The Effect of the Medial Closing Wedge Distal Femoral Varus Osteotomy on the Patellofemoral Joint

Masanari Hamasaki[1], Eiji Kondo[1], Koji Yabuuchi, Koji Iwasaki[2], Yuki Suzuki[2], Masatake Matsuoka[1], Tomohiro Onodera[1], Masayuki Inoue[3], Kazunori Yasuda[4], Tomonori Yagi, Norimasa Iwasaki[2]
[1]Hokkaido University, [2]Hokkaido University School of Medicine, [3]NTT East Japan Sapporo Hospital, [4]Yagi Orthopaedic Hospital

INTRODUCTION: Distal femoral varus osteotomy (DFVO) is a well-described treatment option for patients with valgus malalignment associated with a broad range of knee disorders. DFVO can be performed with medial closing wedge (CW) or lateral opening wedge (OW) techniques. Systematic review reported that no evidence exists proving better results of either the medial CW or the lateral OW techniques. Previous studies reported that medial CW-DFVO (MCW-DFVO) may be a useful concomitant procedure in young patients with lateral meniscus deficiency, focal chondral defects in lateral compartment, chronic medial collateral insufficiency, and/or patellofemoral (PF) instability. Valgus malalignment affects PF tracking and may play a role in the treatment of patients with PF pain, chondral lesions, and PF instability. Valgus affects the Q angle via changes in the medial-lateral position of the tibial tuberosity. The more lateral the tibial tuberosity, the greater tendency of the patella to displace laterally during contraction of the quadriceps. MCW-DFVO reduces the Q angle and medializes the tibial tubercle, which unloads the PF compartment laterally and may improve patellar tracking, thereby decreasing PF pain and instability in select patients. However, change in PF joint congruity after MCW-DFVO remains unclear. The purpose of this study was to clinically and radiologically evaluate the changes of the PF joint congruity in MCW-DFVO.

METHODS: This study design had been accepted by the institutional review board clearance in our hospital. Twenty patients (23 knees) who underwent MCW-DFVO for lateral compartment osteoarthritis (OA) with valgus knee from June 2016 to May 2021 were enrolled prospectively in this study. There were 2 men and 18 women with a mean age of 42 years (range; 14 to 75 years) at the time of surgery. The indication for the MCW-DFVO procedure was symptomatic, isolated lateral compartment OA knees with valgus deformity. In surgical procedure, we performed a biplanar osteotomy of the distal femur. Then, the oblique osteotomy site was gradually closed. A locking plate was fixed to the medial side of the distal femur (Figure 1AB). After surgery, weight-bearing was permitted at 3 weeks after surgery. Clinical and radiological evaluations were performed in all cases before the surgery and at the final follow-up (range; 12 to 64 months). The clinical outcome scores included the functional knee score (Japanese Orthopedic Association (JOA) score) and the Lysholm score. The hip-knee-ankle angle (HKA), lateral femorotibial angle (FTA), mechanical axis, and mechanical lateral distal femoral angle (mLDFA) was measured on an anteroposterior weight bearing radiograph of a single leg, with the knee joint in extension. The mechanical axis was defined as the horizontal distance from the mechanical axis to the medial edge of the tibial plateau, divided by the width of the tibial plateau. The patella height was evaluated by the Caton-Deschamps (CD) ratio on lateral radiograph. The radiological Q-angle was measured as the acute angle between the line connecting the spina iliac anterior superior and the center of the patella and the line from the tibial tuberosity to the center of the patella. PF joint congruity was evaluated using the tilting angle and lateral shift ratio on axial radiographs (Figure 1CD). The femoral anteversion was measured as torsional angle of the femur between the line drawn parallel to the posterior femoral condyles and the line drawn through the center of the femoral neck on the oblique axial CT (Figure 1E). Finally, the rotation of the tibia relative to the femur was evaluated by the tibial tuberosity-trochlear groove (TT-TG) distance using CT (Figure 1F). Statistical analysis was made using a paired t test. The significance level was set at $p=0.05$.

RESULTS: The mean postoperative functional knee score and Lysholm score significantly improved at the final follow-up ($p<0.0001$ for each) (Table 1). The correction angle averaged 7.0° varus. Postoperatively, the mean HKA significantly changed from 6.0° to -2.0° ($p<0.0001$). The mean FTA significantly changed from 168.4° to 177.5° ($p<0.0001$). The mean mechanical axis was significantly corrected from 75.4% to 42.1% ($p<0.0001$). The mean mLDFA significantly changed from 82.3° to 89.3° ($p<0.0001$). Concerning the patella height, there were no significant differences in the CD ratio between pre- and post-operative periods (Table 2). The mean Q-angle was significantly decreased from 11.5° to 6.1° ($p<0.0001$). Regarding the PF joint, the mean tilting angle was significantly decreased from 7.4° to 5.4° after surgery ($p<0.0001$). The mean lateral shift ratio was significantly decreased from 18.2% to 13.9% ($p<0.0001$). The mean femoral anteversion was significantly decreased from 23.2° to 21.8° ($p<0.0001$). The mean TT-TG distance was significantly decreased from 14.6 mm to 12.8 mm ($p=0.0004$).

DISCUSSION AND CONCLUSION: This study clearly demonstrated that postoperative clinical scores significantly improved after MCW-DFVO. The valgus malalignment was significantly corrected to mild varus alignment. Regarding postoperative PF joint, the tilting angle was significantly decreased and the lateral shift ratio showed significant medial translation at the final follow-up compared with the preoperative value. The reduction of PF congruity suggested that this osteotomy might decrease the contact pressure on the lateral PF joint by decreasing the Q angle, TT-TG distance, and femoral anteversion. Recent clinical studies reported that DFVO is a suitable treatment for patellar instability and maltracking due to genu valgum. Our data suggest that MCW-DFVO effectively improved the congruity of the PF joint in valgus deformity.

Figure 1. (A, B) The anteroposterior radiograph before (A) and after (B) the MCWDFVO. (C) The tilting angle was defined as the angle between the line intersecting the widest bony structure of the patella and the line tangentially passing the anterior surface of the femoral condyles. (D) The lateral shift ratio was defined as the ratio of distances pp'/aa'. (E) The femoral anteversion was measured as torsional angle of the femur between the line drawn parallel to the posterior femoral condyles and the line drawn through the center of the femoral neck in the oblique axial view of CT. (F) The TT-TG distance was defined as the distance between the tibial tuberosity (a) and the trochlear groove (b) in the axial view of CT.

Table 1. Clinical and radiological evaluations.

	Pre-operative	Post-operative	*P value*
JOA score (points)	64.3 (14.6)	88.6 (5.5)	*<0.0001*
Lysholm score (points)	58.6 (19.7)	88.1 (5.8)	*<0.0001*
Correction angle (%)	N/A	7.1 (1.5)	
HKA (degree)	6.0 (4.6)	-2.0 (2.4)	*<0.0001*
FTA (degree)	168.4 (4.2)	177.5 (2.8)	*<0.0001*
Mechanical axis (%)	75.4 (10.2)	42.1 (8.7)	*<0.0001*
mLDFA (degree)	82.3 (3.1)	89.3 (3.8)	*<0.0001*

Mean (SD)

Table 2. Change in the patellofemoral joint congruity.

	Pre-operative	Post-operative	*P value*
CD ratio (%)	0.94 (0.25)	0.93 (0.22)	*NS*
Radiological Q-angle (degree)	11.5 (4.6)	6.1 (3.4)	*<0.0001*
Tilting angle (degree)	7.4 (4.3)	5.4 (3.3)	*<0.0001*
Lateral shift ratio (%)	18.2 (7.2)	13.9 (5.9)	*<0.0001*
Femoral anteversion (degree)	23.2 (13.7)	21.8 (12.6)	*<0.0001*
TT-TG distance (mm)	24.6 (12.8)	21.8 (13.2)	*0.0004*

Mean (SD) NS: No significant difference.