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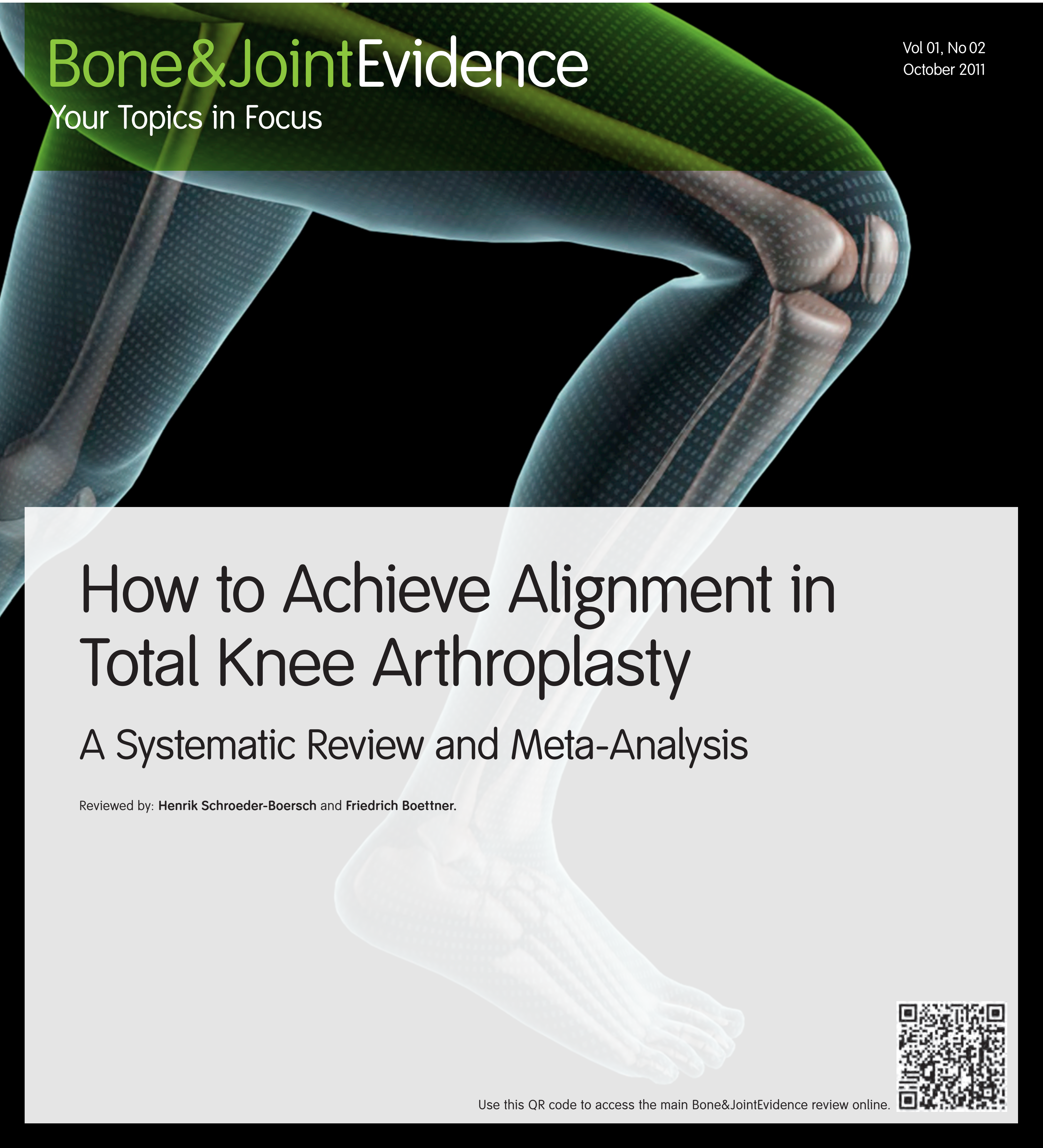

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How to Achieve Alignment in Total Knee Arthroplasty

A Systematic Review and Meta-Analysis

Reviewed by: **Henrik Schroeder-Boersch** and **Friedrich Boettner.**

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Authors:

Shelly-Ann Rampersad BSc[1], **Nikhil Kitchlu** BSc[1], **Mike Saccone** BSc[1], **Sheila Sprague** MSc[1,2], **Mohit Bhandari** MD, PhD, FRCSC[1,2]

1 Global Research Solutions™
2 Centre for Evidence-Based Orthopaedics

Reviewers:

Henrik Schroeder-Boersch MD[1], **Friedrich Boettner** MD[2]

1 Aukamm-Klinik, Wiesbaden, Germany
2 Hospital for Special Surgery, New York, NY, USA

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How to Achieve Alignment in Total Knee Arthroplasty: A Systematic Review and Meta-Analysis.

Purpose of review

The purpose of the current study was to conduct a thorough systematic literature review and meta-analysis of tools and methods used to achieve alignment in total knee arthroplasty (TKA).

Background

An important consideration with total knee arthroplasty is whether the neutral alignment of the leg will be correctly restored following surgery. We performed a systematic literature review of different methods of total knee arthroplasty to improve the understanding of alignment outcomes to date. *Read more on page 4*

Rating

POOR QUALITY | MODERATE | HIGH QUALITY

Why this rating? This is a systematic review and meta-analysis of exclusively current Level I evidence. The evidence rating is very good.

Results

Twenty-nine studies which included data from 3,354 total knee arthroplasties met the inclusion criteria for this review. Data were pooled based on four different groups comparing:

(1) imageless navigation and conventional TKA;
(2) image-based navigation and conventional TKA;
(3) intramedullary and extramedullary alignment;
(4) different navigation systems.

Read more on pages 6–14

Key considerations

A systematic review of the literature found:

- **There was a relative risk reduction of outliers** (alignment greater than +/- 3 degrees from neutral) **in imageless navigation compared to conventional TKA** (63%, 55% and 57% in the mechanical axis, femoral angle and tibial angle alignment, respectively).
- **Meta-analytic techniques could not be used in the remaining comparison groups due to limited data available.**
- **Need for additional studies with:**
  - Larger sample sizes
  - Consistent reporting amongst studies
  - Comparisons between image-based navigation and conventional systems
  - Comparisons between different types of navigation

Background

Total knee arthroplasty (TKA) is a well accepted treatment for osteoarthritis of the knee [1]. An important consideration with TKA is whether the neutral alignment of the leg will be correctly restored following surgery. Malalignment can lead to increased risk of loosening, instability, pain and subsequently, the need for revision [2]. Various systems exist that are utilized for the restoration of alignment, including conventional systems such as intramedullary and extramedullary guides and cutting blocks, as well as more modern computer navigation systems with and without imaging. Whether or not these truly improve the accuracy of alignment is still a matter of debate within the literature [3].

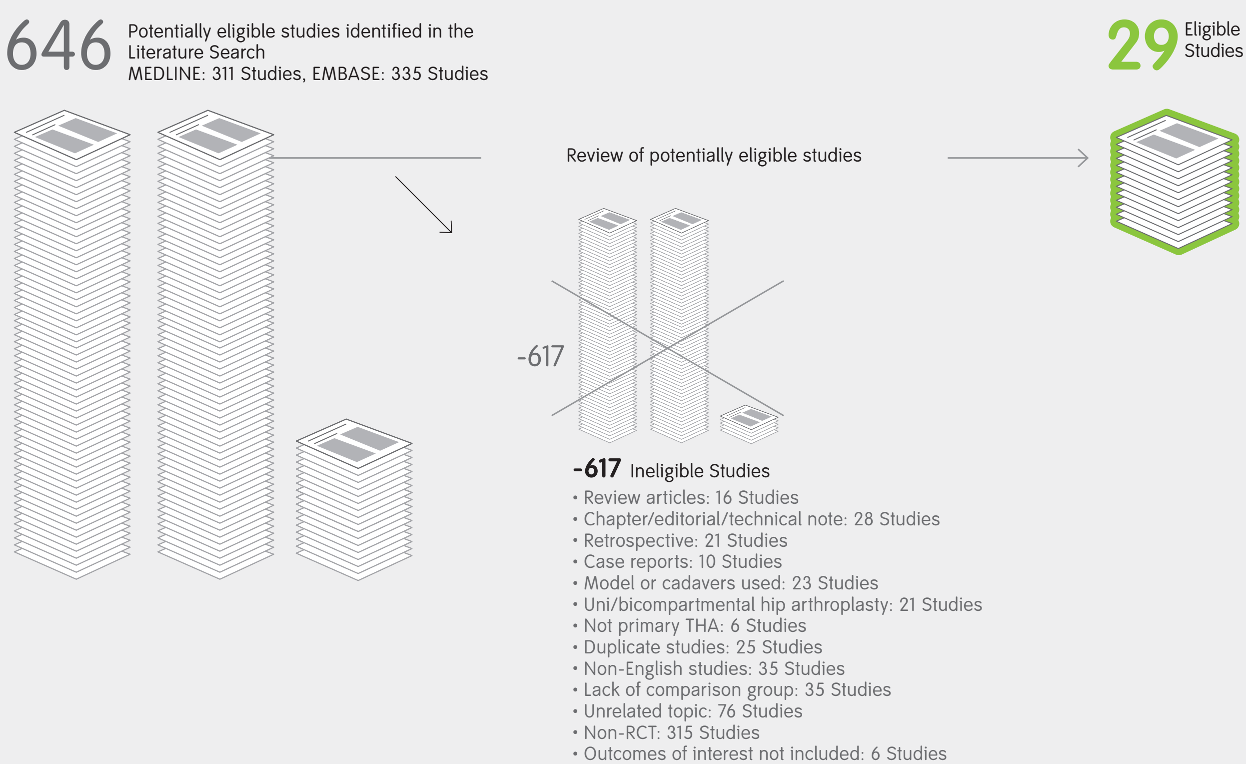
We performed a systematic review and meta-analysis of exclusively randomized controlled trials (level I evidence) concerning alignment in total knee arthroplasty. Studies using imageless computer navigation, image-based computer navigation, and intramedullary and extramedullary alignment for TKA were included. Primary outcomes were the percentage of outliers, defined as alignment deviations greater than three degrees from neutral, in the mechanical axis, femoral angle, and tibial angle. These outcomes were evaluated in four main groups of patients in which the methods compared were: (1) imageless computer navigation versus conventional TKA; (2) image-based navigation versus conventional TKA; (3) intramedullary versus extramedullary alignment; and (4) different types of navigation.

Methods

From 646 potentially eligible studies identified by a literature search, 617 did not meet the eligibility criteria for this review, leaving 29 eligible studies **(Figure 1)**.

Please refer to *Appendix 1*: Methods for further detail on the eligibility criteria and literature search.

Figure 1: Literature Review



Study Characteristics

Study characteristics are summarized in **Figure 2** with further detail found in **Tables 1 to 4**.

Please refer to *Appendix 2*: Results for further detail on the study characteristics.

Figure 2: Study characteristics

	Comparison of imageless navigation to conventional TKA		Comparison of image-based navigation to conventional TKA	
	Navigation	Conventional	Navigation	Conventional
Study designs included:	Randomized studies	Randomized studies	Randomized studies	Randomized studies
Mean age:	68.3 years	68.6 years	72.0 years	70.0 years
Mean sample size:	62.4	57.9	50.0	50.0
% male:	25.5	25.9	35.1	35.1
Number of knees in study:	3008 (25 studies)		100 (1 study)	

	Comparison of intramedullary to extramedullary alignment		Comparison of two different types of navigation	
	Intramedullary	Extramedullary	Navigation	Conventional
Study designs included:	Randomized studies	Randomized studies	Randomized studies	Randomized studies
Mean age:	70.0 years	69.0 years	71.3 years	65.2 years
Mean sample size:	52.0	48.0	27.0	19.0
% male:	42.5	44.1	33.0	47.0
Number of knees in study:	200 (2 studies)		46 (1 study)	

Results Cont.

The percentage of outliers in the mechanical axis, femoral angle and tibial angle for leg alignment are summarized in **Tables 1 to 4**.

Findings are indicative of a reduced rate of alignment outlier when imageless navigation is used in comparison to conventional systems across all three outcomes.

The pooled relative risk of an outlier for mechanical axis, tibial angle, and femoral angle were as follows (**Tables 5 to 7**):

- Mechanical axis: 0.37 (95% CI: 0.28 to 0.50; $p < 0.001$)
- Tibial angle: 0.45 (95% CI: 0.33 to 0.61; $p < 0.001$)
- Femoral angle: 0.43 (95%CI: 0.31 to 0.59; $p < 0.001$)

Unfortunately, due to insufficient data pooled relative risks for the other comparison groups could not be determined.

Please refer to *Appendix 2*: Results for additional details on the study results.

Table 1: Characteristics of included studies comparing imageless navigation to conventional TKA

Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Mean				**Navigation**	**62.4**	**68.3**	**25.5**	**8.9**	**6.4**	**5.0**	
				Conventional	**57.9**	**68.6**	**25.9**	**25.9**	**15.5**	**13.5**	
Bathis et al, 2004				BrainLab navigation	80	68.7	26.3	4.0	8.0	2.0	NR
				Conventional PFC Sigma	80	70.9	33.8	22.0	14.0	6.0	
Bohling et al, 2005				Surgetics navigation	50	69.0	28.0	6.0	NR	NR	NR
				Technical instrumentation	50	70.0	22.0	54.0	NR	NR	
Chauhan et al, 2004				Stryker navigation	35	NR	NR	14.3	0.0	0.0	NR
				Conventional jig-based technique	35	NR	NR	28.6	8.6	8.6	
Choong et al, 2009				Ci Navigation, Depuy	60	70.0	29.8	12.0	NR	NR	Osteoarthritis (103) Rheumatoid arthritis (8)
				Conventional approach using intramedullary and extramedullary guides (Sigma SP2)	55	69.0	50.0	39.0	NR	NR	
Chotanaphuti et al, 2008				BrainLab navigation	86	67.8	11.7	6.0	7.0	3.5	Osteoarthritis (168) Rheumatoid arthritis (12)
				Conventional approach using intramedullary and extramedullary guides	94	67.2	7.0	13.0	14.9	8.5	
Confalonieri et al, 2007				BrainLab navigation	37	73.4	49.0	0.0	5.4	0.0	NR
				Minimally invasive approach using intramedullary and extramedullary guides	37	72.8	46.0	16.2	13.5	16.2	

NR Not reported

Table 1: Characteristics of included studies comparing imageless navigation to conventional TKA (Cont.)

Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Decking et al, 2005	✓			OrthoPilot navigation	27	64.7	33.0	48.1§	18.5§	3.7§	Primary osteoarthritis (39) Rheumatoid arthritis (5) Posttraumatic osteoarthritis (8)
				Manual	25	67.3	32.0	64§	20.0§	20.0§	
Ensini et al, 2006	✓			Stryker navigation	60	68.8	50.0	11.7	0.0	1.7	Primary arthritis secondary to articular or extraarticular fractures and avascular necrosis (120)
				Conventional	60	71.1	33.0	25.0	15.0	3.3	
Hernandez-Vaquero et al, 2010	✓			Stryker navigation	20 OA 20 PD	NR	NR	0.0 OA 10.0 PD	NR	NR	Osteoarthritis (40) Preoperative deformity
				Conventional approach using intramedullary and extramedullary guides	20 OA 20 PD	NR	NR	22.5 OA 50.0 PD	NR	NR	
Hsu et al, 2010	✓			BrainLab navigation	60	70.0	32.0	13.3	10.0	1.7	Bilateral osteoarthritis (NR)
				Conventional approach using intramedullary and extramedullary guides	60			50.0	13.3	11.7	
Kim et al, 2007	✓			BrainLab navigation	100	67.6	15.0	21.0	NR	NR	Bilateral Osteoarthritis (200)
				Conventional approach using intramedullary and extramedullary guides	100			18.0	NR	NR	
Lee et al, 2010	✓			OrthoPilot navigation	60	66.0	5.0	8.0	NR	NR	Osteoarthritis (116)
				Conventional measured resection technique	56	67.0	3.6	27.0	NR	NR	
Luring et al, 2008	✓			BrainLab navigation and minimal invasive surgical (MIS) technique with special MIS pathway instruments	30	70.0	NR	0.0	0.0	0.0	NR
				Conventional technique using the standard PFC specialist II instruments.	30	69.0	NR	5.0	0.0	3.3	
				Freehand MIS with special MIS pathway instruments	30	69.0	NR	10.0	3.3	3.3	
Lutzner et al, 2008	✓			Stryker navigation	40	69.0	32.5	13.0	15.0	NR	Primary or secondary osteoarthritis (80)
				Conventional approach using intramedullary and extramedullary guides	40	69.0	40.0	18.0	5.0	NR	

NR *Not reported*
OA *Osteoarthritis*
PD *Post-operative deformity*
§ *Percentages reported include 3°*

Table 1: Characteristics of included studies comparing imageless navigation to conventional TKA (Cont.)

Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Martin et al, 2007				CT-free VectorVision from BrainLAB	100	70.3	32.0	8.0	5.0	2.0	Osteoarthritis (198) Rheumatoid arthritis (1) Ahlback's disease (1)
				Conventional approach using intramedullary and extramedullary guides	100	71.1	27.0	24.0	14.0	20.0	
Matsumoto et al, 2004				CT-free VectorVision from Brainlab	30	75.3	16.7	12.5	12.5	12.5	Osteoarthrtitis (60)
				Conventional	30	73.3	16.7	37.5	34.4	28.1	
Matziolis et al, 2007				PiGalileo navigation	32	71.0	33.3	3.1	0.0	0.0	Primary arthritis of the knee (60)
				Conventional technique using intramedullary guide	28	70.0		25.0	10.7	17.9	
Mombert et al, 2007				VectorVision TKR navigation system from Brainlab	21	NR	NR	0.0	NR	NR	NR
				Conventional technique using intramedullary guiding system	21	NR	NR	19.0	NR	NR	
Mullaji et al, 2007				Ci navigation, BrainLab	282	65.5	24.0	9.2	9.21*	9.21*	NR
				Image intensifier-guided conventional TKA	185	65.9	23.0	21.6	23.8*	23.8*	
Oberst et al, 2007				VectorVision system from BrainLAB	34	NR	NR	6.0	NR	NR	NR
				Conventional approach using intramedullary and extramedullary guides	35	NR	NR	20.0	NR	NR	
Schmitt et al, 2011				NexGen LPS with navigation	30	70.2	26.7	NR	0.0	12.3	Gonarthrosis (90)
				Stryker navigation- Scorpio PS	30	69.2	26.7	NR	0.0	6.7	
				Conventional NexGen LPS	30	69.6	40.0	NR	10.0	3.3	
Seon et al, 2006				OrthoPilot (Aesculap) – Navigation-assisted less invasive surgical technique (LIS)	49	67.4	10.2	6.1	6 .1	4.1	Osteoarthritis (101) Rheumatoid arthritis (1)
				Conventional approach using intramedullary and extramedullary guides	53	64.8	11.3	11.3	17.0	7.5	

NR *Not reported*

* *Outliers for femoral and tibial angles reported together*

RESULTS

Table 1: Characteristics of included studies comparing imageless navigation to conventional TKA (Cont.)

Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Sparmann et al, 2003	■			Stryker navigation	120	67.4	26.7	0.0	0.8	0.8	Primary osteoarthritis (142) Post-traumatic osteoarthritis (7) Rheumatoid arthritis (65) Psoriatic arthropathy (11) Spondyloarthropathy (8) Scleroderma (2) Lupus erythematous (5)
				Conventional hand-guided technique	120	66.1	34.2	13.3	28.3	10.0	
Stockl et al, 2004	■			Stryker navigation	32	68.2	28.1	0.0	NR	NR	Osteoarthritis (64)
				Conventional method using extramedullary alignment guides	32	72.4	31.3	6.3	NR	NR	
van Strien et al, 2009	■			BrainLab navigation – CT-based	17	71.0	NR	29.4	23.5	23.5	NR
				Brainlab navigation – CT-free	19		NR	10.5	0.0	26.3	
				Conventional	21		NR	33.3	4.8	42.9	

NR Not reported

Table 2: Characteristics of included studies comparing image-based navigation to conventional TKA

Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Mean				**Navigation**	**50.0**	**72.0**	**35.1**	**0.0**	**NR**	**NR**	
				Conventional	**50.0**	**70.0**	**35.1**	**26.5**	**NR**	**NR**	
Victor et al, 2004	■			Fluoroscopy-based navigation	50	72.0	35.1	0.0	NR	NR	NR
				Conventional approach using intramedullary and extramedullary guides	50	70.0	35.1	26.5	NR	NR	

NR Not reported

Table 3: Characteristics of included studies comparing intramedullary to extramedullary alignment

Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Mean				**Intramedullary**	**52.0**	**70.0**	**42.5**	**NR**	**10.0**	**15.0**	
				Extramedullary	**48.0**	**69.0**	**44.1**	**NR**	**6.0**	**35.0**	
Baldini et al, 2008	■			Intramedullary device	50	71.0	33.0	NR	10.0	NR	Varus osteoarthritis (100)
				Extramedullary device	50	70.0	37.0	NR	6.0	NR	
Reed et al, 2002	■			Intramedullary device	54	69.0	51.9	NR	NR	15.0	Osteoarthritis (93) Inflammatory arthritis (7)
				Extramedullary device	46	68.0	52.2	NR	NR	35.0	

NR Not reported

Table 4: Characteristics of included studies comparing two different types of navigation

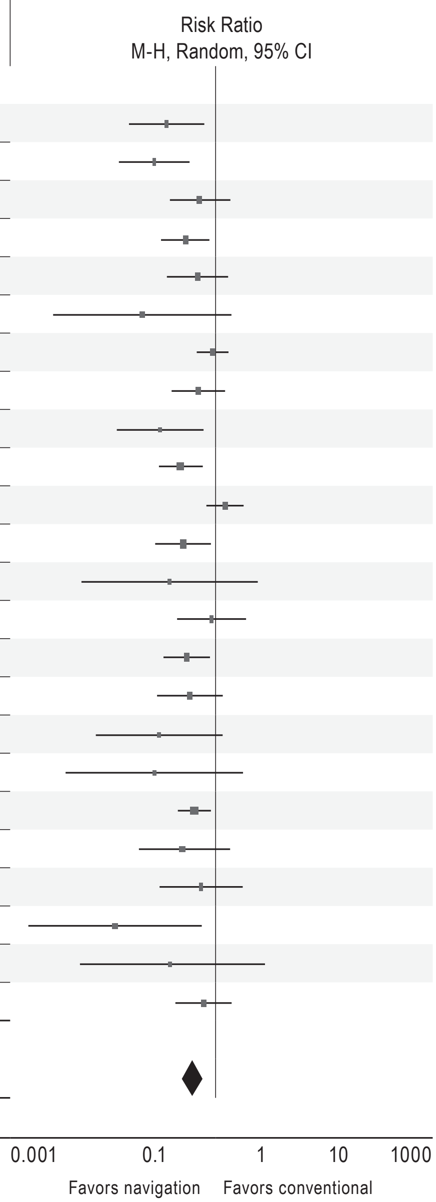
Study	Randomized studies	Prospective studies	Case series	System Used	Sample Size (Number of Knees)	Mean Age (Years)	% Male	Mechanical axis > ±3° (%)	Femoral angle > ±3° (%)	Tibial angle > ±3° (%)	Indication for Procedure
Mean				**Electromagnetic**	**27.0**	**71.3**	**33.0**	**0.0**	**NR**	**NR**	
				Infrared	**19.0**	**65.2**	**47.0**	**5.3**	**NR**	**NR**	
Lionberger et al, 2008	■			Electromagnectic navigation system	27	71.3	33.0	0.0	NR	NR	Osteoarthritis (NR) Rheumatoid arthritis (NR)
				Infrared navigation system	19	65.2	47.0	5.3	NR	NR	

NR Not reported

RESULTS

Table 5: Forest plot of relative risk for the outliers in the mechanical axis for imageless navigation vs. conventional.

Study or Subgroup	Navigation Events	Navigation Total	Conventional Events	Conventional Total	Weight	Risk Ratio M-H, Random, 95% CI
Bathis 2004	3	80	18	80	3.8%	0.17 [0.05, 0.54]
Bohling 2005	3	50	27	50	4.0%	0.11 [0.04, 0.34]
Chauhan 2004	5	35	10	35	4.8%	0.50 [0.19, 1.31]
Choong 2009	7	60	21	55	6.0%	0.31 [0.14, 0.66]
Chotanaphuti 2008	5	86	12	94	4.6%	0.46 [0.17, 1.24]
Confalonieri 2007	0	37	6	37	0.9%	0.08 [0.00, 1.32]
Decking 2005	13	27	16	25	8.1%	0.75 [0.46, 1.23]
Ensini 2007	7	60	15	60	5.7%	0.47 [0.20, 1.06]
Hernandez-Vaquero 2010	2	40	15	40	3.0%	0.13 [0.03, 0.55]
Hsu 2010	8	60	30	60	6.6%	0.27 [0.13, 0.53]
Kim 2007	21	100	18	100	7.5%	1.17 [0.66, 2.05]
Lee 2010	5	60	16	56	5.0%	0.29 [0.11, 0.74]
Luring 2008	0	30	5	60	0.9%	0.18 [0.01, 3.13]
Lutzner 2010	5	40	7	40	4.3%	0.71 [0.25, 2.06]
Martin 2007	8	100	24	100	6.2%	0.33 [0.16, 0.71]
Matsumoto 2004	4	30	11	30	4.5%	0.36 [0.13, 1.01]
Matziolis 2007	1	32	7	28	1.7%	0.13 [0.02, 0.95]
Mombert 2007	0	21	4	21	0.9%	0.11 [0.01, 1.94]
Mullaji 2007	26	282	40	185	8.3%	0.43 [0.27, 0.67]
Oberst 2008	2	34	7	35	2.7%	0.29 [0.07, 1.32]
Seon 2006	3	49	6	53	3.3%	0.54 [0.14, 2.05]
Sparmann 2003	0	120	16	120	1.0%	0.03 [0.00, 0.50]
Stockl 2004	0	32	2	32	0.9%	0.20 [0.01, 4.01]
van Strien 2009	7	36	7	21	5.2%	0.58 [0.24, 1.43]
Total (95% CI)		**1501**		**1417**	**100.0%**	**0.37 [0.28, 0.50]**
Total Events	**135**		**340**			



Heterogeneity: $Tau^2 = 0.21$; $Chi^2 = 44.19$, $df = 23$ ($P = 0.005$); $I^2 = 48\%$
Test for overall effect: $Z = 6.69$ ($P < 0.00001$)

CI	*Confidence interval*
M-H, Random	*A Mantel-Haenszel, random-effects model was used to pool the data.*

◆ *Diamonds indicate pooled relative risk estimates.*
■ *Squares indicate point estimates around which 95% confidence intervals are denoted by a horizontal line.*

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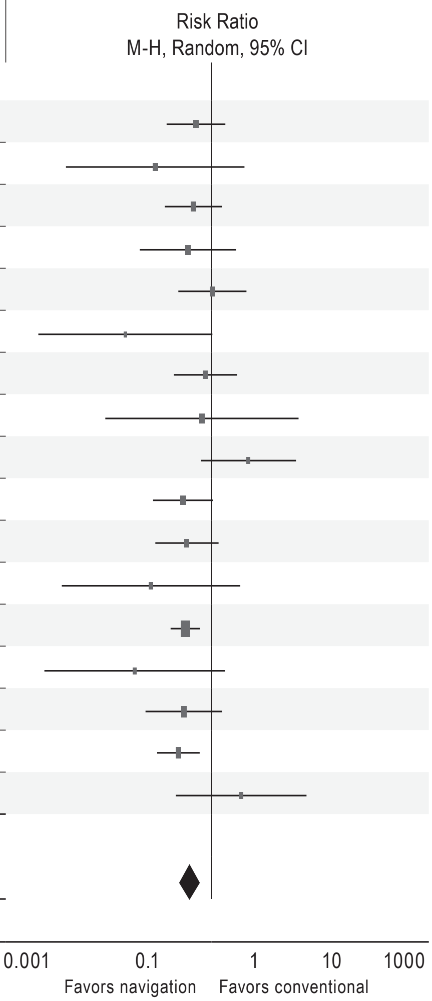
Table 6: Forest plot of relative risk for the outliers in femoral angle for imageless navigation vs. conventional.

Study or Subgroup	Navigation Events	Navigation Total	Conventional Events	Conventional Total	Weight	Risk Ratio M-H, Random, 95% CI
Bathis 2004	6	80	11	80	8.1%	0.55 [0.21, 1.40]
Chauhan 2004	0	35	3	35	1.0%	0.14 [0.01, 2.67]
Chotanaphuti 2008	6	86	14	94	8.6%	0.47 [0.19, 1.16]
Confalonieri 2007	2	37	5	37	3.3%	0.40 [0.08, 1.93]
Decking 2005	5	27	5	25	6.1%	0.93 [0.30, 2.82]
Ensini 2007	0	60	9	60	1.1%	0.05 [0.00, 0.88]
Hsu 2010	6	60	8	60	7.4%	0.75 [0.28, 2.03]
Luring 2008	0	30	1	60	0.9%	0.66 [0.03, 15.64]
Lutzner 2010	6	40	2	40	3.4%	3.00 [0.64, 13.98]
Martin 2007	5	100	14	100	7.6%	0.36 [0.13, 0.95]
Matsumoto 2004	4	30	10	30	6.9%	0.40 [0.14, 1.14]
Matziolis 2007	0	32	3	28	1.0%	0.13 [0.01, 2.33]
Mullaji 2007	26	282	44	185	22.6%	0.39 [0.25, 0.61]
Schmitt 2011	0	60	3	30	1.0%	0.07 [0.00, 1.36]
Seon 2006	3	49	9	53	5.0%	0.36 [0.10, 1.26]
Sparmann 2003	10	120	34	120	14.1%	0.29 [0.15, 0.57]
van Strien 2009	4	36	1	21	1.9%	2.33 [0.28, 19.52]
Total (95% CI)		**1164**		**1058**	**100.0%**	**0.45 [0.33, 0.61]**
Total Events	**83**		**176**			



Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 18.48$, $df = 16$ ($P = 0.030$); $I^2 = 13\%$
Test for overall effect: $Z = 5.29$ ($P < 0.00001$)

CI	*Confidence interval*
M-H, Random	*A Mantel-Haenszel, random-effects model was used to pool the data.*

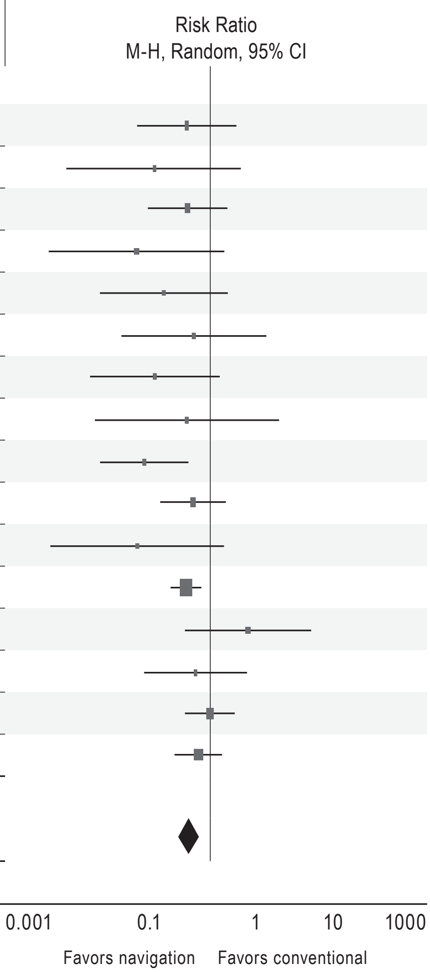
◆ *Diamonds indicate pooled relative risk estimates.*
■ *Squares indicate point estimates around which 95% confidence intervals are denoted by a horizontal line.*

RESULTS

Table 7: Forest plot of relative risk for the outliers in the tibial angle for imageless navigation vs. conventional.

Study or Subgroup	Navigation Events	Navigation Total	Conventional Events	Conventional Total	Weight	Risk Ratio M-H, Random, 95% CI
Bathis 2004	2	80	5	80	4.0%	0.40 [0.08, 2.00]
Chauhan 2004	0	35	3	35	1.3%	0.14 [0.01, 2.67]
Chotanaphuti 2008	3	86	8	94	5.9%	0.41 [0.11, 1.50]
Confalonieri 2007	0	37	6	37	1.3%	0.08 [0.00, 1.32]
Decking 2005	1	27	5	25	2.4%	0.19 [0.02 , 1.48]
Ensini 2007	1	60	2	60	1.9%	0.50 [0.05, 5.37]
Hsu 2010	1	60	7	60	2.5%	0.14 [0.02, 1.13]
Luring 2008	0	30	2	60	1.2%	0.39 [0.02, 7.95]
Martin 2007	2	100	20	100	5.0%	0.10 [0.02, 0.42]
Matsumoto 2004	4	30	8	30	8.1%	0.50 [0.17, 1.48]
Matziolis 2007	0	32	5	28	1.3%	0.08 [0.00, 1.38]
Mullaji 2007	26	282	44	185	30.2%	0.39 [0.25, 0.61]
Schmitt 2011	6	60	1	30	2.5%	3.00 [0.38, 23.80]
Seon 2006	2	49	4	53	3.8%	0.54 [0.10, 2.82]
Sparmann 2003	10	120	12	120	13.6%	0.83 [0.37, 1.85]
van Strien 2009	9	36	9	21	15.1%	0.58 [0.28, 1.24]
Total (95% CI)		**1124**		**1018**	**100.0%**	**0.43 [0.31, 0.59]**
Total Events	**67**		**141**			

Heterogeneity: Tau² = 0.04; Chi² = 16.57, df = 15 (P = 0.35); I² = 9%
Test for overall effect: Z = 5.06 (P < 0.00001)



CI — *Confidence interval*
M-H, Random — *A Mantel-Haenszel, random-effects model was used to pool the data.*

◆ *Diamonds indicate pooled relative risk estimates.*
■ *Squares indicate point estimates around which 95% confidence intervals are denoted by a horizontal line.*

RESULTS

Conclusions

This systematic review aims to assess the degree of realignment in TKA patients, comparing:
1) imageless navigation to conventional TKA,
2) image-based navigation to conventional TKA,
3) intramedullary and extramedullary alignment, and
4) different types of navigation systems.

Specifically, the post-operative leg alignments were analyzed to determine the percentage of outliers outside the recommended ±3° varus/valgus range. Evidence from our meta-analysis is indicative of a significant reduction in the relative risk of an outlier alignment when imageless computer navigation systems are used in comparison to conventional methods. Conventional methods included intramedullary and extramedullary guides. The lack of high quality data available prevented any conclusions from being established in the other aforementioned comparisons. Additional randomized controlled trials comparing image-based navigation and conventional TKA, and between different types of navigation is required to improve the quality of the literature available.

Strengths

- A thorough and systematic review of the literature was conducted using multiple databases.
- Demonstrated reproducibility of selection and quality of assessment criteria.
- The inclusion of only high quality evidence (Level I randomized controlled trials), allowing for meta-analysis.
- High degree of external validity with data from over 3,000 male and female knees that underwent total knee arthroplasty in 29 different studies from a variety of countries.
- Meta-analytic techniques combined high quality evidence from 25 randomized controlled trials comparing imageless computer navigation and conventional methods for achieving knee alignment after TKA, indicating a clear benefit when navigation is used.

Limitations

- Limited studies comparing image-based navigation with conventional TKA, intramedullary and extramedullary alignment and comparison of different navigation systems.
- Limited reporting of specific outcomes in studies.
- Heterogeneity as a result of the different systems and measurement techniques used in the studies, decreased the validity of findings.
- Inability to determine clinical importance of the relative risk reduction in outliers provided by imageless computer navigation in comparison to conventional methods.

Review at a glance

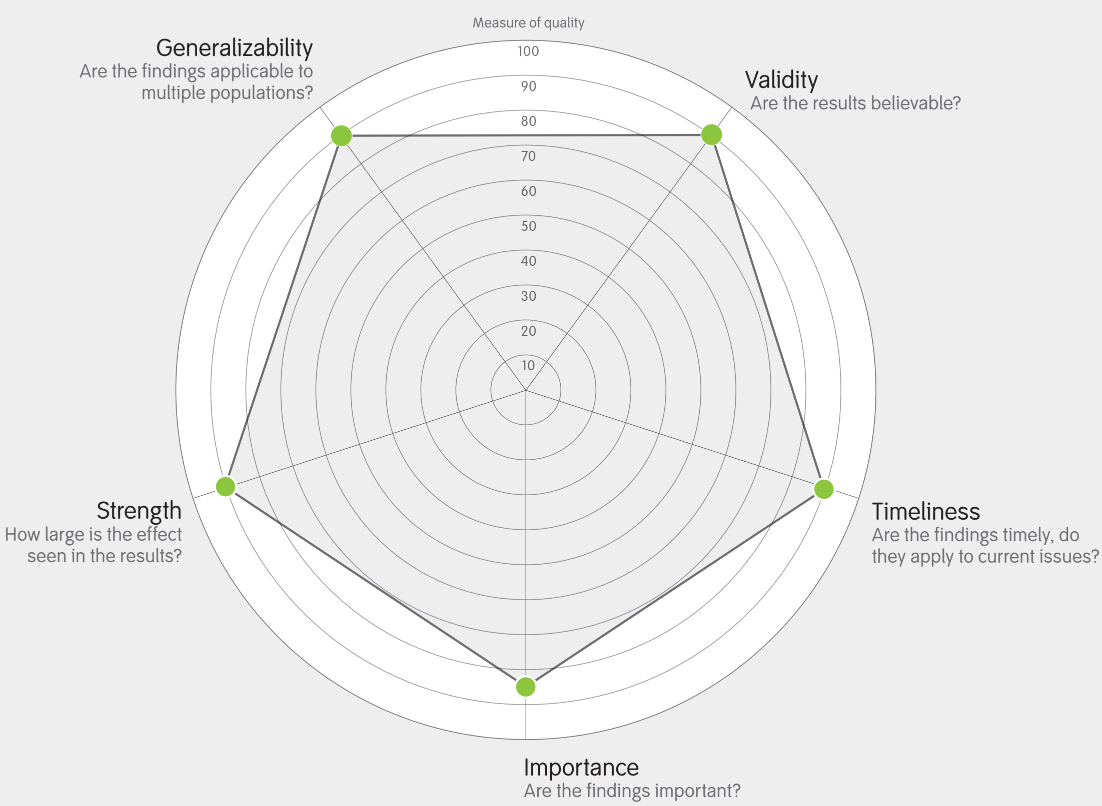
Generalizability
90 out of 100. The included studies assess methods for total knee arthroplasty for any indication, allowing the findings to be applied to a larger population with similar characteristics.

Validity
90 out of 100. Systematic review of high evidence, with fairly consistent reporting on outcomes between included studies.

Timeliness
90 out of 100. This review assesses several alternatives in total knee arthroplasty treatment used for varying indications. All studies in this review were published within the past nine years.

Importance
85 out of 100. The evidence is important in providing patients, orthopaedic surgeons, and healthcare payers information regarding the success in achieving desired alignment when using different systems and methods for total knee arthroplasty.

Strength
90 out of 100. Data from 29 randomized controlled trials were included in this study. The quality of evidence is high, and meta-analytic statistics were performed, allowing for reliable conclusions to be drawn.



For detailed information see **www.kleos.md/literature/background**

REVIEW

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Appendices

Visit **www.kleos.md/literature/bone-joint-evidence/appendices/v01/n02.pdf** for appendices or use this QR code. The following appendices provide further detail:

Appendix 1: Methods
Appendix 2: Results

Please also visit **www.kleos.md/literature/background** to view an online glossary of technical terminology.

Notes

Notes Cont.

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KLEOS, Oberneuhofstrasse 10d, 6340 Baar, Switzerland
Phone +41 41 766 22 55
kleos@smith-nephew.com

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