Cadaveric Results of an Accelerometer Based Pinless Navigation System for Tibial Resection in Total Knee Arthroplasty

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PURPOSE:

Total knee arthroplasty (TKA) has proven to be tremendously successful in the management of knee arthritis, but concerns still exist regarding component positioning, as a recent meta-analysis demonstrated 31.8% of TKAs performed with conventional techniques being in greater than 3 degrees of mechanical axis malalignment 1. Specifically, tibial component malposition has been shown to be present in 11.8% of TKA revisions, and varus malalignment of more than 3° increases the odds of implant failure by roughly 17 times 2,3.

Although numerous comparative studies have demonstrated statistically significant improvements in component alignment with computer-assisted surgical (CAS) techniques versus conventional intramedullary and extramedullary alignment systems, concerns over increased operative times, cost, and the learning curve associated with conversion to computer-assisted surgery has limited its widespread acceptance. The objective of this study was to analyze the accuracy and learning curve associated with the use of a hand-held, accelerometer based, extramedullary navigation system when performing a tibial resection for total knee arthroplasty. Our hypothesis is that utilization of this navigation system improves the accuracy of the tibial resection, in both the coronal and sagittal planes, while requiring a short period of time to learn to use the device.

MATERIALS & METHODS:

10 cadaveric specimens (20 lower extremities), with a mean age of 56 yrs (range: 25-77 yrs), and BMI of 23.9 kg/m² (range: 18-36 kg/m²) were included in this study. 4 orthopaedic surgeons from two separate ACGME accredited fellowship programs were asked to perform a tibial resection utilizing the KneeAlign™ system (OrthAlign Inc., Aliso Viejo, CA) for each specimen. Prior to each procedure, the surgeon was assigned a “goal” of tibial varus/valgus and posterior slope (in degrees), which they attempted to create with their resection. The goals ranged from 2° to 5° of posterior slope, and 1° of valgus to 4° of varus.

The KneeAlign™ system is a hand-held surgical navigation system, 2 x 4 x 2 inches in size, which attaches to an extramedullary tibial jig similar to conventional, extramedullary alignment systems [Figure 1]. The KneeAlign™ tibial jig is utilized to register the medial and lateral malleoli to establish the tibial mechanical axis, and once anatomic landmarking is complete, provides real-time feedback of both the tibial cutting block’s varus/valgus alignment and posterior slope. For each procedure, the time from which the surgeon was handed the device to the point immediately prior to cutting the tibia, was recorded (in seconds).

RESULTS:

Similarly, 95% of the resections were within 2 degrees of the pre-determined goal for posterior slope based on radiographic measurements. The mean difference in alignment was 0.43° ± 1.16° (99% CI -0.24°, 1.10°), while the mean absolute difference was 1.07° ± 0.59° (99% CI 0.72°, 1.41°). When measured utilizing CT, the mean absolute difference between the posterior slope and the pre-determined goal was 0.7° ± 0.47°.

A graph of the time required by each surgeon to use the KneeAlign™ system for each respective specimen is presented in Figure 2.

DISCUSSION:

Computer-assisted surgery has been shown to significantly increase the accuracy of mechanical alignment in total knee arthroplasty, yet ≤3% of TKAs in the U.S. are performed utilizing computer navigation 4,5. Tibial intramedullary (IM) and extramedullary (EM) alignment guides for performing a tibial resection remain the most common techniques used, despite one study demonstrating only 72% accuracy with the use of IM guides, versus 88% with EM guides, in obtaining tibial alignment 90° ± 2° to the mechanical axis ².

The KneeAlign™ system provides intraoperative, real-time feedback to the surgeon without having to consult a monitor outside of the operative field, while avoiding the costs of capital equipment purchases associated with large console CAS systems. In addition, it is compatible with all TKA systems, making it more user-friendly for surgeons accustomed to the use of extramedullary alignment guides, as demonstrated by the minimal learning curve required to utilize this system. Most importantly, this study demonstrates the KneeAlign™ system to be highly accurate, with these results demonstrating 99% confidence that the coronal alignment will be within 0.77° (-0.37° to 0.77°), and posterior slope within 1.10° (-0.24° to 1.10°), of the targeted alignment.

REFERENCES:


Figure 1: Image of the KneeAlign™ system (OrthAlign Inc., Aliso Viejo, CA)

Figure 2: Graph demonstrating the amount of time (in seconds) each surgeon required to use the KneeAlign™ system for each respective specimen