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CASE REPORT

Simultaneous medial closing wedge distal femoral varus osteotomy and double-bundle anterior cruciate ligament reconstruction in the symptomatic femoral valgus deformity: A case report

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Distal femoral varus osteotomy (DFVO) is a widely accepted surgical intervention for patients suffering from valgus malalignment related to knee joint disorders. It can be performed using two different techniques: the lateral opening wedge and medial closing wedge methods, which offer distinct approaches to achieve the desired correction. However, a systematic review has indicated that there is a lack of conclusive evidence supporting

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ABSTRACT

Distal femoral varus osteotomy (DFVO) is a widely recognized surgical procedure used to address valgus malalignment in patients with knee joint disorders. However, it still remains unclear whether anterior cruciate ligament (ACL) reconstruction can be performed in a single procedure along with DFVO. Herein, we present a 73-year-old female patient who developed lateral osteoarthritis of the knee with valgus alignment due to chronic ACL deficiency following a twisting injury during skiing. She was physiologically very active, and strongly demanded to return to sports. We performed a combined procedure involving a medial closing wedge DFVO using an anatomical locking plate, along with double-bundle ACL reconstruction. The postoperative radiograph confirmed successful correction of knee alignment, specifically achieving varus alignment with precise conformance of the anatomical plate to the medial contour of the distal femur following the osteotomy. The patient resumed her previous sports activities without experiencing knee pain. The operated knee demonstrated restored anterior stability, as indicated by negative Lachman test results, and regained full range of motion. Both the Knee Injury and Osteoarthritis Outcome Score and the 2011 Knee Society score demonstrated continuous postoperative improvements over the three-year follow-up period, indicating positive functional outcomes and joint preservation. To the best of our knowledge, this is the first case of medial closing wedge DFVO with anatomic double-bundle ACL reconstruction in the symptomatic femoral valgus deformity with chronic ACL deficiency in the literature.

Keywords: Anterior cruciate ligament, distal femoral varus osteotomy, double-bundle reconstruction, elderly, osteoarthritis, orthopedics, valgus knee.

the superiority of either the lateral opening wedge or medial closing wedge techniques in terms of outcomes.[1] Prior research has suggested that DFVO can be a beneficial adjunctive procedure for young patients who exhibit lateral meniscus deficiency, chronic medial collateral insufficiency, focal chondral defects in the lateral compartment, and patellofemoral instability.[2]

Recently, osteotomy around the knee such as high tibial osteotomy (HTO) with ligament reconstruction has been reported.[3-8] Moradi et al.[9] demonstrated that the simultaneous procedure of lateral closed-wedge distal femoral valgus osteotomy combined with anterior cruciate ligament (ACL) reconstruction was a viable option for addressing femoral varus knees characterized by medial anterior knee instability and osteoarthritis. In a recent study by Kii et al.,[10] the researchers examined the use of medial closing wedge DFVO combined with single-bundle ACL reconstruction for individuals with lateral tibiofemoral osteoarthritis, valgus knee alignment, and ACL deficiency. The authors specifically discussed the concern of potential interference between the femoral tunnel required for ACL reconstruction and the distal locking screws of a conventional locking plate.

Despite the favorable clinical outcomes reported after the DFVO procedure with the introduction of biplanar osteotomy using existing plates,[11] certain challenges persist, particularly in the Asian population, which is often characterized by smaller femurs. The conventional locking plate used for medial closing wedge DFVO presents several challenges, including: *(i)* the need for plate bending due to its straight shape, *(ii)* occasional misdirection of the distal screw, leading to interference within the osteotomized site, *(iii)* potential disruption of the medial patellofemoral ligament (MPFL), and *(iv)* difficulties in inserting proximal screws. To overcome these potential limitations, a newly designed locking plate has been introduced, specifically tailored for medial closing wedge DFVO, called the TriS medial DFO plate system (Olympus Terumo Biomaterials, Tokyo, Japan).[12]

In this article, we present a case treated with a technique that, to the best of our knowledge, has not been reported before in the literature: simultaneous medial closing wedge DFVO and double-bundle ACL reconstruction for symptomatic femoral valgus deformity.[13] The patient underwent medial closing wedge DFVO simultaneously with double-bundle ACL reconstruction.

CASE REPORT

A 73-year-old female patient was admitted to our clinic with knee pain and a sense of instability. At the age of 64, she experienced a knee injury while skiing. During her time as a university student, she underwent an open meniscectomy procedure on her right knee to address lateral meniscus issues. She was a basketball player and skier, and later took a job as a physical education teacher in a senior high school. Prior to the knee injury, the patient had a Tegner activity score of level 6.[14] After experiencing a twisting motion in her knee, the patient described a sensation of dislocation accompanied by knee pain, which resulted in her inability to stand up. She sought immediate medical attention at our affiliated hospital on the day of the injury. During the examination of her right knee, the presence of knee effusion was observed, and a positive Lachman test was performed, indicating the presence of anterior instability. Plain radiographs showed no fracture in the knee. She received conservative treatment with a soft knee brace. The knee instability and pain gradually subsided with conservative treatment. The patient, with a weight of 51 kg, height of 164 cm, and body mass index of 19 kg/m^2, visited our hospital nine years after her initial injury. She was experiencing a giving way sensation in daily life and during sports activities such as golf, skiing, and workouts at the gym. This sensation worsened after she fell on the stairs, resulting in a recurrence of severe pain. During physical examination, the following observations were made: articular swelling, normal range of knee motion, and a limp favoring the right side. Several tests were conducted on the right knee, including the anterior drawer test, Lachman test, pivot shift test, and McMurray test for the lateral meniscus, all of which yielded positive results. The hip joint showed no abnormalities, and there was no indication of leg length inequality. Radiographic images of the affected knee joint revealed a valgus alignment. Furthermore, evidence of osteoarthritis was present, with the lateral component graded as Kellgren-Lawrence Grade 3, the medial component as Grade 2, and the patellofemoral component as Grade 2 (Figure 1).[15] Measurements such as the hip-knee-ankle (HKA) angle, anatomical femorotibial angle (FTA), mechanical axis of the lower limb, mechanical lateral distal femoral angle (mLDFA), and medial proximal tibial angle (MPTA) were recorded to assess the alignment of the right lower limb. The recorded values were 5.0°, 169°, 67%, 83°, and 89°, respectively, as shown in Table I. A positive HKA angle value indicates valgus knee alignment, while a negative value indicates varus

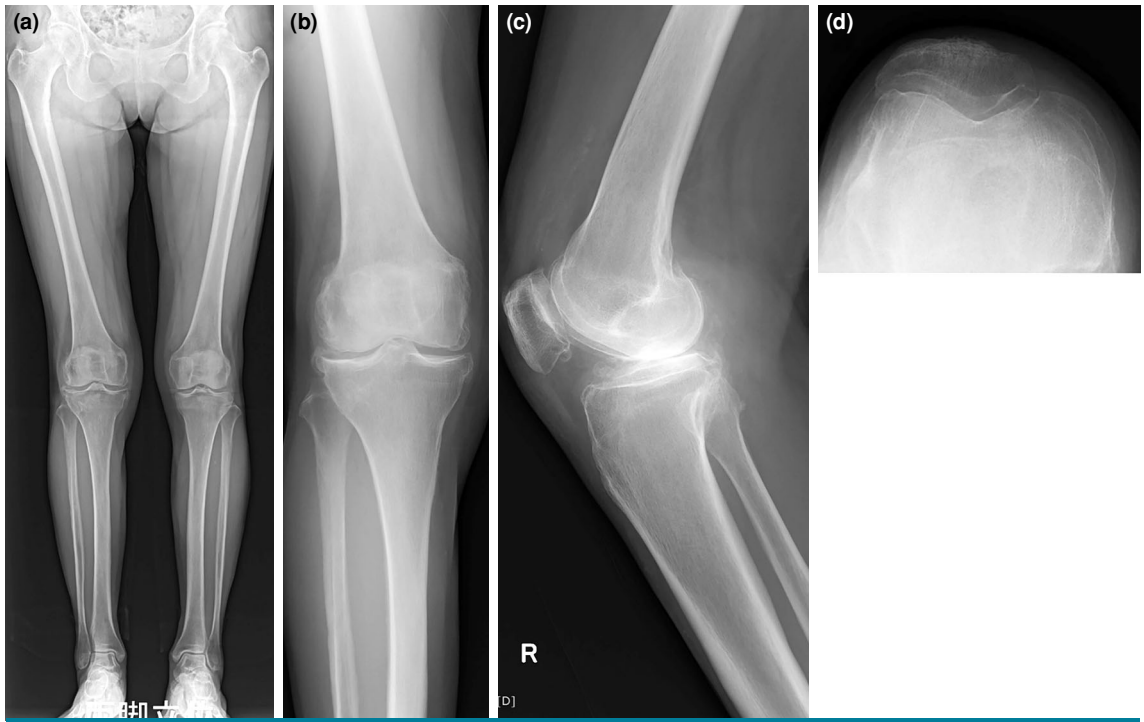

FIGURE 1. Plain radiographs before surgery. **(a)** Anteroposterior radiograph of the whole lower limb, **(b)** anteroposterior, **(c)** lateral radiographs of the knee, **(d)** skyline view.

knee alignment. Magnetic resonance imaging (MRI) of the right knee joint confirmed the following conditions: ACL insufficiency, degenerative tear of the lateral meniscus, and significant cartilage defects in the lateral femorotibial joint. However, no significant damage was observed in the articular surface of the medial femoral condyle or the medial meniscus, as shown in Figure 2. Based on these findings, the patient was diagnosed with secondary valgus knee osteoarthritis accompanied by chronic ACL deficiency.

Preoperative planning

Simultaneous medial closing wedge DFVO and double-bundle ACL reconstruction was selected for the following reasons. First, although her age was 73 years-old, she was physiologically very active, and an overall healthy woman. Despite presenting the options for knee arthroplasty, she strongly desired to return to sports (golf, skiing). Secondly, the affected lower limb exhibited valgus alignment. Based on the slightly below-normal range of the mLDFA and the normal range of the MPTA, the deformity primarily existed in the distal femur rather than the proximal tibia. This conclusion was drawn by considering the deviation of mLDFA from the normal range and the normal value of MPTA. It was also observed that the medial compartment of the knee was unaffected. Additionally, the patient experienced knee pain and anterior instability due to chronic ACL

TABLE I
Pre- and postoperative radiographic measurements

	Preoperative value	Postoperative value
Hip-knee-ankle	5.0°	-1°
Femorotibial angle	169°	175°
Mechanical axis	67%	41%
Mechanical lateral distal femoral angle	83°	90°
Medial proximal tibial angle	89°	N/A
Posterior tibial slope angle	11°	N/A

FIGURE 2. Magnetic resonance imaging (MRI) evaluation before surgery. **(a)** Coronal T2-weighted, **(b)** Sagittal T2-weighted MRI images of the right knee demonstrated lateral femorotibial osteoarthritis and anterior cruciate ligament deficiency.

deficiency. It is noteworthy that the coexistence of femoral tunnels required for double-bundle ACL reconstruction and distal locking screws can be achieved without interference using the recently developed TriS medial DFVO plate system (Olympus Terumo Biomaterials, Tokyo, Japan), a specific locking plate for medial closing wedge DFVO. After careful consideration, it was decided to perform medial closing wedge DFVO along with double-bundle ACL reconstruction to address the lateral loading. The correction aimed for a target mechanical axis of 42% and an HKA angle of –2°, with the mechanical axis intersecting the medial intercondylar eminence of the tibia, requiring a correction of 7°.

Operation

The patient was placed in a supine position on the operating table under general anesthesia. A pneumatic tourniquet was applied to the upper thigh to restrict blood flow. The surgical procedure began with an arthroscopic anatomic double-bundle ACL reconstruction using autografts obtained from the hamstring tendon. The transtibial tunnel technique was utilized following established protocols outlined in previous studies.[16] During graft preparation, the ipsilateral semitendinosus tendon that was harvested was divided into two halves and folded over. To securely fasten the unlooped end of the folded tendon, a commercially available polyester tape

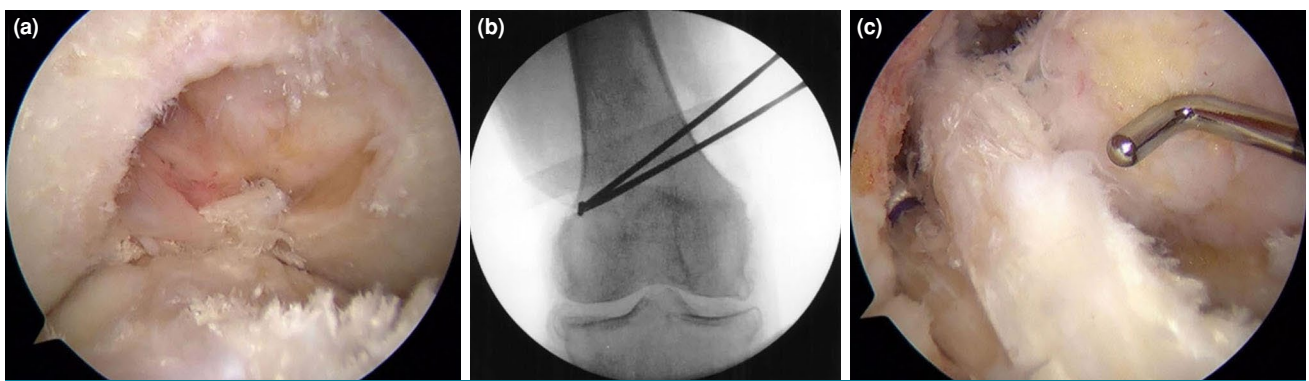

FIGURE 3. Fluoroscopy image and arthroscopic appearance during surgery. **(a)** Fluoroscopy images showing the osteotomy process, **(b)** Osteophyte around the femoral intercondylar notch and anterior cruciate ligament deficiency at time of surgery at 90° of knee flexion in arthroscopic view by use of lateral infrapatellar portal, **(c)** Two grafts transplanted across knee joint at time of surgery at 90° of knee flexion in arthroscopic view by use of lateral infrapatellar portal.

(Leeds-Keio Artificial Ligament; Neoligaments) was employed, utilizing a technique outlined in previous studies.[17,18] At the looped end, an Endobutton CL BTB (Smith & Nephew Inc, Memphis, TN, USA) was affixed.[19]

To address osteophytes around the femoral intercondylar notch, notchplasty was performed using a curved chisel and curette (Figure 3a). The reconstruction of the posterolateral (PL) bundle involved creating a tibial tunnel using a hole-in-one guide (Wire-navigator; Smith & Nephew Inc, Memphis, TN, USA). Similarly, the anteromedial (AM) bundle reconstruction began by inserting a guidewire in the same manner. Tibial tunnels were created using cannulated drills, with the AM and PL bundle grafts prepared to match diameters of 7 mm and 6 mm, respectively. For the femoral tunnels, a guidewire was drilled at the center of the femoral attachment of the AM bundle through the AM tibial tunnel, using an offset guide (Transtibial Femoral ACL Drill Guide; Arthrex). Likewise, a guidewire was inserted at the center of the PL bundle attachment on the femur through the PL tibial tunnel. Cannulated drills were used to create separate sockets for the AM and PL bundles. Following the creation of graft tunnel for ACL reconstruction, a medial closing wedge DFVO procedure was performed through a 7-cm AM longitudinal skin incision, adhering to established protocols described in previous studies.[12,20] A longitudinal incision was made on the muscle sheath of the vastus medialis oblique (VMO), and the VMO was anteriorly retracted from the femur. Precise dissection of the periosteum at the osteotomy site was carried out using a raspatory and a curved elevator, addressing both the anterior and posterior aspects of the femur. To ensure the safety of the neurovascular structures, a radiolucent retractor (Olympus Terumo Biomaterials, Tokyo, Japan) was inserted between the femur and the detached posterior structures.

The VMO attachment site on the medial patella was used to locate the MPFL and expose the anterior, medial, and posterior aspects of the distal femur at the osteotomy site. The DFVO was performed using an ascending biplanar technique under fluoroscopic guidance. A guidewire was inserted at the lateral hinge point, which was determined based on the anterior-posterior fluoroscopic image and positioned in the lateral-proximal area of the lateral femoral condyle. To ensure accurate execution of the osteotomy, a protractor-installed wedge cutting guide was utilized, set at a transverse osteotomy angle of 7°, provided by Olympus Terumo Biomaterials (Tokyo, Japan).[21] Two guidewires were inserted, starting 4 cm proximal to the medial epicondyle and directed toward the lateral hinge point. Two additional guidewires were inserted distally to the proximal guidewires using the wedge cutting guide. An ascending cut was made, starting 10 mm below the anterior aspect of the femur and following the extension line of the distal guidewires (Figure 3b). Proximally, a 20° anterior angle cut relative to the femoral shaft was performed using a thin oscillating saw and chisel. A transverse cut was made along the guidewires, and the bone block was removed. The wedged osteotomy site was, then, carefully closed. Fluoroscopic guidance was used to confirm that the mechanical axis of the corrected knee intersected the medial intercondylar eminence of the tibia, aligning with the preoperative plan. The Tris medial DFO plate system, an anatomical locking plate provided by Olympus Terumo Biomaterials (Tokyo, Japan), was utilized for fixation while ensuring no interference with the MPFL. The conventional square-shaped head plate interfered with the MPFL over a large contact area. In contrast, new medial DFO plate have diamond-shaped head, which decreases the contact area.[12] The distal locking screws were inserted in an anterodistal direction to avoid interference with the femoral tunnels. Four locking screws were inserted into the distal femoral condyle, and four bicortical screws were inserted into the femoral shaft to enhance stability after applying compression force to the wedged osteotomy surface. The PL bundle graft was threaded through the PL tibial tunnel and passed to the femoral tunnel using a passing pin. Similarly, the AM bundle graft was introduced through the AM tibial tunnel and passed to the femoral tunnel following the same procedure (Figure 3c). Although the transverse osteotomy line of the DFVO intersected the femoral AM tunnel, the tunnel bending angle was sufficiently small for the AM bundle graft to smoothly pass through the femoral tunnel after the varus correction achieved by the DFVO. Tensiometers were utilized to tension each graft to 30 N (Yufu Itonaga Co., Ltd., Tokyo, Japan) at 10° of knee flexion, ensuring secure fixation for both grafts.[22] After passing the tape portions attached to the tibia, they were firmly secured using two spiked staples in a turn-buckle fashion, providing a secure fixation. The total duration of the operation was 129 min.

Postoperative course

After a two-week period of immobilization with a soft knee brace, the patient began continuous passive motion exercises. At four weeks post-surgery, partial weight-bearing was allowed, progressing to full weight-bearing at six weeks. A postoperative

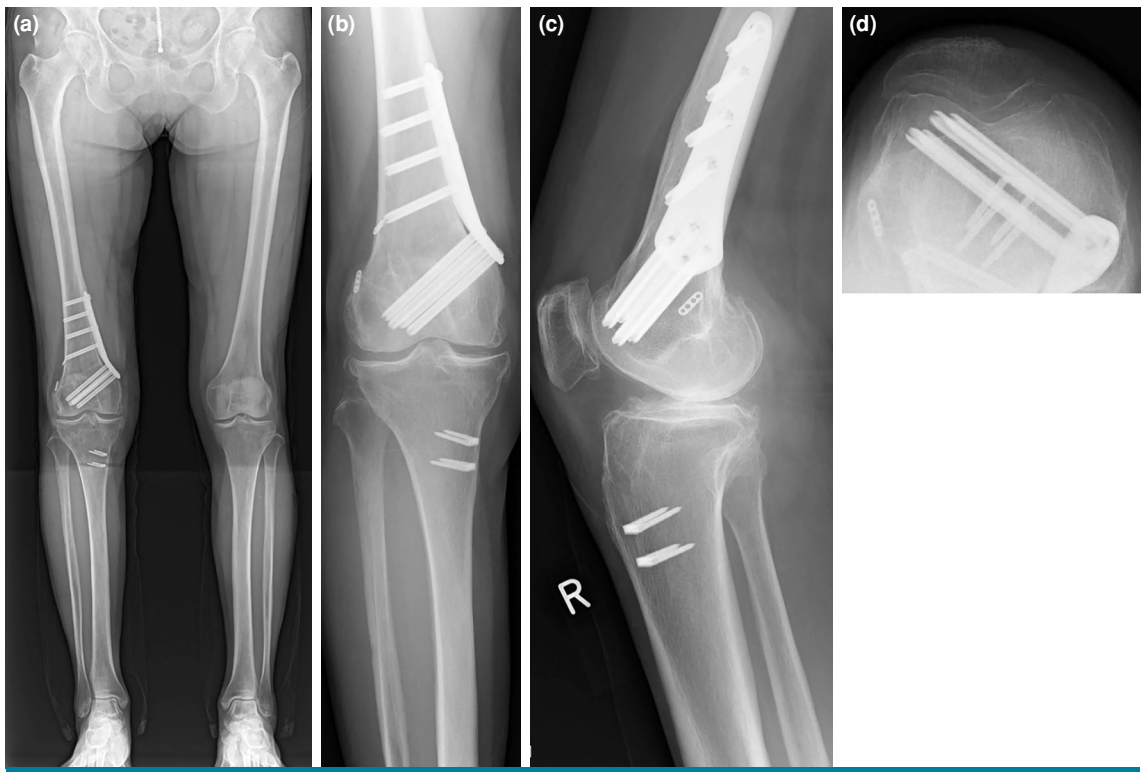

FIGURE 4. Plain radiographs at three years after surgery. **(a)** Anteroposterior radiograph of the whole lower limb, **(b)** Anteroposterior, **(c)** Lateral radiographs of the knee, **(d)** Skyline view.

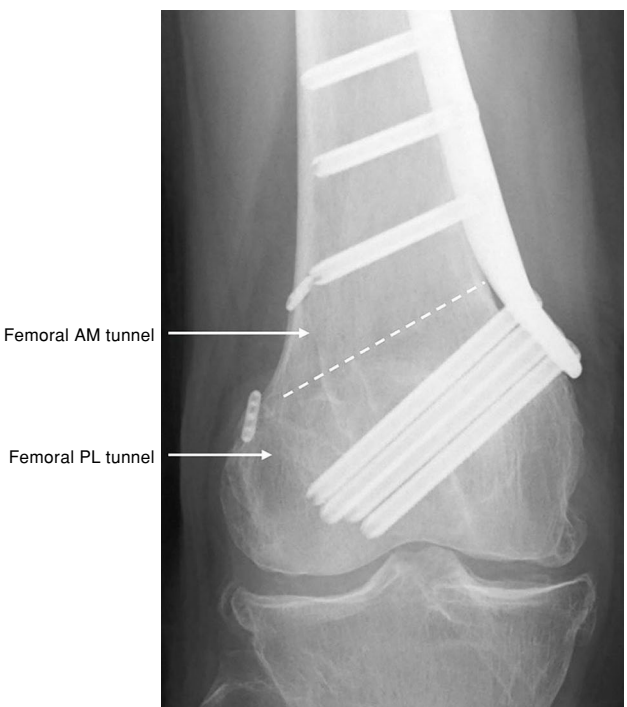

FIGURE 5. Anteroposterior radiograph of the knee after surgery showed femoral AM and PL tunnels and osteotomy line (dotted line).
AM: Anteromedial; PL: Posterolateral.

radiograph confirmed successful correction of varus alignment, with the anatomical plate fitting the contour of the osteotomized distal femur. Measurements of HKA angle, FTA, mechanical axis, and mLDFA were recorded as –1°, 175°, 41%, and 90°, respectively. A computed tomography scan conducted three months later confirmed bone union at the osteotomy site. At the three-year follow-up, the patient had a full range of knee motion, no instability sensations, and negative results on the Lachman and pivot-shift tests, indicating stability. Anterior laxity measurement under a specific force showed a side-to-side difference of 1.76 mm. The patient reported no pain related to the plate and had no limitations in daily activities or sports participation. Radiological examination three years post-surgery showed no loss of correction (Figures 4 and 5). The MRI imaging revealed successful transplantation of both the AM and PL bundle grafts across the knee joint (Figure 6). The functional knee score, assessed by the Japanese Orthopaedic Association score,[23,24] and the Lysholm score[25] showed significant improvement, with scores increasing from 70 to 100 points and from 49 to 100 points, respectively. The objective

FIGURE 6. Magnetic resonance imaging (MRI) evaluation at two years after surgery. **(a)** Coronal T2-weighted, **(b)** Sagittal T2-weighted MRI images of the right knee demonstrated two grafts transplanted across knee joint (yellow arrowheads).

International Knee Documentation Committee (IKDC)[26] was determined as Grade A. Knee Injury and Osteoarthritis Outcome Score (KOOS)[27] showed continuous improvement throughout the three-year postoperative period. While comparing the preoperative and latest follow-up scores, there was significant improvement observed in the Pain, Symptoms, Activities of Daily Living, Function in Sport and Recreation, and Knee-related Quality of Life subscales of the score. The scores increased from 32 to 93 points for pain, 44 to 100 for symptoms, 74 to 99 for activities of daily living, 40 to 100 for function in sport and recreation, and 50 to 100 for knee-related quality of life. In the 2011 Knee Society score[28] comparing preoperative and the latest follow up, improvements were also observed in the symptoms, patient satisfaction, patient expectation, and functional activities scores. The scores increased from 6 to 20 points for symptoms, 8 to 40 for patient satisfaction, 12 to 15 for patient expectation, and 49 to 100 for functional activities.

DISCUSSION

In this article, we present a case of a 73-year-old woman with lateral osteoarthritis of the knee, valgus deformity of the lower limb, and chronic ACL deficiency. To address her desire to return to physical activity, we performed a joint-preserving surgery consisting of medial closing wedge DFVO combined with double-bundle ACL reconstruction. It could be speculated that redistributing the load to the less affected medial compartment not only alleviated pain, but also restored stability.

Medial closing wedge DFVO has become a widely utilized procedure for addressing lateral-compartment osteoarthritis, particularly with the advancement of biplanar osteotomy techniques and the availability of specialized plates designed specifically for medial closing wedge DFVO.[11] The TriS medial DFVO plate is designed to address the altered shape of the distal femur after medial closing wedge DFVO. The larger head-shaft angle better accommodates the changed femoral anatomy, while the distally oriented screws allow for longer screw insertion. The diamond-shaped plate head prevents interference with the MPFL, and the ample space around the oblique osteotomy line facilitates the creation of a femoral tunnel during plate fixation. The use of a cannulated screw system overcomes challenges in screw insertion through the VMO, offering easy removal and reducing the risk of cross-threading. These design improvements not only enhance the ease and safety of the procedure, but also make it possible to perform simultaneous ACL reconstruction.

Previous studies have reported favorable clinical outcomes in medial closing wedge DFVO for lateral osteoarthritis while achieving alignment within the mechanical axis range of 35.9% to 42.6%.[29-31] In a study by Dewilde et al.,[32] the survivorship of lateral opening wedge DFVO was reported to be 82% in 19 knees at a seven-year follow-up. The study also observed an increasing trend in conversion to TKA in cases of under-correction. It is worth noting that correcting the alignment more toward varus can lead to increased medial load on the knee joint.[33,34]

In our case, we aimed to achieve a target alignment of the mechanical axis at 42% and HKA angle at -2° to mitigate the risk of developing further medial compartment osteoarthritis in our physically active patient.

In the past, ACL insufficiency was often regarded as a contraindication for performing HTO.[35] Recent literature suggests that patients with an ACL-deficient varus-angulated knee may not only require isolated HTO, but also an additional ACL reconstruction, either as a simultaneous or staged procedure.[36-42] The study conducted by Li et al.[42] examined the use of simultaneous HTO and ACL reconstruction as a salvage procedure for physically active young patients. The findings of the study demonstrated that this combined approach was successful in restoring anterior stability, reducing medial compartment osteoarthritis, improving subjective evaluations, and enabling patients to confidently return to recreational sports activities. According to the findings of a systematic review,[43] the available evidence suggests that one-stage HTO and ACL reconstruction is a safe and effective procedure for treating patients with symptomatic varus osteoarthritis and concurrent anterior knee instability. However, there is a discrepancy in the rate of anterior laxity. Lattermann and Jakob[6] reported a 31% rate of graft insufficiency in patients who underwent combined HTO and ACL reconstruction. Similarly, in a prospective study by Schuster et al.[39] involving 23 knees, although the mean subjective IKDC score improved at five years, four ACL grafts were found to be insufficient, and two grafts showed signs of degeneration. A study by Jin et al.[44] reported that simultaneous opening wedge HTO and ACL reconstruction in patients with ACL injury and medial compartmental osteoarthritis demonstrated satisfactory functional outcomes and postoperative activity level scores, according to studies. However, it is of utmost importance to note that, in some cases, residual instability and progression of osteoarthritis can still occur despite the combined procedure. Moradi et al.[9] reported that simultaneous lateral closing wedge DFO and ACL reconstruction are valuable procedures for addressing femoral varus knees with medial osteoarthritis and anterior knee instability. After a one-year follow-up, the study showed improvements in all aspects of knee function without any significant complications. Kii et al.[10] reported two cases of simultaneous medial closing wedge DFVO combined with single-bundle ACL reconstruction. The authors highlighted the importance of surgeons being mindful of the potential interference between the femoral tunnel of ACL reconstruction and the placement of distal locking screws. They faced difficulties in inserting long distal locking screws due to this interference. In their second case, which involved severe knee osteoarthritis, arthroscopy showed some laxity in the reconstructed ACL. While there are distinctions between medial closing wedge DFVO and HTO, the decision to perform simultaneous medial closing wedge DFVO and ACL reconstruction should be thoroughly evaluated, particularly in patients with severe knee osteoarthritis.

Several key issues were addressed in this case. When it comes to ACL reconstruction, the utilization of the anatomical double-bundle technique was deemed as the preferred approach for restoring normal knee function, as supported by studies.[16,45] There is an ongoing debate regarding the clinical effectiveness of anatomic double-bundle ACL reconstruction compared to conventional single-bundle reconstruction. In this case, an anatomic double-bundle ACL reconstruction technique was performed simultaneously with medial closing wedge DFVO using the TriS medial DFVO plate. This approach was chosen to address both ACL graft failure and knee joint instability. The TriS medial DFVO plate offers advancements that improve the ease and safety of the DFVO procedure while allowing for simultaneous anatomic double-bundle ACL reconstruction. This combined procedure provides several advantages, including enhanced knee stability, a quicker recovery, and the ability to return to daily activities and sports earlier. However, it is important to consider that this procedure may have a longer operation time and can be more invasive to the knee. Therefore, the surgeon must have not only technical skills, but also follow a systematic and careful approach, ensuring successful outcomes step by step.

Physical activity levels among older individuals have been on the rise due to increasing life expectancy.[46] Concerning ACL reconstruction, recent studies have reported favorable clinical outcomes and high patient satisfaction rates in patients aged 50 years and older who undergo a single-bundle procedure. These studies have suggested that the procedure can be performed with no significant increase in the risk of complications.[47-52] Osti et al.[49] reported that while considering ACL deficiency, factors such as physiological age, the condition of the knee at the time of examination, life expectancy, and physical activity level are likely more significant than just chronological age. These factors should

be taken into account while determining the most appropriate treatment approach for ACL deficiency in older individuals. Cinque et al.[52] reported that patients older than 50 years undergoing single-bundle ACL reconstruction achieved improved function and satisfaction comparable to the younger age group (20 to 30 years). Similarly, Nishio et al.[53] demonstrated no significant differences in postoperative outcomes between patients younger than 40 years and those older than 40 years after double-bundle ACL reconstruction. It is important to note in these reports that much of the literature is observational, with few prospective studies using young individuals as controls. The present case showed a good outcome in a 73-year-old woman, but the propriety of ACL reconstruction in the elderly needs to be further examined.

Regarding osteotomies around the knee, the International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine (ISAKOS) congress in 2005 defined the age range of ideal patients for HTO as 40 to 60 years.[54] However, Kohn et al.[55] and Goshima et al.[56] reported that age did not significantly influence the clinical outcome after HTO. Staubli et al.[57] developed the long locking plate to achieve optimal stability and maintain the correction. Their results indicated that there are no age restrictions for the procedure. In 2020, Japanese women had the longest life expectancy, with an average of 87.7 years of age (men: 81.6 years). The patient of this report was 73 years old. However, she has always been physiologically active, a healthy athlete, and she hoped to return to sports activity (golf, skiing). Therefore, we performed simultaneously medial closing wedge DFVO and double-bundle ACL reconstruction. The patient's three-year clinical results were favorable, with negative Lachman test indicating stability of the ACL reconstruction. The operated knee also demonstrated a full range of motion (ROM), allowing the patient to return to her previous level of sports activity without experiencing any knee pain. These outcomes indicate a successful surgical intervention and a successful rehabilitation process.

Nonetheless, this report has several limitations that should be acknowledged. First, the follow-up period was relatively short, with only a three-year duration. This may limit the ability to assess long-term outcomes and potential complications that could arise over a longer period. Second, the one-stage operation combining DFVO and ACL reconstruction is associated with a longer operation time, which may pose challenges in terms of surgical feasibility and patient tolerance. However, efforts were made to minimize the duration, and the operation was generally completed within approximately 2 h. Finally, there are concerns about the integrity and longevity of the ACL graft itself, particularly in cases of severe lateral knee osteoarthritis. The MRI findings suggesting differences in intensity between the ACL grafts and normal ACL raise the possibility of potential deterioration of the graft tissue over time. Further follow-up and evaluation are needed to assess the long-term stability and function of the ACL grafts in these cases.

In conclusion, the simultaneous procedure of medial closing wedge DFVO with double-bundle ACL reconstruction in patients with symptomatic femoral valgus deformity demonstrated favorable outcomes at the three-year follow-up. While further studies are necessary to assess the reproducibility and long-term efficacy of this surgical strategy, the results of this case suggest that it can be a viable treatment option for patients with these specific conditions. The simultaneous procedure of medial closing wedge DFVO with double-bundle ACL reconstruction could be successfully performed with a specifically designed anatomic plate using a delicate technique, and yield good results even in an elderly patient.

Patient Consent for Publication: A written informed consent was obtained from the patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design: E.K., R.N., H.N., T.A.; Control/supervision: M.M., E.K., K.I., N.I.; Data collection and/or processing: M.M., E.K.; Literature review: K.I., T.O., D.M.; Writing the article: M.M., E.K., R.N., H.N., T.A.; Critical review: T.O., N.I.

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