

Outcomes-Based Assessment of Distal Third Femur Fractures: A Pilot Study

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INTRODUCTION: The selection of implant (nail [NL], plate [PL], or nail/plate [NP]) for patients with distal femur fractures is typically determined by multiple factors including fracture type and surgeon experience. This study uniquely implements a cluster analysis to determine outcomes of patients with distal femur fractures based on fracture classification and type of implant. Selection of the most optimal fixation method for fractures of the distal femur, whether intramedullary nail (NL), lateral locking plate (PL), or nail/plate (NP) is not always clear. An adjunctive clinical and evidence-based surgical tool to help guide orthopaedic surgeons deciding which fixation method to use for distal femur fractures would therefore be of value. This pilot study used cluster analysis to determine outcomes of patients with distal femur fractures based on fracture classification and type of surgical fixation.

METHODS: This is a retrospective cohort study of patients 18 years and older with an isolated distal femur fracture who presented to our institution's Level-1 trauma center between January 1, 2012 and December 31, 2022 and underwent surgery with a NL, PL, or NP dual construct. Patients with polytrauma and peri-prosthetic fracture were excluded. Chart review was performed to collect demographics, AO femur fracture classification, type of fixation method, and evaluate for postoperative complications. Cluster analysis was used as it allowed grouping of patients based on fracture classification and implant type to identify which characteristics led to a certain outcome. Using a partitioning-around-medoids (PAM) approach, Gower distances were calculated between patients to partition them into different clusters. The number of clusters which would yield the highest possible Silhouette Score (a measure of how well patients fit in a cluster based on shared characteristics), while not yielding clusters with redundant implant type and fracture classification combinations, was used for this study. A successful surgical outcome was defined as a surgery which did not result in infection, mortality, non-union, malunion, implant failure, or a substantial decline in ambulatory status. Success was determined for each cluster as the percentage of successful surgeries within a cluster.

RESULTS SECTION: A total of 169 patients (68.64% female, average age 66 years) met the inclusion criteria. A total of 15 clusters were used, allowing for a high Silhouette Score (0.9078). Twelve clusters were 100% homogeneous, while 3 of the 15 clusters had approximately 60% of patients with the majority fracture classification. Extra-articular simple spiral fractures (33A2.1) treated with a PL (n = 4) had a 75.00% success rate (vs 100% with NL [n = 12]). An oblique simple fracture at the distal metaphysis (33A2.2) stabilized with a NP (n = 3) had a 66.67% success rate (vs 72.73% with NL [n = 11] and 72.22% with PL [n = 18]). Extra-articular transverse simple fractures (33A2.3) had a 100.00% success rate with a dual construct [n = 6] (vs 78.57% success rate with PL [n = 14]; and 50.00% success rate with a NL [n = 2]). Extra-articular fragmentary wedge fractures (33A3.2) which were treated with a PL (n = 8) experienced a success rate of 75.00%. Extra-articular multi-fragmentary wedge fractures (33A3.3) treated with a PL (n = 11) had a success rate of 45.45% (vs 40.00% with NL [n = 5]). A partial articular fracture (33B) treated with a PL (n = 17) had a success rate of 88.35%. Patients with complete intra-articular fractures (33C) treated with a dual construct implant (n = 5) had a success rate of 100.00% (vs 61.36% with PL [n = 44] and 77.78% with NL [n = 9]). Other fracture classification/implant type combinations of the distal femur were not represented as a majority of any of the clusters.

DISCUSSION: This pilot study demonstrates the application of cluster analysis to determine the rate of a successful surgical outcome based on fracture class and implant type. Patients with 33A2.1 fractures treated with a NL had a 100% success rate whereas those treated with a PL had a 75% success rate. All patients with 33A2.3 and 33C fractures treated with NP had a successful outcome whereas those treated with NL or PL alone had more variable outcomes. 33A3.3 fractures had a low overall success rate when treated with a NL or PL alone suggesting that these more comminuted extraarticular fractures may benefit from additional fixation with a dual construct. However, before definitive conclusions are drawn and a clinical evidence based surgical tool is developed, future study with a larger sample size and inclusion of patient specific characteristics within the clustering analysis are needed.

SIGNIFICANCE/CLINICAL RELEVANCE: Determining whether a particular patient with a distal femur fracture requires a NL, PL, or NP is essential to the resolution of fractures.

IMAGES AND TABLES:

Table 1: Success rates for each cluster, corresponding to fracture classification and implant. The number of patients in each cluster is given parenthetically.

AO Fracture Classification	Implant		
	Plate	Nail	Nail and Plate
33A2.1	75.00% (4)	100.00% (12)	-
33A2.2	72.22% (18)	72.73% (11)	66.67% (3)
33A2.3	78.57% (14)	50.00% (2)	100.00%* (6)
33A3.1	-	-	-
33A3.2	75.00%* (8)	-	-
33A3.3	45.45% (11)	40.00%* (5)	-
33B	88.35% (17)	-	-
33C	61.63% (44)	77.78% (9)	100.00% (5)

KEY
100.00%
> 75.00% & ≤ 99.99%
> 50.00% & ≤ 75.00%
≤ 50.00%
No clusters with this combination.

* Non-homogeneous clusters