Comparison of Intraoperative and 90-Day Periprosthetic Fracture Rates Between Single Taper, Dual Taper, and Triple Taper Femoral Stem Designs

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INTRODUCTION: Due to the recent introduction of triple taper femoral stems to the market, periprosthetic fracture incidence in triple taper compared to single or dual taper stems has not been well described. Our objective was to evaluate intraoperative and 90-day postoperative periprosthetic fracture risk among single, dual, and triple taper stem designs.

METHODS: A single-institution retrospective cohort study was performed. All cases from February 2016 to December 2023 using cementless single (n=8,533), dual (n=8,515), or triple taper stems (n=5,541) (Table 1) from four implant companies (Table 2) were compared. Intraoperative and early (90-day) periprosthetic fractures were collected. Univariate and multivariable analysis was used to evaluate periprosthetic fracture risk.

RESULTS: Eighty-two early postoperative fractures (0.36%) and 118 intraoperative fractures (0.52%) occurred. Postoperative fractures occurred in 30 single taper (0.35%), 47 dual taper (0.55%), and 5 triple taper stems (0.09%) (p<0.001). Intraoperative fractures occurred in 30 single taper (0.35%), 69 dual taper (0.81%), and 19 triple taper (0.34%) stems (p<0.001). After accounting for age, sex, BMI, ASA score, smoking status, and surgical approach, triple taper stems had a lower risk of early postoperative fracture (OR 0.30, p=0.014) (Table 3) and a similar rate of intraoperative fracture (OR 1.04, p=0.90) compared to single taper stems (Table 4). Compared to dual taper stems, triple taper stems had a lower risk of early postoperative fracture (OR 0.19, p=0.001) and intraoperative fracture (OR 0.41, p=0.002).

DISCUSSION AND CONCLUSION: In a cohort of over 20,000 patients undergoing cementless THA, triple taper femoral stems were associated with a lower risk of early postoperative fracture compared to single and dual taper stems. Intraoperative fracture risk was similar between single and triple taper stems, and higher in dual taper stems.

Table 1. Characteristics of the study sample

Variable	n	%
Age (years)	67.1 (10.7)	
BMI (kg/m^2)	29.0 (5.9)	
Sex		
Female	11,942	52.9%
Male	10,647	47.1%
Race		
Asian	422	1.9%
Black or African American	1,356	6.0%
Other	1,306	5.8%
White or Caucasian	19,505	86.4%
Smoking History		
Current	1,349	6.0%
Former	8,132	36.0%
Never	13,008	57.6%
Unknown	100	0.4%
ASA Score		
1	978	4.3%
2	18,074	80.0%
3+	3,537	15.7%
Surgical Approach		
Direct anterior	4,956	21.9%
Posterior	17,633	78.1%
Stem Design		
Single taper	8,533	37.8%
Dual taper	8,515	37.7%
Triple taper	5,541	24.5%

Continuous variables are reported as mean (standard deviation). Categorical variables are reported as n (%).

Table 2. Femoral stem included in the study sample

Stem Type	Stem Name	Manufacturer
Single taper	Tri-Lock	DePuy Synthes
	Anthology	Smith+Nephew
	Accolade II	Stryker
	M/L Taper	Zimmer-Biomet
	Taperloc	Zimmer-Biomet
Dual taper	Summit	DePuy Synthes
	Synergy	Smith+Nephew
	SecurFit Advance	Stryker
	Echo Bi-Metric	Zimmer-Biomet
Triple Taper	Actis	DePuy Synthes
	Insignia	Stryker
	Polarstem	Smith+Nephew

DePuy Synthes, Raynham, MA; Smith+Nephew, London UK; Stryker, Mahwah, NJ; Zimmer-Biomet, Warsaw, IN

Table 3. Multivariable analysis evaluating early postoperative periprosthetic fracture risk

Variable	Odds Ratio	2.5% CI	97.5% CI	P-value
Age	1.04	1.02	1.07	<0.001
Female sex	3.32	1.97	5.59	<0.001
Body mass index	1.03	0.99	1.07	0.17
ASA score	1.34	0.79	2.26	0.28
Smoking status				
Never	ref			
Former	1.2	0.76	1.91	0.43
Current	2.42	1.11	5.24	0.03
Anterior approach	0.88	0.42	1.86	0.74
Stem Design				
Single taper	ref			
Dual taper	1.61	0.97	2.65	0.06
Triple taper	0.30	0.12	0.78	0.01

Table 4. Multivariable analysis evaluating intraoperative periprosthetic fracture risk

Variable	Odds Ratio	2.5% CI	97.5% CI	P-value
Age	1.01	0.99	1.02	0.54
Female sex	1.77	1.2	2.61	0.004
Body mass index	0.99	0.96	1.03	0.74
ASA score	1.39	0.89	2.17	0.15
Smoking status				
Never	ref			
Former	0.85	0.57	1.26	0.42
Current	0.86	0.37	1.99	0.72
Anterior approach	1.08	0.59	1.96	0.81
Stem Design				
Single taper	ref			
Dual taper	2.55	1.58	4.1	<0.001
Triple taper	1.04	0.58	1.86	0.90