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Treatment of patellar dislocation at terminal knee extension

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Purpose Evaluate efficacy of the technique offered for the treatment of patellar dislocation at terminal knee extension. **Material and methods** The review included 67 patients (84 knee joints) with patellar dislocation at terminal knee extension. Surgical planning with the use of Ilizarov module was based on radiological assessment, CT scans and patients' age. Outcomes of surgical treatment of patients with patellar dislocation at terminal knee extension were followed from 1 to 13 years. **Results** Evaluation criteria of efficient treatment included absence of patellar dislocation, improved knee function and supportability of the limb, relief of knee pain, and the patella being fully engaged with the femoral trochlea on radiographs and CT scans of the knee joint. **Conclusion** The approach to the treatment of patellar dislocation at terminal knee extension facilitated excellent and good results in 97.6 % of the cases. Reoperation was required for two patients to ensure good outcome. Preoperative calculations and accurate technical performance are important for patellar tendon transfer to avoid adverse effects.
Keywords: knee joint, patellar dislocation, terminal knee extension, clinical manifestations, treatment, osteosynthesis, Ilizarov frame, outcome

INTRODUCTION

Patellar dislocation usually occurs as a result of dysplastic changes in the patellofemoral system [1, 2]. The patella is normally displaced over the lateral femoral condyle at the knee flexion. Patellar dislocation manifests immediately after birth with flexion contracture of the knee and genu valgus [3, 4, 5]. There are sporadic cases of lateral and proximal patellar dislocation at the knee extension that reduces itself back into place spontaneously at the knee flexion. The patellar dislocations occur at the terminal knee extension [6]. There are observations of the patella relocating laterally in the coronal plane over anterior surface of the lateral femoral condyle during stance phase for many years but no dislocation occurs. Patellofemoral arthritis is noted to develop in the patients [7, 8]. Major anatomical changes in lateral patellar dislocation at the knee extension include laterally relocated patellar tendon, abnormally high patella (patella alta) and deficiency of vastus lateralis muscle. A nearly right angle between the vastus lateralis muscle and patella and rectus femoris tendon during contraction predisposes for lateral patellar dislocation at terminal knee extension [6]. Patellar dislocations are subdivided into mild, moderate and severe types [9] to choose appropriate treatment strategies. In our opinion, operative treatment is indicated for any type of patellar dislocation at terminal knee extension and a surgical intervention was offered to address the causes leading to the condition to securely re-engage the patella within the trochlea femoral groove. Realignment of the patella as it tracks up and down the femoral trochlea during knee flexion and extension is essential for improving supportability of the leg and functional aspects of the patellofemoral joint.

The purpose of the study was to evaluate efficacy of the technique offered for the treatment of patellar dislocation at terminal knee extension.

MATERIAL AND METHODS

The review included 67 patients (84 knee joints) with patellar dislocation at terminal knee extension. The patients presented with intermittent episodes of lateral patellar dislocations while walking with the knee extended. Patellae relocated to either anterior or anterolateral surface of the lateral femoral condyle at the knee extension. Patellae alternately dislocated in both knee joints of 41 patients, two patients had both patellae dislocated simultaneously, the rest had unilaterally dislocated kneecap with dysplastic

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changes observed in both knees. Patellae relocated laterally and proximally by 1 to 11/2 cm at quadriceps contraction. Hypermobile patellae were observed in coronal plane in all the cases. Patients' age ranged from 6 to 18 years (n = 30), 19 to 30 years (n = 29), 31 to 40 years (n = 6), 41 to 50 years (n = 2). There were 57 females (72 knee joints) and 10 males (12 knee joints). Clinical, radiographic, ultrasonographic and computed tomographic examinations were produced preoperatively and during treatment. An extent of healing of the patellar tendon transferred and subperiosteally fixed to tibia was assessed with postoperative ultrasonography. Patella location was radiologically identified preoperatively and the union of tibia and tibial tubercle transferred with patellar tendon assessed postoperatively. Preoperative computerised tomographic images showed patella position relative to femoral condyle, the sulcus angle of the femoral trochlea, laterally relocated patellar tendon and postoperative scans demonstrated patella realigned within the femoral trochlea.

All patients underwent reconstructive procedure of the extension mechanism of the knee joint [10]. The surgical treatment goals were to decrease an angle under which the vastus lateralis muscle is connected with patella and rectus femoris tendon, correct patella alta and laterally displaced patellar tendon and realign patella within the femoral trochlea. Patellar tendon was fixed subperiosteally in children and through tibial tubercle in adults. Surgical planning was based on radiological and computerized tomographic findings and patient's age. Advantages with the technique were the persisted strength of the vastus lateralis muscle with realignment performed, creation of favourable environment for patellofemoral joint function with patella transferred down and the patellar tendon realigned by the lateral shift measure. Application of the Ilizarov fixation module is practical for mobilisation of the knee after 3 postoperative days and reduced rehabilitation period.

Surgical technique. An incision was made on the lateral aspect of the femur 2 cm proximal to superior pole of patella to tibial tubercle. The vastus lateralis muscle was released from patella and rectus femoris tendon. Then the vastus lateralis muscle belly was mobilised, transferred medially to nearly normal anatomical location and fixed to the rectus femoris muscle with sutures. The vastus lateralis tendon was sutured anteriorly to the base of patella and rectus femoris tendon. With adequately produced manoeuvres the direction of fibres of the vastus lateralis muscle belly and the tendon approximated to the axis of the rectus femoris muscle. Quadriceps contraction could not lead to lateral patellar relocation without any decrease in the muscle strength. With regard to preoperative calculations an island was arranged on tibia for patellar tendon transfer re-engaging patella within femoral trochlea. Patellar tendon was released from tibial tubercle with periosteum and reattached to tibia subperiosteally in patients with open physes. Patellar tendon of adult patients was transferred with tibial tubercle and fixed to tibia with sutures and several short olive wires attached to the rings of the Ilizarov frame mounted at the end of surgical procedure. Tendons and ligaments of patella were medially secured with moderately tensioned sutures. Motion with the knee in 40º flexion was produced. If patella easily glided within the midline of the trochlea the wound was closed layer after layer. With a tendency of either lateral or medial patellar relocation realignment was produced with sutures and tested extension and flexion again. This was not required with adequate practice. Hemostasis was performed during the course of surgery. Articular capsule was repaired if injured while re-engaging patella within femoral trochlea. Active drainage was left in the wound. The wound was sutured and patella fixed with Ilizarov external fixation device [11]. A couple of wires with an angle of 30° between them were placed in the proximal and mid-third tibia and attached to two half-rings connected by rods. A coronal wire with an olive laterally secured was placed in the patella and attached to a hinged unit connected with tibial frame. Dressings were applied to the wound and pin sites.

RESULTS AND DISCUSSION

Bilateral involvement was observed in all the patients. Occasional lateral patellar dislocations were seen to occur during childhood or adolescence after a minor injury and the condition is termed as posttraumatic in the literature. And the dislocation can occur due to dysplastic changes in the patellofemoral system unrelated to an injury. According to many authors, an injury can trigger patellar dislocation due to

the existing dysplastic changes in the knee joint [12]. Greater forces are needed to get patella dislocated without dysplastic changes in the extensor apparatus. We observed an early case of dislocation in a 6-year-old male patient and the rest reported first episodes of dislocation at the age of 8 to 14 years. Compensation capabilities of the knee extensor mechanism restraining patella from dislocation are likely to get exhausted by the age. There were cases of recurrent lateral patellar dislocation at the terminal knee extension that reduces itself back into place spontaneously at the knee flexion. The knee joints appeared normal that made the diagnosis difficult, and the patients were seen late several years after the onset due to the pain associated with patellofemoral arthritis. Two patients were referred to our Centre several months after the first episode of patellar dislocation, another two were seen 30 years later and the rest 63 patients, from 6 to 10 years and over due to misdiagnosis.

Anteroposterior view of the knee joints showed patellae locating either on anterior or anterolateral surface of the lateral femoral condyles partially displaced by 20 to 30 % of the breadth (**Fig. 1**).

Fig. 1 Patella dislocated at terminal knee extension

All patients exhibited patella alta measuring 30 to 35 mm (n = 20), 40 to 50 mm (n = 2) and 24 to 29 mm (n = 45) above the joint line. Sulcus angle of the femoral trochlea measured 162° to 145° (154° on average) on computerised tomographical images (**Fig. 2**). Patellar tendon relocation was measured in millimeters to determine the extent of intraoperative medial transfer (**Fig. 3**).

Computerised tomographic image acquired at mid-level of tibial tubercle was applied over an image acquired at mid-level of femoral trochlea to determine the magnitude for lateral relocation of the patellar tendon. A line passing through the centre of femur (1) and the centre of the femoral trochlea (2) was drawn in the resultant image. Another line was drawn through the centre of tibia (3) and the centre of patellar tendon at the tibial attachment (4). The lines were set at an angle that we termed as a patellar tendon lateralisation angle. The distance between the centre of the femoral trochlea (2) and the centre of patellar tendon at the tibial attachment (4) is the measure for lateral transfer of the patellar tendon [13]. An angle of lateralisation measured 17º to 45º (30.4º on average) for patellar ligaments with the transfer of 16 to 28 mm (20.7 mm on average). The parameters were different even in one patient.

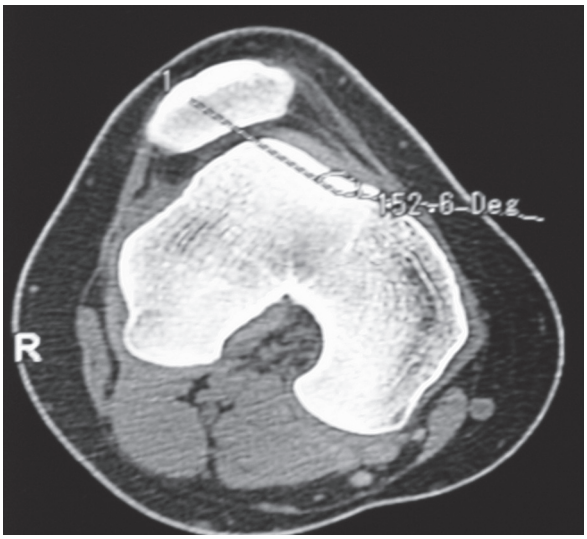

Fig. 2 An instance of measuring sulcus angle of the femoral trochlea using CT image

Fig. 3 Diagram showing the magnitude for patellar tendon transfer

Preoperative measurements were employed for patellar transfer in abnormally high-riding patella (**Fig. 4**).

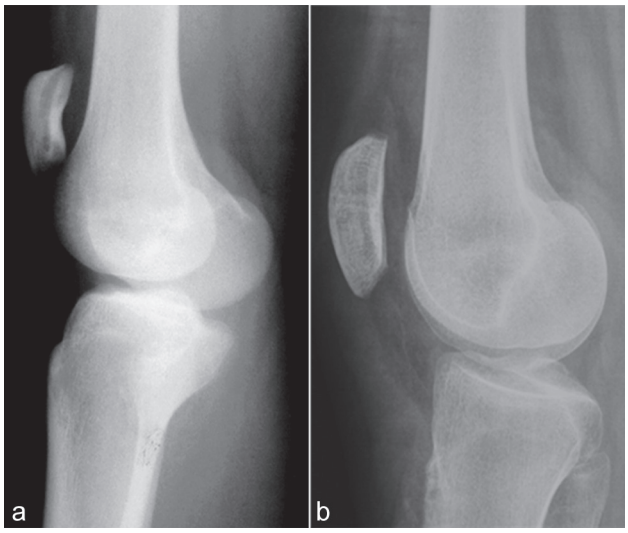

Fig. 4 Radiographs of the knee joint showing preoperative (a) and postoperative (b) patella

Postoperative care was also very important. Dressings were replaced and drainage system removed the next day after surgery. Dressings were changed on postoperative day 3 and then once every 7 to 10 days. Next day after the surgery some weight were allowed to be borne by the operated limb using crutches and a cane recommended after 20 to 30 days. The patients started graduated quadriceps contraction 3 to 4 times per day after four postoperative days and active and passive exercises to the knee after three to five postoperative days. The Ilizarov frame targeted protection of the medial and distal patellar tendon transfer from tensile stress during knee motion prior to healing with underlying tissues. Early knee mobilisation improved trophics of the articular cartilage and interfered with progression of osteoarthritis. It is important for juxta-articular tissues of the knee being not fixed with scars but working together in realignment. The sutured were removed after 20 days at the earliest to prevent wound dehiscence during early knee mobilisation. The transferred patellar tendon with subperiosteal fixation was ultrasonographically assessed after 21 to 23 postoperative days. The patellar tendon transferred with tibial tubercle fixation was radiographically evaluated after 30 to 35 postoperative days. Both examinations showed good healing of the patellar tendon fixed either subperiosteally or through tibial tubercle with the proper bone contact and compression with olive wire provided. Then the Ilizarov frame was taken off. Knee flexion and active extension measured 150º and 170 to 175º, correspondingly, before frame removal (**Fig. 5**).

We have come to the conclusion that optimal knee flexion to be achieved during the treatment is up to 150º. Greater values can result in the patellar wire cutting through tissues, pin tract infection and longer rehabilitation period. Patients continued exercise therapy after the frame came off. Knee function was shown to recover after 71.25 ± 8.63 days. Computed tomographic scans acquired after the treatment demonstrated patella being engaged within the trochlea femoral groove and congruent patellar and femoral trochlea articular surfaces. The two lines forming patellar tendon lateralisation angle and running into one another indicated to an ideal scenario on CT scan. The remaining several degrees were acceptable and had no impact on patellar tracking (**Fig. 6**).

The distance from patella to the knee joint line measured 15 mm (n = 12), 7 to 8 mm (n = 14) and 10 mm (n = 58).

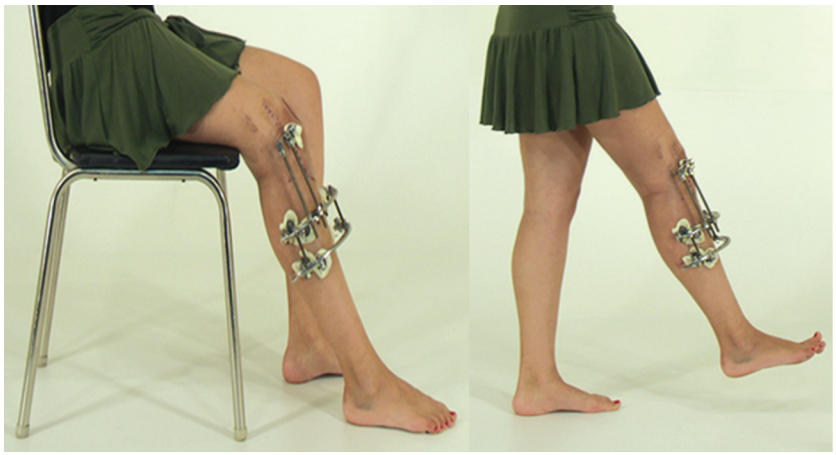

Fig. 5 Photograph of a patient showing ROM of the knee after 21 postoperative days prior to frame removal

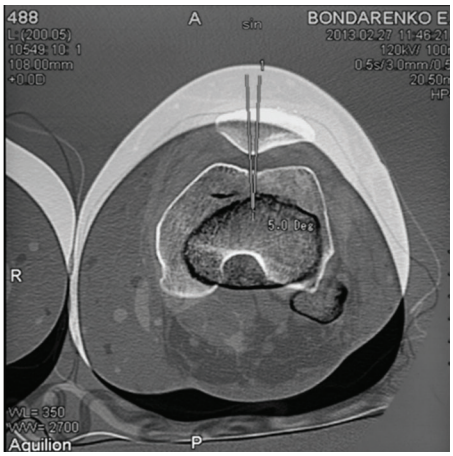

Fig. 6 CT scan showing the patellar tendon lateralisation angle after treatment

Outcomes were followed at one year in all the patients, and at four to thirteen years in 39 cases (48 knee joints). Evaluation criteria of efficient treatment included absence of patellar dislocation, improved knee function and supportability of the limb, relief of knee pain, and the patella being fully engaged with the femoral trochlea on radiographs and CT scans. Poor results at one year were observed in two patients with persisted patella alta, hypermobile patella in coronal plane, limited active extension of the knee that resulted in decreased functional capabilities for the gait. A thorough analysis showed they were caused by errors in preoperative calculations and technical performance of the procedure in one case and by an injury to the patellar tendon in a patient with limited flexion of the knee. Re-surgery was performed for the cases to eliminate patella alta and strengthen the patellar tendon. Three-month follow-up showed a fair outcome. The patients could regain knee function, improve supportability of the leg with no episodes of patellar dislocation. Four-year follow-up showed excellent outcomes in 22 patients and good results in 9 patients aged 30 years and over who reported improved supportability of the limb and recurrent pain in the knee associated with preoperative patellofemoral arthritis and greater physical activity. Several patients of the group developed occupational skills they had been unable to do before the treatment.

Outcomes of 8 patients aged over 30 years were evaluated as good at 13-year follow-up. Six of them reported slight recurrent pain in patella occurring with physical activity. All of them improved supportability of lower limbs. Patients denied additional means of support reporting no sporadic episodes of lateral patellar dislocation and the fear of sudden falls. Patellae were engaged with the femoral trochlea with proper tracking control during knee flexion and extension. Patients regained active knee function and were socially adapted. The patients with patellar dislocation addressed reported either no or minor knee pain associated with deforming arthritis that did not interfere with everyday life. We trust that this occurred due to normal biomechanical conditions provided for patellar functioning with the treatment.

CONCLUSION

A variety of dysplastic changes in locomotor system is manifested in patellar dislocation at terminal knee extension characterised by bilateral involvement and diagnosed several years after birth. Our observations presented with highly riding patellar and laterally relocated patellar tendon. In addition to sporadic episodes of lateral patellar displacement the patients develop patellofemoral arthritis that is difficult to treat. Early diagnosis and optimal treatment options are important. We believe surgery is the only way to address the reasons of lateral patellar dislocation at terminal knee extension. We applied reconstructive procedure aimed at the vastus lateralis muscle transfer to the nearly normal anatomy, correction of patella alta and laterally displaced patellar tendon. CT scans acquired at tibial tuberosity and femoral trochlea were used to calculate medial transfer of the patellar tendon and radiographs of the knee were employed to determine the amount by which patella and the tendon to be brought down. The Ilizarov external fixation targeted protection of the patellar tendon transfer from tensile stress during knee motion. Ultrasonography showed subperiosteally fixed patellar tendon heal with underlying tissues after 21 to 23 day postsurgery. Radiographs of the knee obtained after 30 to 35 postoperative days indicated to the union of tibial tuberosity and tibia with the proper bone contact and compression with olive wire provided. Then the Ilizarov frame was removed with the knee extension of 150º achieved. Patients continued exercise therapy and the knee function was shown to recover after 71.25 ± 8.63 days. The approach to the treatment of patellar dislocation at terminal knee extension facilitated excellent and good results in 97.6 % of the cases. Reoperation was required for two patients to ensure good outcome. Preoperative calculations and accurate technical performance are important for patellar tendon transfer to avoid adverse effects.

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