Bi-cruciate Stabilizing TKA Improves Patellar Tracking
And Increases Patellofemoral Contact Stress Compared With Posterior Stabilizing TKA

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Disclosures:

Introduction:
Total knee arthroplasty (TKA) is a well-established procedure associated with excellent clinical results, particularly pain relief and functional recovery. However, patient-reported outcomes after TKA did not indicate satisfaction levels comparable to those reported after total hip arthroplasty1. Possible reason for poor subjective outcomes could be an abnormal kinematic pattern after TKA, including the medial pivot, lateral pivot, and parallel motion patterns after conventional TKA. A recent implant was designed to achieve normal and predictable medial pivot kinematics using a post-cam design and the tibial surface geometry. Guided motion TKA designs which allow for controlled rollback and guided rotation during flexion may permit kinematics similar to the healthy knee. Among the devices used for bone position data collection, surgical navigation systems, essentially developed in computer-assisted surgery to improve prosthetic component alignment in TKA, can be suitable for studying knee kinematics in the operating theater with good accuracy and manageability. The aim of this study was to evaluate patellar tracking, and patellofemoral (PF) contact stress in posterior stabilizing (PS) and bi-cruciate stabilizing (BCS) TKA intraoperatively in navigated TKA on the same knee. We have hypothesized that there are differences in PF kinematics between PS and BCS TKA.

Methods: Institutional review board approval was obtained prior to initiation of this study. Thirty consecutive patients who had medial osteoarthritis of the knee were enrolled in this study. All knees had a Kellgren-Lawrence grade of 4 in the medial compartment and underwent a primary posterior stabilized total knee arthroplasty (Genesis II; Smith and Nephew, Memphis TN, USA) between May 2010 and December 2010. In all cases, a computed tomography-guided navigation system (Vector Vision 1. 6, Brain LAB, Heimstetten, Germany) was used for accurate implantation with a standardized navigated TKA technique. We performed our procedures using the navigation system according to the manufacturer’s instructions. The air tourniquet was inflated to 280 mmHg in all cases during surgery. The knees were exposed using a subvastus approach and the posterior cruciate ligament was sacrificed at the beginning of the procedure. After appropriate soft tissue releases for the medial structures in the knee, the proximal tibial osteotomy was set on the navigation system perpendicular to the anatomical axis in the coronal plane with 3° posterior inclination in the sagittal plane. After the tibial bone resections, the osteophytes of the femur were removed and the ligament imbalance in the coronal plane was corrected fewer than 2 mm by usual soft tissue release method. This gap balance was checked using ligament balancer (Endplus, Marl, Germany) at 80 N. Flexion gap was measured by navigation system with gap balancer (50 N) at 90° knee flexion after the distal femoral component. The flexion gap applied to navigation system, the amount of external rotation of the femur osteotomy was adjusted by navigation system with balanced gap technique. After all bony resection and soft tissue release were completed, the intraoperative assessment of patellar tracking and PF contact stress was performed twice with the PS and BCS platform and femoral trial components in place on the same patient, according to our previous study2. The amount of bone resection of the patella was equal to the thickness of the patellar component to be placed. The patella ligament was stabilized during the flexion test by temporarily closing with suture, and the tourniquet remained inflated. The real-time assessment of lateral shift of patella from knee extension to flexion was measured by navigation system at kinematic mode. The patella tracker (Brain Lab) was fixed onto the anterior aspect of the patella by small screws. The force exerted on the patellar component was measured directly using uniaxial ultrathin (100 µm) force transducer (FlexiForce; Nitta Corporation, Osaka, Japan) embedded between a backside of trial component of patella and an originally developed metal plate fixed to bony cut surface of the patella. The contact stress was calculated by dividing the total force on the sensor by the sensing area3. Statistical comparison was performed at maximum value of lateral shift of patella and contact force using paired t test. All differences were considered significant at a probability level of 95% (P < 0.05).
**Results:** Lateral shift of patella was significantly larger in BCS TKA knee (4.29 ± 3.71 mm) than that in PS TKA knee (1.21 ± 4.54 mm) (P < 0.00001). Maximum contact load was significantly higher in BCS TKA knee (326.12 ± 206.20 N) than that in PS TKA knee (254.85 ± 167.74 N) (P < 0.01). The PF contact stress increased during knee flexion in all knees. However, no correlations were found knee flex angle at max contact force according between BCS and PS TKA. There is no difference between the mean of knee flexion angle at max contact force of BCS TKA and PS TKA (82.31 ± 21.05 vs. 81.02 ± 26.01 degree). Figure 1 shows case presentation of patellar tracking.

**Discussion:** We compared the intraoperative PF kinematics and PF contact stress between BCS and PS TKA trial component in the same knee. Large lateral shift of patella in BCS group may be explained by femoral external rotation induced by implant design of BCS TKA. High contact road of PF joint in BCS group may be affected by the anterior position of BCS TKA. We must pay more attention to the wear of patellar component and the pain derived from PF joints using the BCS TKA in younger patients. The present study is that the measurements were performed in the same patients. Furthermore, the surgery was performed using computed tomography-based navigation, which can make surgery accurate. On the other hand, the measurements of kinematics under anesthesia are one of the limitations of the study. Future study should be conducted to compare the kinematics of the implanted knee between under anesthesia and daily living activity.

**Significance:**

**Acknowledgments:**

**References:**

**Fig.1** Case presentation of patellar tracking (left, BCS TKA; right, PS TKA). Red points show patella shift, yellow points show patella tilt, and blue points show circle distance of patella to rotational center.

*ORS 2014 Annual Meeting*
*Poster No: 1756*