THERMAL DAMAGE POTENTIAL IS REDUCED BY PULSE-LAVAGE & EARLY REDUCTION DURING HIP RESURFACING

Introduction
A major concern with cemented hip resurfacing arthroplasty (HRA) femoral components is the thermal damage to femoral head during cement curing. The bone damage resulting from thermal injury may lead to loosening [1] or late failure due to collapse of the femoral head. In addition fracture of the femoral neck is a unique complication of HRA with a reported incidence up to 4% [2]; it is suspected that creeping substitution weakens the neck [3], increasing the risk of fracture. We hypothesized that use of a modified surgical technique with extensive pulse lavage and early reduction will lead to reductions in the maximum temperature recorded in the femoral head during HRA, compared to the manual lavage and reduction after curing.

Methods
Patients undergoing total hip replacement were given a dummy HRA procedure, before which two temperature probes (Type T, Kalestead Limited, Braintree, Essex, UK) were inserted into the femoral head and the measuring tip placed close to the reamed surface (Figure 1); the position confirmed by x-ray. Four subjects (Group M, denoting manual lavage and no early reduction) receiving a HRA femoral component using manual lavage and Simplex cement. The heads were removed and sectioned to locate probes.

Femoral temperatures were also measured in the same way for five patients (Group P, denoting pulse lavage and early reduction) receiving a definitive HRA. For these subjects, a 3mm diameter cannula was inserted into lesser trochanter and suction applied during preparation and cementing; pulse lavage for 30 seconds prior to cementing with Simplex, and pulse lavage of the femoral head for 2 minutes, applied 1 minute after cementing the femoral component. The joint was reduced prior to cement curing and pulse lavage applied to the reduced joint.

Temperatures were recorded at 2Hz, using personal computer controlled temperature logger (TCH01, Pico Technology Limited, Cambridge, UK), until the cement finally cured.

The measured data were exported to comma-separated variable files, and further processed using a custom Matlab routine (Matlab version 6.5, The MathWorks Corporation, MA, USA). The maximum recorded temperature in the femur was extracted for each subject; the differences between the two groups (M and P) were examined using the Mann-Whitney U test (SPSS v12, SPSS, USA). The maximum recorded temperature in the femur for the two groups (Figure 1), with the position confirmed by x-ray. Four subjects (Group M, denoting manual lavage and no early reduction) received a HRA femoral component using manual lavage and Simplex cement. The heads were removed and sectioned to locate probes.

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Results
The maximum recorded temperature of the cement remaining in the mixing bowl reached 91.4°C (88.7 to 101.2°C), curing occurred at approximately 17 minutes from the start of mixing. There was a statistically significant difference (p=0.014) between the maximum temperatures observed in the femur for the two groups (Figure 2), with Group M having a median value of 47.2°C (37.0°C to 67.9°C) and Group P having a median value of 32.7°C (31.7 to 35.6°C). For the dummy HRA’s, sectioning showed that all probe tips were within 1 millimetre of the cement.

Discussion
Viable bone in the femoral head and neck is important for long term survival of a hip resurfacing device. The critical temperature for bone necrosis is approximately 47°C [4], it is therefore expected that the manual lavage no early reduction technique will give rise to more thermal necrosis.

Several aspects of the modified surgical technique are seen as being crucial. The lesser trochanter suction reduces the core femoral temperature as does the pulse lavage. Reduction prior to curing means that the femoral component is in contact with the acetabular component and sits in a pool of lavage fluid; this provides a larger thermal sink for dissipating heat.

The modified surgical technique gave rise to maximum recorded temperatures of approximately 36°C, lower than that reported to cause bone cell death. This modified technique is recommended as the potential for thermal bone necrosis is significantly reduced.

References
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Work was funded by Orthopaedic Hospital Foundation, Nuffield Orthopaedic Centre General Charity. Wright Medical Technology provided components for the dummy HRA’s performed.