

# Comparison Between ATTUNE™ Medial Stabilized Knee System and Persona® Medial Congruent™ Bearing System

A review of technical data and clinical experience.

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## Background

The native knee is relatively stable on the medial plateau and mobile on the lateral plateau<sup>[1]</sup>. There are a number of implants on the market that attempt to match this native knee functionality through having a geometry that stabilizes the medial femoral condyle and allows motion of the lateral femoral condyle. Zimmer Biomet have added a Medial Congruent™ Bearing insert to their Persona® system, which has a more conforming medial compartment and flatter lateral compartment compared to the Persona® Cruciate Retraining (CR) insert. It articulates with the multi-radius J-curve design of the Persona® CR femur. The ATTUNE™ Medial Stabilized Insert also has an increased conformity on the medial compartment and works with the ATTUNE GRADIUS™ Curve sagittal geometry to provide enhanced medial stability. The lateral compartment is flatter to encourage mobility. The inserts are size matched to the femur utilizing the LOGICLOCK™ Technology, which allows the design of each insert size to be optimized for the single femur it articulates with.

## Objectives

The goal of this report is to compare these two medially conforming systems, the Persona® Medial Congruent™ Bearing System (Persona MC) and ATTUNE™ Medial Stabilized Knee System (ATTUNE™ MS Knee System) in terms of technical data and through the first-hand experience of Dr. Peters, surgeon who has had clinical experience using both systems.

## J-Curve vs Gradius Sagittal Geometry

Traditionally, femoral implant components have used a “J Curve” or Multi-Radius design (Figure 2). This concept originated from the desire to mimic the extension and flexion facet of the native femur as described by Pinskerova<sup>[2]</sup> and shown in Figure 1.

With a multi-radius design in extension, the broad distal femoral radius is in contact with a conforming and relatively congruent tibia surface giving a large load bearing surface and providing stability to the knee. The smaller posterior femoral radius, where the curve becomes a “J”, is designed to decrease the conformity of the

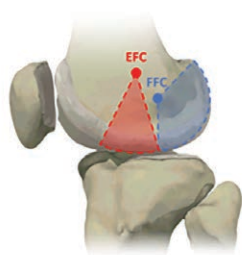


Figure 1. Representation of the medial femoral Extension Facet Center (EFC) and Flexion Facet Center (FFC) and their corresponding radii.

construct, allowing the femur to roll back and rotate as the knee moves to deeper flexion.

Cadaveric testing and computational simulations of multi-radius designs have shown that at the point of transition from one radius to the next, the joint becomes unstable and can experience sudden shifts during knee flexion (Figure 4)<sup>[3]</sup>. This same phenomenon in a multi radius design has also been shown in vivo.<sup>[4]</sup>

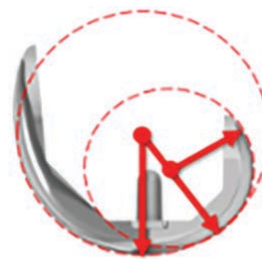


Figure 2. Depiction of a J-Curve or Multi-Radius Sagittal Geometry.



Figure 3. Depiction of the ATTUNE™ Total Knee System gradually reducing radius (ATTUNE GRADIUS™ Curve).

**The femoral component of the Persona® Medial Congruent™ Bearing Knee System is a traditional multi radius J-Curve Design.**

The ATTUNE GRADIUS™ Curve (Figure 3) recognizes the fact that the transition between the extension and flexion radii is important. While there remains a broad distal radius for load bearing and knee stability in extension and a smaller posterior radius for mobility in flexion, there is a gradual, rather than abrupt, reduction of the femoral sagittal radius between 5 and 65 degrees of knee flexion. This has been shown in computational, experimental, and clinical settings to reduce the paradoxical anterior slide seen in multi-radius designs at the transition between radii (Figure 4).<sup>[3, 4]</sup>

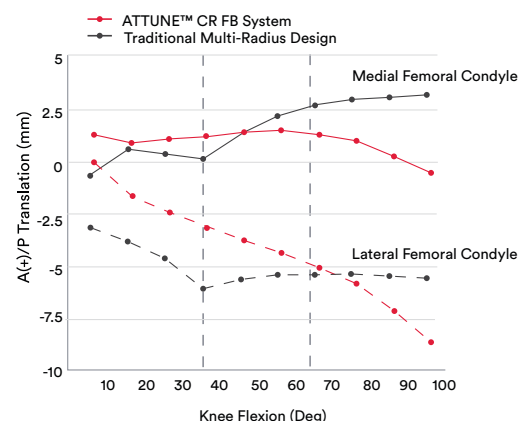


Figure 4. A-P motion of the femoral low point with respect to the tibial insert for a Traditional Multi-Radius and ATTUNE GRADIUS™ Curve Sagittal geometries.<sup>[3]</sup>

# ATTUNE™ Medial Stabilized Insert

The ATTUNE™ MS Knee System comprises the existing ATTUNE™ Cruciate Retaining femoral component (incorporating the ATTUNE GRADIUS™ Curve technology), the existing ATTUNE™ Tibial Base (incorporating the LOGICLOCK™ Tibial Base locking mechanism to allow for femur to insert matching), and a MS Tibial Insert. The asymmetrical design of the ATTUNE™ MS Knee Insert allows for the geometry of the medial and lateral plateaus to be optimized for medial stability and lateral rollback (Figure 5).

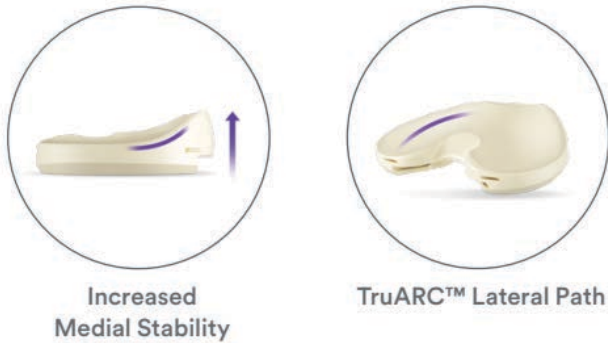


Figure 5. The ATTUNE™ MS Insert incorporating an increased medial lip compared to the ATTUNE™ CR Insert and the TruARC™ Lateral Path.

The ATTUNE™ MS Insert has a TruARC™ lateral geometry whereby the coronal profile is swept around an arcuate path encouraging rotation around the medial condyle. The medial condyle itself has an increased medial lip resulting in a higher anterior jump height than the ATTUNE™ CR Insert and allowing for more anterior medial sagittal conformity.

To analyze the anterior medial conformity, layouts showing the anterior clearance between the femoral component and the anterior medial portion of the insert in similarly sized femurs were generated. As shown by the red areas in Figure 6, the ATTUNE™ MS Knee System has less of an anterior medial clearance and therefore is more conforming than the Persona® MC construct. This decreased clearance could reduce anterior translation of the femur with flexion and be protective of a deficient or sacrificed Posterior Cruciate Ligament (PCL).



Figure 6. Images showing the anterior medial gap at 15 degrees of flexion in an ATTUNE™ Medial Stabilized Insert articulating with a ATTUNE GRADIUS™ Curve femoral geometry (right) and the Persona® Medial Congruent™ Bearing System insert articulating with the Multi-Radius Persona femur (left).

Figure 7 shows that at all flexion angles, there is less clearance with the ATTUNE™ MS Knee System than the Persona® MC. The clearance in the Persona® MC insert increases sharply between 45 and 60 degrees of flexion. This indicates a change in radius, as a single radius would have a consistent clearance as the knee flexes.

In addition, the Persona® system has a peripheral rather than central locking mechanism between the insert and the tibial component. This means that the insert must match the size of the tibia and therefore the system must allow multiple femurs to articulate on the same insert to accommodate situations where the patient has a different sized femur and tibia. The graph (Figure 7) shows that the anterior medial clearance is increased when a smaller femoral component is used on the same insert.

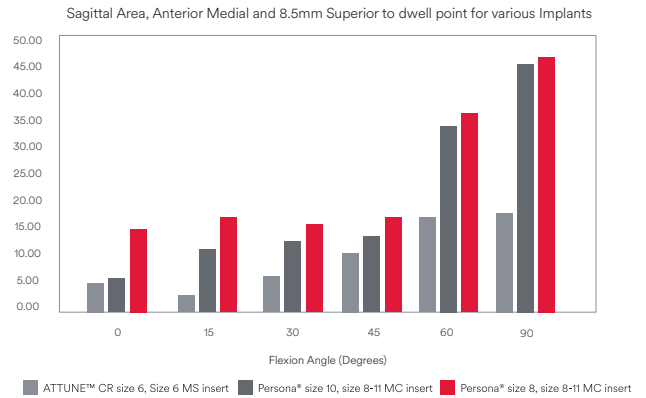


Figure 7. Graph showing the ATTUNE™ MS and Persona® MC anteromedial clearance, including the effect of the allowable size mismatch between Persona® CR femurs and MC inserts.

The posterior geometry of the ATTUNE™ Medial Stabilized Insert is similar to the standard ATTUNE™ Total Knee System Insert, designed to accommodate femoral rollback and prevent the conformity of the insert coming into conflict with the kinematics of the joint.

*“I have noticed that the ATTUNE™ Femoral Component mimics the natural motion and stability of the native knee, and this is further enhanced with the MS Polyethylene Insert. The ATTUNE™ MS Knee System allows both sagittal and coronal stability of the medial pivot point, recreating the native knee dynamics and improving post-operative strength and function. I have also found that the ATTUNE™ Knee System with the MS Design has improved stability in mid-flexion compared to its competitors. In my opinion, the traditional J-curve design with size mismatch contributes to laxity in mid-flexion, which can cause anterior knee pain and weakness”*

- Dr. Peters

# Native Knee Kinematics

The medial and lateral motion of the native knee in a load bearing squat had been studied using MRI and previously published.<sup>[1]</sup> Figure 8 plots the Anterior-Posterior (AP) motion of each femoral condyle with reference to the flexion angle. It shows that the medial condyle is stable, and the lateral condyle rolls back through early flexion, with both condyles rolling back in deeper flexion.

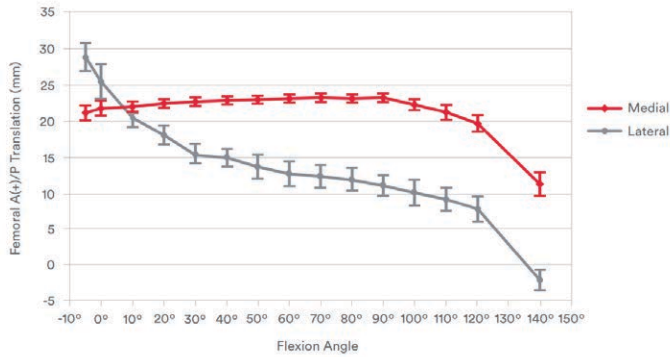


Figure 8. Weight bearing tibio-femoral kinematics of the natural knee through the full flexion arc.<sup>[1]</sup>

# Kinematics - Medial Compartment

The Forward Dynamic model is a computational model that predicts the kinematics of the knee joint across 10 different virtual patients. It has been shown to correlate well with clinical kinematics.<sup>[5]</sup> Tracking the medial condyle AP motion patterns of different designs in this tool allows the assessment of medial stability through the range of motion.

Figure 9 shows that whereas the ATTUNE™ MS Knee System construct has a relatively stable medial condyle throughout flexion, the Persona® MC design changes direction at around 25 and 55 degrees of flexion. The simulation also calculates ligament tension. The predicted tension in the Medial Collateral Ligament (MCL) increases quicker for Persona® MC than the ATTUNE™ MS Knee System after around 30 degrees, suggesting that the MCL may have to play an increased role when there is instability.<sup>[6]</sup>

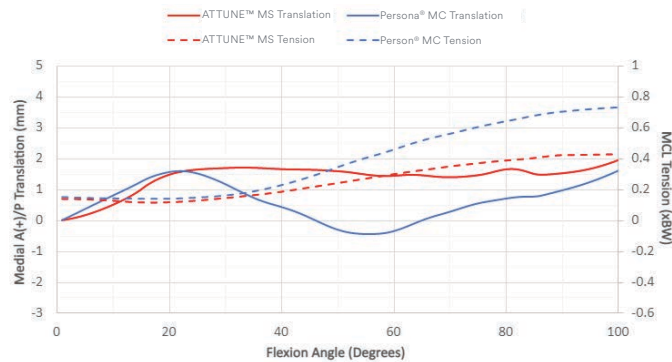


Figure 9. Medial Condyle motion and MCL tension of the ATTUNE™ MS Knee System and Persona® MC Bearing System during a Deep Knee Bend from 0 to 100 degrees of flexion. Zero on the Y axis corresponds to the dwell point of each respective insert.<sup>[6]</sup>

These predicted kinematics correlate well to actual clinical data. A previously published fluoroscopic analysis of the Persona CR® femur and insert shows a similar motion pattern with changes in direction just before 30 and 60 degrees of flexion as can be seen in Figure 10.<sup>[7]</sup> This study is on the Persona® CR insert rather than the Persona® MC insert. However, the similarities in motion suggest that these changes in direction are related to the femoral component, which is the same in the CR and MC constructs.

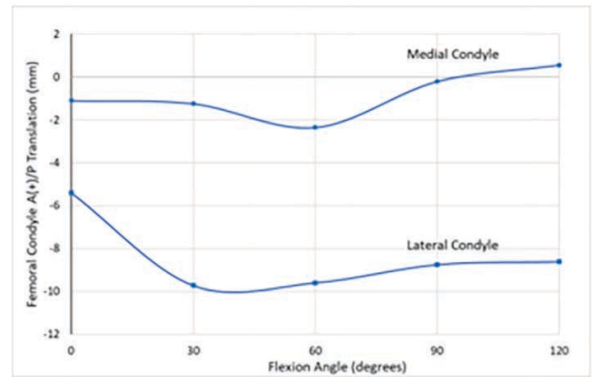


Figure 10. Image recreated from published in vivo fluoroscopy data showing low point movement of the Persona® CR femoral condyles articulating on the Persona® CR insert during deep knee bend.<sup>[7]</sup>

# Kinematics - Lateral Compartment

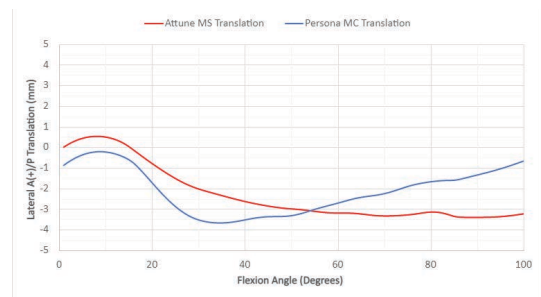


Figure 11. Lateral Condyle motion of the ATTUNE™ MS Knee System and Persona® MC System during a simulated deep knee bend. Zero on the y axis corresponds to the medial dwell point of each insert.<sup>[6]</sup>

*“The one-to-one matching of the ATTUNE™ Total Knee System Femoral Component with the ATTUNE™ MS Tibial Design allows for a more controlled and predictable range of motion on the medial side. This is in comparison to the traditional J-curve designs with an inherent size mismatch that can lead to uncertain femoral motion throughout the motion arc causing soft tissue irritation.”*

- Dr. Peters

Figure 11 shows that the articulation of the ATTUNE GRADIUS™ Curve on the TruARC™ Lateral Path allows the lateral femoral condyle to achieve a smooth continuous posterior rollback from full extension to flexion, similar to that of the natural knee. The Persona® MC knee design demonstrates minimal posterior lateral rollback before translating anteriorly.<sup>[6]</sup> This predicted kinematics of the Persona® MC lateral condyle again correlate well to published fluoroscopic data in Figure 10, which shows rollback until around 30 degrees, then anterior translation of the femur on the tibia.<sup>[7]</sup>

*“The ATTUNE™ MS Knee System permits the femoral component to mimic the natural rollback of the native femur. I have found in my own experience that this contributes to earlier stair climbing ability and increased strength post-operatively. I believe that the MS Design allows increased loading power in flexion and a quicker timed up and go from both a seated position and kneeling compared to its competitors.”*

- Dr. Peters

## Femur to Insert Mismatch

The ATTUNE™ MS Knee Bearing System with the LOGICLOCK™ Tibial Base ensures the femoral component is always matched to the same size insert to achieve the ideal tibiofemoral articulation.

As discussed, the Persona® MC Knee System matches the insert to the tibial component, therefore, to accommodate a mismatch between femoral and tibial sizes in a patient, the system allows for femur to insert mismatching. Femoral component and insert sizing can vary by up to 4 sizes as highlighted in the red boxes (Figure 12) on the Persona® MC compatibility guide.<sup>[8]</sup> As demonstrated previously, a smaller femoral size results in a larger anterior medial gap and therefore lower conformity than a larger femur on the same insert.

MC: Persona® CR Femoral/Persona® MC Bearing and Tibial Compatibility

Tibial Size	TASP Top & Bottom Color	Femoral Size											
		1	2	3	4	5	6	7	8	9	10	11	12
A	Orange	1-2/AB	3-4/AB										
B													
C	Yellow			4-5/CD	6-7/CD	8-9/CD							
D													
E	Green			4-5/EF	6-7/EF	8-11/EF							
F													
G	Blue						8-11/GH					12/GH	
H													
J	Gray											12/J	

Figure 12. Compatibility chart showing acceptable combinations of the Persona® CR femur and Persona® MC Insert.<sup>[8]</sup>

Kinematic analysis using the previously described Forward Dynamic Model was undertaken and shows that there is an increased AP translation during a deep knee bend, indicating a decreased stability with the smallest femur (Figure 13). There is also a corresponding increase in soft tissue tension (Figure 14).<sup>[9]</sup>

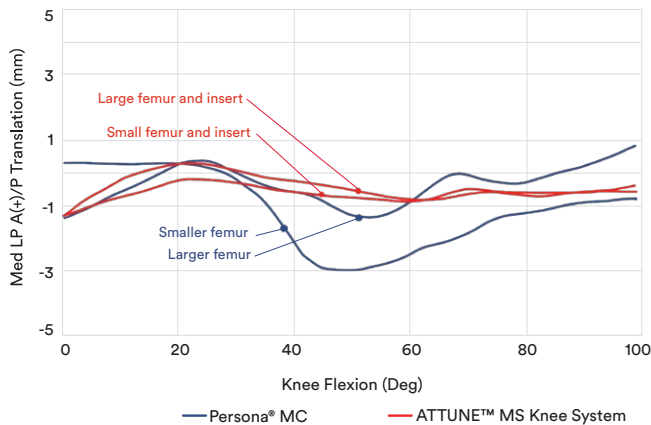


Figure 13. Femoral low point motion on the same simulated patient of two sizes of Persona® CR femur articulating on the Persona® Size 8-11 MC Insert, compared to motion of two consecutively sized ATTUNE™ MS Inserts during a simulated Deep Knee Bend.<sup>[9]</sup>

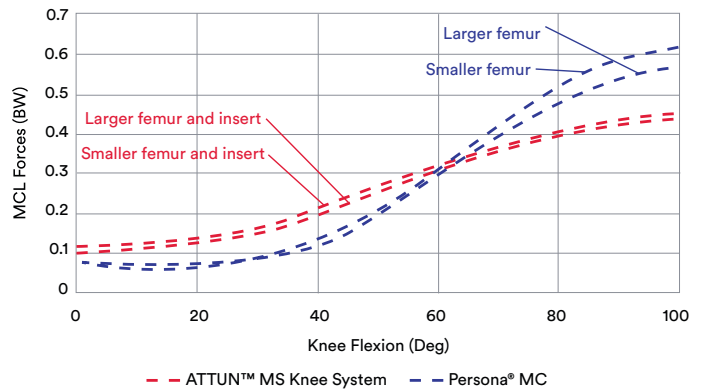


Figure 14. Predicted MCL forces on the same simulated patient from two sizes of Persona® CR femur articulating on the Persona® Size 8-11 MC, compared two consecutively sized ATTUNE™ MS Insert during a simulated Deep Knee Bend.<sup>[9]</sup>

This phenomenon does not exist with the ATTUNE™ Total Knee System, due to the LOGICLOCK™ Tibial Base, which ensures that the femur is only ever used with the optimal sized insert. As can be seen from Figure 13 and Figure 14, the difference in kinematics and soft tissue tension is minimal across different sizes of ATTUNE™ Total Knee System. These differences are related to the size of the components, which contrasts with Persona® MC where the analysis shows differences in tension due to changes in size and conformity.

Analysis of the ATTUNE™ Total Knee System sales has shown that there is a femur/tibia mismatch in approximately 60% of patients.<sup>[10]</sup> The LOGICLOCK™ Tibial Base connection accommodates that mismatch without a compromise in kinematics or soft tissue tensions for those patients. The peripheral locking mechanism in Persona® MC Bearing System means that there is a compromise, which simulations have shown affect kinematics and soft tissue tensions.

*“There is a real noticeable problem with the size mismatch in the traditional J-curves and unconforming tibial inserts that can lead to continued post-operative pain and instability. The ATTUNE™ MS Design allows both sagittal and coronal stability, with less variability. The conforming nature of the ATTUNE™ MS Design can be useful for both surgeons who use either mechanical or kinematic alignment, allowing for a few degrees of tibial coronal variability due to matching conformity.”*

- Dr. Peters

## Clinical Experience

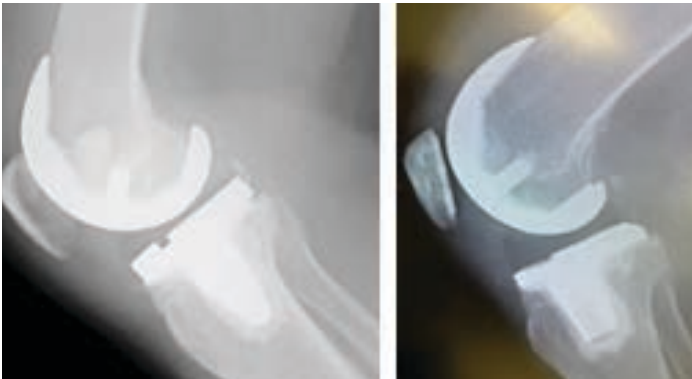


Figure 15. Radiographic images of the ATTUNE™ Medial Stabilized Knee System (left) and Persona® Medial Congruent™ Bearing System (right).

Dr. Peters trained at Michigan State University in Kalamazoo as a resident, doing mainly Posterior Stabilized TKAs. He then went on to complete his residency at Hoag Orthopedic Institute for a total joint fellowship. Dr. Peters currently works in a rural community hospital where he performs 700 procedures a year and was a high-volume user of the Persona MC construct for over 8 years. He has recently been implanting the ATTUNE™ Medial Stabilized Knee System during TKAs and has noticed improvements in his intraoperative stability assessments and has received overall improved patient feedback. In his practice, he feels that he has found there are less unsatisfied patient outliers vs Persona. Dr. Peters believes that the ATTUNE™ MS Total Knee Arthroplasty (TKA) truly results in an improved range of motion, improved patient subjective scores, and functional ability. He believes the asymmetric constraint of the MS Polyethylene allows natural femoral rollback during knee flexion. As a mechanical alignment gap balancing surgeon who routinely sacrifices the PCL, he has found that the MS Design is globally stable throughout the entire arc of motion. He is eager to see the long-term benefits of the ATTUNE™ MS Insert clinically.

*"I have found that the ATTUNE™ MS Design feels and behaves like a partial knee replacement clinically in the early post-operative period. I have noticed that in my active patients who have undergone both a partial knee replacement in one knee and an ATTUNE™ MS total knee in the opposite knee, there is no difference in clinical outcomes or function, and patients often prefer the ATTUNE™ MS Knee System."*

- Dr. Peters

## Conclusions

Both Zimmer Biomet and DePuy Synthes have products that aim to improve medial stability and allow lateral mobility. The ATTUNE™ Medial Stabilized Insert works with the ATTUNE GRADIUS™ Curve geometry on the femur which has been shown clinically to reduce instability and changes in direction during flexion<sup>[4]</sup> whereas the Persona® MC system has a J-Curve design that has been shown clinically to experience changes in direction associated with the transition between radii.<sup>[7]</sup> This may also result in larger tensions in the soft tissues.<sup>[6]</sup>

The philosophy of how the MS Insert connects to the tray also has implications for the stability of the construct. The LOGICLOCK™ Tibial Base centralized locking mechanism allows each size of the ATTUNE™ MS Insert to have a design optimized for the single corresponding femur that it articulates with. The peripheral locking mechanism of the Persona® MC Bearing System means that the insert must be designed to accommodate multiple femoral sizes (in some cases, up to four femoral sizes can articulate on a single insert). The smaller femur in these combinations results in lower conformity and more predicted anterior-posterior motion of the femur and increased soft tissue tension.<sup>[6]</sup>

The ATTUNE™ MS Insert is able to build on the proprietary technologies of the ATTUNE™ Total Knee System to deliver a construct that is designed to provide stability, function, and versatility.



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