

## Current concepts in total knee arthroplasty: Patient specific instrumentation

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### Abstract

Patient specific instrumentation (PSI) in total knee arthroplasty (TKA) promises faster operation time (by using less instruments and individual cutting jigs), less blood loss, faster rehabilitation, better implant sizing and accuracy, superior overall outcome, and at the end - less costs. However, as evident for every new development, its superiority remains to be proven

over the conventional systems. Whilst dissatisfaction is reported to be eminent in up to 30% of patients having undergone conventional TKA, it is unclear, whether PSI can address to these patients as a suitable option in the future. The author believes that the current evidence does not support superiority of PSI in TKA over conventional systems. However, future long-term level I and II studies might aid to show its cost-effectiveness stating same results, accuracy, and overall outcome with less operation time.

**Key words:** Total knee arthroplasty; Patient specific instrumentation; Accuracy; Outcome analysis; Cost-effectiveness

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**Core tip:** Patient specific instrumentation (PSI) in total knee arthroplasty (TKA) promises faster operation time, less blood loss, faster rehabilitation, superior implant accuracy, superior overall outcome, and less costs. However, as evident for every new development, its superiority remains to be proven over the conventional systems. Whilst dissatisfaction is reported to be eminent in up to 30% of patients having undergone conventional TKA, it is unclear, whether PSI can address to these patients as a suitable option in the future. The author believes that the current evidence does not support superiority of PSI in TKA over conventional systems.

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### INTRODUCTION

Patient specific instrumentation (PSI) in total knee

arthroplasty (TKA) was developed to reach the goal of superior component positioning and adequate sizing in less operative time<sup>[1-3]</sup>. There exist various different devices to achieve these goals; most of them include preoperative planning using MRI or CT scans to investigate bony landmarks for the use of adequate positioning of tibial and femoral cutting blocks and jigs<sup>[1-3]</sup>. The promises of PSI are less surgical time, better alignment, fewer outliers, less surgical time, less costs, and overall superior outcome for our patients<sup>[1]</sup>. Whilst dissatisfaction is reported to be eminent in up to 30% of patients having undergone conventional TKA, it is unclear, whether PSI can address to these patients as a suitable option in the future<sup>[4]</sup>. However, as evident for every new development, its superiority remains to be proven over the conventional systems and some controversies have to be discussed when it comes to PSI in TKA. New developments in TKA are often industry driven and whilst adequate component sizing is always beneficial in TKA not all presented devices are reasonable for our patients such as discussed with respect to the gender knee in the past<sup>[5,6]</sup>.

Whilst surgeons argue that PSI saves money and decreases operative time by less turnover time, less sterilization material, faster surgery, and therefore saves costs, it is essential, that the preoperative planning time might not be underestimated<sup>[7]</sup>. This factor might be outsourced but still has to be done prior to using adequate cutting blocks and jigs or similar devices<sup>[2]</sup>. It is therefore questionable, if the overall costs would really decrease over time or if the overall costs for the orthopedic setting would decrease whilst costs and work load for others included in the process of the development of these devices would increase. In addition, the aspect of intraoperative component sizing and positioning is a mandatory ability of the experienced knee surgeon. One might argue that the way to find adequate sizes and component positioning is in fact one of the major qualities of a skilled knee surgeon and therefore should not be given away to a computer and or other form of technical device<sup>[2]</sup>. However, using PSI, this is either given away by using preoperatively designed cutting blocks and jigs or it has to be re-evaluated intra-operatively using conventional methods giving away the benefit of faster surgery<sup>[8]</sup>. As evident for every new development the superiority of PSI in TKA remains to be proven over conventional systems and future long-term level I and II trials are needed in doing so.

## IMPLANT POSITIONING AND ACCURACY

Carpenter *et al*<sup>[7]</sup> investigated PSI in unicompartamental knee arthroplasty (UKA). They prospectively evaluated 30 patients undergoing UKA and performed virtual surgery in a medial and a lateral cohort resulting in 180 virtual surgeries (30 for each of 5 different brands) in total. They evaluated overhang and undercoverage and cortical rim coverage in PSI vs conventional cases

and found that PSI implants for unilateral indication provide significantly less overhang and undercoverage and superior coverage of the cortical rim compared to conventional systems.

Stronach *et al*<sup>[9]</sup> retrospectively evaluated 54 patients who had undergone conventional TKA vs PSI in TKA with respect to the accuracy of implant alignment regarding overall mechanical alignment and sagittal and coronal alignment of the femoral and tibial components. They additionally measured tourniquet time and blood loss. They found the alignment to be similar in both groups but PSI with fewer knees in the target range for posterior slope in addition to a trend for fewer knees in a target range for femoral flexion. These authors concluded that PSI showed no advantage in overall alignment but a worsening of the tibial slope.

Voleti *et al*<sup>[10]</sup> performed a meta-analysis to evaluate implant positioning in PSI vs conventional TKA and found PSI with improved accuracy in the femorotibial angle vs standard instrumentation that demonstrated improved accuracy in the hip-knee-ankle angle. They included 9 studies in total with 428 standard TKAs vs 529 PSI TKAs. They concluded that the current evidence does not support the routine use of PSI in TKA.

Conteduca *et al*<sup>[11,12]</sup> evaluated the accuracy of PSI in TKA in various studies and used an intraoperative knee navigation software during the surgical procedure in 15 patients. They found PSI not to be more accurate or adequate. These authors recommended to control every step before making the definite cuts.

## OUTCOME, OPERATIVE TIME, AND COST EFFECTIVENESS

Lionberger *et al*<sup>[3]</sup> performed a prospective study evaluating the difference of operation time with respect of implant accuracy in 60 patients undergoing TKA randomized to a group with PSI vs computer assisted surgery (CAS). They showed that the mechanical alignment was not different between both groups and that operative time was significantly decreased in PSI allowing for 3 PSI cases vs only 2 CAS cases in one 8 h operating room (OR) day. The authors concluded that the accuracy of CAS is superior to PSI and that PSI provides a slight benefit in reducing OR time.

Voleti *et al*<sup>[10]</sup> performed a meta-analysis to evaluate OR time, blood loss, and costs in PSI vs conventional TKA and found PSI with improved accuracy in the femorotibial angle vs standard instrumentation that demonstrated improved accuracy in the hip-knee-ankle angle. Differences in OR time, blood loss, and costs were not statistically significant between both groups.

Sassoon *et al*<sup>[13]</sup> performed a systematic review and found 16 studies to evaluate accuracy of the implant and 13 studies to evaluate potential cost effectiveness of PSI over conventional TKA. They found no improvement of PSI in postoperative limb or component alignment when compared to standard procedures with a positive

evidence of fewer surgical trays in PSI. In addition, they found no improved overall surgical efficiency or cost-effectiveness of PSI over TKA.

## CONCLUSION

PSI seems to allow for the same accuracy as conventional TKA or computer assisted surgery in TKA. However, accurate control of the alignment before and after the tibial and femoral cuts is recommended questioning the benefit of less operative time and therefore overall cost effectiveness<sup>[14]</sup>. The author believes that the current evidence does not support superiority of PSI in TKA over conventional systems and therefore would not recommend it as a standard in clinical practice. However, future long-term level I and II studies might aid to show its cost effectiveness stating same results, accuracy, and overall outcome with less operation time.

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