Fracture Lines and Patterns in Intra-articular Distal Femur Fractures

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INTRODUCTION:

Distal femur fractures are complex injuries that often present with multiple fragments and zones of comminution, posing significant challenges to fracture fixation. A more comprehensive understanding of intra-articular distal femur fracture patterns may help facilitate more effective communication about these injuries. The purpose of this study was to use preoperative computed tomography (CT) scans to graphically display fracture lines in intra-articular distal femur fractures. We hypothesized that when CT images in the axial, coronal, and sagittal planes were superimposed, a pattern of common fracture lines would emerge.

METHODS:

All skeletally mature patients that underwent operative fixation of Orthopaedic Trauma Association (OTA) type 33C distal femur fractures between 2012 and 2022 were identified across two Level-1 trauma centers. Pre-operative axial, sagittal, and coronal CT scans were obtained. Fracture lines in each plane were traced out and superimposed on standardized distal femur cross sections, generating a fracture map for each plane. Injury and fracture characteristics were summarized and compared between fracture patterns.

RESULTS:

Sixty-three patients (30 female) were identified. Mean age was 54 years (range 15-91), 42 of 63 patients suffered high energy injuries (motor vehicle collision, motorcycle accident, auto versus pedestrian), and 26 suffered open fractures.

On axial CT scans, 59 of 63 fractures contained a central intercondylar split from the intercondylar notch to the trochlea (Figure 1). On coronal scans, fracture lines originated at the notch and exited laterally and medially in the supracondylar region, creating a Y-shape. One third of all fractures contained coronal fracture lines with most involving the lateral condyle. Based on fracture line orientation and location, fractures were divided into 4 main fracture pattern types (Table 1, Figure 2). Type 1 fractures contained a single central sagittal intercondylar split that exited through the trochlea. Type 2 fractures contained oblique or sagittal fracture lines through the weight-bearing surface of the lateral or medial condyles. Type 3 fractures contained lateral femoral condyle coronal fracture lines in addition to the central split, and Type 4 fractures contained medial coronal fractures in addition to the central split. Type 4 fractures (central split and medial coronal fracture line) were associated with lower average medial fracture height (p=0.029) and trended towards a lower rate of medial metaphyseal comminution (p=0.117) (Table 2).

DISCUSSION AND CONCLUSION:

In conclusion, we found that C-type distal femur fractures can present with four main fracture patterns. The majority of fractures contain a central sagittal intercondylar split and a high proportion of fractures contain either medial or lateral coronal fracture lines. Fracture pattern was found to be associated with mechanism of injury, presence of medial comminution, and medial fracture line height. Future studies should focus on clinical outcomes and surgical management fracture





distinct

Table 1. Intra-art	ticular Distal Femur Fracture Patterns	
Fracture Pattern	Description	N (%)
Type 1	Central intercondylar split	36 (57%)
Type 2	Sagittal or oblique split through weight bearing surface	6 (10%)
Type 3	Central split and lateral coronal split	14 (22%)
Type 4	Central split and medial coronal split	6(10%)
ther	Central split, medial and lateral coronal split	1 (2%)
iotal		63 (100%)

able 2. Patient, Injury, and Fracture Characteristics Across Fracture Patterns						
Characteristic	Type 1 (N=36)	Type 2 (N=6)	Type 3 (N=14)	Type 4 (N=6)	All patients (N=63)	
Age (years)	58 +/- 19	52 +/- 14	45 +/- 19	54 +/- 17	54 +/- 19	
High energy injury (%)	20 (56%)	6 (100%)	12 (86%)	3 (50%)	42 (67%)	
Open fracture (%)	11 (31%)	3 (50%)	8 (57%)	3 (50%)	26 (41%)	
Medial comminution (%)	15 (42%)	2 (33%)	8 (57%)	0 (0%)	26 (41%)	
Comminution length (mm)	45.5 +/- 23.3	53.8 +/- 17.2	45.7 +/- 31.4	nia	45.8 +/- 24.6	
Medial fracture	79.0 +/-	93.1 +/-	70.8 +/-	52.2 +/-	75.2 +/- 22.4	

patterns.