

Institution: The University of Oxford
Unit of Assessment: 1
<p data-bbox="143 286 414 324">Title of case study:</p> <p data-bbox="399 347 1197 448" style="text-align: center;">THE OXFORD KNEE: REVOLUTIONISING KNEE REPLACEMENTS</p>
<p data-bbox="143 488 478 526">Summary of the impact:</p> <p data-bbox="143 548 1404 761">Research at University of Oxford led to the development of the Phase 3 Oxford Knee in 1998, a significantly improved and less invasive knee replacement, allowing implantation through a small incision. Due to its many advantages over other knee replacements, including faster recovery, fewer complications and better function, the Phase 3 Oxford Knee is now the most widely used partial knee replacement in the world. Approximately 1 million people have benefitted from this development.</p>
<p data-bbox="143 788 478 826">Underpinning research:</p> <p data-bbox="143 851 1420 1064">For more than 35 years researchers at the University of Oxford have led a programme of research focusing on the knee. Professor David Murray has directed this programme for almost 20 years, leading research that has significantly improved our understanding of how the knee works, why it fails, and how it can best be treated. On the basis of this research, the Oxford Knee and associated surgical techniques, instrumentation, indications and teaching methods have been developed, assessed and progressively improved over the past two decades¹.</p> <p data-bbox="143 1086 1420 1400">Osteoarthritis is the most common cause of joint dysfunction and often leads to knee replacement. Two types of knee replacement can be used: a total knee replacement (TKR), where the whole joint is replaced and the ligaments removed; and a partial or unicompartmental knee replacement (UKR), such as the Oxford Knee, where only the damaged surfaces on one side (compartment) of the joint are replaced and the ligaments are preserved. In the majority of cases, osteoarthritis primarily affects one compartment of the knee, and in these cases the Oxford Knee can be used¹. As wear is a major problem with knee replacements, particularly in young and active individuals, the original design for the Oxford Knee aimed to minimise wear by using a mobile bearing, which reproduces the functions of the normal meniscus¹.</p> <p data-bbox="143 1422 1420 1568">While a recent stereo-Xray study confirmed the success of this design in minimising wear over 20 years², the original Oxford Knee was plagued by inconsistent surgical outcomes. In spite of performing well in the hands of the designer surgeon (and a number of independent surgeons), clinical results nationally and internationally were consistently variable.</p> <p data-bbox="143 1590 1420 1836">The Phase 3 Oxford Knee was introduced in 1998 to address this problem. Designed to be simpler to implant and more reliable, the Phase 3 Oxford Knee has improved implant design, instrumentation, surgical technique and instruction, leading to positive clinical results³. Traditionally the Oxford Knee and other UKR and TKR have been implanted through the same surgical approach, which involves dividing the extensor muscles of the knee and dislocating the kneecap. As the Phase 3 Oxford Knee is implanted through a short incision, without damaging the muscles or dislocating the kneecap it is a far less invasive surgery¹.</p> <p data-bbox="143 1859 1420 2063">Since introducing the Phase 3 Oxford Knee, the University of Oxford researchers have undertaken several studies to show the advantages of the new design. These studies have shown: improved overall function, less complications, less severe complications, and significantly faster recovery times (three times faster than a TKR and twice as fast as traditional UKR)^{1,4}. An additional study showed that due to a lack of wear, the Phase 3 Oxford Knee (which also uses mobile bearings) can be used more frequently than any other UKR among young, active, or obese patients^{1,5}.</p>

Since the introduction of the Phase 3 Oxford Knee, additional research and development has led to the introduction of the cementless Oxford Knee, which is even simpler to implant and has much better fixation than the cemented⁶.

References to the research:

1. Goodfellow J, O'Connor J, Dodd C, Murray D. *Unicompartmental Arthroplasty with the Oxford Knee*. Oxford University Press, Oxford. June 2006. **A book describing the Oxford knee and focusing on indications, techniques, results and complications. It summarises all the research supporting the Oxford knee.**
2. Kendrick B, et al. Polyethylene wear of mobile-bearing unicompartmental knee replacement at 20 years. *J Bone Joint Surg Br* **93**, 470-475, (2011) doi: 10.1302/0301-620X.93B4.25605. **Oxford Stereo-Xray study demonstrating that the wear of the Oxford knee is very low.**
3. Pandit H, Jenkins C, Gill H, Barker K, Dodd C, Murray D. Minimally invasive Oxford phase 3 unicompartmental knee replacement: results of 1000 cases. *J Bone Joint Surg Br* **93**, 198–204 (2011) doi: 10.1302/0301-620X.93B2.25767. **Oxford study describing the outcome of the first 1000 Phase 3 Oxford Knees, implanted using the minimally invasive surgical approach.**
4. Reilly, K. et al. Efficacy of an accelerated recovery protocol for Oxford unicompartmental knee arthroplasty--a randomised controlled trial. *Knee* **12**, 351–7 (2005) doi.org/10.1016/j.knee.2005.01.002. **Oxford randomised study showing it is safe, effective and cost effective to discharge patients early after the Oxford Knee.**
5. Pandit, H. et al. Unnecessary contraindications for mobile-bearing unicompartmental knee replacement. *J Bone Joint Surg Br* **93**, 622–628 (2011). doi: 10.1302/0301-620X.93B5.26214. **Oxford study showing that the outcome of the Oxford UKR is not compromised by weight, age, activity, the state of the patellofemoral joint, and chondrocalcinosis, so these should not be contra-indications.**
6. Liddle, A D et al. Cemented versus cementless fixation in Oxford Unicompartmental Knee Arthroplasty at five years: a randomised controlled trial. *Bone Joint J* 95-B. SUPP 1 67 (2013) Supplement available at http://www.bjjprocs.boneandjoint.org.uk/content/95-B/SUPP_1/67.abstract (Accessed 2013) Presented at British Orthopaedic Association Annual meeting, Manchester, England 11-14 September 2012. **Oxford randomised study showing improved results and fixation with the cementless compared to the cemented Oxford Knee.**

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Details of the impact:

Since its introduction in 1998, around one million people worldwide have been treated with the Phase 3 Oxford Knee. The minimally invasive and more reliable Phase 3 Oxford Knee, has dramatically improved the quality of life for these patients by effectively curing pain and disability with little risk of complication, or need for revision surgery^{3,7,8}.

Improved Health and Quality of Life

Patients requiring knee replacements usually suffer from severe pain in the knee, particularly when active; they also experience poor function, stiffness, deformity and disability. As a result, patients

Impact case study (REF3b)

often find everyday activities difficult. Following implantation of a Phase 3 Oxford Knee these symptoms are significantly improved and often cured, allowing patients to return to their normal lifestyles^{3,4}. The elderly can retain their independence, the young can return to work, and active sportspeople – who often suffer most from knee injury and ineffective knee replacements – can remain active.

Without the availability of the Phase 3 Oxford Knee most patients would have previously received a TKR, which requires the whole knee to be replaced rather than just the damaged compartment. As a result of less invasive surgery, complications occur much less frequently with the Phase 3 Oxford Knee, and when they do occur they are far less severe¹. For example, the rate of infection and blood clots in Phase 3 Oxford Knee implants is approximately half compared to the TKR. During the first three months after knee replacement mortality rates (adjusted hazard ratio) after UKR (such as the Oxford Knee) are around three times less than after TKR. The recovery after the operation is also around three times faster with UKR, therefore patients can return home earlier.

Following implantation of the Phase 3 Oxford Knee, the kinematics of the knee is virtually normal, in comparison to very abnormal kinematics after TKR. As a result, the Phase 3 Oxford Knee offers a better range of movement and improved function, particularly with demanding activities^{1,7}. Furthermore, if problems arise following Oxford Knee surgery it is much easier to convert the replacement to a TKR, than it is to revise a TKR. With updates constantly being implemented, such as the introduction of the cementless Oxford Knee these results are improving. Data from the New Zealand, and England and Wales, National Registers show that the recent introduction of the cementless Oxford Knee has halved the need for revision^{9,10}.

The research from the University of Oxford and other groups, showing the advantages of the Phase 3 Oxford Knee over fixed bearing UKR and TKR, has contributed to the wider use of the Oxford Knee^{7,11}. Treatment options for young active patients with arthritis have been limited in the past because TKR does not tend to allow patients to be very active, similarly to fixed bearing UKRs, they also have an increased failure rate. In contrast, the Phase 3 Oxford Knee allows patients to achieve high levels of activity, without significantly increasing the failure rate⁶. The high failure rate of UKR has also prevented obese patients from receiving a knee replacement, however, as shown by the Murray group, obesity does not compromise the outcome or increase the failure rate of the Phase 3 Oxford Knee⁶.

Commercial & Financial Outcome

As a result of its high performance, the Phase 3 Oxford Knee is now dominating the UKR market. In 2011, the National Joint Registry for England and Wales reported that the Oxford Knee was used in 70–80% of cases between 2003 and 2010⁹. Other National Joint Registers such as that from New Zealand also show the high numbers of Oxford Knees being implanted¹⁰.

As reported by The National Joint Registry in 2011, the enhanced speed of recovery associated with the Phase 3 Oxford Knee has led to patients being discharged (on average) two days earlier than those receiving TKR⁹. An increasing number of clinical centres around the world are now treating Phase 3 Oxford Knee patients as day cases, resulting in greater cost savings for patients, the NHS, and health care providers^{9,12}.

Sources to corroborate the impact:

7. Willis-Owen, C et al. Unicompartmental knee arthroplasty in the UK National Health Service: an analysis of candidacy, outcome and cost efficacy. *Knee* **16**, 473–478 (2009) doi: 10.1016/j.knee.2009.04.006. **An independent study showing that UKR have better outcomes and cost saving (£1,761 per knee) compared with TKRs and should be considered the primary treatment option for about 50% of patients needing knee replacement.**
8. Price, A & Svard, U A second decade lifetable survival analysis of the Oxford

unicompartmental knee arthroplasty. *Clin. Orthop. Relat. Res.* **469**, 174–179 (2011) doi: 10.1007/s11999-010-1506-2. **Study showing that the survival of the Oxford Knee in an independent centre is about 90% at 20 years.**

9. National Joint Registry for England and Wales 8th Annual Report (2011). Available at <http://www.njrcentre.org.uk/NjrCentre/Portals/0/Documents/NJR%208th%20Annual%20Report%202011.pdf> (Accessed 2013). **The National joint registry shows the high numbers of OUKR being implanted. It also shows the lower death rate, lower complication rate and lower in patient stay of UKR compared to TKR.**
10. The New Zealand Joint Registry Thirteen year report January 1999 to December 2011 Available at <http://www.cdhb.govt.nz/njr/reports/A2D65CA3.pdf> (Accessed 2013). **Report showing the increasing numbers of Oxford UKR implants in New Zealand, and that the cementless Oxford has the lowest revision rate of any commonly used UKR.**
11. Sun, P & Jia, Y. Mobile bearing UKA compared to fixed bearing TKA: A randomized prospective study *The Knee* **19** 103–106 (2012) doi: 10.1016/j.knee.2011.01.006. **Randomised study that concludes, “After the learning curve UKR should be considered the primary treatment option for unicompartmental knee arthritis”.**
12. Munk, S et al Early recovery after fast-track Oxford unicompartmental knee arthroplasty. 35 patients with minimal invasive surgery. *Acta Orthopaedica*; **83** 41–45. (2012) doi: 10.3109/17453674.2012.657578. **Paper describing day case Oxford Knee replacement.**