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EDITORIAL

Cemented versus uncemented hip implant fixation

SHOULD THERE BE AGE THRESHOLDS?

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There is continued debate as to whether cemented or cementless implants should be utilized in particular cases based upon chronological age. This debate has been rekindled in the UK and other countries by directives mandating certain forms of acetabular and femoral component fixation based exclusively on the chronological age of the patient. This editorial focuses on the literature-based arguments to support the use of cementless total hip arthroplasty (THA), while addressing potential concerns surrounding safety and cost-effectiveness.

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There is continued debate as to whether cemented or cementless implants should be used in primary total hip arthroplasties (THAs). This has been rekindled in the UK and other countries by directives mandating certain forms of acetabular and femoral component fixation based exclusively on the chronological age of the patient. The National Health Service England consultation document 2019/20 proposes to introduce an extra criterion for primary hip arthroplasty – "At least 80% of patients aged 70 and over receive a cemented or hybrid prosthesis and to change the national variation supporting this BPT so that it is no longer transitional".[1] Many feel that this infringement on surgical choice is concerning, as there are good data for modern cemented and cementless fixation on the femoral side of the hip and surgical training, surgical philosophy, surgeon expertise, and institutional comfort all play a role in defining what is offered to any individual patient.

The challenge is effectively one of resource management. There is a need to balance the procurement cost of the implant itself relative to the cost of the entire procedure and patient journey, and indeed the long-term cost to the patient and the healthcare system.

The literature can be interpreted to show that cemented and cementless femoral components both have excellent outcomes if the procedure is performed to an appropriate standard.[2,3] There is, however, a difficulty in translating the skillset of a surgeon who has been trained in cementless implants into inserting cemented implants, which may in some respects be technically more demanding. There are arguments that all surgeons should be trained in these techniques. It is, however, likely that high-volume surgeons doing well with cementless implants will easily adopt the skillset needed for cementing. However, there are no data to show that surgeons who have poor outcomes with cementless implants will necessarily have better outcomes if they convert to cemented implants in a subset of patients. Moreover, while there is good evidence that particular cemented femoral components have a good long-term track record, cemented acetabular components do not have such a strong provenance.

Increasing demands for THA and limited resources requires cost-effective solutions. The two most interesting facets of the argument are the chronological age of the patient and the cost of implantation. If the latter is significantly different for cemented and cementless implants and comparable patient outcomes and revision rates are achieved, then there is an argument to favour one fixation method over the other. As the chronological age of the patient influences bone quality, the argument is further convoluted if the decision to use a certain method of fixation is based purely on the chronological age of the patient.

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Is there a significant difference in costs based on fixation method?

The face value cost of a cementless femoral component or acetabular component that achieves biological fixation is usually higher than a polished smooth stainless steel implant that is held to bone by cement. It may thus be concluded that cementless implants will invariably be more expensive to use at the index procedure.

However, the procedural cost is determined by several factors including implant expense, costs of ancillary devices such as cement, cement plug, theatre and personnel time, and many others.

In 2013, Pennington et al[4] published the lifetime cost-effectiveness for primary THA with parameters estimated from individual patient data obtained from three large national databases. They concluded that cemented prostheses were the least costly type for primary THA, but for most patient groups hybrid prostheses were the most cost-effective. In their model, cementless prostheses did not provide sufficient improvement in health outcomes to justify their additional costs. Nevertheless, this study had some limitations such as bias associated with insufficient data on quality of life, inaccuracies associated with model-based analysis as well as from prosthesis-related differences in revisions. The work also did not take into consideration the fact that traditionally the more expensive bearings such as ceramic were used with cementless implants, resulting in spurious differences when looking at unit costs of implants.

Zhang et al[5] published their review based on evidence from international joint registries. They reviewed the most updated annual reports from five international joint arthroplasty registries with more than five years' follow-up (Sweden, Norway, England-Wales, Australia, and New Zealand). They also reviewed available randomized clinical trials and meta-analyses in the literature. They concluded that cemented fixation showed an overall better long-term survivorship than cementless fixation in primary THAs. Specifically, cemented fixation survived better in older patients while cementless fixation survived better in younger patients. Once again, the limitation of this particular investigation was that the conclusions were drawn from large databases; physiological age and activity profiles were not considered, and only chronological age was used for analysis. They also looked at survivorship as an outcome rather than quality of life. To illustrate this point, a painful cemented acetabular component that is not revised in an elderly patient will not be reflected in this kind of data analysis. Such a patient may require greater care in the community, which increases the overall costs of the THA but will not be picked up by the database studies.

It is not surprising that other model-based studies have drawn different conclusions. Using a Markov decision analysis based on implant costs, another registry study[6] found that cementless or cemented THAs in a theoretical cohort of 70-year-old patients with fracture of the femoral neck or arthritis involving the hip is not significantly different. The cost-effectiveness profile of cemented prostheses was found to be similar to that of cementless implants. The mean cost difference was noted to be €2,060.44 in 2006, without differences in quality-adjusted life-year (QALY). Based on the data used in the model, cementless prostheses appear to be less costly than cemented ones over five years, but not less cost-effective when an incremental cost-effectiveness ratio of less than €50,000 per QALY was adopted.

Individual surgeon series that look at answering the specific question of cost of implanting cemented versus cementless implants have also favoured the latter.[7-9] The advantage noted for cementless systems is due to reduced theatre time and reduced cost of ancillary products required by cementing systems and reduced costs of operating room personnel.

The other salient factor to be considered is that implant costs vary across institutions. Unnanuntana et al[10] published the results of a study comparing the costs of implanting cemented versus uncemented implants. They noted that the mean cost of implanting a cementless femoral prosthesis was $296 more than the mean cost of implanting a cemented femoral stem, even with the additional expense of two batches of bone cement and the accessories commonly used to achieve a third-generation cementing technique. Interestingly, they also noted that the price difference was less variable if the cost of the prostheses from only the primary implant supplier for each institution was considered. This highlights another important issue in healthcare. Costs of implants have been variable across institutions and high-volume centres can negotiate better unit costs for implants. Antoniou et al[11] reported on the total costs of THA in Canadian hospitals. They reported that the costs were 60% greater in low-volume centres compared with high-volume centres and the controlled unit costs of the implants may contribute to the lower direct and total costs in the high-volume centres.

The other reasons that may have increased the costs of the cementless implants in their case may be that they did not use antibiotics in cement; they also did not include the extra cost of theatre and personnel that is involved with cementation.

Is the outcome of THA determined by fixation method?

When looking at outcomes of THA, it is clear that the results are multifactorial. It is also important to appreciate that the ultimate outcome that is of interest is the health and economic gain to the individual and society, respectively. In order to optimize this, surgeons should look towards improving patient selection and minimizing

complications. Surgical training and experience are key to the success of this. When important decisions such as type of fixation to choose for individual patients is made based on patient age rather than bone quality, medical comorbidities, and surgeon experience, one is deterring from the ultimate goal of arthroplasty namely improving individual patient outcomes that translate to health and economic gain to society.

Does cement have any significant drawbacks?

The argument of using cement in poor bone quality may be catastrophic in patients with low cardiovascular reserve who are receiving a cemented component.[12] This is due to the poorly understood bone-cement implantation syndrome and the mortality associated with it.[13,14] It has been recorded to cause a number of clinical features from hypoxia, hypotension, and cardiac arrhythmias to increased peripheral vascular resistance and cardiac arrest.[12,13,15] While the mortality from use of cement during hip arthroplasty may not be proven, the need for mitigating this risk is well recognized.[14]

The pathophysiology of the cement-related change in physiology is unclear but one of the possible theories has focused on the release of methyl methacrylate into the circulation causing vasodilation. While there is no clear evidence with regards to the effect of anaesthetic technique on this phenomenon, the general principles of management include preoperative identification of high-risk patients, optimization of their cardiovascular reserve before surgery, and intraoperative maintenance of normovolaemia and high inspired oxygen concentrations.[16] As it is a reversible time-limited phenomenon, aggressive resuscitation and supportive treatment are essential to reduce associated morbidity and mortality.[16] If cement is being used in the femoral canal, a safe technique needs to be employed.[17] One strategy for avoiding this risk is to use uncemented implants in the setting of the high-risk patient. Using cement in everyone beyond a certain age may not be ideal in this situation, especially as older age is associated with higher comorbidities. It should be noted that some cementless implants are more suitable than others for poor bone and have less fracture risk.[18,19]

In conclusion, based on the literature, it is hard to justify mandating one particular method of implant fixation in all patients. While cost should be one of the factors that decide the use of implants, it should not be the main driving force. Decision-makers should increasingly seek to identify those patients for whom technology is most cost-effective but should also acknowledge that clinicians may be better equipped at making this decision at the bedside. It is important to understand that the perceived gain in costs of cemented implants is variable based on institution volume and procedural costs. While chronological age may be a surrogate for bone stock, it does not define the quality of bone.

Using cemented implants in elderly patients with compromised cardiovascular states may be associated with some potential intraoperative complications that should also be taken into consideration by surgeons.

Surgeons should have algorithms that allow them to choose appropriate implants and fixation methods for their patients based on bone quality, activity levels and physiological age, and comorbidities. Those algorithms should be supported by surgeons and units examining their data and outcomes on a regular basis. External mandates based on chronological age thresholds have not been shown to improve outcomes, may disincentivize the surgical community, and couple compromise patient care.

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