Nail Plate Fixation Versus Lateral Locked Plating for Distal Femur Fractures: A Multicenter Propensity Matched Analysis

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INTRODUCTION:

Distal femur fractures are devastating injuries associated with significant morbidity and mortality. Surgical management is often challenging given the displaced, intra-articular, and comminuted nature of many of these fractures. Precontoured lateral locking plates (LLP) are currently the most commonly utilized surgical option, but nail plate fixation (NPF) has recently been proposed for fracture patterns at a high risk of nonunion as a way to combine the virtues of each individual technique. The purpose of this multicenter study is to 1) report on outcomes after NPF and 2) compare nonunion and malunion rates after NPF with a propensity matched cohort of distal femur fracture patients treated with LLP.

METHODS:

All adult patients with distal femur fractures who underwent NPF or LLP between 2012 and 2019 at one of the 11 participating institutions were identified. Patient and injury characteristics, operative details, pre- and post-operative radiographs, and outcome variables were collected from inpatient and outpatient records. After using propensity score matching to account for risk factors for nonunion, the rates of malunion and unplanned reoperation to promote union were compared between the two treatment cohorts. Minimum follow-up was set at 12 weeks.

RESULTS:

Thirty-five NPF patients (mean age 52 years old, 69% female) and 873 LLP patients met criteria for inclusion. Of the 35 fractures treated with NPF, 23 (66%) occurred due to high energy mechanisms such as motor vehicle collisions or falls from height, 20 (57%) were intra-articular, 14 (40%) were open, 4 (12%) were periprosthetic, and 21 (60%) had comminution at the medial cortex. No NPF patients required unplanned reoperation to promote union and no NPF patients exhibited varus or hyperextension malunion at final follow-up. Three underwent all-cause unplanned reoperation (2 for infection, 1 for hardware removal) at an average of 92 weeks after surgery. More than 90% were ambulatory with no or minimal pain at final follow-up (Table 1).

Propensity score matching (Figure 1) yielded well-balanced cohorts of 30 NPF patients and 30 LLP patients (Table 2). Compared to LLP patients, NPF patients demonstrated significantly lower rates of both malunion (0% vs. 13%, p=0.038) and unplanned reoperation to promote union (0% vs. 13%, p=0.038).

DISCUSSION AND CONCLUSION: This analysis of 35 patients is the largest series to date reporting on the performance of nail plate fixation for distal femur fractures. Despite a high proportion of high energy, open, and comminuted fractures, no NPF patients underwent unplanned reoperation to promote union. Furthermore, propensity score matched analysis revealed significantly lower rates of malunion or nonunion for NPF compared to LLP. These findings suggest that nail plate fixation can achieve excellent outcomes with a high rate of union for even the most complex distal femur fracture morphologies.

Figure 1. Propensity Score Density Plots

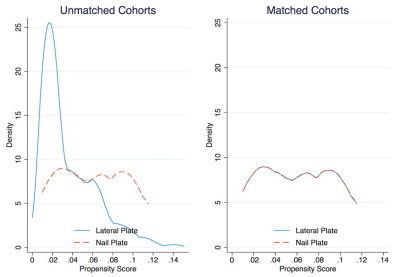

Table 1: Characteristics and Outcomes of 35 Nail Plate Patients

Characteristics	
Age (years)	52 +/- 18.3
Female Sex	24 (69%)
Race or Ethnicity	
Asian	1 (3%)
Black	17 (49%)
Hispanic	1 (3%)
White	16 (46%)
Tobacco Use	9 (26%)
Diabetes	8 (23%)
American Society of Anesthesiology Score	
I	0 (0%)
II	10 (29%)
III	20 (57%)
IV	4 (11%)
V	1 (3%)
Body Mass Index	30.6 +/- 12.8
High energy mechanism*	23 (66%)
Periprosthetic	4 (12%)
Intra-articular	20 (57%)
Open fracture	14 (40%)
Gustilo Anderson Type III	12 (35%)
Head Injury	5 (15%)
Vascular Injury	3 (9%)
Medial Comminution	21 (60%)
Outcomes	
mRUST ≥ 10 at 12 weeks	12 (44%)
Unplanned reoperation	3 (9%)
Promote union	0 (0%)
Infection	2 (6%)
Implant removal	1 (3%)
Malunion (hyperextension or varus)	0 (0%)
Pain at final follow-up	
None	5 (15%)
Mild, not functionally limiting	27 (79%)
Severe, functionally limiting	2 (6%)
Non-ambulatory at final follow-up	3 (9%)
Assistance	
None	11 (37%)
Cane or crutch	6 (20%)
Walker	13 (43%)

* High energy injuries include automobile or motorcycle collisions, vehicle versus pedestrian, bicycle, or scooter, falls from height, gun shots, and explosions. Low energy injuries include ground level falls.

Table 2. Characteristics and Outcomes between Propensity Matched Cohorts

	Lateral Locked Plate (n=30)	**Nail Plate (n=30)**	**P-Value**
Characteristics			
Age (years)	52.8 +/- 17.2	51.5 +/- 18.0	0.773
Female Sex	15 (50%)	21 (70%)	0.114
Body Mass Index	26.0 +/- 8.6	30.7 +/- 13.0	0.281
High Energy Injury	20 (67%)	19 (63%)	0.787
Periprosthetic	6 (20%)	4 (13%)	0.488
Intra-articular	16 (53%)	17 (57%)	0.795
Open fracture	14 (47%)	11 (37%)	0.432
Gustilo Anderson Type III	11 (37%)	9 (30%)	0.584
Medial Comminution	20 (67%)	20 (67%)	1.000
Medial Translation (proportion of condylar width)	0.50	0.41	0.700
Outcomes			
Unplanned reoperation to promote union	**4 (13%)**	**0 (0%)**	**0.038**
Malunion (hyperextension or varus)	**4 (13%)**	**0 (0%)**	**0.038**
Reoperation for infection	0 (0%)	2 (7%)	0.150
mRUST score ≥10 at 12 weeks	11 (46%)	12 (44%)	0.921