Joint line elevation would lead to excessive increase of knee stiffness in revision TKA

1Lin, K J; 2Huang, C H; 1Chen, W C; 1Chung, T W; 1Lai, Y S; +1Cheng C K
1National Yang Ming University, Taipei, Taiwan, 2Mackay Memorial Hospital, Taipei, Taiwan
Senior author ckcheng@ym.edu.tw

ABSTRACT INTRODUCTION:
The effect of joint line position on the clinical outcome after total knee arthroplasty (TKA) is controversial, particularly for revision TKA. Joint line elevation can lead to inferior results and limit knee function.1,2 Although restoration of the joint line level could be within an accuracy of 5mm, joint line elevation more than 5mm will occur during management of distal femoral bone loss with proximalization and undersizing of femoral component or other procedures. Understanding the situation after the change of joint line is critical to TKA. To our knowledge, the influence of joint line position on knee biomechanics is still unclear, particularly on collateral ligaments force. The collateral ligaments play an important role in maintaining knee stability. We investigated the effect of different joint line position on collateral ligaments force.

METHODS:
A CAD model of posterior-stabilized knee (PS knee) system (United Orthopedic Corporation, Taipei, Taiwan) was reconstructed and virtually implanted in the knee. To simulate different joint line position, the anatomical joint line position was used as a reference. A joint line distalization was simulated by distalizing both femoral and tibial components. The elevation of joint line was use of a thick insert. Then, the joint line was shift 5mm distally from the anatomical location as well as 10mm elevated (Fig 1).

To calculate the forces of collateral ligaments including lateral collateral ligament (LCL) and medial collateral ligament (MCL) at different flexion angle, a dynamic knee model used in our previous publication was utilized for kinematics analysis.3 Flexion facet centers of medial and lateral condyles in the PS knee defined the flexion axis. The motion of the femur was confined to rotate about the flexion axis. The tibia could move freely except for flexion. The analysis was carried out from full extension to 90° of knee flexion. Collateral ligaments force during whole knee flexion was recorded.

RESULTS SECTION:
For joint line level at anatomical and distalized positions, LCL force was increased as knee flexion and decreased after 60° of flexion. There was no apparent difference at LCL force between these two joint line levels. As joint line was elevated, LCL force was also increased during knee flexion and the magnitude of LCL force was significantly larger than other two joint line levels. It was raised approximately to twelve-fold of other two joint line levels at 90° of flexion (Fig 2).

MCL force also increased following knee flexion in three joint line positions. Joint line elevation resulted in greater force than other two joint line levels. At 90° of knee flexion, MCL force nearly increased by two-fold (Fig 3) of other two joint line levels.

DISCUSSION:
In several studies, joint line elevation was related to inferior clinical results even though others found no correlation between joint line elevation and clinical outcomes. It was found that joint line elevation was associated with patellofemoral problems, lower knee scores and limit knee flexion. Although literatures have shown that the clinical complications were correlated with joint line elevation, the joint line remains elevated by more than 5mm in over 36% of revision TKAs. Therefore, it is important to understand if joint lone elevation should be avoided in revised TKAs.

In our results, joint line elevation significantly increased collateral ligaments force including both LCL and MCL. It indicated that knee joint stiffness would increase due to elevated joint line. Increase of joint stiffness can improve joint stability. However, the magnitudes of both collateral ligament forces in high joint line level were considerably large. This would excessively increase joint stiffness and expose the knee to great internal loading. Konig et al,4 have reported that joint line elevation can increase contact force of knee joint. Increased joint loading has been related to the wear rate of polyethylene insert after TKA. Therefore, change of joint line position in TKA will influence the clinical outcome.

Moreover, overly stiff joint may also restraint knee motions. Chiu et al,2 revealed that joint line elevation was associated with limited knee flexion capacity.

In conclusion, collateral ligaments force was significantly increased as joint line was elevated. It will excessively increase knee stiffness and result in several complications, putting TKA into high risk. In revision TKA, joint line elevation should be prevented in order to minimize postoperative complications.

REFERENCES: