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Double level de-rotational osteotomy for femoral and tibial external torsion: Report of two cases

Shuntaro Nejima [a,b], Marco Maiotti [c], Steffen Schröter [a,*]

[a] Department of Orthopedics and Reconstructive Surgery, Diakonie Klinikum GmbH Jung-Stilling-Krankenhaus, Siegen, Germany
[b] Department of Orthopaedic Surgery, Yokohama City University School of Medicine, Yokohama, Japan
[c] Shoulder Unit Villa Stuart Hospital, Rome, Italy

A B S T R A C T

Background: Double level de-rotational osteotomy is indicated for 'inwardly pointing knee', which is caused by increased femoral internal torsion and increased tibial external torsion. This report presents two unusual cases of double level de-rotational osteotomy for other patterns of abnormal torsion.
Case reports: Two patients, aged 18 and 16, visited the outpatient clinic of our institute with anterior knee pain and difficulty in walking of one of their knees. Preoperative evaluation of the computed tomography images demonstrated both the femur and tibia were externally rotated approximately 10° from normal value. After double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies, their anterior knee pain had resolved and they were able to walk smoothly.
Conclusion: Double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies can be indicated for increased external torsion of the femur and tibia.

1. Introduction

Anterior knee pain and patellar instability can be caused by various anatomic abnormalities, such as torsional deformity of the lower extremity, trochlear dysplasia, patella alta, and genu valgum. Among them, femoral or tibial torsional deformity is improved by femoral or tibial de-rotational osteotomy, respectively.[1–5] Double level de-rotational osteotomy is indicated for 'inwardly pointing knee', which is caused by abnormal torsion of the femur and tibia.[2,6–8] This procedure usually consists of femoral external de-rotational osteotomy and tibial internal de-rotational osteotomy for increased femoral internal torsion and increased tibial external torsion. There are no reports of double level de-rotational osteotomy for other patterns of abnormal torsion. We report two cases of double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies for increased external torsion of the femur and tibia.

2. Case report

2.1. Case 1

An 18-year-old female visited the outpatient clinic of our institute with anterior knee pain and difficulty in walking of her right knee. There was no history of trauma. Conservative treatment was ineffective. Physical examination exhibited tenderness over the patellofemoral compartment, and the knee range of motion was 0–160°. There was no instability of the patellofemoral joint. External rotation (ER) of both hip joints was 60° and internal rotation (IR) was 20°. On torsional CT scan, femoral internal torsion angle was 13° and tibial external torsion angle was 44.4°, respectively, as measured by the method of Waidelich et al.[9] Both the femur and tibia have a higher torsion of 11° from normal value externally.[10] On the contralateral side, femoral internal torsion angle was 20° and tibial external torsion angle was 43°. Whole-leg alignment in the coronal plane was normal. Therefore, double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies at the diaphysis was planned. As mentioned above, both the femur and tibia were externally rotated approximately 10° from normal value, we planned to internally rotate both the femur and tibia by 10° each.

In an arthroscopic examination, there was no cartilage damage in the patellofemoral joint or subluxation of the patella. A skin incision of 2 cm was made on the anterior knee, a longitudinal incision was made in the middle of the patellar tendon for the transpatellar approach to insert an intramedullary nail for the femur and tibia. Guiding K-wire was placed

* Corresponding author. Department of Orthopedics and Reconstructive Surgery, Diakonie Klinikum GmbH Jung-Stilling-Krankenhaus, Wichernstraße 40, Siegen, 57074, Germany.
E-mail addresses: nejishun@gmail.com (S. Nejima), marcomaiotti.ortopedia@gmail.com (M. Maiotti), steffen.schroeter@diakonie-sw.de (S. Schröter).

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under arthroscopic view to the desired entry point (Fig. 1A) and additionally intensifier control (Fig. 1B and C). Reaming of the femur was performed stepwise from 8 mm to a size of 11 mm. Two Schanz's screws were inserted at the proximal and distal femur across the planned osteotomy site in the femoral isthmus, avoiding interference with the intramedullary nail. The distal Schanz's screw was inserted so that distal one was externally rotated 12° relative to the proximal one. Angle was measured by the iPhone App Angle Meter 360° (Fig. 2A). An approximately 2 cm incision was placed on the anterolateral skin of the planned osteotomy site, and after perforating the femoral cortex with multiple drill, the femur was finally osteotomized with a chisel. The osteotomy site was rotated so that the two Schanz's screws were parallel. A retrograde intramedullary nail RAFN (Retrograde/antegrade femur nail) 340 × 10 mm (DePuy Synthes, Umkirch, Germany) was inserted and fixed with bolts distally. Proximally, one screw was inserted in the dynamization hole.

At the tibia same transpatellar approach was used. The optimal K-wire position at the ventral edge of the tibia plateau in the lateral view and in line with the tibia axis in anteroposterior view was controlled by intensifier (Fig. 1D and E). Intramedullary reaming was performed to 11 mm. As with the femur, tibial torsion was controlled using two Schanz's screws, one proximal and one distal (Fig. 2B). De-rotational osteotomy was performed with multiple drilling and chisel. Fibular osteotomy was added because the osteotomy site of the tibia could not be rotated with isolated tibial osteotomy. After osteotomy of the tibia and fibula, the distal part of the osteotomy site was internally rotated of 11°, and an antegrade intramedullary nail (Expert Tibia Nail; DePuy Synthes, Umkirch, Germany) was inserted and bolts for fixation were used distally and one in the dynamic hole proximal. Then, the fibula was fixed with a 5 hole 3.5 LCP plate.

In postoperative rehabilitation program, no limitation regarding range of motion. Full weight-bearing was allowed immediately. On postoperative CT images, femoral internal torsion angle was 22.7° and tibial external torsion angle was 32.9°, which is nearly normal value. At an outpatient visit 6 months after surgery, her anterior knee pain had resolved and she was able to walk smoothly (Fig. 3A and B). Also, postoperative radiographs showed that bone union at the osteotomy sites had been achieved (Fig. 4A–D).

2.2. Case 2

A 16-year-old male visited the outpatient clinic of our institute with anterior knee pain and difficulty in walking of his left knee. There was no history of trauma. He also had pain in the medial side of his left foot due to external torsional deformity of the whole-lower extremity and constant loading on the medial side of the foot during walking. Physical examination exhibited tenderness over the patellofemoral compartment. There was no instability of the patellofemoral joint. ER of both hip joints was 70° and IR was 10°. On torsional CT scan, femoral internal torsion angle was 12° and tibial external torsion angle was 45.3°, and the total external torsion was approximately 20°. On the contralateral side, femoral internal torsion angle was 16° and tibial external torsion angle was 50°. Whole-leg alignment in the coronal plane was normal. Double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies was planned. We planned to internally rotate both the femur and tibia by 10° each.

In an arthroscopic examination before osteotomy, there were no obvious abnormalities. As in case 1, de-rotational osteotomies were performed at the femoral and tibial diaphyses and fixed with intramedullary nails.

Postoperative rehabilitation program was the same as in case 1. On postoperative CT images, femoral internal torsion angle was 26.1° and tibial external torsion angle was 39.5°. At an outpatient visit 6 months after surgery, his anterior knee and medial foot pain had resolved and he was able to walk smoothly. Subsequently, bone union at osteotomy sites was confirmed (Fig. 5A and B), and the intramedullary nails were

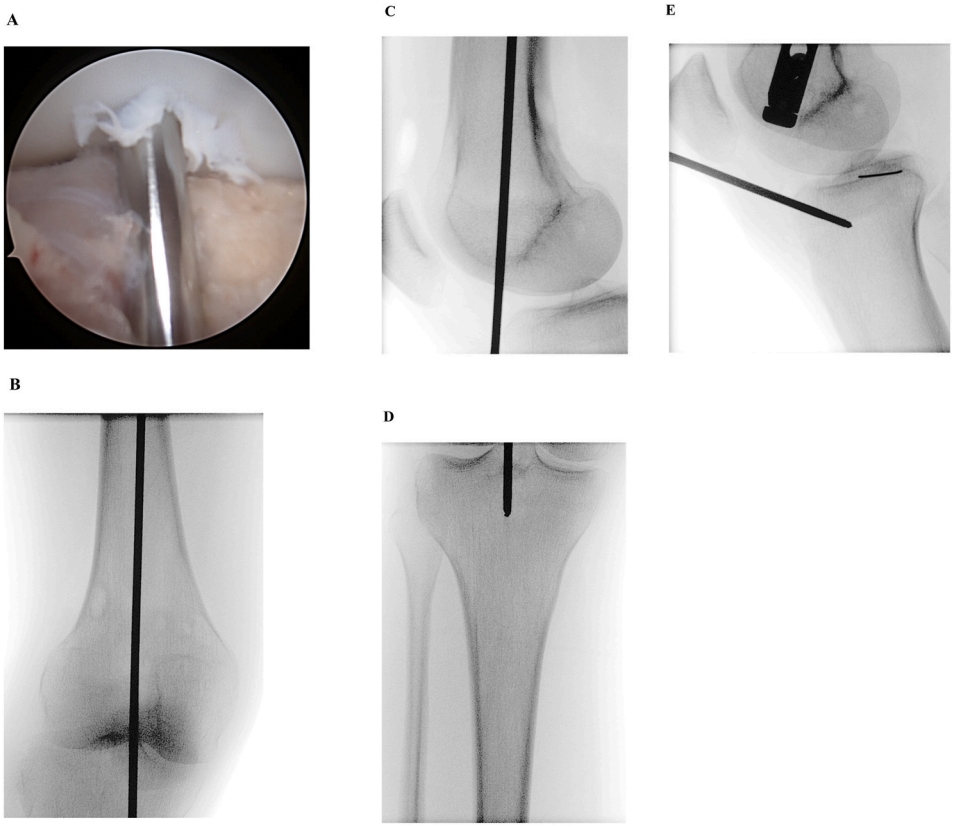

Fig. 1. Guiding K-wire was placed to the desired entry point of the femur and tibia under arthroscopic view (A) and additionally intensifier control (B–E).

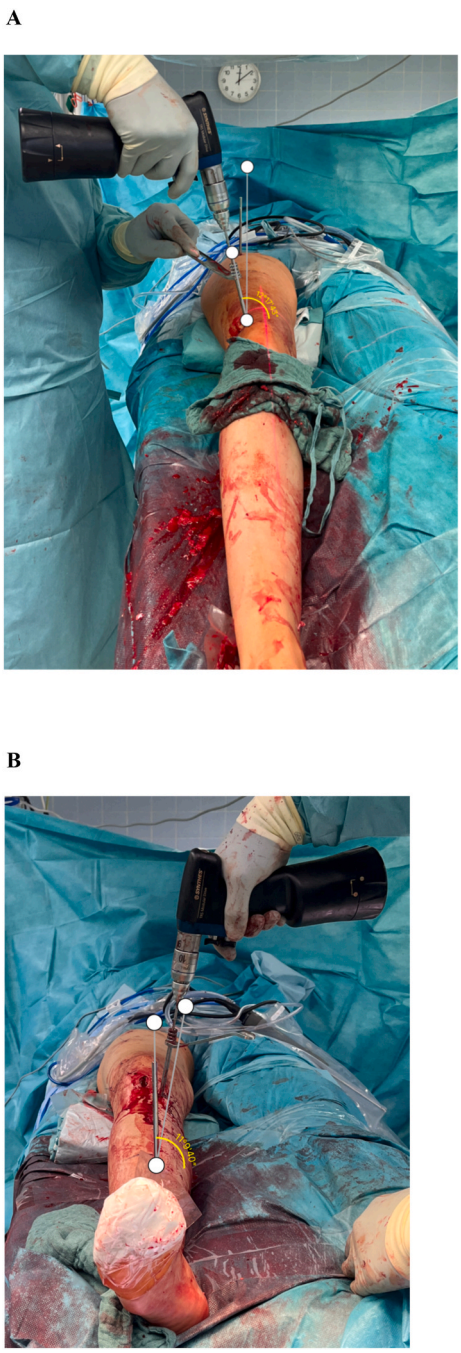

Fig. 2. Two Schanz's screws were inserted at the proximal and distal femur (A) and tibia (B) across the planned osteotomy site in the angulation of the deformity and desired correction.

removed 1 year and 5 months after surgery.

3. Discussion

We experienced two rare cases in which anterior knee pain and difficulty in walking improved after double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies for external torsional deformities of the femur and tibia. To our knowledge, there is no research evaluating the appropriate level for torsional osteotomy.[11] The authors prefer torsional osteotomy at the diaphysis using an intramedullary nail because of minimally invasive. In case 2, the patient had not only anterior knee pain but also foot pain, which was caused by the continued loading on the medial side of the

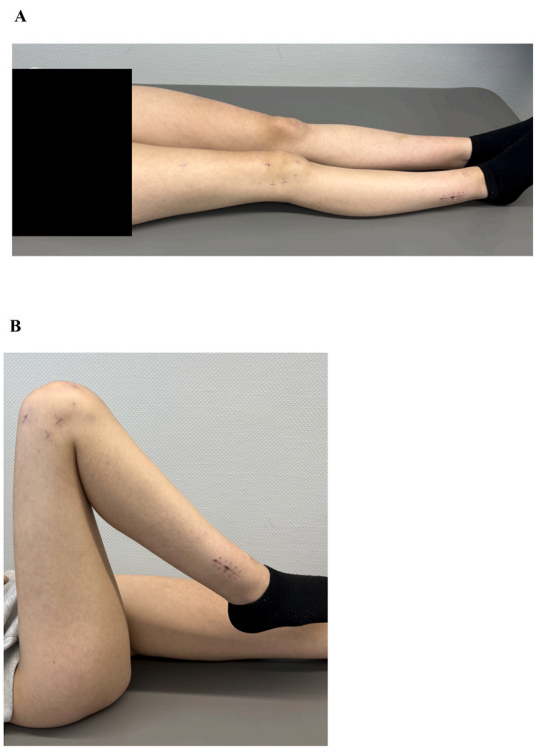

Fig. 3. At an outpatient visit two months after surgery, her anterior knee pain had resolved and she was able to walk smoothly. (A) Knee extension. (B) Knee flexion.

foot during walking due to external torsional deformity of the whole-lower extremity. After double level de-rotational osteotomy, this symptom improved. Although it is known that torsional deformity can result in knee and hip joint symptoms,[12] foot pain is rare. Surgeons should be aware that torsional deformity can cause complaints in joints other than the knee.

Increased femoral internal torsion was related to patellar instability or anterior knee pain[13,14] because femoral internal torsion decreases patellar stability and increases pressure on the patellofemoral joint.[15,16] Although femoral external de-rotational osteotomy is effective for anterior knee pain or patellar instability with femoral internal torsion in previous studies,[2,3,5] there are no reports of femoral internal de-rotational osteotomy for femoral external torsion. In previous biomechanical studies, patellar instability and patellofemoral joint pressure increase not only in internal torsional deformity of the femur but also in external torsional deformity,[15,16] suggesting that external torsional deformity of the femur can also cause patellofemoral symptoms. Also, it is difficult to clearly define a limiting torsional value of the femur and the tibia and an isolated torsional osteotomy of less than 10° will rarely be performed.[12] However, Dagneaux et al.[16] reported that linear distribution in patellar stress with gradual femoral torsional deformity increments. They concluded that internal and external torsional deformity could induce patellofemoral pain syndrome from less than 10° rotation.[16]

Increased tibial external torsion was related to patellar instability or anterior knee pain[17,18] and tibial internal de-rotational osteotomy is effective.[1,2,4] It is thought that anterior knee pain or patellar instability in external tibial torsional deformity is caused by compensatory internal rotation in the hip joint to achieve the optimal foot progression angle.[19] This compensatory mechanism leads the "knee in" gait, and dynamic valgus alignment and a consequent valgus vector on the patella.[19] In addition, the relationship between increased femoral external torsion and the compensatory mechanism also leads to patellofemoral problems. In femoral diaphyseal fractures treated with intramedullary nails,

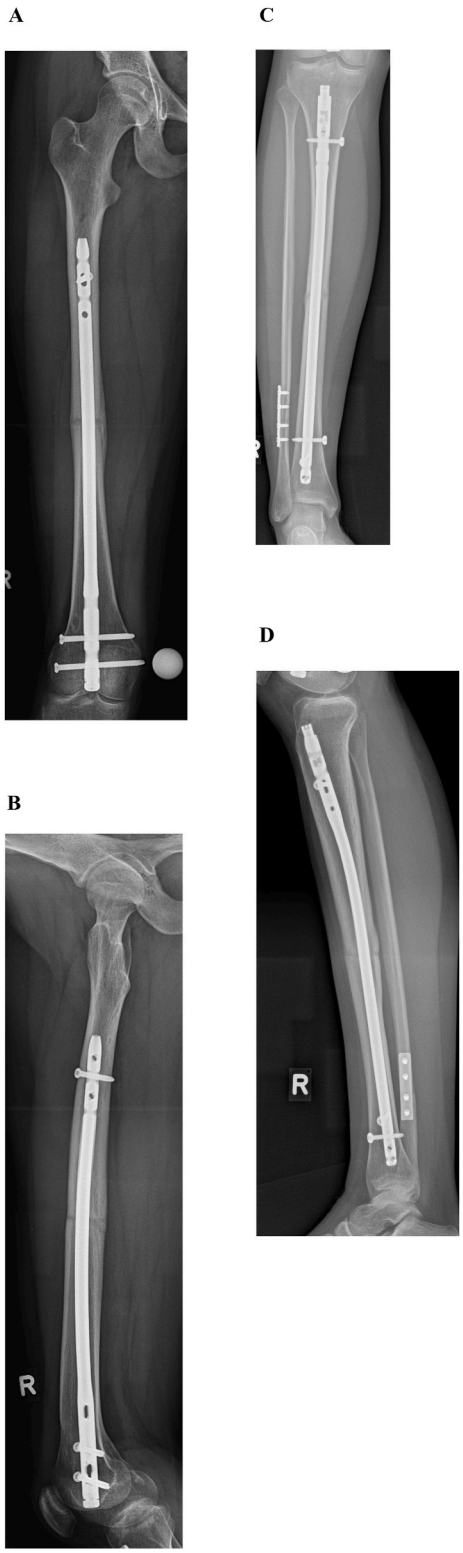

Fig. 4. Postoperative radiographs. (A) Anteroposterior view of the femur. (B) Lateral view of the femur. (C) Anteroposterior view of the tibia. (D) Lateral view of the tibia.

postoperative external torsional deformity led to inferior clinical outcomes related to the patellofemoral joint.[20] This is thought to be because internal rotation of the hip joint to compensate for femoral external torsion is more restricted due to restraints by the external rotator muscles of the hip joint and impingement of the femoral neck to the anterior

Fig. 5. Postoperative radiographs. (A) Anteroposterior view. (B) Lateral view.

acetabulum.[21] From the present cases and the above discussion, double level de-rotational osteotomy can be effective for other combinations of femoral and tibial torsional deformities than femoral internal torsion and tibial external torsion. However, this report is based on only two cases, so more cases should be accumulated and the above speculation should be elucidated in the future.

In conclusion, double level de-rotational osteotomy consisting of femoral and tibial internal de-rotational osteotomies can be indicated for increased external torsion of the femur and tibia.

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Informed consent

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Authors contribution

SN: writing the paper. SS, MM: interpretation. All authors read and approved the final manuscript.

Ethical committee approval

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Declaration of competing interest

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