The Influence of Temperature Generated from Instrument Cutting on the Implant Bone Interface during Hip Resurfacing Surgery

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ABSTRACT INTRODUCTION:
The most common complication of hip resurfacing (HR) arthroplasty is fracture of the femoral neck, which occurs in about 1% of patients. Possible aetiologies include notching, mechanical damage from reaming, and thermal necrosis. Drilling and reaming (Fig. 1) are procedures that produce extreme temperatures and are associated with bone necrosis. We investigated temperatures generated during femoral head preparation during HR arthroplasty.

METHODS:
Ten patients (7 males, 3 females) with osteoarthritis underwent HR surgery through the posterior approach. From the first cutting of the femoral heads until the prosthesis was cemented in place, bone surface temperatures were recorded (Fig. 2) using an infra-red thermal imaging camera. Osteocyte viability in a reamed femoral head of a patient before total hip replacement was evaluated using lactate dehydrogenase (LDH) activity and H&E staining techniques.

RESULTS SECTION:
Temperatures recorded ranged from 35.6 - 82.7 °C (Fig. 3). High temperatures occurred during crown reaming. Increased temperatures occurred in male patients (~ 70.8 °C) where females were on average 40.8 °C. Cell viability was evaluated in three regions; proximal, distal, head centre. Most cells on the samples taken from the proximal and distal regions were not viable (Fig. 4). Samples from the head centre were found to be viable.

The H&E stain did not demonstrate dead cells from thermal necrosis, only cells that have been dead for a long period in vivo.

DISCUSSION:
The LDH activity was a successful assay. The technique allowed us to identify osteocyte viability in large sections of fresh bone by the histochemical demonstration of LDH activity following thermal insult by surgical instruments.

Experimental studies have demonstrated that bone injury may occur at 56.0°C, due to alkaline phosphatase denaturing. On the other hand, osteocytes are known to be more sensitive to temperature, dying at 47.0°C. The temperatures recorded in this study and reached during this procedure may have caused irreversible bone damage. In this study, heat generated during femoral head preparation that exceeds 47.0°C could be a catalyst for osteonecrosis.