Introduction: Balancing of joint gap for both medial/lateral and extension/flexion is a prerequisite for a soft tissue balance in total knee arthroplasty (TKA). Currently, the influence of the extensor mechanism on the joint gap is unknown. We hypothesized that the patellar positioning required during TKA and the magnitude of the extensor muscle forces have a strong influence on joint gap. The purpose of this study was to quantify the effects of extensor mechanism on the joint gap in TKA.

Materials and Methods: To determine the effect of the extensor mechanism on joint gaps during TKA, the following conditions were examined: patella eversion, patella reduction, and patella reduction following repair of the medial arthrotomy (Fig 1). Joint gaps were measured from the implanted femoral component to the cut tibia surface for all conditions. Eight fresh-frozen cadaveric knees ranging in age from 65 to 85 years old were used. Using a medial parapatellar approach, a posterior cruciate ligament sacrificing TKA (Encore Inc., Austin, TX) was performed according to the manufacturer’s guidelines. A custom ligament balancing system that permits simultaneous measurement of joint gaps and the tension of the soft tissues was used to ensure soft tissue balancing. The femoral component was press fitted, the tibial component was not implanted, and the patella was left intact. Specimens were mounted on a custom knee testing system with the femur locked in position for extension or flexion. The most distal margins of the femoral component were set horizontally in extension, and the rotation of the femur was set by aligning the posterior femoral condyles horizontally in flexion. The tibia was allowed 5 degrees of freedom. The medial and lateral joint gaps with 100N tibial distraction force created by hanging weights were measured using a Microscribe 3DLX (Immersion Corp, San Jose, CA) for both extension and flexion. The medial and lateral joint gaps were calculated as the superior-inferior distance between the most distal points of the femoral component in extension (for flexion, the most posterior points of the femoral component) and the center of the cut surface of the tibia on each side. The influence of the quadriceps muscle loading was investigated by varying the quadriceps load from 0N to 125N. Anatomically based loading of the quadriceps was used (1). Additionally 6N and 4N were loaded onto the semimembranosus and the biceps femoris respectively. A repeated measures analysis of variance with a Tukey post hoc test p<0.05 was used for statistical analysis.

Results: In extension, both the lateral and medial joint gaps with patella eversion were significantly smaller than the other two groups from 25 to 125N quadriceps load (p<0.0002 to 0.032). With patella reduction, the lateral and medial joint gaps were smaller than that with repair of arthrotomy, although significant difference was shown only with 100N quadriceps load (p=0.021) at lateral side (Fig 2a,b). In flexion, both the lateral and medial joint gaps with patella eversion were significantly smaller than the other two groups from 25 to 75N quadriceps load (p=0.0002 to 0.010). In contrast, with 125N quadriceps load, the joint gaps with patella eversion was significantly larger than that with repair of arthrotomy (p=0.015) (Fig 2c,d).

Discussion: Eversion of the patella decreased the lateral joint gap significantly more than the medial joint gap. The influence of extensor mechanism on flexion gap differed from extension gap with patellar reduction following repair of arthrotomy. These findings suggest that the extensor mechanism and the patellar positioning in TKA have a strong influence on the joint gap measurement.


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Figure 1. Testing setup of each patellar position, a: patella eversion, b: patella reduction, and c: patella reduction.

Figure 2. a: Lateral extension gap, b: Medial extension gap, c: Lateral flexion gap, d: Medial flexion gap.

Figure 3. a,b: Mean decrease of joint gaps with patella eversion (a: extension, b: flexion), c,d: Mean decrease of joint gaps with repair of arthrotomy (c: lateral, d: medial) (p=0.05).

The decrease of joint gaps relative to no quadriceps load was significantly larger for the lateral side than that for the medial side with patella eversion, from 75 to 125N of quadriceps load in extension (p=0.003 to 0.029), and from 25 to 125N in flexion (p=0.0005 to 0.009) (Fig 3a,b). With repair of arthrotomy, the decrease of flexion gaps relative to no quadriceps load was significantly smaller than that in extension gap with 25 and 50N of quadriceps loads for both lateral (p=0.010 and 0.013) and medial sides (p=0.005 and 0.001). With 100 and 125N of quadriceps loads, the decrease of flexion gaps was larger for extension gap both at lateral (p=0.038 and 0.007) and medial sides (p=0.022 and 0.003) (Fig 3c,d).