

Return to Work After Distal Femoral Varus Osteotomy

Richard N. Puzzitiello,* MD, Joseph N. Liu,[†] MD, Grant H. Garcia,[‡] MD, Michael L. Redondo,[§] MD, Enrico M. Forlenza,^{||} BS, Avinesh Agarwalla,[¶] MD, Adam B. Yanke,[¶] MD, PhD, and Brian J. Cole,^{¶#} MD, MBA

Investigation performed at Midwest Orthopaedics at Rush, Rush University Medical Center, Chicago, Illinois, USA

Background: Distal femoral varus osteotomy (DFVO) is a well-described procedure to address valgus deformity of the knee. There is a paucity of information available regarding patients' ability to return to work (RTW) after DFVO.

Purpose: To report the objective findings for RTW rates and times for patients receiving a DFVO for lateral compartment osteoarthritis secondary to valgus deformity of the knee.

Study Design: Cohort study; Level of evidence, 3.

Methods: This was a retrospective study of patients who received a lateral-wedge opening DFVO. Patients must have worked within 3 years before their operation to be included for analysis. Patients were contacted at a minimum of 2 years postoperatively for interview and questionnaire evaluation, including a subjective work questionnaire, visual analog scale (VAS) for pain, Single Assessment Numerical Evaluation (SANE), and a satisfaction questionnaire.

Results: Overall, 32 patients were contacted at a mean follow-up of 7.1 ± 4.1 years (range, 2.2-13.3 years). The mean \pm SD age at the time of surgery was 30.8 ± 8.8 years (range, 17.2-46.5 years), and 65.6% of patients were female. Eleven patients (34.4%) received a concomitant meniscal allograft transplant, and 12 (37.5%) received a cartilage grafting procedure. The average VAS pain score decreased significantly from 6.1 preoperatively to 3.2 postoperatively ($P = .03$). All patients were able to RTW, at a mean time of 6.0 ± 13.2 months postoperatively (range, 0-72 months). When stratified by work intensity, the average time to return was 13.8, 3.1, 2.7, and 2.9 months for high, moderate, light, and sedentary occupations, respectively. There was no significant difference between these RTW times ($P = .16$), although this analysis may have been limited by the small sample size. Four patients whose work was classified as heavy work (50%) and 3 whose work was classified as moderate work (18.8%) either switched jobs or kept the same job with lighter physical duties as a result of their procedures.

Conclusion: In a young and active population, DFVO for valgus deformity reliably afforded the ability to RTW within a relatively short time for patients with sedentary, light, and moderate occupational demands. However, patients with moderate- to high-intensity occupational demands may be unable to RTW at their preoperative level.

Keywords: distal femoral valgus osteotomy (DFVO); distal femoral osteotomy (DFO); return to work; patient-reported outcomes; meniscal allograft transplant (MAT)

Valgus deformity of the knee is a complex pathology that causes an increase in lateral compartment joint contact pressures.¹⁷ These increased forces result in early lateral tibiofemoral osteoarthritis (OA) progression and are significantly associated with increasing burden of pain and functional deterioration.¹⁷ The disability that results from OA is ranked the highest when compared with any disease⁹ and is associated with a negative effect on work participation.¹ For young patients with incapacitating unicompartmental arthritis, unicompartmental knee arthroplasty remains a viable option; but

younger patients may have less satisfaction after these procedures,^{16,20} especially if they wish to continue high-impact activities.¹⁸

Distal femoral varus osteotomy (DFVO) is a well-described procedure to address valgus deformity of the knee.¹⁸ The aim of this procedure is to realign the mechanical axis to shift weightbearing away from the lateral compartment, thus off-loading areas of worn or damaged cartilage. This procedure is commonly performed in combination with other procedures, such as meniscal allograft transplantation (MAT), to address pathologies that might otherwise cause recurrent symptoms.^{8,18} The outcomes of this procedure have been relatively positive,^{3,11,13} notably providing a mean survival rate of 80% at 10 years, thus being a viable treatment for delaying or reducing the need

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for knee arthroplasty.³ In addition, DFVO for symptomatic valgus malalignment has the advantage of no permanent activity restrictions such as those with total knee arthroplasty (TKA), in which modifying activity is paramount to ensure prosthesis durability.

Previous studies^{4,5,10,19} on DFVO have focused on reporting outcomes after this procedure in terms of validated patient-reported outcomes (PROs), which focus on pain, function, and satisfaction. However, the patients who are indicated for this procedure are often young and active and may be more concerned with their ability to return to work (RTW) and/or sport after the operation. Outcomes regarding the ability to and time-frame for returning to work are not captured with standard PROs.^{6,12} The purpose of this study was to establish a time frame regarding the patients' ability to RTW after DFVO, to assess the level of work they return to compared with their preoperative level, and to examine the effect the level of work intensity has on the patients' ability to RTW.

METHODS

Sample Identification

Institutional review board approval was obtained before the onset of this study. A retrospective query of a prospectively collected patient registry was performed for all patients who received a DFVO for valgus malalignment of the knee $\geq 5^\circ$ by a single surgeon (B.J.C.) from January 2004 to March 2015. Inclusion criteria were patients who received a lateral-wedge opening DFVO for the indication of valgus malalignment, patients who were employed within 3 years before the operation, and patients who were followed up for a minimum of 2 years after surgery. The exclusion criteria were patients who received a revision DFVO, patients who underwent bilateral DFVO within 3 years of each other, and patients who were unable to be contacted to complete the survey at minimum 2 years postoperatively ($n = 5$). After patients were identified for inclusion, a follow-up questionnaire interview was conducted with each patient by telephone or email. If patients were

unable to be contacted by telephone or email, the questionnaire was mailed to their home address.

A total of 54 patients undergoing DFVO between 2004 and 2015 were identified, 14 of whom were excluded because of preoperative employment status. A total of 37 patients met the inclusion criteria for this study, and 32 of these (86.5%) were able to be contacted at a mean \pm SD follow-up period of 7.1 ± 4.1 years (range, 2.2-13.3 years).

Data Collection

The study questionnaire thoroughly assessed work-related outcomes, as well as interval history regarding reoperations, complications, pain, and return of function since the procedure. This questionnaire has been previously used to describe work-related outcomes after other common orthopaedic procedures.^{6,7,12} Patients' levels of work intensity were stratified into sedentary and light-, moderate-, and heavy-intensity physical demands (Table 1).¹² In addition to work-related and surgical outcomes, we also assessed if patients, given the chance, would have their procedure again. Postoperative VAS pain scores and SANE scores, and 4-point Likert subjective satisfaction score were also assessed. The responses of "very satisfied" and "satisfied" were categorized as satisfied and responses of "dissatisfied" and "very dissatisfied" were categorized as dissatisfied. All postoperative assessment scores, survey responses, and independent question responses were obtained at the same point of contact for each patient.

Preoperative SANE score and VAS pain scores were obtained from a prospectively maintained institutional registry. Patient information and characteristics were also extracted from patient charts, including preoperative diagnosis, surgical history, concomitant procedures, complications, and subsequent procedures. Preoperative imaging was assessed to determine the degree of valgus deformity of each knee as well as to assess the degree of OA in patients' knees. Operative notes were reviewed to confirm the procedures performed as well as to record the Outerbridge classification of cartilage defects present. Postoperative radiographs were also reviewed to ensure that the

#Address correspondence to Brian J. Cole, MD, MBA, Division of Sports Medicine, Midwest Orthopaedics at Rush, 1611 West Harrison Street, Chicago, IL 60612, USA (email: brian.cole@rushortho.com).

*Department of Orthopedic Surgery, Tufts University Medical Center, Boston, Massachusetts, USA.

†Department of Orthopedic Surgery, Loma Linda Medical Center, Loma Linda, California, USA.

‡Seattle Orthopaedic Center, Seattle, Washington, USA.

§Department of Orthopedic Surgery, University of Illinois Medical Center, Chicago, Illinois, USA.

||Department of Orthopedic Surgery, Westchester Medical Center, Valhalla, New York, USA.

¶Midwest Orthopaedics at Rush, Rush University Medical Center, Chicago, Illinois, USA.

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Ethical approval for this study was obtained from Rush University Medical Center.

TABLE 1
Occupational Intensity Classifications^a

Occupational Intensity	Description
Sedentary	From negligible to 10 pounds of exertional force to lift, pull, carry, or otherwise move items. Involves sitting most of the time and may have occasional (up to one-third of the time) periods of walking or standing.
Light	From exerting 10 pounds of force frequently (from one-third to two-thirds of the time) to 20 pounds of force occasionally. If exertional requirements are negligible, a job may qualify as light work still if the job requires constant (two-thirds of the time to all of the time) exertion of negligible force at a production pace or requires significant walking or standing. (The constant strain of maintaining production pace can be and is physically demanding of a worker even though the force exerted is negligible.)
Moderate	From exerting 20-50 pounds of force occasionally, 10-25 pounds of force frequently, or an amount greater than negligible and up to 10 pounds constantly.
Heavy	Exertion from 50 to 100 pounds of force occasionally, or 25 pounds of force constantly to move objects.

^aClassifications from the US Department of Labor, as defined in the Dictionary of Occupational Titles.

weightbearing line subsequently fell over the medial tibial spine.

Indications for DFVO were symptomatic, isolated lateral compartment cartilage defects or OA in the setting of $\geq 5^\circ$ of valgus malalignment, as measured on mechanical axis radiographs. Indications for concurrent MAT included being functionally meniscectomized in the lateral compartment, defined as an absence of $>50\%$, as confirmed by imaging or a previous arthroscopic procedure; documented minimal to absent diffuse degenerative changes in the surrounding articular cartilage (Outerbridge grade 2 or less); presence of severe and disabling knee pain unresponsive to nonoperative management for a minimum of 6 months; and presence of knee pain that is responsible for functional limitations resulting in impairment of age-appropriate activity. Outerbridge changes were documented during arthroscopy.

Surgical Technique

The technique utilized for DFVO has previously been described by Mitchell et al.¹³ The angle formed between a line through the center of the femoral head and the center of the tibial spine and a line passing from the talus through the center of the tibia was measured on the preoperative imaging. The degrees of correction necessary to have the weightbearing line fall over the medial tibial spine were then calculated. An oscillating saw and osteotomes were

utilized to make the cuts in the distal femur, leaving the medial cortex intact. A titanium plate with 4.5-mm threaded cortical screws was used proximally and 6.5-mm cancellous distally. The resultant opening wedge was grafted with allograft chips, demineralized bone matrix, local autograft, or iliac crest tricortical allograft.

After the operation, patients were limited to nonweight-bearing for the first 6 weeks before progressing to full weightbearing. A hinged knee brace, locked in extension, was used at all times for the first 2 weeks after the surgery; thereafter, patients could remove the brace at only at night until 6 weeks postoperatively.

Statistical Analysis

All statistical analysis was performed using SPSS Statistics Version 25.0 (IBM). Changes in outcome scores (SANE and VAS pain scores) were compared using non-parametric statistical tests, using 2-tailed hypothesis testing with the level of significance set at $P \leq .05$. To compare RTW time among patients when stratified by work intensity, a 1-way analysis of variance (ANOVA) test was used. A binomial logistic regression was used to determine the associations between patient variable and the patients' ability to return to their preoperative intensity of work.

RESULTS

Among the 32 patients included for final analysis, the mean age at the time of surgery was 30.8 ± 8.8 years (range, 17.2-46.5 years), the mean body mass index (BMI) was 28.9 ± 7.2 kg/m², and 65.6% of patients were female. The dominant leg was operated on in 62.5% of the included cases. A total of 28 (87.5%) patients had previously received a procedure on the leg on which they received a DFVO. Previous procedures included 17 meniscectomies (53.1%), 2 meniscal repairs (6.3%), 4 anterior cruciate ligament reconstructions (12.5%), 8 cartilage procedures (25%), and 4 meniscal transplants (12.5%). When patients were asked why they chose to have a DFVO performed, 24 patients cited pain (75%), 24 to stay active (75%), 19 to improve motion (59.4%), 10 to prevent arthritis (31.3%), and 5 to RTW (15.6%).

Outerbridge grade 3 or 4 cartilage defects were present on the lateral femoral condyle (LFC) in 17 knees (53.1%), and 9 knees (28.1%) had bipolar defects on the LFC and lateral tibial plateau. At the time of the DFVO procedure, 11 patients (34.4%) received a concomitant MAT and 12 (37.5%) received a cartilage grafting procedure. Differences in patient variables between these 2 groups can be found in Table 2. Patients who received a concomitant MAT were significantly younger, and a higher proportion received a cartilage grafting procedure. Additionally, a higher proportion were female patients and had Outerbridge grade 3 or 4 defects on the LFC; however, these differences did not reach statistical significance.

At final follow-up, 14 patients (43.8%) had returned to the operating room for surgery on the ipsilateral knee. Two patients underwent a TKA (6.3%), 1 received a revision

TABLE 2
Comparison Between Patients Receiving Concomitant Meniscal Transplantation and Those Receiving an Isolated DFVO^a

	DFVO	DFVO + MAT	<i>P</i>
Age, y, mean	25.3	32.4	.02
Female	72.7	66.7	.12
LFC cartilage defect ^b	90.1	61.9	.08
Bipolar defects ^b	27.3	23.8	.83
Cartilage grafting	63.6	23.8	.03
RTW	76.2	81.8	.72
Reoperations	42.9	45.5	.89
Satisfaction	85.7	100	.53
VAS, mean ± SD	3.1 ± 2.5	3.4 ± 2.4	.73
SANE, mean ± SD	60.8 ± 19.5	61.4 ± 25.2	.95

^aAll values of DFVO and DFVO + MAT are expressed in percentages unless otherwise indicated. Bolded *P* values indicate statistically significant between-group differences ($P < .05$). DFVO, distal femoral varus osteotomy; LFC, lateral femoral condyle; MAT, meniscal allograft transplant; RTW, return to work; SANE, Single Assessment Numerical Evaluation; VAS, visual analog scale.

^bOuterbridge grade 3 or 4 cartilage defects.

procedure because of broken hardware (3.1%), 5 received a manipulation under anesthesia (15.6%), and 5 had hardware removed (15.6%). The patients who underwent a TKA were female (age, 26 and 40.1 years; BMI, 30.5 and 30.7, respectively) and received these procedures 2.4 and 3.2 years after their DFVO because of persistent pain.

Subjective Outcomes

The average VAS pain score among included patients decreased significantly from a 6.1 preoperatively to 3.2 postoperatively ($P = .03$). The average SANE score increased from 40.1 preoperatively to 64.8 postoperatively ($P = .11$). Two patients (6.3%) stated that they would not have this procedure again in retrospect, and 90.6% of patients reported being satisfied with the outcomes of their procedure. When asked what problems they had experienced with their knee since the procedure, 4 patients cited instability (12.5%), 11 cited catching or locking (34.4%), 15 cited frequent swelling (46.9%), 15 cited pain (46.9%), and 22 cited stiffness (68.6%).

When comparing patients who received an MAT procedure at the time of their DFVO with those who received a DFVO in isolation, there was no significant difference in outcome scores or number of reoperations (Table 2).

Work-Related Outcomes

All 32 included patients were able to RTW after their operation at a median time of 3.0 months (mean ± SD, 6.0 ± 13.2 months; range, 0-72 months). Five patients had workers' compensation medical coverage, and the median time to RTW for these patients was 6 months (mean ± SD, 19.2 ± 29.7 months; range, 3-72 months) ($P = .08$, comparing RTW time of workers' compensation vs non-workers'

TABLE 3
Postoperative Occupations of Patients

Job Intensity	Occupation
Sedentary	Receptionist (n = 2), tutor, attorney
Light	Retail associate (n = 2), merchandise manager, accountant, medical assistant (n = 2), teacher with light physical duties
Moderate	Teacher (n = 6), sculptor, supply chain manager, phlebotomist, retail manager, dancer, project manager, social worker, parks and recreation, entertainment production (n = 2), paramedic
High	Mechanic, professional soccer player, operation manager/entertainer, pipefitter

TABLE 4
Return to Work After Distal Femoral Varus Osteotomy

Intensity	Number of Patients		Direct Rate ^b , %	Months
	Preoperative	Postoperative ^a		
Sedentary	4	4	100	2.7
Light	4	7	100	2.9
Moderate	16	17	81.3	3.1
Heavy	8	4	50	13.8

^aPatients who changed to a less demanding occupation after their procedure were added to the "Number of Patients Postoperative" column of their postoperative occupation's intensity.

^bThe direct rate of return to the same level of occupational intensity for patients preoperatively to postoperatively.

compensation). The postoperative occupations of patients are detailed in Table 3.

Eight patients (25%) classified their occupation as heavy work, 16 (50%) as moderate work, 8 (25%) as light work, and 4 (12.5%) as sedentary. The average times to RTW when stratified by work intensity were 13.8, 3.1, 2, and 2.9 months, respectively (Table 4). Although limited by sample size, there was no significant difference in time to RTW between occupational demand levels on ANOVA analysis ($P = .16$). Four patients whose work was classified as heavy and 3 whose work was classified as moderate either switched jobs or kept the same job with lighter physical duties because of their procedure (Table 4). However, there was no statistically significant difference between the direct RTW rate and the preoperative level of intensity when comparing patients with light and sedentary occupations versus those with heavy occupations ($P = .08$).

The binary logistic regression found no significant effect of patient age at the time of surgery ($P = .52$), BMI ($P = .94$), workers' compensation status ($P = .91$), sex ($P = .83$), concomitant MAT ($P = .79$), concomitant cartilage procedure (0.71), presence of grade III to grade IV cartilage defect ($P > .99$), or presence of bipolar cartilage

disease ($P = .59$) on the patients' ability to return to the same level of intensity of work.

DISCUSSION

The primary finding of this study was that DFVO for valgus deformity of the knee reliably allows patients to return to sedentary, light, and moderate work intensity within a short time period after their procedure. In this study, 100% of patients were able to RTW after their procedure, although 7 patients (29%) with moderate- or heavy-intensity work switched jobs or kept the same job with lighter physical duties. Patients were able to RTW between 2.7 and 3.1 months after their surgery if their occupation was sedentary to moderate. Of those patients with heavy-intensity occupations, the average time to RTW was 13.8 months. While there was a large absolute difference between time to RTW, because of the low number of patients in these 2 groups, this difference did not achieve statistical significance. The findings of this study are helpful in counseling patients and managing expectations for work-related outcomes after DFVO.

Several previous studies^{10,4,19} have reported work-related outcomes after realignment osteotomies around the knee. A recent systematic review by Hoorntje et al¹⁰ identified the rates of RTW after either distal femoral osteotomy or high tibial osteotomy (HTO) for medial or lateral non-compartmental knee OA, knee instability, or concomitant treatment for meniscal repair or transplantation. This review found that the pooled rate of RTW was 85%, and the average time to RTW was 16 weeks. In terms of the capacity at which patients could RTW, 72%-100% of patients returned to the same or higher workload compared with their preoperative level. The rate and time to RTW findings of the current study fall within range of these previous studies. Of note, the systematic review by Hoorntje et al included 14 studies that reported work-related outcomes, 13 of which studied patients after an HTO. While HTO is a procedure that has been shown to be successful in the treatment of varus deformity, its outcomes for treating valgus deformity have been reported to be less successful.^{4,19} In the valgus knee, the deformity often resides in the distal femur, and correcting the proximal tibia can cause increased shear forces on the articular cartilage.¹⁴ For these reasons, HTO represents a distinct procedure, and it is thus difficult to extrapolate those findings for patients receiving a DFVO.

In 2014, de Carvalho et al⁵ evaluated work-related outcomes after DFVO and found that 88.5% of patients resumed normal work duties after their surgery without any functional limitation or decline. Our study found a higher level of RTW comparatively; however, in our cohort, 21.9% either changed occupations or took on a lighter workload because of surgery-related functional limitations. It is important to note that the average age of the patients in the study by de Carvalho et al was 48.6 years, which is considerably higher than that of our study's patients (30.8 years). Furthermore, the level of intensity of the patients' occupations was not reported. The current study

provides insights into a timetable for RTW and the effect that the level of occupational intensity has on these outcomes in a young and active population of patients receiving a DFVO.

Although no statistically significant differences in time until RTW and the rate of RTW between different occupational intensities were found, 7 of the 24 patients with moderate- or heavy-intensity occupations either changed jobs or took a role with lighter physical demands because of limitations from their surgery. This contrasts with the 8 patients with either light-intensity or sedentary occupations, who were all able to return to their full preoperative work status. The effect of higher physical demand occupations on patients' abilities to RTW has been previously highlighted in studies examining patients receiving an HTO. The studies by Bode et al² and Schröter et al¹⁵ found a statistically significant increase in time to RTW for patients with heavy-intensity occupations compared to those with light-intensity occupations. These collective findings can aid surgeons in advising patients who have higher occupational intensity that they may take longer to RTW or may be physically unable to return to the same intensity of work.

We acknowledge limitations of the current study, most notably that it is retrospective in nature. Additionally, the group included in this study varied in previous and concomitant procedures, such as MAT and osteochondral grafting. While these procedures may have influenced the results of this investigation, the intention of this study was to determine the patients' abilities to RTW after DFVO to treat valgus deformity regardless of additional pathology and concomitant treatments. Furthermore, no significant differences in patient outcomes were found when comparing those who received concomitant MAT with those who did not. Another limitation is that the retrospective survey used to assess patient outcomes created a potential for recall bias. However, patient medical and surgical records were cross-referenced to ensure accurate reporting. This retrospective survey and study design were very similar to previous studies^{6,7,12} on work-related outcomes after orthopaedic procedures. Finally, this sample was relatively small, and a statistical comparison when stratifying patients by occupational intensity was likely underpowered. However, the size of the study sample was similar to that of previous studies^{2,5,15} on this topic.

CONCLUSION

In a young and active population, a DFVO for valgus deformity reliably affords the ability to RTW within a relatively short time period, regardless of the occupational demand level. However, patients with occupational physical demands of moderate to high intensity may be unable to return to their preoperative level of work. In addition, this procedure is a safe treatment that results in high patient satisfaction and favorable patient-reported outcomes.

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