Creation of a Patient-Specific Hip Arthroplasty Periprosthetic Femur Fracture Risk Calculator

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INTRODUCTION: Many risk factors have been described for periprosthetic femur fracture (PPFFx) following total hip arthroplasty (THA), yet a patient-specific risk assessment tool remains elusive. The purpose of this study was to develop a high-dimensional, patient-specific risk-stratification nomogram that allows dynamic risk modification based on operative decisions.

METHODS: 16,696 primary non-oncologic THAs performed between 1998-2018 were evaluated. During mean 6-year follow-up, 558 patients (3.3%) sustained a PPFFx. Patients were characterized by individual natural language processing assisted chart review on non-modifiable factors (demographics, THA indication, comorbidities), and modifiable operative decisions (femoral fixation [cemented/uncemented], surgical approach [direct anterior, lateral, posterior], implant type [collared/collarless]). Multivariable Cox regression models and nomograms were developed with PPFFx as a binary outcome at 90-days, 1-year, and 5-years postoperatively.

RESULTS:

Patient-specific PPFFx risk based on comorbid profile was wide-ranging from 0.3%-17% at 90-days, 0.3%-19% at 1-year, and 0.4%-22% at 5-years. Among 18 evaluated patient factors, 7 remained significant in multivariable analysis. The 4 significant non-modifiable factors included: female sex (HR=1.6), older age (HR=1.2 per 10 years), diagnosis of osteoporosis or use of osteoporosis medications (HR=1.6), and indication for surgery other than osteoarthritis (HR=2.1 for fracture, HR=1.7 for osteonecrosis, HR=1.7 for inflammatory arthritis). All 3 analyzed modifiable surgical factors were significant in multivariable analysis as follows: uncemented femoral fixation (HR=2.4), collarless femoral implants (HR=1.4), and surgical approach other than direct anterior (posterior HR=2.0, lateral HR=3.1).

DISCUSSION AND CONCLUSION: This patient-specific PPFFx risk calculator demonstrates wide-ranging patient-specific risk based on comorbid profile. The final model is quite parsimonious and actionable, strengthened by a process that robustly evaluated 18 possible factors. The resultant nomograms can be used as a screening tool to identify high-risk THA patients and individualize operative decisions. Importantly, operative decisions within a surgeon's control were shown to substantially modulate risk. Further refinement will include deep learning-assisted preoperative imaging assessment.