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Original Research

Lateral opening wedge distal femoral osteotomy for symptomatic lateral compartment osteoarthritis: Survivorship and predictive factors at mean 10-year follow-up

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ABSTRACT

Introduction: Lateral opening wedge distal femoral osteotomy (LOWDFO) is a reliable joint-preserving surgical procedure for isolated lateral compartment knee osteoarthritis (OA) and overload in valgus knees.
The aim of this study was to evaluate the long-term survivorship and clinical outcomes of patients undergoing LOWDFO, and to identify the factors associated with conversion to total knee arthroplasty (TKA).
Methods: This was a retrospective study of prospectively collected patients who underwent LOWDFO for isolated lateral osteoarthritis and mechanical overload between 2003 and 2023. Clinical outcomes including the Knee Injury and Osteoarthritis Outcome Score (KOOS), the Veterans RAND-12 (VR-12) Physical and Mental scores, and the International Knee Documentation Committee subjective evaluation form (IKDC) were collected and analyzed. Radiographic parameters included hip-knee-ankle angle (HKA) and lateral distal femoral angle (LDFA). Post-operative complications and further reoperations during the follow-up period were recorded. Survivorship was from conversion to TKA and investigated using Kaplan–Meier curve. Logistic regression was used to identify factors associated with conversion, and p values < 0.05 were considered significant.
Results: A total of 48 patients (56% males, mean age 36.5 ± 11.3 years) were included for analysis. The complication rate was 35.4%, and the reoperation rate was 29.2% at a mean 10.1 ± 4.9-year follow-up. Removal of metal hardware due to pain and/or discomfort was the main cause of reoperation in 20.8% of the patients. The cumulative rate of conversion to TKA at 5 years was 7.0%, 10 years 15.0% and 15 years 29%. Older age was significantly associated with an odd ratio (OR) of 1.16 ($R^2_N = 0.31$; 95% CI: 1.03 to 1.30). The survival analysis showed that patients >45 years at the time of index surgery had an increased hazard ratio (HR) for conversion to TKA of 5.16 (95% CI: 1.32 to 10.10).
Conclusion: LOWDFO yields a 10-year cumulative survivorship of 85% in young patients with lateral compartment isolated knee OA and overload in valgus knees. Age at the time of index surgery is associated with an increased odds of conversion. Removal of metal hardware can affect one in five patients.
Level of evidence: IV.

What are the new findings?

- Varus producing lateral opening wedge distal femoral osteotomy (LOWDFO) showed a cumulative survivorship from total knee arthroplasty (TKA) conversion of 85% and 71% at 10 and 15 years of follow-up, respectively.
- Patients older than 45 years at surgery were associated with a 4-fold greater hazard ratio for conversion to TKA.
- Postoperative complications and reoperations rate was 35% and 29%, respectively, with the main cause of reoperation being pain syndrome related to the metal hardware.

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INTRODUCTION

The outcomes of total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA) in young and active patients affected by knee osteoarthritis can be inferior to those achieved in the older population [1,2], with a recorded revision rate of 8.2% and 17.3% at 10 years after total and unicompartmental knee arthroplasty [3]. Therefore, there is a renewed interest in joint preserving procedures that can delay the need for replacement surgery while providing satisfactory clinical outcomes [4,5].

Varus-producing lateral opening wedge distal femoral osteotomy (LOWDFO) is a widely accepted procedure for managing lateral compartment osteoarthritis (OA) and/or mechanical overload with lower limb valgus malalignment [6,7]. The objective is to improve symptoms while preserving the native knee and delaying or avoiding the need for joint replacement procedures. This is obtained by correcting the mechanical valgus to redistribute the weight-bearing forces and load from the compromised compartment to the healthy opposite one [8–11].

The biomechanical [12] and biological [13] effectiveness of LOWDFO have been described. However, there is still limited evidence on the long-term conversion rate to TKA and functional outcomes [8,14,15]. Predictive factors for failure after LOWDFO are yet to be clearly defined [16]. Furthermore, LOWDFO has been associated with relatively high complication and reoperation rates up to 30% [11], limiting its adoption for the management of knee OA to selected patients and surgeons.

This study aimed to evaluate the long-term conversion rate to TKA and clinical outcomes of patients undergoing LOWDFO at a single high-volume institution. In addition, we identified the factors associated with early LOWDFO failure as defined by conversion to TKA.

The main hypothesis was that LOWDFO was associated with low conversion rate to TKA and satisfactory clinical outcomes in patients affected by lateral OA and mechanical overload with valgus alignment.

METHODS

The study was performed in accordance with the ethical standards in the 1964 Declaration of Helsinki and with the Health Insurance Portability and Accountability Act (HIPAA) regulation. The Institutional Review Board (IRB) Human Research Ethics Committee approved the study protocol. Each patient provided written consent for participation in the study prior to enrollment.

A retrospective analysis of prospectively followed patients who underwent LOWDFO between January 2003 and December 2023 for primary isolated symptomatic lateral compartment knee osteoarthritis or mechanical overload with valgus alignment was performed. All surgical procedures were performed by three fellowship-trained, experienced knee surgeons at a high-volume institution.

The inclusion criteria for LOWDFO were patients >18 years of age with either symptomatic isolated lateral compartment primary knee OA (Kellgren–Lawrence grade 3 or 4) [17] or symptomatic lateral compartment overload with a magnetic resonance imaging (MRI) showing cartilage wear, long leg alignment X-ray showing femoral-related valgus malalignment (lateral distal femoral angle [LDFA]< 89°, medial proximal tibial angle [MPTA] < 91°) appropriate for correction, with associated knee pain that has failed conservative treatment. The exclusion criteria were symptomatic medial and/or patellofemoral OA, rheumatoid arthritis, inflammatory arthritis, history of septic arthritis, flexion range less than 100° or flexion contracture >20°, ligamentous instability, morbid obesity (body mass index [BMI] >40).

Prior to the knee osteotomy, a knee MRI and diagnostic arthroscopy were performed to ensure the osteoarthritis was limited to the lateral compartment. The medial and patellofemoral compartments were investigated for any injury and/or signs of osteoarthritis. The detected cartilage injury was categorized according to the International Cartilage Repair Society (ICRS) score [18].

Surgical procedure

The surgical technique has been previously described, and it was performed through a lateral incision [8]. Preoperative planning was performed on standing lower limb full-leg radiographs. The target opening gap was drawn from a correction planning aiming to achieve a postoperative hit-knee-ankle (HKA) angle of 0–2° varus.

Clinical assessment

The clinical assessment was performed preoperatively, and at 1 and 5 years follow-up using the Knee Injury and Osteoarthritis Outcome Score (KOOS), the Veterans RAND-12 (VR-12) Physical and Mental scores, and the International Knee Documentation Committee subjective evaluation form (IKDC). The range of motion (ROM) was measured using a manual goniometer.

Intraoperative and postoperative complications were recorded and collected. Delayed union was defined as a nonhealed osteotomy after 3 months, while a nonunion was defined as a nonhealed osteotomy after 9 months from surgery or failure of hardware.

Radiographic assessment

Radiographic analysis, including weight-bearing long-leg view and anteroposterior (AP) view, was performed preoperatively and at 6 months postoperatively to obtain the HKA angle and LDFA. All radiographs were taken with the patient in standing position with the knee in full extension and their body weight distributed evenly across both lower extremities. The weight-bearing line (WBL) was detected from the center of the femoral head to the middle point of the proximal talar joint surface. The WBL ratio was defined as the horizontal distance from the WBL to the medial edge of the tibial plateau, divided by the width of the tibial plateau. The joint-line convergence angle (JLCA) was defined as the angle formed by a tangential line between the femoral condyles and the tibial plateau. Two independent investigators performed the radiographic measurements. The interobserver reliability of the measurements was assessed using Cronbach's α coefficient.

Survivorship analysis

The survivorship analysis was conducted using the Kaplan–Meier curve. Failure was defined as conversion to TKA due to symptomatic progression of osteoarthritis. Survivorship of the DFO was obtained from patient-reported data, follow-up visits, and/or telephone interviews, and crossed-referenced with data from the Australian National Joint Replacement Registry. The length of the follow-up for survivorship was determined by the date of the conversion, whereas the clinical outcomes were based on the last follow-up visit, with a minimum of 6 months.

Statistical analysis

Data obtained preoperatively, 1 year after surgery, and at the most recent follow-up were subjected to statistical evaluation. Descriptive results were reported as mean, standard deviation (SD), and range. The normality of distributions was evaluated using the one-sample Kolmogorov–Smirnov test. Continuous variables were compared using the paired *t*-test or the independent samples *t*-test. Discrete variables were compared using the Chi-squared test or Fisher's exact test. Analysis of variance (ANOVA) was used to test the association of preoperative and postoperative continuous variables with the conversion to TKA. In case where data were not normally distributed or the sample size was too small to determine a normal distribution, the Kruskal–Wallis test for nonparametric data was used. The Kaplan–Meier survivorship curve was used to estimate the survivorship rate with a 95% confidence interval. Logistic regression analysis was used to verify the relationship between

survivorship and prognostic factors. All differences were defined as significant at p value < 0.05. All data were analyzed using Jamovi for Mac Version 2.3 (Sydney, Australia).

RESULTS

Between January 2003 and December 2023, 56 patients (56 knees) underwent a LOWDFO for isolated symptomatic moderate to advanced lateral compartment knee OA. Patients lost to follow-up were 8 (14.3%), leading to a clinical follow-up rate of 85.7% with 48 patients (48 knees; left: 20, 42%) included for analysis. The mean follow-up for survivorship was 10.1 ± 4.9 years (range, 0.5–18.7 years). Males were 56% of the patients (27 patients), and the mean age at the time of index surgery was 36.5 ± 11.3 years (range, 19–54 years). The mean BMI was 27.9 ± 4.9 kg/m^2 (Table 1).

Surgical details

Overall, allograft was used in 41 cases (85.4%), bone-graft substitute in 4 cases (8.3%), and missing surgical details on the type of graft were noted in 7 cases (14.6%). The mean osteotomy gap was 9.5 ± 2.4 mm (range, 5–15 mm). The mean osteotomy correction required was 8.8 ± 2.9 mm, while the mean osteotomy correction obtained was 8.2 ± 2.6 mm, yielding an accuracy of 95.3%. Navigation was used on 81.2% of the cases (39 of 48 knees) (Fig. 1).

Arthroscopic findings were available for 32 patients (out of 48, 66.7%) (Table 2).

Clinical and radiographic outcomes

The mean preoperative range of motion was 5.6 ± 6.7° of extension (flexion deformity) to 119.2 ± 9.5° of flexion. At the 12-month follow-up, the mean extension was 3.5 ± 4.6° (paired sample t-test, p = 0.396), and the mean flexion was 125.4 ± 10.5° (paired sample t-test, p = 0.019).

Table 1
Patient baseline characteristics.

Patients characteristics	N/Mean ± SD	Range	%	p Value
Follow-up (survivorship)	10.1 ± 4.9	0.5–18.7	–	
Age (years)	36.5 ± 11.3	19–54	–	
Sex				
Males	27	–	56.3	
Females	21	–	43.8	
Side				
Left	20	–	41.7	
Right	28	–	58.3	
Follow-up (years)	10.1 ± 4.9	0.5–18.7	–	
Standing HKA angle (°)				p < 0.01*
Preoperative	Valgus 6.1° ± 2.3°	Valgus 11.3°–1.4°	–	
Postoperative	Varus 2.2° ± 1.6°	Valgus 4.5° - varus 6.6°	–	
Standing LDFA (°)				p <
Preoperative	85.5° ± 1.5°	83.8°–88.6°	–	0.001*
Postoperative	92.4° ± 2.1°	89.7°–97.2°	–	
WBL ratio (%)				p <
Preoperative	69.6 ± 7.6	54.9–84.9	–	0.001
Postoperative	34.4 ± 3.9	26.9–41.8	–	
JLCA (°)				p =
Preoperative	−0.6° ± 1.4°	−2.5° - 1.5°	–	0.978
Postoperative	0.1° ± 1.1°	−1.7° - 1.2°	–	

N = number; SD = standard deviation; N/A = not available; HKA = hip-knee-ankle; LDFA = lateral distal femoral angle; WBL = weight bearing line; JLCA = joint line convergence angle; * = paired sample t-test; JLCA -ve values = tilted medially; +ve values = tilted laterally.

Preoperative and postoperative clinical scores were available for 32 patients (out of 48, 66.7%) with a mean clinical follow-up of 5.4 ± 3.3 years (range, 0.5–12 years) (Supplementary Material 1, Table 3).

Complication records were available for 100% of the patients (48 patients). Overall, the complication rate was 35.4% (17 of 48 patients), and the reoperation rate was 29.2% (14 of 48 patients). The main complication was symptoms associated with the metal hardware (10 of 17 complications, 58.8%), leading to a metal hardware removal rate of 20.8% (10 of 48 patients). One patient had a fall 6 months after index surgery and sustained a femoral fracture above the DFO plate. The patient underwent subsequent open reduction and internal fixation and recovered uneventfully. Deep venous thrombosis (DVT) occurred in 1 patient (2.1%), and superficial site infection in 1 patient (2.1%). This was treated with broad-spectrum oral antibiotic therapy and did not require additional surgery. No cases of deep infection were reported. No palsy or postoperative signs of direct/indirect trauma to the common peroneal nerve (CPN) were recorded. Nonunion was reported in 6.3% of the cases (3 patients), and all required additional surgery. Intraoperative fracture of the medial hinge occurred in 1 patient (2.1%), who required additional plating and was subsequently followed with toe-touch weight bearing for 4 weeks.

Regarding the preoperative and postoperative radiographic outcomes (Table 1), the correlation coefficients for interobserver reliability were 0.84 for LDFA measurements and 0.89 for HKA measurements, indicating high internal consistency between the observers.

Survivorship

Overall, 10 patients (out of 48, 20.8%) were converted to TKA at a mean of 9.2 years after index surgery (range, 3.9–16.7 years). The cumulative survivorship of the DFOs at 5 years postoperatively was 93%, at 10 years, 85%, and at 15 years, 71% (Fig. 2).

No significant difference in conversion rate was noted between DFOs performed with and without navigation (χ^2 test, p = 0.218) (Table 4).

Predictive factors for conversion

Using logistic regression, older age was significantly associated with an odds ratio (OR) of 1.16 ($R^2_N = 0.31$; 95% CI: 1.03 to 1.30, p = 0.013). Conversely, gender showed no significant association. The survival analysis showed that patients >45 years at the time of index surgery were associated with a hazard ratio (HR) for conversion to TKA of 5.16 (95% CI: 1.32 to 20.10, p = 0.018) compared with patients <45 years, with an estimated 10-year survivorship of 71% vs 92% (Supplementary Material 2). No significant association with sex was observed (95% CI: 0.18 to 2.23).

Logistic regression analysis showed no correlation between increased odds of conversion to TKA and osteotomy gap thickness, lateral, medial, or patellofemoral ICRS grade, preoperative ROM, postoperative complications, postoperative HKA, and postoperative LDFA. The Kruskal–Wallis test identified a small but statistically significant effect when investigating the trochlea ICRS score and conversion to TKA ($\varepsilon^2 = 0.13$, p = 0.049). No other significant differences were identified.

DISCUSSION

The main finding of this study was that LOWDFO represents a valid joint-sparing surgical option in young patients, providing optimal functional outcomes with a cumulative survivorship free from conversion to TKA of 85% at 10 years, and 71% at 15 years postoperatively. Complication and reoperation rates remain high, with the main cause of reoperation being pain related to the metal hardware. Patients over 45 years of age had a 4-fold greater HR of conversion to TKA, while the OR for conversion was 1.16, showing a 16% increase for each year of older age.

The survivorship and associated factors align with the current literature [8,11]. Cance et al. [19] retrospectively analyzed the outcomes of 38 patients who underwent LOWDFO with a minimum 10-year

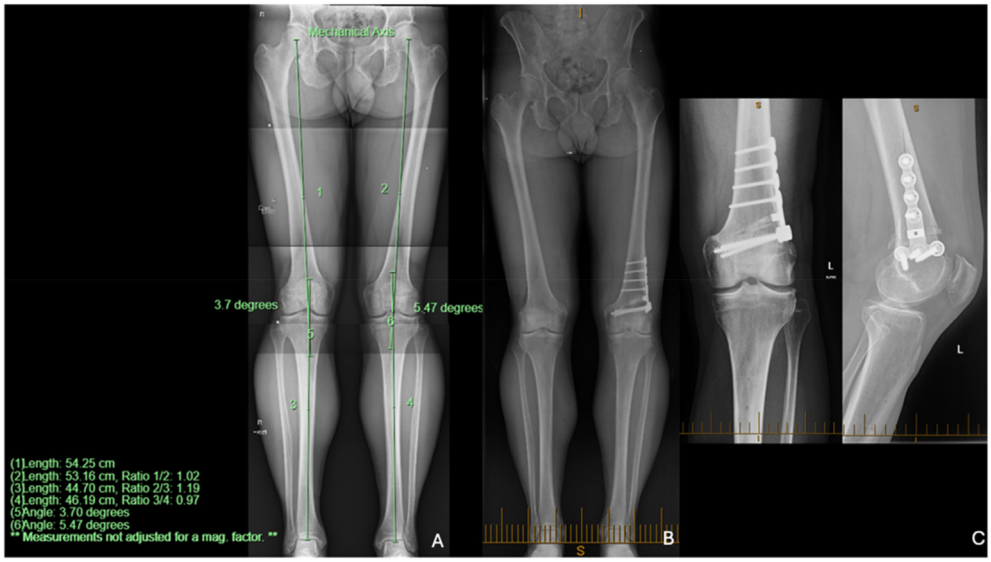

Fig. 1. Preoperative (A), postoperative (B), and 8 years (C) follow-up of 48-year-old patient operated on lateral opening wedge distal femoral osteotomy for symptomatic lateral compartment osteoarthritic changes on genu valgum.

Table 2
Arthroscopic findings before performing lateral opening wedge distal femoral osteotomy classified according to the International Cartilage Repair Society score.

MFC	N	%	MTP	N	%	LFC	N	%
0 - G2	30	96.8	0 - G2	31	100	0 - G2	8	25.0
G3 - G4	1	3.2 %	G3 - G4	0	0	G3 - G4	24	75.0
N/A	17	35.4	N/A	17	35.4	N/A	16	33.3
Total available	31	64.6	Total available	31	64.6	Total available	32	66.7
LTP	**N**	**%**	**Patella**	**N**	**%**	**Trochlea**	**N**	**%**
0 - G2	20	66.7	0 - G2	25	80.6	0 - G2	23	74.2
G3 - G4	10	33.3	G3 - G4	6	19.4	G3 - G4	8	25.8
N/A	18	37.5	N/A	17	35.4	N/A	17	35.4
Total available	30	62.5	Total available	31	64.5	Total available	31	64.6

MFC = medial femoral condyle; MTP = medial tibial plateau; LFC = lateral femoral condyle; LTP = lateral tibial plateau; N = number; N/A = not available.

Table 3
Preoperative and 1-year follow-up knee injury and osteoarthritis outcome score and range of motion.

	KOOS - symptoms		KOOS - pain		KOOS - daily living		KOOS - sports		KOOS - life quality	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Preoperative	52.6	20.4	53.8	18.3	63.9	22.9	28.2	18.6	29.1	16.3
1-year	64.9	24.9	76.1	17.1	82.8	16.9	49.9	30.6	47.8	19.7
p value[a]	0.003	–	$p < 0.001$	–	$p = 0.001$	–	$p < 0.001$	–	$p = 0.002$	–
	VR 12 – physical		**VR 12 – mental**		**IKDC**		**ROM - extension**		**ROM - flexion**	
	Mean	SD	**Mean**	SD	**Mean**	SD	**Mean**	SD	**Mean**	SD
Preoperative	33.9	11.8	47.8	11.4	48.3	15.8	4.6	6.7	119.2	9.5
1-year	42.8	8.8	54.3	14.6	61.4	16.4	2.5	4.6	125.4	10.5
p value[a]	0.047	–	$p = 0.039$	–	$p = 0.017$	–	0.414	–	0.019	–

[a] Paired Samples T-Test, KOOS Knee Injury And Osteoarthritis Outcome Score, SD Standard Deviation, ROM Range of Motion, VR-12 Veterans RAND-12, IKDC International Knee Documentation Committee subjective evaluation form.

follow-up, showing a survivorship free from conversion to TKA of 78.9%. The authors identified older age as a significant factor for conversion, while no difference was noted when investigating other variables. Conversely, Mayfield et al. [16] reported a 10-year survivorship of 73.2% from the California Office of Statewide Health Planning and Development Registry (OSHPD), showing that age and the "initial diagnosis of OA" were significant factors for failure. However, the authors did not specify which compartment was mainly involved (medial, lateral, or patellofemoral) and to what extent. In our study, the involvement of the medial compartment was not identified as a significant factor, in line with similar studies [19]. It is however, difficult to discern whether the older age of patients converted to TKA is secondary to a more common indication for TKA in patients affected by knee osteoarthritis in this age group. Nevertheless, this represents a satisfactory survivorship, considering the main objective is to obtain a pain-free articulation and to delay the need for a joint-sacrificing procedure. In fact, TKA in young patients has been associated with suboptimal outcomes and increased failure rates [3,20,21]. A significant effect was noted between the trochlea ICRS score and the conversion to TKA, suggesting that the trochlear cartilage status at the time of index surgery may play a role in future conversion to

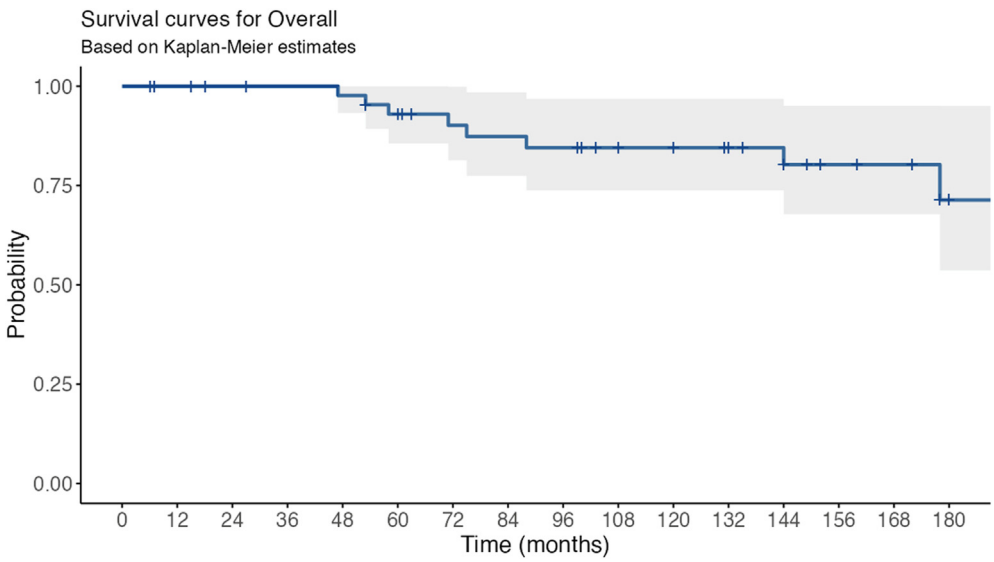

Fig. 2. Survivorship curve of the medial opening wedge high tibial osteotomy.

Table 4
Comparison between patients who experienced a conversion to TKA and the rest of the cohort.

	Conversion TKA N (%)/mean ± SD	Nonconversion TKA N (%)/mean ± SD	P
Age (years)	45.8 ± 5.8	34.1 ± 11.2	**0.003**[a]
BMI (Kg/m^2)	30.4 ± 4.7	27.5 ± 4.9	0.230[b]
Sex			0.729[c]
Males	5 (10.4)	22 (45.8)	
Females	5 (10.4)	16 (33.3)	
Preoperative ROM			
Flexion (°)	116.8 ± 0.8	112.8 ± 22.1	0.817[a]
Extension (°)	3.4 ± 8.1	5.9 ± 4.9	0.232[b]
Surgical outcomes			
Osteotomy gap (mm)	9.3 ± 2.5	10.3 ± 1.9	0.312[b]
Postoperative alignment - HKA (°)	1.7 ± 1.8	2.3 ± 1.6	**0.034**[a]
Radiographic outcomes			
Standing LDFA (°)			0.322[b]
Preoperative	85.4 ± 1.9	85.6 ± 1.3	
Postoperative	91.5 ± 1.7	92.8 ± 2.2	
WBL ratio (%)			0.861[b]
Preoperative	69.5 ± 5.1	69.7 ± 9.2	
Postoperative	34.7 ± 5.1	34.2 ± 3.8	
JLCA (°)			0.205[b]
Preoperative	−0.7 ± 1.6	−0.5 ± 1.3	
Postoperative	−0.6 ± 0.9	0.2 ± 1.0	
[-ve values: tilted medially]			
[+ve values: tilted laterally]			
Cartilage status (ICRS)			
MCF	1.1 ± 0.6	0.8 ± 1.0	0.159[a]
MTP	0.8 ± 0.5	0.6 ± 0.7	0.438[a]
LFC	3.4 ± 0.7	2.8 ± 1.7	1.000[a]
LTP	3.3 ± 0.9	2.7 ± 1.7	0.574[a]
Patella	2.3 ± 1.3	1.6 ± 1.1	0.117[a]
Trochlea	2.5 ± 1.4	1.4 ± 1.2	**0.044**[b]

BMI = body mass index; SD = standard deviation; TKA = total knee arthroplasty; LDFA = lateral distal femoral angle; WBL = weight bearing line ratio; JLCA = joint line convergence angle; ICRS = International Cartilage Repair Society score; MFC = medial femoral condyle, MTP = medial tibial plateau; LFC = lateral femoral condyle, LTP = lateral tibial plateau; HKA angle = hip-knee-ankle angle.

[a] Mann–Whitney U.

[b] t-test.

[c] Fisher's Exact Test.

TKA. Nevertheless, data available in literature is still limited and often contrasting [22,23], limiting the possibility of drawing definitive conclusions about the role of trochlear cartilage wear at the time of index surgery.

The reported complication rate was 35.4% and the reoperation rate was 29.2%. This compares favorably with what reported by Wylie et al. [11], who observed a reoperation rate of up to 44% on 138 LOWDFO at a mean 5-year follow-up. It is worth mentioning that, despite the relatively high complication rate, the number of severe adverse events such as DVT, infection, and intraoperative medial hinge fracture was much lower and in line with the current literature [11,19]. A high proportion of patients (10 of 48 patients, 20.8%) required removal of metal hardware because of a low tolerance of lateral pain and/or irritation, in line with the current literature [11]. Thus, excluding metal hardware removal, the complication rate dropped to 14.6%. It has been widely documented that one of the potential complications of LOWDFO is mechanical friction with the iliotibial band, which can cause irritation, discomfort, and pain, reported in up to a staggering 86% of cases [24]. Therefore, it is important to adequately inform and counsel the patients, knowing that one in four may require subsequent removal of the metal hardware. Patient-specific and more anatomically securing hardware may be considered to decrease the incidence of hardware-related complications [25].

Among the reported complications, the nonunion rate was 6.3%, which compares worse with what reported by Cance et al. [19] at 2.6% in 38 patients with a mean follow-up of 15 years. Nevertheless, our results compare favorably with the outcomes reported by Jacobi et al. at 14% [24]. Wylie et al. [11] showed a delayed union/nonunion rate of 7% when investigating 274 DFOs, including lateral opening and medial closing wedge techniques. No cases of stiffness or early displacement of the DFO were noted in our cohort, comparing favorably with similar studies reporting these complications in up to 13% [19] and 8% [19] of the patients, which could be secondary to the aforementioned pain and irritation at the level of the iliotibial band.

LOWDFOs were associated with a significant improvement in knee flexion, subjective IKDC score, and in different subscales of the KOOS score, including pain, activity of daily living, sports, and quality of life, at a mean 4 years follow-up, in line with the current literature [19,26]. Schröter et al. [27], focused on the association between the postoperative LDFA and clinical outcomes on 52 patients undergoing medial closing wedge DFO at mean 70-month follow-up. The authors showed significantly superior outcomes in case with a postoperative LDFA <90°, suggesting that an overcorrection of the deformity may have a negative impact on the functional outcomes [27]. Our results showed optimal functional outcomes regardless of a mean postoperative HKA of 2.2° varus and a mean postoperative LDFA of 92°. It has been reported in a

biomechanical study that an overcorrecting a native deformity of 10° valgus to up to 5° varus (HKA) yields the largest reduction in lateral compartment pressure and contact area restoring near-normal values compared with the knee in normal anatomic alignment [28]. However, excessive correction should be avoided because it may be associated with other complications, including progression of OA involving the medial compartment (one of the main indications for conversion) [19], modification of the joint line obliquity, and increased technical challenges of a subsequent TKA [27]. Nevertheless, the degree of correction has not been reported as significant factor for conversion, in line with the current literature [11,16,19].

Although patients were prospectively followed, the retrospective design makes the study susceptible to selection and detection bias. The lack of a STROBE statement, due to the data collection methods, represents a significant limitation. The results concerning associated factors pertain to a univariable analysis. A multivariable analysis could not be performed due to the limited sample size and low number of events. Therefore, we acknowledge that we could not determine the role of potential confounding variables that may, in part, explain or moderate this estimate. Data collection was individually performed utilizing an internal database coding; therefore, some patients may have been missed due to incorrect coding, leading to a potential selection bias. We cannot exclude the possibility of a type II error suggesting that no significance is found when, in fact, a larger sample size would enable different findings. Despite the KOOS scale having been defined as more effective and more sensitive in measuring improvements after intervention than the Knee Society Score (KSS) functional scale, the "pain" subsection is characterized by a higher "ceiling effect" which decreases its validity [29]. Despite the low proportion of patients lost to follow-up (14.3%), this may still represent a source of bias. Furthermore, the variable follow-up should be considered as a potential source of bias. Lastly, the optimal postoperative alignment was independently selected by the operating surgeon, based on personal experience and preferences. Thus, the fact that different surgeons were involved may potentially lead to a performance bias.

CONCLUSION

LOWDFO is a reliable joint-sparing procedure for young patients with isolated lateral compartment symptomatic OA and valgus knee deformity. It is associated with satisfactory 10-year survivorship and yields optimal clinical outcomes at mid-term follow-up. Older age is a significant factor for conversion to TKA.

Data availability

Data are available under reasonable request.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships that may be considered as potential competing interests: David Parker reports a relationship with Personalized Surgery that includes: equity or stocks. David Parker reports a relationship with Ganymed Robotics that includes: equity or stocks. David Parker reports a relationship with Smith and Nephew Inc that includes: consulting or advisory, equity or stocks, funding grants, and speaking and lecture fees. David Parker reports a relationship with Arthrex Inc that includes: funding grants and speaking and lecture fees. David Parker reports a relationship with Zimmer Biomet that includes: funding grants. David Parker reports a relationship with Corin that includes: funding grants. Current President of I.S.A.K.O.S. society, DP if there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jisako.2025.100898.

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