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# Evaluation of Long-Term Results of Operative Patellar Dislocation in Children

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## Abstract

**Objective:** To evaluate the clinical and functional outcomes of surgical treatment of patellar dislocation in children.

**Materials and Methods:** A prospective study was conducted from January 1990 to December 2019. Patellar dislocation was classified according to the Bensahel criteria. Two surgical techniques were performed (1) transpatellar iliotibial approach and (2) vastus medialis muscle transfer to the superior border of the patella. Surgical outcomes were classified according to the Kujala knee function scoring system.

**Results:** There were 198 patients (208 knees) who underwent surgery. There were 155 knees (74.5%) that were Type 1 and 53 knees (25.5%) that were Type 2. Surgery was performed via the iliotibial transpatellar (ITT) approach in 114 (121 knees) and vastus medialis muscle transfer to the superior border of the patella (VM) in 84 (87 knees). Overall (208 knees), ITT/VM results: Excellent 75.3%/68.6%; Good 21.5/25.2; Mean score 3.2/6.2; Mean Kujala score: 97.4 points in ITT and 91.2 points in VM (Pvaluate = 0.804444).

**Conclusion:** Two surgical techniques combining complete release of the lateral cruciate ligament, restoration of tension of the medial cruciate ligament, and simultaneous quadriceps reconstruction have achieved high success rates.

***Keywords:*** *Patellar Instability; Common Patellar Dislocation; Partial Patellar Dislocation; Developmental Dysplasia of the Patella (DDP); Dislocation Deformity*

## Introduction

Patellar dislocation is common in children, and many surgical procedures have been described for its treatment [1-3]. Surgical treatments include correction of the extensor mechanism both proximally and distally, and most are associated with significant surgical trauma, extensive scarring, and prolonged rehabilitation. However, no single procedure is appropriate for all cases due to patient variability [4-6]. Soft tissue surgery is recommended during growth to avoid secondary deformities such as retroflexion, which can occur with tibial tuberosity dislocation in children [2].

Many factors contribute to patellar dislocation, including (1) a congenital mechanism (i.e. generalized ligament laxity, patellar or femoral condyle dysplasia, genu valgum, tight lateral band, and high patella [1-3]), and (2) a secondary mechanism, due to iatrogenic

fibrosis of the quadriceps muscle following intramuscular antibiotic injections that alter the traction of the quadriceps muscle, and fibrosis of the vastus lateralis, vastus intermedius, and retinaculum of the lateral patella. In 1961, Hnëvkovský [7] first brought attention to this cause when he reported progressive fibrosis of the vastus intermedius muscle in a young child who had received intramuscular antibiotic injections. Gunn 1964 [8] demonstrated a causal relationship between intramuscular injections and quadriceps contracture.

## Purpose of the Study

The purpose of this paper is to evaluate the clinical and functional outcomes of surgical treatment of patellar dislocation in children.

## Materials and Methods

A prospective study was conducted; From January 1990 to August 2004, 114 patients (121 knees, they were operated according to ITT; and from September 2004 to December 2019, 84 patients (87 knees) were operated according to VM. A total of 128 patients with 132 knees (knee on both sides in 4 patients).

Informed consent was obtained from all participants. The study was approved by the Ethics Review Committee of our Institute and was conducted according to the principles of the Declaration of Helsinki.

Eighty-three right knees (39.9%) and left knees One hundred and fifteen knees (60.1%) were affected; nine patients (4.5%, three males and six females) had problems on both sides. Eighteen knees (9.1%) had recurrent patellar dislocation, in which the patella was always on one side. lateral and the remaining 190 knees (91.3%) had recurrent patellar dislocation. There were twenty-seventy-nine men (39.9%) and one hundred and seventy-nine women (90.1%) in this study.

### Clinical and imaging examinations

Patellar dislocation was determined based on clinical and imaging findings as described below.

**Clinical examination**: For dislocation, we expected to find the following clinical signs: (a) knee deformity; (b) thigh atrophy compared to the contralateral healthy thigh; (c) knee protrusion with knee flexion; patellar internal slip test < 5 mm at 30 degrees of knee flexion [9], and (d) the patient was unable to run.

We also examined the following factors: Q angle [10], genu valgum, and ligament laxity.

### Imaging results

Each patient underwent X-rays (according to Hugston), MRI, CT, and ultrasound of the knee and thigh.

### Roentgenogram

- High knee: High knee was diagnosed in the lateral view using the Isall-Salvati Index [11].
- Lateral patellar tilt: In axial view, we measured the lateral patellar angle according to Laurin., *et al*. [12].
- Abnormal tilt: Abnormal tilt was also calculated in axial view according to Grelsamer and Proctor [13].

### Magnetic resonance imaging (MRI)

Shallow patellar groove: pulley depth was assessed according to Seil., *et al*. [14].

### Quadriceps ultrasound

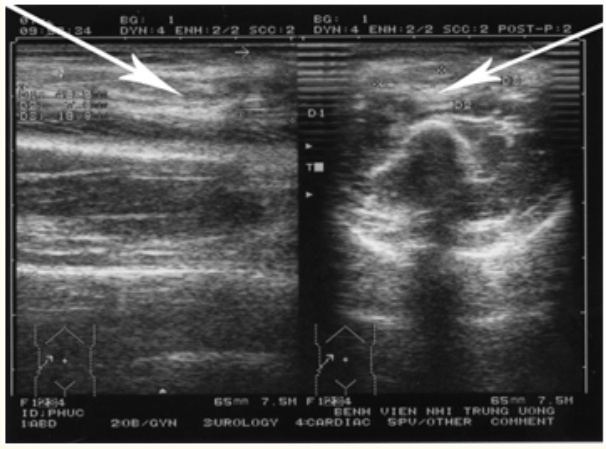


***Figure 1:*** *Ultrasound found fibrous vastus lateralis.*

### Flattening of the distal femoral condyles (CT scan)

We used the Dejour., *et al*. trochanteric dysplasia classification in this study [15].

Distal femoral fascia (ultrasound): We performed ultrasound to assess the presence of distal femoral fascia (Figure 1).

### Patellar dislocation classification

Our patients were classified according to the criteria of Bensahel., *et al*. [16]: (1) Type 1: Patellar dislocation without major radiographic abnormalities; and (2) Type 2: Patellar dislocation with major femoro-patellar dysplasia, namely a high patella and a flat or convex trochanter.

### Surgical technique and procedure

A single surgeon (the author) performed all patient surgeries. All relevant clinical and surgical records were reviewed in advance.

**Patient positioning:** The patient is placed supine on a standard operating table under general anesthesia with a sandbag behind the knee to maintain a 5- to 10-degree angle; the anterolateral portion of the thigh is exposed. We used an anterolateral approach extending from the middle third of the thigh to the tibial tuberosity and the slightly curved lateral border of the patella (Figure 2). The subcutaneous tissue is sufficiently weakened to form a skin flap that allows us to expose the quadriceps femoris, medial and lateral patellar ligaments, iliotibial line, patella, and patellar tendon. This incision avoids perforation of the capsule and infrapatellar nerve.

### The operation was performed in three procedural stages

### Procedure stage 1

The constricting rings are released from the patella and the incision is continued proximally, lateral to the vastus lateralis muscle, thus completely releasing the vastus lateralis and vastus medialis muscles. A slightly curved longitudinal incision is made from the lateral

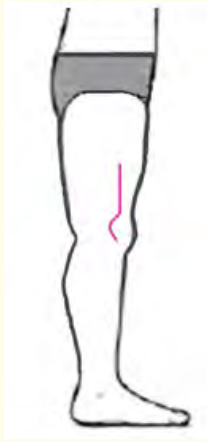

***Figure 2:*** *Skin incision.*

edge of the patella proximally for 8 cm or more if necessary. However, this separate procedure does not allow for complete stabilization of the patella in the ant knee. It is always necessary to separate the vastus medialis muscle attachment from the patella, separate it from the vastus medialis muscle and the basketball line laterally, and then transfer it proximally. The incision of the vastus medialis tendon is continued posteriorly, parallel to the lower border of the vastus medialis muscle, until it reaches the vastus medialis septum. Again, the tendon is left intact to ensure adequate suture space after transfer. When the native septum is visible, the vastus medialis muscle is released for a distance of two to eight cm to attempt straightening. Lateral patellar tendon release: We increase the patellar tendon tension by dividing the tendon into 2 parts, then using a suture to connect one part to the other, 1.5 cm long, using Ethibond suture #2, while keeping the patella in a central position to achieve a 25% conversion rate with a 60-degree headache (Figure 3A and 3B).

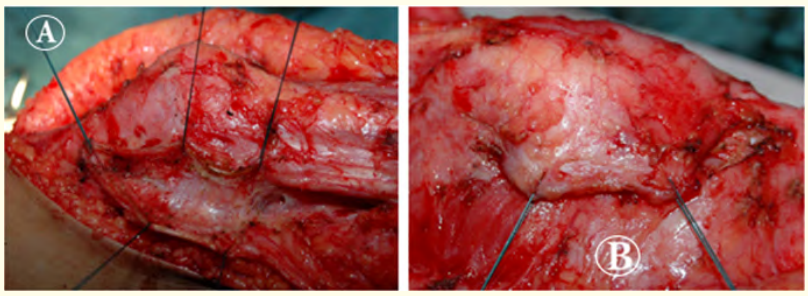


***Figure 3A and 3B:*** *A: Releasing the lateral retinacular tella; B: Restoring the tension of the medial retinaculum.*

### Procedure stage 2: Lengthening the rectus femoris and vastus intermedius

We separated the adhesion between the vastus intermedius tendon and the rectus femoris tendon. Next, we divided the vastus intermedius tendon at the junction of the muscle and tendon, 5 cm from the patella. We performed knee flexion (if the knee flexion is >90o, the vastus intermedius tendon will be cut), and sutured the remaining vastus intermedius muscle to the rectus femoris muscle with a knee flexion of 60º (Figure 4).

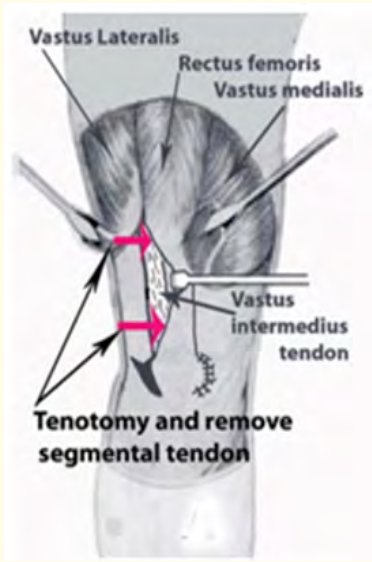


***Figure 4:*** *Separation of vastus intermedius and rectus femoris tendons: Tenotomy at the junction of the muscle and tendon 5 cm distal to the patella. Tenotomy and excision of the vastus intermedius tendon segment. The remaining vastus intermedius is sutured beneath the rectus femoris muscle.*

If the knee cannot be flexed >90°, cut the rectus femoris muscle 2 cm distal to the patella, then suture the rectus femoris tendon to the remaining vastus medialis tendon above the patella, using a No. 2 Ethibond suture while the knee is flexed at 60° (Figure 5). Finally, suture the remaining vastus medialis to the rectus femoris muscle.

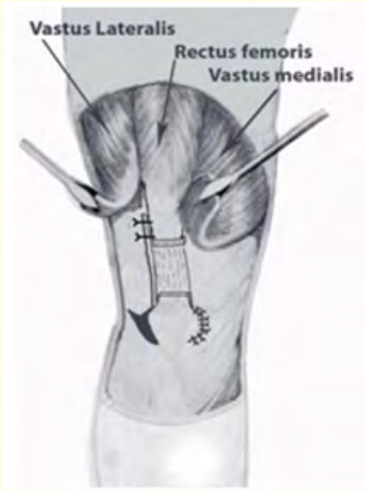


***Figure 5:*** *Tenotomy is performed at the vastus intermedius and rectus femoris tendons 5 cm from the patella and at the rectus femoris muscle 2 cm from the patella. The two tendons, vastus intermedius and rectus femoris, are sutured together by bending the knee at a 60º angle.*

### Procedure stage 3

Iliotibial transfer (ITT) or oblique iliotibial transfer to superior patellar border (VM).

Iliotibial transfer (76 patients operated on from January 1994 - August 2004).

Transfer the Iliotibial bone 3 inches above the superior lateral border of the patella (Figure 6A and 6B).

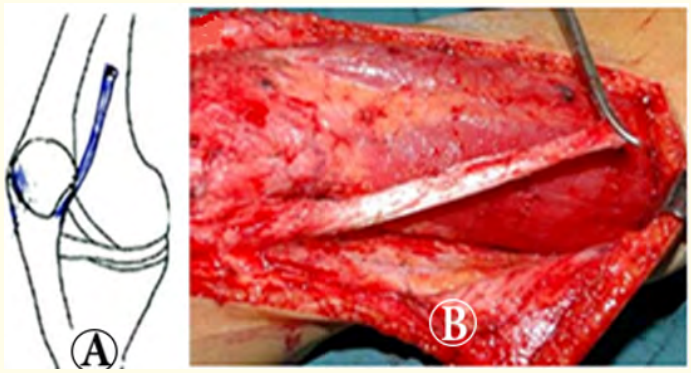


***Figure 6A and 6B:*** *These images belong to left knees during operation. A: Free tenotomy to create about 3 inches iliotibial tract. B: Iliotibial tract was tenotomized.*

Suture the remaining proximal portion to the femoral fascia and create a tunnel between the anterior surface of the patella and the patellar fascia from the superior lateral border to the inferior medial border (Figure 7A and 7B).

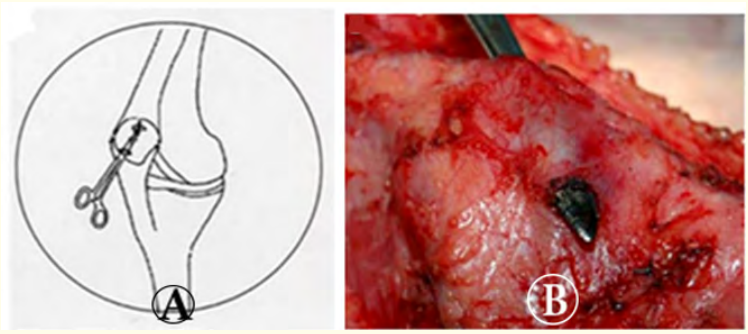


***Figure 7A and 7B:*** *These images are of the left knee during surgery. The tunnel created is located between the front of the patella and the patellar fascia.*

The iliotibial tract is passed through the tunnel, while the patella is displaced medially and distally. The iliotibial tract is sutured to the patella, and the free end of the iliotibial tract is sutured to the semitendinosus attachment with the knee secured 45-60 with a No. 3 Ethibond suture (Figure 8).

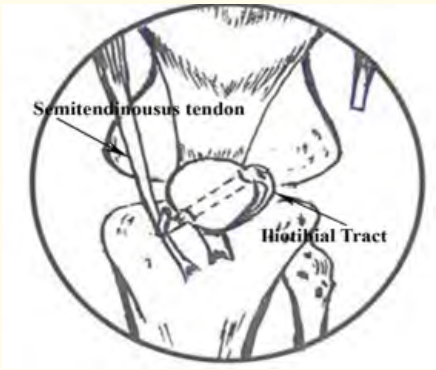


***Figure 8:*** *The iliotibial tract is passed through the tunnel, while the patella is displaced medially and distally. The iliotibial tract is sutured to the patella, and the free end of the iliotibial tract is sutured to the semitendinosus attachment with the knee secured 45-60 with a No. 3 Ethibond suture (Figure 8).*

Transfer of the vastus medialis muscle to the superior border of the patella (VM) (56 patients were operated on from September 2004 to December 2010).

We transferred and sutured the inferior angle of the vastus medialis muscle (VM) to the superior pole of the patella, then transferred and sutured the inferior medial angle of the vastus medialis muscle to the superior medial pole of the patella, using Ethibond No. 2 with the knee flexed at 60 degrees. The vastus lateralis muscle was sutured to the lateral aspect of the rectus femoris (Figure 9) or to the articular tendons (rectus femoris and vastus intermedius), and the patella was moved medially to check for adequate release (to ensure this, we checked that the patella moved normally and smoothly in the intracondylar groove; and that the patella was not tilted or overstretched at the suture line). The knee is repeatedly bent and extended to check that the patella moves normally in its groove.

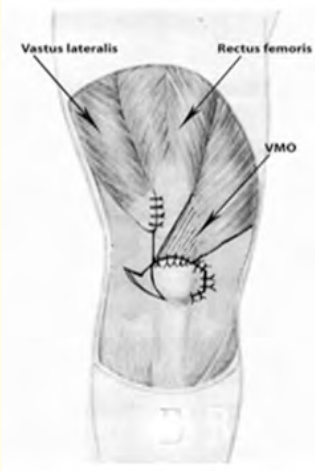


***Figure 9:*** *Vastus mediate is transferred to the superior border with strong sutures and the knee is flexed to 60 degrees. Vastus lateralis is sutured to the lateral aspect of the rectus femoris muscle.*

At this stage, we expect the patella to move smoothly within the medial epicondyle groove and not be tilted or overstretched on the suture line. It is also important to ensure that the lateral border of the patella is aligned with the lateral border of the lateral femoral condyle.

After release is complete, complete hemostasis is achieved by coagulating all sources of bleeding, especially the superior lateral geniculate artery at the superior border of the patella. The skin is closed without leaving any drainage; the lower limb is casted with the knee flexed at 60°.

### Intraoperative biopsy

A biopsy of the vastus lateralis, vastus medialis, vastus intermedius, rectus femoris, fascia latae, lateral patella, and medial patellar retinaculum was performed to look for tissue abnormalities (Figure 10).

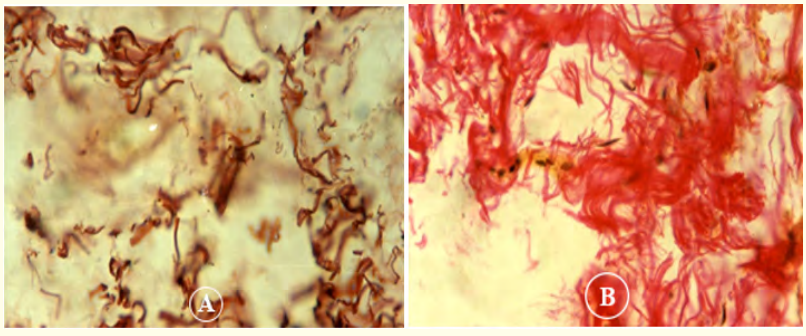


***Figure 10A and 10B:*** *A: Fibrous lateral retinacula; B: Fibrous rectus femoris.*

### Postoperative rehabilitation

After the procedure, the knee is placed in a double cast with the knee flexed 45°-60° (Figure 11). The double cast is a long cast that extends from the knee to the fingers and is divided into two parts, anterior and posterior. The double cast can be easily removed before exercise. After each exercise session, both parts are repositioned with rolled strips. Three days after the procedure, the patella begins to race with an inferior and medial-lateral guide to prevent patellar contracture. During the first two weeks, a physical therapist performs passive range of motion up to 60. After two weeks, range of motion is increased to 90. After three weeks, range of motion is increased to normal. The cast is removed after approximately six weeks, but no weight bearing is permitted. The employee is allowed 25% mechanical energy during the first two weeks and 50% physical energy during the next two weeks. Full energy can be ensured from the fourth to the sixth week after powder release.

***Figure 11:*** *The double capsule cast is long cast placed above knee to toe.*

### Follow-up

Patients were re-examined after three and six weeks, three and six months, one year, and then annually. We classified the results of the surgeries according to Kumar [17], with objective assessment performed using the Fulkerson [10] and Kujala [18] knee function scoring systems. The scores were classified as follows:

- Excellent: 90-100 points
- Good: 80-89 points
- Fair: 70-79 points
- Poor: < 70 points.

### Statistical analysis

Data were analyzed using Epi Info 6.04 statistical software, which is in the public domain for epidemiology, developed by the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, USA, http://wwwn.cdc.gov/epiinfo/html/prevVersion.htm). We performed $\chi^2$ tests for percentages and Student's t-tests to compare means. P values ≤ 0.05 were considered statistically significant. All readings are given as mean values with appropriate standard deviations.

The author is the surgeon who operated on all patients in this study.

## Result

The mean age of patients at surgery was 8 years-4 months (range: 6 years-4 months to 14 years-5 months). The pre- and post-operative clinical and radiological findings of patients who underwent ITT and VM were not different (P > 0.05). The mean pre-operative Q angle was 16.5 degrees and the mean postoperative Q angle was 9.6 degrees (p = 0.000695). Overall (208 knees), ITT/VM results: Result VM/ITT with Excellent 75.3%/68.6%; Good 21.5/25.2; Fair 3.2/6.2; Mean Kujala score: 97.4 points in ITT and 91.2 points in VM (Pvaluate = 0.804444). Long-term follow-up of patients who underwent ITT and patients who underwent VM surgery was not different.

There were 21 (10.1%) bad scars recorded. The comparison of the two techniques and the two age groups under and over 14 years old in this study did not differ (P > 0.05). The techniques in this study were compared with the technique of Baker and Madigan and showed better (P = 0.0085 and P = 0.000001).

The main physical finding was lateral patellar dislocation whenever the head The knee was flexed. With the patella held firmly in the femoral groove, we found a limit of knee flexion of 10 to 20 degrees in 115 knees (55.3%) and 30° in 81 knees (44.7.4%) and constant in 19 knees (9.1%). When the patella was dislocated, full flexion was possible. Due to fibrosis and contracture of the quadriceps femoris after injection, if the patella was held in the intercondylar groove, the knee could not be flexed beyond 30.

### Classification of patellar dislocation

Among our patient cohort, 152 knees (73.1%) were Type 1, and 56 knees (26.9%) were Type 2.

After the surgery we saw remarkable improvement in clinical and roentgenographic findings in our patient cohort.

| Clinical Sign | Pre-Operation | | | Post-Operation | | |
|---|---|---|---|---|---|---|
| | ITT (%) | VM (%) | P valuate | ITT (%) | VM (%) | P valuate |
| Thigh atrophy | 100 | 100 | | 14.1 | 15.2 | 0.85196 |
| Patellofemoral click | 0 | 0 | | 0 | 0 | |
| Swelling | 0 | 0 | | 0 | 0 | |
| The patellar medial glide test < 5 mm at 30 degrees of knee flexion | 100 | 100 | | 0 | 0 | |
| Q-Angle in degrees | 17.3º (13 º -22 º) | 15.6º (14.5º - 20.4º) | 0.8648 | 9.4º (6 º -15 º) | 9.8º (7º - 14.1º) | 0.78966 |
| Mean Kujala score | 59.2 | 45.4 | 0.37977 | 98.7 | 94.6 | 0.80444 |

***Table 1:*** *Clinical signs before and after the operation.*

Clinical signs before and after the operation of these patients were operated ITT and these patient were operated VM were not different.

The average preoperative Q-angle was 15.1 degrees (range, 12.0 degrees to 22.0 degrees). There were 17 knees with a Q-angle greater than 20 degrees. Postoperatively, the average Q-angle was 8.5 degrees (range, 5 to 14 degrees) which was significantly smaller with p = 0.000695.

Preoperatively, limited medial translation of the patella had been the result of slackness or contracture of the lateral patellar retinacula. After the intervention, the patella could be moved normally in both the superior-inferior and the medial-lateral directions at 30 degrees of knee flexion.

| Roentgenographical Sign | Pre-Operation | | | Post-Operation | | |
|---|---|---|---|---|---|---|
| | ITT (%) | VM (%) | Pvaluate | ITT (%) | VM (%) | Pvaluate |
| Patella alta | 20.1 | 22.5 | 0.81176 | 4.1 | 5.8 | 0.96934 |
| Lateral patellar tilt | 75.2 | 61.9 | 0.21302 | 3.8 | 3.4 | 0.72676 |
| Shallow patellar groove | 27.3 | 29.8 | 0.80909 | 2.5 | 3.8 | 0.83963 |
| Flattening of the distal lateral femoral condyles | 22.3 | 20.6 | 0.81284 | 5.6 | 5.2 | 0.71203 |

***Table 2:*** *Imaging findings.*

Imaging finding before and after the operation of these patients were operated ITT and these patient were operated VM were not different.

Preoperatively, patella alta was apparent in 48 knees (23.1%), and postoperatively it was only seen in 5 knees (2.4%). Preoperatively, lateral patellar tilt was found in 114 knees (54.8%), and postoperatively in only 5 knees (2.4%). Preoperatively, there were shallow patellar grooves in 47 (22.5) knees, of which 65 (31.3%) knees had flattening of the distal lateral femoral condyle. Postoperatively, only 7

knees (3.4%) showed shallow patellar groove and 15 (7.2%) knees showed flattening of the distal lateral femoral condyle. We believe that the trochlear groove improvement was due to natural growth and development of the children.

### Ultrasound

Ultrasound found fibrous muscles in the distal one-third of the thigh in all patients.

### Pathological findings

The iliotibial tract was attached to the muscular vastus lateralis at a location about 2.5 cm to 5 cm above the superiolateral patella by fibrous tissues. Contractures were present in the rectus femoris in 128 knees (63.4%), and in the vastus intermedius in 81 knees (38.9%). The vastus medialis oblique was present in 165 knees (81.7%). The VM was degenerated and straightened, and that affected its medial pulling function.

Postoperatively, all patients had the patella aligned with the patellar groove of the femur when flexing and extending. Knee function returned to normal in 176 knees (87.2%). There were limitation of flexion to 60º - 90º in 5 knees (2.5%), and > 90º in 1 knee (0.5%); loss of extension < 10º in 3 knees (1.5%), and 10º - 20º in 1 knee (0.9%); and no cases with loss of extension more than 20º. Loss of extension happened only when both the vastus intermedius and the rectus femoris were severely damaged.

| Result | ITT (%) | VM (%) | Pvaluate |
|---|---|---|---|
| Excellent | 75.3 | 68.6 | 0.60940 |
| Good | 21.5 | 25.2 | 0.90875 |
| Fair | 3.2 | 6.2 | 0.67685 |
| Poor | 0 | 0 | 0 |

***Table 3:*** *Long-term follow-up.*

Mean of Kujala score: 97.4 points in ITT and in 91.2 points in VM (Pvaluate = 0.804444).

Long-term follow-up of these patients were operated ITT and these patient were operated VM were not different.

| Result | Under 14 | | | Over 14 | | |
|---|---|---|---|---|---|---|
| | Baker [2] | Hung* | Pval. | Beker [2] | Hung* | Pval. |
| Excellent and Good | 29 (79%) | 166 (96.5%) | 0.0085 | 14 (88%) | 28 (93.3%) | |
| Fair | 5 (13%) | 6 (3.5%) | 0.2086 | 0 | 2 (6.6%) | |
| Poor | 1 (3%) | 0 | | 2 (12%) | 0 | |
| Recurrence | 2 (5%) | 0 | | 0 | 0 | |
| | 37 | 172 | | 16 | 30 | |

***Table 4:*** *Compare operative result according to age under and over 14 (Baker and Hung*).*

*Pva. Pvaluate; Hung*. In this study: In all (208 Knees), Result ITT/VM: Excellent 75.3%/68.6%; Good 21.5/25.2; Fair 3.2/6.2.*

According to age under and over 14, excellent and good result in this study was better than Beker technique [19] with Pvaluate 0.0085.

The mean age of the patients at latest follow-up was 18 years-8 months (range, 9 years-6 months to 24 years-6 months).

The average length of follow-up was eleven years and seven months (range, from seven years-five months to fourteen years-four months).

### Complications were as follows:

- Infections: None.
- Skin necrosis: None.
- Osteochondral Patellar fracture: None.
- Redislocation or subluxation: None.
- Limitative knee movement: 7 knees.

## Discussion

Williams reported 26 patients with knee stiffness and 13 of them had patellar dislocation [19], Alvarez [20], Dennis [21], Mukherjee [22], and Sharrard [23] reported knee stiffness with patellar dislocation. These patients developed patellar dislocation after repeated injections of antibiotics into the quadriceps muscle. Furthermore, this fibrosis also extended into the medial patellar desert, as demonstrated by the patellar sliding test of 5 mm at 30 degrees of knee flexion (Table 1). What differentiates patellar instability from patient to patient is that a particular technique may not be the right procedure for all patients undergoing patellar sequencing [24]. In 1959, Cotta [25] listed 137 scientific methods for addressing patellar instability. These procedures can be classified into soft tissue balancing procedures and bone transfer procedures. In skeletally immature patients with growth plates, some transfer procedures should be avoided if possible to allow early release of the equinus and subsequent development of knee flexion. The quadriceps base is shortened and shortened. Therefore, realignment of the quadriceps femoris muscles is the most important factor in establishing normal patellofemoral function. However, when only the quadriceps mechanism is corrected, the recurrence rate is high. Many studies have reported rates of re-dislocation ranging from 4 to 44% [26,27]. The results have been reported to be cost-effective, especially when decompression is used as the only procedure [10,28]. Galeazzi [29], Baker [2] used a transpatellar tenotomy technique to treat recurrent patellofemoral dislocation in children. However, this technique has some variations such as patellar ossification or hypermobility, and incomplete repair of high patella [30].

### Surgical technique

### The iliotibial tract passed through patella

The iliotibial tract normally attaches to the superior aspect of the lateral condyle of the tibia. Through this attachment, the gluteus maximus and the vastus lateralis fascia stabilize the slightly flexed knee during weight bearing. However, the iliotibial tract is simply a thick band of the femoral fascia. This fascia forms a septum between the muscles of the quadriceps group and is reinforced on both sides of the patella by fibers that blend with the vastus lateralis and vastus medialis fascia. These fibers are stronger on the lateral side, where they originate from the iliotibial tract. The iliotibial tract lies anterior to the axis of rotation of the knee joint and passes posterior to that axis when the knee is flexed. We passed the iliotibial tract through a tunnel created between the anterior surface of the patella and the patellar fascia, without drilling the patella, so there was no patellar fracture. The iliotibial tract applied a force to stabilize the patella, aligning the patellar mechanism of the quadriceps femoris medially, and providing a medial balancing vector and distal realignment of the extensor mechanism. Our surgical technique met all the requirements of Hinton [31] and Stanitski [32]: (1) release of the abnormal tethering vector, (2) balancing the medial vector, and (3) aligning the patellar-tibial mechanism of the quadriceps femoris.

### Transfer vastus medialis muscle to superior border patella

Transplantation of the vastus medialis muscle, distal and lateral to the anterior patella, was proposed by Madigan, Wissinger, and Donaldson in 1975 [3]. All authors agreed that in children with immature bones, only soft tissue interventions should be performed. In 1975, Madigan., *et al.* [3] (followed by others) transferred the VMO laterally and distally and sutured it directly to the anterior aspect of the

patella or to the medial rectus femoris tendon, according to West [33], in the hope of stabilizing the patella and directing patellar forces inward, thereby hopefully preventing lateral displacement.

The vastus medialis muscle can be functionally divided into long and oblique components. Lieb and Perry [34] reported that in the larger and more proximal long component, the fibers are more vertically oriented, 15 to 18 degrees medially to the longitudinal axis of the femur, whereas the fibers in the distal quadrant of the muscle, the oblique component, are 50 to 55 degrees medially to the longitudinal axis of the femur.

This impression is supported by the findings of Lieb and Perry [34]. Clinical practice has shown an excellent and good rate of 94.7%, without poor results or re-dislocations, demonstrating the superiority of these techniques.

In our study, the VM was often severely atrophied and had a more vertical than oblique orientation, as reported by Andrish [35]. To achieve our first goal, which was to restore the original directional force of the VMO, we freed it from the medial intermuscular septum and transferred it to the superior border of the patella. Unlike Madigan's technique, in which they transferred the insertion site of the vastus medialis laterally and distal to the patella, in our patients the vastus medialis was stretched and shortened, so that the insertion site could not be transferred distally and laterally to the anterior part of the patella. Our second goal was to restore normal alignment and function of the extensor mechanism.

### Compare two technique in this study and other techniques

If we compare the results of Madigan, fifty-eight percent had good or excellent results and 42 percent had poor results after a mean follow-up of twenty-nine months; our results were ninety-four percent had good or excellent results and no poor results or recurrent patellar dislocation; our results were better than those of Madigan with P.valuate 0.000001.

Comparing ITT and VM in the two age groups under and over 14 years old in this study, the postoperative results were similar (P value > 0.05) (Table 4). Comparing the good and excellent results of the Baker technique and the two techniques in this study, it was found that our technique was better than the Baker technique (P value > 0.0085) (Table 5). Bensahel., *et al*. [16] performed surgery for unstable patella in children with good postoperative results of 85%. Several studies have shown good results when using the semitenotomy technique to treat patellar dislocation [36]. Hall., *et al*. [37] described a series of 26 knees with good to excellent results >60%. However, Hall., *et al*. [37] also performed the Roux-Goldthwait procedure on 19 knees in their study, making their data more difficult to interpret. More recently, Letts., *et al*. [38] presented a series of 26 knees with 82% good to excellent results with a recurrence rate of 8%. This study is similar to the previous results reported by Baker., *et al*. [2].

### Limitations and complications

### Loss of extension

3 knees (2.3%) lost 10º-20º of extension. This was due to postoperative weakness of the quadriceps femoris muscle. Although the incidence of this complication is low and occurs in severely injured quadriceps femoris, we still suggest that quadriceps lengthening should only be considered when vastus intermedius release alone cannot achieve greater than 90º of knee flexion.

### Limited flexion

Four knees (3.1%) had limited flexion. All knees had severe vastus intermedius fibrosis and rectus femoris degeneration on examination. In our opinion, this could be due to two reasons, (1) incomplete release of the surrounding fibrosis or (2) insufficient lengthening of the quadriceps femoris. Therefore, we suggest that before completing surgery, knee mobilization using the Ely test [39] should be performed to minimize this complication.

## Conclusion

In children, patellar instability with knee stiffness may occur after repeated intramuscular antibiotic injections, causing quadriceps fibrosis. Bone malnutrition and metabolic inefficiency due to fibrosis and patellar dislocation often result in anatomical lesions such as patellar tilt, high patella, shallow patellar groove, and flattening of the distal femoral condyles.

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**Volume 16 Issue 4 April 2025**