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Review

Systematic review of medial versus lateral survivorship in unicompartmental knee arthroplasty

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ABSTRACT

Background: Unicompartmental knee arthroplasty (UKA) has gained popularity in patients with isolated unicompartmental osteoarthritis. To our knowledge no systematic review has assessed and compared survivorship of medial and lateral UKA. We performed a systematic review assessing medial and lateral UKA survivorship and comparing survivorship in cohort studies and registry-based studies.
Methods: A search was performed using PubMed, Embase and Cochrane systems. Ninety-six eligible studies reported survivorship, of which fifty-eight reported medial and sixteen reported lateral UKA survivorship. Nineteen cohort studies and seven registry-based studies reported combined medial and lateral survivorship.
Results: The five-year, ten-year and fifteen-year medial UKA survivorship was 93.9%, 91.7% and 88.9%, respectively. Lateral UKA survivorship was 93.2%, 91.4% and 89.4% at five-year, ten-year and fifteen-year, respectively. No statistical difference between both compartments was found. At twenty years and twenty-five years survivorship of medial UKA was 84.7% and 80%, respectively, but no studies reported lateral UKA survivorship at these follow-up intervals. Survivorship of cohort studies was not significantly higher compared to registry-based studies at five years (94.3 vs. 91.7, respectively, $p = 0.133$) but was significantly higher at ten years (90.5 vs. 84.1, $p = 0.015$).
Conclusion: This is the first systematic review that shows no difference in the five-, ten- and fifteen-year survivorship of medial and lateral UKA. We found a lower survivorship in the registry-based studies compared to cohort studies.
Level of evidence: Systematic Review of level IV studies.

Contents

1. Introduction

Unicompartmental knee arthroplasty (UKA) has gained popularity in patients with isolated unicompartmental osteoarthritis [1–3].

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The surgery is performed in 8 to 12% of all arthroplasties [2,4–6] with approximately 90% of these surgeries at the medial compartment and 10% at the lateral compartment [7–9]. UKA is often an option for isolated unicompartmental osteoarthritis and is, compared to total knee arthroplasty (TKA), associated with a faster recovery [10,11], improved range of motion [12], better functional outcomes [13,14] and easier revision to TKA [15].

With the increased use of UKA for unicompartmental osteoarthritis many studies have reported survivorship data. The developers associated with the Oxford UKA reported good 10-year survivorship of the medial UKA (98%) [16] whereas the same group reported a lower survivorship of lateral UKA at eight years (92%) [17]. This high 10-year survivorship of the medial UKA is not supported by other studies [18,19] and national registries [4–6,9].

The survivorship of the UKA differs widely in the literature and no previous systematic reviews have reported UKA survivorship. Furthermore, many studies [20,21] and national registries [4,5,22] reported combined survivorship of medial and lateral UKA, while it has been shown that medial and lateral compartments differ in anatomy and kinematics [8,23–27]. Lateral UKA is considered a technically more challenging surgery than medial UKA because of these differences, as well as implants design factors and lower surgical volume as compared to medial UKA [8,28,29].

Because of these anatomic, kinematic and technical differences medial and lateral UKA should not be reported as a combined group. Average survivorship of medial and lateral UKA is not reported and it is unknown whether survivorship of one is superior to the other. Therefore, we performed a systematic review assessing survivorship of both medial and lateral UKA and of combined studies and registries. We hypothesized that medial UKA has a higher survivorship compared with lateral UKA because of its greater surgical experience, implant design differences and anatomic features.

2. Methods

2.1. Search strategy and criteria

Multiple database search engines (PubMed, EMBASE and CENTRAL (COCHRANE Central Register of Clinical Trials)) were searched for studies that reported the survivorship of UKA. Only studies that reported the Kaplan–Meier method [30] were used in the current systematic review. The search terms were 'unicompartmental', 'knee, arthroplasty, replacement', 'partial', 'unicondylar', 'UKA', 'UKR', 'UCA', 'UCR', 'PKA', 'PKR', 'PCA', 'prosthesis failure', 'reoperation', 'survivorship' and 'treatment failure'. The PRISMA guidelines were followed for performing the systematic review [31]. First the search results were collected and then duplicates were removed. Two authors (JL and LM) independently scanned the title and abstract of the studies and considered based upon the inclusion and exclusion criteria. The full texts of the eligible studies were further evaluated considering the inclusion and exclusion criteria. During this second review the references of the studies were evaluated for any additional studies that reported survivorship of UKA. Annual registries and registry-based studies were checked for reporting survivorship and added to the search. Any disagreement between the authors was discussed and a solution was agreed upon in all cases for inclusion or exclusion.

2.2. Inclusion and exclusion criteria

We included studies that were; (I) English articles in humans between January 1, 1990 and September 1, 2015; (II) retrospective or prospective studies; (III) medial UKA, lateral UKA or both; (IV) 50 or more patients in the medial and combined group or 20 or more patients in the lateral group; (V) osteoarthritis as indication for surgery; (VI) reporting survivorship using the Kaplan–Meier method [30] and (VII) reporting survivorship for revision for any reason. We excluded studies that were (I) reporting survivorship for a specific failure mode (i.e. aseptic loosening or infection); (II) previous surgery in the same knee (high tibial osteotomy, UKA, etc.); (III) concurrent knee diagnoses (acute anterior cruciate ligament rupture, acute meniscal tear, etc.) and (IV) multiple studies using the same patient database and reporting the same survivorship.

2.3. Data collection

For this systematic review we divided the studies in four distinct groups: studies that report survivorship of (1) medial UKA, (2) lateral UKA, (3) cohort studies that report a combination of medial and lateral UKA and (4) registry-based studies that report a combination of medial and lateral UKA. All survivorship percentages that were presented in the studies were noted in a datasheet in Microsoft Excel 2011 (Microsoft Corp., Redmond. WA. USA). The period of the cohort, number of initial patients, number of failures, follow-up years and survivorship were noted. In the tables presented in this study, not all cohorts and registries are displayed. Some studies report survivorship of an alternate duration (i.e. 12-year survivorship). However, all studies are plotted in Fig. 1.

2.4. Statistical analysis

We performed statistical analysis with IBM SPSS Statistics 22 (SPSS Inc., Armonk, NY, USA). Independent t-tests were used to compare medial and lateral UKA survivorship and to compare cohort to registry-based studies. The null hypothesis was that both groups were equal and a difference was considered significant when $p < 0.05$.

3. Results

3.1. Search results

After removing duplicates 1072 studies were reviewed on their title and abstract. After this selection and reviewing the full article text, 96 studies were included in our review. Fifty-seven cohort studies [16,18,19,32–85] and one registry-based study [9] reported the medial UKA survivorship. Fifteen cohort studies [17,25–27,29,52,58,61,86–92] and one registry-based study [9] reported the lateral survivorship. Twenty-three cohort studies [20,21,93–113] and seven registry-based studies [3–5,114–117] reported combined medial and lateral UKA survivorship (Fig. 1). All 96 included studies are displayed in Fig. 2.

3.2. Medial survivorship

A total of 47,256 medial UKA were included in this study of which 2429 knees needed revision with a revision rate of 5.1%. The five-year, 10-year, 15-year and 20-year survivorships of medial UKA were 93.9%, 91.7%, 88.9% and 84.7%, respectively. One study reported a 25-year survivorship of 80.0% (Tables 1 and 2, Fig. 2).

3.3. Lateral survivorship

A total of 3296 lateral UKA were included with 168 failures (5.1% revision rate). The five-year, 10-year and 15-year survivorships of lateral UKA were 93.2%, 91.4% and 89.4%, respectively (Tables 1 and 2, Fig. 2).

No statistical differences were found between medial and lateral survivorship at five years ($p = 0.717$), 10 years ($p = 0.887$) and 15 years ($p = 0.913$) (Table 1).

3.4. Combined survivorship

In the combined medial and lateral UKA group we included 92,557 UKA of which 88,648 were from registry data. In the combined studies 89% of the UKA were medial and 11% were lateral. The five-year, 10-year and 15-year survivorships of all combined studies were 92.8%, 88.6% and 84.1%, respectively (Tables 1 and 3, Fig. 2).

3.5. Cohort studies versus registry-based studies

The survivorship of cohort studies was not significantly higher compared to the registry-based combined studies at five-years (94.3 vs. 91.7, respectively, $p = 0.133$) but was significantly higher at 10-years (90.5 vs. 84.1, respectively, $p = 0.015$). At 15 years only one registry-based study reported survivorship and therefore statistical analysis was not performed. One small study reported a 20-year survivorship of 74% and an additional small study reported a 20-year and 25-year survivorship of 84% and 72%, respectively (Tables 1 and 3, Fig. 2).

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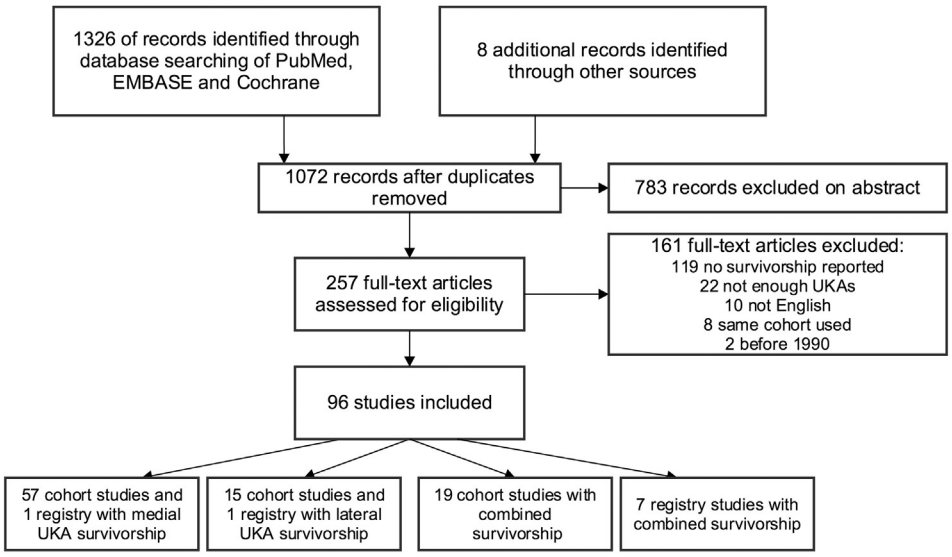

Fig. 1. Flow diagram of the search.

4. Discussion

To our knowledge this is the first systematic review presenting the survivorship of the medial and lateral UKA. We found no statistical differences between medial and lateral UKA at five-year, 10-year and 15-year survivorship. Furthermore, we found that registry-based studies reported a lower survivorship in the combined medial and lateral UKA group compared with the cohort-based studies.

The survivorship of medial UKA at five, 10, 15 and 20 years was 93.9%, 91.7%, 88.9% and 84.7%, respectively. The survivorship of lateral UKA at five, 10 and 15 years was 93.2%, 91.4% and 89.4%, respectively, and no statistical difference was found between medial and lateral UKA. Two cohort studies [52,58] and one registry-based study [9] compared survivorship of medial and lateral UKA within their study analysis and performed a multivariate Cox regression analysis with the medial or lateral side as a covariate. None of the three studies found a significant influence of the UKA side on revision for any reason (all $p > 0.3$).

Although survivorship between medial and lateral UKA in this systematic review did not differ, several authors have emphasized the differences between both arthroplasties [25,26,27]. A group of authors reported three studies about the different kinematics in the medial and lateral compartment [23,24,119]. They found that the lateral femoral condyle demonstrated backward rolling and sliding during flexion whereas the medial compartment did not show this posterior subluxation. Other authors have suggested that the differences in volume of surgical procedures causes the lateral UKA procedure to be more challenging [8,28,29]. Scott [8] stated that with lateral UKA extra attention should be paid to patellar impingement. In high flexion the patellar tracks more laterally and this can cause patellar impingement. It is therefore advisable to ensure that sufficient femoral resection is performed. Ollivier et al. [28] reviewed the lateral UKA technique concluding three aspects that require additional attention in the lateral UKA compared to the medial UKA. Firstly, they stated that lateral compartment overcorrection with lateral UKA should be avoided in order to limit medial progression of osteoarthritis. Secondly, natural kinematics of the lateral femoral condyle should be considered during femoral component positioning to avoid impingement with the tibial spine. Finally, excessive lateral placement in extension should be avoided because it may cause overload of the lateral portion of the tibial plateau.

Recently, Demange et al. [29] stated that using conventional medial implants for lateral UKA could cause a tibial–femoral mismatch. Therefore they developed patient-specific lateral implants and used these for lateral UKA surgery. They compared this technique with the conventional lateral UKA technique and found that the patient-specific lateral

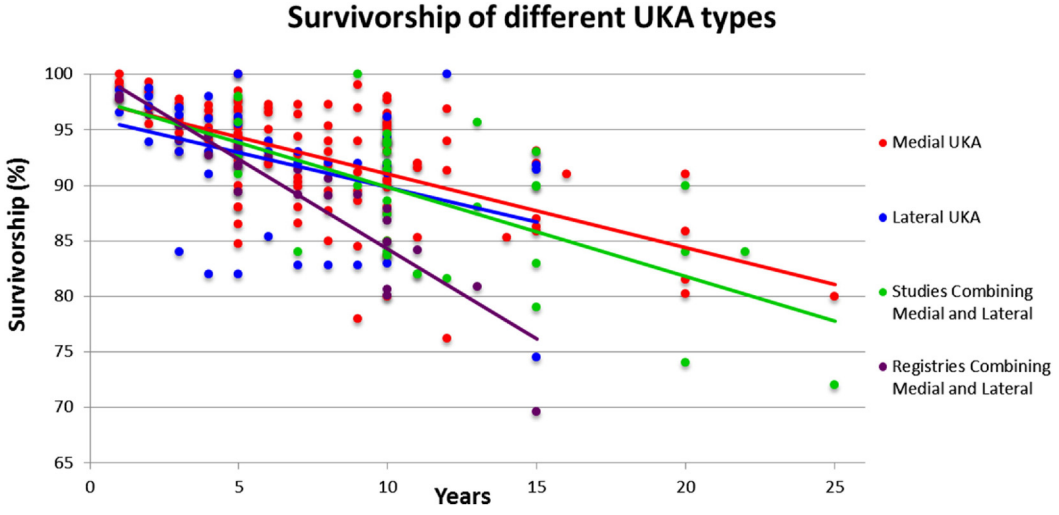

Fig. 2. Studies that reported survivorship of medial UKA, lateral UKA, cohort studies and registry-based studies at different time intervals with linear trends of the studies.

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Table 1
Mean survivorship at five years, 10 year, 15 year, 20 year and 25 year of medial and lateral UKA and cohort- and registry-based combined UKA.

Survivorship	5 year	10 year	15 year	20 year	25 year
Medial	93.9	91.7	88.9	84.7	80.0[a]
Lateral	93.2	91.4	89.4		
Combined	92.8	88.6	84.1	82.7[b]	72.0[a]
Studies combined	94.3	90.5	87.0	82.7[b]	72.0[a]
Registries combined	91.7	84.1	69.6[a]		
Medial vs. Lateral	$p = 0.717$	$p = 0.887$	$p = 0.913$		
Cohort vs. Registries	$p = 0.133$	$p = 0.015$			

[a] Only one study reported survivorship at this follow-up.
[b] Only three studies reported survivorship at this follow-up.

implants had a much better tibial–femoral alignment and had an improved three-year survivorship (97% vs. 85%). However, despite these anatomic, kinematic and technical differences, survivorship between both UKA does not differ.

Another notable aspect of this study is the finding of higher survivorship in the cohort studies compared with registry-based studies. Several authors suggested that results of cohort studies should be questioned when compared to the registry-based studies. A study of Pabinger et al. [120] showed that registries are superior over cohort based studies in reporting survivorship for both TKA and UKA. The authors found that for 82% of the UKA implant types there was poor or no data in cohort studies and stated that the reliability of pooled data from cohort studies should be questioned. The same authors found in a systematic review [121] that there was an overproportional share of studies performed by the prosthesis developers that can influence the overall survivorship. In our study we did not assess the difference in survivorship between the designers and non-designers and this could explain our findings of the higher survivorship of the cohort studies. A study of Labek et al. [122] found the same influence of the designers in the literature and stressed the importance for registry-based studies.

Another explanation for the differences in survivorship between cohort studies and registry-based studies is the fact that cohort studies are often high volume centers reporting outcomes whereas registry-based studies also report low-volume center outcomes. Two studies compared outcomes in high-volume centers with low-volume centers and found indeed better results in high volume centers [123,124]. It would be of additional value if registries and registry-based studies separate the survivorship in medial and lateral UKA in order to compare the survivorship of both UKA procedures in both high-volume and low-volume centers. With these registry-based studies it is also possible to assess the long-term survivorship of lateral UKA because the number of knees in cohort studies is often too small.

There are several limitations in this study. First, the qualities of the selected studies are a limiting factor. We selected all studies that reported survivorship and therefore we did not control the studies for a publication bias. The second limitation is the small number of studies reporting lateral survival. This is especially seen at 15-year survivorship where only 192 lateral UKAs were identified. This should be taken into account when conclusions are drawn on 15-year survivorship of lateral UKA. If future registries and registry-based studies separately report medial and lateral UKA survivorship, it would help overcome this limitation.

In conclusion, this is the first systematic review that shows no difference in the five-, 10- and 15-year survivorship of medial and lateral UKA. We found a lower survivorship in the registry-based studies compared with cohort studies.

Table 2
Studies that present five-year, 10-year, 15-year, 20-year and 25-year survivorship of medial or lateral UKA are displayed.

Medial UKA	Year	No	Failures	RR (%)	5 y	10 y	15 y	20 y	25 y	Lateral UKA	Year	No	Failures	RR (%)	4 y	5 y	10 y	15 y
Ackroyd [32]	2002	408	25	6.1		87.5				Argenson [27]	2008	40	5	12.5			92.0	
Ansari [18]	1997	461	20	4.3		88.0				Ashraf [25]	2002	88	15	17.0			83.0	74.5
Baur [34]	2015	132	5	3.8	95.2					Demange [29]	2015	33	1	3.0				
Bruni [39]	2014	273	25	9.2	92.2	87.6				Demange [29]	2015	20	3	15.0				
Burnett [40]	2014	467	45	9.6	98.5					Gunther [86]	1996	53	11	20.8		82.0		
Chatellard [19]	2013	864	108	12.5		83.7				Heyse [52]	2012	50	3	6.0			91.8	91.8
Eickmann [44]	2006	411	96	23.4	93.0					Liebs [58]	2013	117	14	12.0	93.0	91.8		
Heyse [52]	2012	173	12	6.9		94.1	86.3			Lustig [87]	2011	49	4	8.2			91.1	
Kim [54]	2015	166	16	9.6		90.5				Lustig [61]	2009	60				96.2	96.2	
Kuipers [56]	2010	437	45	10.3	84.7					Lustig [88]	2014	46	7	13.0			94.4	91.4
Liebs [58]	2013	401	32	8.0	93.0					Pandit [89]	2010	53	11	20.8	82.0			
Lim [59]	2012	400	14	3.5	96.7	94.0				Pandit [89]	2010	65	9	13.8	91.0			
Lisowski [60]	2011	244	9	3.7						Pandit [89]	2010	69	1	1.4	98.0			
Lyons [62]	2012	279	37	13.3	94.6	90.4				Pennington [90]	2006	29	0	0.0				100
Matharu [64]	2012	459	20	4.4	94.4					Sah [26]	2007	48	0	0.0		100		
Murray [16]	1998	143	5	3.5		97.7				Smith [91]	2014	101	4	4.0		95.5		
Naudie [65]	2004	113	11	9.7	94.0	90.0				Streit [92]	2012	50	3	6.0				
Pandit [67]	2011	1000	29	2.9	97.5	95.6				Weston-Sim [17].	2014	265	13	4.9	96.0	94.0		
Parratte [68]	2012	156	22	14.1				81.5										
Price [69]	2005	439	23	5.2		93.1	93.1			Baker (UK) [9]	2012	2052	71	3.5	94.8	93.0		
Price [70]	2011	682	29	4.3				91.0										
Rajasekhar [71]	2004	135	5	3.7		94.0												
Robb [72]	2013	494	24	4.9		93.3												
Schlueter [73]	2014	240	10	4.2		95.6												
Steele [76]	2006	203	16	7.9			92.0	85.9	80.0									
Streit [77]	2015	107	5	4.7	97.0													
Svard [78]	2001	124	6	4.8		95.0												
Tabor [79]	2005	100	14	14.0	93.7	89.8	85.9	80.2										
Vasso [80]	2015	136	4	2.9	97.0													
Vorlat [81]	2006	149	16	10.7	94.6	83.7												
Whittaker [82]	2010	150	22	14.7	96.0													
Yoshida [84]	2013	1279	25	2.0	97.9	95.4												
Zambianchi [85]	2014	195	11	5.6	93.1													
Baker (UK) [9]	2012	30,795	1331	4.3	93.1													

In this table only the studies that reported four- (lateral), five-, 10-, 15-, 20- and 25-years survivorship and had >100 medial UKA are presented. RR indicates revision rate.

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Table 3
Cohort and registry-based studies that present five-, 10-, 15-, 20- and 25-year survivorship of combined medial and lateral UKA.

Cohort studies	Year	No	Failures	RR (%)	5 y	10 y	15 y	20 y	22 y	25 y	Registry-based studies	Year	No	Failures	RR (%)	5 y	10 y	13 y	15 y
Argenson [93]	2002	172	5	2.9		94.0					Australia [5]	2014	41,250	4326	10.5	91.7	84.9		
Argenson [94]	2013	70	14	20.0			83.0	74.0			Finland [117]	2014	4713	663	14.1	89.4	80.6		69.6
Berger [95]	2004	62	2	3.2		98.0					Italy [114]	2014	3929	250	6.4		86.8		
Bert [96]	1998	100	12	12.0		87.4					New Zealand [4]	2013	7388	515	7.0	93.5	87.9	80.9	
Capra Jr [97]	1992	52	6	11.5		93.8					Norway [115]	2007	2288	204	8.9		80.1		
Cavaignac [98]	2013	212	15	7.1		93.0					UK [116]	2014	25,982	1279	4.9	91.8			
Foran [101]	2013	62	4	6.5			93.0	90.0			USA [3]	2013	3098	172	5.6	92.0			
Gioe [20]	2003	516	39	7.6	92.6	88.6													
Heck [102]	1993	294	16	5.4	97.9	91.4													
Hernigou [103]	2012	149					90.0												
Lecuire [105]	2008	120	10	8.3	95.7														
Newman [107]	2009	52	4	7.7			89.9												
O'Rourke [108]	2005	136	19	14.0				84.0		72.0									
Rachha [109]	2013	74	5	6.8		94.6													
Rougraff [110]	1991	120	5	4.2		92.0													
Scott [111]	1991	100	13	13.0		85.0													
Sebilo [21]	2013	944				83.7													
Squire [112]	1999	140	12	8.6					84.0										
Tabor [113]	1998	67	11	16.4	91.0	84.0	79.0												

In this table only the studies that reported five-, 10-, 13-, 15-, 20-, 22- or 25-years survivorship are presented. RR indicates revision rate.

Conflict of interest

The authors declare that they have no conflict of interest directly or indirectly related to the subject of this article.

References

[1] Nwachukwu BU, McCormick FM, Schairer WW, Frank RM, Provencher MT, Roche MW. Unicompartmental knee arthroplasty versus high tibial osteotomy: United States practice patterns for the surgical treatment of unicompartmental arthritis. J Arthroplasty 2014;29:1586–9.
[2] Riddle DL, Jiranek WA, McGlynn FJ. Yearly incidence of unicompartmental knee arthroplasty in the United States. J Arthroplasty 2008;23:408–12.
[3] Bolognesi MP, Greiner MA, Attarian DE, Watters TS, Wellman SS, Curtis LH, et al. Unicompartmental knee arthroplasty and total knee arthroplasty among medicare beneficiaries, 2000 to 2009. J Bone Joint Surg Ser A 2013;95 [e1741; e49; e41; e49].
[4] The New Zealand Joint Registry. Fourteen year reportJanuary 1999 to December 2012; 2013.
[5] Annual report 2014 Australian hip and knee arthroplasty register; 2014.
[6] Liddle AD, Judge A, Pandit H, Murray DW. Adverse outcomes after total and unicompartmental knee replacement in 101,330 matched patients: a study of data from the National Joint Registry for England and Wales. Lancet 2014;384:1437–45.
[7] Lewold S, Robertsson O, Knutson K, Lidgren L. Revision of unicompartmental knee arthroplasty: outcome in 1,135 cases from the Swedish Knee Arthroplasty study. Acta Orthop Scand 1998;69:469–74.
[8] Scott RD. Lateral unicompartmental replacement: a road less traveled. Orthopedics 2005;28:983–4.
[9] Baker PN, Jameson SS, Deehan DJ, Gregg PJ, Porter M, Tucker K. Mid-term equivalent survival of medial and lateral unicondylar knee replacement: an analysis of data from a National Joint Registry. J Bone Joint Surg Br 2012;94:1641–8.
[10] Lombardi Jr AV, Berend KR, Walter CA, Aziz-Jacobo J, Cheney NA. Is recovery faster for mobile-bearing unicompartmental than total knee arthroplasty? Clin Orthop Relat Res 2009;467:1450–7.
[11] Smith TO, Chester R, Glasgow MM, Donell ST. Accelerated rehabilitation following Oxford unicompartmental knee arthroplasty: five-year results from an independent centre. Eur J Orthop Surg Traumatol 2012;22:151–8.
[12] Laurencin CT, Zelicof SB, Scott RD, Ewald FC. Unicompartmental versus total knee arthroplasty in the same patient. A comparative study. Clin Orthop Relat Res 1991;151–6.
[13] Isaac SM, Barker KL, Danial IN, Beard DJ, Dodd CA, Murray DW. Does arthroplasty type influence knee joint proprioception? A longitudinal prospective study comparing total and unicompartmental arthroplasty. Knee 2007;14:212–7.
[14] Newman J, Pydisetty RV, Ackroyd C. Unicompartmental or total knee replacement: the 15-year results of a prospective randomised controlled trial. J Bone Joint Surg 2009;91:52–7.
[15] Siddiqui NA, Ahmad ZM. Revision of unicondylar to total knee arthroplasty: a systematic review. Open Orthop J 2012;6:268–75.
[16] Murray DW, Goodfellow JW, O'Connor JJ. The Oxford medial unicompartmental arthroplasty: a ten-year survival study. J Bone Joint Surg Br 1998;80:983–9.
[17] Weston-Simons JS, Pandit H, Kendrick BJ, Jenkins C, Barker K, Dodd CA, et al. The mid-term outcomes of the Oxford Domed Lateral unicompartmental knee replacement. Bone Joint J 2014;96-B:59–64.
[18] Ansari S, Newman JH, Ackroyd CE. St. Georg sledge for medial compartment knee replacement. 461 arthroplasties followed for 4 (1–17) years. Acta Orthop Scand 1997;68:430–4.
[19] Chatellard R, Sauleau V, Colmar M, Robert H, Raynaud G, Brilhault J. Medial unicompartmental knee arthroplasty: does tibial component position influence clinical outcomes and arthroplasty survival? Orthop Traumatol Surg Res 2013;99:S219–25.
[20] Gioe TJ, Killeen KK, Hoeffel DP, Bert JM, Comfort TK, Scheltema K, et al. Analysis of unicompartmental knee arthroplasty in a community-based implant registry. Clin Orthop Relat Res 2003;111–9.
[21] Sebilo A, Casin C, Lebel B, Rouvillain JL, Chapuis S, Bonnevialle P. Clinical and technical factors influencing outcomes of unicompartmental knee arthroplasty: retrospective multicentre study of 944 knees. Orthop Traumatol Surg Res 2013;99:S227–34.
[22] Annual report 2014 Swedish knee arthroplasty register; 2014.
[23] Hill PF, Vedi V, Williams A, Iwaki H, Pinskerova V, Freeman MA. Tibiofemoral movement 2: the loaded and unloaded living knee studied by MRI. J Bone Joint Surg Br 2000;82:1196–8.
[24] Nakagawa S, Kadoya Y, Todo S, Kobayashi A, Sakamoto H, Freeman MA, et al. Tibiofemoral movement 3: full flexion in the living knee studied by MRI. J Bone Joint Surg Br 2000;82:1199–200.
[25] Ashraf T, Newman JH, Evans RL, Ackroyd CE. Lateral unicompartmental knee replacement survivorship and clinical experience over 21 years. J Bone Joint Surg Br 2002;84:1126–30.
[26] Sah AP, Scott RD. Lateral unicompartmental knee arthroplasty through a medial approach. Study with an average five-year follow-up. J Bone Joint Surg Am 2007;89:1948–54.
[27] Argenson JNA, Parratte S, Bertani A, Flecher X, Aubaniac JM. Long-term results with a lateral unicondylar replacement. Clin Orthop Relat Res 2008;466:2686–93.
[28] Ollivier M, Abdel MP, Parratte S, Argenson JN. Lateral unicondylar knee arthroplasty (UKA): contemporary indications, surgical technique, and results. Int Orthop 2014;38:449–55.
[29] Demange MK, Von Keudell A, Probst C, Yoshioka H, Gomoll AH. Patient-specific implants for lateral unicompartmental knee arthroplasty. Int Orthop 2015;39:1519–26.
[30] Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. J Am Stat Assoc 1958;53:457–81.
[31] Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 2009;151:264–9.
[32] Ackroyd CE, Whitehouse SL, Newman JH, Joslin CC. A comparative study of the medial St Georg sled and kinematic total knee arthroplasties. Ten-year survivorship. J Bone Joint Surg Br 2002;84:667–72.
[33] Amin AK, Patton JT, Cook RE, Gaston M, Brenkel IJ. Unicompartmental or total knee arthroplasty? Results from a matched study. Clin Orthop Relat Res 2006;101–06.
[34] Baur J, Zwicky L, Hirschmann MT, Ilchmann T, Clauss M. Metal backed fixed-bearing unicondylar knee arthroplasties using minimal invasive surgery: a promising outcome analysis of 132 cases. BMC Musculoskelet Disord 2015;16:177.
[35] Bergeson AG, Berend KR, Lombardi Jr AV, Hurst JM, Morris MJ, Sneller MA. Medial mobile bearing unicompartmental knee arthroplasty: early survivorship and analysis of failures in 1000 consecutive cases. J Arthroplasty 2013;28:172–5.
[36] Biswal S, Brighton RW. Results of unicompartmental knee arthroplasty with cemented, fixed-bearing prosthesis using minimally invasive surgery. J Arthroplasty 2010;25:721–7.
[37] Biswas D, Van Thiel GS, Wetters NG, Pack BJ, Berger RA, Della Valle CJ. Medial unicompartmental knee arthroplasty in patients less than 55 years old: minimum of two years of follow-up. J Arthroplast 2014;29:101–5.

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[38] Bonutti PM, Goddard MS, Zywiel MG, Khanuja HS, Johnson AJ, Mont MA. Outcomes of unicompartmental knee arthroplasty stratified by body mass index. J Arthroplast 2011;26:1149–53.

[39] Bruni D, Gagliardi M, Akkawi I, Raspugli G, Bignozzi S, Marko T, et al. Good survivorship of all-polyethylene tibial component UKA at long-term follow-up. Knee Surg Sports Traumatol Arthrosc 2014:1–6. http://dx.doi.org/10.1007/s00167-014-3361-2.

[40] Burnett RS, Nair R, Hall CA, Jacks DA, Pugh L, McAllister MM. Results of the Oxford Phase 3 mobile bearing medial unicompartmental knee arthroplasty from an independent center: 467 knees at a mean 6-year follow-up: analysis of predictors of failure. J Arthroplasty 2014;29:193–200.

[41] Carr A, Keyes G, Miller R, O'Connor J, Goodfellow J. Medial unicompartmental arthroplasty: a survival study of the Oxford meniscal knee. Clin Orthop Relat Res 1993;205–13.

[42] Cepni SK, Arslan A, Polat H, Yalcin A, Parmaksizoglu AS. Mid-term results of Oxford Phase 3 unicompartmental knee arthroplasty in obese patients. Acta Orthop Traumatol Turc 2014;48:122–6.

[43] Choy WS, Kim KJ, Lee SK, Yang DS, Lee NK. Mid-term results of oxford medial unicompartmental knee arthroplasty. Clin Orthop Surg 2011;3:178–83.

[44] Eickmann TH, Collier MB, Sukezaki F, McAuley JP, Engh GA. Survival of medial unicondylar arthroplasties placed by one surgeon 1984–1998. Clin Orthop Relat Res 2006;452:143–9.

[45] Emerson Jr RH, Higgins LL. Unicompartmental knee arthroplasty with the Oxford prosthesis in patients with medial compartment arthritis. J Bone Joint Surg Ser A 2008;90:118–22.

[46] Emerson Jr RH, Hansborough T, Reitman RD, Rosenfeldt W, Higgins LL. Comparison of a mobile with a fixed-bearing unicompartmental knee implant. Clin Orthop Relat Res 2002;62–70.

[47] Emerson Jr RH, Higgins LL. A comparison of highly instrumented and minimally instrumented unicompartmental knee prostheses. Clin Orthop Relat Res 2004;153–7.

[48] Felts E, Parratte S, Pauly V, Aubaniac JM, Argenson JN. Function and quality of life following medial unicompartmental knee arthroplasty in patients 60 years of age or younger. Orthop Traumatol Surg Res 2010;96:861–7.

[49] Hall MJ, Connell DA, Morris HG. Medium to long-term results of the UNIX uncemented unicompartmental knee replacement. Knee 2013;20:328–31.

[50] Hamilton WG, Ammeen DJ, Hopper Jr RH. Mid-term survivorship of minimally invasive unicompartmental arthroplasty with a fixed-bearing implant: revision rate and mechanisms of failure. J Arthroplasty 2014;29:989–92.

[51] Hasegawa Y, Ooishi Y, Shimizu T, Sugiura H, Takahashi S, Ito H, et al. Unicompartmental knee arthroplasty for medial gonarthrosis: 5 to 9 years follow-up evaluation of 77 knees. Arch Orthop Trauma Surg 1998;117:183–7.

[52] Heyse TJ, Khefacha A, Peersman G, Cartier P. Survivorship of UKA in the middle-aged. Knee 2012;19:585–91.

[53] John J, Mauffrey C, May P. Unicompartmental knee replacements with Miller-Galante prosthesis: two to 16-year follow-up of a single surgeon series. Int Orthop 2011;35:507–13.

[54] Kim KT, Lee S, Kim JH, Hong SW, Jung WS, Shin WS. The survivorship and clinical results of minimally invasive unicompartmental knee arthroplasty at 10-year follow-up. Clin Orthop Surg 2015;7:199–206.

[55] Kristensen PW, Holm HA, Varnum C. Up to 10-year follow-up of the Oxford medial partial knee arthroplasty—695 cases from a single institution. J Arthroplasty 2013;28:195–8.

[56] Kuipers BM, Kollen BJ, Bots PC, Burger BJ, van Raay JJ, Tulp NJ, et al. Factors associated with reduced early survival in the Oxford phase III medial unicompartment knee replacement. Knee 2010;17:48–52.

[57] Liddle AD, Pandit H, O'Brien S, Doran E, Penny ID, Hooper GJ, et al. Cementless fixation in Oxford unicompartmental knee replacement: a multicentre study of 1000 knees. J Bone Joint Surg Ser B 2013;95(B):181–7.

[58] Liebs TR, Herzberg W. Better quality of life after medial versus lateral unicondylar knee arthroplasty. Clin Orthop Relat Res 2013;471:2629–40.

[59] Lim HC, Bae JH, Song SH, Kim SJ. Oxford phase 3 unicompartmental knee replacement in Korean patients. J Bone Joint Surg Br 2012;94:1071–6.

[60] Lisowski LA, van den Bekerom MP, Pilot P, van Dijk CN, Lisowski AE. Oxford Phase 3 unicompartmental knee arthroplasty: medium-term results of a minimally invasive surgical procedure. Knee Surg Sports Traumatol Arthrosc 2011;19:277–84.

[61] Lustig S, Paillot JL, Servien E, Henry J, Ait Si Selmi T, Neyret P. Cemented all polyethylene tibial insert unicompartimental knee arthroplasty: a long term follow-up study. Orthop Traumatol Surg Res 2009;95:12–21.

[62] Lyons MC, MacDonald SJ, Somerville LE, Naudie DD, McCalden RW. Unicompartmental versus total knee arthroplasty database analysis: is there a winner? Clin Orthop Relat Res 2012;470:84–90.

[63] Manzotti A, Cerveri P, Pullen C, Confalonieri N. A flat all-polyethylene tibial component in medial unicompartmental knee arthroplasty: a long-term study. Knee 2014;21:S20–5.

[64] Matharu G, Robb C, Baloch K, Pynsent P. The Oxford medial unicompartmental knee replacement: survival and the affect of age and gender. Knee 2012;19:913–7.

[65] Naudie D, Guerin J, Parker DA, Bourne RB, Rorabeck CH. Medial unicompartmental knee arthroplasty with the Miller-Galante prosthesis. J Bone Joint Surg Ser A 2004;86:1931–5.

[66] O'Donnell T, Neil MJ. The Repicci II(R) unicondylar knee arthroplasty: 9-year survivorship and function. Clin Orthop Relat Res 2010;468:3094–102.

[67] Pandit H, Jenkins C, Gill HS, Barker K, Dodd CA, Murray DW. Minimally invasive Oxford phase 3 unicompartmental knee replacement: results of 1000 cases. J Bone Joint Surg Br 2011;93:198–204.

[68] Parratte S, Pauly V, Aubaniac JM, Argenson JN. No long-term difference between fixed and mobile medial unicompartmental arthroplasty. Clin Orthop Relat Res 2012;470:61–8.

[69] Price AJ, Dodd CA, Svard UG, Murray DW. Oxford medial unicompartmental knee arthroplasty in patients younger and older than 60 years of age. J Bone Joint Surg Br 2005;87:1488–92.

[70] Price AJ, Svard U. A second decade lifetable survival analysis of the Oxford unicompartmental knee arthroplasty. Clin Orthop Relat Res 2011;469:174–9.

[71] Rajasekhar C, Das S, Smith A. Unicompartmental knee arthroplasty. 2- to 12-year results in a community hospital. J Bone Joint Surg Br 2004;86:983–5.

[72] Robb CA, Matharu GS, Baloch K, Pynsent PB. Revision surgery for failed unicompartmental knee replacement: technical aspects and clinical outcome. Acta Orthop Belg 2013;79:312–7.

[73] Schlueter-Brust K, Kugland K, Stein G, Henckel J, Christ H, Eysel P, et al. Ten year survivorship after cemented and uncemented medial Uniglide(registered trademark) unicompartmental knee arthroplasties. Knee 2014;21:964–70.

[74] Schroer WC, Barnes CL, Diesfeld P, LeMarr A, Ingrassia R, Morton DJ, et al. The Oxford unicompartmental knee fails at a high rate in a high-volume knee practice. Clin Orthop Relat Res 2013;471:3533–9.

[75] Smith TO, Clark A, Glasgow MMS, Donell ST. The mid-term clinical results of the phase 3 Oxford unicompartmental knee arthroplasty: a 6- to 8-year follow-up. Eur J Orthop Surg Traumatol 2012;22:307–14.

[76] Steele RG, Hutabarat S, Evans RL, Ackroyd CE, Newman JH. Survivorship of the St Georg Sled medial unicompartmental knee replacement beyond ten years. J Bone Joint Surg Br 2006;88:1164–8.

[77] Streit MR, Streit J, Walker T, Bruckner T, Philippe Kretzer J, Ewerbeck V, et al. Minimally invasive Oxford medial unicompartmental knee arthroplasty in young patients. Knee Surg Sports Traumatol Arthrosc 2015 [Epub ahead of print].

[78] Svard UCG, Price AJ. Oxford medial unicompartmental knee arthroplasty. A survival analysis of an independent series. J Bone Joint Surg Ser B 2001;83:191–4.

[79] Tabor Jr OB, Tabor OB, Bernard M, Wan JY. Unicompartmental knee arthroplasty: long-term success in middle-age and obese patients. J Surg Orthop Adv 2005;14:59–63.

[80] Vasso M, Del Regno C, Perisano C, D'Amelio A, Corona K, Schiavone Panni A. Unicompartmental knee arthroplasty is effective: ten year results. Int Orthop 2015. http://dx.doi.org/10.1007/s00264-015-2809-4.

[81] Vorlat P, Putzeys G, Cottenie D, Van Isacker T, Pouliart N, Handelberg F, et al. The Oxford unicompartmental knee prosthesis: an independent 10-year survival analysis. Knee Surg Sports Traumatol Arthrosc 2006;14:40–5.

[82] Whittaker JP, Naudie DD, McAuley JP, McCalden RW, MacDonald SJ, Bourne RB. Does bearing design influence midterm survivorship of unicompartmental arthroplasty? Clin Orthop Relat Res 2010;468:73–81.

[83] Wong T, Wang CJ, Wang JW, Ko JY. Functional outcomes of uni-knee arthroplasty for medial compartment knee arthropathy in asian patients. Biomed J 2014;37:406–10.

[84] Yoshida K, Tada M, Yoshida H, Takei S, Fukuoka S, Nakamura H. Oxford phase 3 unicompartmental knee arthroplasty in Japan—clinical results in greater than one thousand cases over ten years. J Arthroplasty 2013;28:168–71.

[85] Zambianchi F, Digennaro V, Giorgini A, Grandi G, Fiacchi F, Mugnai R, et al. Surgeon's experience influences UKA survivorship: a comparative study between all-poly and metal back designs. Knee Surg Sports Traumatol Arthrosc 2015:2074–80.

[86] Gunther TV, Murray DW, Miller R, Wallace DA, Carr AJ, O'Connor JJ, et al. Lateral unicompartmental arthroplasty with the Oxford meniscal knee. Knee 1996;3:33–9.

[87] Lustig S, Elguindy A, Servien E, Fary C, Munini E, Demey G, et al. 5- to 16-year follow-up of 54 consecutive lateral unicondylar knee arthroplasties with a fixed-all polyethylene bearing. J Arthroplast 2011;26:1318–25.

[88] Lustig S, Lording T, Frank F, Debette C, Servien E, Neyret P. Progression of medial osteoarthritis and long term results of lateral unicompartmental arthroplasty: 10 to 18 year follow-up of 54 consecutive implants. Knee 2014;21:S26–32.

[89] Pandit H, Jenkins C, Beard DJ, Price AJ, Gill HS, Dodd CA, et al. Mobile bearing dislocation in lateral unicompartmental knee replacement. Knee 2010;17:392–7.

[90] Pennington DW, Swienckowski JJ, Lutes WB, Drake GN. Lateral unicompartmental knee arthroplasty: survivorship and technical considerations at an average follow-up of 12.4 years. J Arthroplasty 2006;21:13–7.

[91] Smith JRA, Robinson JR, Porteous AJ, Murray JRD, Hassaballa MA, Artz N, et al. Fixed bearing lateral unicompartmental knee arthroplasty—short to midterm survivorship and knee scores for 101 prostheses. Knee 2014;21:843–7.

[92] Streit MR, Walker T, Bruckner T, Merle C, Kretzer JP, Clarius M, et al. Mobile-bearing lateral unicompartmental knee replacement with the Oxford domed tibial component: an independent series. J Bone Joint Surg Ser B 2012;94(B):1356–61.

[93] Argenson JN, Chevrol-Benkeddache Y, Aubaniac JM. Modern unicompartmental knee arthroplasty with cement: a three to ten-year follow-up study. J Bone Joint Surg Am 2002;84-A:2235–9.

[94] Argenson JN, Blanc G, Aubaniac JM, Parratte S. Modern unicompartmental knee arthroplasty with cement: a concise follow-up, at a mean of twenty years, of a previous report. J Bone Joint Surg Am 2013;95:905–9.

[95] Berger RA, Meneghini RM, Sheinkop MB, Della Valle CJ, Jacobs JJ, Rosenberg AG, et al. The progression of patellofemoral arthrosis after medial unicompartmental replacement: results at 11 to 15 years. Clin Orthop Relat Res 2004;92–9.

[96] Bert JM. 10-year survivorship of metal-backed, unicompartmental arthroplasty. J Arthroplasty 1998;13:901–5.

[97] Capra Jr SW, Fehring TK. Unicondylar arthroplasty: a survivorship analysis. J Arthroplast 1992;7:247–51.

[98] Cavaignac E, Lafontan V, Reina N, Pailhe R, Wargny M, Laffosse JM, et al. Obesity has no adverse effect on the outcome of unicompartmental knee replacement at a minimum follow-up of seven years. Bone Joint J 2013;95-B:1064–8.

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[99] Collier MB, Engh Jr CA, Engh GA. Shelf age of the polyethylene tibial component and outcome of unicondylar knee arthroplasty. J Bone Joint Surg Am 2004;86-A:763–9.
[100] Epinette JA, Manley MT. Is hydroxyapatite a reliable fixation option in unicompartmental knee arthroplasty? A 5- to 13-year experience with the hydroxyapatite-coated unix prosthesis. J Knee Surg 2008;21:299–306.
[101] Foran JR, Brown NM, Della Valle CJ, Berger RA, Galante JO. Long-term survivorship and failure modes of unicompartmental knee arthroplasty. Clin Orthop Relat Res 2013;471:102–8.
[102] Heck DA, Marmor L, Gibson A, Rougraff BT. Unicompartmental knee arthroplasty: a multicenter investigation with long-term follow-up evaluation. Clin Orthop Relat Res 1993;154–59.
[103] Hernigou P, Pascale W, Pascale V, Homma Y, Poignard A. Does primary or secondary chondrocalcinosis influence long-term survivorship of unicompartmental arthroplasty? Clin Orthop Relat Res 2012;470:1973–9.
[104] Keblish PA, Briard JL. Mobile-bearing unicompartmental knee arthroplasty: a 2-center study with an 11-year (mean) follow-up. J Arthroplasty 2004;19:87–94.
[105] Lecuire F, Fayard JP, Simottel JC, Charmion L, Edorh G. Mid-term results of a new cementless hydroxyapatite coated anatomic unicompartmental knee arthroplasty. Eur J Orthop Surg Traumatol 2008;18:279–85.
[106] Lecuire F, Berard JB, Martres S. Minimum 10-year follow-up results of ALPINA cementless hydroxyapatite-coated anatomic unicompartmental knee arthroplasty. Eur J Orthop Surg Traumatol 2014;24:385–94.
[107] Newman J, Pydisetty RV, Ackroyd C. Unicompartmental or total knee replacement: the 15-year results of a prospective randomised controlled trial. J Bone Joint Surg Br 2009;91:52–7.
[108] O'Rourke MR, Gardner JJ, Callaghan JJ, Liu SS, Goetz DD, Vittetoe DA, et al. The John Insall Award: unicompartmental knee replacement: a minimum twenty-one-year followup, end-result study. Clin Orthop Relat Res 2005;440:27–37.
[109] Rachha R, Veravalli K, Sood M. Medium term results of the Miller-Galante knee arthroplasty with 10 year survivorship. Acta Orthop Belg 2013;79:197–204.
[110] Rougraff BT, Heck DA, Gibson AE. A comparison of tricompartmental and unicompartmental arthroplasty for the treatment of gonarthrosis. Clin Orthop Relat Res 1991;157–64.
[111] Scott RD, Cobb AG, McQueary FG, Thornhill TS. Unicompartmental knee arthroplasty: eight- to 12-year follow-up evaluation with survivorship analysis. Clin Orthop Relat Res 1991;96–100.
[112] Squire MW, Callaghan JJ, Goetz DD, Sullivan PM, Johnston RC. Unicompartmental knee replacement. A minimum 15 year followup study. Clin Orthop Relat Res 1999;61–72.
[113] Tabor Jr OB, Tabor OB. Unicompartmental arthroplasty: a long-term follow-up study. J Arthroplasty 1998;13:373–9.
[114] Bordini B, Stea S, Falcioni S, Ancarani C, Toni A. Unicompartmental knee arthroplasty: 11-year experience from 3929 implants in RIPO register. Knee 2014;21:1275–9.
[115] Furnes O, Espehaug B, Lie SA, Vollset SE, Engesaeter LB, Havelin LI. Failure mechanisms after unicompartmental and tricompartmental primary knee replacement with cement. J Bone Joint Surg Am 2007;89:519–25.
[116] Liddle AD, Judge A, Pandit H, Murray DW. Determinants of revision and functional outcome following unicompartmental knee replacement. Osteoarthritis Cartilage 2014;22:1241–50.
[117] Niinimaki T, Eskelinen A, Makela K, Ohtonen P, Puhto AP, Remes V. Unicompartmental knee arthroplasty survivorship is lower than TKA survivorship: a 27-year Finnish registry study. Clin Orthop Relat Res 2014;472:1496–501.
[119] Iwaki H, Pinskerova V, Freeman MA. Tibiofemoral movement 1: the shapes and relative movements of the femur and tibia in the unloaded cadaver knee. J Bone Joint Surg Br 2000;82:1189–95.
[120] Pabinger C, Lumenta DB, Cupak D, Berghold A, Boehler N, Labek G. Quality of outcome data in knee arthroplasty. Acta Orthop 2015;86:58–62.
[121] Pabinger C, Berghold A, Boehler N, Labek G. Revision rates after knee replacement. Cumulative results from worldwide clinical studies versus joint registers. Osteoarthritis Cartilage 2013;21:263–8.
[122] Labek G, Neumann D, Agreiter M, Schuh R, Bohler N. Impact of implant developers on published outcome and reproducibility of cohort-based clinical studies in arthroplasty. J Bone Joint Surg Am 2011;93(Suppl. 3):55–61.
[123] Baker P, Jameson S, Critchley R, Reed M, Gregg P, Deehan D. Center and surgeon volume influence the revision rate following unicondylar knee replacement: an analysis of 23,400 medial cemented unicondylar knee replacements. J Bone Joint Surg Am 2013;95:702–9.
[124] Badawy M, Espehaug B, Indrekvam K, Havelin LI, Furnes O. Higher revision risk for unicompartmental knee arthroplasty in low-volume hospitals. Acta Orthop 2014;85:342–7.

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