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ORIGINAL PAPER

A technique for the fabrication of a reinforced moulded articulating cement spacer in two-stage revision total hip arthroplasty

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Abstract We describe an inexpensive method of producing a reinforced articulating cement spacer using a commercially available hip cement mould. We have a cohort of 15 consecutive patients in whom this novel cement spacer has been used. All patients were able to at least partially weight bear and none of the spacers fractured. Thirteen have been explanted at second stage operation after a minimum of eight weeks in situ. Two patients have been unable to undergo a second stage due to unrelated death and medical problems precluding further surgery. The articulating cement spacer described is produced using a technique that is simple, reproducible and allows a reinforced spacer to be created inexpensively without the need for special equipment.

Introduction

Total hip replacement (THR) is one of the most successful and frequently performed orthopaedic procedures. Although rates of deep infection have been reduced by modern methods, this remains one of the most feared complications. The most commonly used approach to treatment in patients with a deeply infected THR is the use of a two-stage protocol with reported success rates of between 87 and 100% [1–9]. The first stage involves removal of the prosthesis with complete debridement of any non-viable tissue and, if present, cement. After microbiology samples have been sent, appropriate parenteral antibiotics are administered until the infection is eradicated. Reimplantation of a new prosthesis is performed at the second stage. Increased local tissue concentrations are achieved by the use of cement spacers or gentamycin beads [3, 10–13] during the first stage. Cement spacers have gained favour due to their ability to deliver high local concentrations of antibiotic and to maintain correct tissue tension and planes. Spacers can be static (non-articulating) or dynamic (articulating). The latter have emerged as the gold standard in recent years because they offer the additional benefit of allowing the patient to be mobile between stages. Spacer fracture during mobilisation has been a potential problem and some spacers have used reinforcement to help prevent fracture from occurring. There are a number of commercially available, ready to use articulating cement spacers as well as generic custom-made moulds. In addition to this many techniques have been described for more economical fabrication of both non-articulating and articulating cement spacers. We describe an economical technique for the creation of an articulating, reinforced cement spacer that has distinct advantages over other spacers.

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Materials and methods

Fifteen consecutive patients had implantation of an articulating cement spacer produced using the method described in this paper. Eleven of the 15 patients underwent first stage revision surgery due to infection of a THR, two for

infection of a hemiarthroplasty and one patient had a two stage primary THR for secondary degeneration as a consequence of previous proven septic arthritis. All patients had the original implants removed and, where present, aggressive debridement and clearance of cement. The cement spacer was created, using the method described below, with gentamycin-loaded cement without the addition of further antibiotics to the cement during mixing. All patients were allowed to mobilise partial weight bearing. If antibiotic sensitivities were known before the first stage, then directed intravenous antibiotic therapy was commenced immediately after surgery. Otherwise, antibiotics were commenced immediately on a best guess basis with advice from a microbiologist and converted to directed therapy as soon as the results of intra-operative cultures were known. A minimum of six weeks intravenous antibiotic therapy was given and continued until inflammatory markers (erythrocyte sedimentation rate and C reactive protein) had returned to normal and the patient had a quiescent wound with no clinical evidence of infection. Once these criteria were fulfilled, second stage surgery was planned.

Surgical Technique - Developed by Senior Author (MS)

In the fabrication of the cement spacer we used antibiotic impregnated cement (Palocos R, Biomet), a commercially available cement spacer mould (Biomet, Warsaw, Il), a rush pin of adequate diameter for size of mould and multiple large blunt drawing up needles. The cement moulds are available in four sizes related to head diameter ranging from a minimum of 43 mm to a maximum of 64 mm. An estimation of the size required was made from preoperative templating and the previous acetabular component size. Intraoperatively we usually performed a small amount of acetabular reaming to help with acetabular debridement. This was also helpful in assessing the required mould size. An appropriate rush pin was selected to act as a central reinforcement rod. This was of a diameter small enough to fit within the shaft of the mould but large enough to provide adequate strength. In practice the rush pin was one-third the diameter of the stem part of the mould. The rush pin was bent to form the same neck shaft angle as the mould and cut to be just shorter than the mould so that it could not protrude. A small hole, just large enough to allow passage of the rush pin, was made in the centre of the head of the mould (Fig. 1). The rush pin was passed into the mould and held in approximately the centre of the shaft. Care was taken at this point to ensure that the pin was not fully inserted. The rush pin was held in place using three drawing-up needles passed transversely through the mould in a criss-cross manner (Figs. 2 and 3). This controlled the position of the rod in the anteroposterior plane. Cement was then introduced at an early stage of polymerisation to fill the

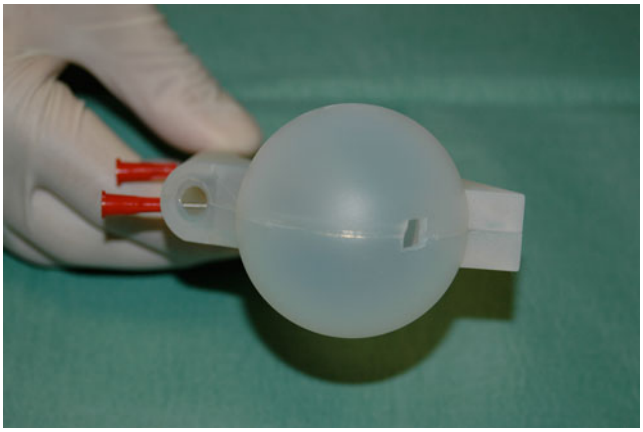

Fig. 1 Small hole cut in the centre of the head of the cement mould to accept the previously bent rush pin

mould. When the cement had reached a level of stiffness whereby it could support the rush pin, the pin was advanced to its final position and the needles were removed (Fig. 4). The cement was allowed to polymerise and then the mould was removed, revealing the smooth, reinforced cement spacer. The spacer was inserted into the canal with a small amount of cement at a late stage of polymerisation placed proximally to secure it and, in particular, to prevent rotation in proximally capacious femora (Fig. 5).

Results

Fifteen patients where discharged from hospital after the first stage operation using either a frame or crutches for partial weight bearing. All patients' inflammatory markers had returned to normal before the second stage. Thirteen of the 15 patients underwent a second stage within ten weeks. One patient died in hospital from unrelated causes before a second stage could be performed. One patient was unable to undergo a second stage due to medical problems and

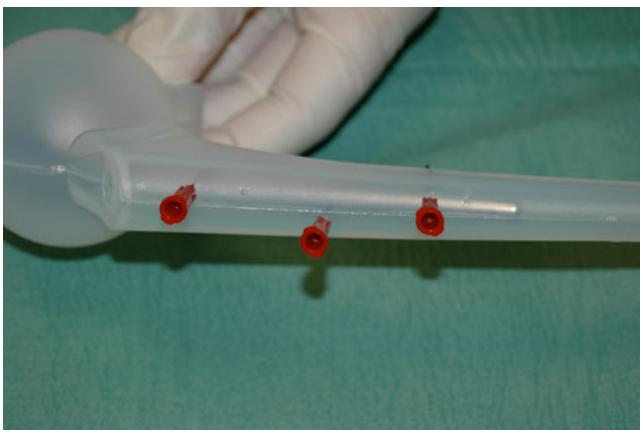

Fig. 2 Insertion of blunt drawing-up needles to support the rush pin in the centre of the mould

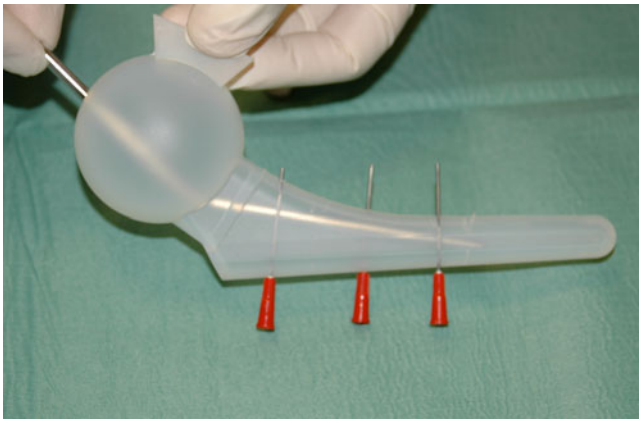

Fig. 3 Insertion of blunt drawing-up needles to support the rush pin, being careful not to fully insert the rush pin

continued to mobilise on the cement spacer until her death at two years after implantation.

There was one spacer dislocation due to rotation of the spacer. This was managed by re-exploration and reinsertion of the spacer in optimal version with proximal cement to secure it. There was one perispacer fracture due to minimal trauma. The fracture occurred in a region of severe osteolysis. The spacer held the fracture stable and no operative intervention was required until the second stage procedure, which was uneventful. We did not observe any significant bone loss with articulation. All patients who had second stage surgery were infection-free at a mean follow-up of 38 months (range 26–60 months).

Discussion

The benefits of a two-stage procedure to treat deep THR infection using an articulating cement spacer have been well described in the literature.

The ideal cement spacer should be inexpensive, easy to produce, allow pain-free non-destructive articulation, be

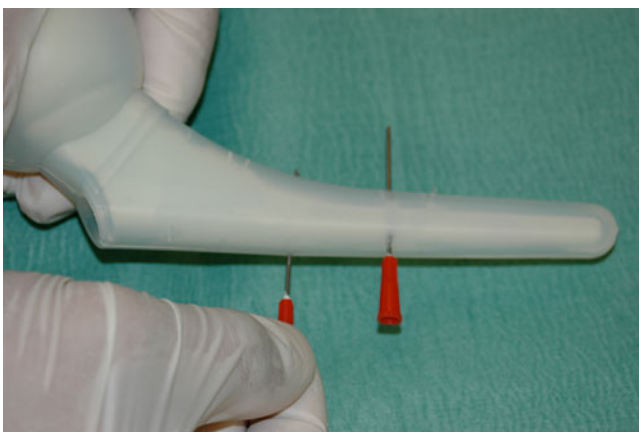

Fig. 4 Advancement of rush pin and removal of supporting needles

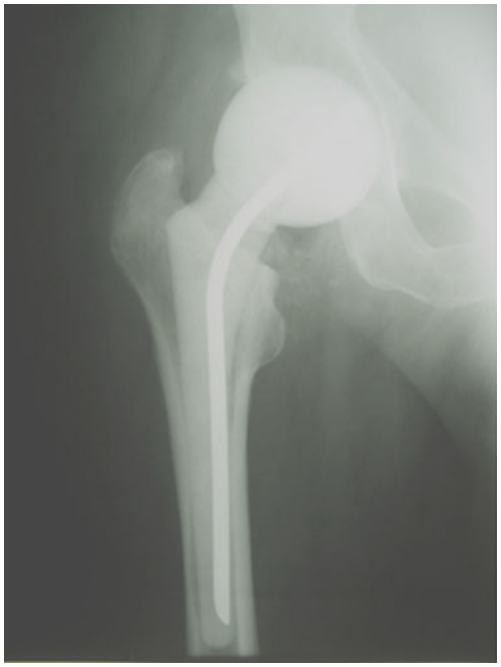

Fig. 5 Smooth articulating reinforced cement spacer in situ

versatile in size, able to produce high local concentrations of a chosen antibiotic and be strong enough to allow weight bearing. The ability to fabricate the spacer intraoperatively also allows introduction of organism-specific antibiotics.

Although generic cement moulds prove ideal in many ways, our experience has shown that if patients attempt weight bearing on an unreinforced spacer there is a tendency for the spacer to fracture. However, other authors have not reported problems with this complication [5, 7]. The concept of improving the strength of a cement spacer by using central metallic reinforcement is not new. This has been attempted in many ways but often to the detriment of the other ideals. In its simplest form this involves hand moulding over a metal rod, nail or plate [6, 14–17]. Although this method is inexpensive, easy and versatile it does not provide a smooth articulation, which may lead to increased bone loss and pain for the patients. Evans [2] described coating a down-sized femoral and acetabular component with cement leaving the articulation free. This resolves the articulation problem but the exposed metal and polyethylene may reduce the chances of complete eradication of infection. Ries and Jergesen [12] formed a smooth articulating surface using the bulb of an irrigation syringe. This was restricted by its single head diameter of 51 mm. Shin et al. [18] adapted this further by forming a bipolar articulation to reduce dislocation, but this meant the metallic head was left exposed. Commercial attempts at a hip spacer have been made. The PROSTOLAC spacer (DuPuy, Warsaw, Il) has been used successfully [8, 11, 19, 20]; however, this is expensive and requires special

equipment. It also has an exposed metal-on-polyethylene articulating surface. The Spacer G [21, 22] is a pre-packed reinforced smooth articulating cement spacer. As it is premanufactured it loses versatility, since the antibiotic content of the cement cannot be tailored to the infecting organism. It is also relatively expensive. Pearle and colleagues [16, 23], who coined the term ANTILOCH, and later Durbhakula et al. [1] both described a virtually identical final spacer product to ours, although by slightly different methods. Both these authors had the moulds made locally based on their own [1] or existing hemiarthroplasty design. This creates a problem of access and reliability for the majority of hospitals. Durbhakula et al. reported a series of 20 patients. Two of these patients retained the spacer as definitive treatment. No patients had evidence of recurrent infection at two years. He also reported two fractures of the spacer, one associated with significant trauma and the other in a very obese patient.

As our spacer uses a commercial mould and readily available products, it is easily accessible and inexpensive. It is available in a range of sizes and has a smooth articulation decreasing the risk of further bone loss and pain. It has a completely covered metallic endoskeleton increasing strength enough to allow partial weight bearing. As it is fabricated intra-operatively, organism-specific antibiotics can be added to the cement mix if the organism is known preoperatively. Such antibiotics must be thermally stable in order to be effective [10]. Elution rates and hence local tissue concentration of antibiotics are dictated by the porosity of the cement, surface area, the type and amount of antibiotic added [3, 10–12, 17]. The addition of antibiotic to the cement is known to affect its structural integrity and strength. This is especially apparent if liquid preparations of antibiotics are used [13]. All these factors must be taken into consideration when contemplating the addition of antibiotics to the cement. In conclusion we describe a smooth, articulating, moulded cement spacer with a central metal endoskeleton that can be inexpensively fabricated intraoperatively without the requirement for special equipment. We have had no problems with spacer breakage despite partial weight-bearing of all patients, and we have not seen significant bone loss with articulation. We have experienced a very low complication rate using the spacer and have successfully eradicated the deep infection in all cases treated. The spacer described fulfils all the requirements of an ideal hip spacer.

Conflict of Interest The authors declare that they have no conflicts of interest.

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