**Femoral Cementing Technique for Hip Resurfacing Arthroplasty: Importance of Cement Application**

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**Introduction:** In two recent retrieval studies and in a finite element model, over-penetration of cement, incomplete seating of the prosthesis with a resultant polar cement mass, or both, have been associated with femoral failures of current generation resurfacing arthroplasties [1, 2].

It has been frequently stated that hip resurfacing is technique sensitive but scientific investigations into cementing techniques are lacking. We developed a laboratory model to analyze differences in cement penetration, cement pressures and interface temperatures for resurfacing arthroplasty. Six cementing techniques using different cement viscosities were analyzed.

**Materials and Methods:** An open-cell reticulated carbon foam was demonstrated to closely simulate human femoral heads as prepared for resurfacing. Custom aluminum shells were made by DePuy with the same inner geometry as the femoral resurfacing components. (ASR™ system, Size 49, DePuy, Leeds, England).

Analyses of six different cementing techniques were performed using high viscosity (HVC) (Smart Set GHV, DePuy, Blackpool, England) and low viscosity cement (LVC) (Endurance, DePuy, Blackpool, England): A) manual application HVC; B) filling of one quarter of the component with LVC and manual application; C) filling of one quarter of the component with HVC and manual application; D) filling of half of the component with LVC; E) filling of half of the component with HVC; and F) complete filling of the component with LVC.

A force of 150 N was used to press five shells in each cement technique group on foam specimens. During seating cement pressures at the top, the chamfer and at the outer wall of the femoral components were measured. Polymerization heat was measured 5 mm under the foam surface using special catheter shaped temperature probes.

Specimens were cut into quarters, surfaces were digitalized and cement penetration areas and depths were quantified using a pixel-analysis-software. The effects of the cementing techniques were examined by Kruscal-Wallis and Mann-Whitney-U-tests (two-sided, p value < 0.05, SPSS Inc., Chicago, Illinois)

**Results:** The mean cement pressures at the top and at the chamfer increased going from cementing technique A to E (Figure 1). The pressures for technique F were similar to those of techniques C and D. HVC techniques C and E showed higher pressures than the comparable LVC techniques B and D.

Maximum temperatures 5 mm below the foam surface for each cementing technique were A) 36.0 ± 4.1°C, B) 45.0 ± 5.7°C, C) 36.2 ± 4.2°C, D) 53.5 ± 2.5°C, E) 48.3 ± 5.6°C and F) 53.2 ± 12.6°C. Statistically significant differences were found in peak temperatures between technique A and B (p=0.016), D (p=0.001), E (p=0.001) and between A and F (p=0.001). Cementing techniques D, E and F exceeded 50°C 5 mm below the foam surface.

Technique A provided a even cement penetration over the available fixation area without involvement of the internal area and the stem. Cement that was applied by any degree of component filling tended to increase the total amount of cement in the construct due to incomplete seating with the creation of a polar cement mantle and flow into the interior area (Figure 2). Cementing techniques that used LVC cement (B, D and F) showed higher interior area cement contents (I) than techniques with HVC (A, E and C). The cement content in the interior area was A) 39.3 ± 26.4 mm³, B) 72.1 ± 16.9 mm³, C) 37.7 ± 10.5 mm³, D) 99.0 ± 24.6 mm³, E) 67.5 ± 15.6 mm³ and F) 121.0 ± 29.0 mm³.

Manual application technique A had complete seating in three of five specimens and a mean cement mantle thickness of 0.5 ± 0.7 mm. All other techniques showed incomplete seating in all specimens with significantly thicker polar cement mantles (p=0.032) up to a maximum of 4.6 ± 1.2 mm for technique E.

**Discussion:** Component filling cementing technique and low viscosity cement resulted in variable degrees of over-penetration, exposure to high temperatures or a risk for incomplete seating, which have been associated with bone necrosis and early fracture. The use of the manual application and high viscosity cement showed clear advantages in our model. It was possible to reach high cement contents in the outer fixation area without the negative effects of interior area penetration.

**References:**

**Figure 1** Box plot for the mean top pressures.

**Figure 2** The cement penetration is shown in the cut faces for the six cementing techniques.