INTRODUCTION: Although total knee arthroplasty (TKA) is a highly successful procedure, wear and damage of the ultrahigh molecular weight polyethylene (UHMWPE) tibial articular surface has been a limiting factor in the service life of knee implants. The situation is also more complicated than in hip prostheses because higher contact stresses are usually present in UHMWPE knee components. Thus, in addition to the surface abrasive/adhesive wear present in UHMWPE acetabular cups, tibial articular surfaces can also undergo subsurface fatigue damage. A promising approach to combat both wear and damage is the use of the highly crosslinked UHMWPE developed in recent years, which have been found to offer an order of magnitude wear reduction in hip wear tests. This report presents the results of a 20 million cycle knee simulator study of the wear of an electron-beam crosslinked UHMWPE (XLPE). The XLPE tibial articular surfaces are compared to their conventional gamma-sterilized UHMWPE counterparts.

MATERIALS AND METHODS: A group of 12 XLPE tibial articular surfaces and a group of 6 conventional UHMWPE liners (gamma controls) were wear tested to five million gait cycles, after which one third of the components were removed for separate examination, while the remaining 8 XLPE components and 4 gamma controls were wear tested to 20 million cycles.

Specimens: Cruciate retaining knees were used. All of the tested tibial articular surfaces, gamma and XLPE, were machined from the same compression molded GUR 1050 UHMWPE lot. The XLPE articular surfaces were machined from bars of UHMWPE crosslinked by subjecting them to 58 kGy or 72 kGy of electron beam. The control articular surfaces were sterilized by gamma radiation in nitrogen at a dose of 37 kGy, whereas the XLPE articular surfaces were gas plasma sterilized. All of the articular surfaces were artificially aged in pressurized oxygen (73 psi) at 70°C for 14 days, based on the aging procedure described by Sanford and Saum.

Knee Wear Test: The knee wear tests were performed in 6-station AMTI knee simulators as described previously. A peak load of 3200 N (720 lb) and a minimum load of 50 N (11 lb) were used. The knees were articulated in undiluted bovine calf serum at the physiological frequency of 1.1 Hz. Each joint was tested in an environmentally sealed chamber in which the serum lubricant was recirculated and maintained at 37 ± 3°C. “Load-soak” articular surfaces were used to correct for fluid absorption.

RESULTS AND DISCUSSION: The XLPE tibial articular surfaces experienced considerably less wear than their gamma counterparts. Plots of the average polyethylene wear versus cycles are shown in Figure 1. After 5 million cycles, the group-averaged cumulative wear rates were 14.4 ± 1.2 mg/million cycles for the gamma controls, 3.70 ± 0.43 mg/million cycles for the 58 kGy XLPE PE articular surfaces, and 1.73 ± 0.26 mg/million cycles for the 72 kGy XLPE PE articular surfaces (± standard error). Thus, the average wear rates reductions measured relative to the gamma controls were therefore 71% and 88% for the 58 kGy and 72 kGy XLPE articular surfaces, respectively, for an aggregate wear reduction of 81%. The aggregate wear reduction decreased slightly after 20 million cycles, to 73%.

One of the four gamma inserts tested to 20 million cycles underwent extensive delamination damage (Figure 2). The onset of delamination was observed visually starting at 12 million cycles. None of the XLPE inserts exhibited signs of delamination after completion of the test at 20 million cycles.

The dimensional stability of the XLPE articular surfaces was acceptable, as determined from penetration (minimum thickness decrease) and medial/lateral compression molded GUR 1050 UHMWPE lot. The XLPE艺术表面被切割成棒状并用电子束照射，使其变为58 kGy或72 kGy的电子束。控制表面经过伽马射线照射在氮气中，剂量为37 kGy，而XLPE表面则经过等离子体照射。所有表面经过压氧(73 psi)在70°C下压氧14天，基于桑福德和萨姆的 Aging Procedure。

Knee Wear Test: 膝关节磨损测试在6台AMTI膝关节模拟器上进行，如以前所述。峰值负载为3200 N（720 lb）和最低负载为50 N（11 lb）。膝盖在未稀释的牛犊小腿关节液中 articulated，在1.1 Hz的生理频率下。每具关节均在密封的环境中进行测试，在其中的关节液被循环并保持在37 ± 3°C。使用“Load-soak”表面来纠正液体吸收。

RESULTS AND DISCUSSION: XLPE膝关节表面的磨损明显小于 gamma 对照。图1中的平均聚乙烯磨损与循环图显示，在500万次循环后，gamma 对照的累积磨损率为14.4 ± 1.2 mg/million cycles，而58 kGy XLPE PE表面的磨损率为3.70 ± 0.43 mg/million cycles，72 kGy XLPE PE表面的磨损率为1.73 ± 0.26 mg/million cycles（±标准误差）。因此，相对于gamma对照的平均磨损率减少了71%和88%，分别为58 kGy和72 kGy XLPE表面，总平均磨损率下降了81%。磨损率在2000万次循环后略微下降，至73%。

其中四个gamma植入物在2000万次循环后出现明显的剥落损伤（图2）。磨损的开始在1200万次循环时被观察到。XLPE植入物在完成200万次测试后没有显示任何剥落损伤的迹象。

尺寸稳定性：XLPE表面的尺寸稳定性是可接受的，通过渗透（最小厚度减少）和 medial/lateral

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