Image-free navigation is effective in conversion of high tibial osteotomy to total knee arthroplasty

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Introduction: Previous studies have suggested that conversion of high tibial osteotomy (HTO) to total knee arthroplasty (TKA) is more difficult than primary TKA. Difficulties in conversion include the presence of proximal tibial deformity, contracted lateral capsular and ligamentous structures with medial laxity, and patella baja. To achieve appropriate bony alignment and soft tissue balance, an image-free computer navigation system was used to perform 6 conversions from HTO to TKA. The purpose of this study was to examine the effectiveness of the image-free navigation system in conversion of HTO to TKA.

Materials & Methods: An image-free computer navigation system (OrthoPilot Ver. 4.2, B/Braun, Aesculap) was used for all conversion procedures in this study. There were 6 knees in 5 patients consisting of 1 male and 4 females with an average age of 65.2 years (range 60-78 years) who underwent the conversional TKA with use of a cemented posterior cruciate-retaining prosthesis (e.motion, B/Braun, Aesculap). Before conversional TKA surgery, 3 knees had undergone a closed-wedge osteotomy while the remaining 3 knees had an open-wedge osteotomy performed. The average femorotibial angle was 169.5º (range 155-174º) and the lower extremity in a valgus alignment of 4.3º (range -3º to 20º) before conversion. The average interval of HTO to conversional TKA was 6.8 years (range 3 to 11 years). The mean follow-up period was 2.9 years (range 2.1 to 5.0 years).

Results: The mean operating time for conversional TKA was 119.8 minutes (range 70 to 144 minutes). Some difficulties were encountered during conversion surgery including difficult eversion of the patella in 3 knees, snipping of the quadriceps was required for 1 knee, medial patellar retinacular release was required for 2 knees. The lower extremity alignment after lateral approach was 4.0º in 0º of knee flexion. Valgus angle was corrected to 0.8º with valgus stress. However, when varus stress was applied at 90º of knee flexion the mechanical angle deviated from neutral by 4.5º valgus. Soft tissue release was required of all knees, including 4 iliotibial band release and 2 requiring both iliotibial band and lateral collateral ligament release. The medial-lateral joint gap difference after tibial osteotomy was 1.5mm with the gap wider laterally at both 0º and 90º of knee flexion. After femoral osteotomy, medial resultant joint gap was 0mm at 0º of knee flexion but over-tightness (-0.3mm) remained on the lateral side. The lateral resultant joint gaps at 90º of knee flexion were 2.7mm on medial side and 3.3mm on lateral side, respectively. The final lower extremity alignment after implant replacement was 1.2º of valgus angle at 0º of knee flexion and 0.3º of valgus at 90º of knee flexion. After conversional TKA, mean femorotibial angle was 174.0º (range 172º to 174º) and lower extremity alignment was 0.5º (range -1º to 1º) of valgus. The mean Japanese Orthopedic Association score improved from 50.0 (range 40 to 65) before TKA to 80.8º (range 65 to 90) after TKA.

Discussion: There are various studies on the correction of soft tissue balancing on TKA for valgus knees. Fiddian et al. reported a modified lateral capsular approach to soft tissue balancing for valgus knees. We also chose the lateral approach in which both surgical exposure and soft tissue release of lateral side could be achieved simultaneously.

With the Orthopilot image-free computer navigation system, simulations of femoral osteotomy and soft tissue balance are possible intraoperatively and may be useful for acquisition of appropriate soft tissue balance. During the planning stage, the quantity of required femoral osteotomy, varus and valgus angles, rotation angle, suitable component and insertion size can be changed to acquire the appropriate joint gap, and this also ensures that there is no medial looseness when the gap position is finalized. If soft tissue release is insufficient, the tight side can be released further by measuring gap width and releasing soft tissue cautiously and progressively to obtain optimal soft tissue balance. If gap imbalance is still a problem, it can be adjusted with femoral osteotomy with the sacrifice of the mechanical angle.

From these results, we obtained satisfactory mechanical alignment and soft tissue balance with the use of image-free computer navigation. Navigation data revealed lateral looseness at the time of joint gap measurement at full extention before femoral osteotomy. However, the amount of osteotomy was profound not only on the tibial side but also on the femoral side, which caused a slight medial looseness overall. Therefore, selection of the lateral approach, which causes minimal invasion of the medial supporting tissue, is a logical procedure. Furthermore, simulation of femoral osteotomy was effective in achieving appropriate soft tissue balance.

Conclusion: Good mechanical alignment and soft tissue balance was obtained for successful HTO conversion to TKA, performed with the lateral approach and using image-free navigation.