WEAR OF UHMWPE Tibial Inserts Under Simulated Obese Patient Conditions

INTRODUCTION

In vitro wear testing of Total Knee Arthroplasty (TKA), based on ISO 14243-1 /-3 (or modifications thereof) traditionally simulates the gait cycle and is based on average theoretical knee joint loading during level walking from the early work of Morrison and Paul [1-3]. Frequently used axial load curve is based on a body weight of 101.6 kg [4], which corresponded to the 95th percentile of adult American body weight in the 1970s [5]. Since then, the demographics have changed and a high fraction of the population is now considered overweight or obese. In 2006, more than half of the TKA patients were obese (Body Mass Index ≥ 30 kg/m²) [6]. From activity monitoring studies, it is known that persons with a BMI of up to 40 or 45 may be still very active despite their excessive body weight. It is unknown to what extent these facts are reflected in pre-clinical wear testing.

The aim of this study was to determine the wear performance of conventional and Prolong® highly crosslinked polyethylene articular surfaces under ISO 14243-3 loading adapted to be realistic for a person with a BMI of 45 and to compare the results with wear testing under loading characteristics according to [4].

MATERIALS AND METHODS

Twelve NextGen® CR total knee system (Zimmer Inc., Warsaw, IN) femoral components were articulated against corresponding 10mm thick aged (according to ASTM F 2003-02) polyethylene tibial inserts (six were made of gas plasma-sterilized Prolong and six of conventional gamma-sterilized UHMWPE) in undiluted bovine serum lubricant under load and motion waveforms according to ISO 14243-3 modified to account for the obese patient (obese-ISO: Figure 1 red curve). Wear of the articular surfaces was determined gravimetrically every 0.5 million cycles (Mc) up to 3.0 Mc and every 1.0 Mc thereafter for a total of 5.0 Mc. Wear rate was corrected for fluid absorption by means of two “load soak” inserts per material subjected to identical load waveforms with no rotations. The results were compared to those obtained from previous wear tests performed according to Johnson [4] (Johnson-ISO, Figure 1, blue curve).

RESULTS AND DISCUSSION

The load profile of the Johnson-ISO [4] differs from the ISO 14243-3 in that it used slightly higher stance phase peak loads and variable and higher swing phase loads (Figure 1).

The imposed motion waveforms for the obese-ISO and the Johnson-ISO conditions were identical to those recommended in ISO 14243-3.

CONCLUSION

Wear rates of the Prolong tibial inserts tested under both loading conditions were reduced by more than 70% compared to their conventional gamma-sterilized counterparts. However, wear rates of both the conventional PE and Prolong inserts under simulated load and motion profiles adapted to account for obese patients were not statistically significantly different from those previously reported from tests performed under Johnson-ISO conditions.

REFERENCES