Cemented hip arthroplasty: why I do it

Jonathan R Howell

Abstract

Total hip replacement is an operation done to relieve pain and restore function and it is one of the most successful health interventions of the last century. Orthopaedic experience with cemented hip arthroplasty extends to over 50 years and in that time refinement of techniques and implants has led to components that offer the best long-term survivorship in almost all patients, as evidenced by research and registry data. However, long-term revision rates are just one of their advantages because cemented components also offer important benefits in their ability to restore patients' anatomy, most importantly offset, leg length and component position as independent variables. The fine control that they offer to surgeons helps them to tailor each operation to the individual's needs and thereby achieve the best result possible for every patient. In the long-term the presence of a well-fixed cement mantle offers the opportunity for cement-in-cement revision if further surgery is required. Components can be considered to be modular at the prosthesis/cement interface and the technique allows a surgeon to revise and return a patient to their primary state.

Keywords Anatomic restoration; lifetime costs; longevity; modularity in revision

Introduction

Total hip replacement (THR) has been described as the operation of the century and its success has meant that THRs are performed in ever-increasing numbers. Data from the National Joint Registry of England and Wales (NJR) has shown that in the decade between 2006 and 2016, there was an 80% increase in the number of THRs performed, from about 48,000 per year in 2006 to over 87,000 in 2016. The latest report from the NJR[1] shows that the choice of fixation for primary THR remains divided, with 38.5% cases fully uncemented, 29.6% fully cemented and 28.1% standard hybrid cases, with a cemented femoral stem and an uncemented acetabular component. Therefore, we can see that about 58% of the THRs undertaken in 2016 were performed using a cemented stem. In this article we will consider both fully cemented THR and hybrid THR and will examine what advantages there may be in using cemented components.

The aims and risks of hip replacement surgery

Most patients undergoing total hip replacement do so to relieve persistent pain, which is not responding to other treatment modalities. Pain relief and greater joint mobility combine to improve patients' function and quality of life. Since 2008 the patient reported outcome measures (PROMs) programme has collected data from THRs funded by the NHS in England. It includes an assessment of symptoms and functional limitations arising from the hip joint itself, the Oxford hip score (OHS), as well as quality of life (QoL) data using the EuroQoL (EQ-5D-3L) proforma. Pennington et al.[2] examined the PROMs data from 43,524 patients undergoing THR with three frequently used and successful examples of cemented, hybrid and uncemented hip replacements. All three methods of fixation produced significant improvements in PROMs, emphasizing the beneficial effect that well-proven designs of THR have on patients' lives, regardless of fixation.

Patients undergoing THR surgery will frequently ask their surgeon how long the hip replacement can be expected to last and clearly longevity of the THR is important to both patient and surgeon. For much of the last three decades orthopaedic research has been focused on rates of aseptic loosening and lysis and this has undoubtedly led to improved materials, designs and techniques for insertion of hip replacements, be they cemented or uncemented. Data from the NJR show that the estimated 12-year revision rates for the majority of THRs is low, at less than 5%, and for the very best designs the rates are 2% or less.

However, loosening and lysis are not the only outcomes of importance, particularly for patients, for whom disappointment may arise from leg length difference, limp, persistent pain, instability and dislocation. Many of these problems have their root cause in a failure to adequately restore a patient's individual anatomy and below we will consider how cement can assist a surgeon in achieving the best results for their patients.

Of course, regardless of how well or otherwise primary surgery is performed, revision surgery may be required in the future of a patient undergoing primary THR. Revision THR procedures are, in general, more complex and time-consuming than primary operations and they are associated with increased risks of intra- and post-operative complications. Choices made at the primary operation may help to facilitate future revision thereby mitigating the risks. We will therefore also examine how the use of cement may help in this respect.

PROMs, long-term results and economics

Patients undergoing THR do so for relief of pain, stiffness and restricted function in the hope of returning to a more active lifestyle. In the short term the results of the surgery can be assessed by PROMs and in the long-term both patient and surgeon wish to minimize the need for further intervention and therefore the survivorship of the operation will be of interest to both. The costs of hip replacement surgery to the provider may be calculated from the initial expenditure on the primary procedure, but the lifetime costs of the hip replacement, taking into account the costs of any revision procedures, are a more comprehensive method of assessment. Assessing the effect of THR fixation on PROMs, long-term results and cost-effectiveness is a complex process, confounded by a number of factors that include patient age, gender, baseline hip function, preoperative medical status and socioeconomic issues.

Pennington et al.[3] looked at the functional outcomes and long-term results of the three most commonly used examples of

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cemented, hybrid and cementless hip replacements reported to the NJR. In 43,524 patients between 55 and 85 years of age undergoing primary THR for osteoarthritis they found that patients who received a cemented THR were older and more likely to be female, to live in a socioeconomically deprived area, to have at least two co-morbidities and to have an American Society of Anaesthesiologists (ASA) grade of more than 3 compared to patients receiving cementless prostheses. Furthermore, compared to those having cementless THRs, recipients of cemented hips reported more severe preoperative symptoms and poorer function, with lower Oxford hip scores, as well as a poorer preoperative quality of life as measured by the EQ-5D. The results of their study showed that the symptoms, function and quality of life of patients in all three fixation groups improved significantly. Minor differences were seen between the groups in their mean postoperative OHS (cemented 37.7, cementless 39.2, hybrid 39.4) but baseline differences between them probably explain much of this variation. Using data from the NJR and national PROMs project, Jameson et al.[4] found a similarly small difference in the PROMs for hips with different fixation methods, which the authors felt had reached statistical significance because of the large numbers involved, but not clinical significance.

Interestingly, both papers found a significant difference in the revision rate across the fixation groups, with the lowest rates of revision exhibited by the cemented THRs and the highest rates by cementless THRs, with hybrids occupying an intermediate position. Although it might be assumed that such differences in revision rates can be attributed to preoperative demographic differences this does not seem to be the case. Pennington et al. calculated hazard ratios for revision adjusted for age, sex, body mass index, ASA grade, Charlson score, surgeon grade and hospital type. Compared to those with cemented total hip replacements, recipients of cementless implants had an increased adjusted hazard ratio for revision of 1.66 ($p < 0.001$) and for patients with hybrid THRs it was 1.26 ($p < 0.001$). It is worth remembering that these results pertain, not to all implants on the NJR, but to the most commonly used three examples of each and therefore to prostheses that have been widely used and tested.

The results above were calculated over the short to medium term, so what about long-term fixation with cement? We have come a long way since Jones and Hungerford wrote about 'cement disease' in 1987. Their misguided conclusion that cement itself was responsible for osteolysis and loosening led to a parting of the ways of orthopaedic surgeons on each side of the Atlantic. In broad terms surgeons in the USA have pursued a cementless path, seeking to avoid the use of cement, which had been inappropriately blamed as the cause for osteolysis. Sadly, osteolysis was not abolished by the introduction of cementless fixation and indeed the combination of poor-quality polyethylene, metal-backed uncemented shells and defective locking mechanisms resulted in massive osteolysis for many thousands of patients. These issues have been addressed in large part through improvements in materials and implant design.

In contrast, in the UK considerable effort was expended in improving the results of cemented THR, through understanding the relationship between cement and stem design and by improvements in surgical technique that have produced excellent long-term results. The taper slip design of stem works with the long-term viscoelastic properties of cement, namely creep and stress relaxation, subsiding tiny distances and loading the cement in compression in which it is strongest. Research from our centre and others[5,6] has shown that the combination of a polished, tapered cemented stem and a modern cementing technique produces long-term results that in all ages are at least as good, if not better, than those reported for cementless fixation. Similarly, improvements in acetabular cementing technique that include exposure of cancellous bone, drill holes for macro-fixation, bone cleaning, cement pressurisation and the use of a flanged cup have led to significant improvements in the results of cemented cups[7,8] with up to 100% survivorship for aseptic loosening at 12.5 years.[7]

The favourable long-term results of cemented hip replacement reported by individual centres are supported by results from the national joint registries. The latest annual report from the NJR[1] presents the results now out to 13 years and it shows that the rate of revision across all patients is lowest in the all cemented group, regardless of the bearing used. The lowest rates of revision are seen when a ceramic on polyethyelene (CoP) bearing is used with cemented components, for which the 13-year revision rate is 3.81%. This compares with 4.49% for uncemented THRs and 4.21% for hybrid hips. For THRs with metal on polyethylene bearings the results show a similar pattern with 13-year revision rates for cemented, uncemented and hybrid hips 4.25%, 5.90% and 4.94% respectively.

It might be assumed that these results reflect the effect of patient age on the outcome of THR and indeed the NJR does show an inverse relationship exists between patient age and THR survivorship. However, for the first time the latest NJR report includes an analysis of the effect of age and gender on outcome across the different fixation groups and again they favour cemented fixation, be that fully cemented or hybrid fixation. For women under 55 years of age the best results are with a cemented THR and a CoP bearing, for which the 10-year revision rate is 3.79%. The corresponding figures for uncemented and hybrid THRs are 4.27% and 3.66% respectively. For men under 55 the pattern of results is similar; cemented THRs combined with a CoP bearing showing lower revision rates than uncemented THRs at all time points, with hybrid hips also showing better survivorship than fully uncemented. For patients of both gender in the 55–64 and 65–74 age groups the patterns are again broadly similar with the best results exhibited by cemented and hybrid fixation, followed by uncemented THR.

These findings are not unique to the NJR. The Nordic Arthroplasty Registry Association (NARA) was established in 2007 by Sweden, Denmark and Norway with Finland joining later, in 2010. It was formed to facilitate research through the combined registries of those countries and the number of hips recorded rivals that of the NJR, but with longer follow-up. They have published on the failure rates of hips from the different fixation classes[9] and the results are strikingly similar to those of the NJR. Including patients older than 55 years and breaking the results down into three age ranges, NARA demonstrates that for patients 65–74 years old and for those over 75 years the 10-year survival for cemented implants was higher than both uncemented and hybrid hip replacements. For patients 55–64, the survivorship of cemented and uncemented hips was similar.

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