INTRODUCTION

There is general consensus that surface roughness negatively affects polyethylene wear resistance in hip and knee arthroplasty. As such, much effort goes toward ensuring implant bearing surfaces are highly polished prior to distribution to the user. The question arises as to the relevance of inadvertent scratches that occur on surfaces during implantation or revision surgery. One specific scenario is the retained femoral component during revision knee arthroplasty. Previous studies implantation or revision surgery. One specific scenario is the retained femoral component during revision knee arthroplasty. Previous studies have also shown that cases in which the femoral component was retained had higher failure rates than cases where all components were exchanged.\(^1,2\)

One study postulated that this could be a result of increased femoral component surface roughness.\(^2\) Other data suggest that it may not be necessary to revise a well-aligned, well-fixed femoral component in certain failure scenarios.\(^3,4\)

Several investigations have simulated surface roughness on total knee femoral components in an effort to determine the importance of this non-ideal environment for the bearing surfaces.\(^5,6\) Arguably, these artificially created imperfections do not accurately reflect the true in vivo conditions. The aim of our study was to further elucidate the effect of total knee femoral component surface roughness on polyethylene wear using a more realistic model.

MATERIALS AND METHODS

Six (n=6) left CoCr Triathlon™ cruciate-retaining femoral components (Stryker Orthopaedics, Mahwah, NJ) were paired with matching 9mm thick Triathlon™ cruciate-retaining conventional polyethylene inserts. Three of the femoral implants, which were unused and new from the manufacturing process, served as control components. The other three implants were retrieved during revision arthroplasty. These components were de-identified of patient specific data prior to being collected for this investigation. Surface roughness was measured at multiple points along each condyle of the six components using a New View 6300 white light interferometer (Zygo, Middlefield, CT).

The six knee components were mounted to a six-station MTS knee simulator (Eden Prairie, MN) set to run normal walking gait kinematics (ISO 14243-3). The cycles were computer controlled at 1Hz with a maximum load of 2600N, 0 to 5.2mm of anterior to posterior translation, -1.9° to 5.7° of internal to external rotation, and a maximum flexion angle of 58°. All chambers were filled with Alpha Calf Fraction serum (Hyclone Laboratories, Logan, UT) diluted to 50% with de-ionized water and 20mMole EDTA.

Gravimetric measurements on the six polyethylene inserts and two polyethylene inserts allowed to soak in serum during the testing were made at 0.5 million cycle intervals up to 2 million cycles. The soaked inserts were utilized to correct for weight changes attributed to fluid absorption during testing. Volumetric wear data were calculated from the weight change of the polyethylene inserts and the known density of the conventional UHMWPE used for this study.

Data were analyzed using the student’s t-test.

RESULTS

The surface roughness (Ra) of our control components was on average 0.039µm; whereas our retrieved components had an average Ra of 0.265µm. This difference was not statistically significant (p=0.063). There is clinical relevance to this difference as the industry standard for a metallic bearing surface is a Ra of < 0.10µm (ASTM F 2083-08). Characterizing the data further showed the retrieved components had a statistically higher deviation from the mean roughness to the highest peak (Rp (peak)) created from metal surface scratches compared to the controls (p=0.042), as shown in figure 1a and b.

DISCUSSION

Similar to the study by Lakdawala et al.,\(^5\), we found that the difference in the mean Ra for our retrieved femoral components and controls was not statistically significant. The mean Ra for these retrievals did, however, fall outside of the standards for metallic bearing surface roughness and had a significantly greater Rp (peak). An increase in polyethylene volumetric wear after 2 million gait cycles was not seen between the two groups. Likewise, previous artificially created surface roughness models have not demonstrated significant differences in volumetric polyethylene wear rates.\(^4,5\) The data suggest that previously reported poor results attributed to retained femoral components during revision knee arthroplasty cannot be solely attributed to the occurrence of inadvertent scratches and increases in surface roughness. It seems that causes for higher failure rates seen in some series on single component knee revisions are more complex than mere changes in the roughness of the condylar surfaces. A potential drawback to this study is the limited sample size as some components may have more severe scratches than those collected for this investigation. Additionally, the study looked only at routine walking gait simulations. Wear patterns may differ at more extreme levels of use. Further investigations under differing conditions are warranted to further substantiate these results.

REFERENCES