Clinical Article

A philosophy and technique for reconstruction of the medial patellofemoral ligament

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Abstract
Our philosophy is to restore the patella to its original position and stability prior to dislocation and rupture of the medial patellofemoral ligament (MPFL). This approach is based on the established principle that "form follows function".

Philosophy
The patella is a sesamoid bone in a soft-tissue sleeve that originates on the anterior iliac spine and proximal femur and inserts distally on the tibial tubercle. The patella aligns itself in this soft-tissue sleeve and not with the femur as such.[1] Until the end of gestation, the form of the patella and trochlea probably has a genetic basis. After birth, the knee goes into full extension and a bipedal stance develops that results in a femoral obliquity and secondary valgus of the extensor mechanism soft-tissue sleeve. These epigenetic factors now determine the position of the patella in relation to the trochlea and probably play a major role in the eventual shape of the patella and trochlea, both of which develop congruent articulating surfaces.[2,3] There is a difference between the bony and cartilage morphology of the patellofemoral joint.[4,5] This means that congruent cartilaginous articulation may co-exist with an underlying bony incongruence.

In the last 30° of extension, the patella lies outside the bony constraints of the trochlea and is now dependent on soft-tissue constraints.[6] The MPFL has been shown to be the primary stabiliser against lateral dislocation.[7] The lateral retinaculum also has a restraining effect against lateral dislocation of the patella.[8]

Beyond 30° of flexion, patellar stability is provided by the trochlea and the soft tissues become less important.

The exact origin of the MPFL on the medial epicondyle is still undecided. Steensen[9] suggests that it attaches anterior to the epicondyle, while Smirk[10] postulates a posterior implantation, although some of his specimens reveal an anterior origin.

In reconstructing the MPFL, the aim should be to create a "favourable anisometry" in the reconstructed ligament

In reconstructions, we prefer an anterior position on the epicondyle as this prevents a windscreen-wiper effect as well as an abnormal and sensitive prominence. In a study presented in 1997, we were able to demonstrate that the MPFL is non-isometric and becomes tight in extension and lax in flexion[11] *(see Illustrations 1 and 2)*. This position has subsequently been confirmed by others.[9,10] In recent unpublished cadaver studies, we could demonstrate that patella alta increases the non-isometry of the MPFL.

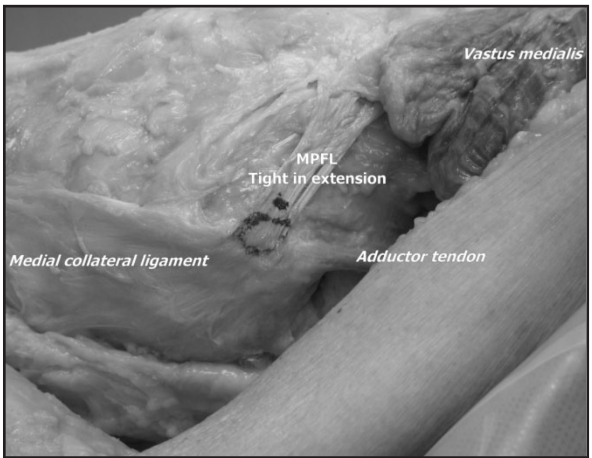


Illustration 1: MPFL tight in extension

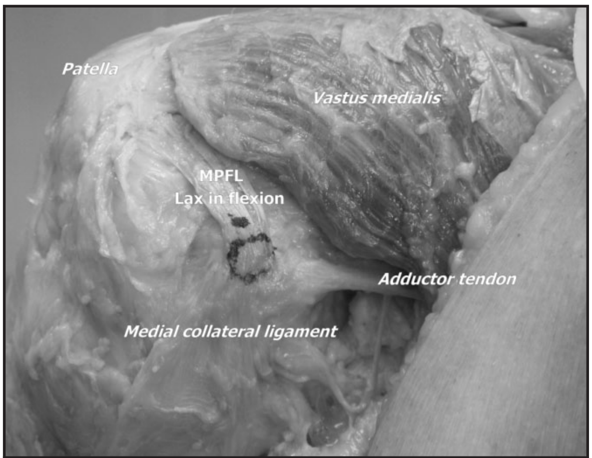


Illustration 2: MPFL lax in flexion

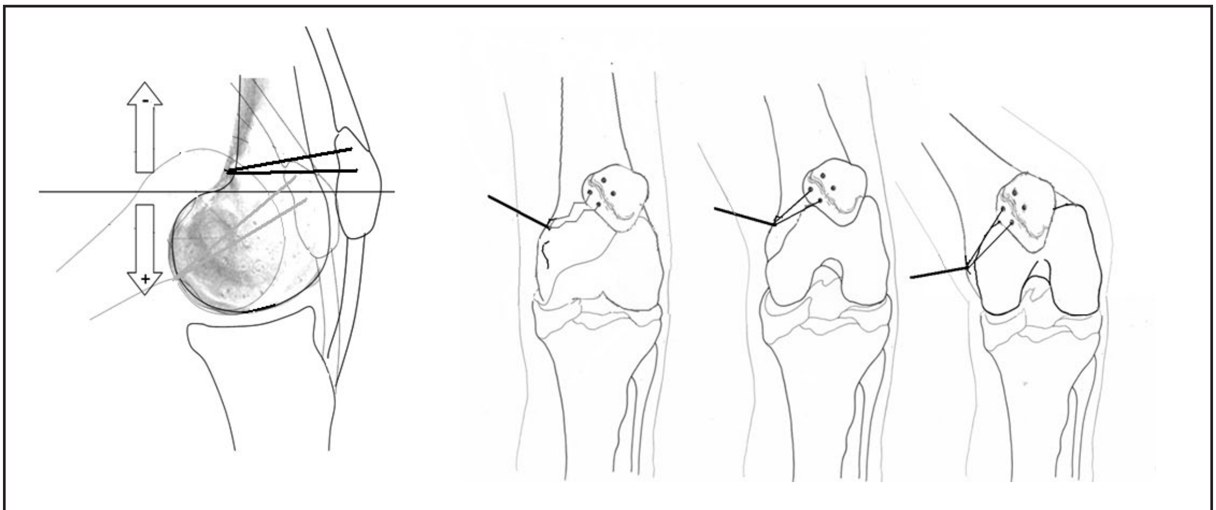


Figure 1: Femoral position more proximal, MPFL is now more lax in extension and tighter in flexion

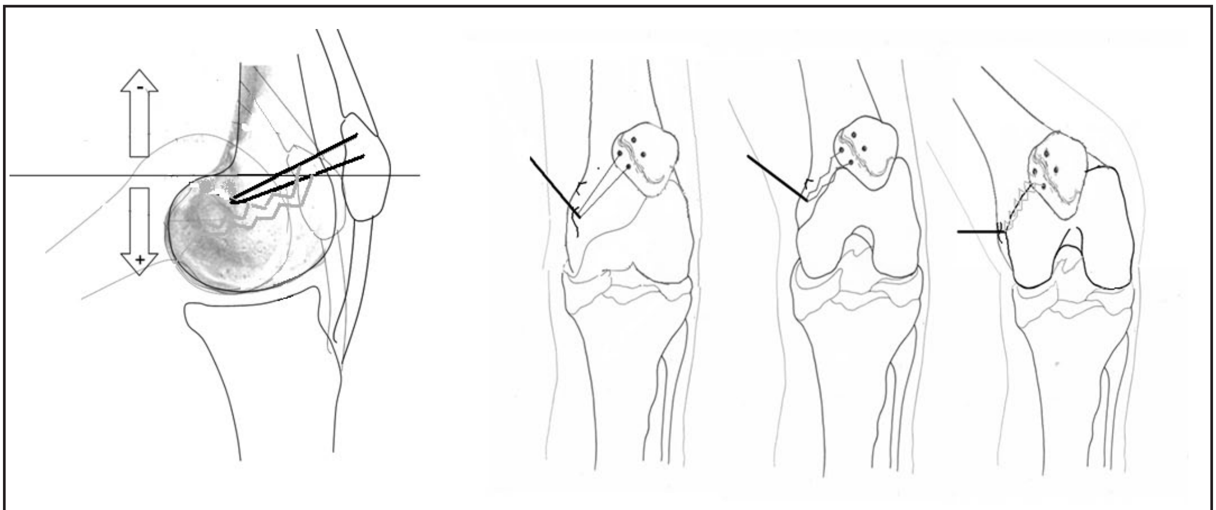


Figure 2: Femoral position more distal, MPFL tighter in extension and more lax in flexion

Placing the reconstruction more proximally, on the medial epicondyle, will result in a reconstructed MPFL that is lax in extension and tight in flexion, which may cause loss of knee flexion and excessive pressure on the medial patellar facet[12] *(Figure 1).* Conversely, placing the reconstruction too distally, on the medial epicondyle, will result in a too tight MPFL in extension and a lax ligament in flexion. A reconstruction that is too tight in extension may result in an extensor lag as the tension in the reconstructed ligament may be more than in the patellar tendon when the quadriceps muscles are maximally contracted *(Figure 2).*

In reconstructing the MPFL, the aim should be to create a "favourable anisometry" in the reconstructed ligament.[13] In cases of severe patella alta, it may be impossible to achieve a "favourable anisometry" as non-isometry increases progressively with the height of the patella. In these cases, a distalisation of the patella might be necessary to improve the isometry.

In contrast to the MPFL, the lateral retinaculum is lax in extension and tightens in flexion.[14,15]

In nearly all patella dislocations there is damage to the MPFL. In our own series, 70% had damage at the patellar insertion while the remaining 30% were damaged at the femoral origin. In all cases, however, there was some interstitial damage to the whole ligament. These findings correspond with that of Garth[17] but differ from the MRI findings of Sallay.[16]

Management

In the majority of patients who present with patellar dislocation, there is underlying pathology such as ligamentous hyperlaxity, trochlear dysplasia and patella alta.[18] This underlying pathology predisposes the patient to an acute overload of the soft-tissue stabilisers and rupture of the MPFL with patella dislocation.

Primary repair has a high failure rate: in our own series, 31% of the cases suffered redislocations in a four-year follow-up period. This corresponds with the results published by Nikku.[19] Most cases of primary dislocations are now treated non-surgically with a brace that allows full flexion but restricts the last 30% of extension. By restricting full extension, the MPFL is relaxed and may heal in a more favourable length. In exceptional cases, a primary reconstruction or direct repair of the MPFL and medial retinaculum would be considered.

The principle of our repair philosophy is to reconstruct the MPFL with stronger tissue than before to compensate for the underlying predisposing pathology and without changing the original position of the patella and its original conformity with its underlying trochlea. The normal MPFL fails at 208 N with an elasticity of 8 N/mm.[20] A double gracilis fails at 1 550 N with an elasticity of 336 N/mm.[21] At present, we prefer a double gracilis graft that, although stronger than the MPFL, is not as strong and stiff as a double semitendinosus tendon.

Pre-operative evaluation consists of a proper clinical examination with specific attention to dynamic patella tracking, patella height and possible P-F chondral damage. The contra-lateral patella is also properly evaluated, as the principle is to restore the injured knee to the pre-dislocation situation. Standard X-rays of the knee are done including a true lateral with the quads maximally contracted. This lateral X-ray is used to evaluate patellar height according to the Bernageau technique.[22] On MRI images, the ratio described by Biedert[23] can be used.

The only surgery to be considered in addition to a MPFL reconstruction is a distal tibial tubercle transfer in cases of severe patella alta.

Surgical technique of MPFL reconstruction

Three 3 cm long incisions are made over the gracilis tendon, over the medial edge of the patella and over the medial femoral epicondyle *(Figure 3).* The gracilis tendon is harvested with a routine technique.

At the incision over the medial edge of the patella, an incision is made through the second fascial layer. From here a dissecting scissors is used to tunnel between the second and third fascial layers towards the medial epicondyle. At the medial epicondyle, the second fascial layer is again incised over the tip of the scissors *(Figure 4).*

Skin incisions over the gracilis, the medial patella and the medial epicondyle

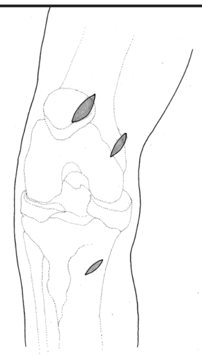


Figure 3:

Dissecting with scissors between the second and third layer from the patella to the epicondyle

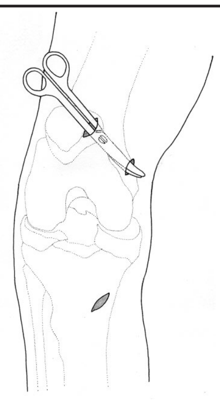


Figure 4:

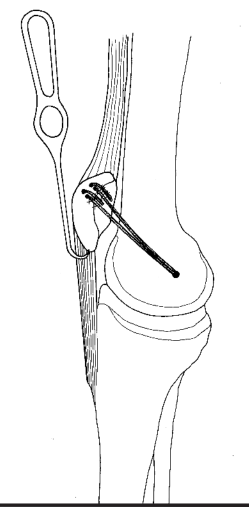
A guide wire is inserted slightly proximally on the anterior slope of the epicondyle. In the proximal third of the medial edge of the patella, two 3 mm drill holes are made approximately 10 to 12 mm apart. These drill holes should be on the edge of the patella. Larger drill holes and holes that go into the centre of the patella might act as stress raisers, which can lead to a stress fracture of the patella and should therefore be avoided. A tape is now placed around the guide wire at the medial epicondyle, then between the second and third fascial layers and through the drill holes at the medial edge of the patella. With the knee in full extension, a bone hook is inserted at the distal pole of the patella. While pulling proximally on the bone hook, in the direction of the femoral shaft, the tape is temporary tied in the drill holes on the patella *(Figure 5)*.

The stability of the patella is compared with that of the opposite knee and the length changes in the tape are observed as the knee is flexed and extended. If the femoral fixation point is correct the patella will be stable in full extension. The tape should be maximally tight at full extension and become progressively more lax with flexion. If this tension pattern is not seen the position of the guide pin on the femur needs to be adjusted. Moving the guide pin more proximally will decrease the tension in extension and increase the tension in flexion *(Figure 1)*. Conversely, moving the guide pin more distally will increase the tension in extension and decrease tension in flexion *(Figure 2)*. The ideal position is where the tape is at its tightest in extension and becomes lax with flexion while stability of the patella is maintained. Care should be taken to ensure that there is more tension in the patellar tendon than in the reconstructed MPFL. This is best achieved by pulling the patella proximally with the bone hook when tying the temporary tape. When a satisfactory tension pattern, in both the tape and patellar tendon is achieved, the guide wire in the epicondyle is overdrilled with a 4.5 mm cannulated drill.

A 5 mm bone anchor is placed in the depth of the drill hole on the femur. The loop of the double gracilis tendon is tied into the femoral bone tunnel with the anchor. The two free ends of the looped tendon are now brought between the second and third fascial layers to the exposed medial edge of the patella and through the two 3 mm drill holes on the medial edge. The free ends of the gracilis tendon are then folded back on themselves *(Figure 6)*.

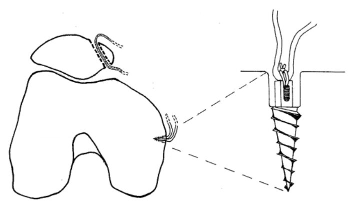
The reconstructed ligament is tensed in the same manner as described above with the testing tape. Tensing is done with the knee in full extension while simultaneously pulling with a bone hook on the patella, in the direction of the femoral shaft. This manoeuvre prevents over-tensing of the reconstructed MPFL. Excessive tension in the reconstructed ligament can lead to an extensor lag. This happens when the tension in this reconstructed ligament is more than in the patellar tendon with the knee locked in full extension by maximum quadriceps contraction.

The stability of the patella is compared with that of the opposite knee and the length changes in the tape are observed as the knee is flexed and extended



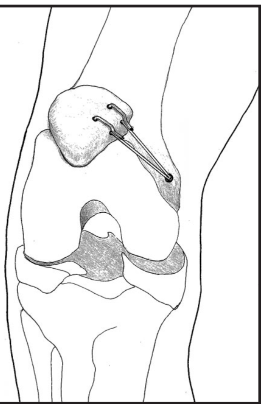
Pull proximally with a bone hook on the patella and the knee in full extension. Tension in the patellar tendon should be more than in the reconstructed MPFL

Figure 5:



5 mm bone anchor anterior to the medial epicondyle. Two 3 mm drill holes through the medial patellar rim

Figure 6:



Reconstructed MPFL from the medial epicondyle to the medial patella

Figure 7:

After tensing, the medial and lateral movement of the operated patella should be similar to that of the contralateral patella, the idea being to restore stability to the pre-dislocation situation. We suggested draping both knees to allow intra-operative comparison of the patellar movement. Once the tensing is satisfactory, the free end of the folded back tendon is sutured to itself and the surrounding soft tissue with non-absorbable material *(Figure 7)*.

Postoperatively, immediate full passive motion is encouraged. Active flexion and light isometric quadriceps exercises are done. For the first 4 weeks postoperatively the patient is mobilised partially weight-bearing, using two crutches.

After 4 weeks, the crutches are discarded and intensive quadriceps rehabilitation starts. Quadriceps rehabilitation is often prolonged and can take up to 6 months or even longer. Normal sports activities can be resumed as soon as full quadriceps rehabilitation is achieved.

Results

Between 1994 and 2006, we did 148 MPFL reconstructions using this technique. In four cases, the MPFL reconstruction was combined with a distal tibial tubercle transfer osteotomy. No medial transfer of the tibial tubercle or lateral retinaculum releases was done on any of the patients. There were three redislocations in this group, all of which were associated with a definitive injury and in all the cases there was an avulsion of the medial edge of the patella. These were all successfully treated with a re-implantation of the avulsed fracture.[24] One patient had an extensor lag secondary to an overtight reconstructed MPFL and was successfully treated with a percutaneous tenotomy

In a 7-year follow-up study of 29 patients done from 1996 to 1999 there were no redislocations and the average scores were as follows: Tegner 5.8, Lysholm 88.5 and IKDC 81. Primary chondral damage to the patella and trochlea had a negative effect on the Lysholm but not on the Tegner or the IKDC scores. There were no signs of progressive P-F degeneration.

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