



Original Article

Surgical treatment of recurrent habitual patellar dislocation associated with severe trochlear hypoplasia and generalized ligament laxity

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A B S T R A C T

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Introduction: Recurrent habitual patellar dislocation can be treated by soft tissue reconstruction or osteotomy or combination of both. However, no single surgical procedure can address the complex issue. We have successfully treated three patients (four knees) with trochlea hypoplasia and generalized ligament laxity with different surgical techniques.

Patients and Methods: From January 2001 to November 2008, four knees of three female patients were presented with recurrent habitual dislocation of the patella and generalized ligament laxity. Different surgical procedures were performed, including Insall proximal realignment in two knees, Roux-Goldthwait procedure in one knee, and combined trochleoplasty and tibial tubercle transfer in one knee. This article reports the functional and radiographic assessments at a mean follow-up of 3.4 years.

Results: The modified Cincinnati score increased from 74 ± 9 preoperatively to 88 ± 6 at latest follow-up; and the Kujala patellofemoral disorder score increased from 75 ± 10 to 86 ± 11 . No recurrent dislocation occurred on all knees. Radiographic parameters improved, including congruence angle and axial linear patellar displacement. The sulcus angle improved in patient who underwent combined trochleoplasty and tibial tubercle transfer.

Conclusions: Surgical treatment for recurrent habitual dislocation of the patella varied according to the severity of the anatomical abnormality and the patellar stability assessed intraoperatively. In severe cases, combined trochleoplasty and tibia tubercle transfer is indicated to correct the recurrent dislocation of the patella. Proper patient selection and good surgical technique are the keys to success.

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1. Introduction

Habitual patellar dislocation is a rare disorder of the extensor mechanism. The etiology of habitual patellar dislocation is multifactorial and is often associated with anatomical abnormalities that predispose to patellar instability, including trochlea hypoplastic patella, genu recurvatum, hyperelastic status, deficient lateral femoral condyle, patellar alta, excessive femoral anteversion, and increased Q angle.^{1–3} The managements ranged from conservative treatment to surgical intervention depending on the severity of the disease. Many surgical procedures are designed to correct recurrent patellar dislocation.^{2–4} Some techniques achieved certain success in selected cases, but none showed universal results. Furthermore,

different clinical results of the same procedure are reported in the literature.^{2,4–11} Therefore, no single surgical procedure can address the complex issue of recurrent habitual patellar dislocation. This issue is further complicated in rare patients with habitual dislocation of the patella associated with trochlea hypoplasia and generalized ligament laxity, such as Ehlers-Danlos syndrome. We have successfully treated three such patients (four knees) using different surgical techniques, including combined trochleoplasty and tibial tubercle transfer. This retrospective study reported the medium-term results with an average follow-up of 3.4 years.

2. Patients and methods

Between January 2001 and November 2008, three female patients presented with habitual dislocation of the patella and generalized ligament laxity. The demographic characteristics are shown in Table 1. Radiographs of the knee showed flat hypoplastic femoral trochlea with nearly 0° sulcus angle, patella alta in lateral view, and lateral dislocation of the patella in anteroposterior view.

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Table 1
Demographic characteristics.

| Patient | Age | Gender | Previous operation | Side | Dysplastic type | Follow up | Procedure |
|---------|-----|--------|--------------------|-------|-----------------|-----------|------------------------------------------------------|
| A | 25 | Female | No | Right | C | 1 yr | Insall proximal realignment |
| B | 42 | Female | No | Right | A | 8 yr | Roux-Goldthwait procedure |
| C | 27 | Female | Yes* | Left | C | 3 yr | Combined trochleoplasty and tibial tubercle transfer |
| C | 30 | Female | No | Right | C | 1 yr | Insall proximal realignment |

* Patient C underwent reduction of patellar dislocation in the left knee and patellar lateral release elsewhere.

Ehlers-Danlos syndrome was clinically suspected with generalized ligament laxity, such as genu recurvatum of the knee, hyperextension of the elbow, hyperelasticity of the metacarpophalangeal joint, and increased skin elasticity (Fig. 1). However, the genetic counseling was nonconclusive at the time of this report.

All patients received conservative treatments for 6 months or longer before surgery. The conservative treatments included knee brace immobilization, physiotherapy with quadriceps and hamstring strengthening exercises, and modification of daily activities. Surgery was performed after failure with conservative treatment. All patients chose to have surgery on one knee at a time.

Preoperative assessments included history and physical examination and radiographs of the knee in anteroposterior, lateral, and merchant views. The patellar height, the sulcus angle, and the patellar position were documented. We also classified the patients according to Dejour's trochlear dysplastic classification.¹²

The procedure selection for the particular patient depends on the stability of the patella examined intraoperatively and the radiographic appearance. Insall proximal realignment was performed in two knees, Roux-Goldthwait procedure in one knee, and combined trochleoplasty and tibia tubercle transfer in one knee.

The right knee of Patient A and the right knee of Patient C were classified as trochlear dysplasia Type C, which was presented as positive crossing sign and double-contour sign on true lateral view and medial hypoplasia on axial view. We performed an extensive medial imbrication procedure as described by Insall et al.¹³ After exposure of the quadriceps mechanism, two incisions were made. The first incision was a medial parapatellar arthrotomy that passes over the medial quarter of the patella. The second is a lateral release extending just distal to the fibers of the vastus lateralis. Realignment was performed by advancing the medial flap containing the vastus medialis obliquus (VMO) laterally and distally in the line of the fibers of the vastus medialis. After suturing, the incision lies in a straight line across the front of the patella and the lateral release should be left open. Stability was achieved with this extensive medial imbrication procedure.

The right knee of Patient B was classified as Dejour trochlear dysplasia Type A, which was presented as positive crossing sign in true lateral view and shallow trochlear groove but still relatively symmetrical and concave. Roux-Goldthwait procedure was carried out on the right knee of Patient B. Imbrication of VMO was performed first. Then the patellar tendon was split longitudinally and its lateral half was released distally with simultaneous patellar lateral retinacular release. The lateral half of longitudinally split patellar tendon was passed under the intact medial half, being sutured under the tibial periosteal flap on the medial site of tibial tubercle.



Fig. 1. Marked skin elasticity clinically suspected with Ehlers-Danlos syndrome.

The left knee of Patient C, classified as Dejour trochlear dysplasia Type C, required concomitant trochleoplasty and tibial tubercle transfer to restore the stability of patella. The intraarticular pathology included the flat hypoplastic trochlea and thin and stretched out medial retinacular structures, including medial patellofemoral ligament (MPFL) and relatively tight lateral retinaculum, gross lateral translational and rotational malalignment of the patella with 15° of Q angle. An oblique lateral trochlear osteotomy was performed with 8-mm thick lateral trochlea, centered to the midline of the femoral sulcus, by means of power saw and osteotome. The lateral trochlea was elevated gently to approximately 8 mm high to provide lateral stability to the patella. An 8-mm wedge allograft was placed in the gap and transfixed with two Kirchner pins. Lateral retinacular release was performed to reduce the lateral pull on the patella. The tibial tubercle was obliquely osteotomized with 5.0 cm long single and then transferred 1.8 cm medially, 1.2 cm anteriorly, and 0.5 cm distally and was transfixed with two screws that provided adequate stability of the tibia tubercle and satisfactory correction of the patellofemoral joint alignment (Figs. 2 and 3). The knee was carried through full range of motion and no impingement was noted. The knee was irrigated. The medial retinacular structure around the MPFL was reinforced with imbrications before wound closure.

Postoperatively, the knees were kept in the knee immobilizer. Patient was ambulated on two crutches with toe-touch weight bearing on the operated leg and was encouraged to perform quadriceps and hamstring strengthening exercises. Partial weight bearing and range of motion were permitted in 3–4 weeks and full

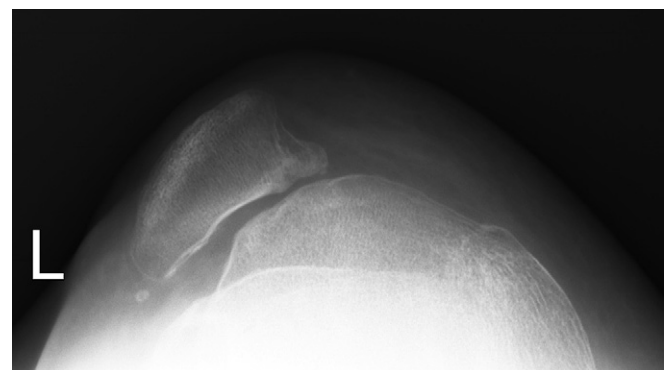


Fig. 2. Preoperative merchant view showing severe trochlear hypoplasia and dislocated patella.

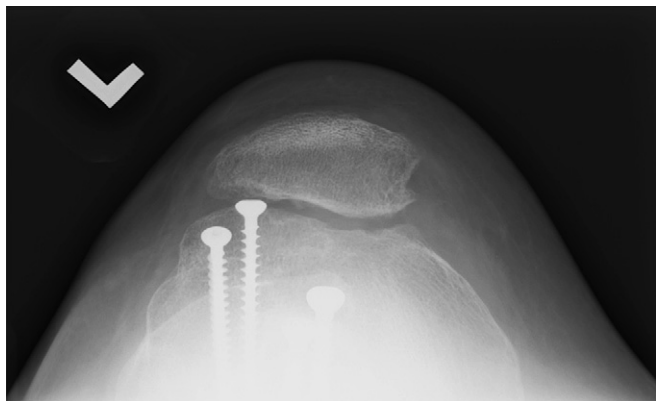


Fig. 3. Postoperative merchant view at 1-year follow-up shows healed trochlear osteotomy and reduced patella. Radiographic parameters, including sulcus angle, congruence angle, and axial linear patellar displacement, all improved much.

weight bearing and progressive physical therapy after 6 weeks when radiographs showed bone healing of the tibial tubercle and trochlea.

Patients were followed up as outpatients at 1, 3, 6, and 12 months, and then yearly. Radiographs of the knee were done at each visit. Functional outcome evaluations included modified Cincinnati Rating System score and Kujala patellofemoral disorder score. The radiographic evaluations included sulcus angle, congruence angle, and axial linear patellar displacement.

The linear displacement measurement was obtained by drawing a reference line across the medial and lateral facets. Perpendicular lines were drawn from the depth of the sulcus through the reference line and from the apex of the posterior tip of the patella through the reference line. The distance between the perpendicular lines was the linear displacement measurement. The new measurement was presented by Urch et al¹⁴ in 2009, as Fig. 4 shows, and was found correlated to congruence angle measurements.

3. Results

The results of functional outcomes before and after treatment are summarized in Table 2. The modified Cincinnati score increased from 74 ± 9 preoperatively to 88 ± 6 at latest follow-up; and the Kujala patellofemoral disorder score increased from 75 ± 10 to 86 ± 11 . No recurrent dislocation occurred on all knees.

The results of radiographic evaluation are summarized in Table 3. The average sulcus angle in Patient A and B and right knee

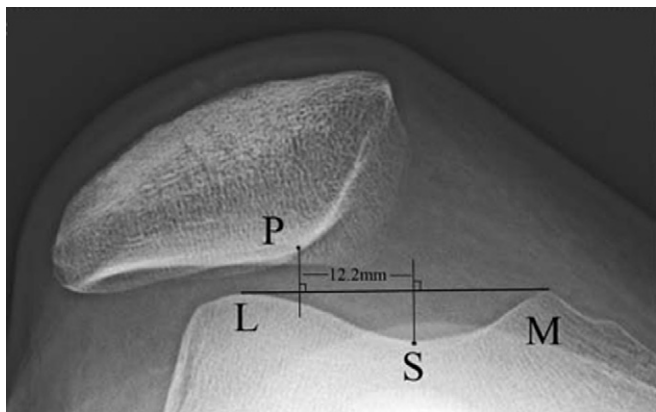


Fig. 4. The measurement of axial linear patellar displacement shows 12.2 mm, which was dislocated.

Table 2
Functional scores before and after treatment.

| Measures | Preoperative | Latest follow-up |
|---------------------|-----------------|------------------|
| Modified Cincinnati | 74.0 ± 9.0 | 88.0 ± 6.0 |
| Kujala score | 75.0 ± 10.0 | 86.0 ± 11.0 |

of Patient C was from 161.2 ± 15.4 preoperatively to 156.0 ± 15.2 postoperatively. The sulcus angle of the left knee in Patient C, who had combined trochleoplasty and tibial tubercle transfer, improved from 176.6 degrees preoperatively to 161.2 degrees postoperatively. The congruence angle improved from 55.0 ± 33.2 to -26.6 ± 27.1 and axial linear patellar displacement from 21.3 ± 22.1 preoperatively to -7.0 ± 10.9 postoperatively (Fig. 4). All patients were able to return to work or school at the latest follow-up. No complications, such as nonunion, infection, fracture, deep vein thrombosis, arthrofibrosis, and so forth were noted. Early osteoarthritis was found only in Patient B, who was 42 year old at the time of surgery. She has mild and occasional pain, and crepitus on stairs climbing and strenuous activities. The remaining three knees were asymptomatic for activities of daily living.

4. Discussion

Untreated symptomatic knees with patellofemoral disorder are prone to osteoarthritis of the patellofemoral joint.¹⁵ In most cases, patients with recurrent habitual dislocation of the patella require surgical intervention except occasional case report with successful conservative treatment.¹⁶ The type of surgery varied according to the severity and the anatomical abnormality of the knee, and there is no single procedure that can address the complex pathoanatomy of the disorder. Traditionally, proximal realignment and distal realignment are most commonly used in the correction of patellar instability. The proximal realignment alters the medial-lateral position of the patella by reconstruction or repair of the MPFL,⁹ whereas distal realignment modifies the position of the patella by transfer of the tibia tubercle. Overall, the success rates of patellofemoral realignment were reported from 20% to 70%.^{7,17,18}

Trochlear hypoplasia is one of the common pathoanatomy associated with recurrent patellar dislocation. Neither proximal nor distal realignment alone is adequate enough to correct trochlear dysplasia. Very little information has been written regarding the surgical treatment for trochlear hypoplasia. Trochlear osteotomy is difficult to perform and the long-term outcome is unknown.¹⁹ Furthermore, the effect of trochlear osteotomy on patellofemoral congruence is problematic and unresolved in long-term outcome. However, trochlear osteotomy can be modified to be more anatomic and less disruptive of the articular cartilage and can be used in conjunction with soft tissue balancing procedure²⁰ as described in our case.

Tibia tubercle transfer has been proven to be effective for the treatment of patellar instability with patellofemoral malalignment.²¹ The procedure is designed to correct the Q angle by medialization and anteriolization of the tibia tubercle, that in turn, to unload the contact stress of the patellofemoral joint and increase or evenly distribute the patellofemoral contact area.⁷ In our cases,

Table 3
Radiographic evaluations before and after treatment.

| Measures | Preoperative | Latest follow-up |
|------------------------------------|------------------|------------------|
| Sulcus angle | 161.2 ± 15.4 | 156.0 ± 15.4 |
| Congruence angle | 55.0 ± 33.2 | -26.6 ± 27.0 |
| Axial linear patellar displacement | 21.3 ± 22.1 | -7.0 ± 10.9 |

all patients present with various degrees of trochlear hypoplasia and patellofemoral malalignment associated with generalized ligament laxity. None of the currently recommended procedures, such as repair or reconstruction of the MPFL, medial imbrication and advancement of VMO, and lateral retinacular release is adequate enough to correct severe trochlear hypoplasia, and additional procedures deemed necessary. To the authors' best knowledge, this article is the first to report the successful use of combined trochleoplasty and tibia tubercle transfer to correct recurrent patellar dislocation associated with severe trochlear hypoplasia and generalized ligament laxity.

The functional status of our patients was relatively normal except the knees despite of generalized ligament laxity. Patients were aware of the patella dislocation; however, knee pain, weakness, and giving way sensation were mild, preoperatively as well as post-operatively.

Sulcus angle and congruence angle on radiographs of the knee are the parameters to describe trochlear hypoplasia. However, they are not the predictors of the surgical outcome. The axial linear displacement measurement correlates well with the congruence angle and is a useful tool to evaluate patellofemoral congruence. The axial linear patellar displacement in our patients improved after the operations as well.

There are many procedures for recurrent or habitual patellar dislocations but none of them can show it is the best. In our opinion, the treatment choices are similar to "reconstruction ladder." First, try patellar lateral release and medial reefing. If the patella is still tending to dislocate, try repair of MPFL or do Insall proximal realignment. At this time, Q angle must be carefully evaluated. If the Q angle is too large, Elmslie-Trillat procedure can be considered. If the Q angle is within normal range or distal realignment has been done but the patella is still unstable, correcting femur trochlear hypoplasia with trochleoplasty should be considered, especially when the femoral trochlea was classified as Type B, C, or D. That is to say, soft tissue balance, Q angle, and then femur trochlear pathoanatomy is the sequence of patellar dislocation treatment.

The limitations of this study included small number of patient population, as one would not anticipate a larger number of patients with such unusual anomalies. As a result, no control was used in the study. The follow-up time is relatively short, and the long-term result of such combined procedure is unknown.

In conclusion, surgical treatment for recurrent habitual dislocation of the patella varied according to the severity of the anatomical abnormality and the patellar stability assessed intra-operatively. In severe cases, combined trochleoplasty and tibia tubercle transfer is indicated to correct the recurrent dislocation of

the patella. Proper patient selection and good surgical technique are the keys to surgical success.

Level of evidence: Level III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees, according to US Preventive Services Task Force.

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