Usage of Unicompartmental Knee Replacement

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Abstract

Severe knee arthritis is commonly confined to one compartment of the knee and therefore can be treated with either Unicompartmental (UKR) or Total Knee Replacement (TKR). Although UKR provides a faster recovery, fewer complications and better function than TKR, the revision rate in national registries is three times higher[1-4]. In view of this high "failure" rate many surgeons either do not implant UKR or do small numbers. As a result only 5% to 10% of knee replacements are UKR[4]. The revision rate of UKR is related to the numbers that surgeons implant, with surgeons doing small numbers having very high revision rates[5]. Many organisations have therefore recommended that surgeons doing small numbers should stop doing UKR or that UKR should only be done in specialist units [6-8]. These recommendations, if adhered to, will decrease the number of revisions. However they will also decrease the number of UKR and therefore the number of patients that can benefit from UKR.

Alternatively surgeons doing small numbers could do more by increasing the percentage of their knee replacements that are UKR (UKR usage)[9]. Recent evidence shows that increased usage decreases the revision rate and is more important than the number done per year [10]: With low usage the revision rate is very high, whether the numbers are high or low. Conversely if the usage is 20% or more the revision rate is low, whether the numbers are high or low. The best recommendation is therefore that surgeons should aim for at least 20% usage. To achieve this surgeons, with low usage, would need to change their indications for UKR. There are simple evidence based indications for some UKR implants that are satisfied in more than 20% of knee replacements[11]. If surgeons use these indications then their UKR usage will be at least 20%. This would result in more UKR being done, the revision rate would decrease and more patients would benefit from UKR.

Advantages and disadvantages of UKR

UKR tend to be implanted in younger, fitter and more active patients than TKR[4]. As these factors influence the outcome of joint replacement, unmatched comparisons of UKR and TKR are likely to be misleading[12]. There is only one randomised controlled trial (TOPKAT) of UKR and TKR that is adequately powered to compare clinical outcomes[13]. At one year this study found that UKR had significantly better functional outcomes as assessed by the Oxford Knee Score (OKS), although the difference was small. In addition UKR patients were more likely to say that they had improved and that they would have the operation again. For other outcomes and longer term data well matched studies are required.

To compare rare events large datasets are needed. In a study of 100,000 knees based on National Joint Registry Data (NJR) and other national datasets, UKR were matched to TKR at a ratio of 1:3 based on 20 variables[2]. In a subset with PROMS the difference in OKS was similar to that in

TOPKAT[3,13], UKR were significantly more likely to achieve excellent OKS (Odds ratio (OR) 1.6), excellent satisfaction (OR 1.3) and the EQ-5D score was better. The length of stay was shorter (1.4 days), the rate of intra-operative complications (OR 0.73), re-admission within the first year (OR 0.65) and transfusion (OR 0.25) were lower[2]. Major medical complications, such as thromboembolism (OR 0.49), infection (OR 0.5), stroke (OR 0.37) and myocardial infarct (OR 0.53) occurred less frequently. The mortality following UKR was also significantly lower (Hazard Ratio at 30 days 0.23, 90 days 0.46, 8 years 0.87). However at eight years the revision rate of UKR was 2.1 x higher than that of TKR and the re-operation rate was 1.4 times higher.

The evidence therefore suggests that apart from revision all outcome measures favour UKR. To get this in perspective the authors of the matched study stated: "If 100 patients receiving TKR received UKR instead; the result would be around one less death and three more reoperations in the first 4 years after surgery"[2]. If all the other advantages were ignored, based on this comparison alone patients would probably choose UKR.

It is generally thought that the higher revision rate of UKR than TKR is because UKR have more poor results. This cannot be the explanation because a number of studies, such as the New Zealand Joint Registry (NZJR), have shown that UKR have less poor results[14,15]. The main reason for the higher revision rate is that the threshold for revision is lower[15]. This is probably because a revision of a UKR is usually technically easier than that of a TKR and the outcome is generally expected to be better[16]. Data from the NZJR suggest that if a UKR is worse post-operatively than pre-operatively (largely those with OKS<20) 60% are subsequently revised, whereas only 10% of similarly bad TKR are revised[15]. In other words; if a UKR has a bad outcome, whether there is a mechanical problem or not, it will probably be revised to a TKR, whereas if a TKR does badly it will probably only be revised in the rare situation where there is an obvious mechanical problem. The issue is therefore with the definition of failure: From a patients perspective a poor outcome or a revision would probably be considered to be a failure. With this definition TKR would have a higher failure rate than UKR. Despite this the overall revision rate of UKR in Registries is too high and needs to be addressed.

Numbers of UKR

The revision rate of UKR in National Registries is much higher than in most published series[17]. One of the reasons for this is that surgeons who publish their results tend to do large numbers of UKR, whereas most surgeons who contribute to National Registries do small numbers. Data from the NJR shows that for surgeons doing UKR, the most common number implanted per year is one, the second most common number is two, the third three etc and the average is five[5]. NJR data also shows surgeons doing small numbers have very high revision rates[5]: Surgeons doing one or two per year had a 4% revision rate per year (which equates to a 60% survival at ten years). The revision rate decreases with increasing numbers: Surgeons doing between 12 and 30 per year have a revision rate of about 1.5% per year and surgeons doing 30 per year or more have a revision rate of 1% per year. The data therefore suggests that surgeons should do at least 12 per year and ideally at least 30 per year.

The first study we were aware of that showed a clear relationship between UKR number and revision rate was an audit based on NZJR data from 2006[18]. In this study the revision rate of Oxford UKR

implanted by surgeons doing at least 12 per year was slightly less than that of TKR. Since then we have encouraged surgeons to implant at least 12 per year. This has had little effect, which, in retrospect, is not surprising as surgeons cannot increase the size of their knee replacement practice and feel that doing a higher proportion of their knees as UKR would increase their revision rate. The main reasons for this is that Kozinn and Scott suggested, in their seminal 1989 review, that the ideal indications for UKR were narrow and if they were broadened the revision rate would increase[19]. If this message did not apply to all implants and surgeons could safely broaden their indications then they would easily be able to increase their number of UKR.

Usage of UKR

When analysing large datasets it is impossible to determine the indications that surgeons used for UKR. An indication about how broad or narrow their indications were can be inferred from the percentage of their knee replacements that were UKR, which has been defined as UKR usage. NJR data suggests that the average UKR usage is 11%[9]. The relationship between UKR usage and UKR revision rate is not what would be expected. Based on Kozinn and Scott's recommendations about 5% of knee replacements would be considered ideal for UKR[20]. It would therefore be expected that the lowest revision rate would be with 5% usage and that the revision rate would increase with higher usage. Analysis of NJR data shows that the revision rate with 5% usage is very high, about 3% per year[9]. As the usage increases, the revision rate decreases until 20% usage, when the revision rate is about 1% per year[9].

There are two possible reasons why the revision rate decreases with increased usage: With increasing usage surgeons do bigger numbers and are therefore technically better. Alternatively with low usage surgeons may be using inappropriate indications for UKR or for revision surgery. Surgeons with low usage tend to implant UKR in younger patients than those with high usage[9]. We therefore suspect that surgeons with low usage tend to use UKR only when the retained parts of the knee are pristine as they are worried about disease progression. This usually occurs when there is early disease in the affected compartment. In these circumstances, particularly with partial thickness cartilage loss, the revision rate is very high[10,21,22]. A recent meta-analysis found that high usage surgeons (>20%) have low revision rates and low usage surgeons (<20%) have high revision rates whether they do low (< 12) or high (>12) numbers of UKR per year[23]. This suggests that it is the indications that really matter and the numbers done are not so important. There were however no publications with high usage surgeons implanting less than five UKR per year. Therefore a sensible recommendation would be that surgeons doing knee replacement should aim for a UKR usage of at least 20%, provided this resulted in them doing at least 5 per year. If this recommendation was adhered to it would reduce the revision rate of UKR and increase the number of UKR implanted so more patients would benefit from UKR.

The most persuasive evidence supporting the recommendation that surgeons should aim for a usage of 20% comes from a life time analysis, which was based on NJR and NHS data with matched UKR and TKR[24]. This model took into account not only the advantages of UKR but also the disadvantages, such as the higher revision rate with the associated costs and outcomes of revision. With low usage (<10%) UKR was less clinically effective than TKR. However with high usage (around 20% to 30%)

UKR was, over the patient's life-time, more clinically effective and provided better quality of life. Furthermore over the patient's life-time, UKR was also cheaper than TKR.

Indications for UKR

To achieve the recommended usage of at least 20% surgeons must use appropriate indications. Unfortunately there is little consensus about the indications for UKR and the indications vary with different implants. However for the mobile bearing Oxford UKR the indications are well defined and evidence based[25]: They are based on the patho-anatomy [25], with the primary indication being Antero-medial Osteoarthritis (AMOA) and osteonecrosis being another rarer indication. The criteria for AMOA (bone-on-bone medially, full thickness cartilage laterally, functionally intact ligaments) are assessed radiographically so the decision whether to do a UKR is straight forward and can be made with the help of a decision aid[11]. If the criteria for AMOA are satisfied then the Kozinn and Scott contraindications, which include damage to the patellofemoral joint, chondrocalcinosis, obesity, youth and high activity, have been shown not to compromise the outcome and therefore do not apply[26,27]. As a result the Oxford UKR can be used in up to 50% of cases, and with this usage optimal results are achieved and the re-operation rate is similar to that of TKR out to 8 years[9,28]. When surgeons start using the Oxford UKR they are often uncomfortable about completely ignoring the Kozinn and Scott contraindications, but providing their usage is at least 20% their results should be good.

With fixed bearing UKR there is little data about indications and contraindications. Many surgeons feel the indications are similar to those of the Oxford UKR but the consensus is that the contraindications are different[29]. For many years the Kozinn and Scott contraindications were used for fixed bearing devices so surgeons did not operate on patients with these contraindications and as a result there is no good evidence whether these compromise the outcome or not. The evidence that does exist suggests at least some should apply. For example the main cause of failure of fixed bearing devices in the second decade is patellofemoral joint problems so some surgeons consider exposed bone in the patellofemoral joint to be a contraindication[30-32]. Some also feel the pain should be localized to the medial joint line and therefore consider anterior knee pain to be a contra-indication. Also the failure rate appears to increase in obesity, activity and in mesomorphic males[29]. Therefore, to reach 20% usage, surgeons using fixed bearing devices should carefully review their indications and use an appropriate device. They should also be cautious of exceeding 20% as this may result in a high long-term failure rate.

Conclusion

UKR has numerous advantages over TKR and one disadvantage, the higher revision rate. The best way to minimise the revision rate is for surgeons to use UKR for at least 20% of their knee replacements. In order to achieve this surgeons need to learn and apply the appropriate indications and techniques. This would decrease the revision rate and increase the number of UKR implanted, which would save money and patients would benefit from improved outcomes over their lifetime.

Conflicts of interest

All authors have completed the ICMJE uniform disclosure at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work: DM has received research grants and honorariums from Zimmer Biomet, a manufacturer of Knee replacements: DM does consultancy and receives royalty from Zimmer Biomet; RP is the immediate past president of the British Association for Surgery of the Knee (BASK). He receives institutional research support and has an educational agreement with Zimmer Biomet. He has an educational agreement with Lima. He sits on the committees of ODEP (Orthopaedic Data Evaluation Panel) and BC (Beyond Compliance).

Acknowledgements

The authors would like to that Barbara Marks for her help with the preparation of this article.

References

1. Jones GG, Kotti M, Wiik AV, Collins R, Brevadt MJ, Strachan RK, Cobb JP. Gait comparison of unicompartmental and total knee arthroplasties with healthy controls. *Bone Joint J 2016;98-B-10 Supple B:16-21.*
2. 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;384-9952:1437-45.*
3. Liddle AD, Pandit H, Judge A, Murray DW. Patient-reported outcomes after total and unicompartmental knee arthroplasty: a study of 14,076 matched patients from the National Joint Registry for England and Wales. *Bone Joint J 2015;97-B-6:793-801.*
4. NJR Editorial Board. 13th Annual Report National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. 2016.
5. Liddle AD, Pandit H, Judge A, Murray DW. Effect of Surgical Caseload on Revision Rate Following Total and Unicompartmental Knee Replacement. *J Bone Joint Surg Am 2016;98-1:1-8.*
6. Briggs T. A national review of adult elective orthopaedic services in England. Getting It Right First Time., 2015.
7. NHS England. Manual for Prescribed Specialised Services 3ed, 2016.
8. Parkinson R. BASK Spring 2016. British Association for Surgery of the Knee, 2016.
9. Liddle AD, Pandit H, Judge A, Murray DW. Optimal usage of unicompartmental knee arthroplasty: a study of 41,986 cases from the National Joint Registry for England and Wales. *Bone Joint J 2015;97-B-11:1506-11.*
10. Hamilton TW, Pandit HG, Inabathula A, Ostlere SJ, Jenkins C, Mellon SJ, Dodd CA, Murray DW. Unsatisfactory outcomes following unicompartmental knee arthroplasty in patients with partial thickness cartilage loss: a medium-term follow-up. *Bone Joint J 2017;99-B-4:475-82.*
11. Hamilton TW, Pandit HG, Lombardi AV, Adams JB, Oosthuizen CR, Clave A, Dodd CA, Berend KR, Murray DW. Radiological Decision Aid to determine suitability for medial unicompartmental knee arthroplasty: development and preliminary validation. *Bone Joint J 2016;98-B-10 Supple B:3-10.*

12. Murray DW, Liddle AD, Judge A, Pandit H. Bias and unicompartmental knee arthroplasty. *Bone Joint J 2017;99-B-1:12-5.*
13. Beard D, Price A, Davies L, Cook J, MacLennan G, Campbell M, Carr A, Fitzpatrick R, Campbell H, Arden N, Doll H, TOPKAT study group, Murray D. A multicentre randomised study comparing total or partial knee replacement - one year results of the TOPKAT Trial. *BASK Annual Spring Meeting.* Liverpool, UK, 2016.
14. New Zealand Orthopaedic Association. The New Zealand Joint Registry. Ten year report: January 1999 - December 2008. .
15. Goodfellow JW, O'Connor JJ, Murray DW. A critique of revision rate as an outcome measure: re-interpretation of knee joint registry data. *J Bone Joint Surg Br 2010;92-12:1628-31.*
16. Thienpont E. Conversion of a unicompartmental knee arthroplasty to a total knee arthroplasty: can we achieve a primary result? *Bone Joint J 2017;99-B-1 Supple A:65-9.*
17. Labek G, Sekyra K, Pawelka W, Janda W, Stockl B. Outcome and reproducibility of data concerning the Oxford unicompartmental knee arthroplasty: a structured literature review including arthroplasty registry data. *Acta Orthop 2011;82-2:131-5.*
18. Hartnett NI, Tregonning RJA, Rothwell A, Hobbs T. Unicompartmental knee arthroplasty - an audit of revisions. The New Zealand Experience. *J Bone Joint Surg Br 2006;88-B-Supp II:318.*
19. Kozinn SC, Scott R. Unicondylar knee arthroplasty. *J Bone Joint Surg Am 1989;71-1:145-50.*
20. Stern SH, Becker MW, Insall JN. Unicondylar knee arthroplasty. An evaluation of selection criteria. *Clin Orthop Relat Res 1993-286:143-8.*
21. Niinimaki TT, Murray DW, Partanen J, Pajala A, Leppilahti JI. Unicompartmental knee arthroplasties implanted for osteoarthritis with partial loss of joint space have high re-operation rates. *Knee 2011;18-6:432-5.*
22. Pandit H, Gulati A, Jenkins C, Barker K, Price AJ, Dodd CA, Murray DW. Unicompartmental knee replacement for patients with partial thickness cartilage loss in the affected compartment. *Knee 2011;18-3:168-71.*
23. Hamilton TW, Rizkalla JM, Kontochristos L, Marks BE, Mellon SJ, Dodd CAF, Pandit HG, Murray DW. The Interaction of Caseload and Usage in Determining Outcomes of Unicompartmental Knee Arthroplasty: A Meta-Analysis. *J Arthroplasty 2017.*
24. Burn E, Murray D, Liddle AD, Pandit H, Hamilton TW, Judge A, Pinedo-Villanueva R. Cost-utility of unicompartmental compared to total knee replacements: an analysis based on matched routinely-collected data from the United Kingdom. *ISPOR.* Vienna, Austria, 2016.
25. Goodfellow JW, O'Connor JJ, Pandit H, Dodd CA, Murray D. *Unicompartmental arthroplasty with the Oxford Knee.* revised 2nd Edition ed. Oxford: Goodfellow Publishers, 2016.
26. Pandit H, Jenkins C, Gill HS, Smith G, Price AJ, Dodd CA, Murray DW. Unnecessary contraindications for mobile-bearing unicompartmental knee replacement. *J Bone Joint Surg Br 2011;93-5:622-8.*
27. Pandit H, Hamilton TW, Jenkins C, Mellon SJ, Dodd CA, Murray DW. The clinical outcome of minimally invasive Phase 3 Oxford unicompartmental knee arthroplasty: a 15-year follow-up of 1000 UKAs. *Bone Joint J 2015;97-B-11:1493-500.*
28. Willis-Owen CA, Brust K, Alsop H, Miraldo M, Cobb JP. Unicondylar knee arthroplasty in the UK National Health Service: an analysis of candidacy, outcome and cost efficacy. *Knee 2009;16-6:473-8.*
29. Berend KR, Berend ME, Dalury DF, Argenson JN, Dodd CA, Scott RD. Consensus Statement on Indications and Contraindications for Medial Unicompartmental Knee Arthroplasty. *J Surg Orthop Adv 2015;24-4:252-6.*
30. 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;95-10:905-9.*
31. Berger R, Della Valle C, Jacobs JJ, Sheinkop MB, Rosenberg AG, Galante JO. The progression of patellofemoral arthrosis after medial unicompartmental replacement: results at 11 to 15 years. *Clin Orthop Relat Res 2006;452:285-6.*

32. Hernigou P, Deschamps G. Patellar impingement following unicompartmental arthroplasty. *J Bone Joint Surg Am 2002;84-A-7:1132-7.*