In vivo kinematics of ceramic total ankle arthroplasty using 2D-3D model registration technique

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ABSTRACT INTRODUCTION:
Recently many implants for ankle arthroplasty have been developed around the world, and especially some mobile bearing, three-component implants have good results. Nevertheless in Japan fixed two-component, semi-constrained alumina ceramic total ankle arthroplasty (TNK Ankle) had been most performed from 1991 and led to improved outcomes(1). But no biomechanical study about TNK Ankle, the only major ceramic ankle prosthesis in the world, has been reported, so the purpose of this study was to reveal in vivo kinematics of TNK Ankle.

METHODS:
Between 2007 and 2008, twenty-one patients (20 women and 1 man) having TAA with TNK Ankle (JMM, Osaka, Japan) examined with fluoroscopy at postoperative 1 year prospectively. Each fluoroscopic image implanted ankle was analyzed with in vivo kinematics using 3D-2D model registration technique. In this study IRB approval and informed consent were obtained from all participants.

Weight-bearing Lateral view of dorsoplantar flexed foot was examined, keeping the whole sole of experimental foot on the floor, and taking a step of contralateral foot forward and backward. Then experimental foot was as dorsiflexed and plantarflexed as possible, passively. The Digital fluoroscopic images were extracted every 5 degrees from fluoroscopic images, these images were analyzed with a 3D-2D model registration software, Kneetrack programmed by Scott banks. In this analysis the STL files of the prostheses provided by JMM were used.

RESULTS SECTION:
According to 3D-2D model registration, the data were gotten with six degrees of freedom (dorsiflexion/plantarflexion, internal/external rotation, varus/valgus).

The average of range of rotation with dorsoplantar flexion between tibial and talar prostheses was 23 degrees, varus/valgus was 1.3 degrees, supination/pronation was 4.4 degrees.

The average of range of translation with anterior/posterior was 0.86 mm, superior/inferior was 0.41 mm, medial/lateral was 1.25 mm.

Intra-observer errors and inter-observer errors when Kneetrack is used for ankle prostheses were investigated with the ankle model bones in which metal beads were implanted. Intra-observer errors were 0.04 degrees (dorsiflexion/plantarflexion), 0.33 degrees (internal/external rotation), 0.25 degrees (varus/valgus), 0.17 mm (anterioposterior), 0.08 mm (superior/inferior), 0.59 mm (medial/lateral), and inter-observer errors were 0.41 degrees (dorsiflexion/plantarflexion), 0.45 degrees (internal/external rotation), 0.3 degrees (varus/valgus), 0.2 mm (anterioposterior), 0.11 mm (superior/inferior), 1.12 mm (medial/lateral).

DISCUSSION:
TAA with TNK Ankle have led to better results with improvement for surface treatments, for example, coated with ceramic beads, calcium phosphate cement, aspirated bone marrow. We considered another factor which could improve clinical results would be joint geometry, from which stable movements of the contact point between talar and tibial components on the joint surface would be derived.

That kinematics of TNK Ankle prostheses was analyzed with 3D-2D model registration, could be expected to establish better joint geometry, that is, more appropriate position and angle to replace the prostheses.

REFERENCE:
References are optional.