Inter-surgeon Variability in the Assembly of Modular Head-neck Tapers in Total Hip Replacement via the Posterior Approach
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INTRODUCTION:
Numerous factors have been hypothesized as contributing to mechanically-assisted corrosion at the head-neck junction of total hip prostheses. While variables attributable to the implant and the patient are amenable to investigation, parameters describing assembly of the component parts can be difficult to determine. Nonetheless, increasing evidence suggests that the manner of intraoperative assembly of modular components plays a critical role in the fretting and corrosion of modular implants. This study was undertaken to measure the magnitude and direction of the impaction forces applied by surgeons in assembling modular head-neck junctions under operative conditions where both the access and visibility of the prosthesis may potentially compromise component fixation.

METHODS:
A surrogate consisting of the lower limb with overlying soft tissue was developed to simulate total hip replacement (THR) performed via a 10cm incision using the posterior approach. The surrogate was modified to match the resistance of the body to retraction of the incision, mobilization of the femur, and hammering of the implanted femoral component. An instrumented femoral stem was surgically implanted into the bone after attachment of three miniature accelerometers in an orthogonal array to the proximal surface of the prosthesis. A 32mm cobalt chrome femoral head was mounted on the trunnion (12/14 taper, machined) of the femoral stem. Fifteen Board-certified and trainee surgeons replicated their surgical technique in exposing the femur and impacting the modular head on the tapered trunnion. Impaction was performed using an instrumented hammer that provided measurements of the magnitude and temporal variation of the impact force. The components of force acting along the axis of the neck and in the AP and ML directions were continuously sampled using the accelerometers.

RESULTS:
For all surgeons, the average value of the peak impaction force was 3765 ± 1094N (range: 2358 to 6225N). Head impact was delivered in an average direction of 24.4 ± 7.5 degrees more vertical than the trunnion axis, though this value varies from 14 to 43 degrees between individual surgeons. On average, the off-axis force perpendicular to the trunnion axis was 1586 ± 736N, however, this value ranged from 634 to 2895N with peak loading of both the head and the implant in varus. Almost all of the applied impact was directed within 10 degrees of the mid-plane of the stem (average deviation: 2.5 ± 5.9 degrees of with only a small force directed anteriorly or posteriorly (average force: 140 ± 396N, anterior). The variability in the magnitude and direction of the impaction force was not associated with the level of training or the surgical experience of the participants (p>0.05).

DISCUSSION AND CONCLUSION:
This study shows that large off-axis forces are developed during manual impaction of modular heads onto stem trunnions via the posterior approach. The variation in magnitude and direction of these forces varies between individual surgeons and is not systematically related to the training or experience of each surgeon in joint replacement. This variability in intraoperative assembly of head-neck junctions may contribute to the severity and incidence of mechanically assisted corrosion in total hip replacement.