CEMENTING TECHNIQUES DURING ORTHOPAEDIC SURGERY: ACHIEVING A UNIFORM CEMENT MANTLE WITH THE RIGHT THICKNESS

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INTRODUCTION

Currently, PMMA bone cement is the most widely used material to secure acetabular cups to the hemi pelvic bone in cemented hip replacements.Achieving a uniform cement mantle with the right thickness during orthopaedic surgery is important for the long-term stability of bone and joint reconstructions [1]. However, it is challenging to achieve this during surgery due to the cup bottoming out. Some acetabular cups with 3 mm cement spacers exist on the market. However, the optimum cement mantle thickness is not always 3mm [1]. Moreover, these cups Acetabular cups with polyethylene spacers were found to have a significantly higher initial rate of failure when compared with cups without cement spacers [2]. Although bone cement is reasonably strong in compression, it is a relatively brittle material, making it susceptible to fracture as a result of tensile loads [3]. We investigated the material properties of Palacos bone cement following our new technique to produce uniform cement mantles of pre-defined thicknesses to ensure that our technique for producing uniform cement mantle did not affect the strength of the bone cement.

METHODS

Bone cement samples were vacuum mixed at 23±1^{0}C and prepared, with and without spacers. The spacers were spherical in shape with a diameter of 3 ± 0.1mm. Four points bending, tensile and compressive tests were carried out according to British Standards Specifications [4,5], using Hounsfield and Instron Testing machines. Deflections were measured, using a linear potentiometric displacement transducers. Each cement specimen was stored at 37^{0}C for at least two weeks in a water bath prior to testing in order to achieve a specific moisture concentration of more than 95% [6]. The sample sizes and geometry of specimens are detailed in Table 1.

RESULTS AND DISCUSSION

There is a reduction of 7.7% and 8.01% (significantly different) in the bending modulus and bending strength of the bone cement specimen, respectively, between groups I and II. However, when the cement spacers are placed away from the central location at 17.5 mm from each end of the specimen, there was a reduction of 2.51% and 1.52% in the bending modulus and bending strength of the bone cement, respectively (not significantly different).

There is a reduction of 1.03% in the compressive strength of the bone cement (not significantly different).

There is a reduction of 30.7% in the tensile strength of the bone cement between Groups I and II (significantly different). However, there is a reduction of only 2.73% in tensile strength between Groups I and III, when the spacers were positioned at 25mm from each end (not significantly different).

Table 1: Details of specimens and results of four-points bending, tensile and compressive tests

Test	Bending	Tensile test	Compressive
Protocol	BS ISO 5833	BS EN ISO 527-1/2	BS ISO 5833
Specimen geometry in mm	Rectangular 75±.1 x 10±.1 x 3.3±.1	Gauge length: 25±.5, as per BS	Cylindrical Dia:6±1mm Ht:12±1mm
Sample groups	I: n= 16 No spacer	I: n= 16 No spacer	I: n=20 No spacer
	II: n= 16 1 spacer in the centre	II: n= 16 1 spacer in the centre	
	III: n=16 2 spacers, at 17.5 mm from each end	III: n=16 2 spacers, at 25 mm from each end	II: n=20 1 spacer positioned centrally
Results (MPa)	Bending Modulus (SD) Bending Strength (SD)	Compressive strength (SD)	Tensile strength (SD)
	Group I 3180 (218) 72.4 (2.7)	Group I 106.4 (2.57)	Group I 43.9 (2.44)
	Group II 2935 (243) 66.6 (2.36)		Group II 30.4 (4.17)
	Group III 3100 (312) 71.3 (2.86)	Group II 105.3 (2.83)	Group III 42.7 (2.52)

CONCLUSIONS

Results of this study suggest that our new technique could be used in cemented hip surgeries to help surgeons achieve an even thickness of cement mantle. If the spacers are positioned in regions of low stress concentration, avoiding the posterior superior location, a uniform cement mantle can be achieved, without affecting the mechanical properties of Palacos bone cement, hence maintaining a stable fixation.

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