Preoperative prediction of gap balance based on the radiographic flexion and extension laxities in robotic total knee arthroplasty

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Introduction: To predict the flexion-extension gap balance of robotic total knee arthroplasty (TKA) preoperatively is difficult when robotic TKA underwent preoperative planning. We develop the new method to predict the intraoperative flexion-extension gap balance using varus stress radiograph during the preoperative planning. The purpose of this study is to evaluate the effectiveness of the new method to achieve balanced flexion-extension gaps in robotic TKA and to evaluate whether flexion-extension gap differences affect the clinical results of TKA.

Materials and Methods: Fifty-one osteoarthritic patients with varus deformity undergoing cruciate retaining total knee arthroplasty using Robodoc® system (Integrated Surgical Systems, Sacramento, CA) were included into this study. Patients using posterior cruciate ligament stabilized implant were excluded for evaluating intraoperative gap balance. We did preoperative planning based on the amount of lateral laxity in extension and flexion using varus stress radiograph. After complete milling by robot and soft tissue balancing, intra-operative extension and flexion gaps were measured using a tensor. Preoperative knees based on the lateral laxities at 0° and 90° flexions were divided into tight extension (≥ 2mm smaller in extension than flexion laxity), tight flexion (≥ 2mm smaller in flexion than extension laxities) and balanced (less than 2mm difference between laxities) groups. We also classified results of the intra-operative gap balance as acceptable (0-3mm larger in flexion than extension gaps), tight (larger extension than flexion gaps) or loose (more than 3mm larger in flexion than extension gaps) based on the difference between extension and flexion gaps. Clinical outcomes were assessed using Hospital for Special Surgery (HSS) scores and Western Ontario MacMaster (WOMAC) scores, which were checked preoperatively and at 1 year postoperatively.

Results: Preoperatively, 34 of 51 cases were balanced groups (≤2mm difference) between extension and flexion laxity. However, 1 cases of tight flexion and 16 cases of tight extension laxities were found. The mean intra-operative extension gap was 21.5mm (SD ±2.2) and the mean flexion gap was 23.2mm (SD ±2.9), flexion-extension gap balance was acceptable in 46 cases (90.1%) and 4 cases (7.8%) showed tight result. And one case showed loose flexion gap (>3mm). There was no significant difference was observed between 3 groups, according to preoperative laxity, in terms of preoperative and postoperative HSS and WOMAC scores. But, according to intraoperative gap balance, acceptable gap balancing group showed a significantly better HSS and WOMAC scores than tight or loose gap balancing groups at 1 year follow up.

Among them, 31 patients underwent 2 degree external rotation cutting to surgical transepicondylar axis (Group A) and 18 patients underwent 0 degree cutting to surgical transepicondylar axis (Group B) for the femoral component rotation. Their preoperative & postoperative clinical outcomes of range of motion, HSS and WOMAC score showed no significant differences between two groups. The intra-operative medio-lateral gap balance in flexion showed significant better result in Group A than Group B (p=0.03).

Conclusion: The new method for prediction of flexion-extension gap balance based on the laxity using a varus stress radiograph showed excellent agreement with intra-operative flexion-extension gap balance. Moreover, robotic TKA using 2 degree external rotation of femoral component showed better mediolateral...
gap balance in flexion. We concluded varus stress radiograph might be useful tool to predict the intraoperative gap balance and help to achieve the precise gap balance in robotic TKA.