A comparison of intra-operative laxity and clinical outcomes in single-radius versus multi-radius femoral design for total knee arthroplasty

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Introduction: To reproduced the accepted anatomic femoral shape, the femoral components of total knee arthroplasties (TKA) often have a J-shaped radius of curvature in which the sagittal plane geometry of the femoral component has a large radius anteriorly, which gradually reduces posteriorly. TKA procedures are being offered to a younger population, who desire a higher level of function in addition to pain relief. Therefore, newer knee designs must not only match the excellent survivorship of existing implants, they should also offer improved functional performance without adverse biomechanical effects. During implantation, the surgeon must balance the knee by a combination of alignment and ligament tensioning to ensure stability; this is usually established at only 0° and 90° of knee flexion. However, there may sometimes be an intermediate arc of flexion where the ligaments are more slack, leading to ‘‘mid-range instability’’ with the multi-radius prostheses. Knee arthroplasty prostheses with a single-radius femoral component design were introduced in an attempt to more accurately reproduce the kinematics of the natural knee. This design has been associated with improved extensor mechanism function and increased functional stability in total knee arthroplasty. One of advantages of single-radius femoral design was to offer better ligament stability based on a maintained isometry of extensor muscle during the whole range of motion. The purpose of this study was to compare intraoperative varus-valgus laxities from 0° to 90° of flexion in patients that received TKA using either a single-radius femoral design or multi-radius femoral design. We also compared the short-term results between two designs.

Materials and Methods: One hundred-fifteen patients, who were awaiting unilateral TKAs, were enrolled into this study. The 115 knees were allocated alternatively to either a single radius femoral design TKA or a multi-radius femoral design TKA group. 56 TKAs was performed by a single radius femoral design (Scorpio NRG, SR group) and 59 TKAs was performed by a multi-radius femoral design (Zimmer NexGen, MR group), both with a minimum of 1-year follow-up. We measured and compared intra-operative varus-valgus laxities at 0°, 30°, 60°, 90° of flexion using the navigation system (Orthopilot, Aesculap, Tuttlingen, Germany) and manual force between the 2 groups. A series of clinical outcomes were evaluated and compared at the time of the latest follow-up including HSS scores, WOMAC scores, VAS score during stair climbing.

Results: The mean total varus-valgus laxities in both groups were significantly less at 0° of flexion(3.2 ± 1.5° in SR group and 3.5 ± 1.8° in MR group) than other selected flexion angle (p=0.011); but the difference was not significant between 2 groups (p=0.062). At 30°, 60° of flexion, the mean total varus-valgus laxities in SR group (6.2 ± 3.5° at 30° of flexion and 6.8 ± 1.5° at 60° of flexion) were significant less than those in MR group (9.2 ± 4.3° at 30° of flexion and 8.3 ± 3.8° at 60° of flexion) (p=0.027 and p=0.042, respectively). In the clinical results with a minimum of 2 year follow-up, we could not find any significant differences between two designs in terms of ROM, HSS, WOMAC and VAS scores during stair climbing.
Conclusion: The single-radius femoral designs for TKA showed evidently less intra-operative mid-flexion stability compared with the multi-radius femoral design. However clinical outcomes revealed no other significant dissimilarity on HSS, WOMAC scores and VAS scores during stair climbing.