How Minimizing Calcar Tip to Apex Distance (CalTAD) Keeps You Moving: A Retrospective Analysis of Patient Outcomes at a Single Center Institution

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INTRODUCTION

Elderly patients often exhibit reduced bone mineral density and compromised trabecular architecture, increasing the risk of implant fixation failure and complications such as screw cutout. Intertrochanteric (IT) femur fractures in this population are typically treated using intramedullary nailing devices with either lag screw or blade fixation into the femoral neck and head. Screw cutout is a serious complication influenced by factors such as tip to apex distance (TAD), calcar referenced tip to apex distance (CalTAD), age, BMI, and bone quality. This study evaluates CalTAD as a strong predictor of screw cutout in IT femur fracture fixation. We hypothesize that minimizing CalTAD, thereby aligning the screw or blade closely with strong calcar bone, reduces the risk of cutout.

METHODS

A retrospective review of patients aged 55 and older who underwent trochanteric femoral nail fixation for IT fractures over a 15-year period at a single center. Institutional Review Board approval was obtained prior to data collection. Postoperative AP and lateral radiographs were analyzed to measure CalTAD and TAD. CalTAD was defined as the distance from the screw tip to the intersection of a calcar-aligned guideline with the femoral head. TAD was defined as the distance from the screw tip to the intersection of a guideline drawn from the apex through the center of the femoral neck. Additional recorded variables included patient age, sex, and BMI. Radiographs obtained at least 3 months postoperatively were reviewed for screw cutout. Statistical analysis included two-tailed t-tests, ROC analysis with DeLong's test, logistic regression, and optimal threshold determination for CalTAD and TAD.

RESULTS

Of 1128 reviewed charts, 361 met inclusion criteria. Patients with cutout (n=9) demonstrated significantly higher mean CalTAD (32.20 ± 6.43mm) compared to those without (21.72± 6.36 mm, n=352; $p < 0.001$). TAD was also significantly different between the two groups (cutout: 25.72 ± 5.13 mm; no cutout: 17.95 ± 5.97; $p < 0.001$). There were 8 cutout patients with a CalTAD above 25 mm, 5 of which also had a TAD above 25 mm. BMI was not significantly different between the two groups (cutout: 23.93 ± 3.59; no cutout: 25.88 ± 6.24; p=0.350), however age was significantly different (cutout: 84.22 ± 13.15 years; no cutout = 75.30 ± 10.07 years; p=0.010). ROC analysis demonstrated that both CalTAD and TAD were strong predictors of screw cutout with area under the curve (AUC) values over 0.8 (CalTAD: 0.889; TAD: 0.858). DeLong's test showed there was a comparable predictive performance between CalTAD and TAD (p=0.448). A univariate logistic regression evaluating the association between CalTAD and screw cutout was highly significant showing that every 1 mm increase in CalTAD was associated with a 19.5% increase in odds of cutout (OR = 1.195, 95% CI: 1.10–1.31, $p < 0.001$). The same analysis demonstrated that TAD was also a strong predictor of increased risk of cutout with each 1 mm increase associated with a 16.2% increase in odds of cutout (OR = 1.162, 95% CI: 1.07–1.28, $p = 0.001$). For every 1-year increase in age there was a slightly significant 10.3% increase in the risk for cutout (OR = 1.103, 95% CI: 1.03–1.20, $p = 0.0137$), and increased BMI was not significant. The optimal threshold determination using ROC analysis for CalTAD and TAD was determined to be 27.09 mm and 20.16 mm respectively. Analysis of Youden's J statistics demonstrated that CalTAD more effectively distinguished patients with screw cutout than TAD, with J statistics of 0.718 versus 0.673.

DISCUSSION

CalTAD is a significant predictor of screw cutout in elderly patients undergoing IT fracture fixation. Higher CalTAD values were associated with increased cutout risk. TAD has long been an important predictor of screw cutout, with reduced cutout risk associated with TAD values less than 25 mm. Our findings corroborate this and even suggest that the optimal threshold values for both CalTAD and TAD might be lower than what has traditionally been accepted. The relatively small sample size of patients with screw cutout is a limitation and may limit the generalizability of our findings. Nevertheless, these results support CalTAD as a potentially stronger predictor of screw cutout than TAD.

SIGNIFICANCE

Existing data regarding the optimal CalTAD for effective IT fixation remains limited, but our findings support CalTAD as a predictor of screw cutout and suggest that exceeding an optimal threshold increases cutout risk. Most importantly, this data highlights the importance of incorporating CalTAD optimization into intraoperative planning to minimize mechanical failure and improve patient outcomes.