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Effect of cavity-defects interaction on the mechanical behavior of the bone cement

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Abstract. The presence of cavities in the bone cement has a great importance for the transport of antibiotics, but its existence in this material can lead to its weakening by notch effect. The aim of this study allows providing a physical interpretation to the cavities interconnection by cracks observed experimentally. The most important stress of Von Mises is localized at the cement/bone interface near the free edge which is the seat of stress concentration. The presence and interaction of cavities in this site concentrate, by notch effect, stresses which tend to the tensile fracture stress of Bone cement.

Keywords: bone cement (PMMA); porosity; interaction; stress concentration

1. Introduction

The bone cements are composed of two components, polymer powder and liquid monomer, which can be mixed with different methods. Depending on the mixing method, this process sometimes generates air voids in the cement (Ayatollahi and Karimzadeh 2012). Another common method for mixing the bone cement components is vacuum mixing in which the polymer powder and liquid monomer are mixed with vacuum pressure. This method is expected to reduce the porosity in the bone cement (Dunne and Orr 2001). The formation and development of microvoids, usually plays a dominant role in the damage and fracture of bone cement. The major problem associated with the presence of flaws due to pores and additives is that when a critical flaw size is achieved, the flaws act as sites of stress concentration, leading to weakening of the cement. The Griffith crack criterion stipulates that there exists a critical flaw size is 70μm. Thus, porosity alone would not compromise the fracture strength of bone cement, especially if all the pores were smaller than the critical flaw size for PMMA. But the size of the pore and their distribution are expected to strongly affect the fracture strength if some of the pores exceed the critical flaw size for PMMA (John *et al*. 2007). Pores at the interface between the cement and femoral stem can also act as sites of stress concentration, with the potential for crack emanating from micropores initiation; the number of these pores can be decreased by preheating the femoral stem

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