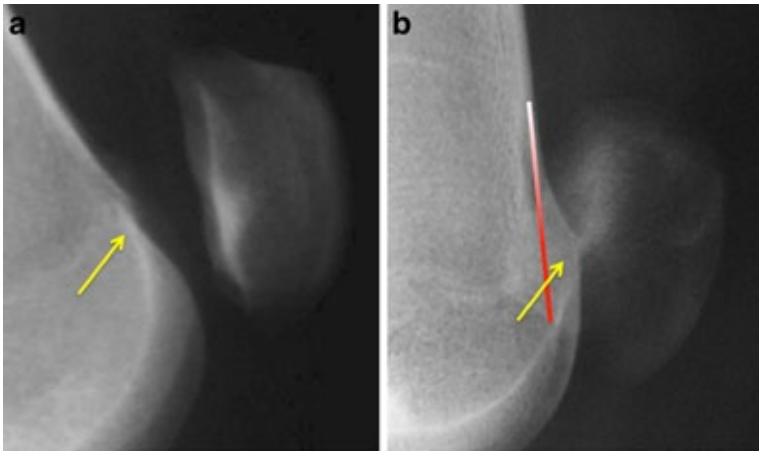


Figure 4. Different types of trochlear dysplasia a: crossing sign without prominence b: crossing sign and marked prominence demonstrating a major dysplasia.

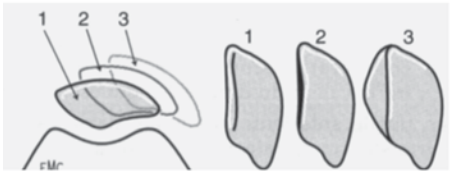


Figure 5. Lateral view in complete extension and quadriceps contraction. It allows to assess patellar tilt, according to the shape of the patella.

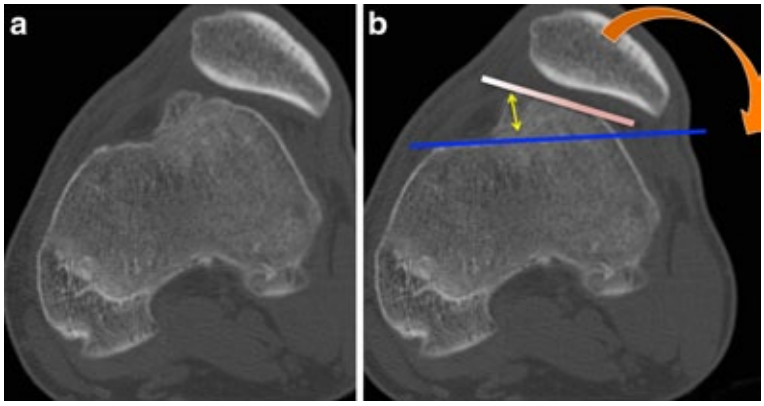


Figure 6. CT scan. It directly evaluates the trochlear prominence. The orientation of the trochlear plane and the trochlear lateralization explain patellar tilt and subluxation.

Operative Technique

The procedure is performed with the patient supine. A tourniquet minimizes bleeding from the exposed areas of cancellous bone. Arthroscopy may be performed to confirm the absence of cartilage defect prior to trochleoplasty surgery. Two techniques – deepening trochleoplasty and recession trochleoplasty – are described below.

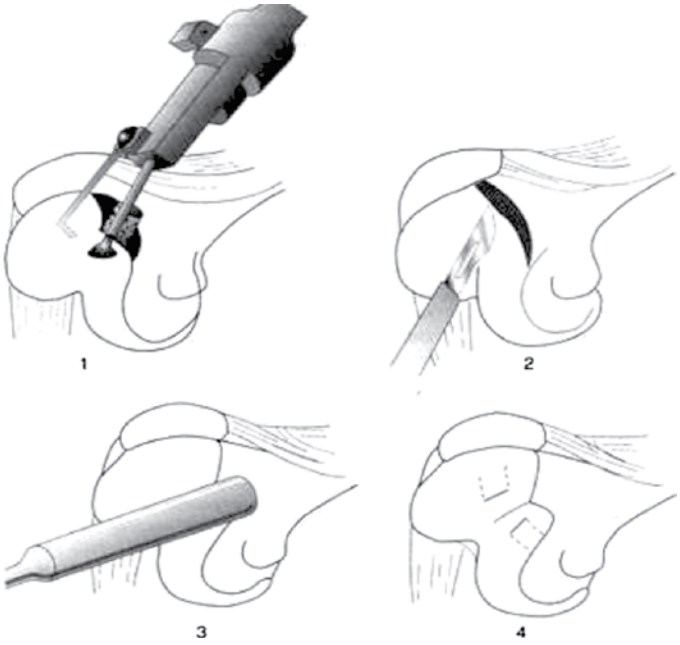


Figure 7. The steps of deepening trochleoplasty.

Deepening Trochleoplasty

Dejour [18] proposed the following technique for deepening trochleoplasty (Figure 7):

- Arthrotomy is performed through a mid-vastus medial approach.
- The patella is translated laterally without eversion.
- Peritrochlear tissue is excised to visualize the anterior femoral cortex and define the amount of bone to be removed.
- The new trochlear sulcus is then drawn, starting from the top of the intercondylar notch and directing proximally with 3° to 6° of valgus. Lateral and medial facets are also demarcated.
- To access the undersurface of the trochlea, a thin strip of cortical bone is removed from the osteochondral edge, and then cancellous bone is removed from the undersurface of the trochlea.
- A drill with a depth guide of 5 mm is used to ensure uniform thickness of the osteochondral flap, which maintains an adequate amount of bone beneath the trochlear articular cartilage. The produced shell must be thin enough to be modeled without being sustaining a fracture.
- More bone is removed from the central portion at the location of the new sulcus. The groove, and sometimes the medial and lateral margins, must be osteotomized.
- The osteochondral flap is then replaced and molded by gentle tapping with a punch.
- The new trochlea is fixed with two small staples (1 mm in diameter), one in each side of the groove. One arm is fixed in the upper part of the trochlear cartilage; the other one in the anterior femoral cortex. The staple is sunk deep to the superior surface of the cartilage.
- Patellar tracking is tested by flexing and extending the knee.

Recession Trochleoplasty

We prefer to perform a lateral approach, as the dysplastic trochlea lies on the lateral aspect of the femoral epiphysis. Our technique aims to treat the underlying anatomic abnormality without compromising the articular surface.

- The incision is made just lateral to the patella, extending from the superior pole to the level of the patella to beyond the tibial tubercle, onto the anterior ridge of the tibia. This permits a tibial tubercle transfer to be performed during the same procedure if required.
- Once the lateral retinaculum is exposed, a lateral arthrotomy is performed using a size 10 blade.
- The synovium is excised and tethering scar tissues proximally and distally are released. The size of the wedge to be excised and the angle to be corrected are guided by pre-operative imaging and measured intra-operatively (Figure 8).
- The osteotomies are initially drawn on the bone with a dermographic pen according to the preoperative planning (Figure 9). Using a reciprocal saw, the antero-posterior cut is performed first, 5 mm above the trochlea.
- Then the posterior cut is made, parallel to the frontal plane of the femur, from the lateral side, and directed medially. It is more precise to start the cut with a rigid osteotome and to complete it with the saw. The distal extent of the osteotomy should be approximately 5 mm away from the sulcus terminalis to give an optimal distal osteochondral hinge and to allow closing the wedge easily.
- An anterior oblique osteotomy completes the bone cuts linking the first two cuts.
- The proximal-based bone wedge is then re-

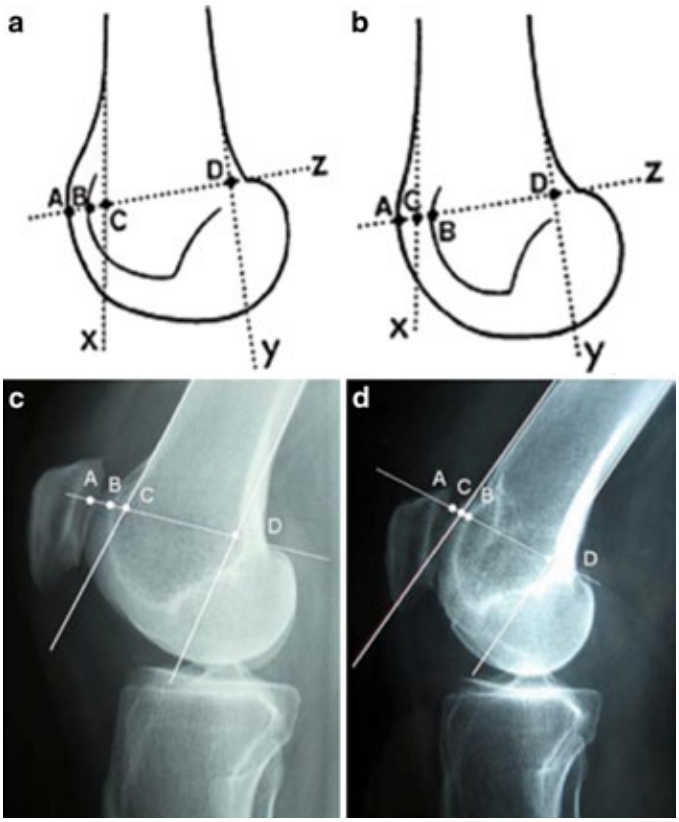


Figure 8. Pre- and postoperative bump height measurement technique. A and B: Drawings showing the Dejour and Walch method for calculating the bump height. Point "D" is the junction between the posterior cortex and articular cartilage. Bump height is measured between points "B" and "C". C: Pre operative lateral radiograph: the boss height is positive. D: Post operative lateral radiograph: the boss height is now negative.

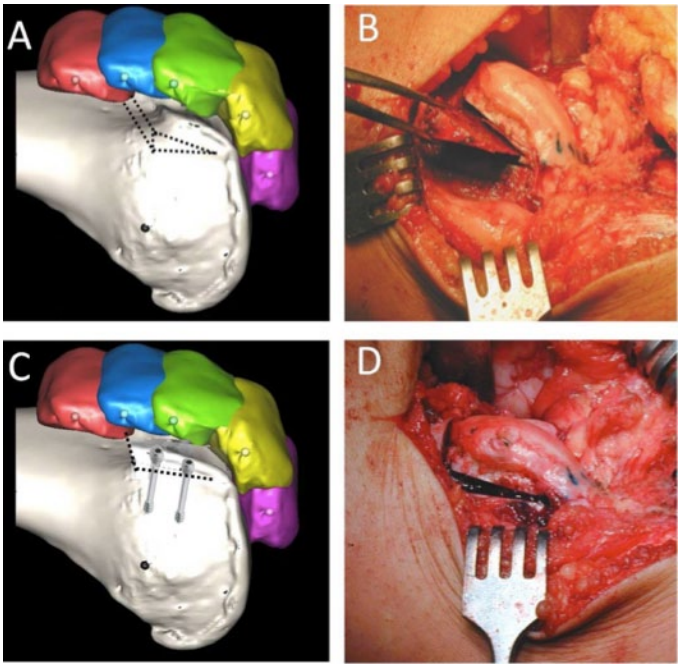
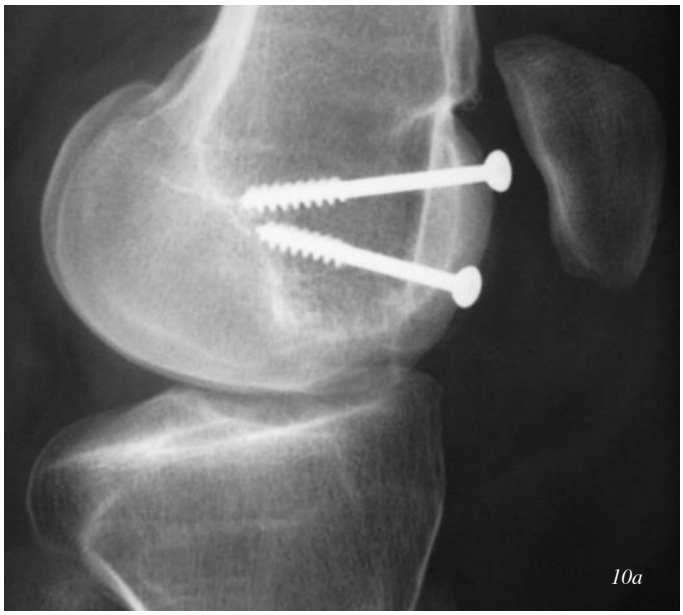
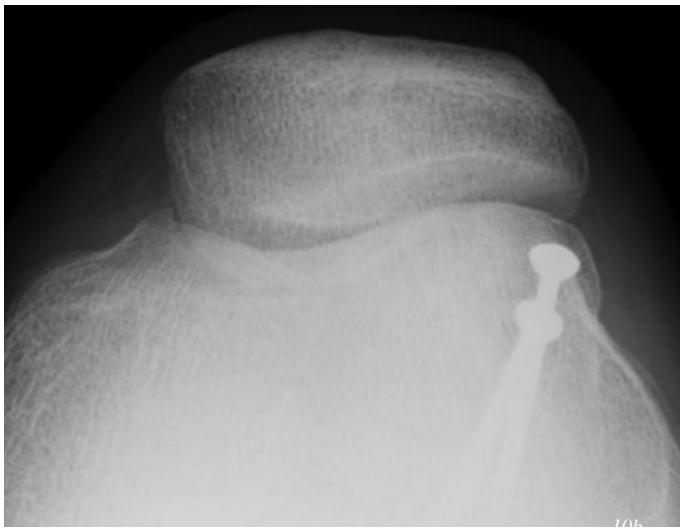


Figure 9. The recession wedge trochleoplasty surgical technique. A and B: The base of the wedge which is removed should be the same in millimeter that the value of the trochlear bump in order to allow the trochlea to settle into a deeper position, without modifying the trochlear groove. C and D: The correction is obtained after removal of the proximally based wedge by progressively applying a pressure on the trochlea. Fixation is carried out with two 3.5-mm cancellous screws, positioned just laterally to the cartilage surface.





Figures 10a-b. Postoperative X rays after Recession wedge trochleoplasty. A: lateral view showing the reduction of the trochlear porminence. B 30° patello femoral view showing the extracartilaginous position of the screws.

moved and correction is achieved by progressively applying sustained gentle digital pressure on the trochlea. The amount of bone removed is just enough to allow the trochlea to settle into a deeper position, without modifying the trochlear groove.

- The correction is secured using 3.5-mm cancellous screws, positioned just laterally to the cartilage surface (Figure 10). We now use two lateral screws only, and so far have had no problems.
- Postoperatively the knee is placed in an extension brace for the initial 3 weeks. Full weightbearing is allowed. Knee flexion is restricted to 0° to 60° for the first 3 postoperative weeks, and then slowly increased to reach 90° on the

sixth week. Return to sports is allowed at 6 months.

Results

Complications/Safety

The risks of the deepening trochleoplasty include breaking of the osteochondral flap; distal detachment; and creating a flap that's too thin, decreasing its blood supply. There are still concerns about the viability of the articular cartilage after trochleoplasty. Recession wedge trochleoplasty has a decreased risk of chondral damage and necrosis. Because the dysplastic segment of trochlea is lifted as a single osteochondral block and there is no need to fashion a new groove by cutting the osteochondral flap, it is possible to preserve a greater amount of subchondral bone. This makes recession arthroplasty a more attractive option for older patients with less pliable cartilage, with decreased risk of possible serious and irreversible articular and subchondral injury. In our series, we reported no cases of chondrolysis, subchondral necrosis, or non-union of the osteochondral block.

It is worthy of note that in cases of recession trochleoplasty, the wedge and the trochlear recess are flat and complementary, whereas in the deepening trochleoplasty, the osteochondral flap might not tally perfectly with the V-shaped recipient bone bed. Any small areas of separation between the two surfaces could slow down the osteointegration process. Similarly, the use of screw to stabilize the osteotomy rather than sutures may increase compressions between the two surfaces. Surprisingly, chondrolysis has never been reported with the deepening trochleoplasty.

Schottle [19] studied the cartilage viability after the Bereiter trochleoplasty. He found that tissue in the trochlear groove remained viable, with retention of distinctive hyaline architecture and composition and only a few minor changes in the calcified layers.

Postoperative stiffness is of considerable concern [8,11-13] and varies from 2% to 46%. In our series, one patient with combined MPFL required arthroscopic arthrolysis for knee stiffness 1 year after the index operation. Another patient required an arthroscopic supratrochlear exostosectomy for a persistent ridge responsible for pain. He was also satisfied and had no complaint at the last follow-up visit and reported no further episodes of instability.

Clinical Outcomes

To date, published outcomes of both deepening and recession trochleoplasty are similar, with improved subjective outcome scores reported in the short term [4,8-14,18]. Comparisons between series are difficult because the surgical procedures and follow-up periods are variable, the number of patients is often small, and patients have been operated on for mixed indications of pain rather than dislocation [12,13]. Moreover, it is not possible to assess the participation of trochleoplasty in the patellofemoral stability because it is rarely performed alone, and other abnormalities are corrected as part of the surgical procedure. As a result, there is a lack of high-level studies reported in the literature.

In Goutallier's case series in which trochleoplasty was performed as a salvage procedure, 67% of patients indicated that they were either satisfied or very satisfied with the outcome of surgery. Other series showed 100% satisfaction rates.

In our series, the operation failed to stabilize the patellofemoral joint in only two cases. The average objective knee score at last follow up was 80 (+/-17) for the Kujala score [20], 70 (+/-18) for the KOOS and 67 (+/-17) for the IKDC. Patients who had a previous surgery, as well as those with patellofemoral chondral lesions noted during the surgery or degenerative changes on the preoperative radiographs, were noted to have a lower Kujala score at last follow up.

Interestingly, all patients operated on for pain-free instability (n = 7) reported having slight pain. This was located at the site of screws to reattach the tibial tubercle and so was not directly related to the trochleoplasty itself. All patients with preoperative pain except one (n = 11) reported significant pain improvement at last follow-up.

Radiologic Outcome

Both deepening and recession trochleoplasty reduce the trochlea bump. In our series, the trochlear groove height changed from an average of 4.8 mm preoperatively to an average of -0.8 mm postoperatively (Figures 7, 8, 10). Patellar tilt changed from an average of 14° (6° to 26°) preoperatively to an average of 6° (range -1° to 24°). It is interesting to note that there was no significant difference in the correction of the patellar tilt angle when comparing the groups did or did not have adjunction of a MPFL reconstruction. Thus, our series suggests that MPFL reconstruction is not necessary when a recession wedge trochleoplasty is performed. The reduc-

tion of the boss height allows the avoidance of lateral misdirection and facilitates the sliding of the patellar into the trochlea recess.

Deepening and recessing trochleoplasty are effective in reducing anterior knee pain, but they do not halt the progression of patellofemoral arthritis – although the follow-up of the above studies is too short to draw any definitive conclusions. In our series [14], at the time of the latest follow-up, six knees had osteoarthritic changes in the patellofemoral compartment, according to the classifcation by Iwano et al [21]. These are similar to the results obtained with deepening trochleoplasty [5]. Trochleoplasty cannot be proposed as a prevention of late osteoarthritis.

Conclusion

Trochleoplasty is indicated as a primary procedure for major trochlear dysplasia with a prominence > 5 mm. Stabilization is obtained in most of the cases with the risk of residual mild anterior knee pain. Trochleoplasty can be also proposed as a salvage procedure when a previous surgery fails. In these cases, one can expect stabilization of the knee and improvement of anterior knee pain.

Reported results are encouraging in terms the prevention of redislocation and satisfaction index. The rate of complications is low. Long-term outcomes have not been reported, and there are no consistent data on the capacity to prevent secondary arthritis.

Technically speaking, the deepening trochleoplasty is a difficult procedure. Recession wedge trochleoplasty is easier to perform. It is never an isolated procedure but always in conjunction with other realignment procedures according to the a la carte surgery concept.

Source

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