

The stem-Cement Interface in Total Hip Replacement

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The concept of low-friction arthroplasty proposed by Sir Charnley in 1960 was considered as a significant contribution to the success of Total Hip Replacement (THR), which is nowadays routinely performed worldwide to treat patients suffering from debilitating hip disorders [1]. This procedure can bring almost immediate alleviation of pain and restoration of hip function, with a quite satisfactory survivorship even at long term follow up. However, failure of the hip prosthesis does occur and the revision surgery is not only more expensive, but also associated with a decisively lower longevity and a higher rate of complication and morbidity. Currently, with a progressively increasing prevalence of THR performed in younger and more active people with a longer life expectancy, much more fortitude and endeavour in research would necessarily be required to gain a deep insight into the failure mechanism in order to further improve the survivorship of THR.

From the mechanical point of view, aseptic loosening has been considered to be the primary reason dominating malfunction of the total joint replacement system, and its occurrence can be attributed to periprosthetic bone resorption, which is further induced by the wear debris generated through wear of the components [2]. Previously, wear between the femoral head and the acetabular cup was regarded as the main source responsible for the generation of wear debris as this interface was designed to allow for movement and to provide the patients with flexibility. Recently, great progress has been made to reduce wear at this articulating head-cup interface with the advent of cross-linked ultra high molecular weight polyethylene and the renaissance of hard-on-hard bearing systems, and wear between the femoral stem and the bone cement is showing an increasing significance in the overall wear of cemented THR [3]. The stem-cement interface, a transitional zone between two materials with significantly different mechanical properties (e.g. stiffness, hardness, elastic modulus), forms a junction through mechanical interlock rather than chemical bonding. Although for a long time it was believed that the femoral stem was well anchored within the cement mantle *in vivo*, a body of evidence was available demonstrating, both clinically and experimentally, that debonding of the stem-cement interface may in fact be inevitable under physiological loading for almost all stem designs [4,5]. The mechanical debonding at this interface would subsequently result in a low-amplitude relative micromotion between the femoral stem and the bone cement, which is considered as the prerequisite for fretting wear and consequent generation of wear debris [6]. It was indicated from an intensive study on surface morphology of explanted femoral stems that the fretting wear mechanism at the stem-cement interface was mainly determined by surface finish of the femoral stem, with different severities of damage to the bone cement [7]. In addition, an *in vitro* simulation was successfully performed recently to reproduce fretting wear on polished femoral stems by modifying the method of fixation to incorporate initial stem implantation in a sawbone, and it was further indicated that the micropores in the bone cement surface played an important part in initiation and propagation of fretting wear on the femoral stem surface [8]. Notwithstanding, the influence of femoral stem geometry and bone cement type on generation of fretting wear has not been deeply investigated as yet, and research into this issue would contribute to a better understanding of the design philosophy of the femoral stem.

Fretting wear at the stem-cement interface is playing a more and more important role in the overall wear of cemented total hip replacement. Consequently, more attention should be paid to this interface to further improve the survivorship of the hip prosthesis.

References

1. CHARNLEY J (1960) Anchorage of the femoral head prosthesis to the shaft of the femur. J Bone Joint Surg Br 42-B: 28-30.
2. Herberts P, Malchau H (2000) Long-term registration has improved the quality of hip replacement: a review of the Swedish THR Register comparing 160,000 cases. Acta Orthop Scand 71: 111-121.
3. Zhang HY, Blunt L, Jiang XQ, Brown L, Barrans S, et al. (2008) Femoral stem wear in cemented total hip replacement. Proc Inst Mech Eng H 222: 583-592.
4. Zhang H, Brown L, Blunt L (2008) Static shear strength between polished stem and seven commercial acrylic bone cements. J Mater Sci Mater Med 19: 591-599.
5. Zhang H, Brown LT, Blunt LA, Barrans SM (2008) Influence of femoral stem surface finish on the apparent static shear strength at the stem-cement interface. J Mech Behav Biomed Mater 1: 96-104.
6. Zhang H, Brown L, Barrans S, Blunt L, Jiang XQ (2009) Investigation of relative micromotion at the stem-cement interface in total hip replacement. Proc Inst Mech Eng H 223: 955-964.
7. Howell JR Jr, Blunt LA, Doyle C, Hooper RM, Lee AJ, et al. (2004) In vivo surface wear mechanisms of femoral components of cemented total hip arthroplasties: the influence of wear mechanism on clinical outcome. J Arthroplasty 19: 88-101.
8. Zhang H, Blunt L, Jiang X, Brown L, Barrans S (2011) The significance of the micropores at the stem-cement interface in total hip replacement. J Biomater Sci Polym Ed 22: 845-856.

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