INTRODUCTION: A common difficulty with total knee arthroplasty (TKA) is obtaining accurate intraoperative soft tissue balancing, an aspect of this procedure that surgeons traditionally address through their “subjective feel” and experience with an everted patella. To this end, we have reported intraoperative soft tissue balance using an originally developed offset type tensor for TKAs that enables us to assess for soft tissue balancing throughout the range of motion about the knee with a reduced patellofemoral (PF) joint. This tensor permits us to intraoperatively reproduce the postoperative alignment of the PF and tibiofemoral joints.

Although many studies have reported on the postoperative knee kinematics in TKA, the influence of intraoperative soft tissue balance on knee kinematics in TKA has not yet been reported. In this study, using the tensor with a navigation system, we therefore measured knee kinematic parameters including tibial internal rotation, tibial anterior translation, and maximum knee flexion angle as well as intraoperative soft tissue balance including joint looseness (joint component gap minus polyethylene insert thickness) and varus ligament balance as described previously. With the parameters obtained intraoperatively, correlations between each parameter were assessed.

METHODS: The subjects were 40 patients diagnosed with osteoarthritis with varus deformity and underwent primary TKA between 2006 and 2009. The mean age at surgery was 74.6 ± 6.7 years (range, 61–90 years). Surgeries were performed by the same senior doctor using cruciate-retaining (CR) TKA (E. M. motion, B. Braun Aesculap, Germany) with the image-free navigation system (Orthopilot 4.2., B. Braun Aesculap, Germany). All TKAs were performed with the tibia first gap technique using the tensor and the navigation system.

Following each bony resection, the tensor was fixed to the proximal tibia and the femoral trial prosthesis was placed. Using the tensor under 40 lb. distraction force, we intraoperatively measured varus ligament balance (°, varus angle) and joint component gap (mm, center gap) at 0°, 10°, 30°, 60°, 90°, and 120° knee flexion guided by the navigation system, with the patella reduced. Intraoperative knee kinematics was measured using the navigation system with all prostheses implanted and the PF joint reduced. Internal-external rotation and anterior-posterior translation were defined as the relative displacement of the origin of the femoral coordinate system to the origin of the tibial coordinate system as described previously. The surgeon manipulated the knee by 3 repetitions of extension and flexion. The extension movement initially began with heel support to record the position of maximum flexion. While supporting the heel with an open palm and touching the thigh with the opposite hand, the surgeon gently flexed the hip and knee to the final points as gravity flexed the knee. We defined the tibial internal rotation and tibial anterior translation as the differences of the value at 60° and at maximum flexion, respectively.

Measurements were analyzed statistically using simple linear regression models and Pearson’s correlation coefficient. P values less than 0.05 were considered statistically significant.

RESULTS: The mean tibial internal rotation and tibial anterior translation were (mean ± SEM) 23.4 ± 2.6 and 7.5 ± 0.7, respectively. The mean joint looseness and varus ligament balance were (mean ± SEM) 0.1 ± 0.3, 1.8 ± 0.3, 3.7 ± 0.4, 4.3 ± 0.5, 2.8 ± 0.5, and 0.2 ± 0.4°, and 2.4 ± 0.6, 3.4 ± 0.6, 4.1 ± 0.6, 4.1 ± 0.7, 1.8 ± 0.7, and 1.1 ± 0.6° at 0°, 10°, 30°, 60°, 90°, and 120° of flexion, respectively. Regression analysis revealed that the varus ligament balance was positively correlated with the tibial internal rotation at 60° and 90° of flexion (R = 0.41, P < 0.01; R = 0.47, P < 0.01, respectively). On the other hand, the varus ligament balance was negatively correlated weekly with the tibial anterior translation at 60° of flexion (R = 0.36, P < 0.05). Furthermore, the joint looseness was positively correlated with the tibial internal rotation at 90° of flexion (R = 0.44, P < 0.01) (Fig. 1). Any other parameters were not correlated with tibial internal rotation and tibial anterior translation.

DISCUSSION: Normal knee kinematic study has shown that femoral posterior translation and femoral external rotation occurred during knee flexion. One of the goals of TKAs is to gain normal knee kinematics. In this study, to reflect postoperative knee condition, the measurement of soft tissue balance by the tensor was performed with PF joint reduced and femoral component in place, and the kinematic assessment was done with all prostheses implanted and the PF joint reduced. Our results of the correlation between varus ligament balance and tibial internal rotation may indicate that the looseness of lateral compartment in relation with the medial side at 60° and 90° of flexion permits rotational mobility, resulting in tibial internal rotation increased. In fact, the relation between joint looseness and tibial internal rotation at 90° of flexion shows positive correlation supported the result. The design of Aesculap’s e.motion implants permits anterior-posterior mobility from 8° hyperextension to 150° flexion with internal-external rotation of up to 15° in extension and 30° in flexion. In addition, the mobile bearing has mobility in the anterior-posterior direction depending on size. The result of the tibial anterior translation using the prostheses type may indicate that the increase of varus imbalance at the largest point in joint looseness, 60° flexion, reflects the compatibility between femoral component and mobile insert, resulting in the restriction of tibial anterior translation.

In conclusion, in the present study, the value of varus balance and joint looseness were found to be one of the factors predicting postoperative knee kinematics including tibial internal rotation and tibial anterior translation.

SIGNIFICANCE: We first showed influence of intraoperative soft tissue balance on knee kinematics in CR TKA.

REFERENCES: