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Analytical and computational sliding wear prediction in a novel knee implant: a case study

Absract

Osteoarthritis (OA) is a commonly occurring cartilage degenerative disease. The end stage treatment is Total Knee Arthroplasty (TKA), which can be costly in terms of initial surgery, but also in terms of revision knee arthroplasty, which is quite often required. A novel conceptual knee implant has been proposed to function as a reducer of stress across the joint surface, to extend the period of time before TKA becomes necessary. The objective of this paper is to develop a computational model which can be used to assess the wear arising at the implant articulating surfaces. Experimental wear coefficients were determined from physical testing, the results of which were verified using a semi-analytical model. Experimental results were incorporated into an anatomically correct computational model of the knee and implant. The wear-rate predicted for the implant was 27.74 mm^3 per million cycles (MC) and the wear depth predicted was 1.085 mm/MC. Whereas the wear-rate is comparable to that seen in conventional knee implants, the wear depth is significantly higher than for conventional knee prostheses, and indicates that, in order to be viable, wear-rates should be reduced in some way, perhaps by using low-wear polymers.

Keywords

Implant; Osteoarthritis; Wear