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No differences between fixed- and mobile-bearing total knee arthroplasty

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Abstract
Purpose For years, numerous studies have been performed to determine whether mobile-bearing total knee arthroplasty (MB-TKA) or fixed-bearing total knee arthroplasty (FB-TKA) is the preferential design in total knee arthroplasty. Reviews and meta-analyses on this subject have focused on a relatively small number of randomised controlled trials, possibly missing important results of smaller studies. The goal of this review was to provide a comprehensive overview of all literature comparing MB-TKA and FB-TKA in the treatment of osteoarthritis of the knee.
Methods An extensive literature search was performed in the PubMed database. All studies that compared MB-TKA with FB-TKA and looked at one of four theorised advantages (insert wear, signs of loosening, survival rate of the prosthesis and clinical outcome) were included.
Results The initial search yielded 258 articles, of which 127 were included after the first screening. The included studies consisted of 9 meta-analyses, 3 systematic reviews, 48 RCT's, 44 comparative studies, 10 reviews and 13 studies that examined patients who received bilateral TKA (one MB-TKA and one FB-TKA). Combining the results of all studies showed that almost all studies found no difference between MB-TKA and FB-TKA.
Conclusions Even when examining all different types of studies on MB-TKA and FB-TKA, the results of this review showed no difference in insert wear, risk of loosening, survivorship or clinical outcome. In daily practice, the choice between MB-TKA and FB-TKA should be based on the experience and judgment of the surgeon, since no clear differences are observed in the scientific literature.
Level of evidence III.

Keywords Fixed bearing · Mobile bearing · Total knee arthroplasty · Review

Introduction

Since the first mobile-bearing total knee arthroplasty (MB-TKA) procedures have been performed in the 1980s [21], numerous scientific studies have compared MB-TKA with fixed-bearing total knee arthroplasty (FB-TKA) [3, 21, 55, 95, 100, 130, 133]. The mobile-bearing design was developed to allow rotation of the insert around the longitudinal axis ("rotating platform") or to allow anterior–posterior translation between the insert and the tibial tray of the prosthesis ("meniscal bearing"). Due to the rotational and the translational properties between the insert and the tibial tray, the mobile-bearing insert can be modelled such that they have a better fit with the femoral component without compromising the natural rotation and translation between femur and tibia. This is contrary to the fixed inserts in FB-TKA, which are relatively flat and, therefore, allow some small rotations and translations, but much smaller compared to the MB-TKA [105].

MB-TKA has been theorised in the literature to result in four advantages over FB-TKA: reduced insert wear, less risk

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of loosening, fewer revisions and better clinical outcome. Firstly, MB-TKA is expected to result in less polyethylene wear because of a larger contact surface between the femoral component and the insert, induced by a more optimal fit of the femoral component and the insert [30]. In addition, the insert can rotate and translate relative to the tibial component, which means that the femoral component slides less on the surface of the insert, which also potentially results in less wear. Secondly, MB-TKA is hypothesised to reduce the chance of loosening of the prosthesis because of less osteolysis [30]. This is thought to be due to the movement of the insert on the tibial tray, resulting in less stress on the bone–cement interface of the tibial component, and less wear-induced osteolysis. The third advantage described in the literature is that less wear and loosening result in a lower number of revisions and, therefore, a better survivorship of the prosthesis [20]. The final theorised advantage of MB-TKA is better clinical outcome. The mobility and design of the insert are hypothesised to result in a more natural movement of the prosthetic knee in daily life. Several disadvantages of MB-TKA have also been described. A known complication of MB-TKA is dislocation of the insert [51, 130]. During surgery, a high level of precision in balancing of the flexion and extension gap is necessary to prevent dislocation or spin-off of the insert. Therefore, MB-TKA is acknowledged to be associated with a prolonged learning curve and an increased risk of soft tissue impingement [30]. Additionally, the fact that in MB-TKA there is a second articulating surface could be a risk for increasing wear as a larger surface of the insert is exposed to friction [30, 130].

In particular, in the last ten years, an increased number of high-quality articles have been published that have studied one or more of the four theorised advantages of MB-TKA. Reviews and meta-analyses have been performed to provide an overview of all the literature available, none finding any significant differences. However, these often include the same studies with a high level of evidence. Several studies have been performed that provide valuable information on MB-TKA and FB-TKA, but are omitted from these overviews because of their methodology. The goal of the present paper is to present an up-to-date overview of the scientific literature that includes studies of different levels of evidence that compare cemented MB-TKA with cemented FB-TKA with respect to insert wear, signs of loosening of the prosthesis, survivorship of the prosthesis and clinical outcome, and to arrive at an evidence-based advise with regard to the preferable type of insert.

Materials and methods

Search strategy

The PubMed MEDLINE database was searched for English language meta-analyses, (systematic) reviews, randomised controlled trials and comparative studies. The search terms used were: mobile bearing, rotating platform, meniscal bearing and anterior–posterior glide rotation. Fixed and total or TKA needed to be present as keywords. Unicompartmental and hemi were excluded in the search. The last search was performed on 17 February 2015. The complete search string can be found in Table 6 in "Appendix"

Eligibility criteria

Two independent reviewers (BF and DD) screened the results of the search, first using the title and abstract of the articles and second using the full text of the remaining articles to identify those eligible for inclusion. Studies comparing clinical, radiological and/or functional results of MB-TKA and FB-TKA were eligible for inclusion. The primary indication for TKA had to be osteoarthritis. In vitro studies, studies with kinematic results or studies that used biomechanical models, were excluded, as well as studies that focused on complete polyethylene tibial components or uncemented prostheses. In the current study, no differentiation was made between meniscal bearing and rotating platform subtypes of MB-TKA or between cruciate retaining and posterior stabilised prostheses.

Eligible articles of which the full text could be retrieved and which reported results on one or more of the four theorised advantages of MB-TKA were included. Wear of the insert had to be assessed by measuring the thickness of retrieved inserts, or using the Knee Society Total Knee Arthroplasty Roentgenographic Evaluation and Scoring System [35], or similar radiological measurement methods. The risk of loosening of the prosthesis had to be reported in the form of radiolucencies or osteolysis around the bone–cement interface. With respect to survivorship and the number of revisions, only those studies were included that reported survival as a result of aseptic loosening. Clinical outcome had to be compared by patient-reported outcome questionnaires looking at pain and functional impairment or by measuring the range of motion by looking at flexion and extension of the knee. In the case of disagreement about an article, this was resolved through a discussion between the reviewers.

Data collection

The following information was extracted from the included studies: author, year of publication, study design (meta-analysis, (systematic) review, randomised controlled trial, comparative study), level of evidence, type of prosthesis, number of prostheses, age of the MB group, age of the FB group and duration of follow-up. In addition, the main results of the articles were studied to see what results they reported for each of the four main outcome categories. For each outcome category that was reported in the article, the result was summarised as either MB = FB (no difference between MB-TKA and FB-TKA), MB (outcome favours MB-TKA) or FB (outcome favours FB-TKA). When several follow-up measurements were reported within a study, the final measurements were used for summarising the results. If a study did not perform a statistical analysis on an outcome category, no result was formulated for that specific category. If a study did not report consistent results within one of the four main outcome categories, there was no final conclusion made for that particular category. If a preference for a type of bearing was reported by patients who participated in bilateral comparative studies, this was also registered.

Data analysis

Final conclusions were based on the studies with the highest level of evidence (LoE), as determined by the reviewers using the criteria reported by several orthopaedic journals [108, 117, 140]. Bilateral comparative studies (where patients received a MB-TKA in one knee and a FB-TKA in the other knee) were considered as level 1 and non-systematic reviews as level 3. If information needed for determining the level of evidence was missing, the level of evidence was reported as one level lower. Because of the large amount of studies included in the current overview, conclusions on the four main categories were primarily drawn by analysing the studies with LoE 1, since these studies are considered to have the highest methodological quality. Afterwards, the results from studies with LoE 2 and 3 were analysed to see whether the results from those studies provided a different view.

Results

Search, Selection and Study characteristics

The PubMed search resulted in 258 articles, 121 of which were excluded based on abstract or title (Fig. 1). A full-text version was retrieved of the remaining 137 studies. After

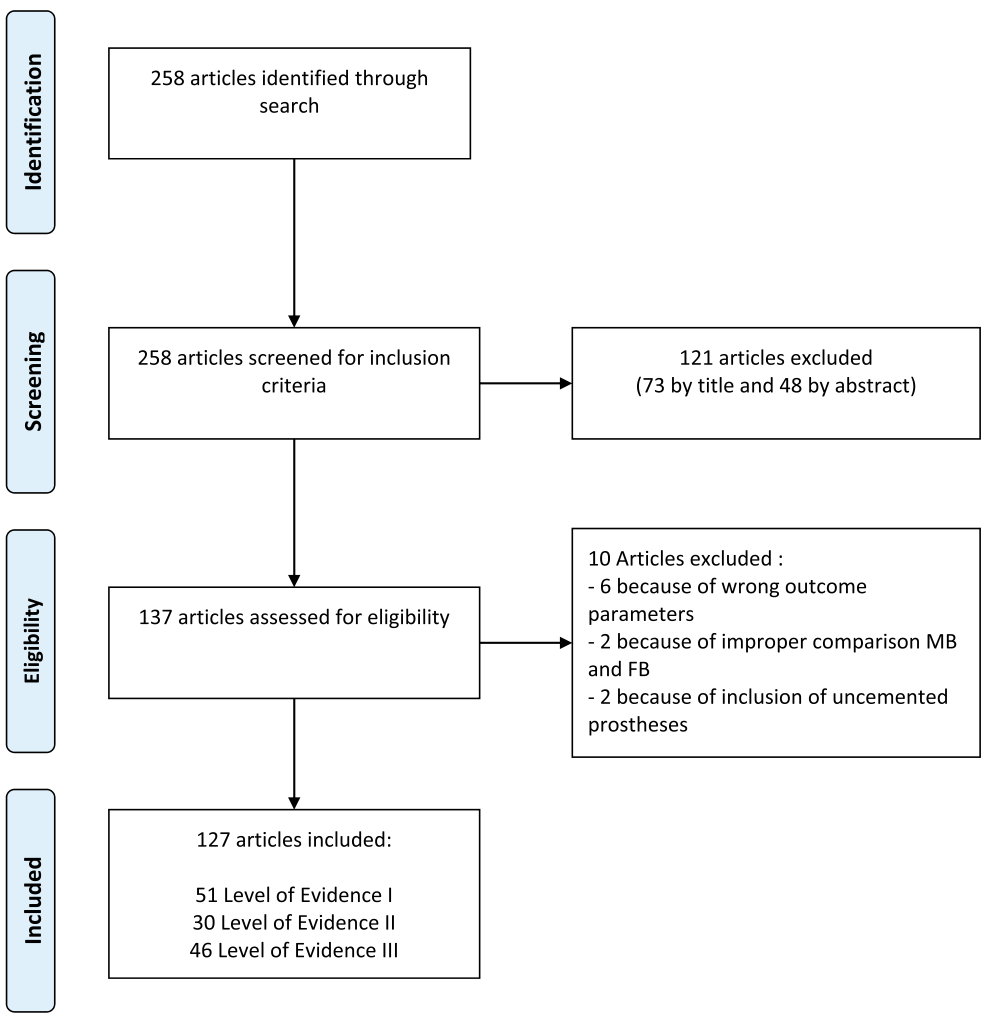

Fig. 1 Study flow diagram [86]

Table 1 Characteristics of included studies

References	Year	Study type	LoE	Type of prosthesis	Number of prostheses (MB/FB)	Age MB (years)	Age FB (years)	Follow-up (years)
Aggarwal [1]	2013	RCT	1	Scorpio MB Stryker; Duracon FB Stryker	29/27	60 (48–76)	55 (41–65)	4–6.5
Aglietti [2]	2005	RCT	2	MBK MB Zimmer; LPS FB Zimmer	65/65	71	70	3 (2.5–4.0)
Apostolopoulos [3]	2011	R	3					
Argenson [4]	2013	CS	3	Multiple	516/330	71	71	min 10 years
Bailey [5]	2015	RCT	1	PFC Sigma CR MB/FB DePuy	161/170	69 (±9)	70 (±8)	2
Ball [6]	2011	RCT	1	Scorpio MB/FB Stryker	51/42	65	64	>2
Banks [7]	2003	CS	3	Multiple	29/92	70 (±8)	70 (±8)	26 (±13)
Banks [8]	2004	CS	3	Multiple	12/47			
Banks [9]	2004	CS	3	Multiple	44/169			
Beard [10]	2007	BiL	1	TMK MB Biomet; AGC FB Biomet	33/33	63 (47–67)	63 (47–67)	3.7 (3–4.7)
Berry [11]	2012	CS	3	PFC Sigma MB/FB DePuy	94/218			3–6
Bhan [12]	2005	BiL	1	LCS MB DePuy; Burstein II FB Zimmer	16/16	63 (40–71)	63 (40–71)	6.0 (4.5–7.5)
Biau [14]	2006	CS	3	Hopital Lyon Sud MB/FB Tornier	42/47	71	71	5
Bistolfi [15]	2014	CS	2	NexGen LPS MB/FB Zimmer	100/100	70 (57–83)	70 (43–87)	2.3
Bo [16]	2014	MA	2	Multiple	1614			2–16.8
Breeman [17]	2013	RCT	2	Multiple (not specified which)	276/263	69 (±8)	69 (±9)	5
Breugem [18]	2008	RCT	1	NexGen Legacy MB/FB Zimmer	47/53	68 (29–86)	71 (53–87)	1
Breugem [19]	2014	RCT	2	NexGen LPS PS MB/FB Zimmer	29/40	78 (62–95)	80 (56–88)	7.9 (6–10)
Catani [22]	2003	CS	3	Insall Burstein II FB Zimmer; MBK MB Zimmer	10/10	62 (59–80)	68 (59–76)	0.7–2.2
Chen [23]	2013	CS	3	PFC Sigma DePuy FB/MB; Genesis II FB Smith & Nephew	106/97	67.6 (±7)	64.4 (±16)	2.7 (0.7–4.3)
Cheng [24]	2013	MA	1	Multiple	1821			
Chiu [25]	2001	BiL	1	AMK FB DePuy; LCS MB DePuy	16/16	68 (51–79)	68 (51–79)	2 (1.3–2.2)
Delport [27]	2006	CS	3	Performance MB/FB Biomet	14/21			13 (12–24)
Delport [26]	2013	CS	2	Performance MB/FB Biomet	267/885			5 (0.25–17)
Dennis [31]	2003	CS	3	Multiple	97/127			
Dennis [32]	2004	CS	3	Multiple	80/187			
Dennis [29]	2005	R	3	Multiple				
Dennis [30]	2006	R	3					

Table 1 continued

References	Year	Study type	LoE	Type of prosthesis	Number of prostheses (MB/FB)	Age MB (years)	Age FB (years)	Follow-up (years)
Engh [33]	2013	CS	3	LCS MB DePuy; Sigma MB/FB DePuy	12/12	59 (39–76)	61 (40–79)	
Evans [34]	2006	CS	3	PFC Sigma MB/FB DePuy	113/100	63 (±8)	68 (±9)	>2
Ferguson [36]	2014	RCT	1	PFC Sigma MB/FB DePuy	163/176	70 (±8)	70 (±8)	2
Geiger [37]	2008	CS	3	E.motion MB Aesculap; PFC FB DePuy	30/30	69	70	2
Gothesen [38]	2013	CS	3	Multiple	6320/11,452			1.8–6.9
Gupta [40]	2014	CS	3	Multiple	114/397	65 (±13)	66 (±11)	
Hansson [42]	2005	RCT	1	Rotaglide total knee System MB Corin Medical; Nuffield total knee System FB Corin Medical	25/27	74 (60–85)	75 (64–86)	
Hanusch [43]	2010	RCT	1	PFC Sigma MB/FB DePuy	50/55	69	70	1.1 (0.8–2.4)
Harrington [44]	2009	RCT	2	PFC Sigma MB/FB DePuy	86/72	64 (38–85)	63 (43–82)	2
Hasegawa [45]	2009	BiL	1	PFC Sigma MB/FB DePuy	25/25	73 (55–81)	74 (55–81)	3.3 (1.5–5.3)
Henricson [46]	2006	RCT	1	NexGen CR FB Zimmer; MBK MB Zimmer	23/26	72 (62–84)	72 (62–83)	2
Higuchi [47]	2009	RCT	2	PFC Sigma MB/FB DePuy	31/45	68 (56–81)	68 (56–81)	4
Ho [48]	2007	CS	3	LCS MB DePuy; MG 1 FB Zimmer	15/36	59 (48–73)	59 (40–74)	9.6 (4.0–13.5)
Hofstede [49]	2015	SR	2	Multiple				
Huang [52]	2002	CS	3	LCS MB DePuy; PCA FB Howmedica; AMK FB DePuy; MG 1 FB Zimmer; Richards Tricon FB S&N;	34/37	65 (±9)	69 (±7)	
Huang [53]	2002	CS	3	LCS MB DePuy; LCS PS MB DePuy; AMK FB DePuy; PCA FB Howmedica; MG 1 FB Zimmer; Richards Tricon FB S&N;	34/46	67 (±7)	67 (±7)	
Huang [50]	2007	R	3	Multiple				
Huang [51]	2009	R	3					
Huang [54]	2011	R	3					
Jacobs [55]	2004	SR	2	Multiple				
Jacobs [56]	2011	RCT	2	BalanSys MB/FB Mathys Medical	46/46	68	67	1
Jawed [57]	2012	BiL	1	PFC Sigma MB/FB DePuy	50/50	3.3 (3.0–3.9)	3.3 (3.0–3.9)	
Jolles [58]	2012	RCT	1	NexGen LPS MB/FB Zimmer	26/29	67 (±8)	70 (±7)	5
Kalisvaart [59]	2012	RCT	1	PFC Sigma MB/FB DePuy	76/76	67 (±8)	67 (±8)	5

Table 1 continued

References	Year	Study type	LoE	Type of prosthesis	Number of prostheses (MB/FB)	Age MB (years)	Age FB (years)	Follow-up (years)
Kim [67]	2001	BiL	1	LCS MB DePuy; AMK FB DePuy	116/116	65 (33–70)	66 (33–70)	7.4 (6–8)
Kim [64]	2007	BiL	1	PFC Sigma MB/FB DePuy	174/174	5.6 (5.2–6.1)		
Kim [68]	2007	BiL	1	LCS MB DePuy; AMK FB DePuy	146/146	70 (42–80)	70 (42–80)	13.2 (11.0–14.5)
Kim [65]	2009	BiL	1	LCS MB DePuy; AMK FB DePuy	61/61	48 (34–55)	48 (34–55)	10.8 (10–12)
Kim [69]	2009	RCT	1	Medial Pivot FB Wright; PFC Sigma MB DePuy	92/92	70 (55–81)	70 (55–81)	2.6 (2–3)
Kim [63]	2010	CS	3	Multiple	816/894	56 (33–65)	59 (33–65)	12.8 (10–17)
Kim [61]	2010	RCT	1	E.motion–FP MB B.Braun; Genesis II FB Smith & Nephew	66/66	70 (55–79)	70 (55–79)	2
Kim [62]	2012	CS	3	LPS Flex MB/FB Zimmer	32/34			1
Kim [60]	2012	RCT	1	Sigma RP MB DePuy; NexGen LPS Flex FB Zimmer	37/36	68 (±6)	66 (±6)	2.5–2.6
Kim [66]	2012	BiL	1	LCS MB DePuy; AMK FB DePuy	108/108	45 (29–50)	45 (29–50)	16.8 (15–18)
Kotani [70]	2005	CS	2	Genesis II MB/FF Smith & Nephew	24/195			>2
Lädermann [71]	2008	RCT	1	PFC Sigma MB/FB DePuy	44/48	72	70	7.1 (5.8–7.8)
Lampe [72]	2011	RCT	1	Columbus MB/FB B.Braun Aesculap	48/52	70 (52–84)	69 (53–84)	1
Li [73]	2014	MA	2	Multiple	1659/1638			>1
Liu [74]	2009	CS	3	LPS Flex MB/FB Zimmer	41,950	72	72	
Lizaur [75]	2012	RCT	1	Trekking MB Samo; Multigen Plus FB Lima	61/58	75 (70–83)	74 (70–82)	2
Lu [76]	2010	CS	3	LCS MB DePuy; PCA FB Howmedica; MG FB Zimmer	15/58	70 (45–81)	70 (45–81)	
Luring [77]	2006	CS	3	VectorVision MB Brainlab; PCF Sigma FB DePuy		67 (±8)	69 (±8)	2
Mahoney [79]	2012	RCT	2	Scorpio PS MB/FB Stryker	252/255	66 (35–81)	66 (40–83)	5.9 (2.2–7.9)
Marques [80]	2014	RCT	1	Columbus RP MB B.Braun; Columbus CR FB B.Braun	48/52	69 (±7)	69 (±8)	3–5
Matsuda [81]	2010	RCT	1	NexGen LPS Flex MB/FB Zimmer	30/31	73 (67–82)	76 (65–85)	5.9 (2.1–8.8)
McGonagle [83]	2014	CS	2	Rotaglide + MB/FB Corin Medical	75/74	66 (31–88)	67 (35–91)	5–10

Table 1 continued

References	Year	Study type	LoE	Type of prosthesis	Number of prostheses (MB/FB)	Age MB (years)	Age FB (years)	Follow-up (years)
Minoda [84]	2010	CS	3	NexGen LPS Flex FB; PFC Sigma MB	28/28	72 (57–83)	74 (57–85)	2
Minoda [85]	2015	RCT	1	Vanguard PS MB/FB Biomet	46/48	74 (±7)	76 (±7)	2
Moskal [87]	2014	MA	1	Multiple	966/944			
Munro [89]	2010	RCT	1	PFC Sigma MB/FB DePuy	25/23	67 (47–83)	68 (50–79)	2
Namba [91]	2011	R	3					
Namba [90]	2012	CS	2	Multiple	4830/41,908	68	62	
Nieuwenhuijse [92]	2013	RCT	1	NexGen LPS MB/FB Zimmer; NexGen LPS Flex MB/FB Zimmer	37/41			5
Nutton [93]	2012	RCT	1	PFC Sigma MB/FB DePuy	36/40	68 (66–71)	70 (67–72)	1
Oh [95]	2009	MA	1	Multiple	906			
Okamoto [96]	2014	RCT	1	NexGen LPS Flex MB/FB Zimmer	20/20	76 (65–88)	78 (70–84)	1
Pagnano [97]	2004	RCT	2	PFC Sigma MB/FB DePuy	80/160	67 (41–80)	67 (41–80)	
Pijls [98]	2012	RCT	2	Interax MB/FB Stryker–Howmedica	21/21	64 (±11)	66 (±14)	10–12
Post [100]	2010	R	3					
Price [101]	2003	BiL	1	TMK MB Biomet; ACG FB Biomet	39/39			1
Radetzki [102]	2013	RCT	2	NexGen LPS FB Zimmer; NexGen LPS Flex MB Zimmer	17/22	73 (±11)	75 (±8)	10.8 (± 0.8)
Rahman [103]	2010	RCT	1	PFC Sigma MB/FB DePuy	24/27	63 (52–72)	62 (44–78)	3.3/3.6
Ranawat [104]	2004	BiL	1	PFC Sigma MB/FB DePuy	25/25	74 (50–89)	74 (50–89)	18–132
Ranawat [105]	2004	CS	3	PFC Sigma MB/FB DePuy	20/20			
Rees [106]	2005	CS	3	TMK knee MB Biomet; AGC Knee FB Biomet	7/7	71 (±4)	71 (±4)	1.0–1.5
Saari [107]	2003	RCT	2	Freeman-Samuelson, MB/FB Finsbury	7/15	68 (64–74)	73 (62–79)	1
Sawaguchi [109]	2010	CS	3	PFC Sigma MB/FB DePuy		70	70	
Schuster [110]	2011	CS	2	BalanSys MB/FB Mathys Medical	32/95	67 (±7)	72 (±8)	3.9 (0.8–5)
Scuderi [111]	2012	RCT	1	NexGen LPS Flex MB/FB	28/19	64 (40–80)	63 (35–81)	2–4
Shemshaki [112]	2012	RCT	1	PFC Sigma MB/FB DePuy	150/150	68 (±14)	70 (±12)	5
Shi [113]	2008	CS	3	NexGen LPS Flex MB/FB	30/26	70 (60–83)	70 (42–85)	6–42
Shi [114]	2014	CS	3	PFC Sigma MB/FB DePuy	10/10	63 (±4)	64 (±3)	1.3 (± 0.5)

Table 1 continued

References	Year	Study type	LoE	Type of prosthesis	Number of prostheses (MB/FB)	Age MB (years)	Age FB (years)	Follow-up (years)
Siebold [115]	2007	CS	3	Duracon deep-dished MB/FB Howmedica	17/26	69 (45–81)	66 (52–80)	6–16
Silvestre [116]	2008	CS	3	Ceragyr MB Ceraver–Ostéal; Hermes FB Ceraver–Ostéal	68/68	68 (54–85)	70 (44–82)	4.7 (4–5)
Smith [119]	2010	MA	1	Multiple	1556/1903			
Smith [118]	2011	MA	1	Multiple	910/882			
Stoner [120]	2013	CS	3	PFC Sigma MB/FB DePuy	25/17	64 (47–85)	66 (47–86)	
Tibesku [122]	2011	RCT	2	Genesis II MB/FB Smith & Nephew	16/22	63 (48–79)	60 (42–74)	2.0 (0.9–3.5)
Tibesku [121]	2011	RCT	2	Genesis II MB/FB Smith & Nephew	16/17	66 (±19)	65 (±10)	2
Tienboon [123]	2012	RCT	2	PFC Sigma MB/FB DePuy	100/100	70 (±6)	68 (±10)	2
Tjornild [124]	2015	RCT	2	PFC Sigma MB/FB DePuy	23/23	66 (54–75)	66 (56–73)	2
Urwin [125]	2014	RCT	2	PFC Sigma MB/FB DePuy	8/8	60 (±8)	59 (±9)	0.8
v/d Bracht [126]	2010	R	3	Multiple				
v/d Voort [127]	2013	SR	2	Multiple	3024/3155			0.5 –13.2
van Stralen [128]	2015	CS	3	BalanSys MB/FB Mathys Medical	40/38	68 (±4)	67 (±5)	1
Vasdev [129]	2009	RCT	1	LCS MB DePuy; NexGen FB Zimmer	60/60	63 (55–75)	63 (57–76)	3.5 (1.0–4.6)
Vertullo [130]	2001	R	3					
Watanabe [132]	2005	BiL	1	Rotaglide MB Corin Medical; NexGen CR FB Zimmer	22/22	60 (35–78)	60 (35–78)	6.6–8.9
Watanabe [131]	2012	CS	2	NexGen LPS Flex MB/FB Zimmer	16/32			2.0 –3.4
Wen [133]	2011	MA	1	Multiple	1950			
Wohlrab [134]	2009	RCT	2	NexGen MB/FB Zimmer	19/22	67	66	5
Wolterbeek [136]	2012	CS	3	Duracon FB Stryker; Triathlon FB/MB Stryker; PFC Sigma FB DePuy; NexGen MB Zimmer; ROCC MB Biomet	23/29			0.4–3.6
Wolterbeek [135]	2012	RCT	1	Triathlon FB/MB Stryker	9/11	63 (±10)	66 (±9)	1
Wonglertsiri [137]	2013	CS	3	LPS MB/FB Zimmer	103/102	65 (35–80)	67 (51–83)	3 (2.3 –3.8)
Woolson [139]	2004	RCT	1	LCS MB DePuy; NexGen FB Zimmer	23/29	69 (37–83)	67 (37–83)	2–6
Woolson [138]	2011	RCT	1	LCS MB DePuy; NexGen FB Zimmer	33/30	78 (48–91)	78 (56–96)	10
Wylde [141]	2008	RCT	1	Kinemax Plus FB/MB Stryker	108/120	69 (41–80)	68 (40–80)	2

Table 1 continued

References	Year	Study type	LoE	Type of prosthesis	Number of prostheses (MB/FB)	Age MB (years)	Age FB (years)	Follow-up (years)
Zeng [142]	2013	MA	1	Multiple	6861			1 – 16.8
Zurcher [143]	2014	CS	2	NexGen LPS MB/FB Zimmer	11/10	62.8 (±12)	65.3 (±12)	>1.3

Multiple: More than 6 different types of prostheses were used. Data in average (±standard deviation) or average (minimum–maximum)

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

reading the full text, another 10 articles were excluded. Six of them did not report on the predetermined outcome variables, two articles had included uncemented prostheses in their analyses, and two articles were excluded because of comparing their own MB-TKA data with literature instead of their own FB-TKA data. All 127 studies are described in Table 1. The included studies consisted of 44 comparative studies (CS), 48 randomised controlled trials (RCT), 13 bilateral studies that compared MB-TKA in one knee and FB-TKA in the other (BiL), 10 reviews (R), three systematic reviews (SR) and nine meta-analyses (MA). No articles from before 2001 were found. Figure 2 shows the number of included papers that was published each year.

Insert wear

Results of the LoE 1 studies that reported on insert wear are detailed in Table 2. All five studies, two of which were bilateral studies, did not find a difference between MB-TKA and FB-TKA when looking at the radiological signs of insert wear. When looking at the LoE 2 and 3 studies, all LoE 2 studies and four out of seven LoE 3 studies did not find a difference between MB-TKA and FB-TKA (Table 7 in "Appendix"). Three LoE 3 studies reported a significant difference in wear in favour of MB-TKA.

Signs of loosening of the prosthesis

Twenty-eight LoE 1 studies reported radiolucencies or osteolysis (Table 3). All studies except for 1 reported no difference for any of these variables. The exception was an RCT by Bailey et al. [5], who reported a significantly higher percentage of radiolucencies around the tibial component in MB-TKA. The LoE 2 and 3 studies did not find a difference between MB-TKA and FB-TKA (Table 8 in "Appendix").

Survivorship

Table 4 shows all results on survival rate and number of revisions. Twenty-five LoE 1 studies were included, and none of these found a significant difference in either survival or revision rate between MB-TKA and FB-TKA. One LoE 2 study and three LoE 3 studies reported a significant difference in favour of FB-TKA for this parameter (Table 9 in "Appendix").

Clinical outcome

All clinical outcome results can be found in Table 5. Overall conclusion of the 50 LoE 1 studies was that there was no difference between MB-TKA and FB-TKA in almost all studies ($n = 47$), with 2 studies reporting results in favour of MB-TKA and 1 study reporting results in favour of

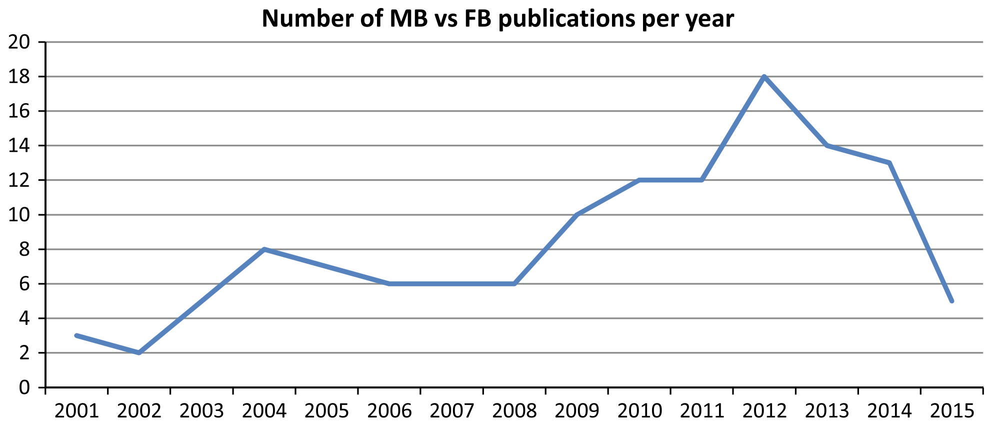

Fig. 2 Number of publications per year

Table 2 LoE 1 insert wear results

References	Study type	Conclusion	Radiological wear	Thickness measurements retrieved inserts MB	Retrieved inserts FB	Low-grade wear	High-grade wear
Breugem [18]	RCT	MB = FB	MB = FB				
Kim [67]	BiL	X		2	2	X	
Kim [68]	BiL	MB = FB	MB = FB				
Smith [118]	MA	X					
Smith [119]	MA	MB = FB	MB = FB				

MB = FB no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

MA meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

FB-TKA. One LoE 2 study and four LoE 3 studies showed clinical outcome results in favour of MB-TKA, opposed to only one that showed more benefits of FB-TKA. However, the other 53 LoE 2 and 3 studies reported no differences (Table 10 in "Appendix").

Discussion

The most important finding of the present study was an absence in difference between MB-TKA and FB-TKA. When comprehensively reviewing all available literature, type of bearing in TKA did not appear to influence insert wear, signs of loosening, survival rate of the prosthesis and clinical outcome. Both the enlarged contact surface and the reduction in movement of the femoral component on the surface of the insert in MB-TKA were hypothesised to result in less polyethylene wear [30]. The studies with the highest LoE included in this overview did not show differences between MB-TKA and FB-TKA in insert wear. This could be explained by the fact that insert wear is rare altogether and occurs late in the life cycle of a prosthesis. Since the 15-year survival rate of TKA is known to be above 90 % [78], only a very small number of patients have revision surgery because of insert wear. With this in mind, studies with large numbers of patients and a very long follow-up are necessary to be able to determine a difference in insert wear between MB-TKA and FB-TKA. Since in vitro studies also have not been able to produce consistent results on insert wear [28, 39, 41, 82, 88], a possible decrease in insert wear does not appear to be an argument in choosing between MB-TKA and FB-TKA. However, when looking at studies included in this overview with a lower LoE, three out of seven LoE 3 studies showed results in favour of MB-TKA. Studies that include retrieved inserts are essential in assessing actual insert wear, but unfortunately this type of research is categorised in a lower LoE and, therefore, often overlooked. The fact that several LoE 3 studies find that MB-TKA appears to be associated with less insert wear is, therefore, noteworthy, but does not seem to be associated with differences in function, outcome or survival.

Taking the LoE of studies into account, the current study shows that radiolucencies and osteolysis around MB-TKA do not differ significantly from FB-TKA. The only LoE 1 study that found a higher percentage of tibial radiolucencies in MB-TKA also showed that this difference did not influence clinical outcome in their patients [5] and,

Table 3 LoE 1 signs of loosening of the prosthesis

References	Study type	Conclusion	Femoral radiolucencies	Tibial radiolucencies	Osteolysis
Aggarwal [1]	RCT	MB = FB	MB = FB	MB = FB	
Bailey [5]	RCT	FB	MB = FB	FB	
Bhan [12]	BiL	MB = FB		MB = FB	
Cheng [24]	MA	MB = FB	MB = FB	MB = FB	
Hanusch [43]	RCT	MB = FB			MB = FB
Henricson [46]	RCT	X	X	X	
Jolles [58]	RCT	X	MB = FB	X	
Kalisvaart [59]	RCT	MB = FB	MB = FB		MB = FB
Kim [67]	BiL	MB = FB	MB = FB		
Kim [66]	BiL	MB = FB	MB = FB		
Kim [64]	BiL	MB = FB	MB = FB		
Kim [65]	BiL	MB = FB	MB = FB		MB = FB
Kim [68]	BiL	MB = FB	MB = FB	MB = FB	
Kim [69]	RCT	MB = FB	MB = FB	MB = FB	
Lädermann [71]	RCT	X	X	X	
Moskal [87]	MA	MB = FB	MB = FB	MB = FB	MB = FB
Munro [89]	RCT	X		X	
Nieuwenhuijse [92]	RCT	MB = FB	X	X	
Oh [95]	MA	MB = FB	MB = FB		
Rahman [103]	RCT	MB = FB	MB = FB	X	
Scuderi [111]	RCT	X	X	X	
Shemshaki [112]	RCT	MB = FB	MB = FB	MB = FB	MB = FB
Smith [118]	MA	X	MB = FB		MB = FB
Smith [119]	MA	MB = FB			
Watanabe [132]	BiL	MB = FB	MB = FB		
Wen [133]	MA	MB = FB	MB = FB		
Woolson [139]	RCT	MB = FB		MB = FB	
Woolson [138]	RCT	X	MB = FB	MB	MB = FB

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

therefore, this higher percentage seems not to be clinically relevant. It should be noted that the patients in this study were only evaluated at a maximum of 2-year follow-up. Whether the increase in tibial radiolucencies found in their MB-TKA group influences revision rates after 10 or 15 years is, therefore, unknown.

Several studies mentioned the number of revisions, but did not perform a statistical analysis to evaluate the differences. It was often unclear whether the revisions were caused by aseptic loosening or all causes. The LoE 1 studies did not show differences in the number of revisions. It is worth mentioning that three studies with a LoE of 2 or 3 showed a lower survival rate for MB-TKA compared to FB-TKA.

In this literature overview, patient-reported outcomes of questionnaires were included to quantify clinical outcome. The included literature showed that the experienced clinical outcome after undergoing MB-TKA did not differ from patients who underwent FB-TKA. The pain scores and ranges of motion of the knee also did not differ between both types of bearing. Besides, it has been shown that differences found in range of motion and questionnaires are hard to translate to clinically important differences, since these differences can fall within the variation of normal range of knee motion [105]. Furthermore, differences in objective measurements, like range of motion, do not appear to relate directly to the subjectively experienced quality of movement [115]. Based on this reasoning, in combination with the high amount of studies that did not find any differences in both the questionnaire results and the range of motion between MB-TKA and FB-TKA, it can be concluded that there is no difference between MB-TKA and FB-TKA in clinical outcome.

A strength of the current literature overview is the large number of included studies. In the first Cochrane review on

Table 4 LoE 1 survival rate + revisions

References	Study type	Conclusion	Survival rate	Revisions
Aggarwal [1]	RCT	MB = FB		MB = FB
Bailey [5]	RCT	MB = FB		MB = FB
Bhan [12]	BiL	MB = FB	MB = FB	
Cheng [24]	MA	MB = FB	MB = FB	MB = FB
Hanusch [43]	RCT	MB = FB		
Jolles [58]	RCT	X		
Kalisvaart [59]	RCT	MB = FB	MB = FB	
Kim [68]	BiL	X	MB = FB	
Kim [64]	BiL	MB = FB		
Kim [65]	BiL	MB = FB	MB = FB	
Kim [66]	BiL	MB = FB	MB = FB	
Kim [67]	BiL	MB = FB	X	X
Lädermann [71]	RCT	X		
Moskal [87]	MA	MB = FB		MB = FB
Nieuwenhuijse [92]	RCT	MB = FB		
Oh [95]	MA	MB = FB		
Rahman [103]	RCT	MB = FB		
Scuderi [111]	RCT	X		
Shemshaki [112]	RCT	MB = FB	MB = FB	
Smith [118]	MA	X		MB = FB
Smith [119]	MA	MB = FB		X
Watanabe [132]	BiL	MB = FB		
Wen [133]	MA	MB = FB		
Woolson [139]	RCT	MB = FB		
Woolson [138]	RCT	X		

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, BiL: bilateral study, *CS* comparative study

this subject in 2004, only 2 articles were of sufficient methodological quality to be included [55]. Scientific research on MB-TKA has increased dramatically after this review, and out of the 127 studies included in the current study, 51 were LoE 1. The present paper provides an overview of both high and lower LoE studies that has not been presented earlier. Another strength is the fact that results were included on four different theorised advantages of MB-TKA, and, therefore, a more complete picture of the results of MB-TKA in comparison with FB-TKA is given.

There are also several limitations to the current study. Included studies were categorised according to their level of evidence [108, 117, 140]. Although this method has proven reliable and has been widely accepted for classifying methodological designs [13, 94], this classification does not fully address the methodological quality [99]. The results of several studies have been included twice, since several RCT and CS studies that were included are also used in the SR and MA studies. It is possible that a small number of studies have not been included because only the PubMed database was searched. However, the chance that these studies would alter the conclusions of this study is small, considering the large amount of included studies and their comparable results. It can be considered a limitation that all different brands of prostheses and the different types (e.g. posterior stabilised/cruciate retaining) in MB-TKA and FB-TKA groups were combined. Because of this heterogeneity, it is possible that better outcome of individual prostheses is not fully addressed. This is inherent to the design of this literature overview and to (systematic) literature studies in general. Based on the consensus amongst LoE 1 studies, it is not to be expected that further differentiation into different types of prostheses would change the conclusions of this literature overview. The number of studies published on MB-TKA and FB-TKA is large and still increasing. However, the recent increase in evidence does not seem to provide new insights. It can, therefore, be argued that the discussion concerning the differences between MB-TKA and FB-TKA is not furthered by additional studies on this subject.

Conclusion

An extensive literature review was performed on studies examining differences between MB-TKA and FB-TKA, including a large number of studies with a lower LoE that are generally overlooked in other reviews. No clear differences were found between MB-TKA and FB-TKA in insert wear, signs of loosening of the prosthesis, survival rate and clinical outcome. Because of this, surgeons deciding between MB-TKA and FB-TKA for use in their day-to-day practice should be guided by different arguments, like surgeon experience with a certain type of prosthesis and financial or logistic advantages of different prostheses.

Table 5 LoE 1 clinical outcome parameters

References	Study type	Conclusion	Questionnaire	VAS	Flexion	Extension	Preference
Aggarwal [1]	RCT	MB = FB	MB = FB		MB		
Bailey [5]	RCT	MB = FB	MB = FB				
Ball [6]	RCT	MB = FB	MB = FB		MB = FB		
Beard [10]	BiL	MB = FB	MB = FB				
Bhan [12]	BiL	MB = FB	MB = FB		MB = FB		
Breugem [18]	RCT	MB = FB	MB = FB	MB = FB	MB = FB		
Cheng [24]	MA	MB = FB	MB = FB	MB = FB	MB = FB		X
Chiu [25]	BiL	MB = FB	MB = FB		MB = FB		
Ferguson [36]	RCT	MB = FB	MB = FB				
Hansson [42]	RCT	MB = FB	MB = FB				
Hanusch [43]	RCT	MB = FB	MB = FB		MB = FB	MB = FB	
Hasegawa [45]	BiL	MB = FB	MB = FB		MB = FB		
Henricson [46]	RCT	MB = FB	MB = FB				
Jawed [57]	BiL	MB = FB	MB = FB		MB = FB		
Jolles [58]	RCT	X	MB = FB	MB = FB	MB = FB	MB = FB	
Kalisvaart [59]	RCT	MB = FB	MB = FB		MB = FB		
Kim [67]	BiL	MB = FB	MB = FB	MB = FB	MB = FB		MB = FB
Kim [61]	RCT	FB	MB = FB		MB = FB		
Kim [69]	RCT	MB	MB = FB				
Kim [64]	BiL	MB = FB	MB = FB		MB = FB		
Kim [60]	RCT	MB = FB	MB = FB				
Kim [65]	BiL	MB = FB	MB = FB		MB = FB		
Kim [68]	BiL	MB = FB	MB = FB		MB = FB		FB
Kim [66]	BiL	MB = FB	MB				X
Lädermann [71]	RCT	MB = FB	MB = FB	MB = FB	MB = FB		
Lampe [72]	RCT	MB = FB	MB = FB		MB = FB		
Lizaur [75]	RCT	X	MB = FB	FB	MB = FB		
Marques [80]	RCT	MB = FB	MB = FB		MB = FB		
Matsuda [81]	RCT	MB = FB	MB = FB		MB = FB	MB = FB	X
Minoda [85]	RCT	MB = FB	MB = FB		MB = FB	MB = FB	
Moskal [87]	MA	MB = FB	MB = FB		MB = FB	MB = FB	
Munro [89]	RCT	MB = FB	MB = FB	MB = FB			
Nieuwenhuijse [92]	RCT	MB = FB	MB = FB		MB = FB	MB = FB	
Nutton [93]	RCT	MB = FB	MB = FB		MB		
Oh [95]	MA	MB = FB	MB = FB		MB = FB		MB = FB
Okamoto [96]	RCT	MB = FB	MB = FB		MB = FB	MB = FB	
Price [101]	BiL	MB	MB				MB = FB
Rahman [103]	RCT	MB = FB	MB = FB		MB = FB		
Ranawat [104]	BiL	MB = FB	MB = FB		MB = FB		MB = FB
Scuderi [111]	RCT	MB = FB	MB = FB		MB = FB		
Shemshaki [112]	RCT	MB = FB	MB = FB	MB = FB	MB = FB		
Smith [118]	MA	MB = FB	MB = FB	X	MB = FB	MB = FB	MB = FB
Smith [119]	MA	MB = FB	MB = FB	X	MB = FB		
Vasdev [129]	RCT	MB = FB	MB = FB		MB = FB		
Watanabe [132]	BiL	MB = FB	MB = FB		MB = FB		
Wen [133]	MA	MB = FB	MB = FB		MB = FB	MB = FB	MB = FB
Wolterbeek [135]	RCT	MB = FB	MB = FB		MB = FB		
Woolson [139]	RCT	MB = FB	MB = FB		MB = FB		
Woolson [138]	RCT	MB = FB	MB = FB		MB = FB		
Wylde [141]	RCT	MB = FB	MB = FB				

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

Appendix

See Tables 6, 7, 8, 9 and 10.

Table 6 Search string for PubMed/MEDLINE

1 Search rotating platform
2 Search meniscal bearing
3 Search anterior–posterior glide rotation
4 Search mobile bearing
5 Search (1 or 2 or 3 or 4)
6 Search total or TKA
7 Search fixed
8 Search (5 and 6 and 7)
9 Search hemi
10 Search unicompartmental
11 Search (9 or 10)
12 Search 8 not 11 filters: abstract; English

Table 7 LoE 2 + 3 insert wear results

References	Study type	LoE	Conclusion	Radiological wear	Thickness measurements	Retrieved inserts MB	Retrieved inserts FB	Low-grade wear	High-grade wear
Aglietti [2]	RCT	2	MB = FB	MB = FB					
Mahoney [79]	RCT	2	X			8	10	X	X
Pijls [98]	RCT	2	MB = FB	MB = FB					
Berry [11]	CS	3	MB		MB	97	218		
Biau [14]	CS	3	MB = FB	MB = FB					
Engh [33]	CS	3	MB = FB	MB = FB		12	12		
Ho [48]	CS	3	MB			15	36	FB	MB
Huang [52]	CS	3	MB			34	37		MB
Lu [76]	CS	3	MB = FB			15	22	MB = FB	MB = FB
Stoner [120]	CS	3	MB = FB	MB = FB	MB = FB	25	17		

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

Table 8 LoE 2 + 3 signs of loosening of the prosthesis

References	Study type	LoE	Conclusion	Femoral radiolucencies	Tibial radiolucencies	Osteolysis
Aglietti [2]	RCT	2	MB = FB	MB = FB		
Bistolfi [15]	CS	2	MB = FB	X	X	X
Bo [16]	MA	2	MB = FB	MB = FB	MB = FB	
Breeman [17]	RCT	2	MB = FB			
Harrington [44]	RCT	2	MB = FB	MB = FB		
Hofstede [49]	SR	2	MB = FB	MB = FB	MB = FB	
Jacobs [56]	RCT	2	MB = FB	MB = FB		
Li [73]	MA	2	MB = FB	MB = FB	MB = FB	
Mahoney [79]	RCT	2	MB = FB			
Namba [90]	CS	2	MB = FB			
Pijls [98]	RCT	2	MB = FB	X	X	
Radetzki [102]	RCT	2	MB = FB	X	X	

Table 8 continued

References	Study type	LoE	Conclusion	Femoral radiolucencies	Tibial radiolucencies	Osteolysis
v/d Voort [127]	SR	2	MB = FB	MB = FB	MB = FB	MB = FB
Wohlrab [134]	RCT	2	X	X		
Zeng [142]	MA	2	MB = FB	MB = FB	MB = FB	MB = FB
Argenson [4]	CS	3	MB = FB			
Huang [50]	R	3	X			X
Huang [53]	CS	3	FB			
Huang [52]	CS	3	X			
Kim [63]	CS	3	MB = FB	MB = FB	MB = FB	X
Minoda [84]	CS	3	MB = FB	MB = FB		
Post [100]	R	3	MB = FB	X	X	

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

Table 9 LoE 2 + 3 survival rate + revisions

References	Study type	LoE	Conclusion	Survival rate	Revisions
Aglietti [2]	RCT	2	MB = FB		
Bistolfi [15]	CS	2	MB = FB	MB = FB	X
Bo [16]	MA	2	MB = FB		MB = FB
Breeman [17]	RCT	2	MB = FB		MB = FB
Harrington [44]	RCT	2	MB = FB		
Hofstede [49]	SR	2	MB = FB	MB = FB	MB = FB
Jacobs [56]	RCT	2	MB = FB		
Mahoney [79]	RCT	2	MB = FB	MB = FB	
McGonagle [83]	CS	2	MB = FB	MB = FB	MB = FB
Namba [90]	CS	2	FB		FB
Pijls [98]	RCT	2	MB = FB		X
Radetzki [102]	RCT	2	MB = FB		X
v/d Voort [127]	SR	2	MB = FB		MB = FB
Wohlrab [134]	RCT	2	X		
Zeng [142]	MA	2	MB = FB	MB = FB	MB = FB
Argenson [4]	CS	3	MB = FB	MB = FB	MB = FB
Gothesen [38]	CS	3	FB		FB
Gupta [40]	CS	3	FB	FB	
Huang [50]	R	3	X	X	
Huang [53]	CS	3	FB	X	
Huang [52]	CS	3	X	X	
Kim [63]	CS	3	MB = FB	MB = FB	MB = FB
Minoda [84]	CS	3	MB = FB		
Post [100]	R	3	MB = FB	MB = FB	

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

Table 10 LoE 2 + 3 clinical outcome parameters

References	Study type	LoE	Conclusion	Questionnaire	VAS	Flexion	Extension	Preference
Aglietti [2]	RCT	2	MB = FB	MB = FB		FB	MB = FB	MB = FB
Bistolfi [15]	CS	2	MB = FB	MB = FB		MB = FB		
Bo [16]	MA	2	MB = FB	MB = FB		MB = FB	MB = FB	
Breeman [17]	RCT	2	MB = FB	MB = FB				
Breugem [19]	RCT	2	MB = FB	MB = FB	MB = FB			
Delport [26]	CS	2	MB = FB	MB = FB				
Harrington [44]	RCT	2	MB = FB	MB = FB		MB = FB		
Higuchi [47]	RCT	2	MB			MB = FB	MB	
Hofstede [49]	SR	2	MB = FB	MB = FB	MB = FB	MB	MB = FB	
Jacobs [55]	SR	2	MB = FB	MB = FB		MB = FB		
Jacobs [56]	RCT	2	MB = FB	MB = FB		MB = FB		
Kotani [70]	CS	2	MB = FB			MB = FB	MB = FB	
Li [73]	MA	2	MB = FB	MB = FB	MB			MB = FB
Mahoney [79]	RCT	2	MB = FB	MB = FB		MB = FB	MB = FB	
McGonagle [83]	CS	2	MB = FB	MB = FB	MB = FB	MB = FB		
Pagnano [97]	RCT	2	MB = FB	MB = FB		MB = FB		
Pijls [98]	RCT	2	MB = FB	MB = FB		MB = FB		
Radetzki [102]	RCT	2	MB = FB	MB = FB		MB = FB		
Saari [107]	RCT	2	MB = FB	MB = FB				
Schuster [110]	CS	2	MB = FB			MB = FB		
Tibesku [122]	RCT	2	MB = FB					
Tibesku [121]	RCT	2	MB = FB	MB = FB	MB = FB	MB = FB		
Tjornild [124]	RCT	2	MB = FB	MB = FB				
Urwin [125]	RCT	2	MB = FB	MB = FB		MB = FB		
v/d Voort [127]	SR	2	MB = FB	MB = FB		MB		
Watanabe [131]	CS	2	MB = FB			MB = FB		
Wohlrab [134]	RCT	2	MB = FB	MB = FB		MB = FB		
Zurcher [143]	CS	2	MB = FB					
Argenson [4]	CS	3	MB	MB		MB = FB		
Banks [7]	CS	3	FB			FB		
Banks [8]	CS	3	X					
Banks [9]	CS	3	X					
Biau [14]	CS	3	MB = FB	MB = FB		MB = FB		
Catani [22]	CS	3	X	X				
Chen [23]	CS	3	MB = FB	MB = FB		MB	MB = FB	
Delport [27]	CS	3	MB			MB		
Dennis [29]	R	3	MB = FB					
Dennis [31]	CS	3	MB = FB					
Dennis [32]	CS	3	MB = FB			MB = FB		
Evans [34]	CS	3	MB = FB			MB = FB		
Geiger [37]	CS	3	MB = FB	MB = FB		MB = FB		
Kim [63]	CS	3	MB = FB	MB = FB		MB = FB		
Kim [62]	CS	3	MB = FB	MB = FB				
Liu [74]	CS	3	MB = FB					MB = FB
Luring [77]	CS	3	MB = FB	MB = FB		MB = FB		
Minoda [84]	CS	3	MB = FB	MB = FB		MB = FB	MB = FB	
Post [100]	R	3	MB = FB	X				
Ranawat [105]	CS	3	MB = FB					

Table 10 continued

References	Study type	LoE	Conclusion	Questionnaire	VAS	Flexion	Extension	Preference
Rees [106]	CS	3	MB					
Sawaguchi [109]	CS	3	MB					
Shi [114]	CS	3	MB = FB			MB = FB		
Shi [113]	CS	3	X	MB = FB		MB = FB		
Siebold [115]	CS	3	X	MB = FB				
Silvestre [116]	CS	3	MB = FB	MB = FB	MB = FB	MB = FB		MB = FB
Tienboon [123]	RCT	3	MB = FB	MB = FB		MB		
v/d Bracht [126]	R	3	MB = FB	MB = FB	X	MB = FB		
van Stralen [128]	CS	3	MB = FB	MB = FB	MB = FB			
Wolterbeek [135]	CS	3	MB = FB	X		MB = FB		
Wonglertsiri [137]	CS	3	MB = FB	MB = FB		MB = FB		

MB = FB: no difference between MB-TKA and FB-TKA. MB: results favour MB-TKA. FB: results favour FB-TKA. X: no conclusion because of missing statistical analysis

LoE level of evidence, *MA* meta-analysis, *SR* systematic review, *R* review, *RCT* randomised controlled trial, *BiL* bilateral study, *CS* comparative study

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