The use of low and high viscosity cement in hip resurfacing arthroplasty: an In-vitro study

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Statement of Purpose: Hip resurfacing is increasingly used in orthopedic arthroplasty. It offers a bone conserving option for the young and active patient and more flexibility in case of a revision surgery. An understanding of how the cementing technique and cement type influences cement penetration is important for surgeons to plan and conduct hip resurfacing procedures. In particular it is important to know if high and low viscosity cement can be applied during this procedure. We hypothesize that high viscosity cements can be used with hip resurfacing implants when an appropriate cementing technique is applied.

Methods: Twelve fresh frozen paired whole cadaver femora were used for this study. Mean age of the donors was 50.1 years (SD 12.6 years) and mean weight 78 kg (SD 13 kg). All femora were x-rayed before the experiments. To determine the implant size, pre-operational planning was conducted by the operating surgeon (U. Kesteris). The paired femora were divided into two groups. Group A consisted of the right and group B of the left femora.

A Durom Hip Resurfacing (Zimmer GmbH, Switzerland) facsimile made of polyoxymethylene was used in order to provide low x-ray absorption. To compensate for the lower stiffness of the material the wall thickness was increased. Small grooves were added for positioning purposes. Surgical Simplex (Stryker Orthopaedics, USA) and Palacos R-40 (Biomet Cementing Technologies AB, Sweden) cement were used.

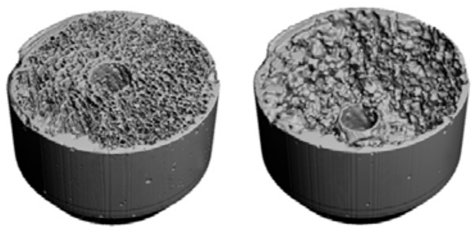

Fig. 1 Three dimensional caudal view on the reference volume (left) and cement penetration volume (right)

In group A low viscosity bone cement (Simplex) at room temperature was applied after a standing period of 3 min. In group B chilled high viscosity bone cement (Palacos) was applied after a standing period of 2 min. Pulse lavage was used in both groups (Pulsavac Plus, Zimmer Inc, USA). The cementing technique in this study corresponded to the clinically applied technique. The applied force during insertion was controlled using a dynamometer (TEC, USA). 14 kg were applied in group A and 18 kg in group B according to clinical practice. The head was resected at the femoral neck and stored in 4 percent buffered formaldehyde solution after the polymerization process of the cement was complete. All samples were digitized using a micro CT-scanner (µCT 80, Scanco Medical, Bassersdorf, Switzerland). Using image processing software (IPL 4.30a, Scanco Medical, Switzerland) each sample was segmented in reference volume and cement penetration volume (
Fig. 1). The reference volume is the bone that is completely covered by the implant and represents the theoretical maximum bone volume that can be penetrated by the cement. The cement penetration volume is the total bone volume that is penetrated by cement. Based on reference and penetration volume the penetration *ratio* and the penetration *depth* were calculated. For each sample the mean bone density of the non-penetrated bone volume was calculated from the CT-data. A paired T-test was performed between groups A and B.

Results / Discussion: The mean penetration *ratio* in group A was 37% (SD 8%) and in group B 41% (SD 8%). The difference was statistically significant (p = 0.03). The mean penetration *depth* in group A was 2.8 mm (SD 0.6 mm) and in group B 3.2 mm (SD 0.7 mm) (**Fig. 2**). The difference was statistically significant (p = 0.02). The mean density of the unpenetrated bone was 194 mg HA/ccm (SD 22.53 mg HA/ccm). There was no statistical significant difference between the right and the left femora in bone density.

Fig. 2 Cement penetration depth in group A (low viscosity cement) and group B (high viscosity cement).

There was a significant increase of 0.4 mm in cement penetration *depth* when a high viscosity cement was used (group B) instead of a low viscosity cement (group A) although intuitively one may tend to think that low viscosity cement would penetrate more easily into the bone. The viscosity of the cement in group B was higher than of group A at the time of implantation, even though it had a shorter standing period. A possible explanation for this behavior could be that a low viscosity cement generates less pressure to penetrate into the bone during insertion of the implant than a low viscosity cement. This behavior is very specific for the investigated type of resurfacing prosthesis that features a predefined pure cement mantle and recesses which allow cement to escape under pressure. These findings may not be transferable to other designs.

Conclusions: The study shows that both low and high viscosity cements can be used with the Durom Hip Resurfacing implant.