

Variation in contact areas in the proximal femur depending on implant design

MARQUEZ-LARA A, PATEL RM, STULBERG SD

Department of Orthopaedic Surgery, Northwestern University, Chicago, IL, USA

r-patel17@md.northwestern.edu

Introduction: A wide variety of conventional uncemented femoral implants have been shown to provide dependable long-term fixation in patients who undergo total hip arthroplasty. Nevertheless, designs continue to evolve to accommodate challenges with variable femoral morphology, preservation of bone stock, and aseptic loosening. While numerous metaphyseal engaging implants exist there is variability in the proximal design. Stem design requires the incorporation of three-dimensional femoral geometry to achieve the goals of restoring kinematics and achieving stable initial fixation. While implants have been designed to obtain appropriate metaphyseal bone contact for secure initial fixation and satisfactory bone remodeling, there are limited data indicating the extent to which current designs come in contact with the proximal femur. The purpose of this study was to determine, using computed tomography (CT) templating, the extent to which 3 contemporary cementless, metaphyseal engaging stems come in contact with the proximal femur.

Methods: The femurs of 30 patients were templated using a CT-based preoperative planning workstation (ORTHODOC, Curexo Tech, California) with three different metaphyseal-engaging stem designs: Straight tapered (Depuy Tri-Lock), anatomical (Stryker ABG II) and curved femoral neck preserving (OmniScience ARC). Stem size was determined to optimize contact. Implants were positioned according to the manufacturers' design rationale. Five anatomical landmarks (levels) were identified from proximally to distally in the coronal, axial and sagittal planes:

1. Osteotomy Level (OL)
2. Midpoint 1 (between OL & LT)
3. Lesser Trochanter (LT)
4. Midpoint 2 (between LT & BCS)
5. Base of Calcar Septum (BCS)

At each of these five levels, fit and fill measurements were taken using two different density thresholds: 1) Linear Gray (endosteal cortex) and 2) Color (cancellous bone). The location of implant contact with bone and the extent of contact of implant with bone were measured at each anatomic level.

Results: These metaphyseal-engaging stems showed distinct contact patterns. The Tri-Lock had most of its medial-lateral contact distally at the metaphyseal-diaphyseal junction. The ABG II had the greatest anterior-posterior contact at all levels. The ARC achieved most of its contact at the femoral neck level. The majority of its distal contact was limited to the anterior quadrant of the metaphysis. The ABG II was the only implant to achieve 100% contact in a given quadrant when assessed in the axial plane. When the contact to cancellous bone, rather than cortical bone, was measured, the extent of bone contact increased for all of the implants.

Average coronal and sagittal fill for the Tri-Lock, ABG II and ARC can be seen on Tables 1.

Conclusions: The design of an implant and the resulting contact pattern within the femoral canal influences initial stem fixation and long-term bone remodeling. Three-dimensional templating allows precise positioning and sizing of the implant according to manufacturers' rationale. The variability in the location and extent of bone contact found in this study suggests that the quality and the shape of the proximal femur may influence the successful use of these implants. This variation in bone contact is likely to have an impact on fixation in bone of various qualities as well as bone remodeling over

time. Understanding the contact patterns present in metaphyseal-engaging stems allows designs to optimize implant stability and minimize stress shielding.

	Med-Lat Fill Ratio			A-P Fill Ratio		
	Tri-Lock	ABG II	ARC	Tri-Lock	ABG II	ARC
Osteotomy Level	63.1	67.4	90.0	44.1	68.5	64.1
Midpoint 1	74.2	77.7	44.9	38.9	67.1	40.7
Lesser Trochanter	88.7	91.1	52.7	44.8	72.4	48.5
Midpoint 2	93.6	90.6	58.8	47.7	76.1	52.1
Base of Calcar Septum	97.4	88.9	64.0	52.2	78.4	54.1
Average	83.4	83.1	62.1	45.5	72.5	51.8

Table 1: Average fill ratios in both coronal and sagittal planes at five different anatomic levels.