Radiographic evaluation of the accuracy of bony resection in the robotic TKA in Asian population

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INTRODUCTION: Total knee arthroplasty (TKA) has been reported that it has long sufficient clinical results for the treatment of severe knee osteoarthritis (OA). To obtain better clinical results and knee kinematics of TKA, accurate bony resection and normal joint gap reproducibility are needed. In the knees of severe valgus or varus deformity, in post-traumatic knee OA, in subjects of severe obesity, and in the revision surgery, it is sometimes difficult to perform accurate bony resection and obtain better joint gap by the manual surgery. Recently, robotic assisted TKA has been investigated [1]. In the robotic TKA, it has been believed that surgeons can perform accurate bony resection with pre-operative planning and proper joint gap can be known before bony resection. However, as the robotic TKA is a newly investigated technique, the accuracy of the bony resection for the small knees of Asian population has not been well investigated. The purpose of this study was to evaluate the accuracy of the bony resection in the robotic TKA for the treatment of knee OA in the Asian population. The hypothesis of this study was that the robotic TKA could resect the bone accurately with the pre-operative planning.

METHODS: Twenty-one (21) subjects (17 female and 4 male: average age 78.7 ± 9.1), were included in this study. Pre-operative diagnosis was knee osteoarthritis more severe than Kellgren-Lawrence grade III. Exclusion criteria were, history of knee surgery, history of knee trauma, and diagnosis except for knee OA, such as rheumatoid arthritis or knee osteo-necrosis. All surgery were performed by a single surgeon (K.S.) with robotic assistance (CORI, Smith and Nephew, Co., Ltd, Boston MA, USA). Journey II BCS-TKA (Smith and Nephew, Co., Ltd, Boston MA, USA) was used for all subjects. Firstly, registration was performed using the markers those rigidly fixed to the distal femur and proximal tibia following the company's manual. Joint surface was mapped, and femoral and tibial joint center, medial and lateral malleolar of the ankle were plotted. In the pre-operative planning, implant placement and the amount of bony resection were determined to reproduce native joint gap through the range of knee motion. In the coronal plane, when suitable joint gap was reproduced, tibial bony resection was planned to be 2° varus, and the femoral bony resection was planned to reproduce the mapped femoral articular surface. In the sagittal plane, bone resection was performed to reproduce native posterior tibial slope. Within 3 weeks after surgery, knee radiographic evaluation was performed. Both in accurate coronal and sagittal knee radiograph, tibial component of varus/valgus alignment, posterior tibial slope angle, and the lateral distal femoral angle (LDFA) were evaluated (Figure 1). Statistical analysis was performed to compare the varus/valgus angle, posterior slope tibial implant alignment, and LDFA between pre-operative planning and post-operative knee radiograph (Mann-Whitney's U test).

RESULTS SECTION: In the coronal plane, pre-operative planning of the tibial component' varus angle was $1.8\pm1.2°$ (range: 0-3°), and post-operative radiographic component' varus angle was $1.9\pm1.1°$ (range: 0-4°). No significant difference was observed between pre-operative planning and post-operative radiographic evaluation. In the sagittal plane, pre-operative planning of the tibial component' posterior slope angle was 4.5±1.3° (range: 3-6°), and post-operative radiographic component' varus angle was 3±1.3° (range: 1-6°). Post-operative radiographic evaluation of tibial posterior slope angle was significantly smaller than pre-operative planning (p<0.001) (Figure 2). Pre-operative planning of LDFA was 83.7±1.8° (range: 81-87°), and the post-operative radiographic measurement of LDFA was 81.5±1.7° (range: 77-85°). Post-operative radiographic evaluation of LDFA was significantly smaller than pre-operative planning (p<0.001) (Figure 3). Considering that every standard deviation of data was approximately 1°, subjects under 1° difference between pre-operative planning and post-operative evaluation were regarded as accurate resection group and others were regarded as non-accurate resection group. In the coronal plane of tibial component, 20 subjects were included to the accurate resection group. On the other hands, in the sagittal plane of tibial component, only 9 subjects were included in the accurate resection group. For the femoral component, 6 subjects were included in the accurate resection group.

DISCUSSION: The most important findings of this study were, bony resection in the robotic TKA showed high accuracy in the coronal plane of tibia component, however, the accuracy were relatively low in the sagittal plane of tibial components' posterior slope angle and femoral component's LDFA. Considerable reason of the result is, in the robotic TKA, bony shape is monitored mainly by the joint surface mapping. However, in this surgical method, mapping of the posterior part of the tibia plateau is relatively difficult because of the remaining distal part femoral bone. For the femoral component, the existence of bone cement would be affected to the LDFA difference. To obtain higher accuracy of bony resection, more detailed joint surface mapping, and the consideration of bone cement amount would be needed.

SIGNIFICANCE/CLINICAL RELEVANCE: For clinical relevance, bony resection accuracy of the robotic TKA for the Asian population was showed in this study. Although, high accuracy was showed in the coronal plane of tibia component, the accuracy in the sagittal plane of tibia component, and coronal plane of femoral component were relatively low. Surgeons should pay attention to perform careful joint surface mapping especially on the posterior part of tibia, and the existence of bone cement amount should be considered when they perform robotic TKA.

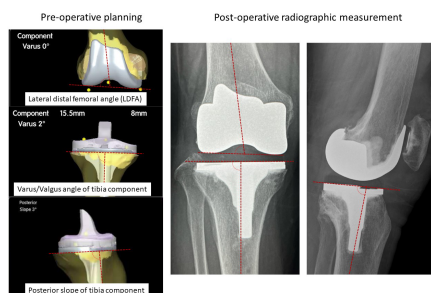REFERENCES: [1] Adamska et al. Medicina (Kaunas) 2023.
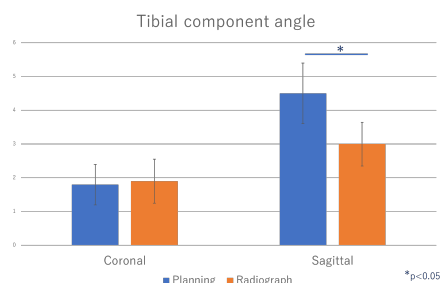
Figure 1.

Figure 2.

Figure 3.