

Alignment changes after fixation of implant and re-registration in imageless navigated total knee arthroplasty

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Introduction: The accuracy in coronal alignment in total knee arthroplasty (TKA) is one of very important factors for success of TKA because it results in better knee function. The potential inaccuracy of alignments in imageless navigated TKA can be caused by various factors including the change of anatomical landmarks, registration process, and so on. The purpose of study is to evaluate the change of femoral coronal alignment after implant fixation and anatomical re-registration and compare the alignments between angles by navigation and postoperative images, and find out the possible cause of it.

Materials & Methods: In thirty two consecutive knees (Male: Female = 1: 31 knees), total knee replacement arthroplasty for primary osteoarthritis (Kellgren – Lawrence grade 3 or over and with clinical symptom by osteoarthritis) was performed with imageless navigation system. After implant fixation through routine procedures including initial registration, femoral coronal alignment was checked (Angle I). Then, femoral anatomical landmarks were registered again (re-registration) and femoral coronal alignment was rechecked (Angle R). We compared two femoral coronal alignments after implantation, Angle I by initial registration and Angle R by re-registration. Then, we measured the degree of varus change after re-registration. For finding out the cause of varus change in coronal alignment, we evaluated the degree of lateral displacement of distal femoral center on intercondylar notch by measuring the relative distance from lateral epicondyle to the femoral center on full length standing anteroposterior radiograph in lower extremity, preoperatively and postoperatively. The coronal varus angle of femur based on mechanical axis was measured in postoperative plain radiograph and reconstructed images from computed tomography by using three-dimensional (3D) imaging software which can do multiplanar reconstruction. The relationship between femoral coronal angles and postoperative alignments were analyzed by paired samples T - test. The relationship between degree of coronal change and that of displacement in femoral center was done by Spearman correlation. P values of less than 0.050 were significant.

Results: Angle I was varus $0.2^\circ \pm 1.2^\circ$ (from varus 2° to valgus 3°), but after re-registration, Angle R changed to varus $1.9^\circ \pm 1.7^\circ$ (from varus 7° to valgus 1°) with significant difference ($p < 0.001$). The degree of change by re-registration ranged from varus 5° to valgus 1° and 6 knees (19%) were varus 3° and more. The degree of lateral displacement of distal femoral center was mean 1.5% (from -1.8% to +6.8%) and 8 knees (25%) were 3.0% and above. The varus change in the femoral alignment was correlated with the lateral displacement of the distal femoral center significantly ($p = 0.018$, $r = 0.429$). The coronal varus angle of femur was varus $1.0^\circ \pm 1.9^\circ$ (from varus 4° to valgus 3°) in postoperative imaging, and varus $1.1^\circ \pm 1.7^\circ$ (from varus 4° to valgus 2°). Both of two angles were different from Angle I and Angle R, and existed between Angle I and Angle R, but there was no significant difference between angles in two postoperative imaging studies ($p > 0.050$). Angle R and postoperative coronal varus angles by plain radiograph and CT all showed a significant much number of outliers (varus 3° and more, valgus 3° and more), compared than the group of Angle I (12 knees in Angle R, 10 knees in plain radiograph, 8 knees in CT versus one knee in Angle I).

Discussion & Conclusion: The results showed postoperative alignment can be different from the alignment based on registration done at the beginning of total knee procedure. The coronal alignment have changed to more varus after implantation and re-registration. Lateral displacement of distal femoral center was correlated with varus change in alignment. The results show postoperative

alignment can be different from the alignment based on registration done at the beginning of total knee procedure. Surgeon should consider that alignment that imageless navigation say based on initial registration may not be the final alignment.