Clinico-radiological analysis of outcomes of total knee arthroplasty with a unique technique of gap balancing using navigation assistance

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Introduction: As advancements are made in the field of total knee arthroplasty (TKA) with respect to the instrumentations, implants, surgical techniques and use of computer assistance in the form of navigation and robotics (CAS or computer assisted surgery), the indications for TKA continue to expand and functional expectations continue to rise. However the most important factors affecting the outcome of a TKA, probably more than the type of implant and instrumentation or the use of CAS, is restoring the mechanical axis and achieving optimum soft tissue balance in both flexion and extension. Achieving the correct soft tissue balance requires achieving a balanced gap in both flexion and extension. Debate still exists on the method of choice in achieving optimal flexion gap balance and thereby flexion stability with opinions divided between both the measured resection technique and the gap balance technique. A major fallacy cited with respect to the gap balance technique is that no consideration is given to the coronal and rotational alignment of the femoral component. We present a unique technique of total knee arthroplasty using the modified gap balance method using navigation which can achieve optimal soft tissue balance, and at the same time maintain acceptable coronal and rotational orientation of the femoral component, and present the clinico radiological outcome of this technique.

Materials and Methods: Eighty-eight patients (112 knees) who underwent TKA using the modified gap balancing technique for osteoarthritis and followed up for at least 4 years were included for this prospective study. Mean follow-up duration was 52.8 months (range, 48–58 months). Orthopilot Version 4.0 or 4.2 (Aesculap, Tuttingen, Germany) navigation systems were used in all cases. Total knee arthroplasties were performed using the cruciate retaining E-motion prosthesis (B. Braun Aesculap). All procedures were performed using the navigation-assisted modified gap balancing technique. After bony resection, flexion-extension gaps were checked at 0° extension and 90° flexion using V-STAT tensor device (Zimmer). Depending on the difference between the flexion and extension gaps obtained on navigation we classified the patients into two groups. Group 1 was the balanced group in which the difference in the flexion and extension group was within 3mm. Group 2 was the unbalanced group in which the difference of extension and flexion gap exceeded more than 3mm. All patients were evaluated for their clinical outcome in terms of improvement in their clinical scores that is HSS, KSS and WOMAC scores and range of motion (ROM). For radiological outcome, we analyzed the post-operative mechanical axis in coronal and sagittal plane and lift off angle and condylar twist angle calculated on modified axial radiograph. The lift off angle is the angle between the posterior condylar line and the line drawn parallel to the tibial base plate. Positive lift of angle value indicated that the lateral gap was larger than the medial gap. Condylar twist angle defined as the angle between the posterior condylar line and the clinical epicondylar axis.

Results: The mean intra-operative extension gap was 20.6 ± 2.2mm and the mean flexion gap was 20.8 ± 2.9mm in balanced group (103 cases of 112 cases, 91.9%). Unbalanced group (9 cases of 112 cases, 8.1%), 8 cases showed extension tight result and 1 case showed flexion tight result. At the final follow-up, balanced group showed better clinical results than unbalanced group. In the balanced group, the final follow-up total knee score was 94.7 ± 4.7 in the HSS system and 19.6 ± 6.2 in the WOMAC system. In the
unbalanced group, the final follow-up total knee score was 92.9 ± 12.1 in the HSS system and 19.8 ± 7.2 in the WOMAC system. KS pain score was 51.8 ± 14.2 in the balanced group and 51.6 ± 17.1 in the unbalanced group. KS function score was 90.9 ± 14.3 in the balanced group and 88.0 ± 18.6 in the unbalanced group. But, no significant difference was found in terms of HSS, WOMAC and KS scores. ROM was not significant between the groups at final follow-up. Lift off angle greater than $1.0^\circ$ occurred more frequently in conventional group. Lift off angle were 0.5 ± 0.2° in balanced group and 0.8 ± 0.5° in unbalanced group. There were no statistical differences in the mean values. Condylar twisting angle were 2.6 ± 1.6° in balanced group and 3.0 ± 1.2° in unbalanced group. And, there was no significant differences in the mean values.

Conclusion: In conclusion, navigation was found to provide information about the amount of bone cutting required based on initial gap differences. In addition, we found that navigation provides an effective means of achieving rectangular flexion-extension gaps during TKA performed using the navigation-assisted modified gap balancing technique.