INTRODUCTION

With the number of patients requiring arthroplasty surgery quickly on the rise, unicompartmental knee arthroplasty provides an effective alternative to the young patient with single compartment involvement. As instrumentation of unicompartmental knee systems improves, more surgeons will take on the procedure. As a joint preserving option, this procedure allows for early treatment all while preserving bone stock for later conversion to a total knee arthroplasty, if or when needed.

Historically there is a general concern with polyethylene thinner than 8mm [1]. Bartel, et al [1] published work concluded that the thickness of the polyethylene component should be maximized to reduce stresses, and recommended a minimum thickness of 8mm. Therefore, currently available implants require a tibial cut large enough to support a polyethylene of at least 8mm in thickness. However, modern materials and design have addressed the issue of high stresses proving the possibility of thinner components. It is the purpose of this study to evaluate the effect of standard walking mechanics on the wear characteristics of thinner polyethylene for a unicompartmental design. This could thereby allow for a smaller tibial resection and thereby preserve more native bone.

MATERIALS AND METHODS

Both left medial/right lateral and left lateral/right medial components were utilized for testing and were paired together to create a bicondylar component. The unicompartmental system (Triathlon® PKR, Stryker Orthopaedics, Mahwah, NJ) consisted of cobalt chrome femoral components and tibial trays, and polyethylene inserts that were manufactured from GUR 1020 UHMWPE that was sequentially annealed and irradiated three times and then gas plasma sterilized (X3™, Stryker Orthopaedics, Mahwah, NJ). The inserts thicknesses were either 8 mm or 6 mm nominal, which corresponded to a polyethylene thickness of 6 mm and 4 mm, respectively.

A 6-station knee simulator was utilized for testing (MTS, Eden Prairie, MN). All motion and loading was computer controlled and waveforms followed ISO 14243-3 [1]. Testing was conducted at a frequency of 1 Hz for 2 million cycles. The lubricant used was Alpha Calf Fraction serum (Hyclone Labs, Logan, UT) diluted to 50% with a pH-balanced 20-mMole solution of deionized water and EDTA (protein level = 20 g/l) [2]. The serum solution was replaced and inserts were weighed for gravimetric wear at least every 0.5 million cycles. Standard test protocols were used for cleaning, weighing and assessing the wear loss of the tibial inserts [3]. Soak control specimens were used to correct for fluid absorption with weight loss data converted to volumetric data (by material density). Statistical analysis was performed using the Student’s t-test.

RESULTS

The results of testing are shown in Figures 1 and 2. There is no statistical difference in volume loss when the wear of the medial and lateral components is combined (Figure 1) (P > 0.05). A separate analysis comparing the medial and lateral components of each thickness also revealed no statistical differences in wear rates (Figure 2) (P > 0.05). None of the inserts showed signs of delamination or fatigue fracture after 2 million cycles.

DISCUSSION

The results of our study demonstrate no significant differences between the 6 and 8 mm polyethylene components at 2 million cycles with respect to wear. This theoretically allows the surgeon to resect less bone at the index procedure thereby preserving more of the patient’s host bone.

It was also appreciated that with the thinner components, the peripheral rim of the polyethylene contained the least amount of material. Following this study, it is recommended the study be repeated with the tibial component in several degrees of mal-rotation to assess the integrity of this rim with respect to mechanical strength.

REFERENCES

[3] ASTM F2025