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A systematic review and meta-regression of mobile-bearing *versus* fixed-bearing total knee replacement in 41 studies

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doi:10.1302/0301-620X.95B9.30386 $2.00

Bone Joint J
2013;95-B:1209–16.
Received 17 October 2012; Accepted after revision 26 April 2013

Mobile-bearing (MB) total knee replacement (TKR) was introduced to reduce the risk of aseptic loosening and wear of polyethylene inserts. However, no consistent clinical advantages of mobile- over fixed-bearing (FB) TKR have been found. In this study we evaluated whether mobile bearings have an advantage over fixed bearings with regard to revision rates and clinical outcome scores. Furthermore, we determined which modifying variables affected the outcome.

A systematic search of the literature was conducted to collect clinical trials comparing MB and FB in primary TKR. The primary outcomes were revision rates for any reason, aseptic loosening and wear. Secondary outcomes included range of movement, Knee Society score (KSS), Oxford knee score (OKS), Short-Form 12 (SF-12) score and radiological parameters. Meta-regression techniques were used to explore factors modifying the observed effect.

Our search yielded 1827 publications, of which 41 studies met our inclusion criteria, comprising over 6000 TKRs. Meta-analyses showed no clinically relevant differences in terms of revision rates, clinical outcome scores or patient-reported outcome measures between MB and FB TKRs. It appears that theoretical assumptions of superiority of MB over FB TKR are not borne out in clinical practice.

Cite this article: ***Bone Joint J*** **2013;95-B:1209–16.**

Mobile-bearing (MB) total knee replacement (TKR) was introduced to reduce the risk of aseptic loosening and wear of the polyethylene insert by increasing implant conformity and minimising the stresses transmitted to the prosthesis–bone interface.[1,2] Whether these properties of MB TKR lead to superior clinical performance over fixed-bearing (FB) TKR is unclear. Several randomised clinical trials have reported conflicting results, and meta-analyses have reported no difference in clinical outcome between MB and FB TKR.[3-5] These meta-analyses were inconclusive with regard to implant longevity, and all had restricted inclusion criteria, leaving only a limited number of studies to be examined. Therefore, this systematic review and meta-analysis addressed implant longevity and included controlled trials without restrictions, thereby providing a comprehensive overview and minimising bias. The primary objective of this study was to determine the clinical outcome of MB TKR in comparison to the conventional FB TKR in primary TKR, with regard to revision rates, range of movement, Knee Society score (KSS),[6] Oxford knee score (OKS),[7] Short-Form 12 (SF-12) score,[8] Western Ontario and McMaster Universities osteoarthritis index (WOMAC)[9] and radiological parameters. The second objective was to search for modifying variables affecting the outcome, using meta-regression analysis.

Materials and Methods

The aim of the search was to identify randomised controlled clinical trials comparing the outcomes of MB and FB primary TKR. The search strategy was composed in collaboration with an experienced medical librarian in order to minimise publication bias.[10] The following databases were searched up to 2012: Medline, EMBASE (OVID version), Web of Science, Cochrane Library and CINAHL (EbscoHost version). The search strategy consisted of the following components, each defined by a combination of controlled vocabulary and free text terms: 1) osteoarthritis or rheumatoid arthritis; 2) total knee replacement; and 3) randomised controlled trial or controlled clinical trial. There were no restrictions on language or date, and relevant articles were screened for additional references.

Two reviewers (KAN, BGP) independently selected the trials to be included in the review. Initial screening based on title and abstract was performed to identify studies that met the following inclusion criteria: 1) the study had to be a (randomised) controlled clinical trial; 2) the interventions evaluated in the trials had to be MB and FB primary TKR; 3) the indication for the patient to undergo TKR had to be osteoarthritis or rheumatoid arthritis; 4) outcome measurement(s) in the studies had to include rate of revision (for any reason, aseptic loosening or wear) with a minimum follow-up of five years, functional outcome score, or patient-reported outcome measurement. Subsequently, the full texts of eligible studies were evaluated and studies were excluded when: 1) the study did not meet the initial inclusion criteria for title and abstract; and 2) the population had already been reported in another included study (the most informative version was included). Abstracts without full text were given full consideration when sufficient clinical outcome data for further analysis were available.

Outcome measures. Primary outcomes were revision rate for any reason, aseptic loosening and wear. Secondary outcomes included functional outcome scores (range of movement and KSS), patient-reported outcome measurements, (SF-12, OKS and WOMAC), radiological evaluation (radiolucent lines and osteolysis around the prosthesis) and implant migration (maximum total point motion (MTPM)) as measured by radiostereophotogrammetric analysis (RSA). A clinically relevant difference between the designs was a difference of 10° in range of movement or 10 points on clinical scores (e.g. OKS, SF-12), based on an expert Delphi consensus study.[11]

Data extraction. Two reviewers (PvdV, KAN) independently extracted data concerning participants (age, gender, body mass index, aetiology); methods (study design, number of TKRs, start inclusion, mean follow-up, number lost to follow-up, date of publication, funding, country); interventions (type of arthroplasty, type of MB, management of the posterior cruciate ligament, use of cement, treatment of the patella); outcomes (revision rates, range of movement, KSS, HSS, OKS, WOMAC, SF-12, radiolucent lines and osteolysis around the prosthesis, MTPM).

Methodological assessment. Critical appraisal was conducted independently by two reviewers (PvdV, KAN) using the Jadad scale.[12] This is a five-item scale designed to assess randomisation, blinding, withdrawals and dropouts, and the score for each article ranges from 0 (lowest quality) to 5 (highest quality). As blinding of the surgeon is not feasible, studies were regarded as ‘double-blind’ when blinding of both patient and assessor was reported. Disagreements about study selection, data extraction and clinical appraisal were resolved by consensus with a third reviewer (RGHHN), who acted as a referee.

Statistical analysis. All data were combined for random-effects meta-analysis (RMA) according to the pooled Mantel–Haenszel test for risk differences (RDs) with 95% confidence intervals (CI), and the pooled standard error for mean differences (MDs) also with 95% CI. Heterogeneity between studies was tested with the I^2 statistic.[13] This test describes the proportion of total variation in outcome measures across studies that is due to heterogeneity rather than chance. Outcome measures showing heterogeneity among different studies were explored with meta-regression analysis (MRA). This model searches for modifying variables that affect the outcome between studies, and can therefore help resolve contradictory outcomes of different studies. Potentially associated variables, such as mean follow-up time, patellar resurfacing and type of MB design, served as covariates to the regression model. In order to assess for publication bias we constructed a funnel plot for studies reporting the primary outcome. A ‘trim and fill’ method was used when there was asymmetry in the funnel plot to adjust for publication bias owing to missing studies and estimate the overall effect size.[14] All analyses were performed with the metaphor package for R v2.13 (R Development Core Team, Vienna, Austria).[15]

Results

Study characteristics. The literature search yielded 1827 possible papers for analysis, of which 41 studies met the inclusion criteria: one publication described two studies[16] (Fig. 1). Those 41 studies comprised 3024 MB and 3155 FB primary TKRs (Table I). A total of 40 were randomised controlled trials[2,4,16-52] and one was a controlled clinical trial.[53] One included study was an abstract describing an unpublished randomised controlled trial.[52] The mean follow-up ranged from 0.5 to 13.2 years. In 19 studies (63%) funding had been received from industry. In all, 39 articles were written in English and one article in German.[41]

Arthroplasty characteristics. With regard to the type of MB, the majority of the studies (26 of 40 reporting on bearing type, 65%) used a rotating platform MB, three (7%) a meniscal bearing, nine (23%) an anteroposterior gliding and rotating platform, and two (5%) a floating platform. In the MB group, 16 studies reported the use of a posterior stabilised implant *versus* 18 in the FB group. In 24 studies the patella was resurfaced. All tibial components were cemented, except in one study.[23]

Study quality. All but one study described the randomisation process, with 29 studies reporting an adequate generation of allocation sequences. Blinding was reported in eight studies, but only one study reported blinding of both patient and assessor. The mean total Jadad score was 2.7 (SD 0.8). Meta-regression analysis showed no effect of the study quality, expressed as the total Jadad score, on the range of movement (0.2°/Jadad unit (95% CI -1.2 to 1.6); p = 0.8, MRA), KSS clinical score (-0.5/Jadad unit (95% CI -1.8 to 0.8); p = 0.4, MRA) and KSS functional score (0.4/Jadad unit (95% CI -1.2 to 1.9); p = 0.6, MRA). There was no evidence of publication bias in studies reporting revision rates confirmed by the lack of asymmetry of the funnel plots.

Revision rates. Meta-analyses for the primary outcomes in studies with a minimum follow-up of five years and studies with a minimum follow-up of ten years revealed no differences in revision rates for any reason, or for aseptic loosening or wear. In studies with a minimum follow-up of five

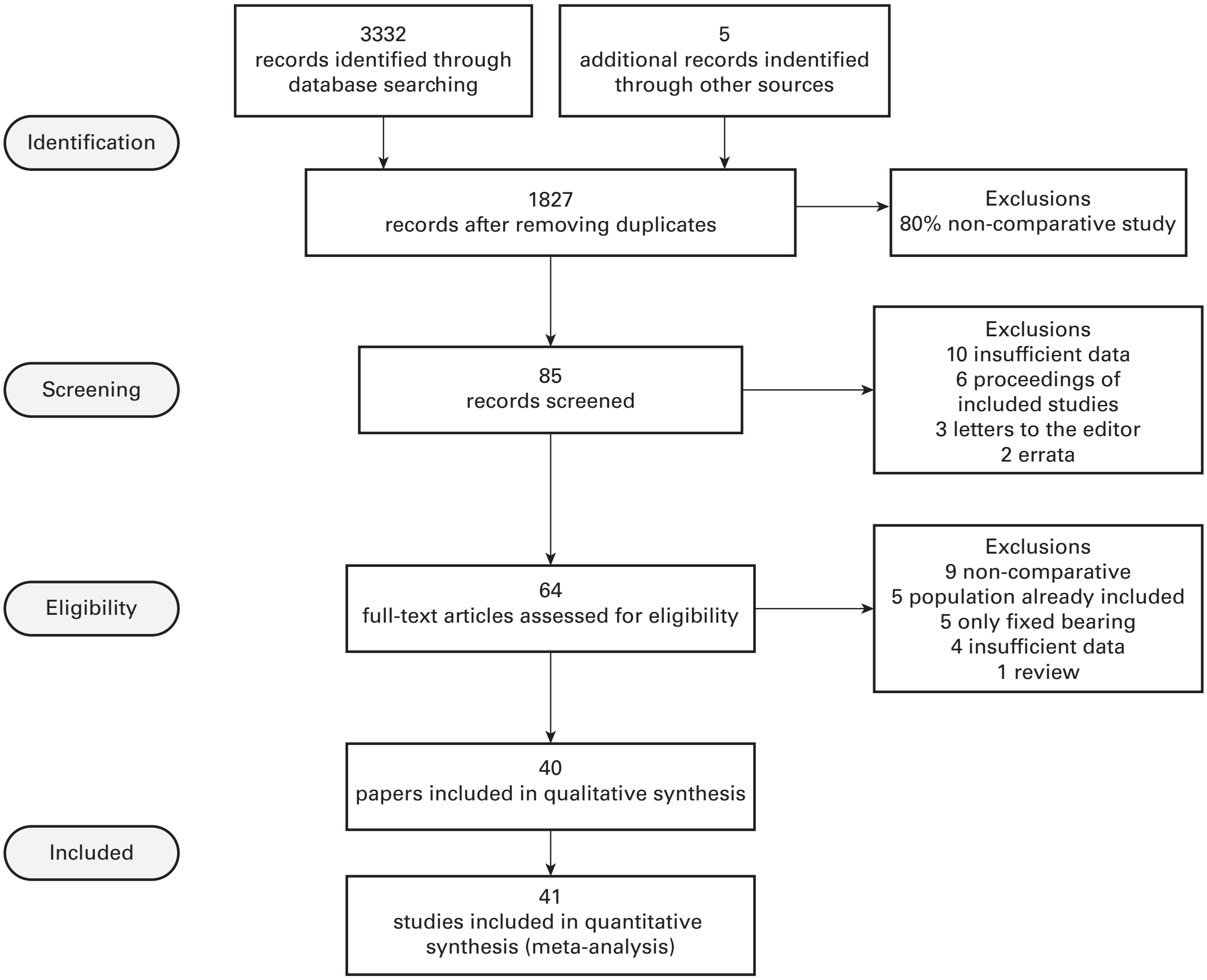

Fig. 1

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram depicting the number of records identified, included or excluded, and reasons for exclusion.

years (n = 13) there were 40 revisions for any reason in 1172 MB TKRs, and 28 revisions for any reason in 1245 FB TKRs (RD -0.01 (95% CI -0.02 to 0.0); p = 0.3, RMA) (Fig. 2). Three MB TKRs and one FB TKR were revised for aseptic loosening (RD 0.0 (95% CI 0.0 to 0.0); p = 0.7, RMA); four MB TKRs and eight FB TKRs were revised for wear (RD 0.0 (95% CI 0.0 to 0.0); p = 0.7, RMA). In studies with a minimum follow-up of ten years (n = 3) there were 13 revisions for any reason in 289 MB TKRs, and 11 revisions for any reason in 276 FB TKRs (RD 0.0 (95% CI -0.01 to 0.0); p = 0.8, RMA). One MB TKR and one FB TKR were revised for aseptic loosening (RD 0.0 (95% CI 0.0 to 0.0); p = 0.7, RMA). Three MB TKRs and six FB TKRs were revised for wear (RD 0.0 (95% CI 0.0 to 0.0); p = 0.2, RMA). There was no evidence of heterogeneity across studies (I^2 = 0.00) for all three outcomes (i.e. revision rate for any reason, aseptic loosening and wear). Therefore, it was not necessary to explore sources of heterogeneity using meta-regression analysis.

Functional scores. Meta-analyses for the secondary outcomes showed an MD in the range of movement of 0.5° (95% CI -0.8 to 1.7); p = 0.6, RMA) in favour of MB TKR (Fig. 3). However, there was considerable heterogeneity (I^2 = 0.75) across studies reporting range of movement, which could be explained by stratifying for the type of MB using meta-regression analysis. In comparison with FB TKR, rotating platforms showed a significantly better range of movement (MD +1.4°, 95% CI 0.2 to 2.7; p = 0.02, MRA) (Table II). The anteroposterior gliding and rotating platform showed a significantly worse range of movement (MD -3.1°, 95% CI -5.5 to -0.8) compared with FB TKR (p = 0.01, MRA). The meniscal bearing and floating platform TKR showed a respectively better (MD +0.4°, 95% CI -3.6 to 4.5) and worse (MD -0.3°, 95% CI -4.8 to 4.3) range of movement in comparison with FB TKR, albeit not

Table I. Details of the included studies of mobile-bearing (MB) and fixed-bearing (FB) total knee replacements

Study	Study	Knees (n)	Implant type*	Mobile bearing design†	Mean follow-up (yrs)	Mean age (yrs)	Female (%)	Osteoarthritis (%)
Aglietti et al[17]	MB	103	MBK – Zimmer	RP + AP gliding	3	70.2	83.8	100
	FB	107	NexGen LPS – Zimmer					
Ball et al[18]	MB	51	Scorpio – Stryker	RP	4	64.5	56	n/a
	FB	49	Scorpio – Stryker					
Beard et al[19]	MB	40	TMK – Biomet	RP + AP gliding	3.7	73.1	60	100
	FB	40	AGC – Biomet					
Bhan et al[20]	MB	34	LCS – DePuy	RP	6	63	68.8	50
	FB	34	Columbus – Zimmer					
Breugem et al[21]	MB	48	NexGen LPS – Zimmer	RP	1	70	64.1	100
	FB	55	NexGen LPS – Zimmer					
Chatterji et al[52]	MB	70	NexGen – Zimmer	RP	1	67	n/a	92.8
	FB	69	NexGen – Zimmer					
Garling et al[2]	MB	21	Interax – Stryker‡	RP + AP gliding	2	66	63.6	31
	FB	21	Interax – Stryker‡					
Gioe et al[22]	MB	191	PFC Sigma – DePuy	RP	3.5	72.2	2.9	97.1
	FB	191	PFC Sigma – DePuy					
Hansson et al[23]	MB	25	Rotaglide – Corin	RP + AP gliding	2	74.5	50	100
	FB	27	Nuffield – Corin					
Hanusch et al[24]	MB	60	PFC Sigma – DePuy	RP	1.1	69.7	49.5	100
	FB	60	PFC Sigma – DePuy					
Harrington et al[25]	MB	68	PFC Sigma – DePuy	RP	2	63.5	64.3	86.3
	FB	72	PFC Sigma – DePuy					
Hasegawa et al[26]	MB	25	PFC Sigma – DePuy	RP	3.3	73	88	100
	FB	25	PFC Sigma – DePuy					
Henricson et al[27]	MB	26	MBK – Zimmer	RP + AP gliding	2	72	62.5	100
	FB	26	NexGen LPS – Zimmer					
Higuchi et al[28]	MB	31	PFC Sigma – DePuy	RP	4	68.4	72.1	100
	FB	45	PFC Sigma – DePuy					
Jacobs et al[29]	MB	50	BalanSys – Mathys Medical	RP + AP gliding	n/a	67.2	70.7	100
	FB	48	BalanSys – Mathys Medical					
Johnston et al[30]	MB	230	TMK – Biomet	RP + AP gliding	2	69	59.9	93.4
	FB	244	AGC – Biomet					
Kim et al[31]	MB	40	PFC Sigma – DePuy	RP	2.5	67	96.3	100
	FB	40	NexGen LPS – Zimmer					
Kim et al[16]	MB	38	e.motion FP – B.Braun-Aesculap	FP	2	68.5	97	100
	FB	38	Genesis II – Smith & Nephew					
Kim et al[16]	MB	38	e.motion FP – B.Braun-Aesculap	FP	2	68.5	97	100
	FB	38	Genesis II – Smith & Nephew					
Kim et al[32]	MB	120	LCS – DePuy	MeBe	7.4	65	69	94.8
	FB	120	AMK – DePuy					
Kim et al[33]	MB	160	LCS – DePuy	RP	13.2	69.8	94.5	94
	FB	160	AMK – DePuy					
Kim et al[34]	MB	194	PFC Sigma – DePuy	RP	5.6	67	64.4	99.4
	FB	194	PFC Sigma – DePuy					
Kim and Kim[36]	MB	69	LCS – DePuy	MeBe	10.8	48.3	73.8	95.1
	FB	69	AMK – DePuy					
Kim et al[35]	MB	92	PFC Sigma – DePuy	RP	2.6	69.5	92.4	100
	FB	92	Advance medial pivot – Wright Medical					
Lädermann et al[37]	MB	52	PFC Sigma – DePuy§	RP	7.1	70.9	68.6	90.4
	FB	52	PFC Sigma – DePuy§					
Lampe et al[38]	MB	48	Columbus – B.Braun-Aesculap	RP	1	70	73	89
	FB	52	Columbus – B.Braun-Aesculap					
Lizaur-Utrilla et al[39]	MB	61	Trekking – Samo	RP	2.5	74.3	79	100
	FB	58	Multigen Plus – Lima					
Mahoney et al[4]	MB	252	Scorpio – Stryker	RP	5.9	66	63.9	100
	FB	255	Scorpio – Stryker					
Matsuda et al[40]	MB	30	NexGen LPS-Flex – Zimmer	RP	5.7	74.8	77	96
	FB	31	NexGen LPS-Flex – Zimmer					
Mockel et al[41]	MB	23	PFC Sigma – DePuy	RP	0.5	69	71.4	79.4
	FB	40	Natural knee II – Centerpulse					
Munro et al[42]	MB	27	PFC Sigma – DePuy§	RP	2	67.4	43.8	100
	FB	27	PFC Sigma – DePuy§					
Pagnano et al[43]	MB	80	PFC Sigma – DePuy	RP	5	67	69.6	100
	FB	160	PFC Sigma – DePuy					
Rahman et al[44]	MB	27	PFC Sigma – DePuy¶	RP	3.5	62.3	62.8	92.2
	FB	27	PFC Sigma – DePuy¶					
Rees et al[45]	MB	40	TMK – Biomet	RP + AP gliding	n/a	70.8	n/a	100
	FB	40	AGC – Biomet					
Scuderi et al[46]	MB	201	NexGen LPS-Flex – Zimmer	RP	2.5	63.6	58.4	97.3
	FB	187	NexGen LPS-Flex – Zimmer					
Munoz et al[53]	MB	69	Ceragyr – Ceraver-Osteal	RP + AP gliding	4.7	69	71.9	n/a
	FB	71	Hermes – Ceraver-Osteal					
Vasdev et al[47]	MB	60	LCS – DePuy	RP	3.5	63	58.3	100
	FB	60	NexGen LPS – Zimmer					
Watanabe et al[48]	MB	22	Rotaglide – Corin	RP + AP gliding	8.1	59.6	95.5	18.2
	FB	22	NexGen LPS – Zimmer					
Wohlrab et al[49]	MB	30	NexGen LPS-Flex – Zimmer	RP	5.5	65.7	56.1	100
	FB	30	NexGen LPS – Zimmer					
Woolson et al[50]	MB	60	LCS – DePuy	RP	11.4	78	n/a	80
	FB	47	NexGen LPS – Zimmer					
Wylde et al[51]	MB	118	Kinemax Plus – Stryker**	n/a	2	68.2	54.5	90.1
	FB	132	Kinemax Plus – Stryker**					

* Zimmer (Warsaw, Indiana); Stryker (Mahwah, New Jersey); Biomet (Bridgend, United Kingdom); DePuy (Warsaw, Indiana); Corin (Cirencester, United Kingdom); Mathys Medical (Bettlach, Switzerland); Braun-Aesculap (Tuttlingen, Germany); Smith & Nephew (Memphis, Tennessee); Wright Medical (Arlington, Tennessee); Samo (Bologna, Italy); Lima (Udine, Italy); Centrepulse (Baar, Switzerland); Ceraver-Osteal (Roissy, France)
† RP, rotating platform; AP gliding, anteroposterior gliding platform; MeBe, meniscal bearing; FP, floating platform; n/a, not applicable
‡ Stryker (Rutherford, New Jersey)
§ DePuy (Leeds, United Kingdom)
¶ DePuy (Raynham, Massachusetts)
** Stryker (Limerick, Ireland)

significant (respectively, p = 0.8 and p = 0.9, MRA). There were no significant differences in KSS clinical (MD +0.3, 95% CI -0.7 to 1.2; p = 0.4, RMA) and functional scores (MD +0.8, 95% CI -0.4 to 2; p = 0.1, RMA) between MB TKR and FB TKR. Heterogeneity across studies reporting KSS clinical and functional scores were moderate (I^2 = 0.67

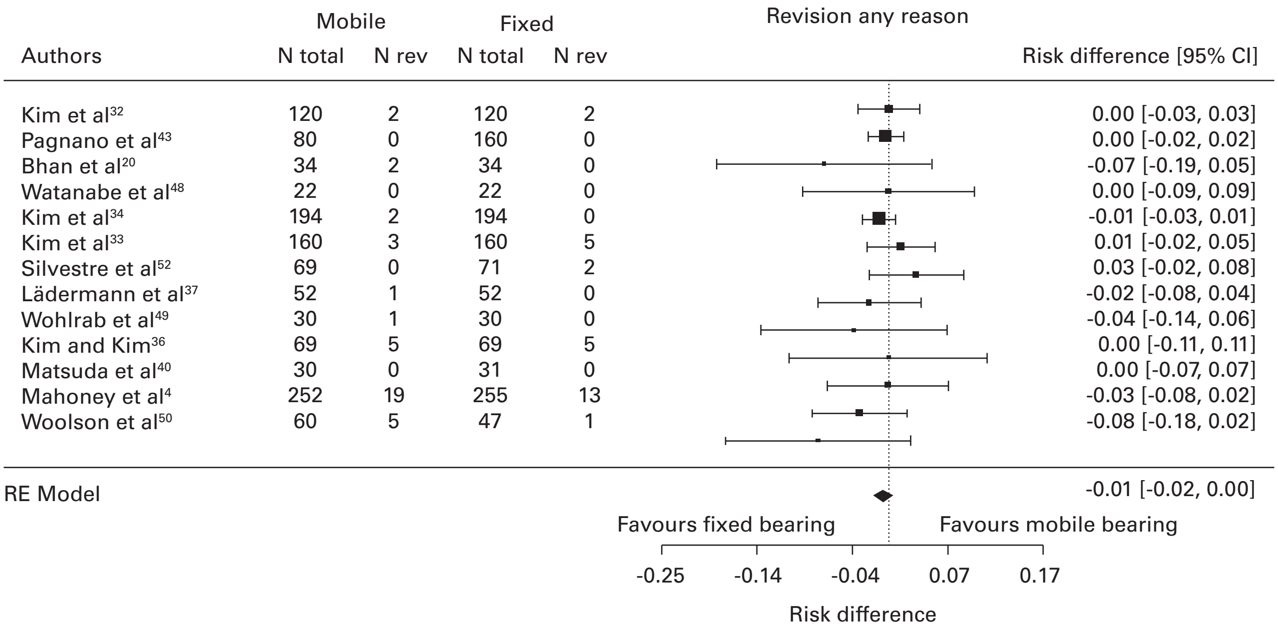

Fig. 2

Forest plot showing the risk difference in revision rate for any reason between mobile- (MB) and fixed-bearing (FB) total knee replacement (TKR) for studies with a minimum follow-up of five years. There is no difference in revision rate for any reason between MB and FB TKR (rev, revised; RE, random effects; CI, confidence interval).

and $I^2 = 0.39$, respectively). This heterogeneity could not be explained by stratifying for type of MB or any other distinct factor. The Hospital for Special Surgery knee score[54] and other clinical knee scores were not analysed because they were inconsistently and infrequently reported.

Patient-reported outcome measurements. The SF-12 physical score was significantly better for the MB TKR (MD +1.3 (95% CI 0.1 to 2.5); p = 0.01, RMA). There were no differences in SF-12 mental score (MD +0.02 (95% CI -1.5 to 1.6); p = 0.9, RMA), OKS (MD +0.6 (95% CI -0.5 to 1.7); p = 0.4, RMA) or WOMAC score (MD -0.1 (95% CI -1.5 to 1.4); p = 0.8, RMA).

Radiological evaluation. Radiological evaluation revealed no differences for the presence of radiolucencies (RD 0.0 (95% CI 0.0 to 0.0); p = 0.2, RMA) or of osteolysis (RD 0.0 (95% CI 0.0 to 0.0); p = 0.9, RMA) around the prosthesis. As only a limited number of studies reported MTPM and because of the considerable heterogeneity ($I^2 = 0.44$) across those studies, the MTPM could not be used for analysis.

Discussion

The results of the meta-analyses indicated that there were no clinically relevant differences in terms of revision rates, range of movement, KSS, OKS, SF-12 or radiological parameters. Considering the large number of trials included (41 studies comprising over 6000 TKRs), this study provides strong evidence against any clinical advantages of MB over FB TKR.

Previous meta-analyses have investigated the difference between MB and FB TKR.[3,5] By including clinical trials without restrictions, our comprehensive overview maximised the number of observations and strengthens the outcomes. The possibility of introducing heterogeneity by including a wider range of implant types was analysed with meta-regression analysis.

The primary outcome of this study, revision rate, is inextricably linked to follow-up time. The anticipated benefit of MB TKR of fewer revisions is expected to manifest itself after longer follow-up. In order to account for the potential late appearance of revisions, only studies with a minimum follow-up of five years were included in the meta-analyses for revision rates. We found no difference in revision rates between MB and FB TKR. The results of this meta-analysis could therefore not support the theoretical benefits of MB TKR.

There were no differences between MB and FB TKR in terms of incidence of radiolucencies and osteolysis around the prosthesis. Studies reporting MTPM measured with RSA have showed no difference at two years' follow-up, suggesting good long-term survival for both designs.[23,27] Garling et al[2] also found no difference between MB and FB TKR implant migration measured with RSA at two years' follow-up. However, low variability in the data from the MB group was suggestive of a more predictable and forgiving design with respect to these small degrees of implant migration compared with the FB design. RSA is a feasible method to assess implant migration, and short-term RSA results have proved to be predictive of implant longevity.[55] Therefore, more long-term RSA studies would enhance our understanding of the predictive value of RSA on future implant failure due to aseptic loosening in MB and FB TKR.

We found no clinically relevant difference in the range of movement between MB and FB TKR. However, there was

Authors	Mobile N	Mobile ROM	Fixed N	Fixed ROM	Mean difference [95% CI]
Kim et al[32]	114	123.2	114	120.9	2.30 [-1.28, 5.88]
Hansson et al[23]	21	117	19	117	0.00 [-8.07, 8.07]
Mockel et al[41]	12	108	27	104	4.00 [-4.81, 12.81]
Bhan et al[20]	32	105.6	32	106.9	-1.30 [-5.10, 2.50]
Aglietti et al[17]	65	108	65	112	-4.00 [-8.47, 0.47]
Watanabe et al[48]	22	105.8	22	106.5	-0.70 [-7.82, 6.42]
Garling et al[2]	20	114.7	20	116	-1.30 [-9.36, 6.76]
Henricson et al[27]	23	110.4	26	112.7	-2.30 [-3.56, -1.04]
Kim et al[33]	146	135	146	132	3.00 [-0.31, 6.31]
Beard et al[19]	27	105.3	27	105.3	0.00 [-6.54, 6.54]
Kim et al[34]	174	130	174	131	-1.00 [-4.42, 2.42]
Silvestre et al[53]	68	105	68	112	-7.00 [-9.41, -4.59]
Breugem et al[21]	47	113.3	53	111.7	1.60 [-3.50, 6.70]
Gioe et al[22]	176	109.1	136	110.9	-1.80 [-4.71, 1.11]
Vasdev et al[47]	59	102	59	101	1.00 [-1.80, 3.80]
Harrington et al[25]	68	117.7	71	115.1	2.60 [2.03, 3.17]
Higuchi et al[28]	31	115.5	45	112.4	3.10 [-2.84, 9.04]
Hasegawa et al[26]	25	128	25	129	-1.00 [-8.21, 6.21]
Kim and Kim[36]	61	118	61	120	-2.00 [-6.61, 2.61]
Kim et al[35]	92	127	92	115	12.00 [7.47, 16.53]
Ball et al[18]	51	125	42	124	1.00 [-3.46, 5.46]
Matsuda et al[40]	30	118.8	31	116.2	2.60 [-3.92, 9.12]
Rahman et al[44]	24	116	27	116.4	-0.40 [-7.55, 6.75]
Kim et al[16]	33	131.3	33	133	-1.70 [-6.97, 3.57]
Kim et al[16]	33	130.2	33	129.2	1.00 [-3.73, 5.73]
Hanusch et al[24]	50	101	55	100.8	0.20 [-3.85, 4.25]
Munro et al[42]	25	114	23	117	-3.00 [-7.98, 1.98]
Lampe et al[38]	44	115	52	113	2.00 [-2.80, 6.80]
Woolson et al[50]	27	112.7	24	110.4	2.30 [-4.85, 9.45]
Kim et al[31]	37	133	36	129	4.00 [-1.25, 9.25]
Mahoney et al[4]	178	120	183	119	1.00 [-1.68, 3.68]
Scuderi et al[46]	151	127	141	127.2	-0.20 [-3.90, 3.50]
Lizaur-Utrilla et al[39]	60	109.5	57	103.4	6.10 [0.78, 11.42]
Chatterji et al[52]	68	103.1	68	104	-0.90 [-5.29, 3.49]
RE Model					-0.01 [-0.02, 0.00]

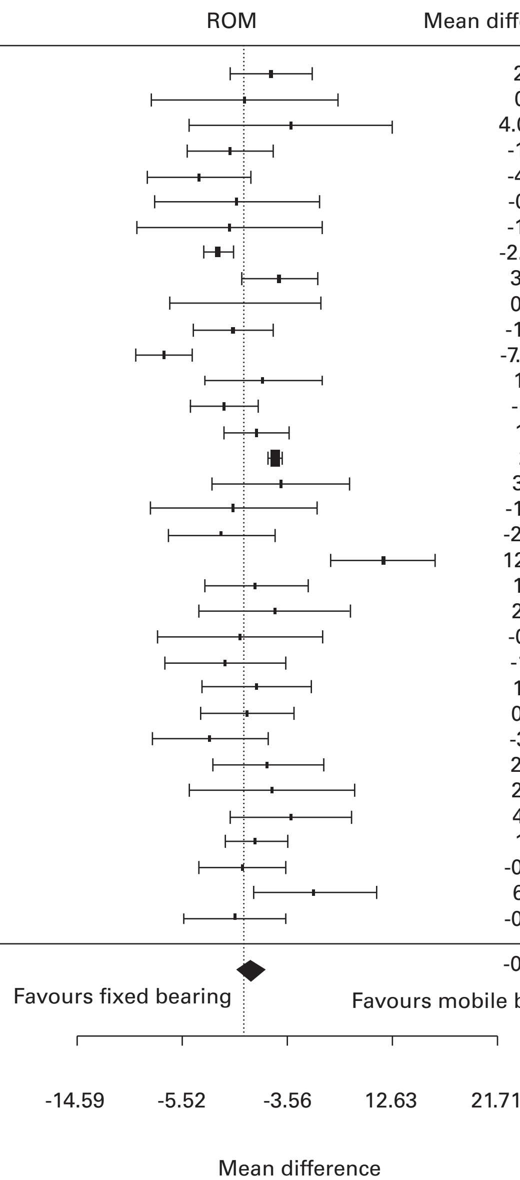

Fig. 3

Forest plot showing the mean difference in post-operative range of movement (ROM) between mobile- (MB) and fixed-bearing (FB) total knee replacement (TKR). There is no difference in range of movement between MB and FB TKR. However, a wide variation in data is clearly visible, indicating heterogeneity across different studies (RE, random effects; CI, confidence interval).

considerable heterogeneity across the studies, indicating that any differences in the range of movement between MB and FB TKR may depend on other factors. Indeed, the variation in design of the mobile bearing produces differences in range of movement between MB and FB TKR. Several MB designs are available, each accommodating different types of mobility, ranging from pure rotation to pure translation to combined rotation and translation. Most designs consist of a single piece of polyethylene, whereas the meniscal bearing type has individual medial and lateral inserts. Although we found a significant difference in the rotating platform and the anteroposterior and rotating platform compared with FB TKR, this difference was small (< 10°) and may lack clinical relevance.[11] Previous meta-analyses by Carothers et al[3] and Wen et al[5] also reported an influence of the design of MB platform on post-operative range of movement. Carothers et al[3] compared different MB designs in 14 studies and found a significant difference in the rotating platform over platforms with a combined anteroposterior and rotation movement. The

Table II. The influence of outcome measures on type of mobile-bearing (MB) design. The different MB designs are compared with fixed-bearing (FB) total knee replacement (TKR). A positive coefficient favours MB TKR, a negative coefficient favours FB TKR. Range of movement is significantly different between the rotating platform and the anteroposterior gliding and rotating platform, with the rotating platform having the best range of movement compared with FB TKR (MD, mean difference; CI, confidence interval)

	Rotating platform		Meniscal bearing		AP gliding and rotating platform		Floating platform	
Outcome	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value	MD (95% CI)	p-value
Range of movement	1.44 (0.20 to 2.69)	0.02	0.42 (-3.63 to 4.48)	0.84	-3.14 (-5.47 to -0.81)	0.01	-0.26 (-4.81 to 4.28)	0.9
Knee Society score								
Clinical	0.35 (-0.79 to 1.49)	0.6	0.12 (-3.6 to 2.85)	0.95	-0.02 (-2.42 to 2.38)	1	0.23 (-3.49 to 3.95)	0.9
Function	1.35 (-0.15 to 2.86)	0.1	1 (-6.13 to 8.14)	0.78	-0.92 (-4.23 to 2.38)	0.6	-0.57 (-4.5 to 3.35)	0.8

mean improvement in range of movement was 5.8° better in the rotating platform group. However, they did not use a FB control group, so their results may be subject to confounding factors. Wen et al[5] performed subgroup analyses comparing rotating platforms and anteroposterior gliding and rotating platforms to FB TKRs in six studies.[5] They found a trend towards a better range of movement of 1° for the FB TKR than with the rotating platform MB TKR, which was considered to be clinically irrelevant.

It should be recognised that the pre-operative range of movement has an important influence on post-operative range of movement.[56] In order to give an accurate comparison between MB and FB TKR in terms of range of movement, the improvement in range of movement should be examined. Although many studies report the pre-operative range of movement, few studies report the improvement. Using the pre- and post-operative ranges to calculate the improvement is not feasible, as these values might not represent the same patients.

We found no difference in clinical outcome scores between MB and FB TKR. The KSS was the most frequently reported clinical outcome score, especially in studies emanating from North America. However, the KSS is not validated and may not be sensitive enough to detect a difference. Therefore, we also evaluated the OKS, a validated clinical outcome score.[7] Meta-analysis of the OKS confirms the meta-analysis of the KSS in that no significant difference between MB and FB TKR could be established. With regard to other patient-reported outcome measures, we could find no clinically relevant difference between MB and FB TKR. There was a significant difference in SF-12 score, which in the most favourable case would be two points in favour of MB TKR, but this difference is not clinically relevant.

The strengths of our study are the large number of patients and revisions and the lack of restrictions in the literature search. Our results therefore represent a comprehensive overview of experience with MB and FB TKR. The meta-regression analysis provided the possibility to show, within a large population, which factors influence the outcome measures and to correct for factors that might modify the results. The influence of publication bias was negligible as determined by funnel plots.

We acknowledge some limitations. It was not possible to meta-analyse some important outcomes, such as implant migration measured by RSA, because they were reported infrequently and inconsistently. The methodological quality of the included studies varied. Although high quality is preferable, there was no influence of study quality, expressed by the Jadad score, on the outcomes.

In conclusion, this systematic review and meta-analysis comprising over 6000 TKRs did not show any clinically relevant differences in revision rates, clinical outcome scores or patient-reported outcome measures between MB and FB TKR. The rotating platform designs performed slightly better than the anteroposterior gliding and rotating platform types in terms of range of movement, but this difference was small and unlikely be clinically relevant. Theoretical assumptions of less aseptic loosening and wear for MB TKR could not be proven, at this point in time, as revision rates between the two designs were comparable.

The authors would like to thank the Atlantic Innovation Fund (Atlantic Canada Opportunities Agency) and the Dutch Arthritis Association (project number: LLP13; 08-1-300) for providing funding for this study. The Atlantic Innovation Fund and the Dutch Arthritis Association were not involved in the design or conduct of the study; in the collection, management, analysis or interpretation of the data; or in the preparation, review or approval of the manuscript. The authors would also like to thank J. W. Schoones, Medical Librarian at Walaeus Library, Leiden University Medical Center, Leiden, The Netherlands, for composing the search strategy.

Although none of the authors has received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article, benefits have been or will be received but will be directed solely to a research fund, foundation, educational institution, or other non-profit organisation with which one or more of the authors are associated.

This article was primary edited by G. Scott and first-proof edited by D. Rowley.

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