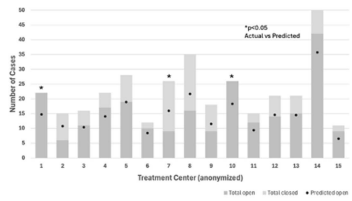
Treatment-center Variations in Open versus Closed Reduction for Non-elderly Femoral Neck Fractures

Charlotte Frances Wahle, Afshin Anoushiravani, Shravya Kakulamarri, Joseph Patterson, Cory Alan Collinge, Saam Morshed

INTRODUCTION:
Femoral neck fractures (FNF) in young, healthy individuals are rare but potentially debilitating injuries — carrying a high risk of long-term complications such as nonunion and avascular necrosis. Existing evidence consistently suggests that the quality of the reduction is one of the most critical surgeon-dependent predictors of favorable outcomes. However, the optimal surgical approach for attaining this reduction remains controversial in non-elderly patients. Previous research has demonstrated the existence of treatment center variation in several other surgical interventions, influenced by a lack of formal practice guidelines, conflicting supporting evidence, resource availability, institutional policies, and surgeon and patient-specific factors. The purpose of this study was to examine whether the decision to perform open reduction in the surgical management of FNF in non-elderly individuals varies by treatment center in a manner that is independent of patient or injury-specific factors.
METHODS:
We identified all patients aged 18–60 who presented with OTA/AO type 31B femoral neck fractures to 25 North American Level 1 trauma centers and underwent operative fixation. A retrospective chart review collected demographics, injury characteristics, operative data, and follow-up information. Differences between patients treated with open versus closed reductions were analyzed using two-tailed t-tests and chi-squared tests. Bivariate analyses identified covariates for multivariate modeling. The propensity for treatment with open versus closed reduction was estimated given patient and fracture characteristics. Predicted probabilities of open reduction were averaged for each treatment center and used to assess variation in each center's proportion of open reductions. Logistic models of treatment approach were fit with and without indicator variables for treatment centers to test the impact of exclusion of treatment center using a likelihood ratio test.
RESULTS:
The sample included 818 patients with a mean age of 43.9 SD 11.3 , 56.7% of patients were male, 37.0% presented with a Pauwels angle >50 degrees. Median follow-up was 54.6 weeks (IQR 29.3-96.6). During the follow-up period, 404 patients (49.4%) experienced complications and 224/818 (27.4%) underwent revision surgery. Open reduction was performed more frequently for 225/352 (63.9%) displaced FNFs compared with 131/466 (28.1%) non-displaced FNFs ($p<0.001$). In the combined cohort, open reduction was more likely with greater fracture severity and male sex, while smoking, diabetes, ESRD, steroid use, and elevated age were linked to lower likelihood. Among 348 displaced fractures, the observed rate of open reduction (70.1%) closely aligned with the predicted probability (66.1%), though three centers deviated significantly from that which would be predicted by case mix. In 453 non-displaced cases, open reduction correlated with male sex, higher fracture severity, and three centers again demonstrated significant variation from predicted rates. A likelihood ratio test showed significant deterioration of model fit with exclusion of treatment center for both groups ($p<0.001$).
DISCUSSION AND CONCLUSION: The decision to perform an open versus closed reduction for FNFs in non-elderly patients was significantly influenced by treatment center regardless of patient characteristics and case-mix, suggesting that factors beyond case-mix at the treatment-center level bias operative decision making.

Figure 1: Total number of **(a)** displaced and **(b)** non-displaced femoral neck fractures treated with open versus closed fixation. Black dot represents predicted probability based on logistic regression.

a.



b.

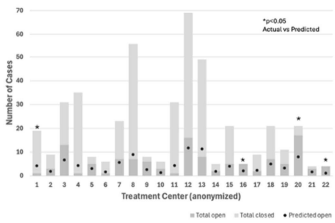


Table 1: Baseline Demographic and Injury Characteristics

	ORIF (n=356)		CRIF (n=462)		*P*
Patient Characteristics					
Age (y)	40.1	(38.9-41.3)	46.9	(46.0-47.9)	<0.001
Male sex	225	63.7%	239	52.5%	0.001
Current smoker	126	35.6%	136	29.5%	0.057
Current alcohol abuse	48	13.5%	46	10.0%	0.117
Steroids	8	2.3%	36	7.8%	0.001
Diabetes mellitus	17	4.8%	55	11.9%	<0.001
ESRD	12	3.4%	38	8.2%	0.004
Arthritis	3	1.3%	5	3.5%	0.159
Injury Characteristics					
Time to OR	3.8	(2.0-5.5)	2.9	(0.8-5.0)	0.521
Displacement	225	63.2%	125	27.5%	<0.001
Associated femoral shaft fracture	70	19.7%	43	9.3%	<0.001
Comminution	212	61.3%	157	34.1%	<0.001
Pauwels angle >50 degrees	116	63.5%	187	40.5%	<0.001
OTA Class					<0.001
1	48	13.9%	17	3.7%	
2	262	75.7%	237	51.5%	
3	36	10.4%	206	44.8%	