“Designed by nature, shaped by technology”

Robert Larsson
Hvidovre – 25 Augusti 2015
We know

- Population
- BMI
- Medelage
- Patients expectations
- Primary knees
- Hospitals costs

Need to do more for less money
The Effect of Built-In External Femoral Rotation on Patellofemoral Tracking in the GII TKA

B. Kaper, M. Woolfrey, B. Bourne

Journal of Arthroplasty, December 2000

ODEP EXPLAINED
Click here to find out why ODEP ratings are important

<table>
<thead>
<tr>
<th>Brand - All</th>
<th>Revision Rate at 12 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENESIS II</td>
<td>5.0%</td>
</tr>
<tr>
<td>PFC</td>
<td>5.6%</td>
</tr>
<tr>
<td>TRIATHALON</td>
<td>6.0%</td>
</tr>
<tr>
<td>NEXGEN</td>
<td>6.5%</td>
</tr>
<tr>
<td>VANGUARD</td>
<td>7.6%</td>
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*TRIATHALON and VANGUARD revision rate at 8 years only

Robert B. Bourne, M.D.
843 consecutive
Mean 9.5 years (5-11)

118°
4%
98%
The Genesis II in primary total knee replacement: A systematic literature review of clinical outcomes (2011)

survivorship of 96% at 11.9 years follow-up.

Mohit Bhandari a,⁎, Walter Pascale b, Sheila Sprague a, Valerio Pascale c

a Department of Surgery, McMaster University, Hamilton, Canada
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the success of TKA has been measured mainly by
- pain relief
- means of survivorship analysis
  measures durability
  does not reflect functional results
Functional Activities Important to Patients

Weiss et. al. "What functional activities are important to patients with knee replacements?" CORR. (404): 172-88. 2002.

- Patients report that after TKA, they have difficulty participating in the activities important to them.


- “Patients who had total knee replacements still experienced substantial functional impairment compared with their age- and gender-matched peers, especially when doing biomechanically demanding activities.”
Conclusion

“This suggests that significant improvements in the procedure and prosthetic designs are needed to restore normal knee function after a total knee arthroplasty.”

“This desire for greater function will grow with younger, more active patients seeking a return to lifestyle, not just pain relief.

-P. Noble, M.D.

Performance/Satisfaction of TKA’s v THA?

- Post THA: sports activities increased from 36% to 52%
- Post TKA: sports activities decreased from 42% to 34%

*The Ulm Osteoarthritis Study - K Huch*

- Up to 20% of patients are not satisfied with the outcome following total knee replacement
- Only 82% to 89% of primary TKA patients are satisfied

*J Bone Joint Surg Br. 2010 Sep;92(9): Scott CE, Howie CR, MacDonald D, Biant LC*

*Clin Orthop Relat Res. 2010 Jan;468(1):57-63: Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD*
This study examined the effect of patient attributes on expectations before total knee arthroplasty (TKA). A total of 1943 patients completed an Expectations Survey before TKA. Demographics, surgical history, baseline Medical Outcomes Study Short Form 36 (SF-36) score, Knee injury and Osteoarthritis Outcome Score (KOOS), and Lower Extremity Activity Scale score were obtained. On univariate analysis, expectations (mean score, 77.6) correlated with SF-36 General Health, age, SF-36 Vitality, KOOS Quality-of-Life, and Lower Extremity Activity Scale.

Our data show that high, potentially unrealistic, expectations are common and not confined to young or active patients, highlighting the need for discussion of realistic expectations with all patients.

Functional Activities Important to Patients
Journey Design Goals

Function
- Increase stability (anterior and mid-flexion)
- Achieve normal kinematics
- Deep flexion (155°)

Durability
- Low wear
- Strong interfaces (poly lock and bone)

Robustness
- Insensitive to mal-implantations
Normal Knee Kinematics

A. Williams et al, JBJS 2002
The operated knee; Abnormal Kinematic

Normal Knee Kinematic vs. Conventionell PS TKA

Normal Knee Kinematic
0° - Screw-home, anterior AP position
0-90° - Medial pivot
90 – 155° Posterior Translation

Conventionally PS TKA Kinematic
0° - No screw-home, posterior overhang
0-90° - Lateral pivot, paradoxal translation
90-max - Abnormal axial rotation
Normal Knee Kinematic vs. Guided Motion Knee Kinematic

Normal Knee Kinematic
- 0° - Screw-home, anterior AP position
- 0-90° - Medial pivot
- 90-155° - Posterior translation

Guided Motion Knee Kinematic
- 0° - Screw-home, anterior AP position
- 0-90° - Medial pivot
- 90-155° - Posterior translation
It would seem likely that the articular surface geometry is a more potent factor in driving knees kinematics.

The dramatic differences in sagittal shapes of the medial and lateral compartments account for the similarly clear differences in the medial and lateral kinematics.

The shapes of the normal knee are recreated = guided motion knee design.
My Questions

• Are you satisfied with just a pain relief knee?
• How do you measure patients satisfaction?
• If you can replace with kinematics why don't you do it?
• What knee would you prefer?
  Pain relief
  Pain relief and Kinematic
We are smith&nephew
Normal Knee vs conventional knee vs Journey design

Function
• Shape
• AP Stability
• Kinematics
• Flexion
Normal Knee

Function
- Shape
- AP Stability
- Kinematics
- Flexion
Shape – Normal Knee

Medial
• More distal than lateral
• Posterior condyle circular
• Large posterior offset

Lateral
• Distally less round
• Posterior offset smaller
Shape – Normal Knee

Medial Plateau
- Concave shape
- Sulcus located near AP midline

Lateral Plateau
- Convex shape
- No geometric constraint for AP motion
Shape – Normal Knee

- Medial condyle more distal
- $3^\circ$ joint line
AP Stability – Normal Knee

- Medial sulcus
  - Medial posterior femoral condyle rests nearly flush with posterior tibia

- ACL
  - Provides anterior stability (limits tibia anterior translation)

- PCL
  - Provides posterior stability (limits tibia posterior translation)

- Force environment of anterior position promotes femoral posterior rollback
Kinematics – Normal Knee

0° (Full Extension)

• Screw-home (5° femoral internal axial rotation)
• Posterior femoral condyle nearly flush with posterior tibia

0-90°

• Medial pivot (rollback + femoral external axial rotation)
• Q-angle minimized (quad mechanism straight line)

90-155°

• Posterior femoral translation
• Axial rotation ceases

Normal Knee Kinematics

A. Williams et al., JBJS 2002
Flexion – Normal Knee

• Small lateral condyle posterior offset
  - Lateral condyle must be more posterior to clear tibia

• Large medial condylar posterior offset
  - Medial condyle can be more anterior to clear tibia

• Quadriceps mechanism straight
  - Patellofemoral ML shear forces minimized

top view of tibia at 90° flexion
Normal Knee Function

Shape
- Concave/convex tibia
- Medial sulcus near AP midline

AP Stability
- ACL/PCL
  - Anterior position causes femoral rollback

Kinematics
- Medial pivot from 0-90°
  - Femur rollback only from 90-155°

Flexion
- Posterior position and condylar offset clear tibia
- Patellofemoral ML shear forces minimized
Total Knee Arthroplasty
Shape – Conventional PS Knee

- Insert and femoral condylar thicknesses equal
- 0° joint line

Concave medial / lateral compartment

Sulcus
AP Stability – Conventional PS Knee

- Posterior medial sulcus
- Femoral posteriorly overhangs tibia
- Lack of ACL
  - Causes anterior instability

<2 mm

10 mm
Kinematics

PCL Retaining
The Replaced Knee; Abnormal Kinematics

ACL Deficient knee - Kinematic
The Replaced Knee;
Abnormal Kinematics

ACL deficient knee

paradoxical motion
(forward sliding of the femur during flexion)
Abnormal Kinematics; femoral roll-back

paradoxical motion
(forward sliding of the femur during flexion)

mainly in CR knees
more on the medial than on the lateral side
The Replaced Knee; Abnormal Kinematics

ACL deficient knee

PCL substituting (cam-post mechanism)

- guidance of motion is limited to a forced roll-back in flexion
- symmetric roll-back, giving equal posterior translations on the medial and lateral sides

Can cause a cam-post conflict and post wear

Cam-post ≠ working
The Replaced Knee;
Abnormal Kinematics

ACL deficient knee
The Replaced Knee; Abnormal Kinematics

Normal Knee Kinematics vs. Conventional PS TKA

Normal Knee Kinematics
0° - Screw-home, anterior AP position
0-90° - Medial pivot
90 – 155° Posterior Translation

Conventional PS TKA Kinematics
0° - No screw-home, posterior overhang
0-90° - Paradoxical translation, lateral pivot
90-max - Posterior translation, abnormal axial rotation
some (ab)normal kinematic patterns can be related directly to an important functional parameter that can be measured as a hard endpoint:

flexion of the replaced knee
Kinematics - summary

- ACL deficient knee
  ↓
- PCL ≠ working
  cam-post ≠ working
  ↓
- roll-forward of the femur in flexion
- tibial internal rotation with flexion but lateral pivot
Shape - Journey

Physiological Joint Line

• Bone resections perpendicular to the mechanical axis
• Implant thickness equal to bone resected
• Joint line restored at 3° (offset of approximately 2.5 mm)
• Patent
Shape - Journey

Lateral Tibial Compartment

• High conformity in the coronal plane
• Gentle convex posterior slope
• Promotes natural tibia internal rotation
• Reduces post force
• Posterior insert thickness greater than 8 mm
Shape - Journey

Medial Tibial Compartment

• Concave surface
• Provides AP stability and helps minimize paradoxical motion
• Promotes medial pivot
• Posterior lip acts as meniscus for stability
• 6.7 mm minimum thickness
Guided Motion Knee Design Goals

- Restore anterior stability
- Achieve normal knee kinematics
- Deep flexion
- Durability
  - Comparable wear
- Robustness
  - Insensitive to mal-alignment
- Proof of principle

BCS: Bi-Cruciate Stabilised
Guided Motion
Stability

Anterior Cam

- Provides anterior stabilization (if necessary) during early gait (up to 20° flexion)
- Approximately 1-2 mm of AP laxity and 6° of hyperextension laxity

- Medial sulcus
- Medial posterior femoral condyle rests nearly flush with posterior tibia
- Force environment of anterior position promotes femoral posterior rollback
AP Positioning

BCS: Bi-Cruciate Stabilised

Guided Motion Knee
**Kinematics:** Guided motion

**Tibia Articular Surface Geometry**

Medial Plateau
- Concave shape
- Anterior lip
- Flat posteriorly

Lateral Plateau
- Convex shape
- No geometric constraint for AP motion
Guided Motion Knee
Sagittal Profile

- Sagittal profiles (medial, lateral, trochlear) closely match anatomy
- Medial condyle more distal than lateral condyle
- Trochlear depth near anatomic
- Lateral condyle thickness less than medial
Extended Posterior Condylar Surfaces

- 15° posterior resection
- Posterior condylar surfaces extended by approximately 4 mm
- Implant thicknesses equal to bone resection
- Posterior offset maintained
- Deep flexion
Normal **Shapes** + Normal **Position** + Normal **Motion**
Clinical Experience over the >100,000 cases

Overall survivorship with partial or total implant revision as an endpoint was 98%. (1-5 years)

Side effects first generation
Clinical Experience over the >80,000 cases

<table>
<thead>
<tr>
<th>Complication</th>
<th>BCS Occurrence</th>
<th>Conventional Baseline Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manipulations</td>
<td>2.7% (Surgeon Poll)</td>
<td>1%-4.5% (Harato &amp; Crockarell)</td>
</tr>
<tr>
<td>Dislocations</td>
<td>0.3% (Bellemans)</td>
<td>0.1% - 0.25% (Lombardi)</td>
</tr>
<tr>
<td>Antero-Lateral Pain</td>
<td>7.2% (Bellemans)</td>
<td>1.6% (Healthy Knees)</td>
</tr>
</tbody>
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Journey BCS

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Journey BCS II
Journey II BCS – Articular design changes

- **J II BCS – orange**
  - BCS – green
  - Reduces tension on Iliotibial and IT-Patellar bands

- **Medial View**
  - Keeps MCL strain more consistent
  - 1mm

- **Lateral View**
  - 2mm
  - Cam change superiorly reduces rollback and contact lower on post in flexion

- **Reduces femoral rollback (more anatomic) and reduces iliotibial band tension**

Confidential – Do not Distribute
Journey II BCS – Periphery changes

Reduces tension on IT-Patellar Band

Reduces overhang and contact with popliteal tendon

Reduces ML overhang

Superior View (Anterior Flange)
standard / narrow implants

- Improved the AP-ML ratio by narrowing the femoral implants (2-8) by 1 size
  → JII BCS size 6 ML = J BCS Size 5 ML)
Journey II BCS – Post and PS box changes

Lateral View

Legion – Blue    J II BCS – Orange
BCS – Green

Box is increasing to accept taller post and allow constrained insert. Still smaller than Legion Primary PS box.

Posterior View

J II BCS – orange    BCS – green

Balances patellar impingement while maximizing safety dislocation factor in flexion.
Journey II BCS – Dislocation Prevention

Key Point:
BCS II is equal to or safer than Legion Primary at all flexion angles
PHYSIOLOGICAL MATCHING
Stability throughout a range of motion

0° → 0° - 20° → 20° - 60° → 60° - 155°

Mid-line Sulcus  Anterior Cam  Posterior Medial Lip/Horn  Posterior Cam
Future: Journey Family

JOURNEY II BCS Bi-Cruciate Stabilized System
Restoration of PCL / ACL function

JOURNEY II CR Cruciate Retaining System
Retention of the PCL

JOURNEY II XR Bi-Cruciate Retaining System
Retention of both ACL / PCL
We are smith & nephew