ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2015;49(5):530–538
doi: 10.3944/AOTT.2015.15.0044

A combined procedure for irreducible dislocation of patella in children with ligamentous laxity: a preliminary report

Muharrem İNAN[1], İlker Abdullah SARIKAYA[2], Ali ŞEKER[3], Kubilay BENG[4]

[1]İstanbul University Cerrahpaşa Faculty of Medicine, Department of Orthopedics and Traumatology, İstanbul, Turkey
[2]Children's Orthopaedic Clinic, Department of Orthopedics and Traumatology, İstanbul, Turkey
[3]İstanbul Medipol University Faculty of Medicine, Department of Orthopedics and Traumatology, İstanbul, Turkey
[4]Baltalimanı Training and Research Hospital, Department of Orthopaedics and Traumatology, İstanbul, Turkey

Objective: Irreducible patellar dislocation accompanying ligamentous laxity is rarely seen in pediatric patients. The most common complaints due to this condition are inability to walk, delayed walking, and difficulties with orthotics. The purpose of this retrospective study is to describe a novel surgical technique to treat dislocated patella in patients with symptomatic ligamentous laxity.

Methods: Fourteen knees of 9 patients operated on by a single surgeon between 2009–2012 were included in the study. The tensor fascia was divided into 2 strips, and these strips were passed via the joint and sutured to themselves. The combined procedure additionally includes lateral capsular release, vastus lateralis (VL) resection, medial capsular plication, and Z-plasty of the rectus femoris (RF) tendon.

Results: Mean age at the time of surgery was 6.9±3.3 years (range: 4–13 years). The mean follow-up was 37.6±0.9 months (range: 26–49 months). Patellofemoral instability was restored for all patients by using combined surgical technique. Patellar lateralization developed in 2 patients, in whom stability was obtained via secondary medial plication.

Conclusion: Our results show that this combined surgical procedure stabilizes the knee and treats patellar dislocation accompanying ligamentous laxity in pediatric patients.

Keywords: Irreducible; ligamentous laxity; patellar dislocation; procedure.

Level of Evidence: Level IV Therapeutic Study

Irreducible patellar dislocation accompanying ligamentous laxity is rare.[1–3] Paton classified this extensor mechanism impairment as an acquired dislocation, which is a subgroup of childhood irreducible patellar dislocation.[4] However, regardless of the aetiological variability, the primary issue is the disturbance in the stability and extensor mechanism of the knee due to patellofemoral joint dislocation and muscle imbalance. Several methods aimed at ensuring patellofemoral joint congruence have been described.[5–9] However, the overall success rate was low due to the severity of underlying diseases and the necessity of using soft tissue surgery instead of bone procedures on skeletally immature patients.[5,10–12]

Correspondence: Ali Şeker, MD. İstanbul Medipol Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Anabilim Dalı, İstanbul, Turkey.
Tel: +90 212 – 460 71 57 e-mail: aliseker@doctor.com

Submitted: January 06, 2015 **Accepted:** March 28, 2015

Available online at
www.aott.org.tr
doi: 10.3944/AOTT.2015.15.0044
QR (Quick Response) Code

Fig. 1. Clinical examination at final follow-up. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

The purpose of this study is to give the preliminary results of the combined surgical procedure for treating an irreducible dislocation of the patella in skeletally immature patients with ligamentous laxity. The study was approved by an ethics committee.

Patients and methods

Patients who were treated between 2009–2012 for irreducible congenital patella dislocation were retrospectively reviewed. Exclusion criteria were dislocated patella without ligamentous laxity or patients who had previously undergone surgery. Fourteen knees of 9 patients (6 male, 3 female) with the mean age of 6.9±3.3 years (range: 4–13 years) were included. Down syndrome was diagnosed in 6 patients, meningomyelocele in 2 patients, and Prader-Willi syndrome in 1 patient.

Patients underwent clinical examination to assess knee range of motion (ROM), recurvation, valgus-varus deformity, and stability both presurgery and at final follow-up (Figure 1). Instability was classified according to Dugdale et al.[2]

Anterior-posterior and lateral knee radiographs were taken preoperatively (Figure 2), postoperatively (Figure 3), and at final follow-up. The radiographic examination of patellofemoral congruence and patellar hypoplasia was assessed. The patellofemoral joint and components of the extensor mechanism were evaluated intraoperatively by direct visualization.

Differences were evaluated statistically using SPSS 15 (SPSS Inc., Chicago, IL, USA). A p value of <0.05 was accepted as statistically significant.

Under general anesthesia, in supine position a lateral skin incision was begun from the junction of middle third and distal third of the femur extending to the lateral condyle, curving anteromedially and ending 2 cm above the tibial tuberosity. The tensor fascia lata (TFL) was separated from surrounding soft tissues starting from the most proximal point to the Gerdy's tubercle. The TFL was transected in anterior-posterior direction as proximally as possible. The proximal end of TFL was freed and reflected distally up to its insertion. The TFL was split longitudinally by sharp dissection into 2 strips

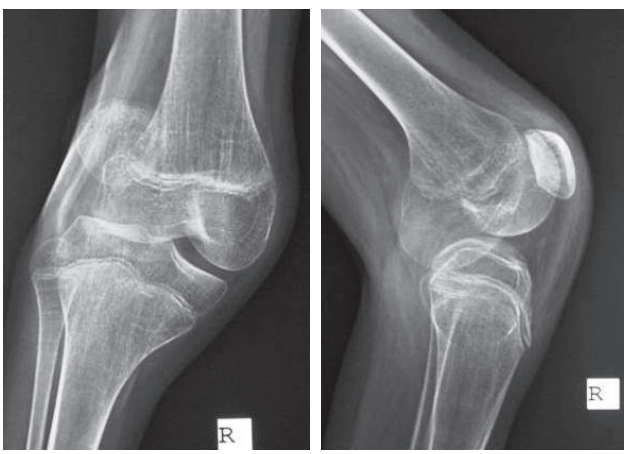

Fig. 2. Preoperative anterior-posterior and lateral radiographs.

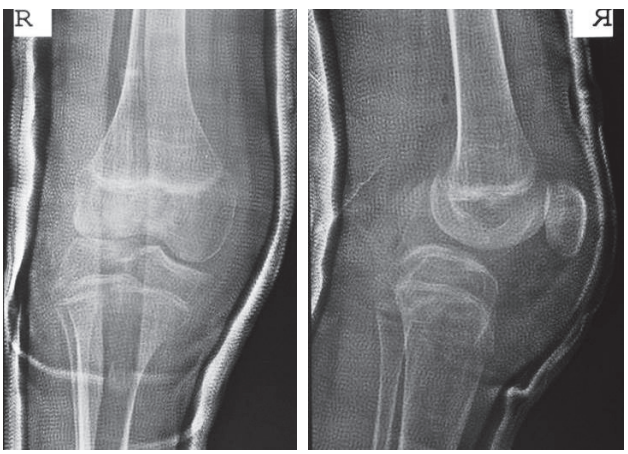

Fig. 3. Postoperative anterior-posterior and lateral radiographs.

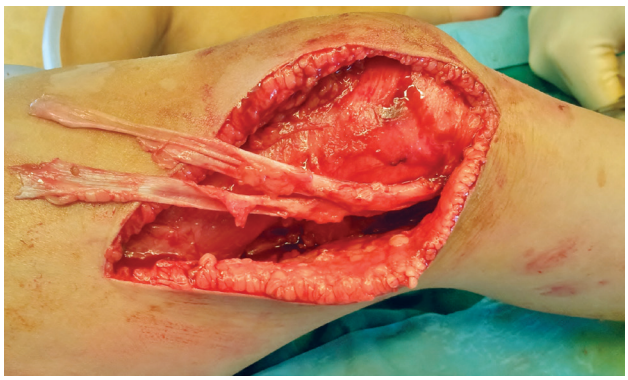

Fig. 4. The TFL was transected in an anteroposterior direction as proximally as possible. The TFL was split longitudinally into 2 longitudinal strips in order to make 2 ligaments (anterior and posterior limbs of the TFL).

(Figure 4). The free ends of the anterior and posterior limbs of the proximal TFL were prepared separately using the Krackow method: 4 loop locking sutures were passed along the medial side and lateral sides, avoiding the middle third of the tendon width.[13] The vastus lateralis tendon (VL) was released from the quadriceps tendon (QT), where it inserts to the patella (Figure 5). The lateral joint capsule and retinaculum were cut longitudinally starting from the proximal lateral border of the patella. Lateral release was completed with extension of this incision proximally into the VL.

An anteromedial 4 cm longitudinal incision was made superomedially to the patella. The vastus medialis muscle (VM) and medial joint capsule were divided longitudinally, and the medial femoral condyle was exposed. The semitendinosus muscle (ST) was revealed and identified with a clamp. The anterior limb of TFL was introduced via an incision on the lateral joint capsule and advanced to medial incision through the patellofemoral joint behind the patella (Figure 6). The anterior limb of TFL was rerouted from the posterior of the ST (Figure 7) to the

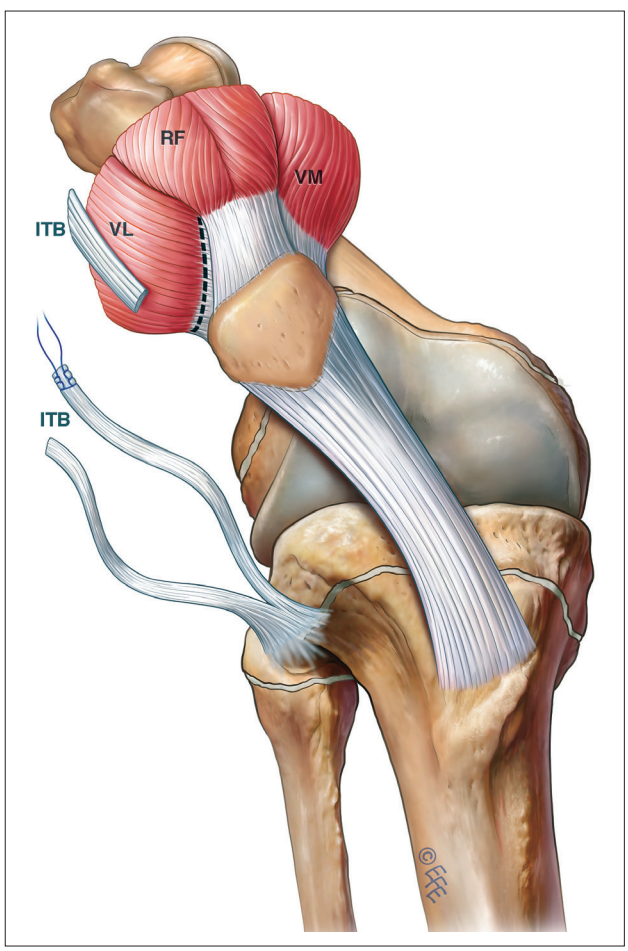

Fig. 5. The free ends of the anterior and posterior limbs were prepared with the Krackow method. The vastus lateralis muscle (VL) was released from the quadriceps tendon (QT), where it merges with the QT to the point of adherence to the patella.

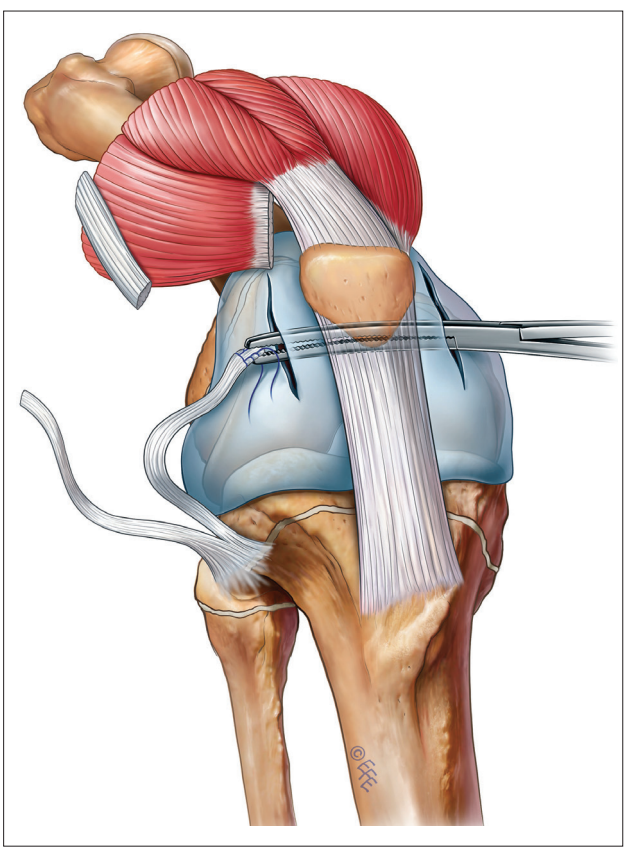

Fig. 6. The anterior limb of the TFL was moved through the gap in the lateral joint capsule, which was created during lateral release, to the back of the patella. The anterior limb of the TFL was advanced to the antero-medial incision area by passing it through the patellofemoral joint (behind the patella and in front of the lateral femoral condyle and trochlea). The anterior limb of the TFL was advanced then in front of the medial femoral condyle by perforating the medial joint capsule.

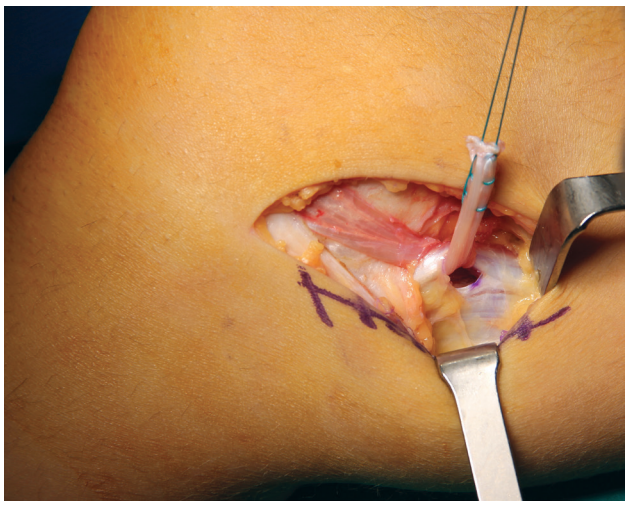

Fig. 7. The anterior limb of the TFL was rerouted around the semitendinosus muscle (ST) (from the back of the ST to the anterior and by looping back onto the ST).

anterior by looping back onto the ST (Figure 8). It was sutured to the medial patellar pole subperiosteally (Figure 9). During this maneuver, patella should be reduced and patellofemoral congruence should be reestablished.

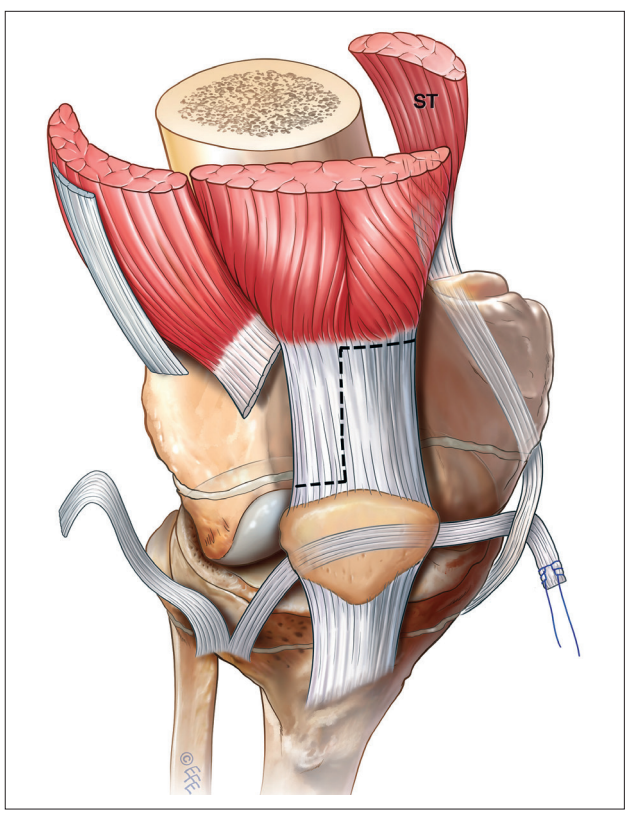

Fig. 8. The rectus femoris (RF) was cut longitudinally 5 cm at its midline superior to the starting point where it is attached to the patella. The RF was cut from this point to the lateral side of the knee at a 90° angle to the first cut. The distal cut was medial to the starting point of the first cut.

A hole was opened subperiosteally on the lateral surface of the lateral femoral condyle, and the posterior limb of TFL was rerouted through this hole. The posterior limb was looped back and tightly sutured onto itself against varus stresses. The released VL was sutured to the lateral side of the QT while the knee was in 90° of flexion (Figure 10).

If the patella was subluxed during knee flexion, medial plication was performed. The medial joint capsule and retinaculum were incised longitudinally throughout the length of the medial side of patella. The VM was detached from the superomedial patellar pole, but the synovial membrane was not perforated. The patella was reduced into trochlear groove, and the VM was sutured to the medial patellar pole. Following patellar reduction, if there was a limitation in flexion, the rectus femoris muscle (RF) was lengthened with Z-plasty (Figure 10).

A long-leg plaster cast was applied to hold the knee in 30–45° of flexion, and weight-bearing was prohibited for 3 weeks postsurgery. After cast removal, active-passive exercises up to 90° of flexion were initiated, and weight-bearing was permitted. Full knee flexion was begun on the 6th postoperative week.

Results

Mean follow-up time was 37.6±10.9 months (range: 26–49 months). A normal knee flexion (150°) was measured after surgery in all patients. Flexion contracture was diagnosed in 7 knees with a mean of 20.71°±12.3° (range: 10–40°) preoperatively and in 3 knees with a

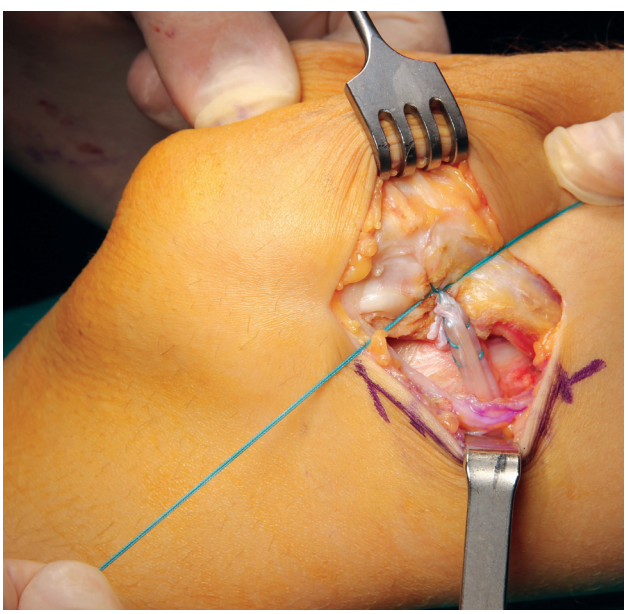

Fig. 9. The anterior limb of the TFL was sutured to the medial pole of the patella subperiosteally.

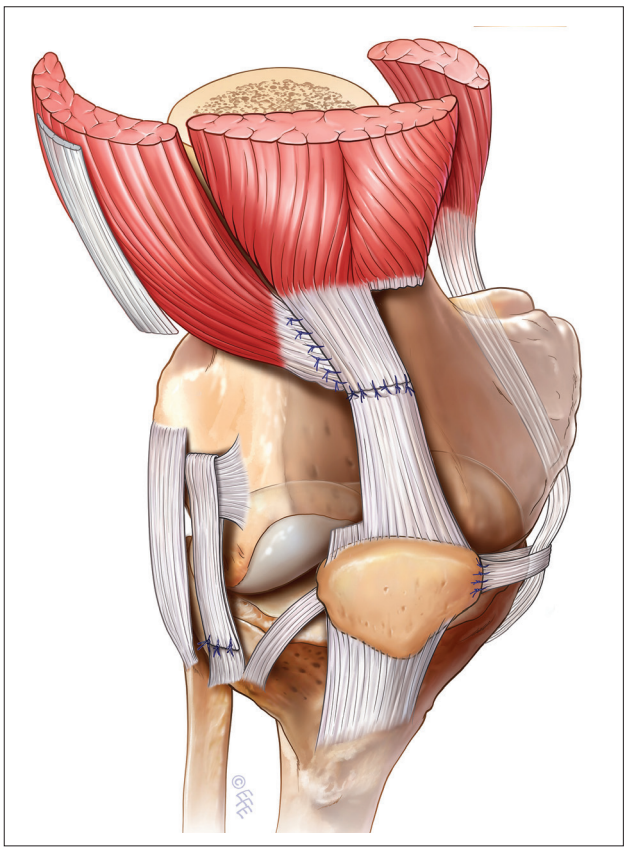

Fig. 10. The VL was sutured to the lateral side of the QT while the knee was in 90° of flexion. The posterior limb of the TFL was rerouted subperiosteally on the lateral surface of the lateral condyle (it was passed through a hole that was opened subperiosteally on the lateral surface of the lateral condyle), looped back onto itself, and finally secured using sutures with a tightness that would be able to withstand varus stress.

mean of 6.6°±2.8° (range: 5–10°) at final follow-up.

Preoperatively, recurvation was observed in 5 knees with an average of 23°±6.7° (range: 15–30°), whereas postoperatively 3 knees recovered completely, and recurvation decreased from 30° to 10° in 2 knees. In addition, genu valgum was detected preoperatively in all patients and corrected intraoperatively.

Grade 5 instability was diagnosed according to Dugdale in all patients preoperatively. Patellofemoral instability was restored in all cases intraoperatively, but medial plication had to be repeated in 2 cases because of recurrent Grade 3 patellofemoral instability (Table 1). Complete patellofemoral stability was achieved in all cases, and no redislocation existed at the final examination (Grade 1 according to Dugdale).

Preoperative radiological examinations found the patella to be hypoplastic and dislocated on the lateral aspect of the femur. At the last examination, the patella was in the trochlear groove in all patients radiologically.

There were 7 intraoperative findings: 1) The quadriceps tendon was malrotated and situated with the patella on anterolateral aspect of the femur and knee joint; 2) The RF, VL, lateral joint capsule, and TFL were contracted; 3) The patella was hypoplastic with a flattened articular surface; 4) The anterior intercondylar groove and trochlea were underdeveloped; 5) There was genu valgum deformity; 6) There was external tibial torsion deformity; 7) VM was atrophic, and medial joint capsule was thickened.

VL resection, lateral release, medial plication, and TFL transfer were performed in all cases, and lengthening of RF was performed in 11 knees. Additionally, supracondylar femur extension osteotomy had to be performed in 1 patient due to knee flexion contracture which did not improve after lengthening of hamstrings (Table 1).

Wound detachment was seen in 1 patient and treated by local soft tissue debridement. There was no deep infection or neurovascular complication.

Discussion

Paton classified irreducible patellar dislocation into 2 groups: true and acquired congenital dislocations.[4] True congenital dislocation includes fixed flexion and valgus deformity with various degrees of patellofemoral dysplasia. Acquired dislocation was observed in children with joint laxity or muscular imbalance. Paton suggested the term "developmental dysplasia and dislocation of the patella" instead of the term "congenital" dislocation.[4] Our study included patients with acquired irreducible patella dislocation due to ligamentous laxity and muscular imbalance.[14–17] Irreducible patellar dislocation and muscular imbalance cause many difficulties.[5,12] In our study group, both knee flexion contracture and recurvation deformity were observed. However, patients with Down syndrome may have generalized ligamentous laxity, which may cause recurvation of the knee joint, yet some of these patients in our study suffered knee flexion contracture due to long-term fixed irreducible patella dislocation. To assist in addressing those difficulties, surgical methods aim to reconstruct the extensor mechanism with reduction of the patella.[8,18]

To restore the extensor mechanism, some procedures have been described, including lateral release, medial plication, and transfer of the extensor mechanism to the anterior.[19–22] Such methods, including soft tissue procedures, are increasing in popularity.[21] However, bony procedures, including the transfer of the patellar tendon, may lead to recurvation, as a result of growth plate injury at proximal tibia.[10,11] Furthermore, some studies have

Table 1. The patients' diagnosis and physical examination findings pre- and postsurgery.

Case	Sex	Underlying disease	Side	Knee flexion contracture (°) before operation	Knee flexion contracture (°) at last follow-up	Recurvation (°) before operation	Recurvation (°) at last follow-up	Note
1. MS	M	Prader-Willi syndrome	R	10	–	–	–	Because of Grade 3 patellofemoral instability, medial plication was repeated 1 year after surgery. Complete patellofemoral stability was achieved.
			L	15	5	–	–	–
2. NHS	F	Down syndrome	R	–	–	20	–	–
			L	–	–	15	–	Because of 20° flexion contracture, hamstring release was performed again 1 year after surgery. The extension was 0° at the final follow-up.
3. OFC	M	Down syndrome	R	10	5	–	–	–
			L	30	10	–	–	–
4. SMB	F	Meningomyelocele	R	–	–	30	10	–
			L	–	–	30	10	–
5. MO	M	Meningomyelocele	L	–	–	–	–	–
6. SK	M	Down syndrome	R	–	–	–	–	Grade 3 patellofemoral instability was detected in the second month after treatment. Medial plication was repeated in the 6th month after the operation. Complete patellofemoral stability was achieved.
7. YNT	F	Down syndrome	L	–	–	20	–	–
8. KO	M	Down syndrome	R	10	–	–	–	–
9. BO	M	Down syndrome	R	30	–	–	–	–
			L	40	–	–	–	Because of 15° flexion contracture, serial casting was performed at the 1st month after the operation. The extension was 0° at the final follow-up.

experienced recurrence rates of up to 80%.[10,14,23] Our technique aims to release the abnormal vectors acting on the patella, restore stability, and realign the extensor mechanism without damaging the growth plate. In this study, preliminary results encourage the use of the combined technique in patients with patellar instability.

Pathologically, shortened TFL, QT, stretched lateral joint capsule, and VL pull the patella laterally.[10] Stanisavljevic suggested the transfer of the entire extensor mechanism to the medial side.[18] However, the entire extraperiosteal release of the QT requires a wide incision, extensive lateral dissection, and may lead to an inadequate imbalance in the patellar groove while riding the patella. Additionally, Camathias reported high failure rates with the Stanisavljevic procedure.[23] Goldthwaite and[6] and Gordon[7] suggested extensive lateral

release and distal partial transfer of the patellar tendon. However, we believe that it is difficult to achieve sufficient medialization of the patellar tendon only by lateral release and patellar tendon transfer. Likewise, patellar tendon transfer can lead to growth plate injury at proximal tibia in the Goldthwaite and Roux procedure. Our incision and soft tissue dissection was narrower than the Stanisavlijevic procedure. We aimed to balance the lateral and medial forces affecting the patella and released only the tight parts of the VL and lateral joint capsule by transferring a section of TFL to the medial side and performing medial plication to obtain stabilization.

Hung determined that in the majority of patients, fibrosis was detected in the VL and TFL, which provides the force that works to rotate the patella externally and laterally.[22] A contracted TFL affects the knee in the direction of flexion-valgus and induces external tibial torsion. The author reported the use of iliotibial tract for patellar dislocation which occurred after intramuscular injection and passed iliotibial tract through a tunnel in front of the patella, but in our technique, we placed the TFL posterior to the patellar ligament. Furthermore, we rerouted the anterior limb of the TFL from the back of the ST to the anterior by looping back onto the ST to achieve dynamic stability, which rotated the patella internally and medially during knee movements. Theoretically, dividing the TFL and transferring to the ST muscle aids in the correction of the knee valgus-flexion deformity and internally rotates the tibia. The improvement of the recurvation and valgus of the knee following surgery supports our hypothesis. We also believe that passing the TFL in front of the patella may cause increase in pressure on the patellofemoral joint and results in degenerative changes.

The iliotibial band is a hip abductor and external rotator and pelvic stabilizer on the ipsilateral hip. Lattermann suggested that loss of the TFL leads to a mild reduction of hip flexion and external rotation.[24] Our patients with patella dislocation due to muscle imbalance and lateral instability are examples of this generalized instability. This surgical procedure disturbed the TFL-iliotibial band and lateral joint capsule (the structures that provide resistance against varus stresses on the knee joint), but we tightly sutured the posterior limb of the TFL subperiosteally on the lateral surface of the lateral femoral condyle to increase resistance against varus stresses. Furthermore, we did not observe Trendelenburg gait or any other sign of hip abductor weakness.

Poor results have been reported with single lateral release.[10,25] Tenodesis of the ST surrounding the patella has been suggested by Galaezzi as a method for treating recurrent patella dislocations.[26–28] Deie suggested reconstruction of the medial patellofemoral ligament for adolescents using ST. The ST is transferred to the patella using a pulley in the posterior third of the proximal aspect of the medial collateral ligament.[26] However, the isometricity of the ST's transferred tendon is maintained during knee flexion and extension; only static stability can be achieved with these methods. Additionally, the major difficulty of ST tenodesis is the tendon's insufficient length, making it impossible to pass through the patella. The major complications of this technique are patella fracture and degeneration.[22] Beyond medial plication, transfer of the TFL to the medial side of the patella is our preferred method. The TFL was rerouted from the back of the ST to the anterior by looping back onto the ST to achieve dynamic stability, which rotated the patella internally and medially during knee movements. In order to ensure that the patella remained in the trochlear groove, the anterior portion of the TFL was secured to the superior-medial pole of the patella. Medial structures were repaired at a degree of tightness that provided patellofemoral congruence after cutting parts of the medial joint capsule, the medial retinaculum, and the VM. These were sutured immediately to the superior medial pole of the patella. To avoid patella fracture, we placed the TFL posterior to the patellar ligament, rather than passing it through a hole in the patella.

In our technique, the anterior limb of the TFL is passed from the lateral joint capsule to the medial of the knee through the front of the femoral condyle, which is thought to prevent anterior translation of the femur as an intra-articular reconstructive method. However, in the literature, several extra-articular reconstructive techniques utilizing gracilis and semitendinosus tendons are currently in use to treat anterior instability.[29,30] Pearl and Bergfeld noted that the role of extra-articular procedures in the final outcome is limited.[31] Furthermore, Kennedy et al. compared 3 pediatric ACL reconstruction techniques biomechanically.[32] He advocated that the iliotibial band technique restored AP translation better but may constrain the knee to rotational forces. Likewise, Scott suggested the intra-articular transfer of the iliotibial band permits earlier rehabilitation.[33] Although no studies have investigated patients with irreducible patellar dislocation with ligamentous laxity, our study showed that passing the TFL in front of the knee joint reduces anterior translation of the tibia and supports anterior stability. Longer-term results are needed to determine the affect of TFL on the articular cartilage.

Our operative findings are similar with those of other

studies.[18,34] Our data demonstrate that when the patella is realigned in the trochlear groove, development of the trochlear groove and the patella occurs during the growing period. Likewise, when the abnormal vectors on the lateral side disappear, genu valgum and external torsion deformity of the tibia will be improved.

Most authors consider the lengthening of the quadriceps as an essential part of the procedure in order to allow the patella to remain reduced.[35,36] Intraoperatively, we decided to lengthen the RF in 11 of 14 cases to avoid extension contracture, an obstacle to patellofemoral reduction. The most notable adverse finding of RF lengthening procedures is extension weakness of the knee.[37] We postoperatively determined flexion contracture in 3 patients. Extension weakness due to RF lengthening, postoperative immobilization position (a long-leg plaster cast in 30–45° of knee flexion), and hamstring contracture due to preoperative knee position (resulting from a dislocated patellofemoral joint) are the possible reasons for flexion contracture. We also had to perform a hamstring tenotomy and a serial casting application.

We did not use Q angle in pre- and postoperative evaluation of our patients. However, our study included patients with acquired irreducible patella dislocation due to ligamentous laxity and instability. In all cases, the patella was dislocated, and many of our patients had flexion contracture. Supporting this, Aglietti claimed that patellar movement on extension can affect the measurement of Q angle.[38] We believe that measurement of Q angle in patients with dislocated patella and flexion contracture may not be a reliable guide for measurement.

The disadvantages of this study are its limited number of patients and short follow-up period. Additionally, none of the patients had reached skeletal maturity. Despite the limited patient number, the rarity of the selected patient group should be considered.[1,4,31] Because of the short follow-up, we have labeled our study a preliminary report, in which we described a promising new surgical method in detail. However, we accept that the long-term effects of our surgical technique require further study.

In summary, we treated knee instability accompanied by patella dislocation due to muscle imbalance with a combined method, including transfer of the TFL to the patella, lateral release and medial plication of the capsule, release of the VL, and lengthening of the RF. Early results showed that this combined procedure could be an effective alternative treatment method for this difficult-to-treat knee instability accompanied by patellar dislocation. Further studies with longer-term follow-ups are necessary to evaluate our results.

Conflics of Interest: No conflicts declared.

References

1. Bettuzzi C, Lampasi M, Magnani M, Donzelli O. Surgical treatment of patellar dislocation in children with Down syndrome: a 3- to 11-year follow-up study. Knee Surg Sports Traumatol Arthrosc 2009;17:334–40.
2. Dugdale TW, Renshaw TS. Instability of the patellofemoral joint in Down syndrome. J Bone Joint Surg Am 1986;68:405–13.
3. Swaroop VT, Dias L. Orthopedic management of spina bifida. Part I: hip, knee, and rotational deformities. J Child Orthop 2009;3:441–9.
4. Paton RW, Bonshahi AY, Kim WY. Congenital and irreducible non-traumatic dislocation of the patella--a modified soft tissue procedure. Knee 2004;11:117–20.
5. Ghanem I, Wattincourt L, Seringe R. Congenital dislocation of the patella. Part I: pathologic anatomy. J Pediatr Orthop 2000;20:812–6.
6. Goldthwait JE. Slipping or recurrent dislocation of the patella: with the report of eleven cases. American Journal of Orthopedic Surgery, Vol. 1, pp. 293-308, 1903. J Bone Joint Surg Am 2003;85–A:2489.
7. Gordon JE, Schoenecker PL. Surgical treatment of congenital dislocation of the patella. J Pediatr Orthop 1999;19:260–4.
8. Jones RD, Fisher RL, Curtis BH. Congenital dislocation of the patella. Clin Orthop Relat Res 1976;119:177–83.
9. Langenskiöld A, Ritsilä V. Congenital dislocation of the patella and its operative treatment. J Pediatr Orthop 1992;12:315–23.
10. Gao GX, Lee EH, Bose K. Surgical management of congenital and habitual dislocation of the patella. J Pediatr Orthop 1990;10:255–60.
11. Ghanem I, Wattincourt L, Seringe R. Congenital dislocation of the patella. Part II: orthopaedic management. J Pediatr Orthop 2000;20:817–22.
12. Wada A, Fujii T, Takamura K, Yanagida H, Surijamorn P. Congenital dislocation of the patella. J Child Orthop 2008;2:119–23.
13. Krackow KA, Thomas SC, Jones LC. A new stitch for ligament-tendon fixation. Brief note. J Bone Joint Surg Am 1986;68:764–6.
14. Diamond LS, Lynne D, Sigman B. Orthopedic disorders in patients with Down's syndrome. Orthop Clin North Am 1981;12:57–71.
15. Livingstone B, Hirst P. Orthopedic disorders in school children with Down's syndrome with special reference to the incidence of joint laxity. Clin Orthop Relat Res 1986;207:74–6.
16. Ramaswamy R, Kosashvili Y, Murnaghan JJ, Yau CK, Cameron JC. Bilateral rotational osteotomies of the proxi-

mal tibiae and tibial tuberosity distal transfers for the treatment of congenital lateral dislocations of patellae: a case report and literature review. Knee 2009;16:507–11.
17. Williams JJ, Graham GP, Dunne KB, Menelaus MB. Late knee problems in myelomeningocele. J Pediatr Orthop 1993;13:701–3.
18. Stanisavljevic S, Zemenick G, Miller D. Congenital, irreducible, permanent lateral dislocation of the patella. Clin Orthop Relat Res 1976;116:190–9.
19. Conn HR. A new method of operative reduction for congenital luxation of the patella. J Bone Joint Surg 1925;7:370.
20. Eilert RE. Congenital dislocation of the patella. Clin Orthop Relat Res 2001;389:22–9.
21. Green JP, Waugh W, Wood H. Congenital lateral dislocation of the patella. J Bone Joint Surg Br 1968;50:285–9.
22. Hung NN. Using an iliotibial tract for patellar dislocation in children. J Child Orthop 2008;2:343–51.
23. Camathias C, Rutz E, Götze M, Brunner R, Vavken P, Gaston MS. Poor outcome at 7.5 years after Stanisavljevic quadriceps transposition for patello-femoral instability. Arch Orthop Trauma Surg 2014;134:473–8.
24. Lattermann C, Lobenhoffer P. Biomechanical changes in the hip, femur and knee joint after removal of a tensor fasciae latae flap. [Article in German] Handchir Mikrochir Plast Chir 1996;28:76–82. [Abstract]
25. Kolowich PA, Paulos LE, Rosenberg TD, Farnsworth S. Lateral release of the patella: indications and contraindications. Am J Sports Med 1990;18:359–65.
26. Deie M, Ochi M, Sumen Y, Yasumoto M, Kobayashi K, Kimura H. Reconstruction of the medial patellofemoral ligament for the treatment of habitual or recurrent dislocation of the patella in children. J Bone Joint Surg Br 2003;85:887–90.
27. Grannatt K, Heyworth BE, Ogunwole O, Micheli LJ, Kocher MS. Galeazzi semitendinosus tenodesis for patellofemoral instability in skeletally immature patients. J Pediatr Orthop 2012;32:621–5.
28. Letts RM, Davidson D, Beaule P. Semitendinosus tenodesis for repair of recurrent dislocation of the patella in children. J Pediatr Orthop 1999;19:742–7.
29. Lemaire M. Chronic knee instability. Technics and results of ligament plasty in sports injuries. [Article in French] J Chir (Paris) 1975;110:281–94. [Abstract]
30. Marcacci M, Zaffagnini S, Marcheggiani Muccioli GM, Neri MP, Bondi A, Nitri M, et al. Arthroscopic intra- and extra-articular anterior cruciate ligament reconstruction with gracilis and semitendinosus tendons: a review. Curr Rev Musculoskelet Med 2011;4:73–7.
31. Pearl AJ, Bergfeld JA, editors. Extraarticular reconstruction in the anterior cruciate ligament deficient knee. Champaign: Human Kinetics Books; 1992.
32. Kennedy A, Coughlin DG, Metzger MF, Tang R, Pearle AD, Lotz JC, et al. Biomechanical evaluation of pediatric anterior cruciate ligament reconstruction techniques. Am J Sports Med 2011;39:964–71.
33. Scott WN, Schosheim PM. Intra-articular transfer of the iliotibial muscle-tendon unit. Clin Orthop Relat Res 1983;172:97–101.
34. Bensahel H, Souchet P, Pennecot GF, Mazda K. The unstable patella in children. J Pediatr Orthop B 2000;9:265–70.
35. Bergman NR, Williams PF. Habitual dislocation of the patella in flexion. J Bone Joint Surg Br 1988;70:415–9.
36. Hung NN, Tan D, Do Ngoc Hien N. Patellar dislocation due to iatrogenic quadriceps fibrosis: results of operative treatment in 54 cases. J Child Orthop 2014;8:49–59.
37. Jackson AM, Hutton PA. Injection-induced contractures of the quadriceps in childhood. A comparison of proximal release and distal quadricepsplasty. J Bone Joint Surg Br 1985;67:97–102.
38. Aglietti P, Insall JN, Cerulli G. Patellar pain and incongruence. I: Measurements of incongruence. Clin Orthop Relat Res 1983;176:217–24.