A NEW METHOD OF STEM IMPACTION REDUCES THE RISK OF FEMORAL FRACTURES IN THR

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INTRODUCTION
Femoral fractures are a serious complication of cementless THR, especially when rasps and stems are inserted through smaller incisions. One strategy to minimize this complication is to use a pneumatic impactor which delivers a series of repetitive impulses to the rasp in contrast to the single impacts delivered during manual rasping. This study was designed to compare cortical strains generated when rasping the femur using a pneumatic rasp impactor, in comparison with conventional manual techniques.

METHODS
Seven pairs of fresh-frozen femora of similar canal size were harvested from donors of average age 74 years (range: 55–84 years). Each femur was templated for implantation of a cementless tapered locking stem commonly used via mini-incisions (SL Plus, Plus Orthopedics) and potted 10cm below the templated distal tip. Rosette strain gauges were attached to each femur at five key locations shown to correspond to peak regions of surface strain identified by photoelastic stress analysis. Gauges were positioned in the following regions: proximal medial (10mm distal to the lesser trochanter (LT); proximal anterior and proximal posterior (25mm distal to LT); medial (60mm distal to LT) and lateral (100mm distal to LT) (Figure 1).

One femur from each pair was manually broached, while the contralateral bone was prepared using the pneumatic rasp impactor. The in vivo mechanical environment of the femur was simulated using foam cushioning (Figure 2). During manual broaching, the load delivered with each hammer blow was recorded with an impulse hammer. The pneumatic impactor was operated under a pressure of 0.8MPa and exerted ~1.0N of axial force, notwithstanding the load exerted by the surgeon. Dynamic strains generated during these procedures were continuously monitored at 14,200 Hz, with principal tensile strains calculated at each measurement site. Standard AP and ML radiographs were taken after each broach insertion. Paired t-tests were used to determine statistically significant differences in strain between the two broaching techniques.

RESULTS
Manual rasping generated peak tensile strains averaging 487 +/- 337 µstrain (range: 50-1595 µstrain) compared to 365 +/- 195 µstrain (range:75-1151 µstrain) with the pneumatic impactor, an overall increase of 34% (p=0.0005) (Figure 3). During manual rasping, the largest acute strains were experienced during manual rasping, with 14% of strain measurements at the distal-lateral and proximo-medial recording sites exceeding 1000 µstrain. In comparison, only 5% of proximo-medial strain measurements exceeded 1000 µstrain during pneumatic rasping. Similarly, potentially destructive cortical strains (>1000 µstrain) recorded at all measurement sites were significantly more prevalent during manual canal preparation (9%) than pneumatic rasping (1%) (Figure 4).

DISCUSSION
1. Rasping the femur with a pneumatic impactor generates less cortical strain than manual rasping at critical sites within the femur.
2. Use of a pneumatic impacting device is recommended for preparation of the femur for THR to reduce the risk of intraoperative fractures, especially in elderly and osteoporotic patients, and in procedures performed via mini-incisions.

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