Femoral Micromotion Analysis for the CR ATTUNE® Cementless Femoral Component

Abraham Wright, Principal Engineer | DePuy Synthes, Warsaw, IN.

Abstract

Purpose

The purpose of this study was to evaluate and compare the initial stability of the ATTUNE® Cruciate Retaining (CR) Cementless Femoral Component compared to the femoral component of the LCS™ Total Knee System.

Materials and Methods

Cadaveric testing of six pairs of femurs using 3D-optical scans and CT-scans to measure bone cut accuracy, bone mineral density (BMD), and micromotion across multiple regions of interest along the bone-implant interface.

Results

The ATTUNE CR Cementless Femoral Component design was shown to reduce the incidence of micromotion and increase the pull-off force required when compared to the LCS Cementless Femoral Component. The ATTUNE CR Cementless Femoral Component appears to have the potential to achieve equivalent or better initial fixation[1] as the clinically proven LCS Cementless Femoral Component.[2-4]

Introduction

Fixation for cementless Total Knee Replacement (TKR) is achieved by early initial fixation caused by friction, usually achieved with a press-fit, combined with a design that reduces micromotion to allow long term biologic fixation. The ATTUNE CR Cementless Femoral Component is designed to have more accurate femoral resections through improved cutting techniques compared to previous DePuy Synthes cementless designs. Also, the anterior-posterior (AP) surfaces of the ATTUNE CR Cementless Femoral Component are designed to contact distal surfaces with rails at chamfers for an accurate fit.

The ATTUNE Cementless CR Femoral Component is made from cobalt chromium alloy, with all surfaces on the bone-implant interface coated with POROCOAT™ Porous Coating (Figure 1). The femoral geometry is the same as the ATTUNE® Cemented Cruciate Retaining Femur, leveraging technologies like the ATTUNE GRADIUS™ Curve and GLIDERIGHT™ ARTICULATION to cementless TKR. The ATTUNE Cementless CR Femoral Component comes in the same sizes as the ATTUNE Total Knee System, increases by 3 mm increments A/P just like the ATTUNE Total Knee System, and utilizes AOX™ Antioxidant Polyethylene.

Figure 1: ATTUNE CR Cementless Femoral Component

The purpose of this white paper is to demonstrate the potential for enhanced initial fixation with the ATTUNE CR Cementless Femoral Component.

Discussion

In cementless TKR, biologic fixation is provided by a porous surface coating and minimal micromotion. The femoral implant with porous surface coating is implanted with a press-fit for initial stability and fixation. Optimizing the initial fixation of the cementless implant can be achieved by minimizing micromotion at the bone-implant interface. Low amounts of micromotion at the bone-implant interface, < 50 µm[5], are considered to be ideal for biologic fixation, while higher amounts, >150 µm, are known to result in fibrous tissue formation.[6]

Baseline micromotion for the ATTUNE CR Cementless Femoral Component was studied and compared to the clinically successful LCS Knee System.[2-4] Micromotion measurements were taken at nine points along the bone-implant interface during gait and at seven points during simulated deep knee bend (DKB) (Figures 2,3).

Figure 2[1]: Cadaveric Micromotion during simulated gait cycle

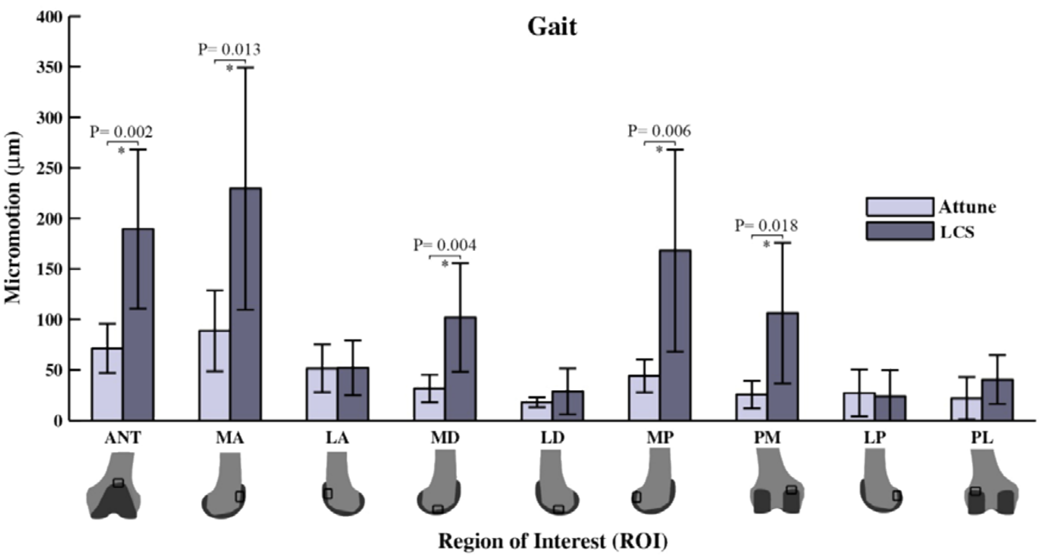


Figure 2: Micromotion measurements during gait analysis comparing the ATTUNE CR Cementless Femoral Component to the LCS Cementless Femoral Component. Micromotion was recorded at nine points along the bone-implant interface. The results of this graph show the measured amount of micromotion, motion between the bone and implant, seen at various specific regions on the femoral component as a gait cycle is replicated. As you can see here, some regions exhibited far less micromotion than what was seen in the LCS Cementless Femoral Component.

Figure 3[1]: Cadaveric Micromotion during simulated deep knee bend

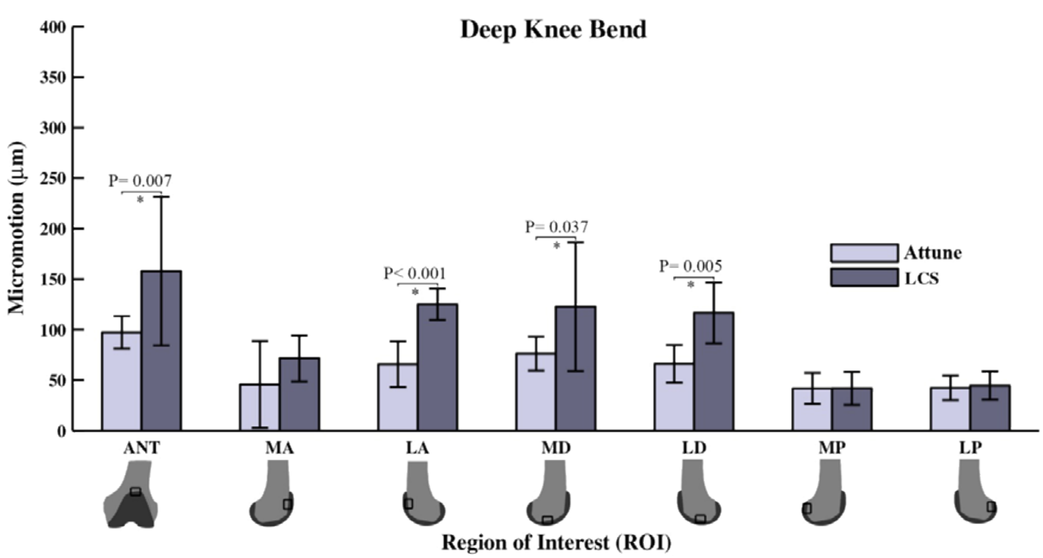
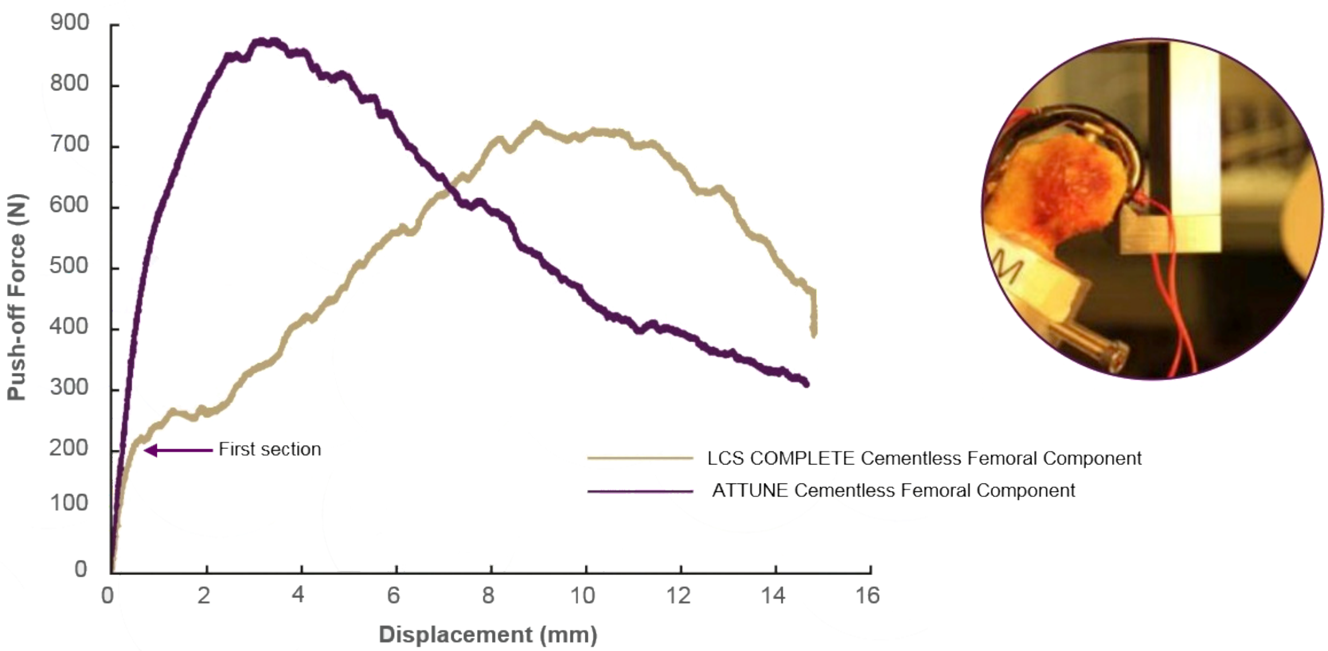


Figure 3: The Micromotion testing was repeated during simulated Deep Knee Bend. In cadaveric testing, the design of the ATTUNE Cementless Femoral Component was shown to reduce the incidence of micromotion when compared to the LCS Cementless Femoral Component. The results of this graph show the measured amount of micromotion, motion between the bone and implant, seen at various specific regions on the femoral component as a deep knee bend is replicated. As you can see here, some regions exhibited far less micromotion than what was seen in the LCS Cementless Femoral Component.

Once the micromotion testing was complete, further cadaveric testing for high flexion push-off test was initiated for both components. On average, the ATTUNE Cementless CR Femoral Component required 2.4 times higher force to reach 150 µm of movement than the LCS Cementless Femoral Component (p=0.002) (Figure 4).[1]

Figure 4[1]:High flexion push-off test results.



Key Takeaway:

The lower micromotion demonstrated by the ATTUNE CR Cementless Femoral Component compared to the LCS Cementless Femoral Component combined with the higher pull-off force[1] and clinical history of POROCOAT Porous Coating[2-4] suggests a potential for the ATTUNE Cementless CR Femoral Component to achieve equivalent or better initial fixation as the clinically successful LCS Knee.

References

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DePuy Orthopaedics, Inc.
700 Orthopaedic Drive
Warsaw, IN 46582
USA
Tel: +1 (800) 366-8143
Fax: +1 (800) 669-2530

DePuy (Ireland)
Loughbeg, Ringaskiddy
Co. Cork, Ireland
Tel: + 353 21 4914 278

www.depuysynthes.com