

Supplementary article data

Effect of rotational alignment on outcome of total knee arthroplasty

A systematic review of the literature and correlation analysis

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Table 1a. Overview of data extracted from the articles included in systematic review

Study	Level of evidence	Study population ^a	Bearing ^b	Prosthesis ^c	Patella ^d	Fixation ^e	Time from index operation ^f	Inclusion criteria ^g
Barrack 2001	III	14 sympt. vs 14 asympt. TKA	FB	CR	symptomatic: 9 res. / unres. asymptomatic: 9 res. / 5 unres.	o	5.7 (5–7) yr	Anterior knee pain (min VAS 3/10)
Bedard 2011	IV	34 sympt. TKA	o	o	o	o	17 mo	Stiffness (flexion contracture > 15° and/or flexion < 105°)
Bell 2012	III	56 sympt. vs 56 asympt. TKA	FB	PS	o	C	sympt. 26 mo asympt. 1 yr	Unexplained pain
Bhattee 2014	IV	9 satisfied vs 14 nonsatisfied secondary patella resurfacing	21 FB, 2 MB	21 CR, 2 PS	23 res.	o	42 mo from primary TKA to resurfacing; 34 mo after resurfacing	Secondary patella resurfacing for anterior knee pain
Boldt 2006	III	38 sympt. vs 38 asympt. TKA	MB	PS	o	o	o	Stiffness (flexion contracture > 10° and/or flexion < 90°)
Fosco 2010	IV	24 sympt. TKA	MB, FB	CR, PS	5 res. / 19 unres.	o	25 (5–84) mo	Anterior knee pain
Harvie 2011	I	20 CAS vs 20 articular surface-mounted CAS TKA	o	o	unres.	C	1 yr	Primary TKA
Hofmann 2003	IV	34 sympt. TKA	o	o	o	o	27 (6–91) mo	Painful TKA with asymmetrical gap or stiffness or premature TKA failure of unknown cause
Huang 2014	III	24 CAS vs 27 jig-based TKA	o	CR	o	C	46 (24–74) mo	Primary TKA (valgus osteoarthritis with mechanical axis > 10°)
Kienapfel 2003	III	18 sympt. vs 18 asympt. TKA	FB	CR	36 res.	U	o	Failure of metal-backed patella prosthesis
Kim 2012	II	40 mobile vs 40 fixed-bearing TKA	40 MB, 40 FB	PS	o	o	mobile-bearing 2.6 yr; fixed-bearing 2.5 yr	Primary TKA

Table 1a. Continued

Study	Level of evidence	Study population ^a	Bearing ^b	Prosthesis ^c	Patella ^d	Fixation ^e	Time from index operation ^f	Inclusion criteria ^g
Lad 2013	II	50 CAS vs 50 jig-based TKA	o	o	o	o	2 yr	Primary TKA
Lakstein 2010	III	24 sympt. vs 24 aseptic loosening TKA	o	o	o	o	sympt. 37 (24–65) mo; aseptic loosening 42 (24–92) mo	Persisting complaints and >3° rotational error of either component and > 2 yr follow-up
Longstaff 2009	II	146 TKA	FB	CR	unres.	o	1 yr	Primary TKA
Lützner 2012	IV	73 TKA	MB	CR	unres.	C	21 mo	Primary TKA
Matsuda 2001	IV	13 TKA	FB	CR	12 res./ 1 unres.	12 U 1 C	74 (104–150) mo	Primary TKA
Matsuda 2010	II	30 mobile vs 31 fixed-bearing TKA	30 MB, 31 FB	CR	61 res.	C	mobile-bearing 5.5 (2.1–8.8) yr fixed-bearing 5.3 (2.3–8.1) yr	Primary TKA
Mizu-uchi 2008	II	37 CAS vs 39 jig-based TKA	o	o	76 res.	C	6 mo	Primary TKA
Nicoll 2010	III	39 sympt. vs 26 asympt. TKA	FB	CR, PS	symptomatic: 22 res./17 unres. asymptomatic: 13 res./13 unres.	o	sympt. 5.2 (SD 2.3) yr asympt. 4.2 (SD 1.7) yr	Painful TKA (KSS pain > 20)
Pietsch 2012	IV	14 sympt. TKA	5 FB, 9 MB	8 CR, 6 PS	7 res., 1 patellectomy	o	36 (12–36) mo	Painful TKA or stiffness and isolated internally malrotated femoral component > 4°
Romero 2007	III	18 sympt. vs 10 asympt. TKA	FB	CR	28 res.	o	sympt. 42 (24–156) mo asympt. 44 (26–151) mo	Painful TKA and lateral flexion instability
Sensi 2011	II	100 TKA	o	PS	100 res.	o	72 (61–78) mo	Primary TKA
Sternheim 2012	III	51 sympt. vs 51 aseptic loosening TKA	o	o	o	o	sympt. 30 (5–139) mo aseptic loosening 128 (20–254) mo	Painful TKA or stiffness and >3° combined internally malrotated components or >2° internal malrotation of either component
Woolson 2014	I	22 PSI vs 26 jig-based TKA	o	PS	48 res.	C	6 mo	Primary TKA (degenerative or posttraumatic, males)
Zhang 2012	II	41 CAS vs 41 jig-based TKA	o	PS	unres.	o	6 mo	Primary TKA

o: data unknown

^a TKA: total knee arthroplasty, CAS: Computer-assisted surgery;^b FB: fixed-bearing, MB: rotating/mobile-bearing;^c CR: cruciate retaining, PS: posterior stabilized;^d res.: resurfaced, unres.: unresurfaced;^e C: cemented, U: uncemented;^f Range in parenthesis, mo: month; yr: year; SD: standard deviation;^g VAS: visual analogue scale

Table 1b. Overview of data extracted from the articles included in systematic review

Study	Functional assessment ^a	Femur rotation	Tibia rotation	Combined rotation	Mismatch rotation	CT protocol femur	CT protocol tibia ^b
Barrack 2001	KSS	x	x	x	o	Berger protocol	Berger protocol
Bedard 2011	KSS	x	x	x	o	Berger protocol	Berger protocol
Bell 2012	OS	x	x	x	x	Berger protocol	Berger protocol
Bhattee 2014	HSS, OS	x	x	o	o	Berger protocol (no sex difference)	Line center tibia plateau to medial 1/3 tuberosity vs PCL bearing
Boldt 2006	HSS	x	o	o	o	Berger protocol	Berger protocol
Fosco 2010	KSS	x	x	x	o	Berger protocol	Berger protocol
Harvie 2011	KSS	x	x	o	x	Perth CT protocol	Perth CT protocol
Hofmann 2003	KSS	x	x	x	o	Berger protocol (no sex difference)	Berger protocol
Huang 2014	KSS, HSS	x	x	o	o	Perth CT protocol	Line center tibia plateau to medial 1/3 tuberosity vs PCL bearing
Kienapfel 2003	KSS	x	x	o	o	Berger protocol (no sex difference)	Transmalleolar axis vs PCL bearing
Kim 2012	KSS, HSS	x	x	o	o	Condylar twist angle	Projected aTEA vs tibia AP axis
Lad 2013	KSS	x	o	o	o	Berger protocol (no sex difference)	Berger protocol
Lakstein 2010	KSS	x	x	x	o	Berger protocol	Berger protocol
Longstaff 2009	KSS	x	o	o	x	Perth CT protocol	Perth CT protocol
Lutzner 2012	KSS	o	o	o	x	Line through femoral fixation pegs vs sTEA	Line center tibia plateau to medial 1/3 tuberosity vs PCL bearing
Matsuda 2001	KSS	x	x	o	o	Condylar twist angle	Berger protocol
Matsuda 2010	KSS	x	x	o	x	Berger protocol (no sex difference)	Line center tibia plateau to medial 1/3 tuberosity vs PCL bearing
Mizu-uchi 2008	KSS	x	x	o	o	Berger protocol (no sex difference)	Line center tibia plateau to medial 1/3 tuberosity vs PCL bearing
Nicoll 2010	KSS	x	x	x	x	Berger protocol	Berger protocol
Pietsch 2012	KSS, HSS	x	o	o	o	Berger protocol (no sex difference)	Berger protocol
Romero 2007	KSS, WOMAC	x	o	o	o	Condylar twist angle	o
Sensi 2011	KSS, HSS	x	x	o	o	Berger protocol (no sex difference)	Projected sTEA vs PCL bearing
Sternheim 2012	KSS	x	x	x	o	Berger protocol (no sex difference)	Berger protocol
Woolson 2014	KSS	x	o	o	o	Berger protocol (no sex difference)	o
Zhang 2012	KSS	x	x	x	x	Berger protocol (no sex difference)	Berger protocol

x: data known;

^a HSS: Hospital for special surgery knee score, KSS: Knee society score, OS: Oxford score, WOMAC: Western Ontario and McMaster Universities Arthritis Index;^b sTEA: surgical trans epicondylar axis, aTEA: anatomical trans epicondylar axis, PCL: Posterior condylar line, AP: antero posterior.

Table 2. Indication and results of revision for malrotation

Study	No of cases	Operation indication	Type of operation (a)	Femur malrotation	Tibia malrotation	Combined malrotation	Mismatch malrotation	Preoperative assessment of KSS	Postoperative assessment of KSS
Bedard 2011	34	Stiffness	ToR	3.1 in, 24/34 1.3 ex, 10/34	13.7 in, 33/34 1.0 ex, 1/34	14.8 in (2.7 in–33.7 in)	Not reported	Pain 10.3 Knee 41.6 Funct. 48	Pain 33.7 Knee 77.3 Funct. 65.7
Fosco 2010	8	Anterior knee pain and combined malrotation < 4°	PP	0.5 in [1.5] (3.5 in–1 ex)	1.6 ex [1.9] (1 in–5 ex)	1.1 ex [2.1] (2.5 in–4 ex)	2.1 ex [2.8] (2 in–7 ex)	Knee 50 Funct. 37	Knee 78 Funct. 69
Fosco 2010	16	Anterior knee pain and combined malrotation > 4°	ToR	2.0 in [2.3] (8 in–1 ex)	1.5 ex [7.1] (13 in–12 ex)	0.4 in [7.9] (13 in–12 ex)	3.5 ex [7.1] (13 in–13 ex)	Knee 51 Funct. 36	Knee 85 Funct. 81
Hofmann 2003	26	Painful asymmetrical flexiongap or stiffness or unexplained complains and > 5° malrotation of either component	ToR	5.6 in (3 in–10 in) 12/26 10 ex 1/26	8.4 in (3 in–26 in) 23/26	Not specified combined malrotation 10/26	Not reported	Not reported	KSS not specified, good results (20/26)
Lakstein 2010	24	Pain after > 2 year and >3° malrotation of either component	ToR 23 FR 1	2.6 in [3.2] (8.5 in–5 ex)	4.3 in [4.3] (12 in–3 ex)	6.8 in [4.8] (15 in–1 ex)	Not reported	Knee 33 [18]	Knee 80 [8]
Pietsch 2012	14	Isolated femoral internal malrotation ≥4° and flexion ≥ 90° (group A) or flexion < 90° (group B)	ToR	7.1 in (4.1 in–10 in)	Not specified normal rotation	Not reported	Not reported	Function group A: 52 [13] (26–69) group B: 65 [19] (30–90) HSS 63	Function group A: 85 [8] (66–94) group B: 84 [12] (65–100) HSS 83
Sternheim 2012	51	Pain or stiffness and combined internal malrotation > 3° or internal malrotation > 2° of either component	ToR 47 FR 2 TiR 2	1.3 int [2.5] (8.5 in–5 ex)	2.1 int [6.0] (18 in–10 ex)	3.5 int [6.0] (21 in–8 ex)	Not reported	Knee 44 (2–74) Funct. 49 (25–90)	Knee 75 (43–99) Funct. 60 (30–100)

in: internal, ex: external, Standard deviation in brackets, Range in parenthesis, KSS: Knee Society Score; HSS: Hospital for Special Surgery Knee Score;
^a FR: femoral revision, PP: patella prosthesis, ToR: total revision, TiR: tibial revision.