



Case report

# Simultaneous anterior cruciate ligament reconstruction and dome-shaped high tibial osteotomy for severe medial compartment osteoarthritis of the knee

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Received 29 June 2016; revised 31 July 2016; accepted 15 August 2016

Available online 24 September 2016

## Abstract

**Background:** The optimal surgical procedure to address both anterior cruciate ligament (ACL) deficiency and medial compartment osteoarthritis (OA) has been controversial.

**Case report:** A 49-year-old woman with a 30-year history of chronic anterior cruciate ligament (ACL) deficiency, medial compartment osteoarthritis, and varus deformity presented with medial knee pain and apprehension with walking and playing soccer. Her preoperative range of motion was from 0° of extension to 135° of flexion. The anterior drawer sign (1+), Lachman test (1+), and pivot shift test (glide) were positive before surgery, as measured by the International Knee Documentation Committee knee examination form. The patient underwent simultaneous arthroscopic ACL single-socket and single-bundle reconstruction using hamstring tendons, dome-shaped high tibial osteotomy using the TomoFix fixation device, and mosaicplasty to the medial condyle. The standing femorotibial angle changed from 185° preoperatively to 172° postoperatively. Range of motion exercises were started 1 week after surgery, and partial weight bearing was allowed 2 weeks after surgery. The patient returned to her baseline physical level 2 years after the operation. Range of motion was –10° of extension and 130° of flexion, and the anterior drawer sign, Lachman test, and pivot shift test were all negative at the final 3-year follow-up.

**Conclusion:** An ACL reconstruction combined with a dome-shaped high tibial osteotomy using a locking plate is one option for treating an aged athlete with ACL deficiency and severe medial compartment osteoarthritis, and can allow the athlete to return to sports activity.

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**Keywords:** dome-shaped osteotomy; medial osteoarthritis; anterior cruciate ligament (ACL); reconstruction

## Introduction

The number of anterior cruciate ligament (ACL) reconstructions in aged patients has been increasing in the United States.<sup>1</sup> Middle-aged patients with ACL deficiencies and severe osteoarthritis (OA) of the femorotibial joint are sometimes seen in the outpatient clinic. The optimal surgical procedure to address both ACL deficiency and medial

compartment OA has been controversial: ACL reconstruction alone,<sup>2</sup> high tibial osteotomy (HTO) alone,<sup>3</sup> staged combined ACL reconstruction and HTO,<sup>4</sup> and a combination of ACL reconstruction and HTO<sup>5–10</sup> have all been explored.

To the best of our knowledge, no previous studies have reported a return to baseline physical activity in patients with severe OA who were treated with a combination of a dome-shaped osteotomy fixed by a locking plate and an ACL reconstruction. Here, we present a case of simultaneous ACL reconstruction and dome-shaped HTO in an athlete with ACL deficiency and severe OA of the medial compartment.

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## Case Report

The patient was a 49-year-old female with the chief complaint of left knee pain and apprehension while walking. She had sprained her knee playing soccer 30 years ago and had experienced medial knee pain with walking for the past 20 years. Her Tegner activity score was 7. Her preoperative range of motion was 0° of extension and 135° of flexion. The anterior drawer sign (1+), Lachman test (1+), and pivot shift test (glide) were all positive according to the International Knee Documentation Committee form.<sup>11</sup> The radiographic Kellgren–Lawrence classification was Grade 4 and the standing femorotibial angle (FTA) was 185° (23% mechanical axis point from the medial edges of the level of the tibial plateau: MA; Figures 1A and 1D). The medial proximal tibial angle and mechanical lateral distal femoral angle were 84.9° and 87.4°, respectively. The only medial proximal tibial angle was slightly out of normal range. The tibial slope was 5°.

The patient was diagnosed with ACL deficiency and severe medial compartment OA, but she hoped to continue sports activity. The Japanese Orthopaedic Association (JOA) and Lysholm scores were 50 and 36, respectively. Arthroscopy revealed that the ACL was absent (Figure 2A). In the lateral compartment, the cartilage on both the femur and the tibia, as well as the meniscus, was nearly intact (Figure 2C).

First, an osteochondral graft was performed at the medial femoral condyle using an osteochondral autologous transfer system (Acufex, Smith & Nephew, Andover, MA, USA). Two 8.5 mm osteochondral grafts were harvested from the non-weight-bearing area of the lateral femoral condyle. In

addition, a microfracture was created around the osteochondral graft area and on the lateral tibial plateau. Second, 1.5 cm was resected from the middle third of the fibula and a dome-shaped HTO was performed. Both osteotomy sites were fixed proximally and distally using the TomoFix Japanese system (Synthes, Bettlach, Switzerland) with the aim of making the FTA 172° (60% MA, Figures 3, 4A). The proximal plate was affixed with two posterior screws, and the anterior screw was deferred at this time. An ACL single-socket and single-bundle reconstruction was performed by means of a transtibial technique using the four-strand semitendinosus tendon combined with the Leeds–Keio ligament and TightRope RT (Arthrex Inc., München, Germany; Figure 3). The line of the osteotomy was 22 mm distal to the tibial joint line, and the tibial tunnel was created at the proximal site of the osteotomy line so as not to interfere with the osteotomy site (Figure 3). Bone tunnels were made in the femur (6.5 mm) and in the tibia (7.5 mm). The graft length pattern was 2 mm over the top pattern. The tendon was fixed using double spiked staples (Meira, Gifu, Japan) at the distal osteotomy site under 30 N load at 10° of knee flexion. Finally, the anterior screw was inserted so as not to interfere with the tibial bone tunnel (Figure 4A, B).

The rehabilitation protocol was as follows. A knee brace with a 30° extension limit was placed postoperatively to prevent graft stretching for 1 month. Range of motion exercises were started at 1 week. Partial weight bearing was started at 2 weeks, and full weight bearing was permitted at 4 weeks. The knee brace was removed at 3 months, at which time the patient started jogging. At 6 months, the patient was allowed to resume sports activity. One year after the operation, she returned to sports activity.

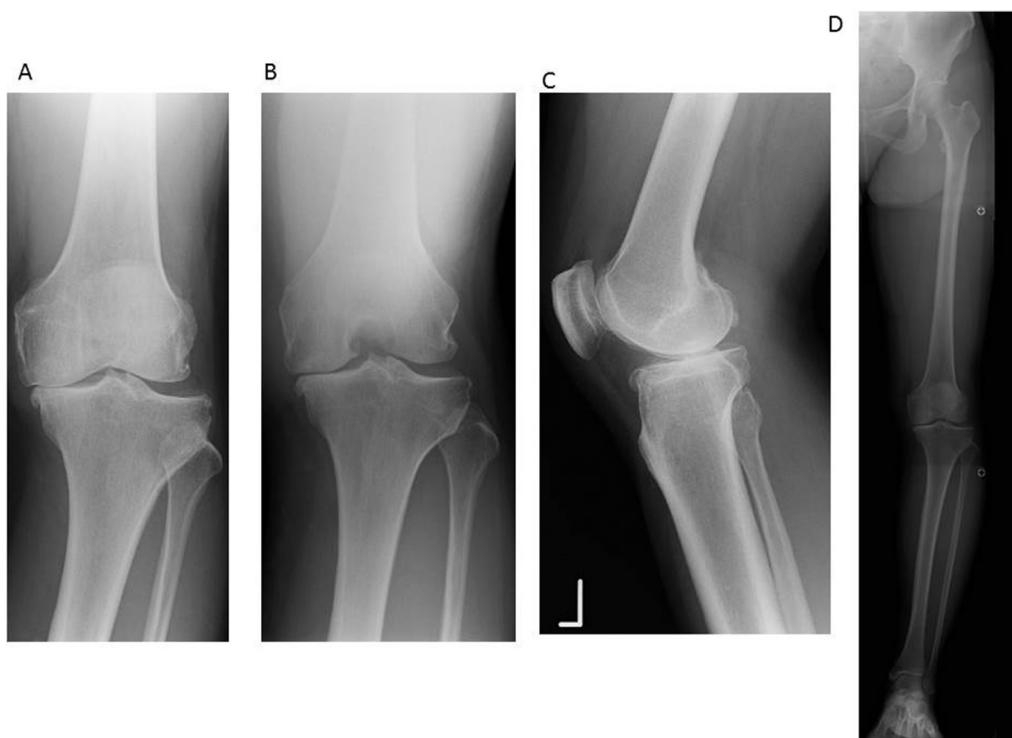


Figure 1. Preoperative radiographs: (A) weight-bearing anteroposterior view, (B) Rosenberg view, (C) lateral view, and (D) long standing axis weight-bearing view.

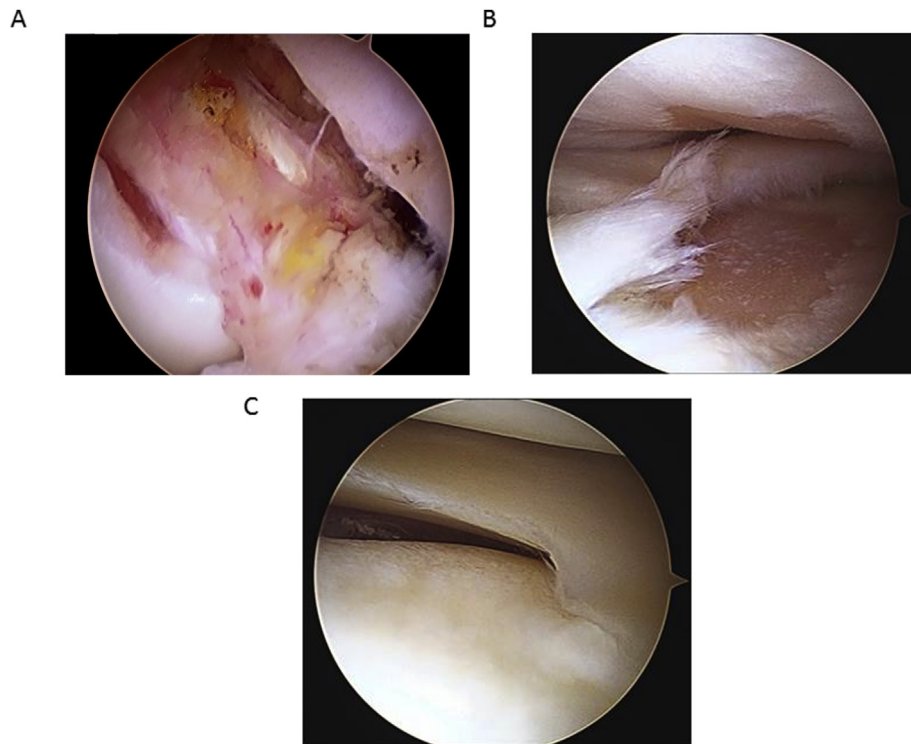


Figure 2. Arthroscopic findings during the first surgery: (A) absence of ACL and osteophytes around the intercondylar space, (B) medial compartment, and (C) lateral compartment. ACL = anterior cruciate ligament.

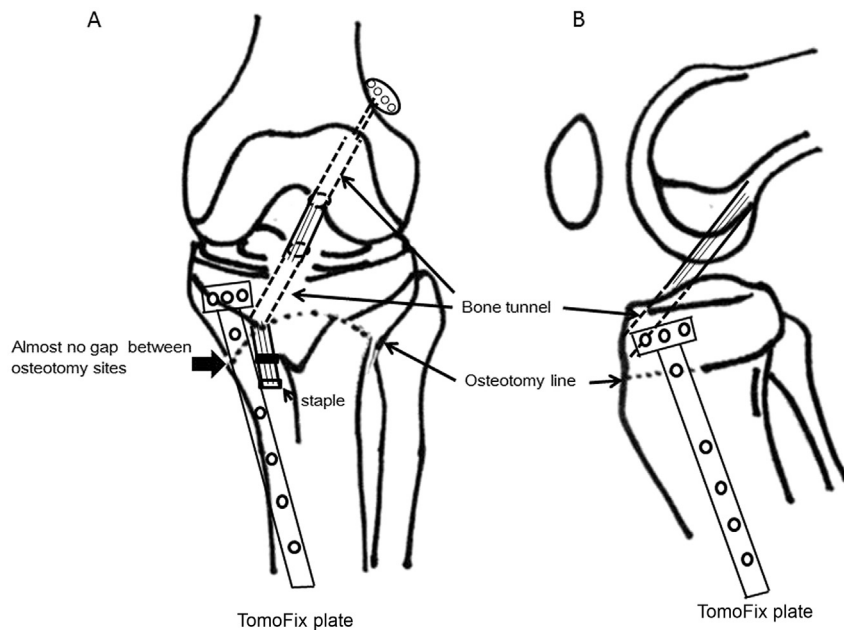


Figure 3. Schematic of surgical procedure: (A) anteroposterior view and (B) lateral view.

Two years after the operation, bone union was achieved and the plate was removed (Figures 5A and 5B). The standing FTA was 172° (Figure 5C) and the tibial slope was 5°. Arthroscopy revealed that the tension and bulk of the reconstructed ACL were good, and a notchplasty of the lateral wall was not needed (Figure 6A). The repair site of the medial condyle was

in almost the same condition as adjacent intact areas (Figure 6B). Degeneration of cartilage on the lateral condyle and meniscus had not progressed compared with the preoperative findings (Figure 6C). At the final follow-up 3 years after the operation, the range of motion was –10° in extension and 130° in flexion. The anterior drawer sign, pivot shift test

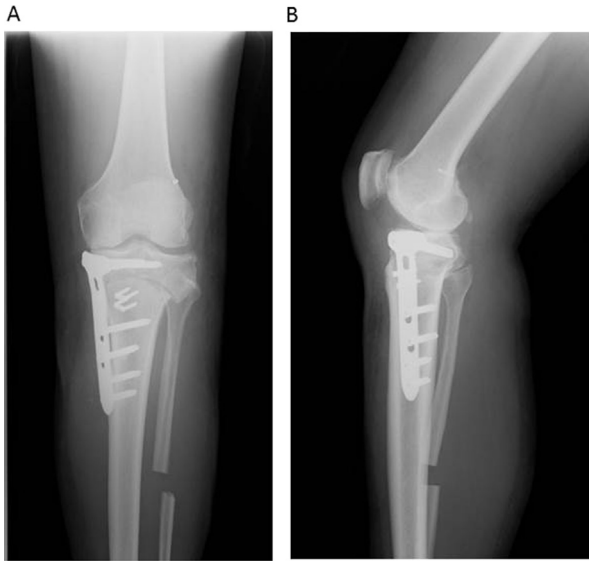


Figure 4. Postoperative radiographs 1 month after surgery: (A) weight-bearing anteroposterior view and (B) lateral view.

and Lachman test were negative. Magnetic resonance imaging showed that the cartilage on both the lateral condyle and the lateral tibial plateau had not changed for 3 years (Figure 7). The patient returned to her original level of sports activity 2 years after the operation. The JOA and Lysholm scores improved to 93 points and 95 points, respectively, at the final follow-up.

## Discussion

ACL reconstruction with or without HTO in middle-aged patients with medial compartment OA is controversial. Akamatsu et al<sup>12</sup> reported good clinical results after simultaneous ACL reconstruction and open-wedge osteotomy using the TomoFix system. However, in all previously reported cases, the presurgical FTA was  $< 185^\circ$ , which limits leg discrepancy and patella baja after HTO. We use simultaneous ACL reconstruction and open-wedge osteotomy in cases with an FTA of  $< 185^\circ$ .

In the current case, the patient was a middle-aged athlete and the FTA was exactly  $185^\circ$ . Closed osteotomy has the disadvantage of shortening legs, which can be critical for athletes. In our case, only the medial proximal tibial angle before operation was slightly out of normal range, and double osteotomy was not necessary and more invasive than other osteotomies. Besides, the medial proximal tibial angle of this case was  $93^\circ$  after the planning of domed osteotomy, less than the  $94^\circ$  benchmark reported as a good clinical result of double osteotomy.<sup>13</sup> Based on these factors, we therefore chose an ACL reconstruction with a dome-shaped HTO with a locking plate. Our technique provided excellent results, and the patient returned to her original level of sports activity 2 years after the operation.

A dome-shaped HTO has several advantages: it has no presurgical FTA limitation, it provides a wide bone contact area, it has a low incidence of leg discrepancy, and it does not change patellar height compared with an open-wedge



Figure 5. Postoperative radiographs: (A) weight-bearing anteroposterior view 2 years after surgery, (B) lateral view 2 years after surgery, and (C) standing long axis weight-bearing view 3 years after surgery.



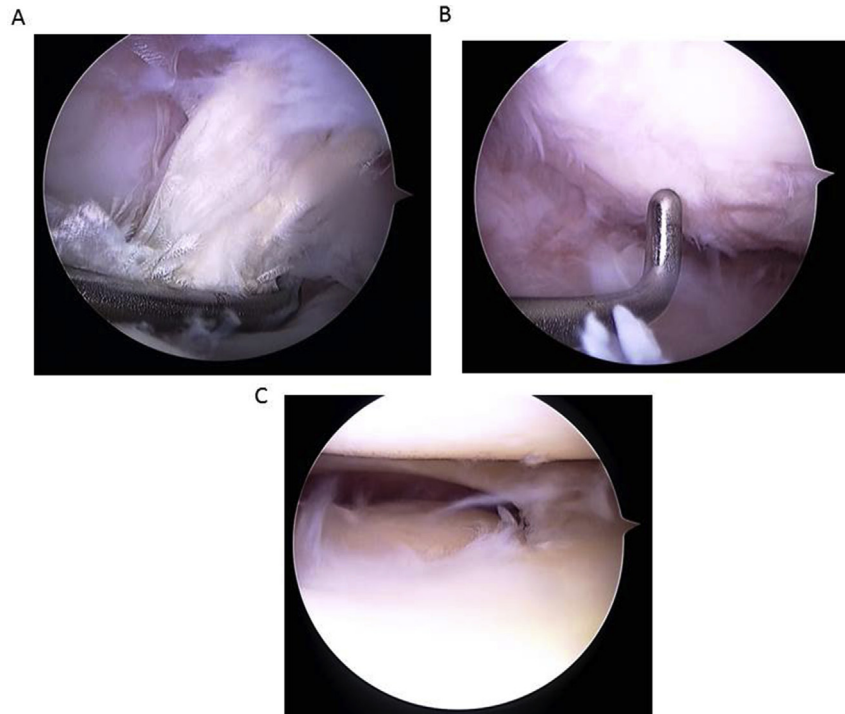


Figure 6. Arthroscopic findings 2 years after surgery: (A) reconstructed ACL, (B) medial condyle at the site of the osteochondral graft, and (C) lateral compartment. ACL = anterior cruciate ligament.

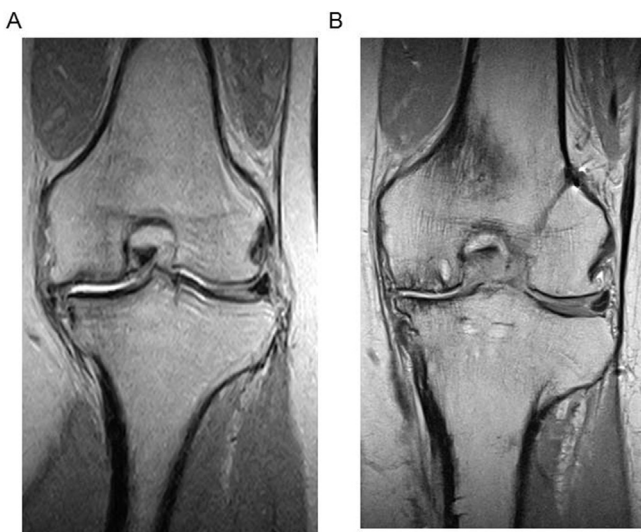


Figure 7. Pre- and postsurgery proton density MRI: (A) coronal view before surgery and (B) coronal view 3 years after surgery. MRI = magnetic resonance imaging.

HTO.<sup>14,15</sup> It has been reported that the tibial posterior slope decreases significantly following a dome-type HTO with external fixation on one side.<sup>16</sup> In our case, the angle of the tibial slope was 5° both before and after the operation. The stability of the tibial slope might have been due to the technical support provided by an intraoperative check of plate fixation using an image intensifier and the rigid locking plate system might have prevented a decrease in the posterior slope after operation. In addition, in the dome-shaped HTO with

ACL reconstruction, the fixed place of the LK ligament on the tibial side of the ACL reconstruction was more proximal and stable than that of an open-wedge HTO because the bone gap between the proximal and distal sides of the osteotomy was less than it would be for an open-wedge HTO (Figure 3).

The fixation technique of combining a dome-shaped HTO and a TomoFix plate, to the best of our knowledge, has not previously been reported. The advantages of this combination are a wider bone contact area of the dome-shaped HTO and the rigid fixation provided by a locking plate such as TomoFix, which promotes bone union and accelerates rehabilitation. In fact, the patient was allowed partial weight bearing 2 weeks after the operation because the osteochondral plugs, which were grafted on the medial condyle, became stable by this time. The combination of a dome-shaped HTO and a TomoFix plate prevents a loss of correction after the osteotomy and accelerates the initiation of rehabilitation.

In conclusion, an ACL reconstruction combined with a dome-shaped HTO using a locking plate is one option to successfully treat middle-aged athletes with ACL deficiencies with medial compartment OA and an FTA of  $\geq 185^\circ$ . The procedure allows the athletes to return to their original level of sports activity within 2 years of surgery.

#### Conflicts of interest

The authors declare that no financial or material support of any kind was received for the work described in this article.

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