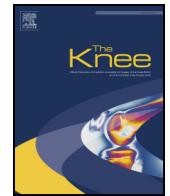


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## The Knee



# Mid- to long-term survivorship of oxidised zirconium total knee replacements performed in patients under 50 years of age

Alexander W. Glover <sup>\*</sup>, Alasdair J.A. Santini, John S. Davidson, Jill A. Pope

*The Lower Limb Arthroplasty Unit, The Royal Liverpool and Broadgreen University Hospitals NHS Trust, Liverpool L7 8XP, United Kingdom*

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## ABSTRACT

**Background:** Oxidised zirconium has the wear properties of ceramic with the breakage resistance of metal. This results in less wear and is of benefit to younger, higher demand patients. We report the short- to mid-term survival of 103 *Profix* zirconium total knee replacements performed in patients under 50 years of age at time of surgery.

**Methods:** Data was collected prospectively and survival analysis undertaken with strict end points used. SF (Short Form) 12 and WOMAC (Western Ontario and McMaster University) scores were recorded at pre-operatively and at twelve months, one, three, five, seven and ten years.

**Results:** The average age at operation was 43.21 years (range 20–50 years) with a mean follow-up of 8.56 years (range five to 15 years). No patients died with one patient lost to follow-up after seven year review. The mean WOMAC score improved from 53 to 29, and the mean SF12 physical component improved from 29 to 36. The five year survivorship for implant related complications was 99.03% (95% CI 94.64–100.0) due to tibial component aseptic loosening at year one. Reoperation for any cause at five years including stiffness was 94.09% (95% CI 88.69–98.11). Forty-four patients were at least ten years post-operative at the time of analysis, with no aseptic loosening of either component giving 10 year femoral component survival of 100% and all cause revision of 95.4%. The only zirconium femoral failure was at 12 years.

**Conclusions:** Our data shows excellent mid-term survivorship of oxidised zirconium total knee replacements in younger, higher demand patients.

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## 1. Introduction

Total knee arthroplasty is an effective treatment for advanced inflammatory and degenerative conditions affecting the knee, with long lasting functional improvement of more than 30% in any assessment score [1]. Implant survivorship is over 96% at between 15 and 20 year follow-up [2–4]. The most recent (2017) National Joint Registry (NJR) report [5] found the cumulative revision risk at 13 years to be 4.20% for patients with a mean implant age of 69.

According to that same recent NJR report [5], 108,713 patients underwent knee replacement in the UK in 2016, itself a 3.5% increase on the year previous. Kurtz et al. [6] extrapolated a growing trend towards younger age at implantation over recent decades and estimated that, by the year 2030, the number of patients under the age of 65 undergoing the procedure will rise to over one million worldwide; in so doing, they will become the dominant age group undergoing the procedure.

Younger patients are more active than their elderly counterparts, placing more demand on the prosthesis. This results in more wear and particulate debris which in turn leads to polyethylene debris related osteolysis. This negatively affects implant survivor-

<sup>\*</sup> Corresponding author at: SpR - Trauma and Orthopaedic Surgery, 1 Thatcher Close, Bowdon, Altrincham, Cheshire WA14 3FX, United Kingdom.  
 E-mail address: [alexander.w.glover@googlemail.com](mailto:alexander.w.glover@googlemail.com) (A.W. Glover).

ship, with 10 year implant survival between 85% and 91% [7]. This is borne out of the data from the most recent NJR report [5], with risk of revision rising to 10% at 13 years for those aged 55 years or less at the time of the primary procedure.

In a bid to minimise the rate of wear and increase longevity in knee arthroplasty, much work has been focussed on the bearing surface. Highly cross linked polyethylene (XLPE) has shown to be effective in hip arthroplasty [8], but this process weakens the structure, making it more prone to cracking [9]. This makes it an imperfect choice in knee arthroplasty, where the contact stresses far exceed that of the hip. An alternative bearing surface for the femoral prosthesis which reduces wear without altering the polyethylene insert is therefore desirable.

Oxidised zirconium is a relatively new material introduced by Smith and Nephew (Watford, UK) for this purpose. It comprises a zirconium/nobium alloy (97.5% Zr:2.5% Nb) metal substrate whose surface transitions into a ceramic-like zirconium oxide outer layer when heated at 500 °C. The composite structure means that as there is no physical separation between the oxidised and non-oxidised layers, there is no bonding weakness. The surface layer is extremely abrasion resistant in comparison to tradition bearing materials, such as cobalt chrome. It also has a much lower coefficient of friction against both cartilage and ultra-high molecular weight polyethylene (UHMWPE). These two factors give it an extremely low wear rate in simulator testing, which in turn is purported to decrease the rate of polyethylene debris-related osteolysis. This would make it a superior choice of bearing for use in young, high demand patients.

Given this is a relatively nascent technology, papers looking at the survivorship of total knee replacements utilising this technology are only just beginning to populate the literature. We present an in-depth 10 year survival analysis of the *Profix* (Smith & Nephew, Watford, UK) total knee replacement using an oxidised zirconium femoral component on an all-polyethylene tibial base performed in patients aged 50 years or younger at time of the index procedure.

## 2. Materials and methods

Between January 2001 and January 2010, 98 patients under the age of 50 underwent a total of 103 cemented oxidised zirconium *Profix* total knee replacements with a conforming all poly-ethylene tibial component. The department policy was to use an all polyethylene tibial tray in all young patients as it permitted the use of a thicker polyethylene in a bid to improve the load transmission to bone in these high demand patients.

Pre-operatively, all patients were seen by a clinical physiotherapy specialist who recorded their range of movement, and performed an assessment using the Short Form (SF) 12 and Western Ontario and McMaster University (WOMAC) scores. This data was added prospectively to the departmental registry.

All operations were performed either by the two senior authors (AJAS, JSD) or by a senior surgical trainee under their direct supervision with all patients managed in accordance with the unit's standardised perioperative care plan. All patients were followed up at regular intervals by members of the surgical team and the clinical physiotherapy specialist. At each visit they were assessed by a member of the surgical team who documented range of motion using a goniometer, and filled in the PROMS data as described above. This data was again added prospectively to the departmental database. Radiological assessment was performed at 12 months, three, five, seven and ten years post-operatively using the Knee Society Roentographic Evaluation System (KSRES) score to objectively identify signs of loosening. Scores of 10 or more indicate impending failure of the prosthesis, and revision should be considered.

In terms of survivorship, we defined four strict end points – revision for loosening of the femoral component, revision for loosening of the tibial component, all cause revision, and worst case scenario. The worst case scenario group was calculated by assessing those lost-to-follow-up and assuming them to have failed in the year after they were lost-to-follow-up. The survival analysis was presented in life tables as described by Armitage [10] using 95% confidence intervals via the Rothman method [11]. The data is presented as means  $\pm$  one standard deviation.

## 3. Results

### 3.1. Clinical data

We identified 103 total knee replacements performed in 98 patients who were 50 years or younger at the time of surgery, with the male:female ratio of 40:58. The mean age at operation was 43 years (range 19–50). No patients died in the study period, and only one patient had been lost to follow-up after seven year review. The mean follow-up was 8.5 years (range five to 15) years. All patients were at least five years post-surgery at the time of analysis, with 44 at least ten years post-operatively, irrespective whether they had failed for any reason or been lost-to-follow-up. Mean pre-operative flexion was 85° ( $\pm$ 10°) and post-operatively this increased to 100° ( $\pm$ 10°) at five years and 98° ( $\pm$ 14°) at 10 years. Pre-operative fixed flexion was six degrees ( $\pm$ 9°). Post-operatively this improved to two degrees ( $\pm$ 5°) at 10 years.

### 3.2. Radiological analysis

We identified four knees with radiological evidence of loosening. One knee required revision for aseptic loosening beneath the tibial component at one year post-operatively. This occurred following a fall, and hence was identified as being traumatic in aetiology. This required revision of the tibial component in isolation, as the femoral component was found to be well fixed.

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