Multi-Center Evaluation of Knee Kinematics during different Activities for Anatomic Total Knee Design

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Some of the authors of this publication are also working on these related projects:

- resurfacing revisions View project
- kinematic alignment technique for total hip replacement (KA THA) View project
Multi-Center Evaluation of Knee Kinematics during different Activities for Anatomic Total Knee Design

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No Conflicts of Interests to Disclose
Introduction

First Generation Bi-Cruciate Substituting TKA (2005) - Design

- Restore native knee kinematics
- Anatomic joint line (asymmetric polyethylene insert, 3° varus)
- Inherent screw-home mechanism to favor femoral internal rotation in full extension

First Generation Bi-Cruciate Substituting TKA (2005) - Complications

- Increased incidence of ilio-tibial band (ITB) friction syndrome
- Episodes of knee dislocation
- Mechanical stress and fibrous metaplasia on the posterior capsule for excessive posterior femoral roll-back

- 8% Lateral Parapatellar Release
- 4% Antero-lateral knee pain, conservative treatment
- 1.5% Persistent pain at the ilio-tibial tract
- 3% Post-operative stiffness treated with manipulation under anesthesia
Introduction

Second Generation Bi-Cruciate Substituting TKA (2013) - Design

- Taller box walls
- Thickness of the anterior flange: reduced of 1-2 mm to decrease tension on the ITB and ITPB
- Width: 2-3 mm decreased to limit implant overhang
- Superior cam position to decrease femoral rollback, increase femoral external rotation, lower the point of tibial post contact in deep flexion
- Increased height of the post and anterior placement
Introduction

- Similar kinematic patterns from 0-30° and beyond 90° of knee flexion
- Lack of screw-home mechanism in BCS design compared to native knee (ACL resection)
- Post-cam mechanism replicates the role of the cruciates for antero-posterior displacement, but not for axial rotation
- In mid flexion (30-60° flexion) cruciates function can not be maintained

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**Aim of the study**

**In Vivo Kinematics of the Journey II Bi-Cruciate Stabilized Knee System: InVivo Fluoroscopic Analysis during Activities of Daily Living**

- **Study Design:** Multicenter, prospective, post-market study
- **Primary Objective:** evaluate the kinematic behavior of a bi-cruciate substituting total knee system

*Do we need «normal knee» kinematics to get back to optimal function and pain free joint?*
Materials and Methods

- Two Centers:
  - Università di Modena e Reggio-Emilia, Italy: 10 patients
  - Universiteit Gent, Belgium: 10 patients

- Journey II BCS Total Knee System implanted in all cases

- Examination time point: mean 9.3 months post-operatively (min. 3 - max. 13 months)

- Examined motions

  Università di Modena e Reggio-Emilia:
  - Open Chain Flexion-Extension (FE)
  - Closed Chain Stair Climbing (SC)
  - Closed Chain Chair Rising (CH)

  Universiteit Gent:
  - Open Chain Flexion-Extension (FE)
  - Closed Chain Squatting (SQ)
  - Closed Chain Rising and Sitting (CH)

- Iterative “shape matching” technique of 3D prosthetic CAD models overimposed on 2D video-fluoroscopy images
**Materials and Methods**

**Kinematic Analysis**

**Femoral**
- Center of condyles for medial and lateral flexion facets

**Tibial**
- ML dimension:
  - Centers defined at 1/4 and 3/4 of ML tibial implant width
- AP dimension:
  - 0 = most posterior point of tibial insert
  - 1 = most anterior point of tibial insert
  - Equal for medial and lateral compartment, regardless asymmetry in implant geometry

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Results: Open Chain – Flexion/Extension

Axial Rotation

- Progressive moderate external rotation of the femoral component relative to the tibia with flexion
- Wide Standard Deviations
- No significant differences between the two centers

AP Medial / Lateral Positioning

- Progressive posterior translation of the condyles with flexion
- Slight medial condyle anterior translation between 0-50°
- Bigger lateral condyle displacement
- No statistically significant differences between the two centers
Results: Close Chain – Chair Rising

Axial Rotation

- Significant progressive external rotation of the femoral component relative to the tibia with flexion
- No significant differences between the two centers

AP Medial / Lateral Positioning

- No significant medial condyle AP displacement with knee flexion
- Slight lateral condyle posterior displacement with knee flexion
- No statistically significant differences between the two centers
Results

Università di Modena e Reggio-Emilia

- Knee kinematics is strictly dependent on activity
- Muscle activity and external joint loading affect knee kinematics
Results

• Knee kinematics is strictly dependent on activity

• Muscle activity and external joint loading affect knee kinematics

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Results

Flexion / Extension

Post-Cam engagement at 50° of knee flexion
Results

Chair Rising

Post-Cam engagement at 80° of knee flexion
Conclusions

- 16 Journey II BCS patients compared with 16 Journey BCS patients during two close chain motions
- Similar patterns of femoral axial rotation with flexion
- Reduced absolute values of medial and lateral condyles posterior displacement in Journey II BCS
- Design changes in the recently-introduced total knee system contributed to modify its in-vivo knee kinematics

Catani F. et al J Orthop Res., 2009
Conclusions

- Consistent kinematic patterns between the two centres (Università di Modena and Universiteit Gent)

- Less «guided» knee kinematic pattern (open chain ≠ closed chain)

- Reduced posterior translation of medial and lateral side compared to the first design

- More posterior tibio-femoral position translation on the lateral side compared to medial

- Future addressings: correlation between knee kinematics and patient’s satisfaction