Influence of pre-operative deformity on surgical accuracy and time in robotic-assisted TKA

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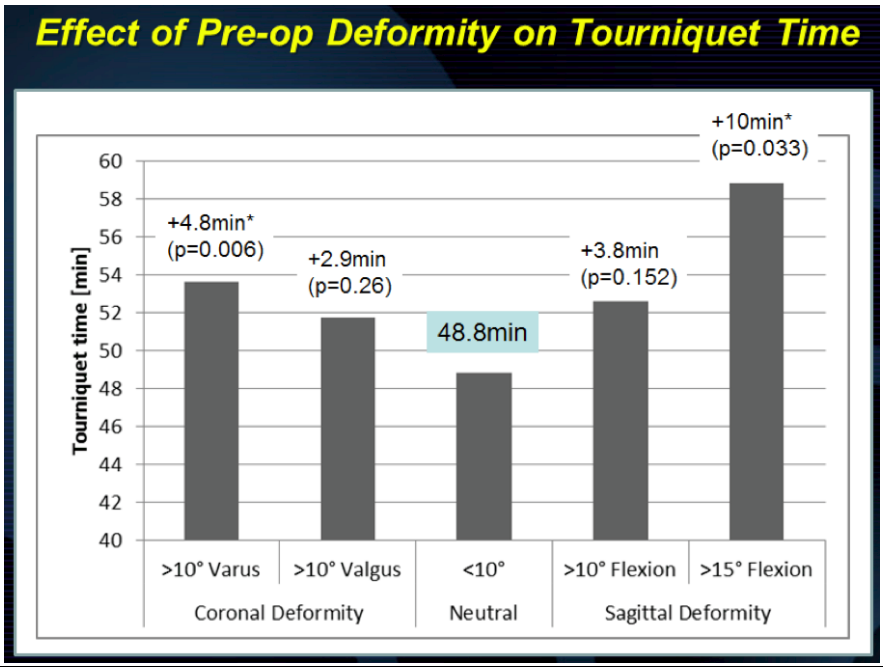
Introduction: Severe angular deformities in total knee arthroplasty require specific attention to bone resections and soft tissue balancing. These can add technical complexity and time, with some authors reporting an increase of approximately 20 minutes in mean surgery time when managing large deformities with conventional instrumentation [1].

We evaluated the utility of computer-navigation with imageless BoneMorphing® and Apex Robotic Technology (A.R.T.®) for managing large deformities in TKA. BoneMorphing® allows for real-time visualization of virtual bone resection contours, limb alignment and soft-tissue balance during TKA. A.R.T. permits accurate cutting and recutting of the distal femur in 1mm increments. We asked what effects do severe pre-operative deformities have on post-operative alignment and surgery time in comparison to knees with only mild deformities when using this system. We also measured the early knee functional outcomes of this group of patients.

Methods: This was a retrospective cohort study of 128 consecutive A.R.T. TKA's performed by a single surgeon (mean age: 71y/o [range 53–93], BMI: 31.1 [20–44.3], 48males). Patients were stratified into three groups according to their pre-operative coronal plane deformity: Neutral or mild deformity <10° (baseline group); Severe varus ≥10°; severe valgus ≥10°; and according to the degree of flexion contracture: Neutral or mild flexion from -5° hyperextension to 10° flexion (baseline group); hyperextension ≤-5°, and severe flexion ≥10°. The degree of deformity and final postoperative alignment achieved was measured using computer navigation in all patients and analyzed using multivariate regression. The APEX CR/Ultra Knee System (OMNIlife Science, Inc.) was used in all cases. A students t-test was used to compare pre- and post-operative (3- 6 months) Knee Society Scores (KSS) and Knee Functional Scores (KSSF) for all patients.



Results: Pre-operative coronal alignment ranged from 27° varus to 22° valgus. Postoperative alignment across all patients ranged from 2° valgus to 3.5° varus and from 4° flexion to -4° hyperextension.

Effect of Deformity on Alignment Accuracy: Mean post-operative alignment was 1.4° varus in the control group,

0.4° varus in the severe valgus group (p=0.004), and 1.8° varus in the severe varus group (p=0.111). Preoperative flexion, obesity, and gender had no significant effect on alignment accuracy or final extension.

Tourniquet Time: Mean tourniquet time for the control group was 48.8 minutes [95% CI: 45.3 – 52.4] (figure 1). Severe varus knees took 4.8 minutes longer (p=0.006), while valgus knees took 2.9 minutes longer (p=0.260). Flexion contractures ≥10° and ≥15° increased tourniquet time by 3.8 minutes (p=0.152) and 10 minutes (p=0.033), respectively. Tourniquet time was slightly longer in obese patients by 3.2 minutes (p = 0.048) and was 6.3 minutes shorter for females than males (p<0.001).

Knee Functional Outcomes: KSS and KSSF scores for all patients were: Pre-Op – KSS 18.7, KSSF 42.9; Post-Op (3-6 months) – KSS 97.6, KSSF 91.9. The improvement was significant (p<0.001) for both scores.

Conclusions: We have shown that in one surgeon's hands severe coronal deformities and flexion contractures can be consistently corrected to within 3-4° of neutral when using A.R.T. This was achieved by assessing the pre-resection kinematics, formulating a virtual plan, and executing and validating in real time that plan's execution. The additional time required for managing these more difficult cases using this technology was typically less than 5 minutes, which demonstrates the effectiveness of real-time navigation and robotics for TKA.

References

[1] Hernández-Vaquero D, et al. Computer assistance increases precision of component placement in total knee arthroplasty with articular deformity. Clin Orthop Relat Res. 2010 May;468(5):1237-41.