

Flexion Gap Preparation Opens Both the Extension and Flexion Gap during Total Knee Arthroplasty

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INTRODUCTION:

Soft-tissue balancing of the knee is fundamental to the success of total knee arthroplasty (TKA). Preparing equal and rectangular extension and flexion joint gaps is the most important goal in TKA because this facilitates functional restoration of the knee [1]. Recent fluoroscopic kinematic study showed that rotation of the femoral component using a gap balancing technique resulted in better coronal stability than using measured technique and suggested that a gap balancing technique will improve functional performance and reduce polyethylene wear [2].

The different methods for gap balancing technique include the following: 1) initial preparation of the flexion gap followed by matching of the extension gap to the width of the flexion gap [3]; 2) initial preparation of the extension gap followed by matching of the flexion gap to the width of the extension gap [4]. The latter procedure, so called "modified gap technique", minimizes the risk of joint line elevation. However, the theoretical disadvantage of the latter procedure is that the preparation of the flexion gap (resection of the posterior femoral condyle and removal of the osteophytes on the posterior aspect of the femur to re-establish the posterior capsular recess) would change the tension of the posterior soft tissue structures and thus the width of the extension and flexion gap, and disturb the preparing equal and rectangular extension and flexion joint gaps. Previous reports showed that the preparation of the flexion gap opens the extension gap either in posterior stabilized (PS) TKA [4] or cruciate ligament-retaining (CR) TKA [5]. To date, there is a paucity of data whether the flexion gap changes before and after the preparation of the flexion gap or not.

The purpose of this study was to quantify the change in the extension and flexion gap caused by preparation of the flexion gap in PS TKA.

METHODS:

One hundred consecutive knees with varus osteoarthritis who underwent PS TKA were included. The knees were exposed using a medial parapatellar approach, and the anterior and posterior cruciate ligaments were resected. The cut into the proximal tibia was made. The surface of the tibial bone was cut perpendicular to the frontal plane and inclined 3 degrees posterior in the sagittal plane using an extramedullary alignment guide. The cut into the distal femur was made using an intramedullary alignment guide. Operative technique and measuring method was as follows (Figure 1):

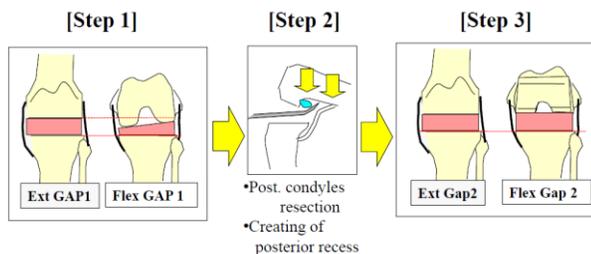


Figure 1: Scheme of the "modified gap technique".

[Step 1] After the medial soft tissue release was performed, the extension gap (**Ext Gap 1**) was measured using a tension device (Gap Maker, Biomet Japan, Tokyo, Japan) at 120 N of distraction force. Then, the flexion gap was measured using Gap Maker at the same distraction force as extension gap (**Flex Gap 1**). (Figure 2)

[Step 2] The rotation and the thickness of resection for the posterior femoral condyle were set by Gap Maker to make the equal and rectangular flexion gap. The setting of posterior femoral condyle resection (thickness [mm] and angle from the posterior condylar line [degrees]) was recorded.

[Step 3] After resection of the posterior femoral condyle, osteophytes on the posterior aspect of the femur were carefully removed and the posterior capsular recess re-established. After this procedure, the final gap was measured (**Ext Gap 2** and **Flex Gap 2**).

A paired t-test was performed to compare the difference between the extension and flexion gaps and the difference in the increase in the extension or flexion gap at each step.



Figure 2: The distance (mm) and tilt angle (degrees) of joint gap were measured using Gap Maker at 120 N of distraction force (Biomet Japan, Tokyo, Japan).

RESULTS:

[Step 1] Gap before preparation of the flexion gap:

Ext Gap 1 was 21.3 +/- 0.2 mm (mean ± standard error) and 2.0 +/- 0.2 degrees varus. **Flex Gap 1** was 14.0 +/- 0.2 mm and 4.0 +/- 0.3 degrees internal rotation.

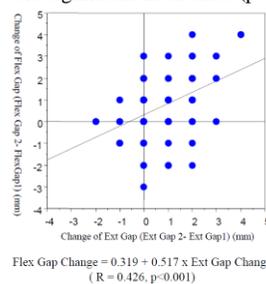
[Step 2] The setting of posterior femoral condyle resection:

The setting of posterior femoral condyle resection was 8.2 +/- 0.1 mm and 4.2 +/- 0.2 degrees external rotation. Thus the planned flexion gap, that is the sum of Flexion gap 1 and the setting of posterior femoral condyle resection, was 22.2 +/- 0.2 mm and 0.3 +/- 0.2 degrees external rotation.

[Step 3] Gap after preparation of the flexion gap:

Ext Gap 2 was 22.1 +/- 0.2 mm and 1.3 +/- 0.1 degrees varus. **Flex Gap 2** was 22.9 +/- 0.2 mm and 0.2 +/- 0.2 degrees external rotation.

Flexion gap preparation increased the extension gap by 0.8 +/- 0.1 mm and tilt by 0.7 +/- 0.1 degrees valgus. The difference between Extension gap 1 and Extension gap 2 were significant both in distance and tilt angle (p<0.001). Flexion gap preparation increased the flexion gap by 0.7 +/- 0.1 mm and tilt by 0.1 +/- 0.2 degrees internal rotation. The difference between the planned flexion gap (the sum of the flexion gap 1 and the setting of posterior condyle resection) and Flexion gap 2 were significant in distance (p<0.001), but not in tilt angle.



The amount of gap increase was not significant between extension gap and flexion gap. Regression analysis showed statistically significant relationship between the change of extension gap and the change of flexion gap (R = 0.426, p<0.001) (Figure 3).

Figure 3: Relationship between Ext and Flex Gap change (mm)

DISCUSSION:

To our knowledge, this is the first report on the influence of flexion gap preparation on both extension and flexion gap during the TKA. The current study shows that preparation of the flexion gap in PS TKA significantly increases the width of the previously prepared extension gap by 0.8 mm and flexion gap by 0.7 mm. However, the mean of increase was less than 1 mm and the amount of increase was not significant between extension gap and flexion gap. Therefore, flexion gap preparation does not disturb the modified gap technique in terms of the making equal extension and flexion gap.

Although flexion gap preparation did not significantly change the flexion gap rotation (0.1 degrees internal rotation), but significantly changed the extension gap tilt (0.7 degrees valgus). To make rectangular extension and flexion gap, extension gap should be prepared slightly varus before flexion gap preparation.

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