Paper #43

Impaction Force Influences Taper-Trunnion Stability in Total Hip Arthroplasty

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Introduction: Lack of uniformity in femoral head-trunnion assembly protocols and higher offset femoral heads may be associated with increased complication rates, possibly due to insufficient taper-trunnion engagement. This study investigated the influence of femoral head impaction force, number of head strikes/energy sequence, and head offset on the strength of the taper-trunnion junction.

Methods: Thirty titanium-alloy trunnions were mated with 36-mm zero-offset cobalt-chromium femoral heads of corresponding taper angle and preloaded with 10N. Each was mounted below a drop tower calibrated to impact the head with 2.5J or 8.25J, resulting in approximately 6kN or 14kN impaction force, respectively, in a single strike or combinations of 6kN+14kN or 14kN+14kN. Additionally, ten 36-mm heads with -5 and +5 offset were impacted with sequential 14kN+14kN strikes. Heads were subsequently disassembled utilizing a screw-driven mechanical testing frame and peak distraction force was recorded. Statistical calculations were performed using one-way ANOVA and Student's t-tests with statistical significance set to $p<0.05$.

Results: Femoral head pull-off force was 45% the strike force, and heads struck with a single 14kN impact showed a pull-off force twice that of the 6kN group. Two head strikes with the same force did not significantly differ from those struck once for either 6kN ($p=0.09$) or 14kN ($p=0.9$). If the forces of the two impactions varied, but either impact measured 14kN, a 50% higher pull-off force was found compared to impactions of either 6kN or 6kN+6kN. Femoral head offset did not significantly change the pull-off force among -5, 0, and +5 heads ($p=0.37$).

Conclusion: Femoral head impaction force significantly determines femoral head stability, while offset does not affect pull-off force. Multiple head strikes do not add additional strength, as long as a single strike achieves 14kN force at the mallet-head impactor interface. Insufficient impaction force may lead to inadequate engagement of the trunnion-taper junction.

Notes