

Paper #204

Effect of Proximal Tibial Morphology on a Tibial Cut Line in Bicruciate-Retaining Total Knee Arthroplasty: An Analysis Using a Computed Tomography-Based 3-Dimensional Preoperative Planning System

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Summary:

In a set of proximal tibial cuts reproducing an anatomical posterior tibial slope in bicruciate-retaining total knee arthroplasty, patients with smaller medial tibial slope had more risk of damages of posteromedial structures of the knee because of tibial cut lines closer to semimembranosus insertion.

Abstract:

Background

Tibial cut reproducing an anatomical posterior tibial slope (PTS) is a theoretical prerequisite for physiological kinematics with bicruciate-retaining total knee arthroplasty (BCR-TKA). Therefore, in Asian population who have large PTS on average, it is hypothesized that a tibial cut line in BCR-TKA becomes posteriorly steep and has more potential risk of damage of posteromedial structures of the knee. The purpose of this study was to clarify an effect of proximal tibial morphology on the level of the tibial cut line in BCR-TKA using a computed tomography (CT)-based 3-dimensional (3D) preoperative planning system.

Methods

Consecutive fifty patients who underwent bicruciate-retaining knee arthroplasty for varus knee osteoarthritis with no tibial bone defect were included. Six of fifty patients were excluded because of lack of preoperative CT images, and remaining forty-four patients (30 females and 14 males, average 71.9 ± 6.8 years old) were retrospectively evaluated. With a use of a CT-based 3D preoperative planning system (ZedKnee®), we measured medial tibial slope (MTS) on coronal plane and medial PTS on sagittal plane in a reconstructed 3D tibial bone model. Then, we set a simulated tibial cut line neutral on coronal plane with posterior inclination same as medial PTS on sagittal plane at 9 mm below the surface of the subchondral cortical bone (i.e., 11 mm below the surface of the cartilage) of the lateral tibial plateau. Relationship between proximal tibial morphology (medial PTS and MTS) and the distance from the tibial cut line to the semimembranosus insertion (dSM) was analyzed. We defined dSM as positive value when the cut line located proximal to semimembranosus insertion.

Results

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The mean values of medial PTS, MTS and dSM were $10.7 \pm 3.2^\circ$, $5.5 \pm 1.9^\circ$ and 1.3 ± 2.2 mm respectively. There was not significant correlation between medial PTS and dSM, however, there was significant positive correlation between MTS and dSM ($r = 0.57$, $P < 0.01$). A simple linear regression was calculated to predict dSM based on MTS. A significant regression equation was found ($F(1, 42) = 20.51$, $P < 0.01$), with an R^2 of 0.33. Predicted dSM was equal to $-2.32 + 0.66 \times (\text{MTS})$.

Discussion

Contrary to our hypothesis, PTS had no significant relationship with the level of the tibial cut line at posteromedial corner of the knee in trying to reproduce an anatomical PTS. On the other hand, MTS had significant positive correlation with dSM, and this fact meant that smaller MTS resulted in higher risk of damage of posteromedial structures of the knee. Especially, it was estimated that, in the case of MTS smaller than 3.5° , care must be taken in tibial cut reproducing an anatomical PTS to avoid cutting into the semimembranosus insertion.

Conclusion

In a set of tibial cuts reproducing an anatomical PTS in BCR-TKA, patients with smaller MTS had more risk of damages of posteromedial structures of the knee because of tibial cut lines closer to semimembranosus insertion.