VISIONAIRE◊ Patient-Specific Instrumentation (PSI) vs conventional instrumentation in total knee arthroplasty (TKA): results from a systematic literature review and meta analysis

Summary

Compared to TKA carried out with conventional instrumentation, VISIONAIRE TKA:

- Significantly reduced the odds of an outlier in the mechanical axis by 40% (p<0.0001)
- Led to significantly more efficient operations, with reductions in operating room time (p=0.02), turnover time (p=0.022) and tourniquet time (p=0.01)
- Significantly reduced the odds of requiring a blood transfusion by more than 50% (p=0.01)

Background

Malalignment following TKA remains a challenge which is associated with reduced patient satisfaction and postoperative complications.[1–3] Patient-specific instrumentation has been developed to try to address this problem. VISIONAIRE Cutting Guides use the patient's MRI and X-rays to design cutting blocks which are specific to the patient's anatomy. VISIONAIRE PSI has been extensively published on allowing for a robust analysis through a systematic literature review and meta-analysis of multiple outcomes.

Methods

A systematic review of the literature using EMBASE, PubMed and Google Scholar was carried out to identify all VISIONAIRE studies (Figure 1).[4]

Studies were only included in the final analysis if they were written using English language, compared the clinical outcomes of VISIONAIRE TKA and conventional instrumentation and reported on alignment accuracy, intraoperative outcomes or postoperative outcomes:

- Alignment accuracy: mechanical axis outliers, coronal component alignment outliers, sagittal component alignment outliers and femoral component rotation outliers
- Intraoperative outcomes: operating room time, operating room turnover time, tourniquet time; incidence of blood transfusion and number of instrument trays
- Postoperative outcomes: incidence of postoperative complications, patient length of stay and return to function

Meta-analyses were performed on all outcomes except number of trays, operating room turnover time and return to function, due to not being a formal outcome, low number of studies and differences in reporting respectively.

The systematic literature review identified 24 studies which met the eligibility criteria and were included in the meta-analysis,[4] 11 of which were randomized controlled trials (Figure 1).

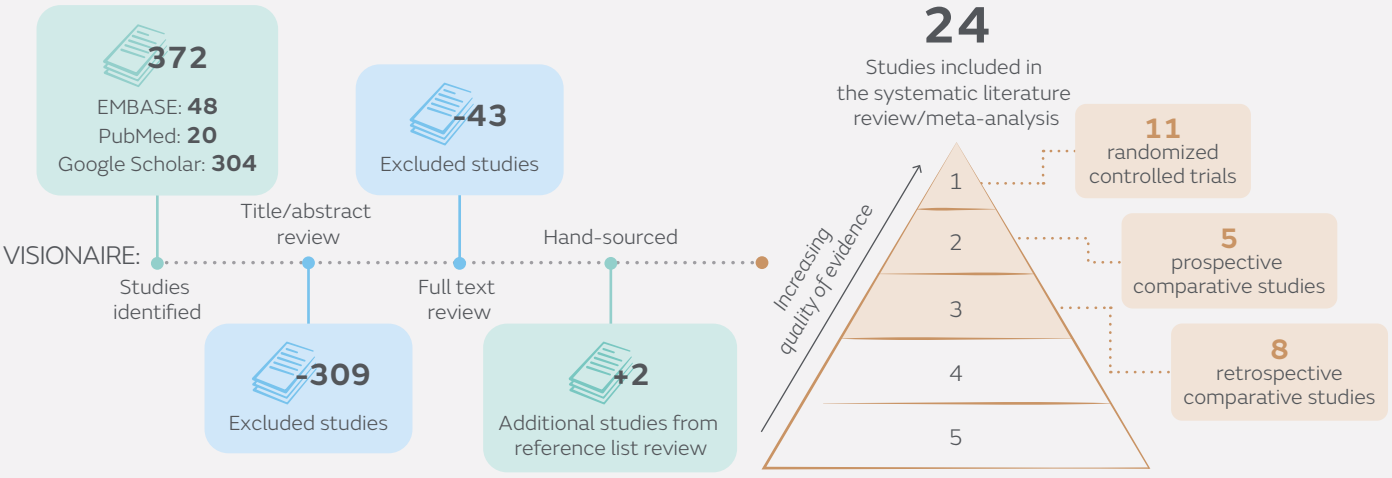

Figure 1. Search strategy and overview of VISIONAIRE TKA evidence showing number of studies by level of evidence

Results

Accuracy

- Fifteen studies reported on the number of mechanical axis outliers[5–20]
  - VISIONAIRE◊ reduced the odds of an outlier by 40% compared to conventional instrumentation (odds ratio [OR], 0.60; 95% confidence interval [CI]: 0.47–0.77; p<0.0001; Figure 2)
- Six studies reported on the number of coronal plane outliers after TKA with VISIONAIRE or a conventional technique[6–8,12,14,15]
  - There was no significant difference in the overall odds of an outlier in the coronal plane, or for the tibial or femoral component when assessed separately
- Five studies reported on the number of sagittal plane outliers[6–8,12,15]
  - There were no significant differences in overall odds of an outlier in the sagittal plane or for the tibial component when assessed separately
  - The odds of an outlier in the sagittal plane was significantly higher for the femoral component with VISIONAIRE compared to conventional instrumentation (OR, 1.88; p=0.0059)
- Five studies reported on the number of rotational component alignment outliers[6,8,12,15,29]
  - There were no significant differences between VISIONAIRE and conventional instrumentation

Intraoperative outcomes

Operating room time

- Seventeen studies reported on the length of time spent in the operating room[6–9,11–14,17,18,20–26]
  - VISIONAIRE resulted in a significant reduction in mean operating room time of 6.16 minutes (7.3% less time) compared to conventional techniques (95% CI: -0.89, -11.42; p=0.02; Figure 3)

Operating room turnover time

- One study reported on operating room turnover time[20]
  - Turnover time between cases was 42% shorter with VISIONAIRE (6.4 minutes shorter; p=0.022 ; Figure 4) than conventional techniques

Tourniquet time

- Seven studies reported on tourniquet time[8,17,20,22,23,27]
  - Mean time in tourniquet was significantly reduced by 12.94 minutes (15.9% less time) with VISIONAIRE compared to conventional instrumentation (95% CI: 3.10–22.79; p=0.01; Figure 5)

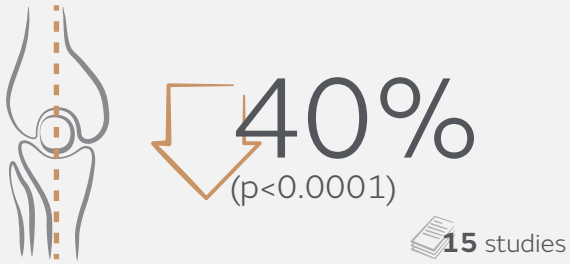

Figure 2. Reduction in odds of an outlier in the mechanical axis alignment of VISIONAIRE TKA, compared to conventional instrumentation

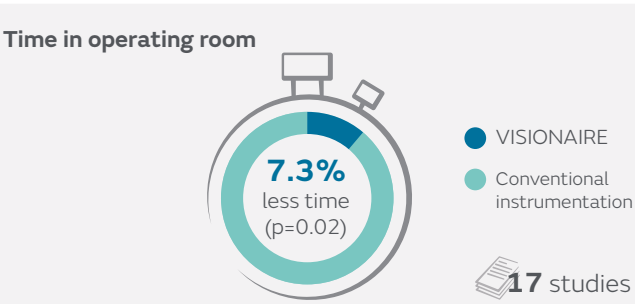

Figure 3. Percentage reduction in operating room time for VISIONAIRE compared to conventional techniques

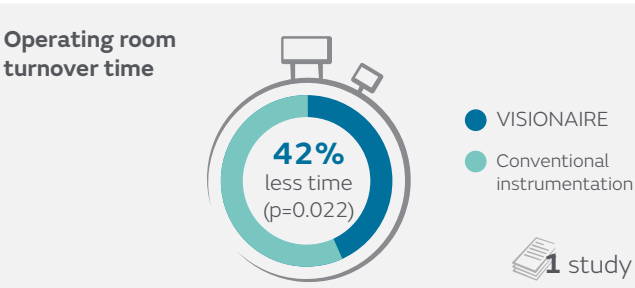

Figure 4. Percentage reduction in operating room turnover time for VISIONAIRE compared to conventional techniques. No meta-analysis was conducted on this outcome as only one study was identified.

Figure 5. Percentage reduction in tourniquet time for VISIONAIRE compared to conventional techniques

✚ Evidence in focus

Number of trays

- Although not a formal outcome in most studies, six studies commented on the number of trays[5,16,17,20,23,26]
  - All commented on the reductions in the number of trays seen with VISIONAIRE◊ compared to conventional instrumentation

Blood loss

- Eight studies reported mean values of blood lost during TKA;[5,7,11,14–16,20,26] however, the absence of standard deviations or ranges prevented a meta-analysis from being performed
- Six studies reported on the odds of a blood transfusion[5,13,14,20,22,28]
  - The odds of requiring a blood transfusion were 53% lower with VISIONAIRE compared with conventional instrumentation (OR, 0.47; 95% CI: 0.26–0.83; p=0.01; Figure 6)

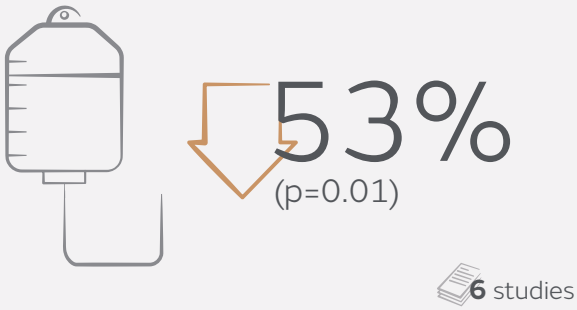

Figure 6. Percentage reduction in odds of requiring a blood transfusion with VISIONAIRE, compared to conventional instrumentation

Postoperative outcomes

Postoperative complications

- Six studies reported on postoperative complications[6,17,18,22,24,27]
  - No significant difference in the odds of a postoperative complication between VISIONAIRE and conventional instrumentation

Length of stay

- Nine studies reported on length of stay[7,13,18,21,22,25–28]
  - Mean length of stay was significantly reduced by 0.39 days (11.1% less time) with VISIONAIRE compared to conventional instrumentation (95% CI: 0.25–0.53; p<0.0001; Figure 7)

Return to function

- Eleven studies reported on assessment of postoperative return to function[5–7,12,14,16–18,24,25,28]
  - In general, the balance of evidence suggests there is no significant difference between VISIONAIRE and conventional instrumentation
  - One study reported significantly higher KSS clinical scores compared to conventional instrumentation at 6 weeks post-TKA (90 vs 65; p=0.02), but no significant differences were observed at 3 or 12 months[24]

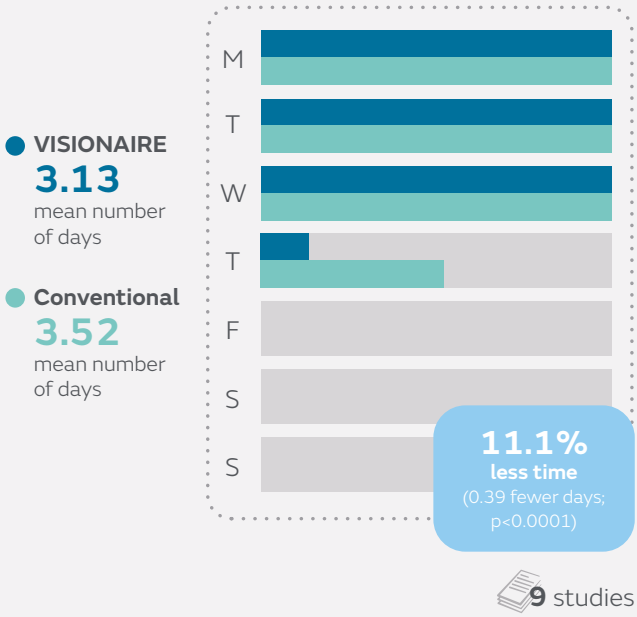

Figure 7. Comparison of mean number of days spent in hospital

Conclusions

VISIONAIRE PSI has been extensively published on in the literature. Results from this systematic literature review and meta-analysis show that its use leads to improvements in mechanical axis accuracy, efficiency in surgical procedures and length of hospital stay in comparison with conventional instrumentation.

Additional health economic data

Health economic analysis to assess the impact on hospital costs of VISIONAIRE◊ TKA compared to conventional TKA was outside of the scope of this systematic literature review and meta-analysis. However, a recent retrospective, real-world study has shown that hospital costs associated with VISIONAIRE were significantly lower than conventional instrumentation ($14,910 vs $16,018; p<0.0001; Figure 8).[30]

Click here to view the full summary.

Figure 8. Mean estimated cost saving with VISIONAIRE compared to conventional instrumentation

References

1. Huang NF, Dowsey MM, Ee E, et al. Coronal alignment correlates with outcome after total knee arthroplasty: five-year follow-up of a randomized controlled trial. *J Arthroplasty*. 2012;27(9):1737–41. **2.** Matsuda S, Kawahara S, Okazaki K, et al. Postoperative alignment and ROM affect patient satisfaction after TKA. *Clin Orthop Relat Res*. 2013;471(1):127–33. **3.** Momoli A, Giarretta S, Modena M, et al. The painful knee after total knee arthroplasty: evaluation and management. *Acta Biomed*. 2017;88(2s):60–67. **4.** Smith+Nephew 2020. Systematic literature review and meta-analysis of the accuracy, efficiency and satisfaction using VISIONAIRE. Clinical and Medical Affairs Evidence Analysis Report: EA/RECON/VISIONAIRE/001/v6. **5.** Predescu V, Prescura C, Olaru R, et al. Patient specific instrumentation versus conventional knee arthroplasty: comparative study. Int Orthop. 2017;41(7):1361–67. **6.** Huijbregts H, Khan R, Fick D, et al. Component alignment and clinical outcome following total knee arthroplasty: a randomised controlled trial comparing an intramedullary alignment system with patient-specific instrumentation. *Bone Joint J*. 2016;98-B(8):1043–49. **7.** Abane L, Anract P, Boisgard S, et al. A comparison of patient-specific and conventional instrumentation for total knee arthroplasty: a multicentre randomised controlled trial. *Bone Joint J*. 2015;97-B(1):56–63. **8.** Marimuthu K, Chen D, Harris I, et al. A multi-planar CT-based comparative analysis of patient-specific cutting guides with conventional instrumentation in total knee arthroplasty. *J Arthroplasty*. 2014;29(6):1138–42. **9.** Daniilidis K, Tibesku C. A comparison of conventional and patient-specific instruments in total knee arthroplasty. *Int Orthop*. 2014;38(3):503–508. **10.** Moubarak H, Brilhault J. Contribution of patient-specific cutting guides to lower limb alignment for total knee arthroplasty. *Orthop Traumatol Surg Res*. 2014;100(4 Suppl):S239–42. **11.** Bali K, Walker P, Bruce W. Custom-fit total knee arthroplasty: our initial experience in 32 knees. *J Arthroplasty*. 2012;27(6):1149–54. **12.** Pfitzner T, Abdel M, von Roth P, et al. Small improvements in mechanical axis alignment achieved with MRI versus CT-based patient-specific instruments in TKA: a randomized clinical trial. *Clin Orthop Relat Res*. 2014;472(10):2913–22. **13.** Vide J, Freitas T, Ramos A, et al. Patient-specific instrumentation in total knee arthroplasty: simpler, faster and more accurate than standard instrumentation-a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(8):2616–21. **14.** Tammachote N, Panichkul P, Kanitnate S. Comparison of customized cutting block and conventional cutting instrument in total knee arthroplasty: a randomized controlled trial. *J Arthroplasty*. 2017:pii: S0883-5403(0817)30863-X. **15.** Pourgiezis N, Reddy S, Nankivell M, et al. Alignment and component position after patient-matched instrumentation versus conventional total knee arthroplasty. *J Orthop Surg (Hong Kong)*. 2016;24(2):170–74. **16.** Stone A, Sibia U, MacDonald J. Functional Outcomes and Accuracy of Patient-Specific Instruments for Total Knee Arthroplasty. *Surg Innov*. 2018;25(5):470–75. **17.** Teeter M, Marsh J, Howard J, et al. A randomized controlled trial investigating the value of patient-specific instrumentation for total knee arthroplasty in the Canadian healthcare system. *Bone Joint J*. 2019;101(5):565–72. **18.** Turgeon TR, Cameron B, Burnell CD, et al. A double-blind randomized controlled trial of total knee replacement using patient-specific cutting block instrumentation versus standard instrumentation. *Can J Surg*. 2019;62(6):460. **19.** Zahn R, Graef F, Conrad J, et al. Accuracy of tibial positioning in the frontal plane: a prospective study comparing conventional and innovative techniques in total knee arthroplasty. *Arch Orthop Trauma Surg*. 2020:1–8. **20.** DeHaan A, Adams J, DeHart M, et al. Patient-specific versus conventional instrumentation for total knee arthroplasty: peri-operative and cost differences. *J Arthroplasty*. 2014;29(11):2065–69. **21.** Barke S, Musanhu E, Busch C, et al. Patient-matched total knee arthroplasty: does it offer any clinical advantages. *Acta Orthop Belg*. 2013;79(3):307–11. **22.** Myers K, Merwin S, Cabrera B, et al. An evaluation of the need for blood transfusion when using patient specific instrumentation for total knee arthroplasty. *Int J Orthop Rehabil*. 2014;2:54–60. **23.** Nankivell M, West G, Pourgiezis N. Operative efficiency and accuracy of patient-specific cutting guides in total knee replacement. *ANZ J Surg*. 2015;85(6):452–55. **24.** Kosse N, Heesterbeek P, Schimmel J, et al. Stability and alignment do not improve by using patient-specific instrumentation in total knee arthroplasty: a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc*. 2017;Nov 28:doi: 10.1007/s00167-00017-04792-00163. **25.** Stolarczyk A, Nagraba L, Mitek T, et al. Does patient-specific instrumentation improve femoral and tibial component alignment in total knee arthroplasty? A prospective randomized study. *Adv Exp Med Biol*. 2018;1096:11–17. **26.** Noble JJ, Moore C, Liu N. The value of patient-matched instrumentation in total knee arthroplasty. *J Arthroplasty*. 2012;27(1):153–55. **27.** Rathod PA, Deshmukh AJ, Cushner FD. Reducing blood loss in bilateral total knee arthroplasty with patient-specific instrumentation. *Orthop Clin North Am*. 2015;46(3):343–50. **28.** Vundelinckx B, Bruckers L, De Mulder K, et al. Functional and radiographic short-term outcome evaluation of the Visionaire system, a patient-matched instrumentation system for total knee arthroplasty. *J Arthroplasty*. 2013;28(6):964–70. **29.** Heyse T, Tibesku C. Improved femoral component rotation in TKA using patient-specific instrumentation. *Knee*. 2014;21(1):268–71. **30.** Thomas S, Patel A, Patrick C, Delhougne G. Total hospital costs and readmission rate of patient-specific instrument in total knee arthroplasty patients. *J Knee Surg*. 2020. doi:10.1055/s-0040-1713353.

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