Oncological Indication Does Not Portend Worse Outcomes After Proximal Femoral Replacement: Prior Surgical Burden rather than Diagnosis, Drives Revision Risk

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Significance & Hypothesis: Proximal femoral replacement (PFR) is employed for both oncological reconstruction and complex non-oncological limb salvage. Many surgeons presume that these populations have different outcomes due to the differences in their underlying indication for surgery. We hypothesized that oncological patients would experience higher rates of failure and revision surgery than their non-oncological patients due to their underlying disease and radio-chemotherapeutic treatments.

Innovation: This is one of the largest single-institution series directly contrasting oncological and non-oncological PFR outcomes, and the first to our knowledge to show that the assumption of inferior outcomes in oncological patients is unfounded, with apparent disparities fully explained by prior surgical history.

Approach: We retrospectively reviewed 505 consecutive patients undergoing PFR at a single tertiary center between 2000-2025, stratified by indication (oncological, n=409; non-oncological, n=96). Primary outcomes were any revision surgery, Henderson modes of failure (Types 1–5), amputation, implant retention, and all-cause mortality. Group comparisons used Fisher exact or Mann–Whitney tests. Effect sizes were reported as risk ratios (RR) and risk differences (RD) with 95% confidence intervals. Time-to-event analyses used Kaplan–Meier estimation with log-rank tests. Predictors of revision were examined with univariable and multivariable Cox proportional hazards models incorporating indication, age, sex, ASA class, prior surgery at site, and removal of prior hardware.

Results: Contrary to common clinical assumption, oncological patients did not experience higher revision or failure rates than non-oncological patients. Revision occurred in 14.7% of oncological versus 29.2% of non-oncological patients (RR 0.50, 95% CI 0.34–0.74; p=0.001), with oncological patients demonstrating lower rates of Type 1 soft tissue failure (5.6% vs 14.6%; RR 0.39, 95% CI 0.21–0.72; p=0.007) and Type 4 deep infection (6.4% vs 16.7%; RR 0.38, 95% CI 0.21–0.68; p=0.003). Amputation (2.4% vs 2.1%; p=1.000) and implant retention at final follow-up (92.4% vs 88.5%; p=0.220) were statistically indistinguishable. On univariable Cox analysis, oncological indication appeared protective (HR 0.60, 95% CI 0.38–0.95; p=0.030). After adjustment, however, indication was no longer significant (aHR 0.77, 95% CI 0.48–1.26; p=0.30), while prior surgery at the operative site emerged as the dominant independent predictor of revision (aHR 3.31, 95% CI 1.49–7.31; p=0.003). Notably, non-oncological patients more often carried this risk factor (76.0% vs 30.3%; p<0.001), as well as having higher rates of prior hardware removal (67.7% vs 26.2%; p<0.001) and prior infection (24.0% vs 1.0%; p<0.001).

Discussion & Impact: Oncological indication does not confer worse mechanical or infectious outcomes following PFR, challenging a widely held clinical assumption. Rather, revision risk is driven by the burden of prior surgery at the operative site, regardless of whether the underlying indication is neoplastic. These findings should reframe preoperative counseling and risk stratification around surgical history rather than diagnostic category.

Table 1. Baseline demographic, comorbidity, and operative characteristics by indication.

Variable	Oncological (n=409)	Non-oncological (n=96)	p-value
Age at surgery (years), mean ± SD	60.5 ± 15.7	63.5 ± 17.1	0.127
Male sex, n (%)	207 (50.6%)	44 (45.8%)	0.428
BMI (kg/m²), median (IQR)	27.5 (23.3–31.9)	29.2 (25.1–36.3)	0.022
White race, n (%)	366 (89.5%)	78 (81.2%)	0.036
ASA class ≥3, n (%)	343 (83.9%)	82 (85.4%)	0.759
Current smoker, n (%)	62 (15.2%)	29 (30.2%)	0.001
Diabetes mellitus, n (%)	68 (16.6%)	24 (25.0%)	0.077
Chronic kidney disease, n (%)	27 (6.6%)	11 (11.5%)	0.130
Prior infection at site, n (%)	4 (1.0%)	23 (24.0%)	<0.001
Prior surgery at site, n (%)	124 (30.3%)	73 (76.0%)	<0.001
Removal of prior hardware, n (%)	107 (26.2%)	65 (67.7%)	<0.001
Follow-up (years), median (IQR)	0.97 (0.19–3.02)	1.76 (0.45–5.73)	0.002

Continuous variables are summarized as mean ± standard deviation or median (interquartile range) and compared using Welch's t-test or Mann–Whitney U test, respectively. Categorical variables are summarized as counts (percentages) and compared using Fisher exact test. ASA, American Society of Anesthesiologists; BMI, body mass index; F/U, follow-up; IQR, interquartile range; SD, standard deviation.

Table 2. Major complications, Henderson modes of failure, and survival outcomes by indication.

Outcome	Oncological (n=409)	Non-oncological (n=96)	RR (95% CI)*	p-value
Any revision surgery	60 (14.7%)	28 (29.2%)	0.50 (0.34–0.74)	0.001
Type 1 – Soft tissue failure	23 (5.6%)	14 (14.6%)	0.39 (0.21–0.72)	0.007
Type 2 – Aseptic loosening	2 (0.5%)	2 (2.1%)	0.23 (0.03–1.65)	0.165
Type 3 – Structural/fracture	8 (2.0%)	4 (4.2%)	0.47 (0.14–1.53)	0.255
Type 4 – Deep infection	26 (6.4%)	16 (16.7%)	0.38 (0.21–0.68)	0.003
Type 5 – Tumor progression	22 (5.4%)	0 (0.0%)	—	0.012
Amputation	10 (2.4%)	2 (2.1%)	1.17 (0.26–5.27)	1.000
Implant removal	31 (7.6%)	11 (11.5%)	0.66 (0.34–1.27)	0.220
Implant retained at final F/U	378 (92.4%)	85 (88.5%)	1.04 (0.97–1.12)	0.220
2-yr revision-free survival (KM)	84.3%	71.8%	—	0.015§
5-yr revision-free survival (KM)	72.3%	66.3%	—	0.015§
All-cause mortality	244 (59.7%)	31 (32.3%)	1.85 (1.37–2.49)	<0.001

**Risk ratio (RR) compares the oncological cohort to the non-oncological cohort (reference); RR <1 indicates lower risk in the oncological group. §Log-rank p-value for Kaplan–Meier revision-free survival comparison across the full follow-up interval. KM, Kaplan–Meier; RR, risk ratio;*

Table 3. Univariable and multivariable Cox proportional hazards models for all-cause revision surgery.

Variable	Univariable HR (95% CI)	Uni. p	Multivariable aHR (95% CI)	MV p
Oncological indication (ref: non-oncological)	0.60 (0.38–0.95)	0.030	0.77 (0.48–1.26)	0.300
Age at surgery (per year)	1.00 (0.99–1.02)	0.546	1.00 (0.99–1.02)	0.870
Male sex	1.11 (0.73–1.69)	0.637	1.18 (0.77–1.80)	0.457
ASA class ≥3	1.55 (0.89–2.72)	0.123	1.32 (0.73–2.40)	0.358
BMI (per kg/m²)	1.00 (1.00–1.01)	0.294	—	—
Prior surgery at site	2.30 (1.49–3.56)	<0.001	3.31 (1.49–7.31)	0.003
Removal of prior hardware	1.85 (1.21–2.83)	0.004	0.59 (0.28–1.26)	0.171

The multivariable model included 484 patients and 87 revision events (approximately 14 events per covariate). BMI was excluded from the multivariable model given a null univariable association. A hazard ratio >1 indicates increased revision risk per unit (continuous variables) or for presence of the characteristic (categorical variables) relative to the reference category. HR, hazard ratio; aHR, adjusted hazard ratio; ASA, American Society of Anesthesiologists; BMI, body mass index; CI, confidence interval.