Mobile bearing total knee arthroplasty improves patellar tracking but does not change tibial rotation
: In vivo measurements using computer navigation

INTRODUCTION:
Tibial rotation is an important aspect of knee function and can be altered after total knee arthroplasty. With knee flexion, the tibia internally rotates relative to the femur, and conversely, externally rotates with knee extension in normal knee. Mobile bearing total knee prosthesis may allow greater unconstrained tibial rotation. Rotation of rotating platform polyethylene insert with the femoral component, independent to the firmly fixed tibial tray, should reduce stress transmitted to the fixation interface of tibial tray and create the potential for self-alignment of polyethylene insert with the femoral component. An additional advantage of the self-aligning feature of rotating platform TKA systems is the potential facilitation of central patella tracking (1). A rotating platform design, through bearing rotation, permits self-correction of component rotational malalignment, allowing better centralization of the extensor mechanism. That process of self alignment might be expected to improve patellar tracking, decrease the rate of lateral retinaculum release and the prevalence of postoperative patellar tilt or subluxation. However, controversies exist in clinical study concerning the effect of rotating platform on patellar tracking. It has reported that a decrease in the rate of lateral retinaculum release from 10% with the fixed-bearing TKA, to 0% in a series of 100 mobile-bearing knee replacements of a posterior-stabilized rotating platform design (2). Another study has reported that rotating platform knees did not improve patellar tracking (3).

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 theatre with a good accuracy and manageability. The aim of this study was to evaluate tibial rotation, patellar tracking and patello-femoral contact pressure in mobile and fixed platform intra-operatively in navigated TKA on the same knee. We hypothesized that there are differences in patellar tracking and tibial rotation between mobile bearing TKA and fixed bearing TKA.

METHODS:
Sixty knees of posterior stabilized total knee prostheses (P.F.C. Sigma RP-F, DePuy, Warsaw, USA) were evaluated using a CT-guided navigation system (Vector Vision, Brain LAB, Heimstetten, Germany). Surgery was performed by single surgeon using subvastus approach to eliminate the influence of approach to muscle balance. No patients had received lateral recinaculum release. The intraoperative assessment of tibial rotation, patellar tracking and PF contact forces were performed twice with the mobile and fixed platform trial components into place on the same patient. The amount of bone resection of the patella was equal to the thickness of the patellar component to be placed. 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 ultra thin (100um) force transducer (FlexiForce, Nitta Corporation, Osaka, Japan) embedded between a back-side of trial component of patella and a originally developed metal plate fixed to bony cut surface of the patella. Statistical comparison was performed at maximum value of rotation of tibia, medial shift of patella, lateral tilt of patella, and contact force using paired t-test. All differences were considered significant at a probability level of 95% (p < 0.05).

RESULTS:
Tibial rotation has no significant difference between fixed and mobile knee (Table.1). Medial shift occurs in proportion to knee flexion in all knees. Medial shift of patella was significantly larger in fixed knee than that in mobile knee (p<0.05). Lateral tilt of patella increased during knee flexion in both of the bearing. In fixed knee, lateral tilt angle is significantly larger than that in mobile knee (p<0.05). Maximum contact force was significantly higher in fixed knee (p<0.05) (Table.2). As expected, the PF contact force increased during knee flexion in all knees. A fixed platform knee had a greater PF contact force especially in the last half of the range of knee flexion angle (Fig. 1).

DISCUSSION:
Fixed bearing knee prosthesis with a high conformity bearing surface provides low contact stress, but produces high torque at the bone-implant interface predisposing to component loosening. Conversely, prosthesis with a low conformity bearing surface produces less constraint force that decreasing component loosening, but generates high contact stress leading to early failure of polyethylene. In the present in vivo study showed that rotating platform improved patellar tracking and patello-femoral contact force. It might be expected that the self-aligning feature of a rotating platform mobile-bearing knee would decrease the prevalence of tilt and medial shift. These results suggest that the mobile bearing knee also solves the kinematic conflict of fixed bearing knee because a high conforming articular surface can coexist with free motion. Concerning the tibial rotation during knee motion, there is no significant difference between mobile knee and fixed knee. This result implies that shear stress to the polyethylene insert of fixed knee is larger than that in mobile knee. Strength of the present study is that the measurements were performed in the same patients. This comparison can decrease the variability among patients. Furthermore, the surgery was performed using CT based navigation, that can make surgery accurately. On the other hand, the measurements of kinematics under anesthesia are one of the limitations of the study.

REFERENCE: