Sports Medicine Research Center, Keio University

ISAKOS Congress 2025

Is Bi-Cruciate Stabilized Total Knee Arthroplasty Better Than Conventional Knee Arthroplasty In Knee Biomechanics During Gait?

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ISAKOS Congress 2025

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Research grant: Japan MDM

Sports Medicine Research Center, Keio University

Introduction

- Bicruciate-stabilized (BCS) total knee arthroplasty (TKA) attempts to replicate anterior stability and rotational facilitation.

- Several studies have investigated the effects of BCS implants on gait biomechanics.

- However, detailed information of gait biomechanics of BCS compared with other implant designs have not been analyzed so far.

Purpose

- **The purpose was to compare knee kinematics and kinetics among four different conditions including BCS TKA, posterior-stabilized (PS) TKA, unicompartmental knee arthroplasty (UKA), and normal knees.**

Materials and Methods

A total of 51 subjects

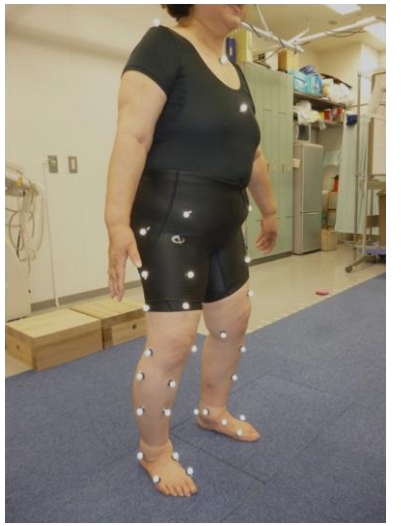
- **12 BCS TKAs** (Journey II BCS system, Smith and Nephew Inc., Memphis, TN, USA)
- **16 PS TKAs** (Trimax®, Posterior Stabilized, Ortho Development, Draper, UT, USA)
- **13 UKAs** (High Flex Knee®, Zimmer, Warsaw, IN, USA)
- **10 healthy subjects (controls)**

・All subjects underwent unilateral procedures.

・Patients underwent a standard rehabilitation program which consisted of early range of motion and weight-bearing exercises as tolerated.

・The protocol was approved by IRB of our university. All participants provided written informed consent

Materials and Methods



Gait analysis: the average of 11.0 months after surgery

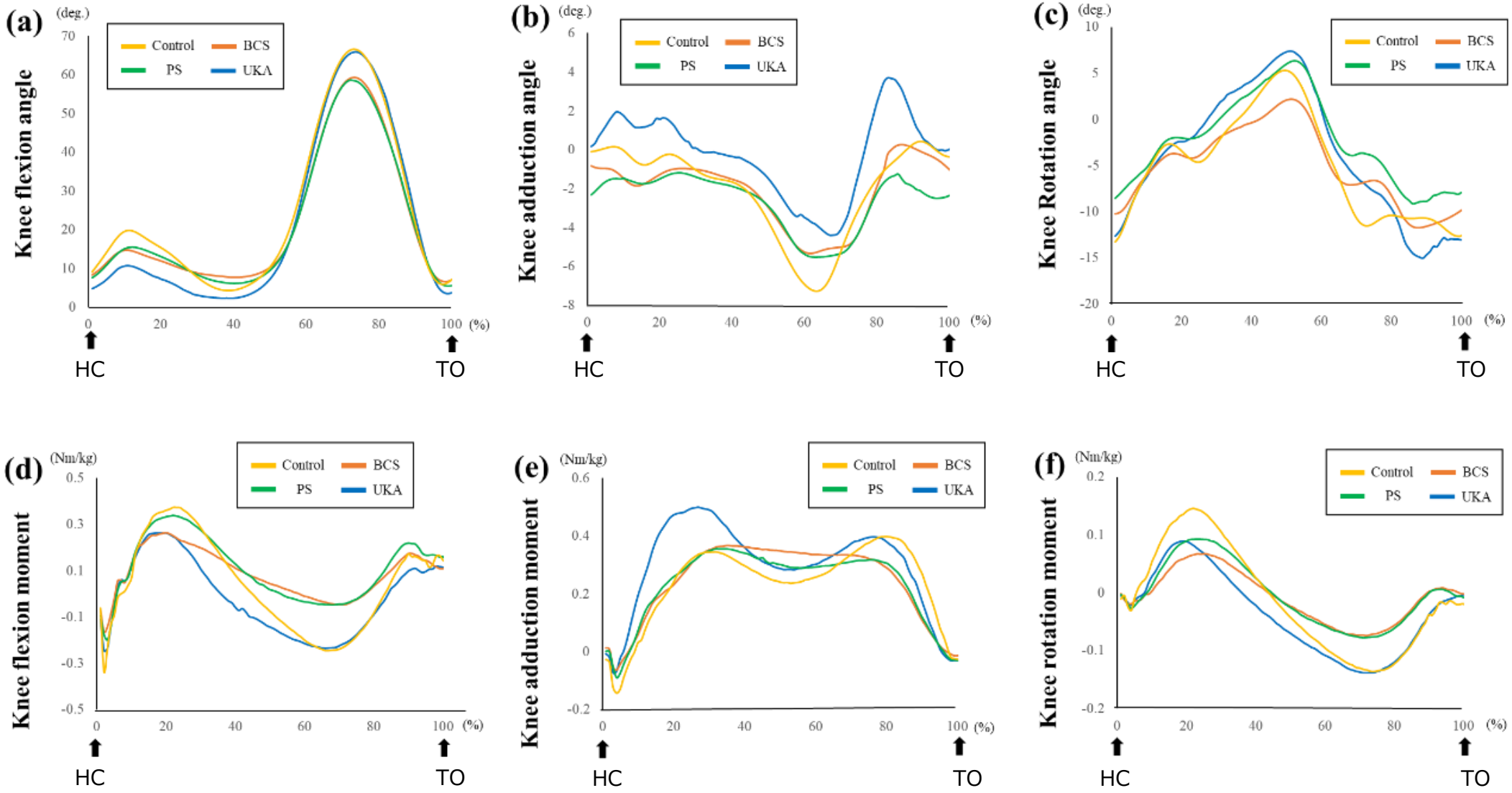
Gait analysis system

- **8 infrared cameras** (120 frames/s, Oqus, Qualisys, Sweden)
- **2 force plates** (sampling rate 600 Hz, ; AM6110, Bertec, Columbus, OH, USA)
- **44 reflective markers**

Visual3D (C-motion, Boyds, MD, USA) was used to assess three-dimensional biomechanics during level walking on a 5-m walkway.

Comparisons among groups were conducted using the Kruskal–Wallis test, and post hoc analysis was performed for those parameters. Statistical significance was set at $p < 0.05$.

Results (waveforms of knee kinematics and kinetics)



Results (biomechanical gait parameters at the knee joint)

	Control	BCS TKA	PS TKA	UKA	P*
Extension excursion during midstance phase (deg.)	15.5 (12.0, 22.1) a)	8.1 (6.4, 9.9)	9.7 (5.6, 13.1)	10.5 (5.4, 13.2)	0.017
Rotation excursion (deg.)	19.3 (17.0, 21.6)	12.6 (9.1, 16.6) c)	15.3 (12.0, 18.5)	18.4 (17.6, 26.0)	0.016
Peak extension moment (Nm/kg)	-0.27 (-0.32, -0.19) b)	-0.10(-0.20, 0.04)	-0.11(-0.14, -0.01)	-0.23 (-0.35, -0.14)	0.0057
Peak internal rotation moment (Nm/kg)	-0.14 (-0.16, -0.12) b)	-0.09(-0.13,-0.05)	-0.08(-0.12,-0.05) d)	-0.17 (-0.21, -0.10)	0.0026

*** Kruskal-Wallis test compared comparing control, BCS, PS, and UKA**
a) Significant difference between control and BCS
b) Significant difference between control and PS
c) Significant differences between BCS and UKA
d) Significant differences between PS and UKA

Discussion (Literature Review)

Evaluation of anteroposterior accelerometric change after bi-cruciate stabilized total knee arthroplasty and posterior stabilized total knee arthroplasty

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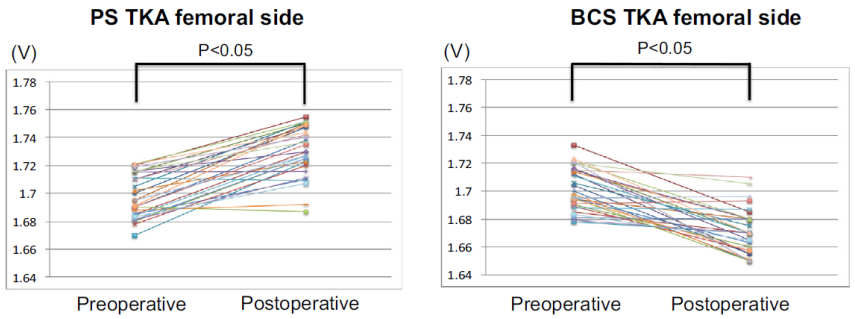
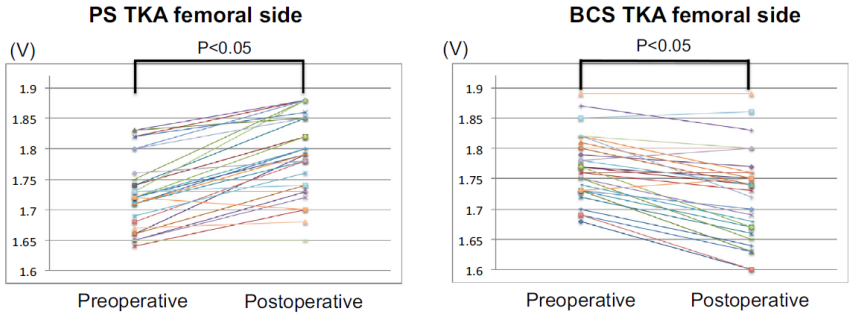
30 BCS TKAs
30 PS TKAs



Swing Phase



Stance Phase

・BCS TKA showed lower anterior–posterior acceleration than PS TKA.

Discussion (Literature Review)

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Original Article

A comparison of gait characteristics between posterior stabilized total knee and fixed bearing unicompartmental knee arthroplasties

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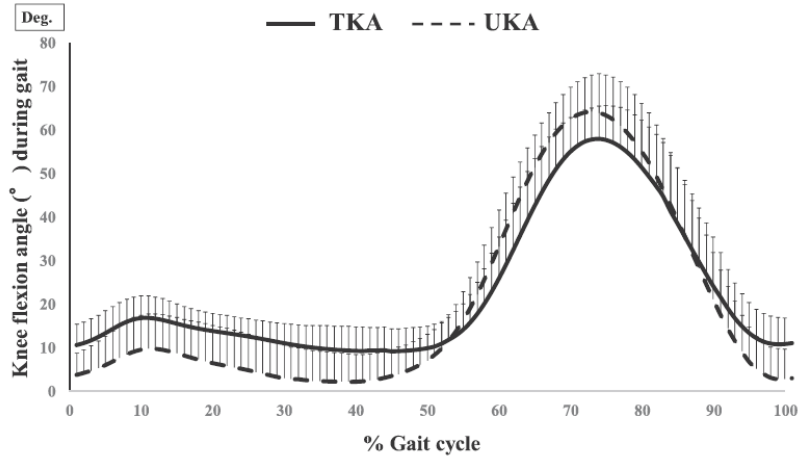


Fig. 2. Kinematic waveform in the sagittal plane. Knee flexion angles at heel contact and during weight acceptance phase were larger in TKA patients, compared with UKA patients.

UKA patients exhibit better sagittal knee motion and tibial internal rotation moment than TKA patients.

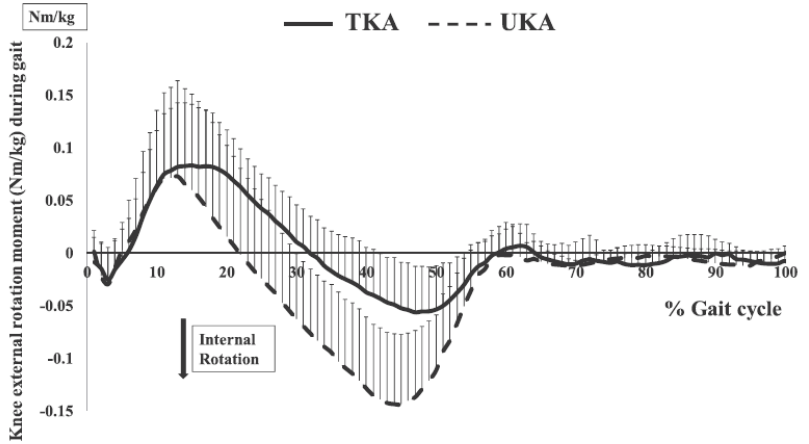
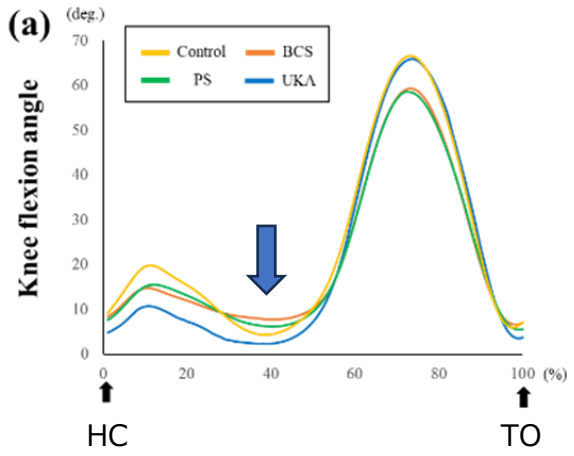


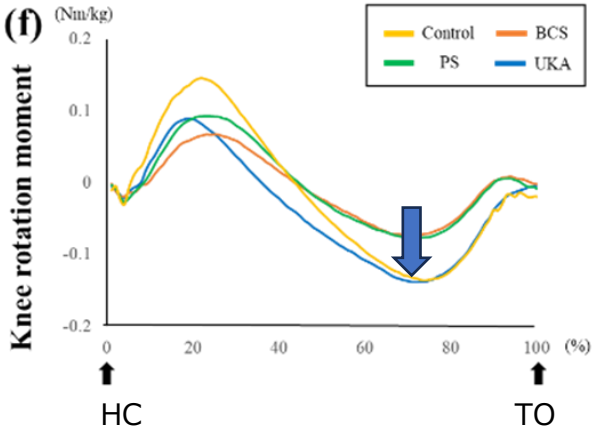
Fig. 3. Kinetic waveform in the axial plane. Internal rotation moment was smaller in TKA patients, compared with UKA patients.

Detailed information of gait biomechanics of BCS is unknown.

From the present study



Extension excursion during midstance phase is smaller in BCS and PS TKAs (stiffening strategy).



Peak internal rotation moment is smaller in BCS and PS TKAs (pivot shift avoidance gait).

BCS TKAs were similar to PS TKAs during gait.

Summary

- ✓ **BCS TKAs exhibited different biomechanical characteristics compared to natural knees and UKAs during gait.**
- ✓ **Ideally, BCS TKA has ACL function. However, BCS TKAs were similar to PS TKAs during gait.**

Thank you very much

Keio University