Can patient specific instruments-guided total knee arthroplasty deliver its proposed advantages?

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Introduction: Total knee arthroplasty (TKA) is one of the most commonly performed orthopaedic surgeries worldwide and has proven to be cost-effective and efficacious in the treatment of osteoarthritic knees. Recently, the introduction of Patient Specific Instrument-guided surgery (PSI) may represent the next forward leap in surgical technique for TKA. PSI allows "three-dimensional virtual surgery" to be performed pre-operatively to determine the ideal customization of patient-specific knee cutting jigs. These individualized cutting jigs allow precise bone resection adapted to the unique shapes and angles of the knee joint. Blood loss may be reduced and the duration of surgery is shortened, which in turn reduces the risk of infection and anaesthetic risks. PSI also offers the proposed advantage of better lower limb alignment and implant placement.

Methods: 50 patients who underwent a primary TKA at our center were prospectively randomized into two surgical technique arms. In Group 1, the patients underwent TKA using conventional techniques. In Group 2, the patients underwent TKA using PSI technique. To minimize performance bias, we ensured the learning curve of PSI-guided TKA was overcome by commencing recruitment of patients only after the mean duration of surgery of ten consecutive PSI-guided TKAs was similar to the mean duration of surgery of the first five TKAs of this same group.

The duration of surgery, length of hospital stay, post-operative drop in hemoglobin level and need for transfusion were recorded. Post-operative films were taken when the patients were able to weight-bear fully. Two reviewers blinded to the surgical method performed the measurements on the radiographic films on two separate occasions. Four radiographic measurements were recorded on the coronal films: 1) Hip-Knee-Ankle Angle (HKA); 2) Coronal Femoral-Component Angle (CFA); 3) Coronal Tibia-Component Angle (CTA). Two radiographic measurements were recorded on the saggital films: 1) Saggital Femoral-Component Angle (SFA); 2) Saggital Tibia-Component Angle (STA). The Student's unpaired t-test, Pearson Chi-Square test and Fisher's Exact test were used for statistical analysis.

Results: There was no significant difference between the two groups for age, BMI, gender and side of operated knee. The length of hospital stay was shorter in the PSI group but this was not statistically significant. The duration of surgery was 16.2 minutes shorter in the PSI group compared to the conventional group ($p<0.001$).

The HKA, CFA, CTA and STA were similar in both groups. For SFA, there was a difference of 1.74° flexion ($p=0.021$) (Table 1). Nonetheless, both the mean SFA of the conventional group (89.02° ± 2.69°) and the PSI group (87.28° ± 2.46°) lie within the acceptable range of 87° to 90° for good placement of implant.

	Conventional	PSI	P-value
HKA (°)	180.58 ± 2.91	179.22 ± 3.33	> 0.05
CFA (°)	90.68 ± 1.99	89.80 ± 2.11	> 0.05
CTA (°)	89.34 ± 1.88	89.94 ± 1.94	> 0.05
SFA (°)	89.02 ± 2.69	87.28 ± 2.46	0.021
STA (°)	85.68 ± 2.37	84.22 ± 3.59	> 0.05

There was no significant difference in the number of outliers for lower limb alignment (HKA) and implant placement (CFA, CTA, SFA and STA) for both groups ($p>0.05$). However, we found that most of the outliers for lower limb alignment (HKA) had varus deformity for the conventional group but valgus deformity for the PSI group ($p=0.007$).

Discussion: We postulate that the shorter duration of surgery could be the result of the ability to customize the patient-specific cutting jigs and determine optimal implants size pre-operatively, therefore reducing the additional time for trial implants testing intra-operatively. For good lower limb alignment and optimal implant placement, the PSI-guided technique was as accurate as the conventional technique. However, there were more outliers with valgus deformity than varus deformity when using the PSI technique. Patients with post-operative valgus deformity have slightly better implant survivorship and lower revision rate, compared to patients with post-operative varus deformity[1].

Conclusion: We could not justify the additional cost of SGD 1900 and the additional waiting time of 6 weeks before surgery. We conclude that PSI-guided TKA should not be implemented as the standard of care at this moment.

References

1. Fang DM, Ritter MA, Davis KE. Coronal alignment in total knee arthroplasty: just how important is it? J Arthroplasty. 2009;24:39-43.