PATELLAR EVERSION AFFECTS SOFT TISSUE BALANCE IN TOTAL KNEE ARTHROPLASTY

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INTRODUCTION
Bony alignment and soft tissue balance have been considered as the most important surgical principles in total knee arthroplasty (TKA). The surgical technique and instrumentation for TKA have concentrated on accurately resecting the tibia and femur with the intended angle and level. Recently, the computer-assisted surgery has been reported to improve the accuracy of the osteotomies in TKA. In contrast, soft tissue balance remains difficult to evaluate during the operation, leaving its management much to surgeon’s feel. Although a number of devices and methods have been described to assess soft tissue balance in TKA, conventional methods require patellar eversion, which means joint alignment cannot be reproduced during the measurements.

We hypothesized that patellar eversion would affect soft tissue balance and alter the joint alignment. Thus, we developed a new TKA tensor enabling the measurement with the patello-femoral (PF) joint reduced and tibio-femoral position corrected. Following this, the effect of patellar eversion on soft tissue balance and the gap size was examined by the intraoperative measurement using this tensor.

NEW TKA TENSOR DESIGN
The new tensor consists of three parts: upper seesaw plate, lower platform plate and extra-articular main body. Curved arms from main body connecting two independent plates at the antero-medial corner of tibia are passed through the medial parapatellar arthroscopy. The platform plate can be firmly fixed to the osteotomized tibia. The seesaw plate is attached to the arm of the main body via a single shaft providing a central pivot in the coronal plane. In addition, this plate can move in a proximal-distal direction by means of a rack and pinion mechanism with the main body. A designated joint distraction force between the two plates can be exerted using the specially made torque driver. Following osteotomies and femoral trial prosthesis insertion, two plates are placed in the joint. The seesaw plate has a post at the center to engage the inter-condylar space and cam of the femoral trial prosthesis. This post and cam mechanism controls tibio-femoral position in coronal and sagittal planes, reproducing the joint alignment after the TKA (Fig.1). In the preliminary in vitro experiment, the error for the joint distraction force was demonstrated to be less than 3%.

MATERIALS and METHODS
Ligament imbalance was assessed by the measurement of angular deviation of the seesaw plate to the platform plate. The joint gap was defined as the distance between the seesaw plate and cut tibial surface at the mid-point. The measurements were carried out with 4 different knee flexion angles (0, 45, 90, 135°) Joint distraction force was set at 40 lbs.

The subjects were 27 consecutive patients (30 knees) who underwent the posterior stabilized TKA. Patients with valgus deformity were not included. Average femoro-tibial angle was 6.9 degrees of varus. The joint gap and ligament balance were assessed with the PF joint either everted or reduced with patellar trial prosthesis. The effects of the PF joint status on the joint gap and ligament balance were analyzed using paired t test. The comparison between different flexion angles was performed using the repeated measures analysis of variance (ANOVA). Differences of P<0.05 were considered statistically significant.

RESULTS
Average time required for measurement was 9.4 minutes. Average joint gaps were 12.6, 18.3, 20.3, 22.1mm with patellar eversion and 12.7, 18.0, 19.2, 15.9mm with PF joint reduced at 0, 45, 90 and 135° of flexion respectively. Joint distraction force was set at 40 lbs. The subjects were 27 consecutive patients (30 knees) who underwent the posterior stabilized TKA. Patients with valgus deformity were not included. Average femoro-tibial angle was 6.9 degrees of varus.

Ligament imbalances to varus were 3.9, 3.2, 3.0 and 2.9° with patellar eversion, and 4.6, 4.0, 4.3 and 4.2° with the PF joint reduced at 0, 45, 90 and 135° of flexion respectively. The extent of the varus ligament imbalance was significantly increased by the PF joint reduction at 45 and 90° of flexion. Ligament balance was not affected by the knee flexion angle (Fig.3).

DISCUSSION
Although extension gap was not affected by the position of the patella, PF joint reduction significantly decreased the flexion gap. When the PF joint reduced, the joint gap dramatically decreased in deep knee flexion. This indicates that the tension in the extensor mechanisms might have an important role in limiting joint separation in flexed position. Furthermore, it is thought that the magnitude of the decrease in joint gap with knee flexion correlates to the severity of the contracture in the extensor mechanism, thus it may be used as a predictor of range of motion after TKA.

The ligament balance in the coronal plane was also affected by the status of patella. Although the effect of patellar eversion on the coronal ligament balance varied from knee to knee, varus imbalance was underestimated at 45 and 90° of flexion when the patella was everted. Tension of the laterally reflected extensor mechanism was thought to reduce lateral joint gap resulting in less varus imbalance.

The current study deals with intraoperative measurements under anesthesia, thus the results could not be directly extrapolated to the in vivo conditions. However, it can be concluded that the PF joint should be reduced to assess joint gap and soft tissue balance in TKA. The use of a new tensor for intraoperative assessment will be valuable in improving the accuracy of surgical procedures in TKA.