Use of a Tensor with a Navigation to Assess the Accuracy of the Soft- Tissue Balance in Total Knee Arthroplasty

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Introduction
One of important factors to achieve stable postoperative results is to obtain proper soft tissue balance at the time of total knee arthroplasty (TKA). With a goal of accurate gap balance during TKA, we developed a tensor called Joint Dependent Kinematics (JDK- mini II, Stryker, Tokyo, Japan) and presented the tensor in this meeting last year. Computer navigation has been proven to be a useful tool to improve the accuracy of component placement and the alignment in TKAs. To evaluate the intra-operative preciseness of the tensor, we compared the data of joint gap and soft tissue balance on the tensor with those on the navigation system.

Materials and Methods
Patients:
A total of 74 primary TKAs in 49 patients were performed between April 2009 and December 2009. There were 3 male and 46 female patients ranging in age from 60 to 85 years (mean, 72.9 years old). The diagnosis was osteoarthritis in 41 cases, osteonecrosis in 1 case, and rheumatoid arthritis in 7 cases. The patients underwent TKA using a posterior-stabilized design (Scorpio NRG, CR and PS Primary Knee System, Stryker or Scorpio Plus, Mobile Bearing Knee System, Stryker), with resurfacing of the patella.

Tensor Device:
At surgery, we use the tensor with the joint distraction force at 30, 40 and 50 lb. The tensor consists of 2 metallic plates that are located on the surfaces of the tibia and the femur. So, it allows us to assess the joint gap and the medial/lateral angular deviation between the surfaces of the tibia and those of the femur. Additionally, it has the offset arm which allows us to investigate soft tissue balance with the patella in the normal position.

Surgery:
A midline surgical incision with a midvastus approach was used. After osteotomies were removed, the anterior cruciate ligament and posterior cruciate ligament were sacrificed. At our institution, we use the modified gap technique to balance the knee at the time of TKA. After the initial bone cuts of the distal femur and the proximal tibia, the soft-tissue balances were measured at 0° extension and 90° flexion. The soft-tissue release was performed until the tensor showed angulation <3° in both flexion and extension. After all bony resections and soft tissue releases, the tensor was used again to measure the soft-tissue balances at 0° extension and 90° flexion.

Navigation System:
A computed tomography (CT)-free navigation system (precision Knee Navigation/ V4.0-23, Stryker) was applied. Optical tracker pins are attached to the distal femur and the proximal tibia. Bony landmark are identified using a pointer. The joint gap, the angular deviation, and implant positions were displayed on a computer.

Results
After all bony resections and soft tissue releases, the average extension gap (0 degree) between the distal femur and the proximal tibia was 18.9±3.0 mm with the tensor and 19.5±2.9 mm with the navigation, with 30lb of joint distraction force. The average angular medial deviation of the tensor and the navigation was 0.7±1.5 and 1.2±3.2 at 0° extension, respectively (Figure 1A, 1B). Similarly, the average flexion gap (90 degree) between the posterior femur and the proximal tibia was 15.5±3.6 mm with the tensor and 15.1±3.5 mm with the navigation. The average angular medial deviation of the tensor and the navigation was 0.9±2.2 and 0.0±9.4 at 90° flexion, respectively (Figure 1C, 1D). There was good correlation between the gap measurements using the tensor and the navigation at both 0° extension and 90° flexion (Figure 1E: extension gap R²=0.70, p<0.001, 1F: flexion gap R²=0.58, p<0.001). Results of soft-tissue balance just after the initial bone cuts between the tensor and the navigation were almost identical (Data not shown). Additionally, the results for other joint distraction forces, i.e. 40 lb and 50 lb, showed a similar tendency with the results of 30 lb distraction force.

Discussion:
The usefulness of a navigation system to improve the accuracy of the alignment and implantations has been widely recognized. In this study, the soft tissue measurements with the tensor were significantly correlated with the measurements with the navigation, suggesting that the measurements with the tensor were useful to assess soft tissue balance at the operation, especially the modified gap technique. The navigation system is expensive, complicated, and is not available for all hospitals. The tensor is easy to perform and practical for clinical use. Additionally, the balance could be evaluated with a patella in the physiologic normal position by using the tensor, which would be expected to indicate more accurate intra-operative outcomes. The tensor has several limitations. First, it has not shown any information about the tibial rotation and component placement. Second, the rotational alignment of the femoral component was not evaluated between the tensor and the navigation. Use of a tensor in conjunction with a computer-assisted navigation system would improve the accuracy of the alignment and implantations.

Significance:
The tensor was accurate to evaluate soft tissue balance, i.e., joint gap and the angular deviation, during TKA as well as use of the navigation system.