Soft tissue balancing using a navigation system with an offset type tensor in cruciate-retaining and posterior-stabilized total knee arthroplasty

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Introduction: Despite the success of manual total knee arthroplasty (TKA), a common difficulty in the manual procedure is obtaining accurate intra-operative soft tissue balancing, which surgeons traditionally address through "subjective feel" and experience. The measurement of soft tissue balance has been performed in an unphysiological knee condition, without the femoral component in place and with the PF joint in reduction. Knee instability after primary TKA due to inadequate correction of soft tissue imbalances is considered an important factor in early TKA failure. Therefore, a new tensor has been developed for TKA that enables assessment of soft tissue balancing throughout the range of motion in the knee with reduced PF joint and femoral component in place. This tensor permits intra-operative reproduction and post-operative alignment of the PF and tibio-femoral joints. The design of this tensor, the initial intra-operative soft tissue balance measurement, and its clinical relevance in TKA were previously described [1-3]. In previous studies, soft tissue balance measurements were performed only using the measured resection technique. In the series of the studies, the pattern of soft tissue balance differed between cruciate-retaining (CR) and posterior-stabilized (PS) TKA [4, 5]. Therefore, the purpose of the present study was to clarify the hypothesis that the pattern of soft tissue balance differs between CR and PS TKA even when using the gap technique.

Materials & Methods: One hundred and forty-one TKAs - 98 CR and 43 PS TKA (e-motion. B. Braun Aesculap, Germany) - were performed in varus type osteoarthritic patients using a CT-free navigation system (Orthopilot 4.2. B. Braun Aesculap, Germany). An offset type TKA tensor designed to facilitate soft tissue balance measurement throughout the range of motion with a reduced and repaired patello-femoral joint and femoral component in place was used with the tibia first gap technique to balance soft tissues (joint component gap and ligament balance) at 0, 10, 30, 60, 90 120 degrees of flexion.

Results: In assessment of the joint component gap, the gap value in CR TKA showed a significant increase to 30 degrees of flexion, consistent during mid-range flexion and a significant decrease during deep knee bend. However, the gap value in PS TKA showed a significant increase to 60 degrees of flexion and decreased during deep knee flexion ($p<0.05$). In the comparison of CR and PS TKA, the gap in PS TKA showed a significant larger value compared to that in CR TKA at 60, 90, and 120 degrees of flexion ($p<0.05$).

In the assessment of ligament balance, varus angle in CR TKA gradually increased to 60 degrees of flexion and then decreased at deep knee flexion. However, the varus angle in PS TKA showed a gradual increase at deep knee flexion. In the comparison of CR and PS TKA, the varus angle in PS TKA showed a significantly larger value compared to that in CR TKA at 90 and 120 degrees of flexion ($p<0.05$).

In CR TKA, joint component gap and varus ligament balance showed no significant differences between extension and flexion. When both differences within ± 3mm joint component gap and ± 3° ligament balance between extension and flexion were defined as equalized rectangular gaps, 71. 4% of CR TKAs (70/98) met the criteria. However, in PS TKA, joint component gap and varus ligament

balance at flexion showed significant larger values compared to extension. According to the above mentioned definition of equalized rectangular gaps, only 32.6% of PS TKAs (14/43) met the criteria.

Discussion: Both types of prosthetic implant showed similar patterns of soft tissue balance throughout the range of motion, while PS TKA showed larger values especially from mid-range to deep flexion compared to CR TKA. In the previous study with the measured resection technique, the intra-operative soft tissue balance differed between CR and PS TKA [4, 5]. As expected, even with the gap technique, the pattern of intra-operative soft tissue balance differed between CR and PS TKA. The advantage of the measured resection technique is recognized as the preservation of joint line by avoiding excessive release of medial structures. In the procedures with the measured resection, to this end, residual lateral ligament laxity tends to be allowed. In contrast, with the gap technique, focusing on an adjustment of varus/valgus ligament balance sometimes results in excessive release of medial structures to equalize the lateral laxity and the use of thicker polyethylene insert. Interestingly, the present study which had the same concept as the measured resection technique of avoiding joint line elevation and allowing residual lateral ligamentous laxity, demonstrated that soft tissue balance with the tibia first gap technique had a similar pattern to the previously reported measured resection technique in both CR and PS TKA [4, 5].

Conclusion: Using the tibia first gap technique with the tensor allows appropriate soft tissue balancing especially in CR TKA.

References

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