Attune® Knee System

Cementless

Analysis of Tibial Base design in the ATTUNE® Cementless RP Tibial Base

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Introduction

Total Knee Replacement (TKR) has been widely recognized as one of the most common and successful surgical procedures with more than 95% implant survivorship at ten years.[1] Fixation methods for TKR vary, allowing orthopaedic surgeons to use either cemented or cementless options for fixation.

Fixation for cementless 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. Design options for the underside of a cementless tibial baseplate to achieve these short and long-term goals include a central stem, a central keel, and the addition of pegs.

The goal of the ATTUNE® Cementless RP Tibial Baseplate was to combine the proprietary ATTUNE Knee Technologies with biologic fixation. To enhance initial fixation a peg design was chosen for the ATTUNE Cementless RP Tibial Baseplate due to the low incidence of micromotion,[2] designed to encourage biologic fixation. The location of the pegs also mattered. Computer modelling was used to determine, and verify, the peg location.[7] A clinically proven porous surface[3-5] was applied to this design (Figure 1.)

The purpose of this white paper is to demonstrate the depth of the research conducted during the design of the ATTUNE® Cementless Rotating Platform (RP) tibial base.

Figure 1: Underside view of the ATTUNE Cementless RP Tibial Baseplate

Figure 1: The ATTUNE® Cementless RP Tibial Baseplate is designed with 4 pegs positioned radially from the central cone of the RP tibial base. The pegs and the underside of the ATTUNE Cementless RP Tibial Baseplate are coated in POROCOAT Porous Coating, with a grit blasted central keel

Discussion

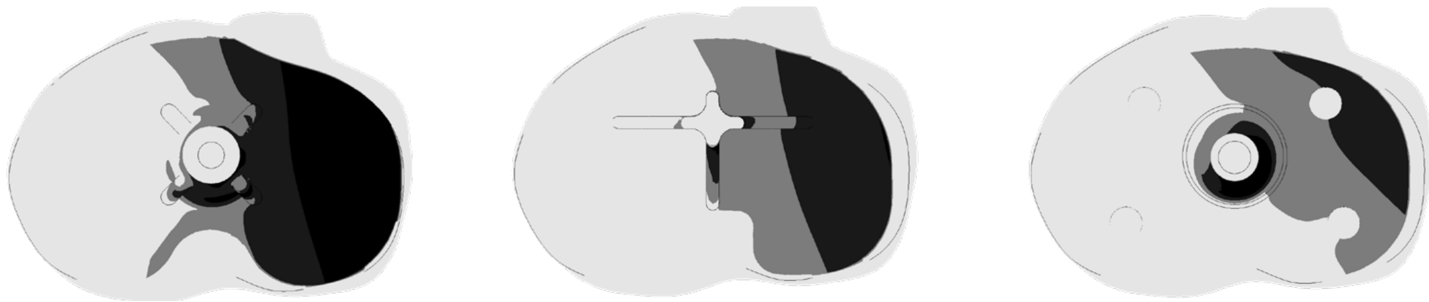
Design of the underside of the ATTUNE Cementless RP Tibial Baseplate

During the development of the ATTUNE Cementless RP Tibial Baseplate, three different designs were considered. The first design was from the LCS COMPLETE™ Knee System, which was a central stem that gains fixation from the intercondylar bone. The second design was a central keel, such as the P.F.C.™ SIGMA® Knee System. The final design considered for the ATTUNE Cementless RP Tibial Baseplate incorporated four pegs positioned radially from a central cone, like the MBT DUOFIX™ Knee.

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,[2] are considered to be ideal to ensure biologic fixation, while higher amounts, >150 μm, are known to result in fibrous tissue formation.[6]

A primary goal for the ATTUNE Cementless RP Tibial Baseplate was to optimize initial fixation by reducing micromotion. Taylor et al. had studied micromotion on these historically available designs.[2] They found that the pegs on the underside of the tibial baseplate resulted in the least micromotion during the five dominant activities of the gait cycle: Walking, Stair Ascent, Stair Descent, Deep Knee Bend, and the transition from standing to sitting (Figure 2).[2]

The results from this study led to the selection of a central cone with four pegs located radially from the cone for the ATTUNE Cementless RP Tibial Baseplate.



1. Mean micromotion of the LCS COMPLETE Knee System during the gait cycle.
2. Mean micromotion of the P.F.C. SIGMA Knee System during the gait cycle.
3. Mean micromotion of the MBT DUOFIX Knee System during the gait cycle. This design demonstrated the least amount of micromotion tested and was selected as the inspiration for the ATTUNE Cementless RP Tibial Base design.

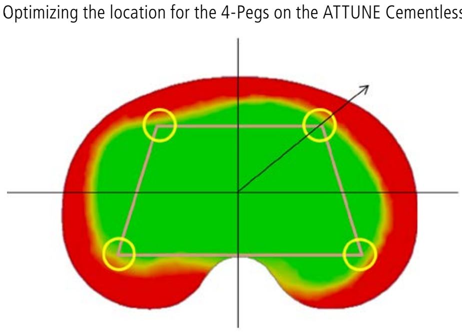
Figures 2-1:2-3: Composite Peak Micromotion Plots demonstrating micromotion through the gait cycle, adapted from Taylor et al.[2] Light gray areas are < 50 μm. Black areas are regions with > 150 μmm. The design with 4 pegs demonstrated the least mean micromotion. Pegs were added to the underside of the ATTUNE Cementless RP Tibial Baseplate.

Purpose

Peg location on the underside of the ATTUNE Cementless RP Tibial Baseplate

The design decision on where to place the pegs on the ATTUNE Cementless RP Tibial Baseplate was of crucial importance. The pegs must be in the best possible position to reduce micromotion while simultaneously preventing cortical impingement. Peg location closer to the periphery may reduce micromotion in the tibial bone. However, the risk for cortical impingement increases as the pegs may be placed closer to the periphery (Figure 4). Determining the optimal balance should result in a cementless knee with low micromotion and no cortical impingement, which may lead to long term clinical success.

Figure 4: Optimizing the location for the 4-Pegs on the ATTUNE Cementless RP Tibial Baseplate[10]



Computational modelling (MATLAB) using the TRUMATCH® Personalized Solutions CT dataset (N=14,250)[7] was used to compare peg location with the ATTUNE Cementless RP Tibial Base to the MBT DUOFIX™ Tibial Base. The location of each of the 4 pegs were calculated to determine if the pegs would impinge on the inner cortex. The purpose of this study using the TRUMATCH Personalized Solutions patient dataset was to calculate the best location for the tibial base pegs with the aim to achieve optimal fixation on the ATTUNE® Cementless RP Tibial Baseplate.

The results from this study demonstrated the average distance from the peg to the cortical edge was larger for the ATTUNE Cementless RP Tibial Baseplate than for the MBT DUOFIX Tibial Baseplate. These results demonstrate a reduced likelihood for cortical impingement with the ATTUNE Cementless RP Tibial Baseplate compared to the MBT DUOFIX Baseplate, while maintaining necessary proximity for optimal fixation (Figure 5).

Figure 5: Cortical Clearance ATTUNE Cementless Rotating Platform Tibial Baseplate

Figure 5: Figure 3: Visual representation of the reduced risk of cortical impingement for the ATTUNE Cementless RP Tibial Baseplate compared to a previous design.7

Porous coating on the underside of the ATTUNE Cementless RP Tibial Baseplate

In cementless TKR, biologic fixation is provided by a porous surface coating and minimal micromotion. DePuy Synthes POROCOAT™ Porous Coating has a well-established clinical history, with 98.9% implant survivorship at 10 years follow-up[3] and 98.3% implant survivorship at 18 years follow-up with revision for any mechanical reason or poor clinical knee score.[4]

POROCOAT Porous Coating is applied to the underside of the ATTUNE Cementless RP Tibial Baseplate, fully coats the 4 pegs, and is on the proximal surface of the central cone. The placement of the POROCOAT Porous Coating is designed to reduce micromotion, in turn encouraging biologic fixation.

Key Takeaway:

1. The ATTUNE Cementless RP Tibial Base was designed with 4 pegs positioned radially around the central cone to reduce micromotion, which is designed to optimize initial fixation.
2. The peg locations for the ATTUNE Cementless RP Tibial Baseplate were computationally verified to reduce the risk of impingement on the inner cortex while maintaining necessary proximity for optimal fixation compared to a previous design, using a dataset of real world patients to verify the result.[7]
3. The clinically proven POROCOAT Porous Coating[3-5] has been applied to the underside of the ATTUNE Cementless RP Tibial Baseplate

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