

# Reoperation to Promote Union or to Address Deep Surgical Site Infection in 228 Periprosthetic Distal Femur Fractures: A Multicenter Study

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## INTRODUCTION:

Periprosthetic distal femur fractures (PDDFs) are a devastating complication following total knee arthroplasty (TKA). These injuries occur at a rate of 0.25-2.3% in primary TKA patients, with rates up to 38% in revision TKAs<sup>1-5</sup>. PDDFs have been associated with significant morbidity including loss of independence in more than 50% of patients and an associated 25% one-year mortality rate<sup>6</sup>.

PDDFs with well-fixed implants can be managed with pre-contoured lateral distal femoral locking plates (LDFLP). This technique remains technically demanding with high rates of nonunion and varus deformity resulting in the need for revision<sup>7-8</sup>. Despite advances in locking plate technology and implant design, LDFLPs in PDDFs continue to have reported nonunion rates of 6-22% and complication rates in up to 37% of patients<sup>9-18</sup>.

Postoperative deep surgical site infection (DSSI) occurs in 0-9% of PDDFs treated with LDFLPs<sup>10,14,19</sup>. The development of DSSI can lead to significant pain, debilitation, and significantly increasing the cost of care<sup>20-21</sup>.

As the rate of TKA procedures performed is expected to increase significantly with the aging population<sup>22</sup>, optimizing treatment strategies to reduce complications and improve patient outcomes becomes paramount.

## METHODS:

After institutional review board approval, initial screening using ICD-10 and CPT codes was performed at ten tertiary care referral centers. Patients 18 years or older with PDDFs (OTA/AO Classification Type 33A and 33C) who underwent surgical fixation between January 2012 and December 2019 exclusively utilizing LDFLPs were eligible for inclusion. Patients with pathologic fractures or with follow up less than 3 months without an outcome event (unplanned reoperation to promote union or for deep surgical infection) prior to this timepoint were excluded. Fracture fixation constructs utilizing medial plates, intramedullary nails, or hybrid fixation constructs were excluded from analysis. In total, 228 fractures met inclusion criteria and were included for analysis.

Patient records were reviewed to record patient demographics, surgical procedures performed, implants used, and complications that occurred. Twenty candidate factors were included in our logistic regression model to assess for risk factors associated with the need for reoperation to promote union (Table 1). Seventeen candidate factors were included to assess for risk factors associated with the need for reoperation for deep surgical site infection (DSSI) (Table 2).

Patient, injury, and construct characteristics were summarized using counts and percentages for categorical variables and means with standard deviations for continuous variables. These descriptive figures were calculated for the total cohort as well as for subgroups of patients who did and did not undergo a reoperation to promote union or develop deep surgical site infection requiring reoperation.

Postoperative radiographs were reviewed to identify the presence of medial cortex comminution and to identify two measures of the reduction: anatomic lateral distal femoral angle (aLDFA) and medial translation of the articular block. These parameters were measured by study authors utilizing a method which was standardized with the use of detailed instructions and a representative annotated radiograph (Figure 1). Medial translation was measured from the medial cortex of the proximal fragment to medial cortex of the distal fragment and normalized to the condylar width in millimeters (mm) to control for image rotation. Medial comminution was measured in mm from the intact proximal fragment to the distal intact segment to the articular block. ALDFA was measured in degrees.

The initial models were reduced using backward stepwise elimination based on a minimum Akaike Information Criterion. The factors remaining in the final model were reported as odds ratios with 95% confidence intervals and p-values. The significance threshold for all analyses was set to a two-sided alpha of 5%. We used multiple imputation by chained equations to impute missing data for the reported model.

## RESULTS:

There was an 8.3% (19/228) rate of unplanned reoperation to promote union. Predictive factors for the need for reoperation to promote union included increasing body mass index (BMI) (odds ratio [OR] =1.09; 95% confidence interval [CI]: 1.02-1.16; p=0.01), increasing number of screws in the distal fracture segment (OR =1.73 95% CI: 1.06-2.95; p=0.03), and decreasing proportion of proximal segment screws that are locking (OR = 0.17; 95% CI: 0.03-0.70; p=0.02).

There was a 4.8% (11/228) rate of reoperation to address DSSI. No statistically significant predictive factors in multivariate or univariate analysis were identified.

## DISCUSSION AND CONCLUSION:

In total, 8.3% of PDDFs treated with LDFLPs underwent unplanned reoperation to promote union. Increasing patient BMI and increasing number of screws in the distal fracture segment were found to be predictive factors, while increased locking screws in the proximal segment was found to be protective. In total, 4.8% of patients in this cohort underwent reoperation to address DSSI. No significant associated factors were identified.

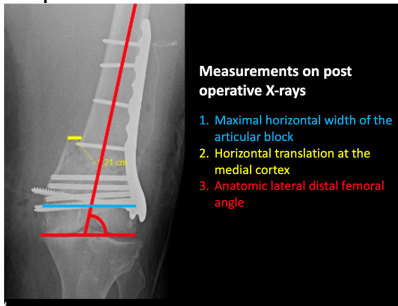


Table 2. Descriptive and univariate statistics with respect to reoperation to promote union

Factor*	No reoperation to promote union (N = 208)		Reoperation to promote union (N = 15)		p-value
	Count (N, %)	Count (N, %)	Count (N, %)	Count (N, %)	
Gender	179 (79)	155 (76)	15 (76)	15 (76)	0.8
Age	72.1 (10.5)	72.3 (10.5)	70.3 (11.0)	70.3 (11.0)	0.5
Race					0.5
White	162 (77)	148 (73)	14 (73)	14 (73)	
Black or African American	29 (13)	38 (19)	1 (5)	1 (5)	
Hispanic or Latino	7 (3)	7 (3)	0 (0)	0 (0)	
American Indian or Alaska Native	1 (0)	1 (0)	0 (0)	0 (0)	
Asian	1 (0)	1 (0)	0 (0)	0 (0)	
Native Hawaiian or Other Pacific Islander	0 (0)	0 (0)	0 (0)	0 (0)	
Tobacco use					0.2
Never	111 (53)	101 (50)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	
Diabetes					0.1
Never	111 (53)	101 (50)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	
Intra-articular					0.6
Never	111 (53)	101 (50)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	
Medial comminution present					0.5
Never	111 (53)	101 (50)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	
Open fracture					0.7
Never	111 (53)	101 (50)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	
Number of distal segment screws	4.8 (0.5)	5.3 (0.5)	5.9 (0.5)	5.9 (0.5)	0.046
Number of proximal segment screws	4.8 (0.5)	4.6 (0.5)	4.1 (0.4)	4.1 (0.4)	0.038
Number of proximal cortical screws engaged	8.3 (0.6)	8.4 (0.5)	7.9 (1.4)	7.9 (1.4)	0.3
Proportion of proximal screws that are locking	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.2
Intraoperative weight bearing on talonavicular	10 (4.8%)	14 (7.0%)	1 (5.3%)	1 (5.3%)	0.6

\*All categorical variables given as N(%) and evaluated with the Fisher test. Continuous variables given as mean (standard deviation) and evaluated with the t-test.

Table 3. Descriptive and univariate statistics with respect to deep infection

Factor*	Deep infection (N = 228)		No infection (N = 217)		Infection (N = 11)		p-value
	Count (N, %)	Count (N, %)	Count (N, %)	Count (N, %)	Count (N, %)	Count (N, %)	
Gender	221 (100)	222 (100)	203 (94)	203 (94)	18 (8)	18 (8)	0.6
Age	72.1 (10.5)	72.2 (10.5)	70.3 (11.0)	70.3 (11.0)	70.3 (11.0)	70.3 (11.0)	0.07
Race							<0.01
White	162 (77)	154 (77)	148 (73)	148 (73)	14 (7)	14 (7)	
Black or African American	29 (13)	39 (19)	1 (5)	1 (5)	1 (5)	1 (5)	
Hispanic or Latino	7 (3)	7 (3)	0 (0)	0 (0)	0 (0)	0 (0)	
American Indian or Alaska Native	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Asian	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Native Hawaiian or Other Pacific Islander	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Tobacco use							<0.01
Never	111 (53)	101 (50)	11 (58)	11 (58)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	11 (58)	11 (58)	
Diabetes							0.5
Never	111 (53)	101 (50)	11 (58)	11 (58)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	11 (58)	11 (58)	
Intra-articular							<0.01
Never	111 (53)	101 (50)	11 (58)	11 (58)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	11 (58)	11 (58)	
Medial comminution present							0.6
Never	111 (53)	101 (50)	11 (58)	11 (58)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	11 (58)	11 (58)	
Open fracture							0.8
Never	111 (53)	101 (50)	11 (58)	11 (58)	11 (58)	11 (58)	
Current	25 (12)	37 (19)	3 (16)	3 (16)	3 (16)	3 (16)	
Former	72 (34)	112 (55)	11 (58)	11 (58)	11 (58)	11 (58)	
Number of distal segment screws	4.8 (0.5)	5.3 (0.5)	5.9 (0.5)	5.9 (0.5)	5.9 (0.5)	5.9 (0.5)	0.6
Number of proximal segment screws	4.8 (0.5)	4.6 (0.5)	4.1 (0.4)	4.1 (0.4)	4.1 (0.4)	4.1 (0.4)	0.038
Number of proximal cortical screws engaged	8.3 (0.6)	8.4 (0.5)	7.9 (1.4)	7.9 (1.4)	7.9 (1.4)	7.9 (1.4)	0.3
Proportion of proximal screws that are locking	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.6 (0.2)	0.2
Intraoperative weight bearing on talonavicular	10 (4.8%)	14 (7.0%)	1 (5.3%)	1 (5.3%)	1 (5.3%)	1 (5.3%)	0.6

\*All categorical variables given as N(%) and evaluated with the Fisher test. Continuous variables given as mean (standard deviation) and evaluated with the t-test.