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No difference between unicompartmental versus total knee arthroplasty for the management of medial osteoarthtritis of the knee in the same patient: a systematic review and pooling data analysis

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Abstract

Introduction: One-third of patients with knee osteoarthritis (OA) has involvement of only one compartment, especially the medial one.

Sources of data: We performed a comprehensive search of studies comparing unicompartmental knee arthoplasty (UKA) and total knee arthroplasty (TKA) in the same patient on PubMed, OVID/Medline, Cochrane, CINAHL, Google scholar and Embase databases.

Areas of agreement: UKA is indicated in knee with medial OA, no flexion deformity, no joint instability and no varus deformity.

Areas of controversy: Although high tibial osteotomy, UKA and TKA have been proposed to address medial OA of the knee, the best management is still controversial.

Growing points: Studies investigating surgical management of medial OA of the knee are increasingly frequent.

Areas timely for developing research: Large, multicentre, powered, randomized trials comparing UKA and TKA are needed to identify the best

management for medial OA of the knee. Moreover, new score systems for satisfaction of the patient should be formulated.

Key words: osteoarthritis, knee, unicompartimental arthroplasty, total arthroplasty

Introduction

Degenerative changes of the knee more frequently involve all the joint, including medial, lateral and patellofemoral compartments.[1,2] However, up to 30% of patients can develop OA in only one compartment of the joint, especially the medial one.[3,4]

The management of OA of the medial compartment of the knee aims to reduce pain, restore function and improve quality of life.[5] Several surgical approaches have been proposed to address it, such as high tibial osteotomy, unicompartmental knee arthroplasty (UKA) and total knee arthroplasty (TKA),[6] according to the age and the level of activity of the patient, and the clinical features of the knee.[7] However, the best management of these patients is still controversial.[8,9]

Classic indications for UKA include: medial OA of the knee, range of motion (ROM) with at least 90° of flexion, no anterior or posterior cruciate lesion (ACL/PCL), none or slight (<10°) flexion deformity, none or slight (<5°) varus deformity and no obesity.[10–12] However, during the last 30 years, the indications for UKA have been greatly extended.[13,14] Although obesity could affect the longevity of the implant, good outcomes have been reported in these patients.[15] ACL tears are also considered a relative contraindication for the UKA. Indeed, ACL reconstruction in combination with UKA procedure seems to provide stability of the knee preventing the failure of the implant in the mid term.[16] Moreover, UKA surgery can be also performed in selected patients with ACL-deficient knee without ACL reconstruction reporting, with successful outcome in the long term.[17] Although this approach can provide symptom relief maintaining an active lifestyle, appropriate counselling of the patient is recommended to achieve successful results.

Compared with TKA, the unicompartmental arthroplasty is associated with some advantages such as femoral and tibial bone stock sparing, reduced intraoperative and postoperative blood loss, shorter period of hospital stay and preservation of physiologic biomechanics of the knee with an increased ROMs.[18] Finally, the cost-effective analysis on both procedures reported better results in favour of the UKA.[19] Although several authors compared UKA and TKA, investigating survivorship and costs to functional outcomes and patient satisfaction,[20–28] only three studies compared UKA and TKA in the same patients.[18,29] The comparison of different implants in the same patient allows to avoid differences in terms of lifestyle, such as functional activity or smoke, and physical features, such as body mass index, which can affect the performance of the prostheses. Therefore, this design provides a matched group for an appropriate comparison.

The aim of the present study was to perform a systematic review and pooling data analysis of the studies comparing UKA and TKA implanted in the same patient for the management of medial knee osteoarthritis and assessing functional outcome, complications and survivorships of the prostheses.

Materials and methods

A review of the literature was performed in a systematic fashion using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) checklist and algorithm (Fig. 1).[30,31] 'Unicompartmental arthroplasty', 'total arthroplasty', 'osteoarthritis' and 'knee' were used as keywords to perform the literature search in PubMed, Medline, CINAHL, Cochrane, Embase and Google Scholar databases over the years 1980–2014.

The search of literature and data collection were performed by three reviewers in a blind fashion. All potentially eligible articles were evaluated from inception of databases to November 30, 2013. Only papers published in peer-reviewed journals were considered eligible, and their relevance was established on the basis of title and abstract. After the article selection, bibliographies were assessed by reviewers

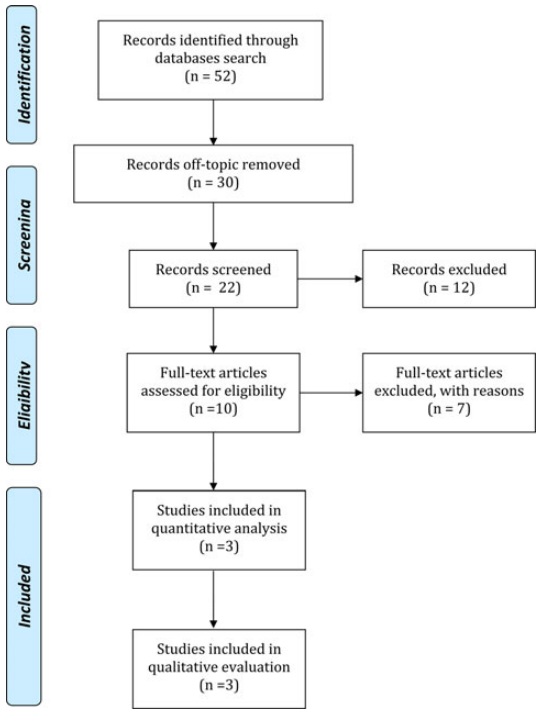

Fig. 1 Literature search algorithm.

to detect further relevant articles, including reviews and meta-analyses.

We included only articles comparing UKA and TKA procedures in the same patient, which provided the following data: demographics, description of surgical procedure, follow-up period, clinical outcome score and complications. Narrative and quantitative reviews, case reports, technical notes and letters to editors were excluded. To minimize the selection bias, all the included and excluded articles were reviewed and discussed by all the authors. Any disagreement was resolved by discussion.

Statistical analysis

Categorical variables were expressed as frequency with percentage. Continuous variables were expressed as average value with range. The preoperative and postoperative values of Knee Society Score, Function Score and ROM in both groups were compared by using the Wilcoxon signed rank test. A *P*-value of <0.05 was considered significant. All statistical analyses were performed with SPSS 19.0 version.

A pooling data analysis was performed using a fixed-effects model with RevMan 5.1.4 version to evaluate the effectiveness of procedures, in terms of Knee Society Score, Function Score and ROM, complications related to surgery and survivorships of prostheses. The test for overall effect (Z-value) was used to assess statistically significant differences between the two groups. The heterogeneity, defined as variability among studies secondary to true differences between studies instead of sampling error, was investigated using both a χ^2 test and the I^2 statistic.[32] An I^2 value >50% was considered suggestive of substantial heterogeneity.[33]

Results

Searching of the literature and reference scanning identified 52 references, of which 42 were excluded because the abstract showed that they did not deal with the topic at hand and/or missed the inclusion criteria (Fig. 1). The evaluation of remaining full-text articles resulted in the exclusion of further seven articles, because of insufficient data and absence of comparison between UKA and TKA in the same patient.

Finally, we included three articles, assessing patients who underwent UKA on one knee and TKA on the other.

Demographics

A total of 160 knees in 80 patients (45 males and 35 females) were included, with an average age of 70 years (range, 41–89 years). The assessment of patients was performed at an average follow-up of 57.2 months (range, 7.2–153 months).

Surgery

All the included studies, describing 80 patients, reported details on the implanted prosthesis (Table 1). In the TKA group, 71 implants were cemented posterior cruciate-retaining prostheses (with patellar resurfacing in 29 patients), 6 were cemented posterior stabilized prostheses (with patellar resurfacing in 2 patients) and 3 were Press-Fit condylar system (with patellar resurfacing in only one patient). In the UKA group, 40 implants were cemented all polyethylene, and 17 were cemented metal-backed. In 23 patients of

Table 1 Details of the included studies

Authors	Study design (level of evidence)	Sample size (*N*)	Gender	BMI mean (range)	Age (years) mean (range)	Follow-up (months) mean (range)	Survivorship (%)
Dalury *et al.*[34]	Retrospective (III)	23	F: 11 M: 12	30.5 (22–49)	TKA: 68 (41–89) UKA: 69 (47–88)	TKA: 45.9 (7.2–148) UKA: 41.6 (11.5–59.8)	TKA 100 UKA 100
Costa *et al.*[29]	Prospective (III)	34	F: 15 M: 19	29.8 (19–38)	73 (49–86)	60 (24–89)	TKA 100 UKA 85
Laurencin *et al.*[18]	Retrospective (III)	23	F: 9 M: 14	—	67	81 (38–153)	TKA 100 UKA 100

the UKA group, no details about the prosthesis were provided.[18]

Function

Two[29,34] of three studies, describing 57 patients, assessed the function in terms of KSS and function score. In the unicompartmental group, the mean value of KSS was 46.95 (26–65) preoperatively and 92.85 (61–100) postoperatively ($P < 0.00001$). In the TKA group, the average value of KSS was 40.7 (22–58) preoperatively and 93.15 (64–100) postoperatively ($P < 0.00001$). A statistically significant difference between both groups was found in terms of preoperative values of KSS ($P < 0.0001$; $I^2 = 72\%$; heterogeneity $P = 0.06$), whereas no difference of postoperative values of KSS was reported ($P = 0.89$; $I^2 = 0\%$; heterogeneity $P = 0.85$).

In the UKA group, the average value of function score was 50.2 (30–70) preoperatively and 89 (50–100) postoperatively ($P < 0.00001$). In the TKA group, the average value of function was 49.7 (25–70) preoperatively and 89.4 (50–100) postoperatively ($P < 0.00001$). Between the two groups, no difference was found in terms of preoperative ($P = 0.69$; $I^2 = 0\%$; heterogeneity $P = 0.75$) and postoperative values of function ($P = 0.79$; $I^2 = 0\%$; heterogeneity $P = 0.79$).

Pain

One[34] of three studies, describing 23 patients, assessed the pain prior and after surgery by using the pain score included in the KSS. This score ranged from 0 to 50, with lower values indicating higher pain reported by the patient. In the UKA group, the average value was 13 (10–20) preoperatively and 43.7 (45–50) postoperatively. In the TKA group, the average value was 15.2 (10–20) preoperatively and 45.2 (45–50) postoperatively. There was no difference between both groups in terms of preoperative and postoperative pain ($P > 0.05$).

Range of motion

Two[18,34] of three studies, describing 46 patients, reported the ROM. In the unicompartmental group, the mean value of ROM was 110.7° (100°–130°) preoperatively and 124.3° (110°–135°) postoperatively ($P < 0.00001$) (Table 2). In the TKA group, the average value of ROM was 108.7° (95°–125°) preoperatively and 114.8° (108°–130°) postoperatively ($P = 0.004$). Between the two groups, no difference was recorded in terms of preoperative values of ROM ($P = 0.6$; $I^2 = 60\%$; heterogeneity $P = 0.11$), whereas the postoperative values of ROM were significantly higher in the UKA group ($P < 0.0001$; $I^2 = 93\%$; heterogeneity $P = 0.0002$).

Complications

The overall rate of complications was 5% (4 of 80) in the UKA group and 2.5% (2 of 80) in the TKA group ($P = 0.4$).[18,29,34] In the former group, a tibial plateau fracture at the tibial jig pin site was reported in four patients. In the latter group, one patient developed a recurrent haematoma, managed with

Table 2 Clinical outcomes in the included studies

Authors	Pain preop mean (range)	Pain postop mean (range)	KSS preop mean (range)	KSS postop mean (range)	Function preop mean (range)	Function postop mean (range)	ROM preop mean (SD)	ROM preop mean (SD)
Dalury *et al.*[34]	TKA: 15.2 (10–20) UKA: 13 (10–20)	TKA: 45.2 (45–50) UKA: 43.7 (45–50)	TKA: 42.4 (35–52) UKA: 45.9 (35–59)	TKA: 90.3 (87–98) UKA: 89.7 (87–99)	TKA: 53.4 (50–60) UKA: 53.4 (50–60)	TKA: 87.8 (80–100) UKA: 87 (68, 75–100)	TKA: 109.5 (12.5) UKA: 115.43 (13.3)	TKA: 119.6 (7) UKA: 122.6 (9.3)
Costa *et al.*[29]	TKA: 39 (22–58) UKA: 47 (26–65)	TKA: 96 (64–100) UKA: 96 (61–100)	TKA: 39 (22–58) UKA: 48 (26–65)	TKA: 96 (64–100) UKA: 96 (61–100)	TKA: 46 (25–70) UKA: 47 (30–70)	TKA: 91 (50–100) UKA: 91 (50–100)	—	—
Laurencin *et al.*[18]	—	TKA: 83% no pain UKA: 96% no pain	—	—	—	—	TKA: 108° UKA: 106°	TKA: 110° UKA: 126°

debridement, and another patient presented a deep venous thromboses at 16 days after surgery.

In the included studies, the survivorship of TKA was 100%, whereas the survivorship of UKA was 94% ($P = 0.09$)[18,29,34] at a mean follow-up of 57.2 months. In the UKA group, five patients required revision to a TKA. In four patients, the failure of the prosthesis was related to tibial plateau fractures, causing persistent pain of the knee. In one patient, the indication for the revision was pain due to progressive degenerative joint disease.

Discussion

UKA provides a statistically significant greater ROM of the knee compared with TKA. Moreover, there is no statistically significant difference between UKA and TKA in terms of function scores, complications and survivorships.

Although several surgical treatments have been proposed for OA of the medial compartment of the knee, such as high tibial osteotomy, UKA and TKA, the best management of these patients is still controversial.

The analysis of preoperative and postoperative function showed a statistically significant improvement after surgery in terms of ROM, KSS and function score in both groups. However, the comparison of postoperative values between the two groups showed a superiority of UKA over the TKA in terms of ROM achieved, whereas no differences in terms of KSS and function score were found.

In our pooling data analysis, we reported a slight superiority of TKA in terms of survivorship (100 vs. 94%) with an average follow-up of 57.2 months, but this was not statistically significant ($P = 0.09$).[18,29,34] These findings are consistent with those published in recent studies investigating UKA[35,36] for medial OA of the knee, showing survival rates up to 100% at a 10-year follow-up from surgery.[37] Although previous studies reported significantly higher failure and revision rates in UKA than those in TKA,[38–41] current data show no difference between UKA and TKA. The increase in the survivorship rate of the UKA over the past two decades could be related with the improvement of the implants' design and operative techniques.[42,43] Moreover, the experience of the

surgeon is another critical factor. As minimally invasive surgery could be high demanding, the inadequate experience of the surgeon may lead to greater incidence of technical errors and early failures.[44–48] Previous studies reported higher failure rates in centres with small number of UKA procedures (<10) per year than those reported in high-volumes centres.[49,50]

The analysis of the complications showed no differences in the overall rate between UKA and TKA groups.[18,29,34] Moreover, although complications were more frequent in the UKA group (5 vs. 2.5%), they were reported only in one of the included studies and were tibial plateau fractures caused by the design of prosthesis.

Recently, two large studies[51,52] based on data from Hospital Episode Statistics (HES) and National Joint Registry of England and Wales (NJR) data showed that the rates of perioperative death and serious morbidity are significantly lower in patients undergoing UKR compared with patients undergoing TKR. However, the use of TKR instead of UKR is still strongly encouraged by statistics based on revision rates alone, despite UKR has been reported as cheaper and safer operation. Moreover, taking account the revision alone as outcome, a painful joint replacement that is not revised will be considered as a success from registry analysis. For these reasons, the policy in knee arthroplasty should be reviewed worldwide.[53]

Two of the included studies reported on the patient's preference about the surgery. Dalury *et al.*[34] reported that all patients preferred the UKA over the TKA. In the study by Laurencin *et al.*,[18] 11 of 23 patients preferred the UKA, 3 preferred the TKA and 9 did not report any difference. Although no score has been designed to adequately assess patient's satisfaction, the difference in terms of patient's preference between UKA and TKA could be referred to some potential advantages in favour of the UKA procedure, such as bone stock sparing, reduction of intraoperative and postoperative blood loss, better pain management, shorter recoveries and shorter hospital stays.[10,18,54] In terms of function, UKA provides higher ROM, lower incidence of stiffness and less need for rehabilitation, as UKA maintains normal knee kinematics[54–56] and saves the anterior cruciate ligament, maintaining the normal joint proprioception.[57,58]

Patient's satisfaction is strongly related to the patient's expectations before surgery. Usually, the expectation of young males about the clinical outcome after surgery are greater than those the implant can really provide.[59] Some authors refer to this issue, the higher early risk of revision for UKA in younger (<60 years) compared with older patients.[40] For this reason, the preoperative interview with the patient plays a critical role, particularly in younger male patients, to explain clearly the risk of limited satisfaction after a knee replacement procedure.[60]

The strength of this systematic review is that we performed a pooling data analysis across the eligible studies. This analysis allowed us to compare UKA and TKA in terms of ROM of the knee, function scores, complications and survivorships. Another strength of the study is represented by the homogeneity between the UKA and TKA groups, because there was no difference between the two groups in terms of preoperative values of function score and ROM.

We are aware that the present systematic review has several limitations, mainly related to the poor quality of the included studies. First, although we included comparative studies, none was a level I randomized trial. However, because we compared unicompartmental and total replacement in the same patient, no randomized studies can be performed to address this particular issue. Moreover, the overall sample size of this review was small at 80 patients and 160 knees, despite including all the studies available in literature. Second, an objective assessment of the preoperative and postoperative function with validated scales was not performed in all the included studies. Indeed, the measurement of ROM and KSS score for knee function were respectively performed in only two studies.[18,29,34] Moreover, none of the included studies compared the two groups in terms of preoperative grade of OA. On the other hand, data on the complications and failure of the prosthesis were reported in all the included studies. Moreover, the included studies reported a comparison between the two groups in terms of ROM and function scores at a mean 57 month follow-up, but no results referring the first postoperative months are available in this respect.

For this reason, we were not able to detect any eventual difference between UKA and TKA in the short term, although there are no differences in the midterm, except for the ROM. Third, none of the included studies performed a systematic assessment of patients' satisfaction. Indeed, patients seem to prefer UKA over TKA, despite no significant differences being present in terms of functional outcomes, such as KSS. We believe that these results could be associated with some advantages of UKA, including lower blood loss, decreased postoperative pain, shorter recoveries, and shorter hospital stays, and less need for rehabilitation. As these aspects cannot be evaluated with joint-specific scores, such as the KSS, we recommend to perform a comprehensive assessment of the patients by using scores for quality of life together with joint-specific scores. Moreover, new score systems for satisfaction of the patient should be formulated, taking into account parameters affecting the return to the daily life after surgery, such as postoperative pain, hospital stay, period of rehabilitation and time of return to work/leisure activity. Finally, future efforts must include conducting large, multicentre, adequately powered, randomized trials to identify the best management for medial OA of the knee.

In conclusion, there are no statistically significant differences between UKA and TKA in terms of function scores, complications and survivorships, but UKA provides a statistically significant greater ROM. Moreover, the vast majority of the patients prefer UKA on the basis of shorter period of hospital stay, faster recovery and less need for rehabilitation. Although the best management osteoarthritis of the medial compartment of the knee is still controversial, these results support the routine use of UKA for medial compartment osteoarthritis.

Conflict of Interest statement

The authors have no potential conflicts of interest.

References

1. Ackroyd CE. Medial compartment arthroplasty of the knee. *J Bone Joint Surg Br* 2003;85:937–42.
2. Longo UG, Loppini M, Fumo C, et al. Osteoarthritis: new insights in animal models. *Open Orthop J* 2012;6:558–63.
3. Ledingham J, Regan M, Jones A, et al. Radiographic patterns and associations of osteoarthritis of the knee in patients referred to hospital. *Ann Rheum Dis* 1993;52:520–6.
4. Maffulli N, Loppini M, Longo UG, et al. Bovine xenograft locking Puddu plate versus tricalcium phosphate spacer non-locking Puddu plate in opening-wedge high tibial osteotomy: a prospective double-cohort study. *Int Orthop* 2013;37:819–26.
5. Felson DT, Lawrence RC, Hochberg MC, et al. Osteoarthritis: new insights. Part 2: treatment approaches. *Ann Intern Med* 2000;133:726–37.
6. Griffin T, Rowden N, Morgan D, et al. Unicompartmental knee arthroplasty for the treatment of unicompartmental osteoarthritis: a systematic study. *ANZ J Surg* 2007;77:214–21.
7. Insall JN, Ranawat CS, Aglietti P, et al. A comparison of four models of total knee-replacement prostheses. *J Bone Joint Surg Am* 1976;58:754–65.
8. Maffulli N, Longo UG, Gougoulias N, et al. Long-term health outcomes of youth sports injuries. *Br J Sports Med* 2010;44:21–5.
9. Maffulli N, Longo UG, Spiezia F, et al. Sports injuries in young athletes: long-term outcome and prevention strategies. *Phys Sportsmed* 2010;38:29–34.
10. Kozinn SC, Scott R. Unicondylar knee arthroplasty. *J Bone Joint Surg Am* 1989;71:145–50.
11. Deshmukh RV, Scott RD. Unicompartmental knee arthroplasty for younger patients: an alternative view. *Clin Orthop Relat Res* 2002;404:108–12.
12. Scott RD, Santore RF. Unicondylar unicompartmental replacement for osteoarthritis of the knee. *J Bone Joint Surg Am* 1981;63:536–44.
13. Archibeck MJ, White RE Jr. What's new in adult reconstructive knee surgery. *J Bone Joint Surg Am* 2001;83-A:1444–50.
14. Lombardi AV Jr, Berend KR, Berend ME, et al. Current controversies in partial knee arthroplasty. *Instr Course Lect* 2012;61:347–81.
15. Palumbo BT, Scott RD. Diagnosis and indications for treatment of unicompartmental arthritis. *Clin Sports Med* 2014;33:11–21.
16. Tinius M, Hepp P, Becker R. Combined unicompartmental knee arthroplasty and anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2012;20:81–7.
17. Plancher KD, Dunn AS, Petterson SC. The anterior cruciate ligament-deficient knee and unicompartmental arthritis. *Clin Sports Med* 2014;33:43–55.

18. Laurencin CT, Zelicof SB, Scott RD, et al. Unicompartmental versus total knee arthroplasty in the same patient. A comparative study. *Clin Orthop Relat Res* 1991;273:151–6.
19. Robertsson O, Borgquist L, Knutson K, et al. Use of unicompartmental instead of tricompartmental prostheses for unicompartmental arthrosis in the knee is a cost-effective alternative. 15,437 primary tricompartmental prostheses were compared with 10,624 primary medial or lateral unicompartmental prostheses. *Acta Orthop Scand* 1999;70:170–5.
20. Ackroyd CE, Whitehouse SL, Newman JH, et al. 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.
21. Amin AK, Patton JT, Cook RE, et al. Unicompartmental or total knee arthroplasty? Results from a matched study. *Clin Orthop Relat Res* 2006;451:101–6.
22. Hassaballa MA, Porteous AJ, Learmonth ID. Functional outcomes after different types of knee arthroplasty: kneeling ability versus descending stairs. *Med Sci Monit* 2007;13:CR77–81.
23. Hassaballa MA, Porteous AJ, Newman JH. Observed kneeling ability after total, unicompartmental and patellofemoral knee arthroplasty: perception versus reality. *Knee Surg Sports Traumatol Arthrosc* 2004;12:136–9.
24. Hassaballa MA, Porteous AJ, Newman JH, et al. Can knees kneel? Kneeling ability after total, unicompartmental and patellofemoral knee arthroplasty. *Knee* 2003;10:155–60.
25. Hopper GP, Leach WJ. Participation in sporting activities following knee replacement: total versus unicompartmental. *Knee Surg Sports Traumatol Arthrosc* 2008;16:973–9.
26. Walton NP, Jahromi I, Lewis PL, et al. Patient-perceived outcomes and return to sport and work: TKA versus mini-incision unicompartmental knee arthroplasty. *J Knee Surg* 2006;19:112–6.
27. Weale AE, Halabi OA, Jones PW, et al. Perceptions of outcomes after unicompartmental and total knee replacements. *Clin Orthop Relat Res* 2001;382:143–53.
28. Weale AE, Murray DW, Crawford R, et al. Does arthritis progress in the retained compartments after 'Oxford' medial unicompartmental arthroplasty? A clinical and radiological study with a minimum ten-year follow-up. *J Bone Joint Surg Br* 1999;81:783–9.
29. Costa CR, Johnson AJ, Mont MA, et al. Unicompartmental and total knee arthroplasty in the same patient. *J Knee Surg* 2011;24:273–8.
30. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ* 2009;339:b2700.
31. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009;339:b2535.
32. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med* 2002;21:1539–58.
33. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ* 2003;327:557–60.
34. Dalury DF, Fisher DA, Adams MJ, et al. Unicompartmental knee arthroplasty compares favorably to total knee arthroplasty in the same patient. *Orthopedics* 2009;32. pii: orthosupersite.com/view.asp?rID=38057.
35. Goodfellow J, O'Connor J. The mechanics of the knee and prosthesis design. *J Bone Joint Surg Br* 1978;60-B:358–69.
36. Goodfellow JW, Kershaw CJ, Benson MK, et al. The Oxford Knee for unicompartmental osteoarthritis. The first 103 cases. *J Bone Joint Surg Br* 1988;70:692–701.
37. Svard UC, Price AJ. Oxford medial unicompartmental knee arthroplasty. A survival analysis of an independent series. *J Bone Joint Surg Br* 2001;83:191–4.
38. Weale AE, Murray DW, Newman JH, et al. The length of the patellar tendon after unicompartmental and total knee replacement. *J Bone Joint Surg Br* 1999;81:790–5.
39. Emerson RH Jr, Higgins LL. Unicompartmental knee arthroplasty with the oxford prosthesis in patients with medial compartment arthritis. *J Bone Joint Surg Am* 2008;90:118–22.
40. Kuipers BM, Kollen BJ, Bots PC, et al. Factors associated with reduced early survival in the Oxford phase III medial unicompartment knee replacement. *Knee* 2010;17:48–52.
41. Mercier N, Wimsey S, Saragaglia D. Long-term clinical results of the Oxford medial unicompartmental knee arthroplasty. *Int Orthop* 2010;34:1137–43.
42. Lewold S, Goodman S, Knutson K, et al. Oxford meniscal bearing knee versus the Marmor knee in unicompartmental arthroplasty for arthrosis. A Swedish multicenter survival study. *J Arthroplasty* 1995;10:722–31.
43. Knutson K, Lewold S, Robertsson O, et al. The Swedish knee arthroplasty register. A nation-wide study of 30,003 knees 1976–1992. *Acta Orthop Scand* 1994;65:375–86.
44. Longo UG, Rizzello G, Berton A, et al. A review of preclinical and clinical studies using synthetic materials for meniscus replacement. *Curr Stem Cell Res Ther* 2013;8:438–43.
45. Khanna A, Gougoulias N, Longo UG, et al. Minimally invasive total knee arthroplasty: a systematic review. *Orthop Clin North Am* 2009;40:479–89. viii.
46. Longo UG, Maffulli N, Denaro V. Minimally invasive total knee arthroplasty. *N Engl J Med* 2009;361:633–4; author reply 634.

47. Longo UG, Maffulli N, Denaro V. Rivaroxaban versus enoxaparin after total knee arthroplasty. *Lancet* 2009;374: 681–2; author reply 683.
48. Luscombe KL, Lim J, Jones PW, et al. Minimally invasive Oxford medial unicompartmental knee arthroplasty. A note of caution! *Int Orthop* 2007;31:321–4.
49. Lisowski LA, van den Bekerom MP, Pilot P, et al. Oxford Phase 3 unicompartmental knee arthroplasty: medium-term results of a minimally invasive surgical procedure. *Knee Surg Sports Traumatol Arthrosc* 2011;19:277–84.
50. Koskinen E, Paavolainen P, Eskelinen A, et al. Unicondylar knee replacement for primary osteoarthritis: a prospective follow-up study of 1,819 patients from the Finnish Arthroplasty Register. *Acta Orthop* 2007;78:128–35.
51. Hunt LP, Ben-Shlomo Y, Clark EM, et al. 45-day mortality after 467 779 knee replacements for osteoarthritis from the National Joint Registry for England and Wales: an observational study. *Lancet* 2014;384:1429–36.
52. Liddle AD, Judge A, Pandit H, et al. 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.
53. Cobb JP. Patient safety after partial and total knee replacement. *Lancet* 2014.
54. Price AJ, Webb J, Topf H, et al. Rapid recovery after oxford unicompartmental arthroplasty through a short incision. *J Arthroplasty* 2001;16:970–6.
55. Deshmukh RV, Scott RD. Unicompartmental knee arthroplasty: long-term results. *Clin Orthop Relat Res* 2001;392:272–8.
56. Lombardi AV Jr, Berend KR, Walter CA, et al. Is recovery faster for mobile-bearing unicompartmental than total knee arthroplasty? *Clin Orthop Relat Res* 2009;467: 1450–7.
57. 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.
58. Maduekwe UI, Zywiel MG, Bonutti PM, et al. Scientific evidence for the use of modern unicompartmental knee arthroplasty. *Expert Rev Med Devices* 2010;7:219–39.
59. Scott CE, Howie CR, MacDonald D, et al. Predicting dissatisfaction following total knee replacement: a prospective study of 1217 patients. *J Bone Joint Surg Br* 2010;92:1253–8.
60. Clement ND, Duckworth AD, MacKenzie SP, et al. Medium-term results of Oxford phase-3 medial unicompartmental knee arthroplasty. *J Orthop Surg (Hong Kong)* 2012;20:157–61.