The Correlation between the Insert Thickness and the Joint Gap with a Tensor in Unicompartmental Knee Arthroplasty

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Disclosures:

Introduction: There have been numerous advances in unicompartmental knee arthroplasty (UKA) instrumentation and cement fixation techniques that have led to an increase in the survivorship of UKA in the past decade [1, 2]. The success of UKA relies greatly on proper soft-tissue tensioning to obtain a balanced extension-flexion gap and varus-valgus stability [3]; however the soft tissue balance during UKA is still dependent on surgeon ability and experience. Recently, a tensor that is designed to assess soft tissue balance during UKA has been developed [4]. The purpose of this study was to compare the ‘component gap’ throughout the range of motion between four different distraction forces. Secondly, given the data obtained, the correlation between the ‘component gap’ and the insert thickness selected was also examined to explore the appropriate distraction force.

Methods: 28 cases of 27 patients (18 female and 9 male) were included. The inclusion criteria is radiographic diagnosis of isolated medial compartmental osteoarthritis or idiopathic osteonecrosis, fixed flexion deformity of less than 5 degree, an active range of motion (ROM) over 90 degree, and less than 15 degree of varus deformity. The mean age was 71.8±8.5 years old (range: 58-85), and the average coronal plane femorotibial angle (FTA) was 181.2±3.2 degree preoperatively. All the patients received a conventional medial Zimmer Unicompartmental High Flex Knee System (Zimmer Inc, Warsaw, Ind).

UKA Tensor
The UKA tensor consists of three parts: an upper seesaw plate, a lower platform plate with a spike and an extra-articular main body (Fig. 1A). Both plates are placed at the medial compartment of the knee (Fig. 1B). This device is ultimately designed to permit surgeons to measure the joint medial compartment/joint component gap, while applying a constant joint distraction force. Joint distraction forces ranging from 10lb (4.5 kg) to 40lb (18.2 kg) can be exerted between the upper and lower plates through a specially made torque driver which can change the applied torque value (Fig. 1C). By measuring the distance at a constant joint distraction force, joint medial compartment/joint component gaps can be measured.

Intraoperative Measurement
After inflating the tourniquet to 280mmHg, a limited medial para-patellar approach was performed. Then a proximal tibial osteotomy was performed first ensuring that bone cut was made perpendicular to the mechanical axis in the coronal plane and with 7 degree of posterior inclination along the sagittal plane. Following the tibial osteotomy, a distal femoral osteotomy was performed first ensuring that bone cut was made perpendicular to the mechanical axis in the coronal plane and with 7 degree of posterior inclination along the sagittal plane. Following the tibial osteotomy, a distal femoral osteotomy was performed and the tensor was placed as its lower platform was fixed to the proximal tibia while the upper plate was fitted to the medial femoral component. During the measurement, the medial parapatellar arthrotomy was temporarily repaired and thigh and knee were aligned in the sagittal plane to eliminate the external load on the knee. The joint gap (mm) between the tensor and the femoral trial prosthesis was measured and defined as the ‘component gap’. The ‘component gap’ (mm) was measured at 0 (full extension), 10 (extension), 30, 45, 60 (mid-range of flexion), 90 (flexion), 120 and 135 (deep flexion) degree of knee flexion with 10, 20, 30, and 40lbs. distraction force respectively.

Statistical Analysis
The data were expressed as a mean±standard error of the mean (SE). For comparing the parameters in the ‘component gap’ between each angle, the paired Student t test was applied. Pearson’s correlation coefficient was used to analyze the relationship between the ‘component gap’ and the insert thickness. Data analyses were performed using PASW Statistics 21 (SPSS, Chicago, IL). Statistical significance was accepted at p<0.05.

Results: The ‘component gaps’ increased in proportion to the increase of distraction force and showed similar gap kinematics with four different distraction forces. The ‘component gap’ decreased significantly during full extension (10 to 0 degree of knee flexion) with each distraction force (p<0.001, respectively). The ‘component gap’ increased toward 30 degree of knee flexion, then kept the value until 135 of knee flexion (Fig 1).

The mean value of the insert thickness was 9.0±1.0mm. The insert thickness was strongly correlated with the ‘component gap’ of 10, 30, 45 degree of knee flexion with over 20 lbs distraction force. (20lbs distraction force; r=0.803, 0.845, 0.802, 30lbs distraction force; r=0.870, 883, 0.831, 40lbs distraction force; r=0.819, 0.860, 0.829 at 10, 30, 45 degree flexion, respectively) (Fig 2).
Discussion: The ‘component gap’ was significantly decreased during full extension (from 10 to 0 degree of knee flexion) with each distraction force. The decreased gaps during full extension were thought to be due to the posterior slope of tibial osteotomy. In this study, the posterior slope was planned to be 7 degree to tibial bone axis in the sagittal plane according to the implant design. The posterior slope of tibial osteotomy resulted in the smaller gap at full extension compared to 10 degree of knee flexion.

The insert thickness in UKA was strongly correlated with the ‘component gap’ of 10 degree to mid-range of knee flexion compared to at full extension. These results suggested that the ‘component gap’ not at full extension but at 10 degree to mid-range of knee flexion with this tensor assisted surgeons to make the selection of insert thickness during UKA. In addition, the insert thickness in UKA was also strongly correlated with the ‘component gap’ at over 20lbs compared to 10lbs. These results indicated the ‘component gap’ of 10 degree of knee flexion to mid-range of flexion with at least 20lbs distraction force is necessary to have a strong correlation with the insert thickness.

A major limitation of this study is the lack of clinical or functional outcomes in this patient cohort; the study was intended to measure the intraoperative soft-tissue balance during UKA and examined the correlation of the ‘component gap’ with insert thickness. Certainly, long-term studies on the outcomes of UKA in this series are needed to delineate a possible advantage of the measurement of this tensor. Second, one prosthesis of UKA was examined in this study. Different prosthetic designs may afford varying results in the ‘component gap’.

Significance: The ‘component gap’ was increased in proportion to the increase of distraction force and showed the similar kinematic pattern with the different distraction forces. The ‘component gap’ of 10 degree of knee flexion to mid-range of flexion with at least 20lbs distraction force is a promising indicator for surgeons to make the selection of insert thickness during UKA.

Acknowledgments: no support was received
