Surgeon Volume and Outcomes for Intertrochanteric Hip Fracture Fixation

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INTRODUCTION:

Geriatric intertrochanteric femur fractures represent a significant cause of morbidity and mortality, which is only increasing with the aging population, both in the United States and internationally. Hip fracture fixation represents a key skill within orthopaedic surgery with many orthopaedic surgeons from a variety of subspecialty trainings covering hip fracture call. The outcomes of these surgeries have significant impacts on healthcare costs at all levels, as well as for the patients and their families. The factors influencing complications, reoperations, and mortality remain an area of exploration, in order to help optimize patient outcomes, particularly as care focusing optimizing patient care for this potentially fragile and vulnerable geriatric hip fracture population becomes increasingly critical within the healthcare system.

METHODS: We performed a retrospective observational study of 2063 intertrochanteric hip fractures from 2014 to 2023 at a large academic institution. Patient variables included demographics, comorbidities, fracture characteristics, and operative variables. The primary outcomes were re-operation, any radiographic bony complication, 30-day and 1-year all-cause mortality, and achievement of target Tip-Apex-Distance (TAD) between 10 and 25mm. Patients and surgeons were grouped into tertile cohorts based on cumulative case volume during the study period, with an approximately equal total number of cases per cohort: Low (N=51 surgeons each with < 42 cases; N=656 total cases), Medium (N=12 surgeons each with 42-74 cases; N=687 total cases), and High (N=7 surgeons each with >75 cases; N=720 total cases). Patient and surgeon-level univariate comparisons were performed using Kruskal-Wallis tests for continuous variables, chi-square tests for categorical variables, and chi-square test of proportions for outcome rates. Patient-level multivariate logistic regression was conducted for each outcome, incorporating age, gender, smoking status, Body Mass Index (BMI), American Society of Anesthesiologists (ASA) Status, fracture stability, and operating surgeon case volume (numeric).

RESULTS: Patients treated by low-, medium- or high-volume surgeons were similar across age, BMI, ASA status, smoking, and fracture pattern stability (Table 1). Fracture fixation quality as assessed by achieving a TAD of 10-25 mm, adequate reduction in the sagittal plane and restoration of Shenton's line were also similar across patients of surgeons at all volumes of hip fracture fixation (Table 1). When comparing outcomes for these individual patients treated by surgeons with low-, medium- or high-volume hip fracture caseloads, complications, reoperation rates, and both 30-day and 90-day mortality were similar (Table 2). However, when comparing reoperation rates across surgeons with similar case volumes, surgeon reoperation rate decreased with increased experience (Table 3). Overall, patient and fracture characteristics were the strongest predictors of achieving a TAD 10-25 mm, risk for bony complications, likelihood of reoperation and both 30-day and 1-year mortality. Namely, when controlling for other factors, fracture stability and gender correlated with achieving a TAD 10-25 mm. Age, male gender, BMI, ASA status and fracture instability were correlated with a patient's risk for reoperation. BMI and age correlated most with risk for bony complications. ASA status, age, gender and BMI most strongly predicted 30-day and 1-year mortality (Table 4).

DISCUSSION AND CONCLUSION:

When considering surgeons that have a low, medium or high hip fracture fixation volume, reoperation rates decrease with increased hip fracture case load experience. Consequently, for an individual surgeon, increased case load of hip fracture fixation does decrease the risk for patients requiring reoperations. However, on an individual patient level, individual patient and fracture characteristics are more associated with outcomes, and their surgeon's volume of hip fracture fixation is not statistically significantly associated with increased rates of complications, reoperations or 30-day or 1-year mortality.

Table 1. Patient Characteristics and Surgical Variables

	Low (N=656 cases)	**Medium** (N=687 cases)	**High** (N=720 cases)	***p*-value**[1]
Demographics				
Age *(years)*	83.4 ± 8.5	84.0 ± 8.5	84.3 ± 8.5	0.187
Gender				0.274
Female	72.6% (476)	76.3% (524)	73.6% (530)	
Male	27.4% (180)	23.7% (163)	26.4% (190)	
BMI *kg/m²*	24.8 ± 5.5	24.5± 5.4	25.2 ± 5.8	0.058
Smoking				0.082
Current	9.5% (62)	9.7% (66)	6.4% (46)	
Never	48.2% (314)	44.4% (302)	47.3% (339)	
Quit	42.2% (275)	45.9% (312)	46.3% (332)	
N/A	5	7	3	
ASA Status	2.92 ± 0.53	2.93 ± 0.56	2.96 ± 0.58	0.300
Surgical variables				
Surgery Duration *(min)*	68.9 ± 37.3	55.1 ± 26.9	64.8 ± 37.5	**<0.001***
EBL *(mL)*	166.6 ± 173.1	151.0 ± 143.2	142.1 ± 125.3	**0.043***
Fracture Stability				0.253
Stable	44.2% (290)	48.5% (333)	45.1% (325)	
Unstable	55.8% (366)	51.5% (354)	54.9% (395)	
Sagittal Plane Adequate Reduction				0.056
No	10.5% (67)	12.2% (82)	8.3% (58)	
Yes	89.5% (572)	87.8% (589)	91.7% (642)	
N/A	17	16	20	
Restoration of Shenton's Line				0.156
No	2.7% (17)	4.3% (29)	4.6% (32)	
Yes	97.3% (620)	95.7% (647)	95.4% (668)	
N/A	19	11	20	
Tip-Apex Distance	18.9 ± 6.0	19.3 ± 6.4	18.5 ± 6.6	0.098

[1] p-values calculated using Kruskal-Wallis test for numeric variables, chi-square test for categorical variables, and chi square test of proportions for outcome rates.

Table 2. Patient-level outcomes

	Low (N=656 cases)	**Medium** (N=687 cases)	**High** (N=720 cases)	***p*-value**[1]
Re-operation	5.0%	6.0%	5.0%	0.187
Any Bony Complication	3.2%	2.6%	3.7%	0.484
30-day mortality	6.7%	6.7%	4.4%	0.117
1-year mortality	22.7%	26.6%	21.9%	0.089
Tip-Apex Distance 10-25mm	36.6%	40.2%	38.7%	0.132

[1] p-values calculated using chi square test of proportions for outcome rates.

Table 3. Surgeon-level outcomes (Within-Cohort Mean Rates)

	Low (N=51 surgeons)	**Medium** (N=12 surgeons)	**High** (N=7 surgeons)	***p*-value**[1]
Re-operation rate	6.4%	5.9%	4.9%	**0.005**
30-day mortality rate	7.2%	6.3%	4.5%	0.224
1-year mortality rate	22.7%	26.3%	22.1%	0.336
TAD[2] 10-25mm rate	80.4%	79.2%	81.0%	0.168

[1] p-values calculated using chi square test of proportions for outcome rates.
[2] Tip-Apex Distance

Table 4. Patient Outcome Regression Models

Reoperation

Term	Odds Ratio	CI Lower	CI Upper	P-value
(Intercept)	0.602	0.058	5.981	0.667
Age	0.974	0.950	0.998	0.036
GenderMale	0.517	0.295	0.862	0.015
SmokingNever	0.592	0.307	1.202	0.131
SmokingQuit	0.576	0.299	1.166	0.110
BMI	1.056	1.024	1.088	< 0.001
ASA_Status	0.629	0.440	0.900	0.011
Unstable_FxClfUnstableFx	1.610	1.072	2.456	0.024
surgeon_volume	1.002	0.997	1.006	0.493

30-day mortality

Term	Odds Ratio	CI Lower	CI Upper	P-value
(Intercept)	1.68e-04	1.20e-05	0.002	< 0.001
Age	1.062	1.034	1.091	< 0.001
GenderMale	2.071	1.374	3.101	< 0.001
SmokingNever	0.504	0.242	1.119	0.077
SmokingQuit	0.653	0.324	1.414	0.253
BMI	0.950	0.911	0.988	0.013
ASA_Status	2.294	1.618	3.261	< 0.001
Unstable_FxClfUnstableFx	1.069	0.732	1.566	0.731
surgeon_volume	0.996	0.991	1.001	0.105

TAD 10-25mm

Term	Odds Ratio	CI Lower	CI Upper	P-value
(Intercept)	5.574	1.317	23.966	0.020
Age	0.996	0.981	1.011	0.577
GenderMale	0.696	0.533	0.912	0.008
SmokingNever	0.892	0.550	1.411	0.632
SmokingQuit	1.085	0.671	1.714	0.732
BMI	0.995	0.974	1.017	0.646
ASA_Status	1.239	0.999	1.536	0.051
Unstable_FxClfUnstableFx	0.644	0.506	0.819	< 0.001
surgeon_volume	1.000	0.998	1.003	0.870

1-year mortality

Term	Odds Ratio	CI Lower	CI Upper	P-value
(Intercept)	7.84e-04	1.79e-04	0.003	< 0.001
Age	1.062	1.047	1.078	< 0.001
GenderMale	1.980	1.550	2.527	< 0.001
SmokingNever	0.666	0.430	1.047	0.073
SmokingQuit	0.787	0.513	1.224	0.278
BMI	0.940	0.919	0.962	< 0.001
ASA_Status	2.315	1.885	2.855	< 0.001
Unstable_FxClfUnstableFx	1.003	0.807	1.247	0.978
surgeon_volume	0.999	0.996	1.001	0.403

Any Bony Complication

Term	Odds Ratio	CI Lower	CI Upper	P-value
(Intercept)	0.068	0.003	1.299	0.078
Age	0.972	0.942	1.004	0.082
GenderMale	0.689	0.350	1.268	0.252
SmokingNever	1.001	0.387	3.123	0.998
SmokingQuit	1.000	0.388	3.106	0.999
BMI	1.080	1.042	1.119	< 0.001
ASA_Status	0.701	0.440	1.118	0.136
Unstable_FxClfUnstableFx	1.800	1.061	3.156	0.034
surgeon_volume	1.005	0.999	1.010	0.096