

In Vivo Kinematic Effects of Ball and Socket Third Condyle as a Post-cam Mechanism in Tri-condylar Knee Implants

Shinichiro Nakamura^{1, 2}, Adrija Sharma², Kenji Nakamura³
Noboru Ikeda³, Jun Kawai³, Sumesh M. Zingde²
Richard D. Komistek², Shuichi Matsuda¹

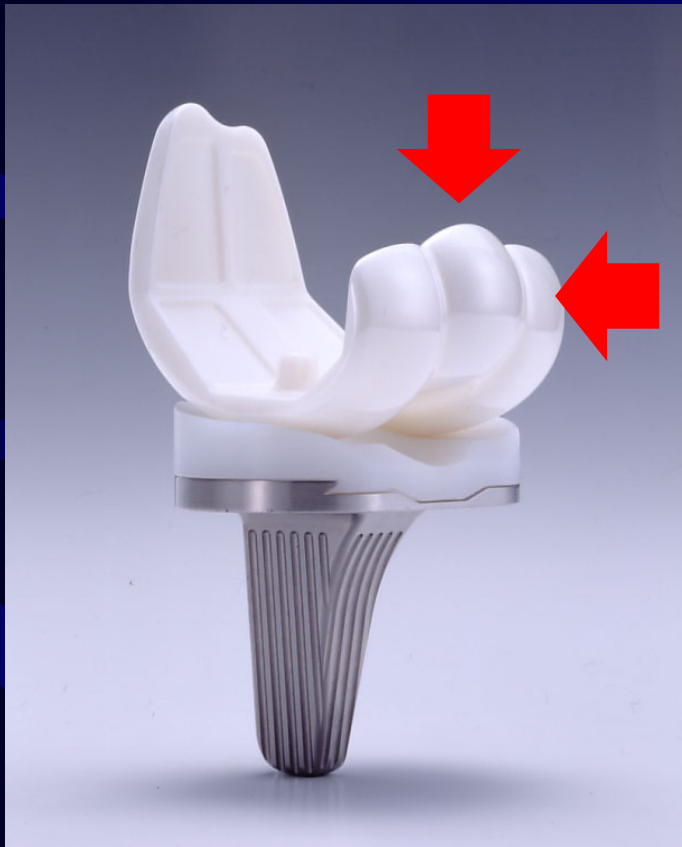
- 1 Department of Orthopedic Surgery, Kyoto University, Graduate School of Medicine, Kyoto, Japan
- 2 Center for Musculoskeletal Research University of Tennessee, Knoxville, TN, USA.
- 3 Department of Orthopedic Surgery Tamatsukuri Hospital, Matsue, Shimane, Japan

Conflicts of Interest

In support of this research, one or more of the authors received grants from Kyocera Medical (Osaka, Japan).

Introduction

Tri-condylar implant: Bi-Surface Knee (Kyocera Medical, Japan)



The third condyle was expected

1 To replace the function of a post-cam mechanism

2 To act as a load-bearing interface in flexion

Purpose

To examine examine the kinematic effects of the ball and socket third condyle during a deep knee bend activity

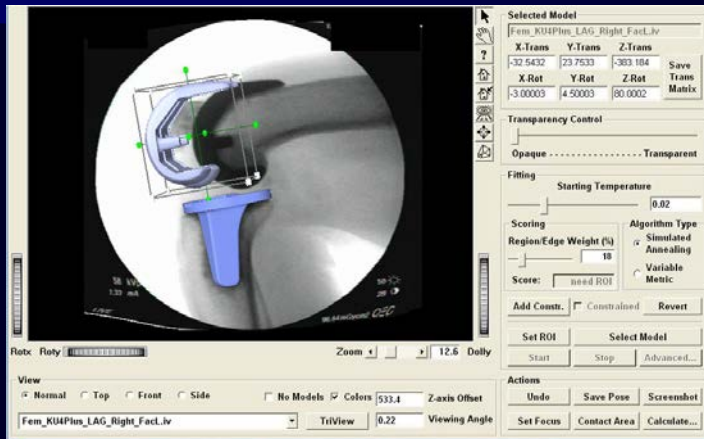
To confirm the contact status of the ball and socket joint

Materials and Methods

17 knees implanted with a tri-condylar TKA

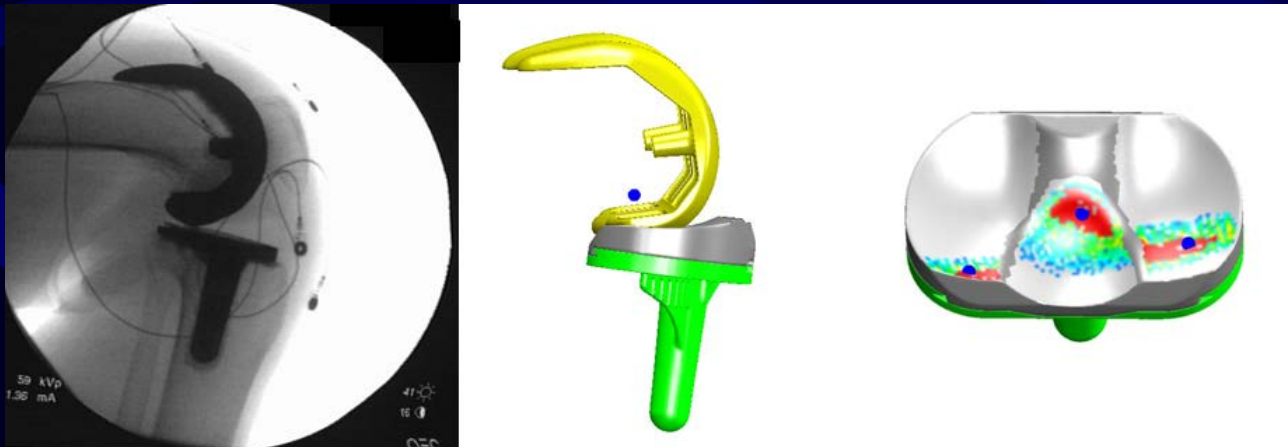
Age	77.6 ± 6.3
Gender (Male / Female)	2 / 15
Period from surgery (months)	5.4 ± 2.2
Height (cm)	148.8 ± 6.6
Weight (kg)	56.8 ± 11.8
BMI	25.6 ± 5.8

3D model fitting (Mahfouz 2003 IEEE)



Error analysis
less than 0.5 mm
less than 0.5°

Ball and socket joint contact



Distance < 1 mm
represented
ball contact

Evaluation for kinematics

Medial contact position

Lateral contact position

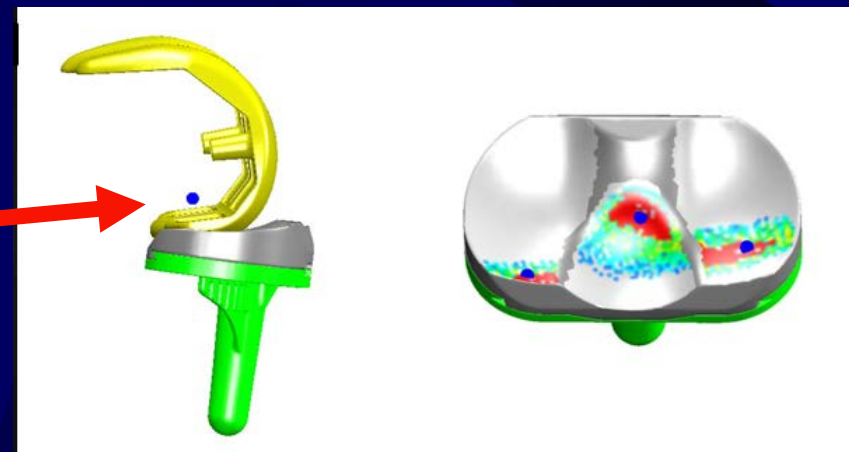
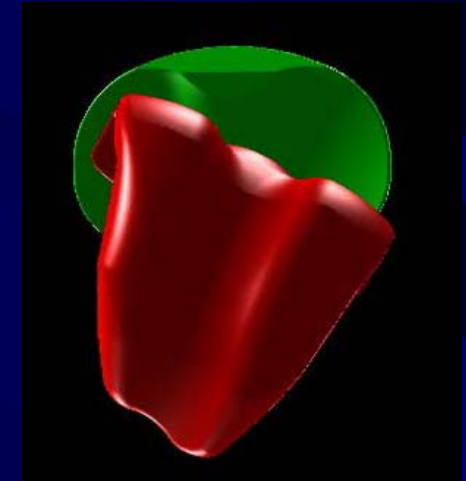
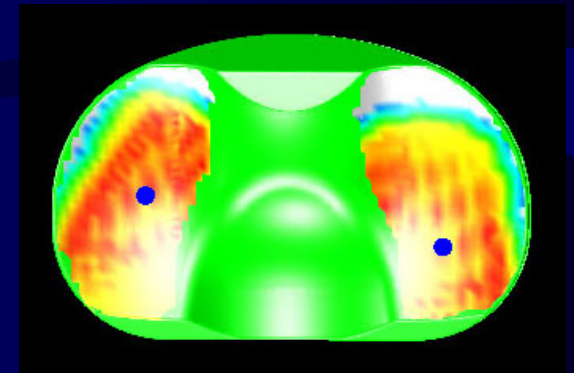
Axial rotation

Ball and socket contact

Contact angle

Contact location

Motion of ball center



Results

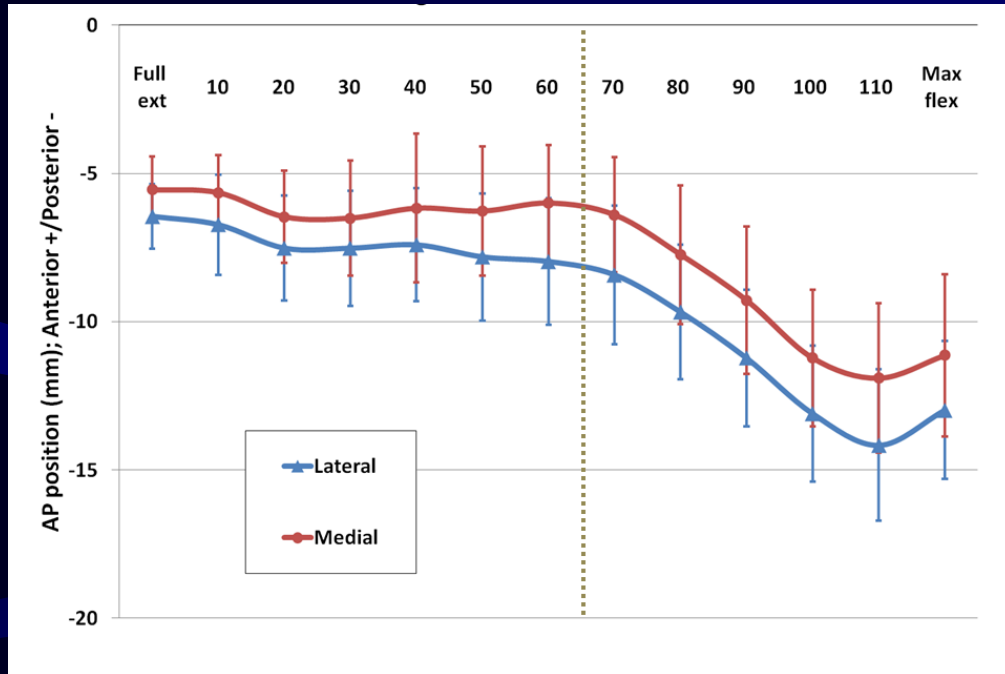
Range of motion

Extension	2.0 ± 6.0°
Flexion	109.8 ± 15.5°

Ball contact

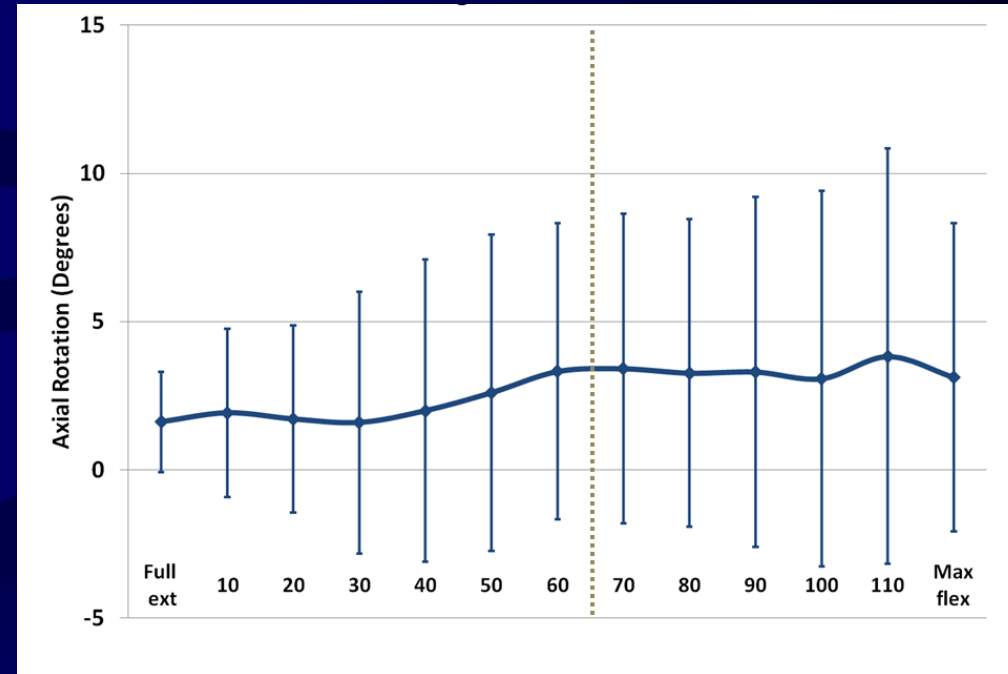
50°	2 knees
60°	7 knees
70°	6 knees
80°	2 knees
Average	64.7 ± 8.7°

Contact position



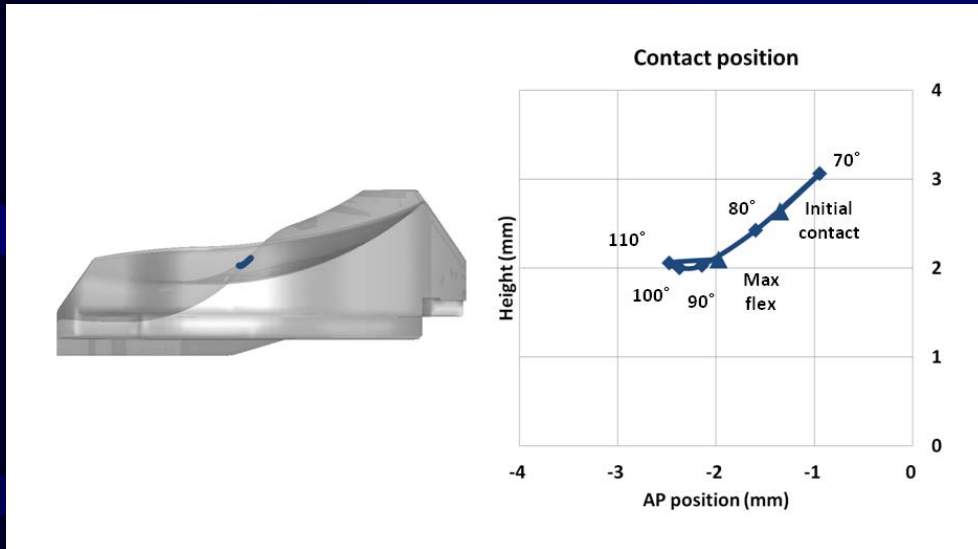
Posterior translation was significantly greater after contact

Axial rotation



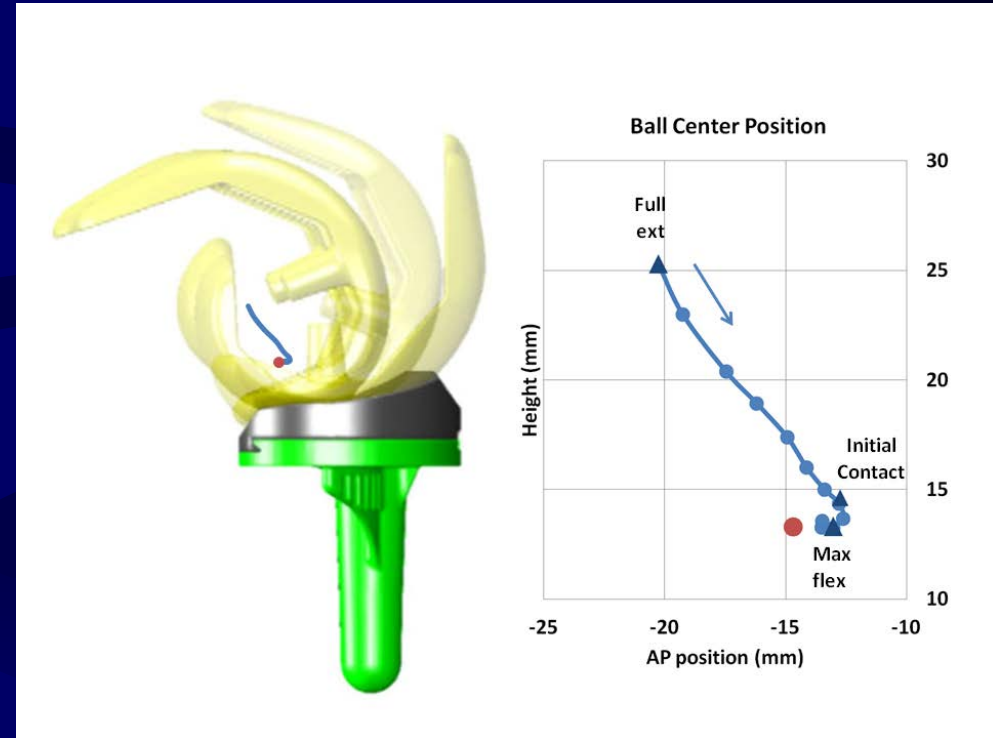
Axial rotation remained still after contact

Contact position (Ball joint)



Contact position
remained low

Motion of ball center

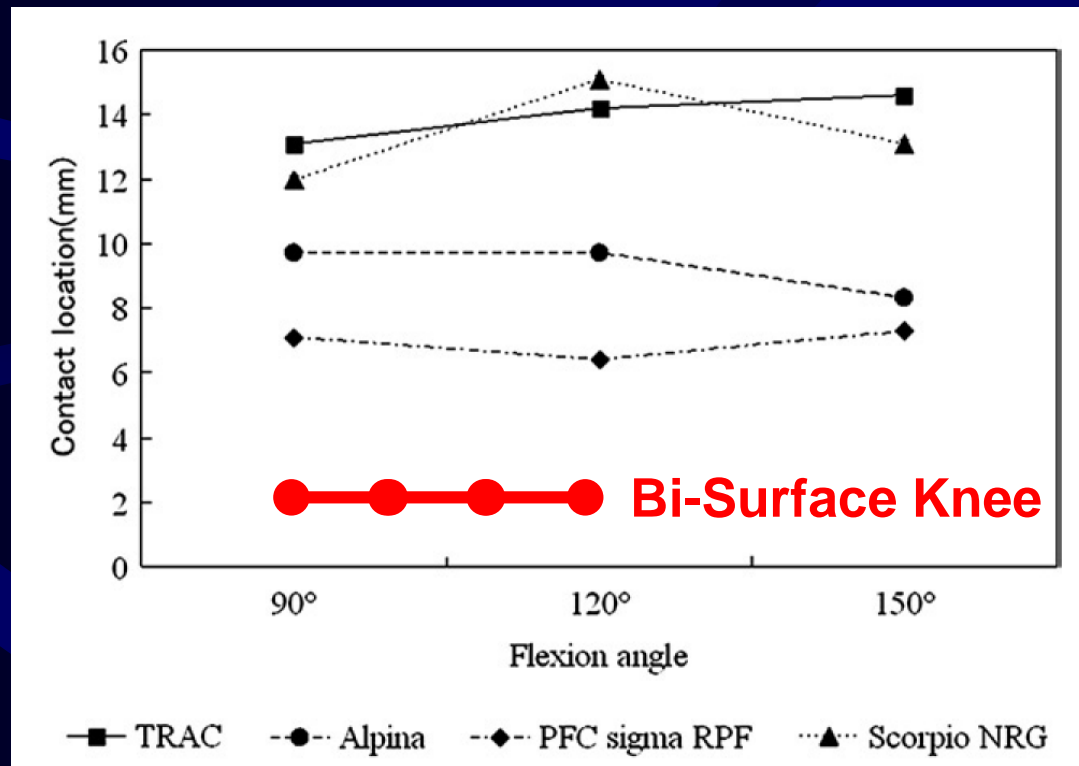


The center of the ball
joint stayed after contact

Discussion

Contact location of post-cam

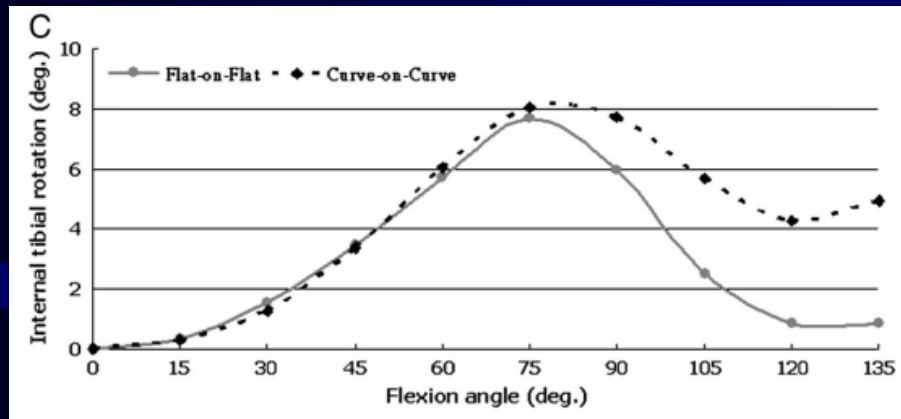
(Akasaki 2008 J. Arthroplasty)



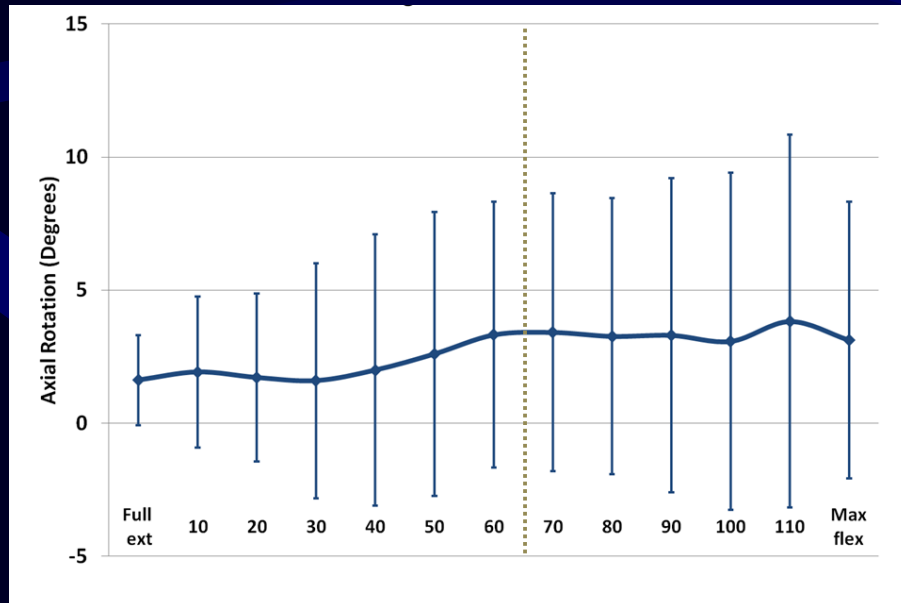
Height of ball contact remained low in Bi-Surface Knee

Shape of post-cam

(Huang 2011 Clin Biomechanics)



Rotation angle decreased after post-cam contact especially in flat-on-flat post



Ball and socket did not prevent axial rotation after contact.

Conclusion

The third condyle induced intensive posterior translation of both condyles, and did not prevent axial rotation.

Separating the kinematics before and after the post-cam engagement, and analyzing the contact status of the post-cam, might aid our understanding of the effects of the post-cam mechanism in detail.