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Anterior cruciate ligament reconstruction with anterior closing wedge osteotomy for failed high tibial osteotomy—A case report

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ABSTRACT

BACKGROUND: Increased posterior tibial slope (PTS) is considered a risk factor for anterior cruciate ligament (ACL) injury. Previous studies revealed that medial opening wedge high tibial osteotomy (OWHTO) tends to increase PTS. However, knee instability from increased PTS is not a reported complication after OWHTO, and the treatment strategy is unclear.

METHODS: A 55-year-old woman who complained of left knee pain underwent OWHTO for early-stage medial compartment osteoarthritis by another doctor. After the first surgery, her left knee pain decreased; however, 1 year after OWHTO, she began to feel left knee instability, and the primary doctor consulted our clinic. Physical examination revealed a positive Lachman's test, and radiographs showed that PTS had increased from 8 degrees to 15 degrees. According to these findings, we diagnosed an aggravated symptomatic knee instability secondary to increased PTS after OWHTO. We then performed ACL reconstruction using the quadriceps tendon and tibial anterior closing wedge osteotomy (ACWO), which is a newly-developed technique to correct PTS for revision ACL reconstruction.

RESULTS: Postoperatively, PTS was corrected from 15 degrees to 7 degrees, and the patient's Lysholm score improved from 39 to 95, 1 year postoperatively.

CONCLUSIONS: ACL reconstruction with ACWO is a possible treatment option for the PTS-increased knee after OWHTO.

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1. Introduction

High tibial osteotomy (HTO) is an established treatment method for early stages of medial compartment osteoarthritis [1]. There are two main surgical techniques in HTO: lateral closing wedge and medial opening wedge techniques [2]. Surgeons should be familiar with their potential advantages and disadvantages. Recently, studies have reported that posterior tibial slope (PTS) increased after opening wedge HTO (OWHTO) [3–5]. A high-PTS knee is an adverse environment for the anterior cruciate ligament. Therefore, when performing HTO, especially in the anterior cruciate ligament (ACL)-deficient knee, sagittal alignment should be considered [4]. However, no reports state that anterior–posterior knee instability occurs after OWHTO, and the treatment strategy for such a case is still unknown. Anterior closing wedge osteotomy (ACWO) is a recently-reported new technique to correct PTS with ACL revision surgery [6–8]. This report presents a patient with an aggravated symptomatic knee instability with increased PTS after OWHTO treated by primary ACL reconstruction (ACLR) with anterior closing

wedge osteotomy. This paper has been reported in line with the SCARE criteria [9].

1.1. Presentation of case

The patient was a 55-year-old woman who complained of pain when walking upstairs. The patient had a history of twisting her knee, after which time, she walked during her activities of daily living, with no running. She didn't have any history of medication and comorbidity. She began to feel left knee pain during walking and saw another orthopaedic doctor who found tenderness at the patient's medial joint space. Lachman's test was positive, but giving way was not present at that time. Radiographs showed medial joint space narrowing, a hip–knee–ankle angle of 10-degrees varus, medial proximal tibial angle of 82 degrees, and a PTS of 8 degrees (Fig. 1a and b). Magnetic resonance imaging showed that the ACL was diminished (Fig. 2a). According to these findings, we diagnosed medial compartmental osteoarthritis of the knee. Medial OWHTO was performed by the primary doctor. After the first surgery, her left knee pain was diminished, and she could walk long distances without pain. However, 1 year after medial OWHTO, she began to feel left knee instability when stepping down stairs, and the primary doctor consulted our clinic. Physical examination revealed a range of motion of 0 degrees in knee extension and 130 degrees in flexion.

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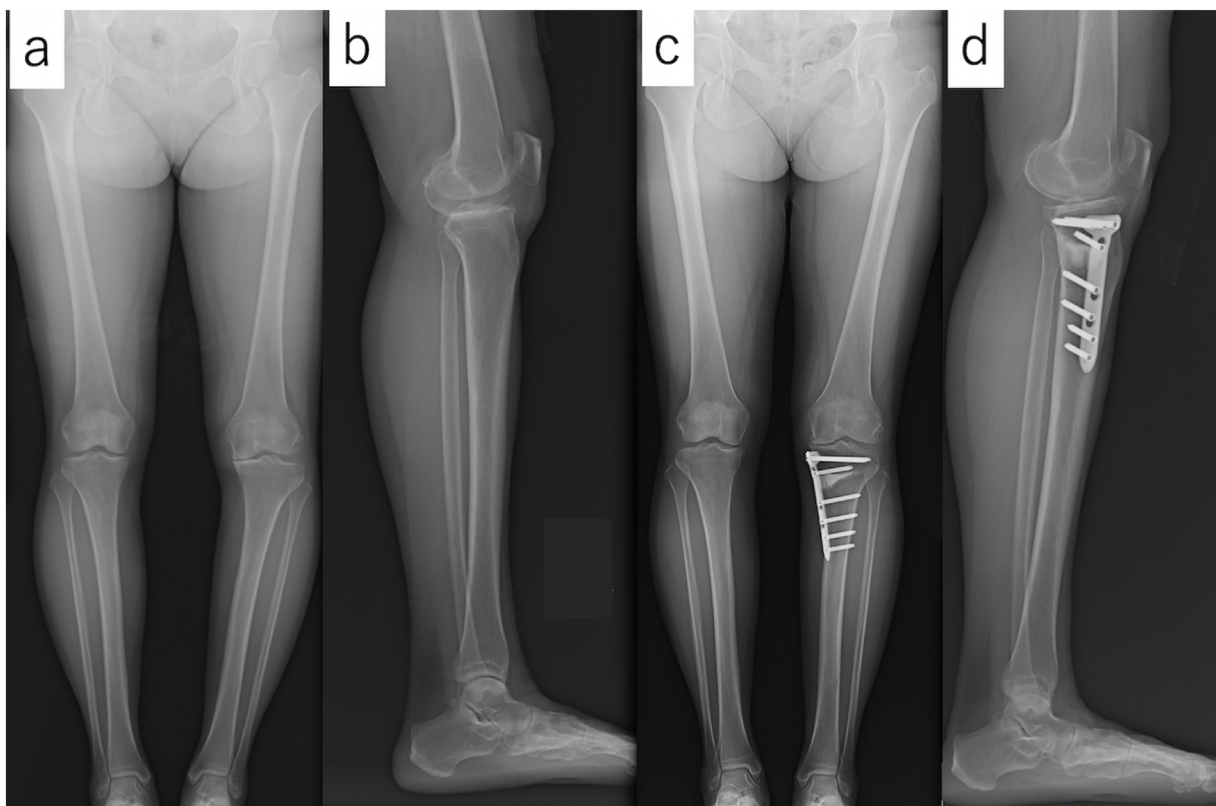


Fig. 1. Whole leg radiographs before (a,b) and after (c,d) the first surgery.

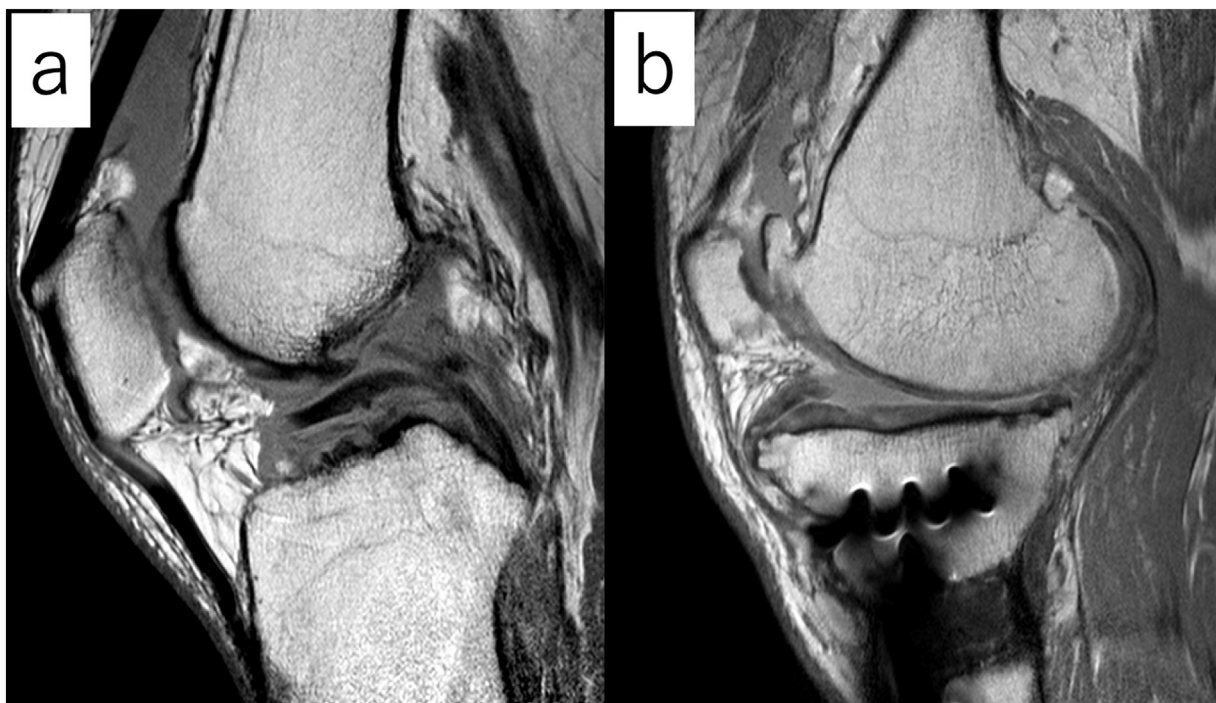


Fig. 2. Magnetic resonance imaging T1 sagittal view showed anterior cruciate ligament was diminished before the first surgery (a) and anterior translation of tibia after the first surgery (b).

There was no swelling and tenderness, but Lachman’s test was still positive. The side-to-side difference was 6 mm measured by a KT-2000 knee arthrometer (MEDmetric Corporation, San Diego, CA). Radiographs showed a hip–knee–ankle angle of 3-degrees valgus

and a medial proximal tibial angle of 94 degrees. PTS was increased to 15 degrees (Fig. 1c and d), and magnetic resonance imaging showed anterior translation of the tibia (Fig. 2b). According to these findings, we diagnosed an aggravated symptomatic knee instabil-

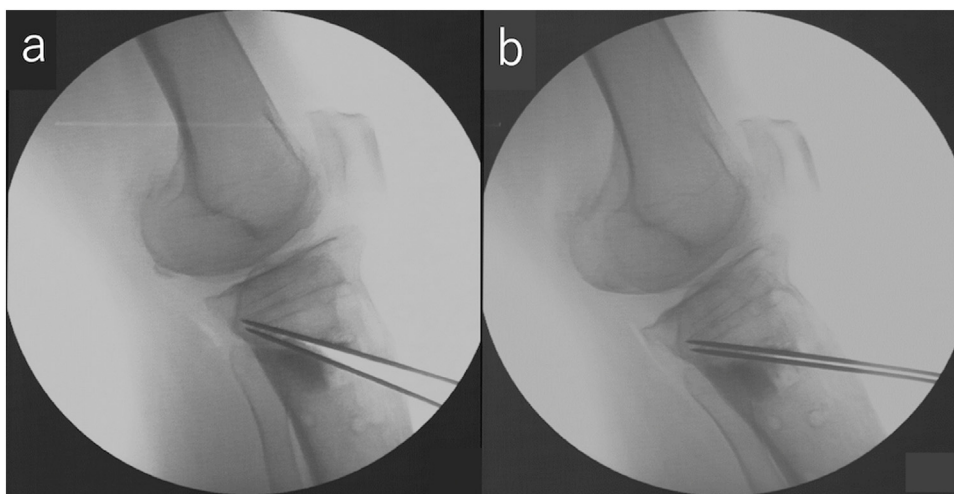


Fig. 3. Intraoperative fluoroscopic control of the K-wire insertion (a) and anterior bony segment resection (b).

ity secondary to increased PTS after OWHTO. ACL reconstruction using the quadriceps tendon and tibial ACWO were performed by an experienced surgeon in osteotomy and arthroscopic surgery for more than 15 years.

1.2. Surgical techniques

First, diagnostic arthroscopy was performed to evaluate other injuries. Regarding the arthroscopic findings, the ACL was diminished, which was consistent with preoperative findings. A degenerative medial meniscal tear was observed, and partial meniscectomy was performed. We then removed the plate via the previous skin incision on the medial side of the tibia. A quadriceps tendon graft was harvested, and tibial and femoral tunnels were drilled, as previously described [10]. An additional skin incision was made at the lateral side of the tibia to perform ACWO while maintaining sufficient distance from the medial incision. Osteotomy was performed below the tibial tuberosity in accordance with Hess and Peterson's report [8]. Based on the preoperative plan, we removed an 8-mm osseous wedge under fluoroscopic guidance (Fig. 3). The tibia was fixed using an angular stable plate (TriS Medial HTO Plate System; Olympus, Tokyo, Japan). The plate was placed relatively posterior to avoid the tibial graft tunnel and screw holes from the previous surgery.

The last step was graft passage and fixation. The graft was fixed to the femur with an Endobutton CL device (Smith and Nephew, Andover, MA) and to the tibia with Double Spike Plates (Smith and Nephew, Andover, MA) in 20° of knee flexion with 20 N of tension.

Postoperative rehabilitation began with range of motion exercise 1 week postoperatively. The patient's knees were supported by a brace for 1 week after surgery. Partial weight bearing was allowed at 1 week, and full weightbearing was allowed at 6 weeks.

1.3. Postoperative evaluation

One year after surgery, the patient's Lysholm score had improved from 39 to 95. Radiography showed that PTS was corrected from 15 degrees to 7 degrees (Fig. 4). The patient's chief complaint of knee instability was improved, and she could run for the first time in 30 years.

2. Discussion

The main finding of this study is that the newly-established technique, ACWO, was chosen as a salvage surgery after failed HTO.

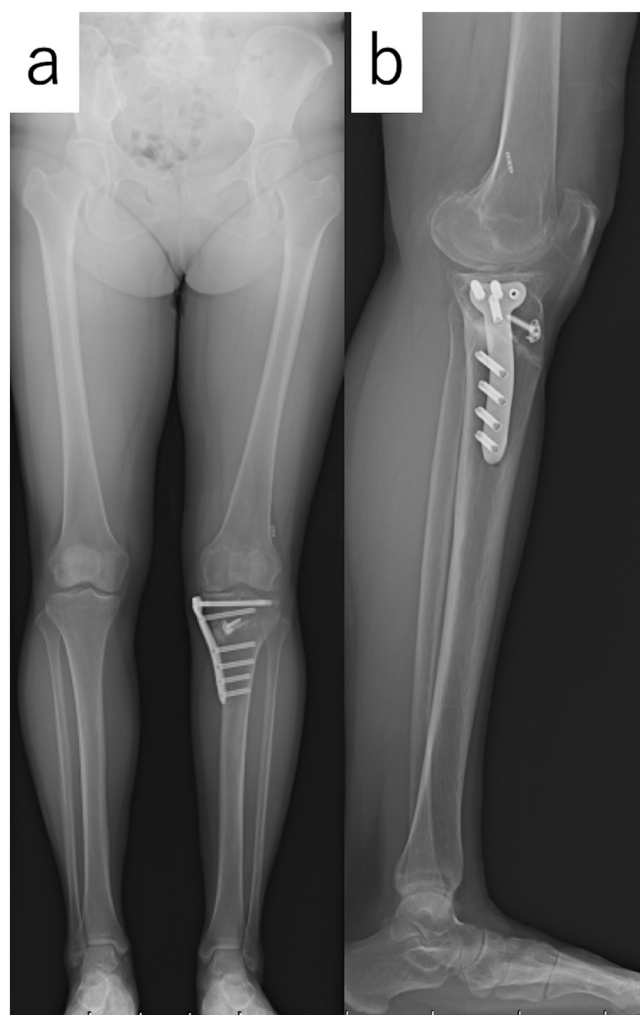


Fig. 4. Whole leg radiographs a year after anterior cruciate ligament reconstruction with anterior closing wedge osteotomy.

Recently, increased PTS has been considered a risk factor for both recurrent instability after ACLR and primary ACL injury [11,12]. Webb et al. reported that the likelihood of further ACL injury after ACLR was increased by a factor of five among patients with a PTS ≥ 12 degrees compared with patients with a PTS < 12 degrees

[13]. Christensen et al. also documented the odds ratio for graft failure stating that the odds ratio for a 2-degree increase in lateral PTS was 1.6, and that the odds ratio increased to 2.4 and 3.6 for 4 degree and 6 degree increases in the lateral PTS, respectively [14]. A high-PTS knee is an adverse environment for the ACL, and previous studies showed that OWHTO tends to increase PTS [3–5]. Lusting et al. discussed that this change was related to the location of the hinge of the lateral tibial cortex, but potential clinical consequences of tibial slope changes remained unknown [3]. Griffin reported, in his kinematic study, that an increase in PTS after OWHTO would shift the resting position of the tibia anteriorly relative to the femur [15]. Ranawat et al. compared the alignment kinematics between closing wedge and opening wedge HTO for ACL-sectioned cadaveric knees and reported that OWHTO showed inferior tibial slope correction and more anterior tibial translation [16]. In spite of these kinematic studies, the relationship of PTS to clinical and functional outcomes remains unclear. Symptomatic knee instability secondary to increased PTS was not reported as a complication after HTO [17,18]. Therefore, this may be a rare complication that may occur secondary to slope changes. The sagittal plane alignment is key and must not be overlooked, especially in the ACL-deficient knee [4,19,20]. In our patient, it might have been better to choose closing wedge osteotomy instead of the opening wedge technique at the first surgery. However, increasing numbers of surgeons prefer OWHTO because of its convenience. Patients such as ours do exist, and surgeons must be able to perform salvage surgery.

ACWO is a newly-developed technique to correct PTS for revision ACLR. Dejour et al. and Sonnery-Cottet et al. first described this novel technique [6,7], and Hess and Peterson modified the technique to avoid detaching the tibial tuberosity [8]. ACWO is indicated when PTS is greater than 12 degrees at the revision ACL surgery [6–8]. Our patient was not a case of recurrent instability after ACLR, but instead, a case of apparent instability after OWHTO. This situation would be a good indication for ACWO because the knee instability was evident after OWHTO, which increased the PTS and subsequent anterior tibial translation. Only Hess et al. advocated that ACWO was indicated for patients with PTS of > 15 degrees [8]. The definitive indications for ACWO for the primary ACL-deficient knee needs further clinical investigation. It is difficult to conclude the efficacy with just with 1 case. We should continue the technique to establish the efficacy for such cases.

3. Conclusion

ACLR with ACWO is one of the treatment options for the PTS-increased knee after OWHTO.

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Ethical approval

The paper is a case report, and therefore does not require ethics approval.

Consent

Informed consent has been obtained from the patient, and all identifying details have been omitted.

Author contribution

Kazuya Nishino: Conception and design. Drafting of the article.
Yusuke Hashimoto: Conception, and critical revision of the article for important intellectual content.
Yohei Nishida: Interpretation of data.
Hiroaki Nakamura: Conception and design, final approval of the article.
All authors read and approved the final manuscript.

Registration of research studies

Not applicable. No research study involved.

Guarantor

The guarantor of this article is Prof. Hiroaki Nakamura.

Provenance and peer review

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Declaration of Competing Interest

We wish to confirm that there are no conflicts of interest associated with this publication.

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