eMP™

Evolution®
Medial-Pivot Knee System
The ACL-PCL Substituting Knee

Design Rationale

15 Years of Excellent Outcome Data

Designed to Restore Natural Stability and Kinematics

Proven to Enhance Quadriceps Efficiency

MicroPort Orthopedics
Full Function, Faster™

Table of Contents

3 ***Introduction***

4 ***The Medial-Pivot Knee System***

4 Clinically Successful Design – 15 Years of Excellent Outcome Data

6 Linking Kinematic Theories to Implant Designs

8 Traditional Implant Designs – Cause of Instability and Poor Satisfaction

10 The Unique Design Features of the eMP™ Knee System

14 ***Functional Outcome Measures***

15 Patient Satisfaction

16 Evidence of Enhanced Quadriceps Efficiency

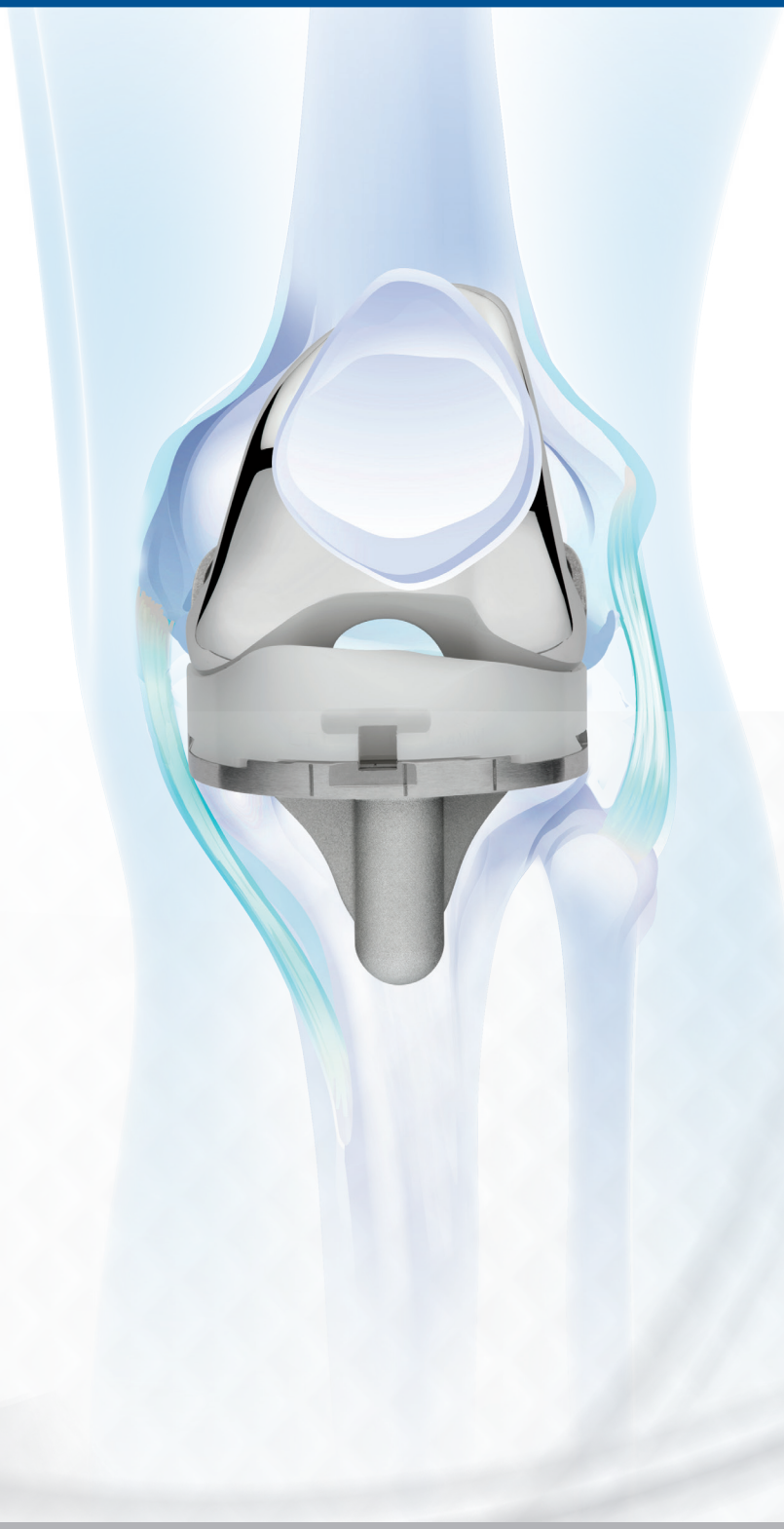
18 References

Introduction

The eMP™ Knee System now stands on over 15 years of clinically demonstrated success with its first to market Medial-Pivot design that was built on the latest kinematic evidence of the natural stability and motion of the knee.[1] Through its unique design, natural AP stability and motion are restored, thereby effectively addressing common problems seen with traditional designs, such as anterior knee pain and quadriceps avoidance.

Patients are more satisfied with the eMP™ Knee System over more traditional designs because of the stability provided through the high tibiofemoral conformity in the medial compartment and the natural mobility provided in the lateral compartment.[2]

Through this natural stability and mobility, the quadriceps is not required to contract to prevent the femur from sliding forward on the tibia, as seen with traditional implant designs. This enhanced quadriceps efficiency minimizes the force acting on the extensor mechanism and can allow patients to return to activities of daily living sooner and with more comfort.



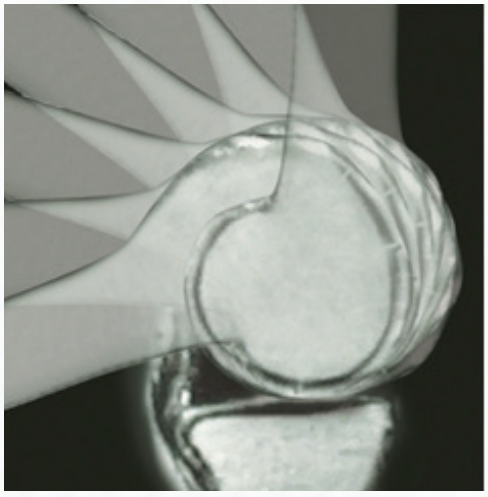
The Medial-Pivot Knee System

Clinically Successful Design – 15 Years of Excellent Outcome Data

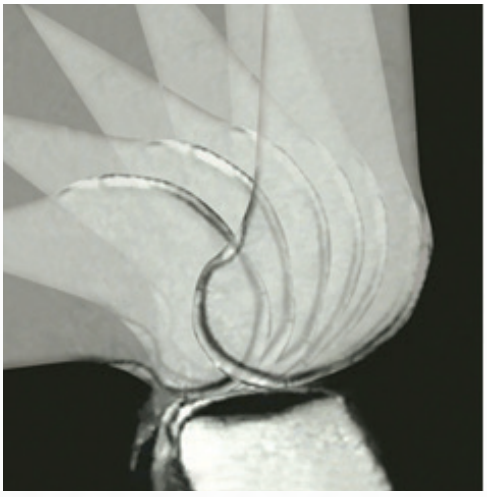
When the Medial-Pivot Knee was first released, it was met in the orthopedic community with skepticism. For many years orthopedists have clung to the concept of a hinge-like knee, with multiple radii, that rolls back in flexion.

Challenging this traditional axiom of knee kinematics, pioneers in the field, such as J. David Blaha, MD, Mr. Michael Freeman, MD, Richard Komistek, PhD, and Vera Pinskerova, PhD, provided kinematic and radiographic evidence that supported medial-pivoting kinematics and stability of the knee. This evidence demonstrated that the normal knee exhibits a fixed flexion-extension axis with a stable medial compartment and mobile lateral compartment.[1]

MRI Images of the Normal Knee[1]:



Stable Medial Compartment



Mobile Lateral Compartment

Since the Medial-Pivot Knee System was first released over 15 years ago, it has achieved outstanding clinical success worldwide.

97.2% Survivorship at 10 and 15 Years[4]
(Karachalios, 2015)

99.2% Survivorship at 5 Years[5]

97.6% Survivorship at 8 Years[5]
(Fitch, 2015 Meta-Analysis, 8 studies, n=1146 TKR)

98.3% Survivorship at 8 Years[6]
(Chinzei, 2014)

98.1% Survivorship at 7 Years[7]
(Yuom, 2014)

96.6% Survivorship at 5 Years[8]
(Schmidt, 2014)

Linking Kinematic Theories to Implant Design

In order to understand the functional outcome differences produced by various implant designs, it is critical to first examine the thought progressions that led to these designs. Many of today's popular designs still adhere to outdated kinematic theories that require less conforming tibiofemoral articulation to produce rollback. However, instead of producing rollback, these designs have been shown to produce instability and limited function.[29,33,35] The eMP™ Knee System restores function by replicating the natural AP stability and medial-pivot motion of the knee.[29,36]

Kinematic Theories

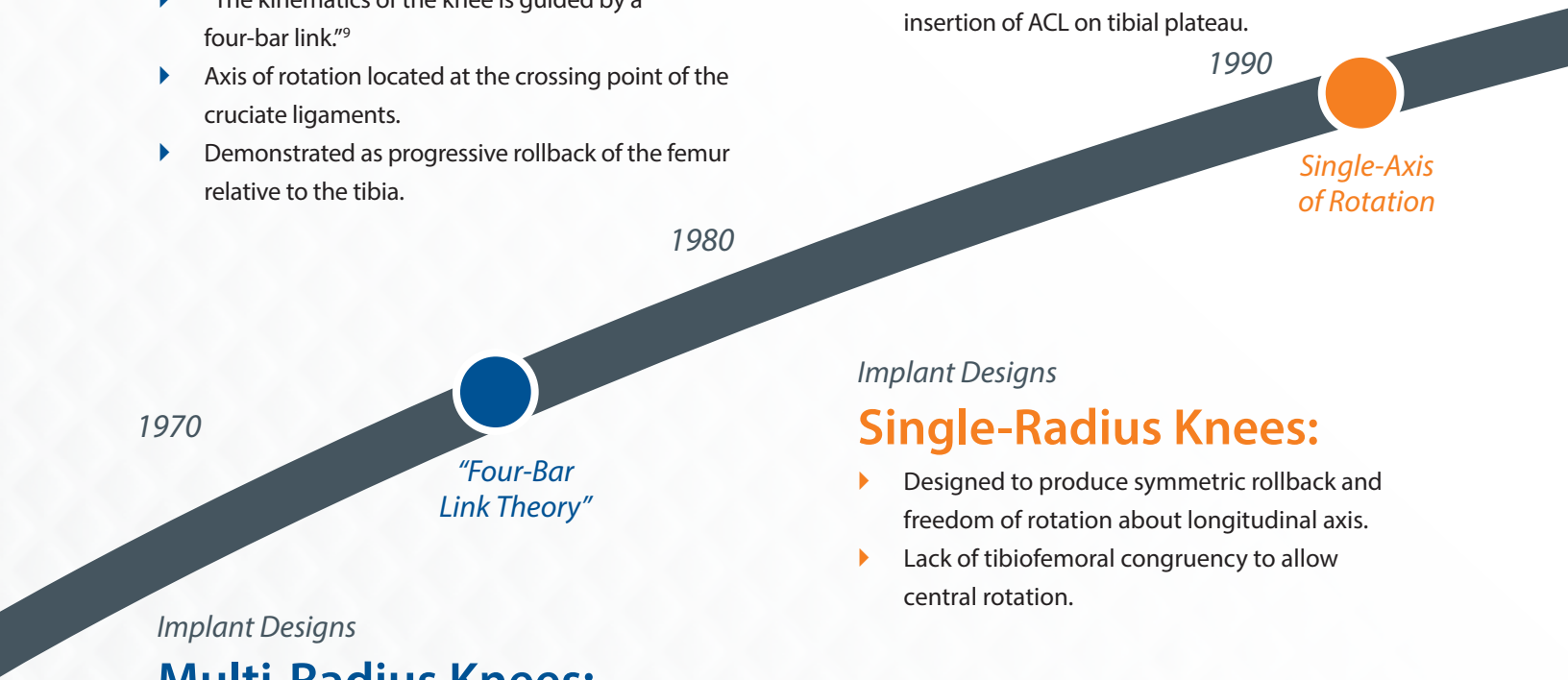
First Generation
"Four-Bar Link" Theory:

- "The kinematics of the knee is guided by a four-bar link."[9]
- Axis of rotation located at the crossing point of the cruciate ligaments.
- Demonstrated as progressive rollback of the femur relative to the tibia.

Implant Designs

Multi-Radius Knees:

- Designed to produce rollback.
- Rollback dictates limited tibiofemoral conformity.
- Commonly associated with anterior sliding, instability, and anterior knee pain.



Kinematic Theories

Second Generation
Single-Axis of Rotation:

- Hollister AM. The axes of rotation of the knee. 1993.[3]
- Single flexion – extension axis runs through collateral ligament origins.
- Longitudinal axis of rotation passes through insertion of ACL on tibial plateau.

Implant Designs

Single-Radius Knees:

- Designed to produce symmetric rollback and freedom of rotation about longitudinal axis.
- Lack of tibiofemoral congruency to allow central rotation.

Kinematic Theories

Latest Generation
Medial-Pivoting Kinematics:

- Medial side of the knee stays stable and demonstrates spinning kinematics.
- Lateral side moves anterior and posterior to accommodate rotation of the tibia.
- Sagittal view shows circular articulating surfaces.

2000

Medial-Pivoting Kinematics

Implant Designs

The Medial-Pivot Knee:

- Designed to promote medial stability and lateral mobility.
- Constant radius femoral component, both in the sagittal and coronal plane, is matched with a highly conforming medial compartment and less conforming lateral compartment to allow translation.

Traditional Implant Designs – The Cause of Instability and Poor Satisfaction

Following decades of improvement to technique and implant design, 20% of knee replacement patients continue to remain unsatisfied.[12] Many of today's popular implant designs built with less tibiofemoral conformity have been shown to produce anterior sliding of the femur on the tibia. Much of this dissatisfaction can be explained through functional limitations caused by instability – the underlying cause of limitations such as anterior knee pain and loss of quadriceps performance.

Roughly ***25%*** of all revisions in TKA are for instability following surgery.[13-17]

Consequences of Instability

Anterior Knee Pain

- As the femoral component of a traditional implant design slides forward in early flexion, the added force causes the extensor mechanism to attempt to stabilize the knee during activities.
- This force eventually causes pain by tiring the extensor mechanism.

Loss of Quadriceps Performance

- As the extensor mechanism tires, a quadriceps avoidance gait pattern is developed by the patient trying to adapt to the pain.[18]
- In order for patients to compensate for the instability and pain, the quadriceps must continually contract in order to prevent the femur from sliding forward.
- ***Patients ultimately waste much of their quadriceps performance attempting to compensate for this instability.***

Sliding forward of the femur on the tibia.

The Unique Design Features of the eMP™ Knee System

The eMP™ Knee System provides a proven and unique solution to problems such as instability, anterior knee pain, and functional limitations through its functionally-restorative design that replicates the natural stability and motion of the knee.

Flexion Stability

- Promoted through high medial conformity and constant radius spherical condyles.
- Increased flexion and enhanced quadriceps efficiency achieved through longer constant flexion radius with more posterior, medial dwell point.

Anatomic Motion

- Driven through a stable medial compartment and a mobile lateral compartment that rotates or pivots about the medial.

Wear-Limiting Design

- Enabled through a maximized contact area and repeatable motion path that minimizes contact stresses.

The eMP™ Knee System represents the perfect balance of natural medial stability and lateral mobility.

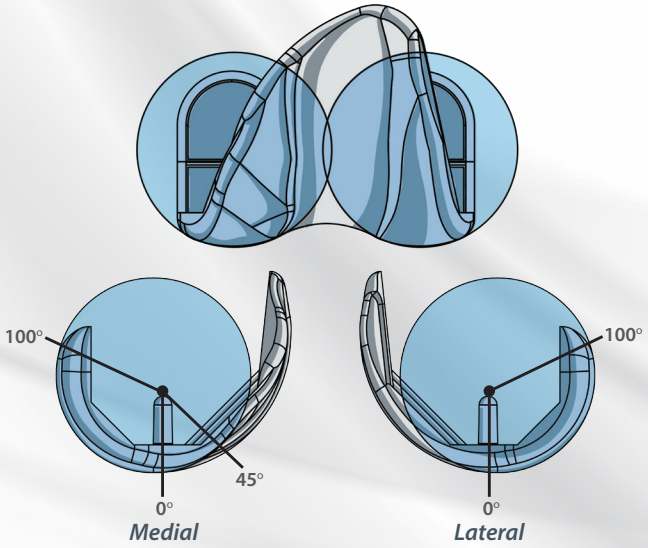
Flexion Stability

High Conformity

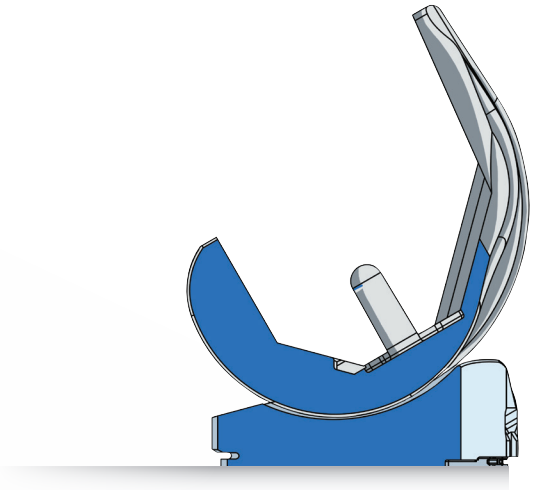
- Medial ball-in-socket articulation.
- Formulated to maximize stability throughout the range of motion and provide high flexion.

Increased Flexion Potential

- Larger posterior condylar offset and posterior tibial dwell point allow for a more posterior position of the femur on the tibia.
- Allows for deeper amounts of flexion.



Only knee design with spherical geometry in both sagittal and coronal planes.



Medial compartment of the eMP™ Knee flexed at 30°

Constant Radius

- Literature has shown that constant radius knee replacements exhibit higher clinical function when compared with multi-radius knee replacements.[19]
- The eMP™ Knee is not the only design on the market featuring a constant femoral radius, but it is the only system that matches the sagittal radius with the coronal radius to create the spherical shape in each condyle.

RESULTS

Natural medial stability in the eMP™ Knee substitutes for the ACL, PCL and bony geometry and allows the quadriceps to perform like normal. By enhancing quadriceps efficiency, patients can experience increased proprioception and more normal feeling following surgery.

Anatomic Motion

Normal Feeling

- The high anterior and posterior lips on the eMP™ tibial insert substitute for both cruciates.
- Lateral arcuate path allows 15^0 of rotational freedom for more normal feeling. [2]

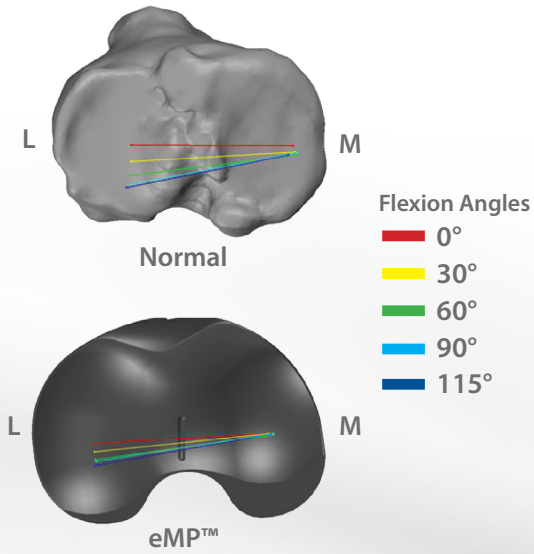
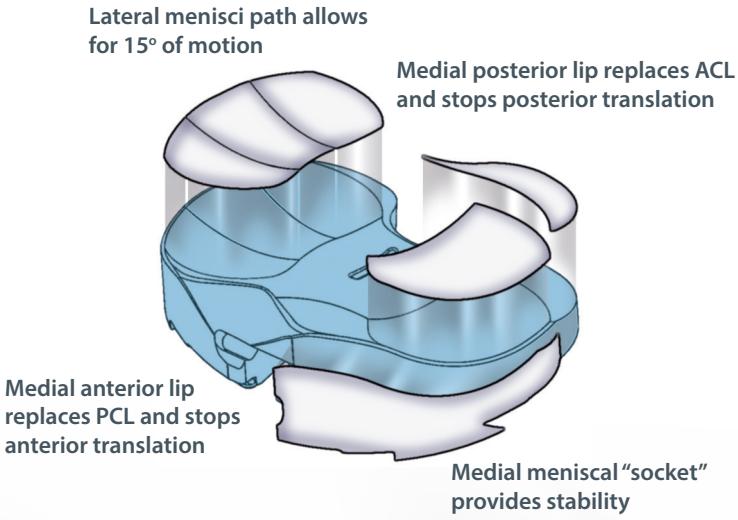


FIGURE 1: Contact points from full extension to full flexion (115°) evaluated for the normal knee and the eMP™ Knee System.



Natural Function

- The eMP™ insert is designed to guide natural axial rotation of the tibia about the stable medial compartment.
- Natural function observed in the normal human knee is thus replicated in the eMP™ Knee System. **Figure 1**

RESULTS

Predictable anatomic motion allows normal quadriceps engagement, optimized patellar tracking in the trochlear groove, and natural axial rotation of the tibia.

Wear-Limiting Design

Minimized Contact Stresses

- High contact throughout the range of motion (ROM) to minimize contact stresses.[27]
- *In vitro* wear assessment data demonstrates that implant design may be more important than bearing materials. **Figure 2**

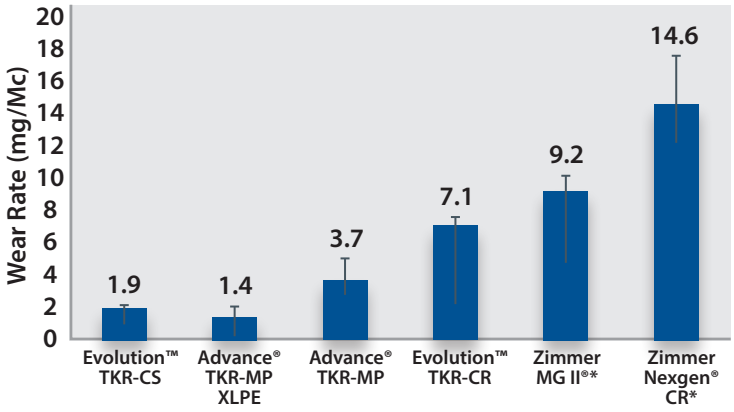
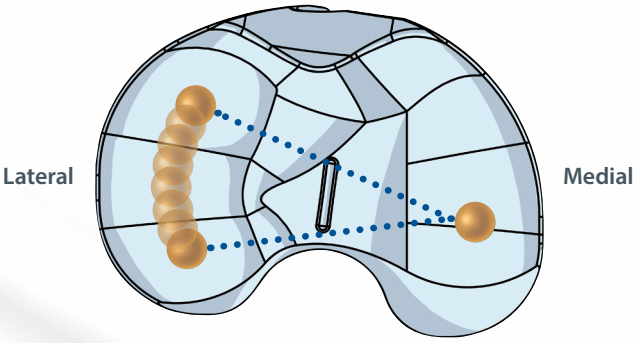


Figure 2 | Wear rates for EVOLUTION™, ADVANCE® and two Zimmer systems

**Wear data retrieved from literature sources.[21-22] Wear testing was not performed by MicroPort Orthopedics.*



eMP™ Knee System exhibits a repeatable motion.

Repeatable Motion Path

- Reproduces the kinematics of the natural knee.
- Resists multi-directional motion often occurring in traditional knee replacements, which increases wear. [24, 30-34]

RESULTS

Patients not only demand a high-functioning knee, but also expect their implant to be durable and long lasting. The innovative, anatomically inspired design of the eMP™ Knee System has been shown to have a lower wear potential in a comparative aspiration study. [20-33] This wear-limiting design is due to the repeatable motion path and minimized contact stresses. [24-26]

Functional Outcome Measures

52% of the patients who have had total knee arthroplasty report some degree of limitation in performing functional activities such as kneeling, squatting, moving laterally, turning and cutting, carrying loads, stretching, leg strengthening, tennis, dancing, gardening, and sexual activity.[11]

The eMP™ Knee System more effectively restores function to patients through its unique, stabilizing design that provides a constant moment arm on which the extensor mechanism to act. Evidence of this functional restoration is found in outcome measures that discern objective and subjective differences produced against competitive implant designs and healthy controls. These *in vivo* assessments of ***Patient Satisfaction*** and ***Quadriceps Efficiency*** following TKA provide strong support for the efficacy and success of the eMP™ Knee System.

The eMP™ Knee System stands alone amongst other implant designs in its ability to effectively address functional measures of satisfaction and performance in activities of daily living following surgery.[2, 29]

14

Patient Satisfaction

Patients feel the difference in stability!

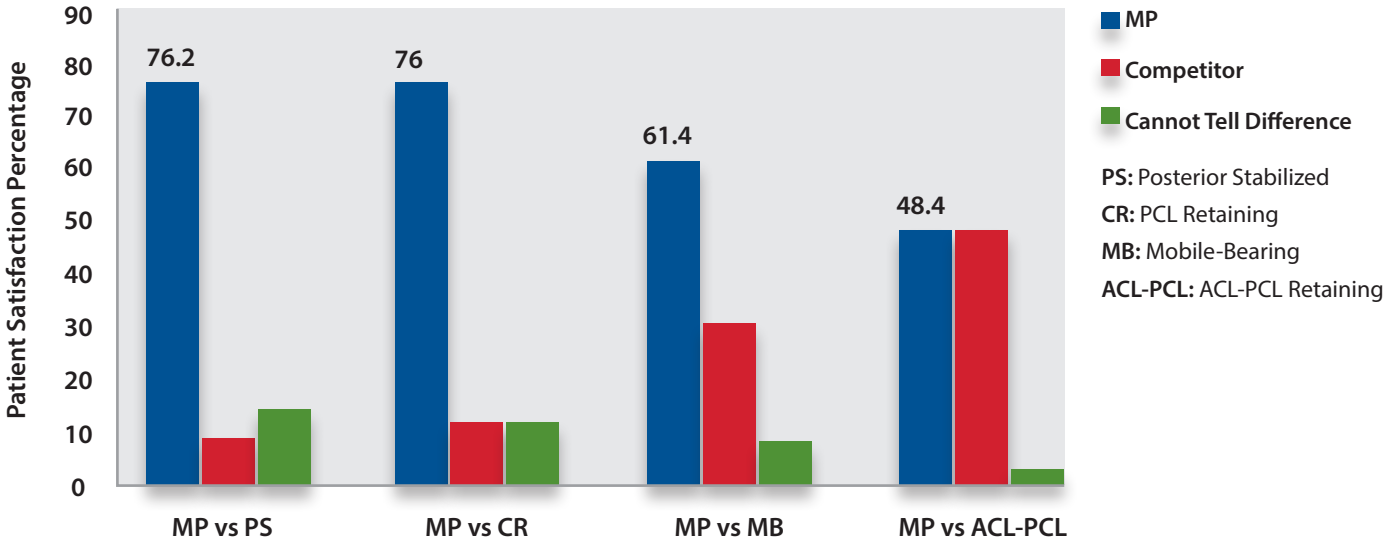
Pritchett, 2011

Patients prefer a bicruciate-retaining or the medial-pivot total knee prosthesis. JOA. 2011; 26 (2): 224-8.

This bilateral patient preference study sought to examine if patients have higher satisfaction with one prosthesis over another.[2]

- 440 patients underwent bilateral TKR using a different prosthesis on each side.
- Five knee prostheses were used: ACL-PCL Retaining, Posterior Cruciate-Retaining (CR), Medial-Pivot (MP), Mobile-Bearing (MB) and Posterior-Stabilized (PS).
- The study found patients who underwent bilateral staged TKA were more likely to prefer retention of the ACL and PCL or substitution with the MP Prosthesis.

Medial-Pivot vs. Competitive Knee Designs



Basis for Higher Patient Satisfaction

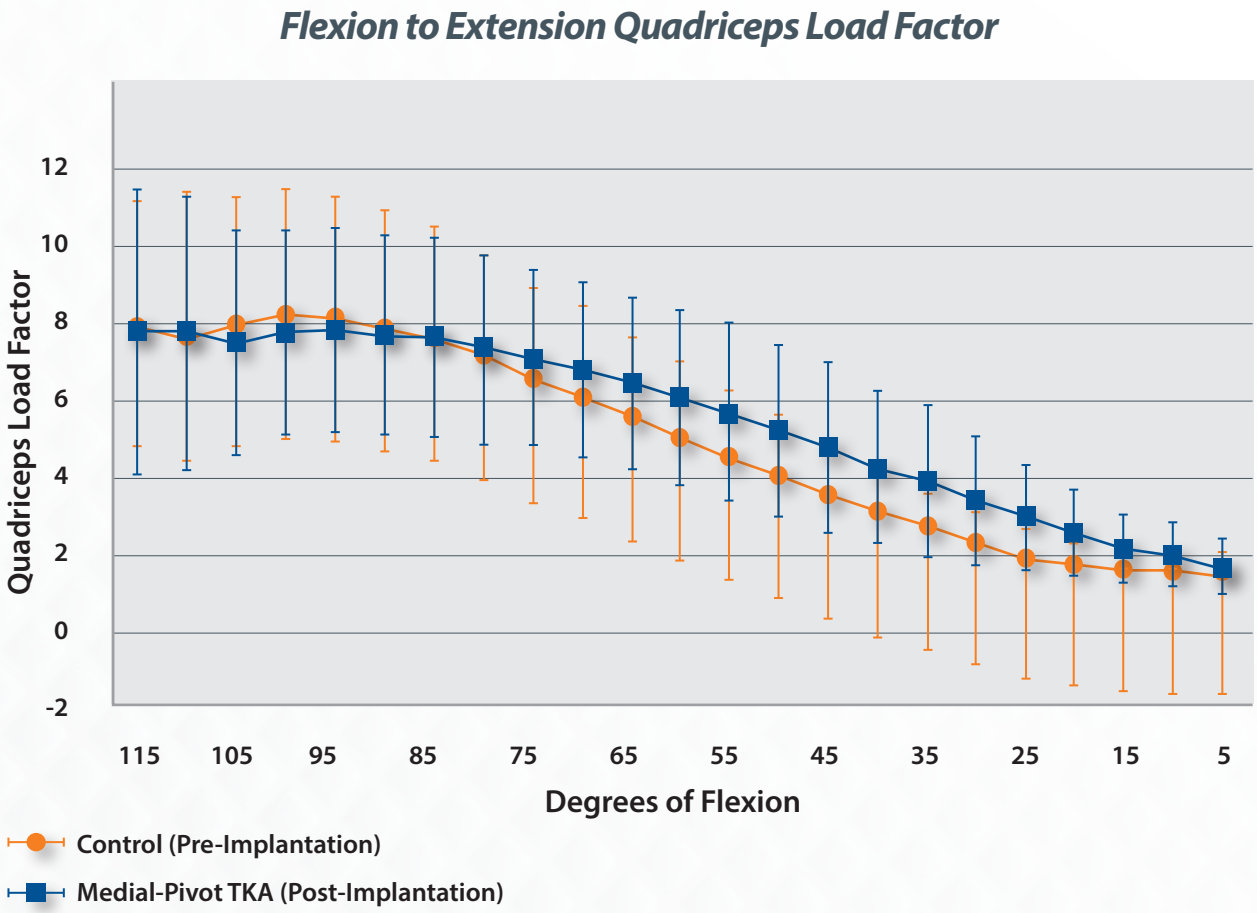
- Feels More Normal
- Stronger on Stairs
- Feels More Stable Over All
- Fewer Clunks, Pops, and Clicks

Evidence of Enhanced Quadriceps Efficiency

Similar Quadriceps Efficiency to Control Group

One *in vitro* study of the quadriceps efficiency following TKA with the eMP™ Knee System demonstrated a similar quadriceps load factor to the control group.[36] This similarity suggests:

- Quad rehab quality and speed are affected by AP stability inherent in the implant design.[28]
- The combination of the medial spherical radius and conformity of the medial tibial insert provides a constant moment arm on which the extensor mechanism to act.

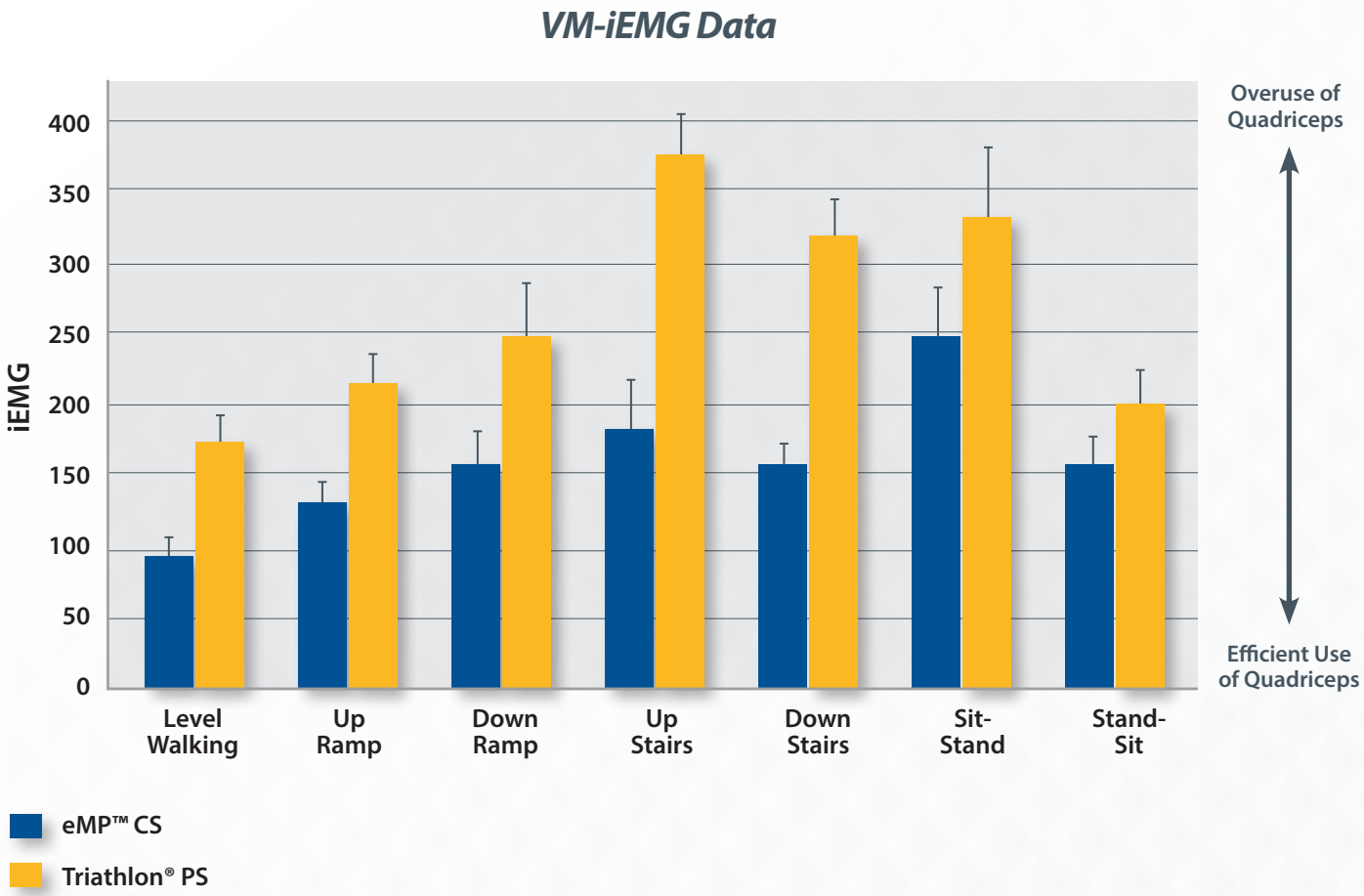


Enhanced Quadriceps Efficiency Following TKA

The graph below demonstrates, through EMG data* of the vastus-medialis (VM), the enhanced quadriceps efficiency found in patients with an eMP™ CS Knee over that of patients with a Triathlon® PS Knee.[29]

Patients with improved quadriceps efficiency and AP stability may experience:

- More normal feeling.
- Improved patellofemoral mechanics.
- Superior single-leg weight-bearing flexion performance.[2]



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