Excessive Bone Resection Angle Outliers Following Conventional Total Knee Arthroplasty Techniques Can Be Improved With Intraoperative X-rays

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Introduction: The conventional bone resection technique in TKA is recognized as less accurate than computer-assisted surgery (CAS) and patient-matched instrumentation (PMI). With the conventional technique, outliers >3º from pre-operative planning are seen more often than with CAS and PMI and even >5º outliers are not rare. However, CAS and PMI are not available to all surgeons performing TKAs. CAS is too expensive for some hospitals and increases both the operative time and the fracture risk through a pin hole. PMI requires preoperative computed tomography (CT) or magnetic resonance imaging (MRI), which can be difficult in some hospitals. PMI also involves additional cost and time (usually several weeks) to create a patient-matched device. Furthermore, it was recently reported that PMI accuracy is not always better than that of the conventional bone resection technique. As such, most surgeons use the conventional technique for distal femur and proximal tibia resection, and efforts to improve bone resection accuracy with conventional technique are necessary. Here, we examined intraoperative X-rays after bone resection of the distal femur and proximal tibia with conventional bone resection technique. If the cutting angle was not good and the difference from preoperative planning was >3º, we considered re-cutting the bone to correct the angle.

Methods: From September 2013 until February 2014, 103 knees were included in this study. The cutting angle of the distal femur was preoperatively determined by whole-length femoral X-ray. The conventional technique with an intramedullary guide system was used for distal femoral cutting. The distal femur was usually resected perpendicular to the mechanical axis. When the distal femoral cutting angle was >8º in cases with severe lateral bowing of femur, 8º to the femoral shaft was selected as the cutting angle. Proximal tibial cutting was performed perpendicular to the tibial shaft with an extramedullary guide system in all cases. The cutting angles of the distal femur and proximal tibia were estimated by intraoperative X-ray with the lower limb in extension position and with a spacer block between the femur and tibia. When the cutting angle was >3º different from the preoperatively planned angle, re-cutting of distal femur or proximal tibia was considered. Re-cutting of the bone was performed with a posterior reference femoral posterior cutting device composed of an oblique spacer and a reference pin guide for a cutting block (Fig. 1).

Results: The subjects were 87 knees of females and 16 knees of males. The average age was 72.1 (50-87) years old. The knees required surgery due to osteoarthritis (95), rheumatoid arthritis (4), and osteonecrosis (4). The average femoral cutting angle against the femoral shaft on intraoperative X-ray was 83.5º (SD: 2.3º, 77.9-90.0º), and the angle difference from preoperative planning was 0.0º (SD: 2.1º, 7.1º valgus to 6.0º varus). The average femoral cutting angle was good; however, >3º and >5º outlier
cases were observed in 13 knees (12.6%) and 4 knees (3.9%), respectively. The average tibial cutting angle was 1.0° varus (SD: 1.9°, 3.2° valgus to 6.4° varus). Over 3° outliers were observed in 10 knees (9.7%), and >5° outliers were noted in 3 knees (2.9%). Cutting angle correction was performed in 15 knees (14.6%) on the distal femur and 13 knees (12.6%) on the proximal tibia. On the postoperative X-ray, the angle difference from the preoperatively planned femoral component setting angle was 0.1° varus on average (SD: 2.0, valgus 4.5° to varus 6.0°). Outliers >3° were observed in 13 knees (12.6%) and >5° was observed in only 1 knee (1.0%) (Fig. 2). The tibial component setting angle was 0.9° varus on average (SD: 1.6°, valgus 2.6° to varus 4.4°). Outliers >3° were observed in 10 knees (9.7%), and no cases were >5° (Fig. 3). Cases with outliers >3° were not different between intra- and postoperative estimation; however, the number of >5° outliers was decreased from 7 knees (6.8%) to 1 knee (1.0%) including both the femoral and tibial sides (p < 0.05, Chi-square test).

**Discussion:** Precise bone cutting technique is important for TKA. Several reports have mentioned its effects on clinical outcomes; however, the bone resection accuracy of the conventional technique is far from satisfactory. Some recently developed technologies for precise bone resection in TKA include CAS, PMI, and portable navigation. However, these new technologies involve additional cost and have not been clearly shown to improve accuracy. Some studies have already reported that there is no difference between PMI and the conventional technique with regard to bone resection accuracy. More studies are needed to confirm that portable navigation improves accuracy. Most surgeons currently use the conventional technique, and we think it is possible to improve bone resection accuracy with the conventional technique in TKA. Our method is simple and requires just one intraoperative X-ray. This is cost-effective and can be performed by most surgeons. Our results showed that the average angle of initial bone resection was good; however, there were some outliers. The number of >3° outlier was not changed by intraoperative X-ray and bone re-cutting; however, the number of >5° outliers was obviously decreased. Our findings indicate that a single intraoperative X-ray can reduce the number of excessive bone resection angle outliers in TKA.

**Significance:** This report indicates that intraoperative X-ray can improve bone resection accuracy with the conventional TKA technique, which is used by most orthopedic surgeons around the world.
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