Does a Collar Reduce the Risk of Periprosthetic Bone Failure in a Modern Triple Taper Design

Josef Jolissaint, Ryan T Helbock, Fernando J Quevedo-Gonzalez, Timothy M Wright, Elizabeth Gausden, Peter Keyes Sculco

INTRODUCTION: Periprosthetic femur fracture (PPF) is a common complication after total hip arthroplasty (THA) with poor outcomes. Although multiple factors can cause PPF, collared stems are thought to help prevent PPFs by transferring loads at the calcar region. Either by collarless stem design or final stem position the collar does not always contact the calcar. Our goal was to quantify the effect of a collar in preventing PPFs in a modern triple taper design implant.

METHODS:

We created computational finite element models from preoperative/pre-PPF CT-scans of six patients who suffered PPF and five controls matched by age, weight, height, and sex who did not. Stems were virtually implanted based on preoperative templating, assuming idealized surface-to-surface contact between bone and implant (no press-fit or gaps). For each case and control we simulated a stumbling load with and without collar-calcar contact. Bone was modeled as non-homogeneous, with properties derived from CT scans. We computed the risk of failure of bone in contact with the implant's on-growth surface by relating its strain values to the bone yield strain. Descriptive statistics quantified the amount of interfacial bone at risk of failure.

RESULTS:

PFF patients tended to have less high-density bone (≥1 g/cm3) contacting the implant than controls. Patients with PPF had more bone at risk of failure (100% of bone's strength) than controls with (1.6 – 14.3% vs. 1 – 4.4% of interfacial bone) and without a collar (8.5 – 39.9% vs. 8 – 15.5%). For PFF patients and controls, a collar significantly reduced the amount of bone at risk of failure.

DISCUSSION AND CONCLUSION:

In this computational model, a collar reduced the amount of bone at risk of mechanical failure, which could explain the lower PPF risk of triple taper collared implants. In all patients the collar significantly reduced the amount of bone experiencing failure.