ANTIBIOTIC DISTRIBUTION IN A BONE CEMENT SPACER SAMPLE

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INTRODUCTION
Deep infection after total joint replacement is a severe complication, and the use of antibiotic-loaded bone cement as a joint spacer is an established and efficient treatment method to treat infected arthroplasties. When preparing the cement spacer for infected hip arthroplasty, the outline of the spacer is generally cylindrical to fill the medullary space in the femur. The cylindrical part of the spacer is almost identical whether it is fabricated with an articulating mold, a cement gun nozzle, or simply handmade. Hand mixing of high-dose antibiotics (> 2g of antibiotic per 40g of bone cement) with bone cement is still inevitable in order to fabricate the antibiotic loaded cement spacer for infected arthroplasty. Considering no commercially available high-dose antibiotic loaded bone cement products are available, Hanssen et al. recommended that the polymethylmethacrylate monomer and powder should be mixed first to form the liquid cement before adding the antibiotic powder [1]. The rationale behind this recommendation was that combining high-dose antibiotic powder to bone cement before the liquid monomer was introduced made mixing difficult. Furthermore, although in their paper there were many descriptions about the cement and antibiotics dosage, there was no discussion of the effect different cement viscosity would have on the mixing difficulty of the antibiotic powder.

This study was undertaken to investigate the effect of cement mixing technical tip recommended by Hanssen et al. on antibiotic distribution in a cylindrical cement spacer model. Tetracycline was used as the antibiotic and its distribution was quantitatively calculated by obtaining images under the fluorescent light microscope. Furthermore, we also investigated whether the difference of cement viscosity had any significant effect on antibiotic distribution in the cement spacer model when using the traditional cement mixing technique i.e. the addition of antibiotic powder to bone cement powder before adding the liquid monomer.

METHODS
Three groups of ten cement spacer samples were prepared. The samples were made of polymethylmethacrylate bone cement that contained 2g of powdered tetracycline hydrochloride (Tetrex®, Bristol-Myers Squibb Company, Victoria, Australia) per 40g pack of cement powder.

Group A (control): The antibiotic and cement powder were mixed thoroughly before the liquid monomer was added. Medium viscosity cement (Simplex® P, Howmedica, Limerick, Ireland) was utilized in this group.

Group B (technique difference, by Hanssen et al.): The cement powder and the liquid monomer were mixed before the antibiotic was added. The antibiotic was added to the cement during liquid phase and then mixed thoroughly. Simplex® P was utilized in this group.

Group C (cement viscosity difference): Low viscosity cement (CMW 3®, DePuy CMW, Blackpool, UK) was utilized in this group.

Preparation of all three groups of bone cement spacers were carried out as follows: Once the antibiotic, cement powder and the liquid monomer were added (order dependant on the above described groups) the blend was mixed inside an inert bowl with a spatula until a dough-like consistency mass was formed that did not stick to the surgical gloves according to the manufacturer’s instructions. After mixing, the cement was packed into a 6mm diameter-12mm height steel mold. It was packed into the mold from one side to reduce the number of air pockets in each spacer. Excess cement was removed from the sides and the spacers were left to cure for 30 minutes. After the setting time the plates from either side were eradicated and cement spacer samples removed. From each of the spacer samples three cross sections were harvested: one from the edge, one 4mm from the edge, and the final one 8mm from the edge. These sections were cut with 0.15mm diameter diamond wire saw and polished with 600-grid sand paper till they were approximately 0.1mm thick (Fig 1A, B). All the three cross sections from each of the cement spacer samples were examined under the fluorescent microscope. All the images were magnified 1.25x to observe the entire section and recorded as jpeg images. The images were converted into grey scale images (Fig 2) and the shining spots were calculated as the distribution of the tetracycline. Calculations were obtained utilizing Bioquant Nova Prime (BIOQUANT Image Analysis Corporation, Nashville, TN). The fluorescent spots were automatically calculated in pixels. To evaluate the distribution of the antibiotics in the spacer sample, we selected the cross section with the highest number of pixels and the one with the lowest number of pixels from each of the three cross sections and calculated the difference between them. This was done for each of the groups. Group A and B were compared to investigate the effect the mixing technique had on the antibiotic distribution difference. And group A and C were compared to investigate the effect cement viscosity had on the antibiotic distribution difference. A Tukey-Kramer’s post-hoc test was used to determine the level of significance (p<0.05).

RESULTS
The average difference between the maximum and minimum number of pixels of each of the cross section are 4179.00 ± 2133.07 pixels in group A, 2259.50 ± 1823.68 in group B, and 2556.30 ± 1543 in group C. No statistical significance was observed between group A and B nor A and C (Fig 3).

DISCUSSION
It is generally accepted that medium Paracos-R® (medium viscosity cement, Smith & Nephew, Memphis, TN) has more efficient elution characteristics compared with other cement types. The elution ability of the Paracos-R® was reported to be double compared Simplex® P and CMW 3®, while the elution characteristics of Simplex® P and CMW 3® are reported to be similar. In order to eliminate the factor of the cement quality itself and any effect that might have on the study, we used the latter two products to compare the effect different viscosity cements would have on the antibiotic distribution throughout the cement spacers (group A and group C). The study showed no significant difference between group A and C indicating that cement viscosity has no significant effect on antibiotics distribution and that even distribution could be achieved with either low or medium viscosity cement.

REFERENCE