Medial Closing-Wedge Distal Femoral Varus Osteotomy via Lateral Approach: The New Surgical Technique for Treating Valgus Osteoarthritic Knee

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Research Article

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Abstract

Background and purpose: The medial closing-wedge distal femoral varus osteotomy (MCW-DFVO) was an excellent operation for painful valgus lateral unicompartmental osteoarthritic (OA) knee, especially in the young patient. Originally, it requires a medial approach that has more precarious. On top of that, releasing of the iliotibial band (ITB) that is the deforming force needs added incision. Therefore, this study aims to describe the new surgical technique of MCW-DFVO that uses a lateral approach and lateral plating to treat the valgus OA knee. Additionally, we also reveal the outcomes of our technique as the case series.

Materials and method: Ten patients (12 knees) who underwent MCW-DFVO via a lateral approach were retrospectively reviewed. The inclusion criteria were age > 18 years, isolated lateral compartmental OA knee, no significant patellofemoral pain, and ROM > 90 degrees. We excluded the inflammatory joint disease, unstable knee (femorotibial joint subluxation > 1 cm), and prior surgical procedure. Demographic data, pre- and postoperative ROM, radiographic outcomes, complications, and survivorship were recorded.

Results: The mean age, body mass index, and preoperative ROM were 55.3 ± 4.0 years, 25.4 ± 3.7 kg/m2and 113.3 ± 11.5 degrees, respectively. The preoperative valgus deformity was 162.3 ± 4.8 degrees, and the Final post-operative alignment was 182.3 ± 2.6 degrees. Overall mean operative time of this technique was 92.5 ± 26.7 minutes. During the follow-up period, post-operative ROM was decreased to 108.8 ± 11.7 degrees. One knee required plate removal due to hardware irritation, and another knee required subsequent total knee arthroplasty (TKA) at 1 and 8.5 years after DFVO, respectively. The survivorship of this technique was 91.7% at the mean survival time of 13.8 years (95% confidence interval, 11.9 – 15.7 years).

Conclusion: This study proposed the new surgical technique of MCW-DFVO via a lateral approach. This technique provided a satisfactory outcome and excellent survivorship. However, further research with a larger sample size was required.

Introduction

The distal femoral varus osteotomy (DFVO) was the ideal surgical treatment for fail conservative, painful valgus lateral unicompartmental osteoarthritic (OA) knee because it shifts the load from damage lateral compartment to the healthy medial compartment. In the case of valgus deformity, Matsuda et al. [1] found that the lateral femoral condyle was hypoplasia and was severely distorted compared to normal and varus OA knee. Previous investigators found that it provides better outcomes compared to the proximal tibial varus osteotomy [2,3]. Generally, DFVO is recommended for patients who have age < 60 years, isolated lateral compartmental OA knee, no significant patellofemoral pain, high demand activities, and a good range of motion (ROM) [4]. The contraindications include inflammatory joint disease and unstable knee (femorotibial joint subluxation > 1 cm) [5].

The surgical techniques of this procedure can be divided into three types; medial closing-wedge (MCW-DFVO), lateral opening-wedge (LOW-DFVO), and dome DFVO (D-DFVO). MCW-DFVO is a common and widely used technique proposed by McDermott et al. [6]. This technique offers a stable osteotomy site, needless to use the bone graft and good results [5,6]. However, MCW-DFVO has several limitations. Originally, it requires a medial approach that has more precarious. On top of that, releasing of the iliotibial band (ITB) that is the critical deforming force needs added incision [7]. Moreover, medial plating has not achieved a biomechanical benefit because it was applied at the adductor moment side, which cannot provide a tension band function [5].

Therefore, this study aims to describe the new surgical technique of MCW-DFVO that uses a lateral approach and lateral plating to treat the valgus OA knee. Additionally, we also reveal the outcomes of our technique as the case series.

Materials And Methods

Our institutional review board approved this study. Ten patients (12 knees) who underwent MCW-DFVO via a lateral approach were retrospectively reviewed. The inclusion criteria were age > 18 years, isolated lateral compartmental OA knee, no significant patellofemoral pain, and ROM > 90 degrees. We excluded the inflammatory joint disease, unstable knee (femorotibial joint subluxation > 1 cm), and prior surgical procedure. Demographic data, pre- and post-operative ROM, radiographic outcomes, complications, and survivorship were recorded. All procedures were performed in accordance with relevant guidelines.

Preoperative planning

The mechanical femorotibial angle (FTA) was measured to define the severity of valgus deformity based on bilateral full length standing alignment film. The preoperative mechanical axis was drawn from the center of the femoral head to the talus's center. It indicated where the weight passed through the knee. According to the method of Dugdale et al. [8], the final weight-bearing line was placed at a position 48-50% across the tibial plateau width from medial to lateral. The acceptable final alignment was 0-3 degree varus (180-183 degrees) of FTA [9]. The angle between the line from the center of the femoral head to the point of 48% across the tibial plateau width and the line from the center of talus to the point of 48% coordinate was measured and named radiographic correction angle. Then, the angle between the distal femoral joint line and the proximal tibial joint line was measured and called the condylar angle. This angle could be corrected by releasing ITB intraoperatively. Thus, the predetermined correction angle (ICA) was finally calculated from the radiographic correction angle minus the condylar angle.

The lateral and axial radiographs of the knee were also assessed for sagittal plane deformity and patellofemoral joint conditions. The Rosenberg view [10], a 45 degrees posteroanterior flexion weight-bearing radiograph at of knee, was additionally used to diagnosis the early OA in the posterior compartment of the knee.

Surgical technique

This surgical technique was established and performed by the senior author (KC). The patient was placed in a supine position on the radiolucent table. This procedure could be performed with or without using the sterile thigh tourniquet. A curvilinear incision was started from Gerdy’s tubercle and then along the lateral side of the femoral shaft. The incisional length was approximately 8-10 cm. ITB was identified and released from Gerdy’s tubercle(Figure 1A and 1B). Vastus lateralis muscle was detached from the intermuscular septum and retracted anteromedially to visualize the distal femur.

Under fluoroscopic exam, the Kirsch wires (K-wire) were inserted to guide the osteotomy cut. The first K-wire was inserted at the metaphysodiaphyseal junction of the lateral side of the distal femur that was proximal to the trochlear groove. Its direction was aimed parallel to the distal femoral joint line. The second K-wire was then inserted with an entry point just distal to the first K-wire. Using an intraoperative goniometer assisted, the direction of the second K-wire was planned to make the angle with the first K-wire equal to ICA. The final direction was confirmed by measuring ICA from a fluoroscopic image.(Figure 2A and 2B)

The Homann’s retractor was placed close to the medial cortex and retracted anteromedially to visualize the anterior cortex and protect the vascular structures. Another Homann’s retractor was placed close to the posterior cortex and retracted posteriorly to identify the distal femur's posterior cortex. Then, the osteotomy was performed along the first guided wire using an oscillating saw. The plane of the saw blade was set perpendicular to the lateral femoral shaft axis. The anterior, posterior, and lateral cortices were completely cut. The medial cortex's 5 mm thickness remained to reduce the risk of vascular injury and preserve the stability of the distal femur for the second osteotomy cut. The second osteotomy cut was done along the second K-wire with the remaining 5 mm thickness of the medial cortex.

In the correction of sagittal plane deformity, the angle setting between two osteotomy planes was crucial. Flexion contracture of the knee could be improved by cutting the second osteotomy with the posterior slope while genu recurvatum could be improved by cutting with anterior slope. After that, the two osteotomies were completely cut using the osteotome, and the cut bone wedge was removed. Without the lateral hinge, the distal femoral fragment could be freely moved and adjusted the position to reduce the geometric deformity of the distal femur—the final alignment in the desired FTA of 0-3 degree varus(Figure 3A, 3B and 3C). After satisfying, two divergent temporary K-wires fixation was done from the anterolateral part of the distal fragment to the posteromedial part of the proximal fragment. The entry points of these wires had not hindered the plate placement.(Figure 4A)

For the fixation technique, the 5-hole titanium distal femoral locking compression plate (DF-LCP, Synthes, Solothurn, Switzerland) was selected and bend into the contour of the distal femur. After creating the tunnel, DF-LCP was placed along the center of the lateral side of the distal femur.(Figure 4B) The most distal screw hole was placed just above the intercondylar notch. At least 4 locking screws were inserted into the distal fragments, while at least 3 locking screws were inserted into the proximal fragment via the stab skin incisions. The final alignment, plate, and screw positions were rechecked.(Figure 4C) At the end of the operation, a vacuum drain was placed along with the plate. The fascia sheath was then repaired. Subcutaneous tissue and skin were sutured. The non-compressive dressing was applied.

In the postoperative rehabilitation, isometric quad. riceps exercise and ankle pumping were started as soon as possible to prevent venous thromboembolism. The ROM exercise and walking with toe-touch weight-bearing was allowed in the first operative day. The drain was left in place for 48 hours. Partial weight-bearing was permitted beginning 2 weeks after surgery, and full weight-bearing was permitted after the radiographic union was observed.

Results

The patients' data were shown in Table 1. The mean age, body mass index, and preoperative ROM were 55.3 ± 4.0 years, 25.4 ± 3.7 kg/$m^2$and 113.3 ± 11.5 degrees, respectively. The preoperative valgus deformity was 162.3 ± 4.8 degrees, and the Final postoperative alignment was 182.3 ± 2.6 degrees. Overall mean operative time of this technique was 92.5 ± 26.7 minutes. During the follow-up period, postoperative ROM was decreased to 108.8 ± 11.7 degrees. One knee required plate removal due to hardware irritation, and another knee required subsequent total knee arthroplasty (TKA) at 1 and 8.5 years after DFVO, respectively. The survivorship of this technique was 91.7% at the mean survival time of 13.8 years (95% confidence interval, 11.9 – 15.7 years). The Kaplan-Meier curve was demonstrated in Figure 5.

Discussion

Our senior author (KC) proposed the unique surgical technique of MCW-DFVO via a lateral approach for treating isolated lateral compartmental OA knee. It contributed to good outcomes and survivorship. Our technique had the combined advantages of MCW-DFVO and lateral approach, including stable osteotomy site, unnecessary to use the bone graft, ability to release ITB for reducing the deforming and biomechanical-benefit lateral plating. Nevertheless, this technique still had technically demanded. Furthermore, complete osteotomy cut in our technique led to the loss of lateral hinge that affected in decreased stability. But the ability to adjust distal femoral fragment for reducing the geometric deformity was superseded.

Because a small number of patients were suitable for DFVO, most of the previous studies [9,12–22] were case series. We reviewed the previous literature of DFVO and demonstrated the outcomes in Table 2. From a systematic review of Saithna et al. [23], they found that survivorship of DFVO was 64% to 84% at 10 years. For the long-term outcomes of DFVO, Kosashvili et al. [16] reported that 48.5% of patients required subsequent total knee arthroplasty. While 30.3% and 21.2% of patients had good and poor functional outcomes, respectively. The mean follow-up time in their series was 15.1 years. Compare to our study, the novel technique provides excellent results. The survivorship of our technique was 91.7% at the mean survival time of 13.8 years (95% confidence interval, 11.9 – 15.7 years).

For the complications, a previous systematic review [23] reveals that the most common complications of overall DFVO were hardware irritation that required subsequent removal of the plate. The loss of correction angle was the problem after MCW-DFVO due to inadequate fixation or poor bone quality [13,24]. While LOW-DFVO had a higher incidence of delayed union or non-union of the osteotomy site that might be needed bone graft [9,19], our surgical technique could address these problems. However, hardware irritation still existed in our series.

There were several limitations to this study. First, the number of patients was minimal. However, we would like to demonstrate the new surgical technique in this series. In the future, we tried to collect more number of patients and reported the outcomes. Second, because this study was retrospective design, bias and confounder were difficult to control. Furthermore, we had no data about the functional outcome or activity level of the patients after surgery.

Conclusion

This study proposed the new surgical technique of MCW-DFVO via a lateral approach. This technique provided a satisfactory outcome and good survivorship. However, further study with a larger sample size was required.

Declarations

Compliance with Ethical standards

Ethical approval and consent to participate: This study included human participants. It had been approved by Siriraj Institutional (Si 226/2014 ID 221/2557 (EC2)). Informed consent was obtained from all individual participants included in the study. This study was approved by Siriraj Institutional Review Board (SIRB) and retrospectively registered at Thaiclinicaltrial.gov (TCTR202010427002).

Consent for publication: All authors have read and approved the final submitted manuscript.

Availability of data and material: Requests for data not shown in the body of this manuscript can be made to the corresponding author.

Competing Interest: The authors declare that they have no conflict of interest.

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Authors' contributions:

Chaturong Pornrattanamaneewonng, M.D.,M.Sc and Rapeepat Narkbunnam M.D. provided research questions, conducted data collection, analyzed data, discussion and developed the full manuscript. Pakpoom Ruangsomboon M.D. examined all data analysis, detailed the results, statistical calculation and collected and monitored data. Keerati Chareancholvanich M.D. also provided the research question and useful advice manuscript for journal publication.

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Tables

Table 1. Data of the patients

No.	Gender	Age (yr)	Side	BMI (kg/m^2)	Range of motion (°)		FTA (°)		Follow-up time (yr)	Complications
					Preop	Postop	Preop	Postop		
1	Female	59	Right	27.9	120	110	166	184	14.8	-
2	Male	47	Right	23.4	120	100	168	180	11.1	-
3	Female	59	Right	31.5	120	120	161	183	11.0	-
	Female	60	Left	31.4	120	120	159	183	10.2	-
4	Male	53	Right	24.0	120	120	163	185	6.3	-
5	Female	58	Right	26.8	110	120	160	179	7.8	-
6	Female	56	Right	19.1	90	90	156	186	8.5	Converse to TKA
	Female	57	Left	20.9	120	105	169	183	8.7	Plate removal
7	Female	54	Right	25.5	120	120	155	185	5.0	-
8	Male	49	Right	25.1	110	90	169	178	5.7	-
9	Female	54	Right	24.9	90	110	161	182	5.1	-
10	Female	57	Right	24.2	120	100	161	180	5.0	-

BMI: body mass index, FTA: femorotibial angle, TKA: total knee arthroplasty

Table 2. Previous studies and outcomes of distal femoral varus osteotomy (DFVO)

Authors	Year	n	Aimed final alignment	Implant	Follow-up time (mean, range)	Survivorship
Medial closing-wedge DFVO						
Finkelstein et al.	1996	21	0° FTA	Blade plate	133(97-240) mons	64% at 10 yrs
Stähelin et al.	2000	21	1-3° varus FTA	Semitubular plate	5(2-12) yrs	NA
Wang et al.	2005	30	0° FTA	Blade plate	99(61-169) mons	87% at 10 yrs
Backstein et al.	2007	40	0° FTA	Blade plate	123(39-245) mons	82% at 10 yrs
Omidi-Kashani et al.	2009	23	0° FTA	Blade plate	16.3(8-25) Mon	NA
Kosashvili et al.	2010	33	0° FTA	Blade plate	15.1(10-25) yrs	51.5% at 15.6 yrs
Lateral opening-wedge DFVO						
Das et al.	2008	12	3° valgus FTA	Puddu plate	74(51-89) mons	NA
Zarrouk et al.	2010	22	2-3° valgus FTA	Strelitzia type blade plate	54(36-132) mons	91% at 8 yrs
Jacobi et al.	2011	14	NA	Tomofix plate	45(26-64) mons	NA
Thein et al.	2012	7	0° FTA	Puddu plate	6.5 yrs	100% at 6.5 yrs
Dewilde et al.	2013	16	2° varus FTA	Puddu plate	68(31-127) mons	82% at 7 yrs
Saithna et al.	2014	21	0° FTA	Tomofix or Puddu plate	4.5(1.6-9.2) yrs	79% at 5 yrs

FTA: femorotibial angle, NA: not applicable

Figures

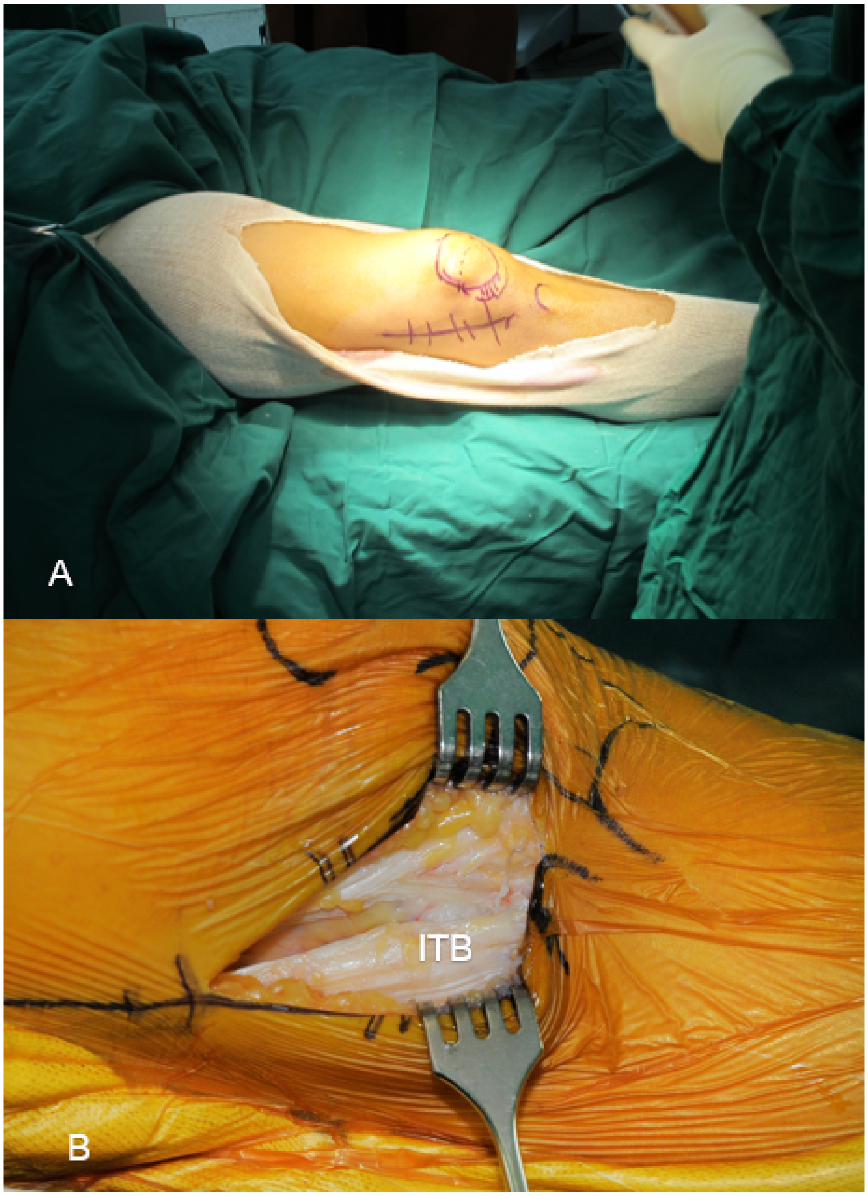

Figure 1

A. The patient was placed in a supine position on the radiolucent table. A curvilinear incision was started from Gerdy's tubercle and then along the lateral side of the femoral shaft. B. The incisional length was approximately 8-10 cm. ITB was identified and released from Gerdy's tubercle

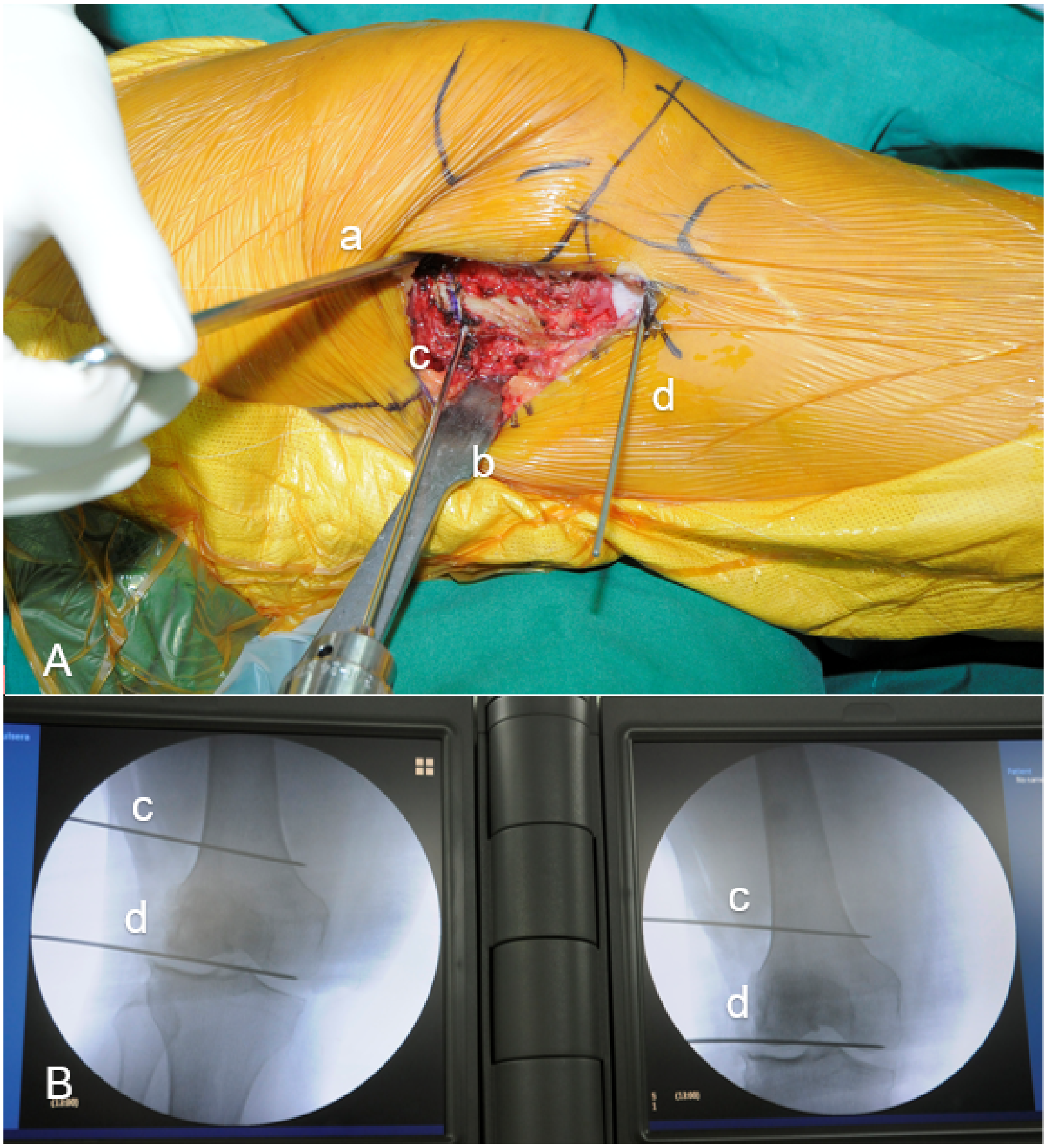

Figure 2

A. The Homann’s retractor (a) was placed close to the medial cortex. Another Homann’s retractor (b) was placed close to the posterior cortex and retracted posteriorly to identify the distal femur's posterior cortex. B. The fluoroscopic exam shjow the first K-wire (c) was inserted at the metaphysodiaphyseal junction of the lateral side of the distal femur that was proximal to the trochlear groove. The second K-wire (d) was then inserted with an entry point just distal to the first K-wire.

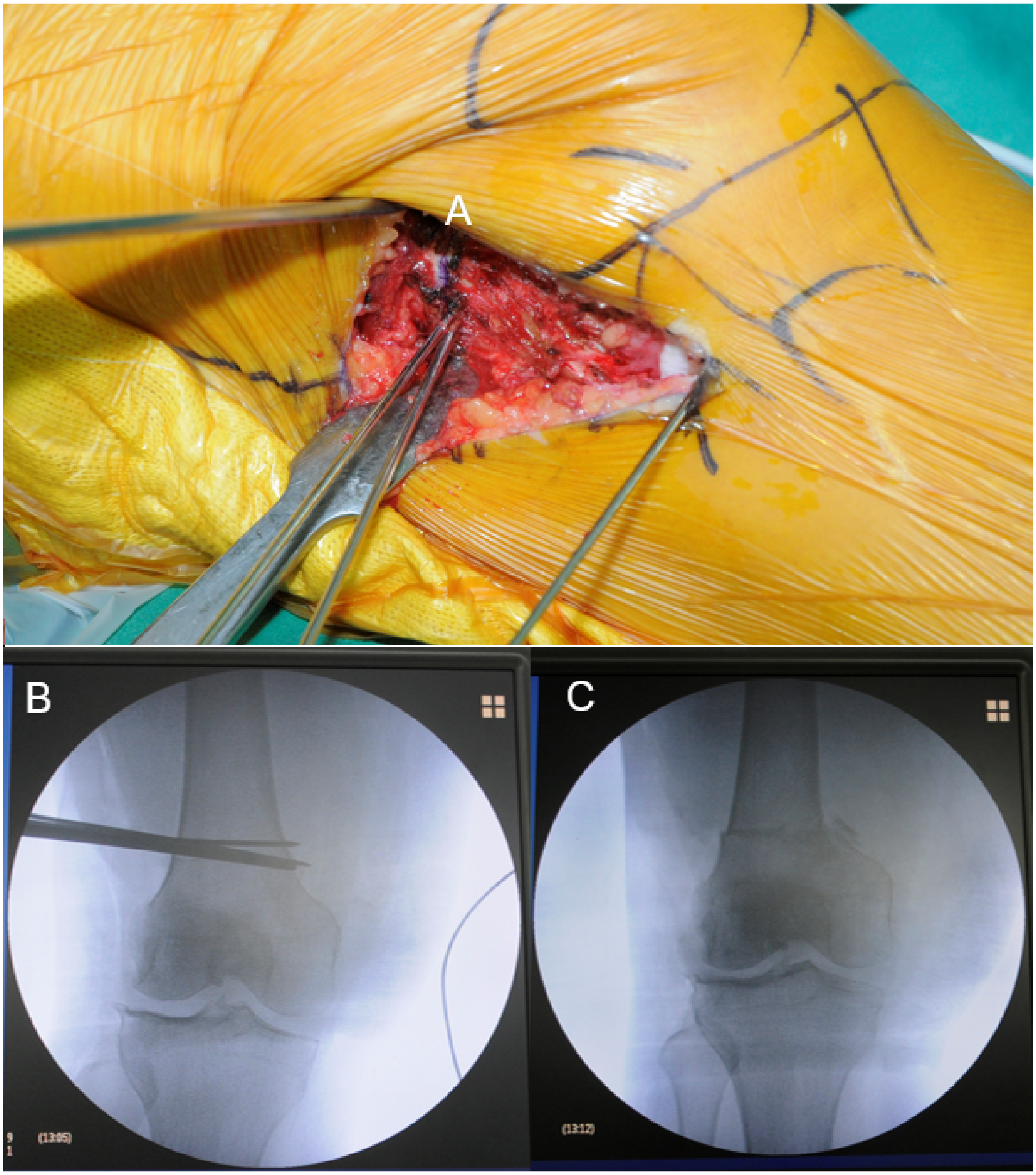

Figure 3

The osteotomy (A) was performed along the guided wire using an oscillating saw. After that, the two osteotomies were completely cut using the osteotome (B), and the cut bone wedge was removed. Without the lateral hinge, the distal femoral fragment could be freely moved and adjusted the position to reduce the geometric deformity of the distal femur (C).

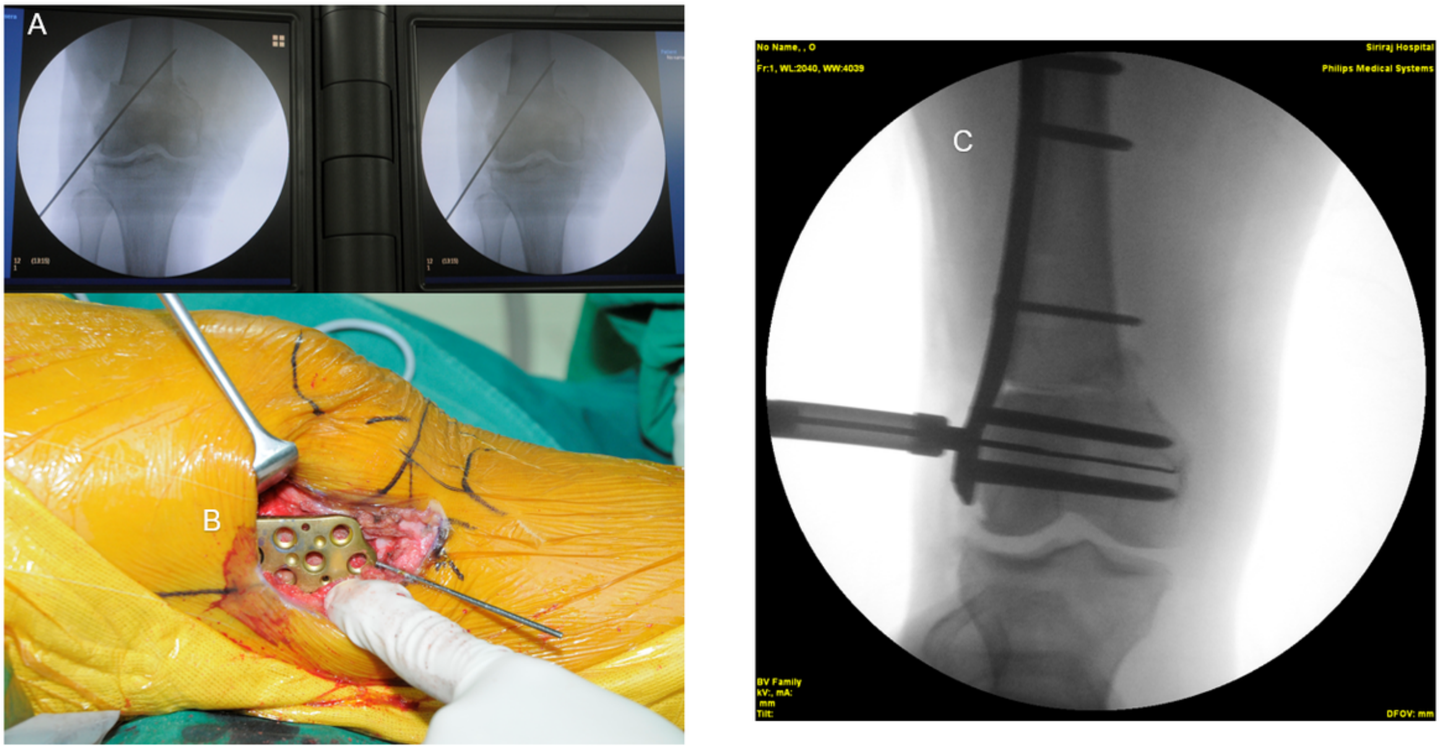

Figure 4

After satisfying, two divergent temporary K-wires fixation was done from the anterolateral part of the distal fragment to the posteromedial part of the proximal fragment (A). After creating the tunnel, DF-LCP was placed along the center of the lateral side of the distal femur (B). The final alignment, plate, and screw positions were rechecked (C).

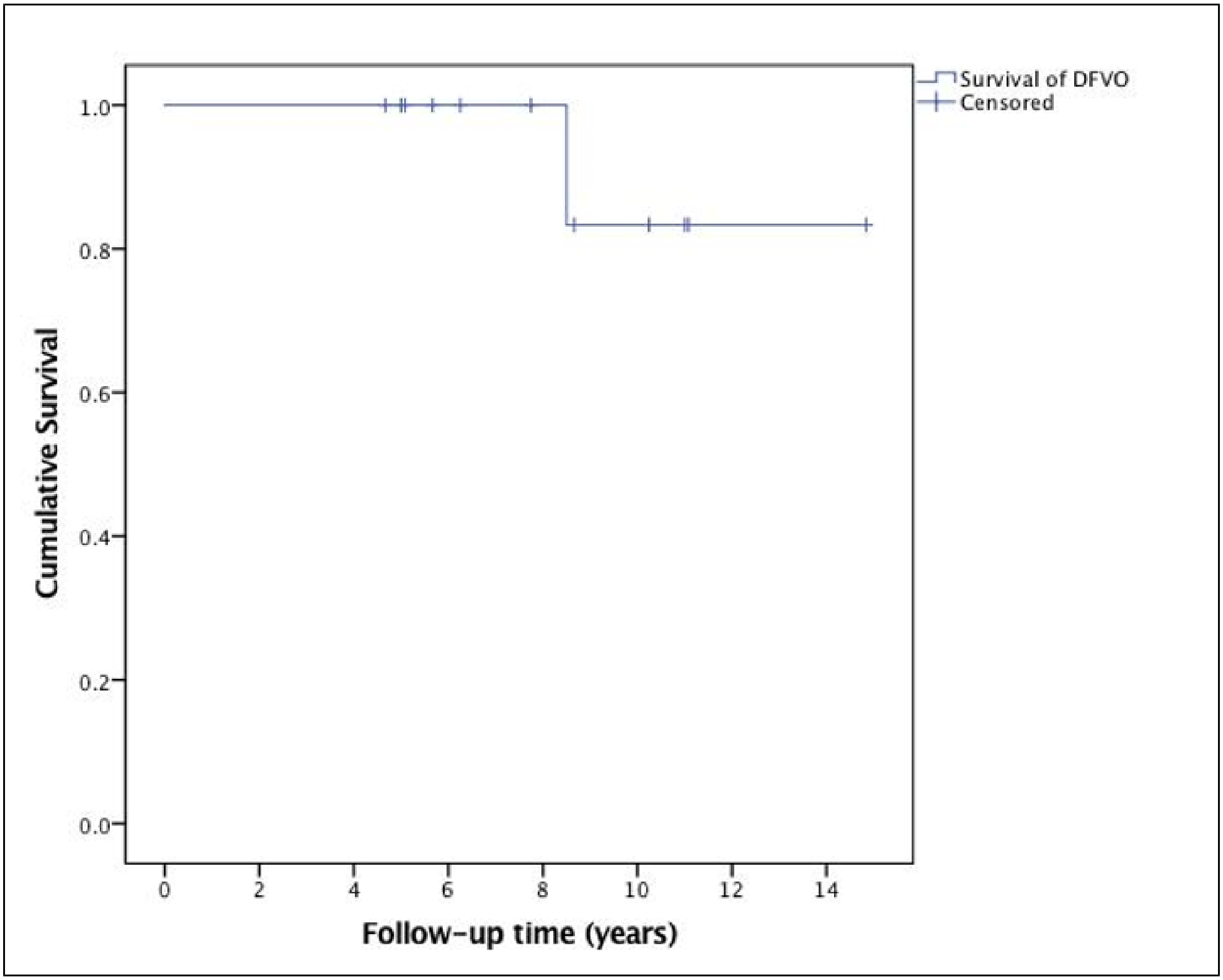

Figure 5

The Kaplan-Meier curve of the medial closing-wedge (MCW-DFVO) in the study.