Patellar Tracking and Patello-Femoral Contact Pressure in Mobile and Fixed Bearing Total Knee Arthroplasty: In vivo Measurement of the Same Knee

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Introduction: Mobile-bearing total knee replacement (TKR) designs have been the focus of renewed interest in recent years (1). In part, that interest has been generated by the concept that a mobile-bearing knee design has the ability to self align and, therefore, to accommodate at least small mismatches in the rotational position of the tibial and femoral components after total knee arthroplasty (TKA). That process of self alignment might be expected to improve patellar tracking, decrease the rate of lateral retinacular release and the prevalence of postoperative patellar tilt or subluxation seen on routine radiographic followup, and improve maximal knee flexion. 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 retinacular release from 10% with the fixed-bearing TKR, 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 patellar tracking and patello-femoral contact pressure in mobile and fixed platform intra-operatively in navigated TKA on the same knee.

Materials and Methods: Forty 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 recinacular release. The intraoperative assessment of patellar tracking and PF contact forces were performed 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 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: Medial shift occurs in proportion to knee flexion in all knees. Medial shift of patella was significantly larger in fixed group than that in mobile group (p=0.001) (Fig.1, A). Lateral tilt of patella increased during knee flexion in both of the groups. In fixed group, lateral tilt angle is significantly larger than that in mobile group (p<0.05) (Fig. 1B). Maximum contact force was significantly higher in fixed group (p=0.05) (Fig. 1C). 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 two thirds of the range of knee flexion angle (Fig. 2).

Discussion: A good patellar tracking is in fact considered important for the success of TKA, since complications at the PF joint represent one of the main causes of failure. 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. Rotating platform knee design might accommodate some of rotational mismatches that lead to kinematic conflict and result in decreased patello-femoral contact forces.

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.