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Case Report

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A New Technique Combining Open-Wedge High Tibial Osteotomy and Medial Meniscus Reconstruction Using the Semitendinosus Tendon

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Abstract

Background: Open-wedge high tibial osteotomy (OWHTO) is an established surgical treatment for medial osteoarthritis of the knee. There is a tendency in recent years that the optimal postoperative alignment is less than that of previous reports and defined as %MA (Mechanical Axis) 50-60%. On the other hand, a larger angle of correction reportedly improves postoperative pain score and a reduction in the angle of correction is unlikely to yield positive results regarding pain. We think that recovering the meniscus function is necessary to avoid excessive deviation from the normal anatomical alignment and obtain positive clinical results. We performed OWHTO and meniscal reconstruction simultaneously, using the semitendinosus tendon for medial knee osteoarthritis.

Methods: One patient (64-years-old male) who under went this surgery have been followed up for more than 1 year. The MRI was done, and the Knee injury and Osteoarthritis Outcome Score (KOOS) was adopted to evaluate the clinical effect. Firstly, we harvested semitendinosus tendon, and that was doubled and a Krackow suture was used on both ends with a 2-0 Fiber Wire. Secondly, the anterior and posterior bone tunnels were created at the anterior and posterior horn foot prints of the medial meniscus to prevent interference with the HTO plate screw. Thirdly, we passed the prepared tendon through the bone tunnel and fixed the prepared tendon by an endobutton. At last, we performed biplanar OWHTO.

Results: This patient did not show any complications. At 1 year after the operation, his medial knee pain disappeared and normal range of motion was obtained compared with the contralateral knee joint. The X-ray and CT showed a good union of osteotomy lesion. The knee function score improved at 1 year after operation.

Conclusions: This procedure can reproduce the normal anatomical alignment and knee function, and, improved patient satisfaction can be expected compared to previous methods. This report will be the first step in replicating normal knee function in patients with knee osteoarthritis.

Keywords

Meniscal reconstruction, Open-wedge high tibial osteotomy, Medial knee osteoarthritis, Semitendinosus tendon

Introduction

Open-wedge high tibial osteotomy (OWHTO) is an established surgical treatment for medial osteoarthritis of the knee. However, significant deviations from thenormal anatomical alignment result in poor postoperative knee function; when the postoperative medial tibial plateau angle (MTPA) exceeds 95°, the cases result in a lower knee-function score. Therefore, there is a tendency in recent years that the optimal postoperative alignment is less than that of previous reports and defined as % MA (Mechanical Axis) 50-60% [1]. On the other hand, a larger angle of correction reportedly

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improves postoperative pain score [2] and a reduction in the angle of correction is unlikely to yield positive results regarding pain. We think that recovering the meniscus function are necessary to avoid excessive deviation from the normal anatomical alignment and obtain positive clinical results, because the medial meniscus carries about 50% of the compartment load [3]. There has been a trend towards aggressive meniscus repair, such as posterior root repair and centralization, which has been reported to be performed in combination with HTO [4]. In cases of degenerative tear of the medial meniscus, it is difficult to repair it employing the above methods. Similar to casesin which simultaneous distal femoral osteotomy (DFO) and meniscal reconstruction were performed for lateral knee osteoarthritis [5], we performed OWHTO and meniscal reconstruction simultaneously, using the semitendinosus tendon for medial knee osteoarthritis. To our knowledge, this is the first report on the simultaneous surgery of OWHTO and meniscal reconstruction using the semitendinosus tendon. Reconstructing the medial meniscus with OWHTO can result in near-normal knee function in patients with osteoarthritis.

Methods

Patient indication

Reconstructing the medial meniscus with OWHTO is indicated for medial osteoarthritis with a degenerative tear of the medial meniscus; this could not be untreated by techniques, such as meniscus suture, posterior root repair, and centralization.

Description of the surgical technique

A trial was performed with a saw bone prior to the actual surgery. We have included the following steps of the technique in the procedure diagram:

1. As with conventional OWHTO, a straight skin incision of approximately 10 cm was made on the medial side of the proximal tibia.
2. The attachment of the pes anserinus was separated, with the harvesting of the semitendinosus tendon and the release of the superficial layer of the medial collateral ligament (MCL). The harvested semitendinosus tendon was doubled, and a Krackow suture was used on both ends with a 2-0 Fiber Wire (Arthrex, Naples, FL, USA).
3. The knee joint was examined using arthroscopy, the degenerative meniscus was resected, and the damaged cartilage was debrided. The presence of the anterior and posterior horn footprints of the medial meniscus was confirmed. The bone tunnel was created posteriorly to prevent interference with the HTO plate screw (Figure 1a, Figure 1b and Figure 1c). Likewise, a guide pin (2.4-mm Kirschner wire) was inserted using the director drill-guide system (Acufex; Smith & Nephew, Mansfield, MA, USA) (Figure 1d and Figure 1e). At this point, 4.5 mm cannulated and 6.0 mm retrograde drills (Smith & Nephew) were used to drill the final bone tunnel, ensuring a length of 10 to 15 mm from the posterior horn footprint of the medial meniscus after the plate was temporarily placed and the direction of posterior screw was checked (Figure 1f). The anterior tunnel was created similarly.
4. The graft was initially guided into the posterior tunnel and fixed with a pull-out technique using the ENDOBUTTON® (Smith & Nephew) (Figure 2a). The center of the grafted tendon was marked with 3-0 Vicryl® (Ethicon, Inc., Somerville, NJ). It was guided and placed in 1/2 of the medial tibial plateau area with the aid of micro SutureLasso™ (Arthrex) (Figure 2b). The graft was subsequently guided into the anterior tunnel. The FiberTak® soft anchor (Arthrex) was fixed in the 1/3rd and 2/3rd of the medial tibial plateau area, and the graft was fixed during a centralization procedure (Figure 2c). The middle-to-posterior segment was sutured all-inside with Fast-fix™ (Smith & Nephew) (Figure 2d), and the anterior segment was fixed using a micro Suture Lasso™ and 2-0 Fiber Wire (Figure 2e). Finally, the anterior end of the graft was fixed with a pull-out technique using the Endobutton® (Figure 2f).
5. Biplane OWHTO, superior to the tibial tuberosity, was performed using a Tris plate® (Olympus Terumo Biomaterials, Tokyo, Japan) and an artificial bone (β-tricalcium phosphate, Olympus Terumo Biomaterials). The target postoperative percentage of the mechanical axis (%MA) was 55% on a full-length standing radiograph. This confirmed the non-interference of the proximal-posterior screw by the inserted guide pin, placed in the posterior horn footprint and plate.
6. The attachment of the pes anserinus and the superficial layer of the MCL were repaired. The subcutaneous tissue was closed with 3-0 Vicryl and the skin was closed with 4-0 Nylon. A drain tube was inserted under the skin at the osteotomy site.

Case presentation

A 64-year-old man had been suffering from severe knee pain for several years. On physical examination, the range of motion was observed to be -5° in extension and 130° in flexion. Severe tenderness of the medial joint space of the right knee joint was observed. The lower extremity had a varus deformity. The hip-knee-ankle (HKA) angle was 6.8°, and the %MA was 18.2% on the standing radiograph (Figure 3a). Radiographs displayed a narrowing of the joint space in the medial compartment, and the mechanical MTPA was 85.8° (Figure 3b). Magnetic resonance imaging revealed an articular cartilage defect at the medial femoral condyle and medial tibial plateau and extrusion of the medial meniscus (Figure 3c). Following the approval of the Ethical Committee of Hiroshima University Hospital, the patient's consent was obtained after providing him with detailed information regarding the surgical procedures. OWHTO and meniscal reconstruction were performed usingthe semitendinosus tendon (Figure 3d, Figure 3e and Figure 3f).

Rehabilitation

The knee was immobilized at 20° flexion for 1 weekpost-surgery. Thereafter, active and passive motion exercises were initiated. Partial and full weight-bearing was permitted at 2 and 4 weeks, respectively.

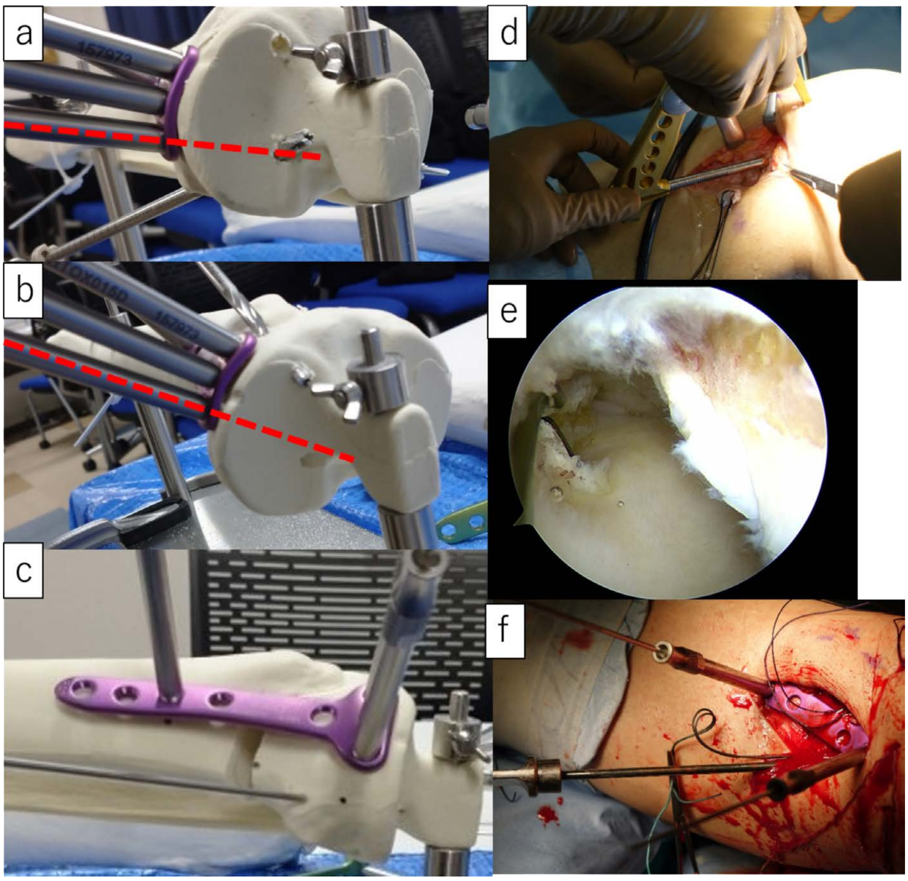

Figure 1: Saw bone model

a) The posterior screw and the bone tunnel may interfere with one another. This can be addressed through shortening the posterior screw or placing the plate anteriorly; b) We must be cautious not to damage the popliteal nerve and the vascular tissue as the screw is inserted in the direction of the knee fossa ; c) Appearance of the plate and guide pins for the posterior tunnel; d) The Acufex guide pin system to drill a posterior bone tunnel; e) Arthroscopic view of the guide pin for the posterior tunnel; f) The temporarilyplaced plate determining the position of the posterior bone tunnel.

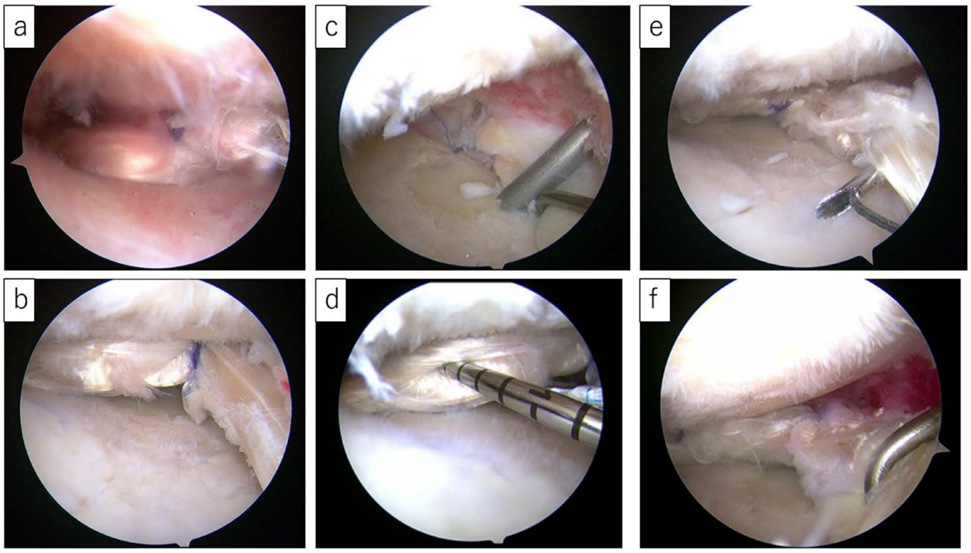

Figure 2: Arthroscopic meniscal reconstruction with the semitendinosus tendon:

a) The graft is guided to the posterior tunnel and fixed with a pull-out technique; b) The center of the grafted tendon is marked with 3-0 Vicryl Plus; c) The middle-to-posterior segment is sutured using the all-inside technique with Fast-fix; d) FiberTak®anchor and the graft are fixed in the required position during the centralization procedure; e) FiberTak®anchor and the graft are fixed in the required position during the centralization procedure; f) Reconstruction of the medial meniscus.

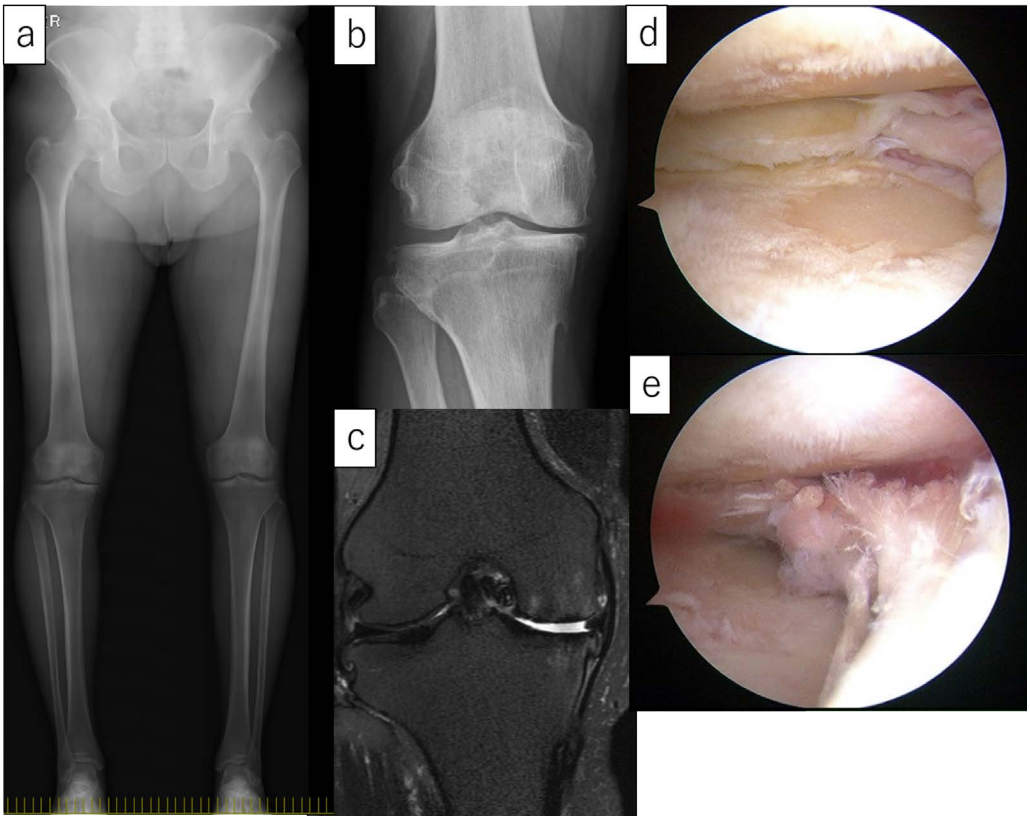

Figure 3: a) Standing radiograph of the lower extremity; b) Standing radiograph of the right knee; c) Coronal view on magnetic resonance imaging; d) Arthroscopic view of the medial compartment prior to and post meniscal reconstruction; e) Arthroscopic view of the medial compartment prior to and post meniscal reconstruction.

Table 1: The clinical outcome was assessed using knee function score preoperatively and 1 year after operation (Lysholm score, Japanese Orthopaedic Association score and Knee injury and Osteoarthritis Outcome Score).

	Pre-op	Pre-op 1 year
Lysholm score	38	85
Japanese Orthopaedic Association score	65	95
KOOS score		
Symptoms	50	71.4
Pain	44.4	77.8
Activity of daily life (ADL)	73.5	92.6
Quality of life (QOL)	35	45
Sports and recreational activities (SP)	25	50

Results

The postoperative HKA angle was -1.6°; %MA, 53.6%; and MTPA, 94.0°. The clinical outcome was assessed using the Lysholm Knee score, Japanese Orthopaedic Association (JOA) score and Knee injury and Osteoarthritis Outcome Score (KOOS) that include 5 sub groups: symptoms, pain, activity of daily life (ADL), quality of life (QOL), and sports and recreational activities (SP). The Lysholm knee score, JOA score and KOOS scores 1 year after the operation improved: The results were shown in (Table 1). The range of motion 1 year after operation was observed to be 0° in extension and 130° in flexion.

Discussion

Fujisawa, et al. Defined the optimal alignment as 62.5% of mechanical axis (Fujisawa's point) after closed wedge HTO, and it has been used as a measure of correction for high tibial osteotomy for many year [6]. El-Azab HM, et al. Reported that the clinical results of undercorrection group (<50%: Mechanical axis) was significantly lower than that of overcorrection group (>70%: Mechanical axis) [2]. Lee SJ, et al. reported that IKDC score of under-correction group was significantly lowered than that of optimal and overcorrection groups [7]. They suggested that undercorrection had a negative influence on the outcome of OWHTO. As described above, in the past, there were many reports that recommended overcorrection rather than undercorrection. Akamatsu, et al. reported that patients with a postoperative MTPA greater than 95° had a lower KOOS sports sub scale that patients with a postoperative MTPA of 95° or less at 2 year postoperatively [8], and Nakayama, et al. reported that a MTPA of 95° or greater than 95° may induce detrimental stress to the articular cartilage [9]. La Prade RF, et al. reported the patients had alignment maintained at the 54% point at a mean of 3.6 years' follow-up, and this translated to substantial improvement in outcome scores [10]. Therefore, there is a tendency in recent years that the optimal postoperative alignment is less than that of previous reports and defined as % MA (Mechanical Axis) 50-60% and MTPA of 95°or less [1]. It is understandable that it is better to reduce the correction angle to achieve an anatomical alignment equivalent to that of a normal knee functionally, but the dilemma arises when we want to increase the correction angle in order to eliminate medial knee pain. Therefore, we focused on reconstructing the medial meniscus to reduce the correction angle, eliminate medial pain and reproduce a normal knee function, and performed the simultaneous surgery of OWHTO and meniscal reconstruction using the semitendinosus tendon.

The expected outcomes and advantages of this method are shown below: [1] The procedure is expected to replicate near-normal load distribution function and joint kinematics of the knee by reconstructing the medial meniscus; [2] The procedure could reduce the angle of correction by reproducing the meniscus function and the near-normal anatomical alignment of the knee; [3] DLO is performed in cases where the preoperative plan shows an MTPA > 95°. If it becomes possible to reduce the angle of correction by reconstructing medial meniscus, we will be able to deal with almost all patients by doing tibial osteotomy only. It is expected to improve clinical results if we do not have to do DFO because complication rate of DFO is much higher than that of HTO; [4] Patient satisfaction and clinical results are expected to improve for the reasons stated above.

However, surgical techniques are required and detailed preoperative planning is necessary, and the following points should be noted: [1] In patients with small skeletal structures, the proximal screw of the HTO plate may interfere with the posterior bone tunnel created for meniscus reconstruction. In patients needing simultaneous anterior cruciate ligament (ACL) reconstruction and OWHTO, the anterior screw is shortened to avoid interference with the tibial tunnel.This does not lead to decrease in the fixation force of the HTO plate. Likewise, interference between the proximal screw and the posterior bone tunnel can be dealt with by shortening the proximal posterior screw. Alternately, the plate can be placed slightly forward. Injury must be avoided to the popliteal nerve and the vessels due to the posterior placement of the screw (Figure 1a and Figure 1b); [2] There is a possibility of the external rotation of the distal tibia when correcting the alignment through harvesting ofthe semitendinosus tendon. This can be prevented by avoiding rotation of the distal tibia during plate fixation; [3] Graft failure may occur postoperatively. Rasping, drilling of the femur intercondylar wall, and augmentation with a fibrin clot would effectively promote engraftment of the tendon.

The functions of the medial meniscus include load distribution, ensuring joint conformity, joint stabilization, proprioception and etc [11,12]. The medial meniscus transmits about 50% of the load, and medial meniscectomy reduces the contact area of the femoral condyle by 50-70% and increases the contact pressure by 100% [3,13]. Thompson used five cadaveric knees to examine the amount of meniscus displacement in normal knees from 0° of knee extension to 120° of knee flexion [14]. They reported that the medial meniscus anterior segment was displaced 7.0 mm and the posterior segment was displaced 3.2 mm posteriorly. Musahl found that anterior tibial translation increased significantly (5.5 mm) after medial meniscectomy in the Lachman test (anterior loading of 68 N) in ACL-deficient knees [15]. As described above, the medial meniscus plays many important roles. Therefore, it remains to be investigated whether the reconstructed meniscus reproduces the same static and dynamic function as the normal meniscus.

Conclusions

The procedure we report may reduce the correction angle, thus, better reproducing the normal anatomical alignment and knee function compared to previous methods. In addition, improved patient satisfaction can be expected. This report will be the first step inreplicating normal knee function in patients with knee osteoarthritis.

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Competing Interests

None.

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