

# Joint gap kinematics in total knee arthroplasty measured by navigation system

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**Introduction:** Soft tissue balancing remains the most subjective procedure in total knee arthroplasty (TKA). This remains difficult despite the availability of several devices developed to assist surgeons to obtain better soft tissue balance, including tensors, spacers, and navigation system. Traditional measurements of the joint space are performed with the patellar everted, and are thereby performed in unphysiologic knee configuration with limited knee flexion angles. We therefore adopted a navigation system which enables to measure medial and lateral gap spaces separately, throughout the range of motion, while reproducing physiologic knee configuration with the patellofemoral joint reduced. Purpose of the present study was to clarify joint gap kinematics in TKA measured by navigation system.

**Materials & Methods:** The subjects were 44 consecutive patients (55 knees) who underwent primary posterior-stabilized (PS) TKA using the navigation system (Ci-system®, Depuy brainLab) between January 2010 and April 2011. There were 37 women and 7 men with a mean age at operation of 63 years (58 to 73). The original diagnosis was degenerative osteoarthritis in all patients. Patients with valgus deformity and severe bony defects were excluded. After the posterior cruciate ligament sacrifice, complete soft tissue balancing, and fixation of all components with cement, the length of medial and lateral joint gap spaces were measured separately by navigation system throughout the range of motion (0 deg, 30 deg, 45 deg, 60 deg, 90 deg, 120 deg, and full flexion). The joint component gap was measured before and after deflation of tourniquet, first with patella everted and then reduced. The joint gap measured by the navigation system is the gap between the distal end of femoral component and proximal tibial osteotomy line.

**Results:** Deflation of tourniquet did not effect on gap space measurements. Average medial joint gap space change was 1.2 mm (range, 0.35-2.48 mm) and 1.32 mm (range, 0.38-2.55 mm) with patellar reduced and everted, respectively. Average lateral joint gap space change was 1.54 mm (range, 0.29-2.37 mm) and 1.65 mm (range, 0.45-2.30 mm) with patellar reduced and everted, respectively. Significantly larger lateral joint gaps were found, when compared to the medial joint gaps, during the initial 60 deg and at maximum (average 138 deg when patella everted, and average 131 deg when reduced) of knee flexion with both patellar everted and reduced. In the measurement with patellar eversion, however, significantly larger medial joint gaps were found, when compared to the lateral joint gaps, during knee flexion of 60 deg to 120 deg. In contrast, when patellar reduced, there were no significant differences between medial and lateral joint gap during knee flexion of more than 60 deg. When comparing the joint gaps with patellar eversion and patellofemoral joint reduction, there were no significant differences in the medial joint gaps during the initial 60 deg of knee flexion. Medial joint gaps with patellar eversion, however, showed significant increase during knee flexion of more than 60 deg. In contrast, lateral joint gaps were generally increased (significantly at 30 deg, 60 deg, and 90 deg) throughout the range of knee motion with patellofemoral joint reduction except at maximum knee flexion angle.

**Conclusion:** Intraoperative joint gap spaces were measured in PS TKA with a navigation system. Medial and lateral joint gap spaces changed within 2mm, throughout the range of knee motion, regardless of patellofemoral joint reduction status. Medial joint gap spaces were significantly tighter than the lateral side during the initial 60 deg of knee flexion; however, lateral joint gap spaces were tighter than the medial side at 90 deg and 120 deg of knee flexion with patellar eversion. Medial joint gaps increased continuously throughout the range of knee motion, and significantly during knee flexion of more than 60 deg with patellar eversion.

Medial and lateral joint gap measurements showed different patterns with patellar eversion and patellofemoral joint reduction. However, such changes occurred within 2mm (in average) throughout range of knee motion. Additionally, tourniquet did not effect on gap space measurements.