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Low-Cost Customized Cement Hip Spacer: A Surgical Technique Utilizing Low Contact Dynamic Compression Plate (LC DCP)

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Abstract

Background: Hip arthroplasty has favorable outcome in trauma and in degenerative joint disease [1]. The incidence of periprosthetic joint infections is on the rise, with an incidence of 1% to 2% [2]. This is attributed to the growing number of arthroplasty procedures conducted annually. Two-stage revision remains the conventional treatment option for such infections, incorporating antibiotic-loaded spacers [3]. However, the cost of preformed antibiotic spacer cement poses a financial challenge for certain countries. Our study aims to introduce an affordable technique, allowing surgeons with limited economic resources to utilize a low contact dynamic compression plate (LC-DCP) along with cement and antibiotics to manually craft a geometric joint spacer.

Case Presentation

A 68-year-old woman developed a periprosthetic joint infection after undergoing hip hemiarthroplasty. A two-stage technique was planned. We used a handmade cement spacer following comprehensive debridement. An LC-DCP, manually coated with geometric antibiotic-loaded bone cement, was utilized to fill the joint space and control infection locally. Subsequent follow-ups revealed enhanced mobility and no signs of infection. Unfortunately, the patient was lost to follow-up as she passed away due to pneumonia.

Surgical Technique: The patient underwent a first-stage revision one month after left hip hemiarthroplasty, revealing significant pus and a loose implant. An antibiotic spacer was constructed using a 3.5 mm LC-DCP, gentamicin, vancomycin powder, and low-viscosity antibiotic cement, customized to match the patient's normal neck-shaft angle. After thorough debridement, multilayer closure and sterile dressing application concluded the surgery.

Conclusion: A hand-made antibiotic-loaded cement spacer using LC-DCP provides an affordable alternative for articulating commercially available spacers. This solution is particularly beneficial when commercial products are unavailable or financially inaccessible.

Introduction

Total hip arthroplasty is the preferred treatment for various arthropathies [4]. While the clinical outcome of total hip arthroplasty is typically highly favorable or excellent, there is still a small yet significant risk of encountering serious complications during these procedures [5,6], accounting for approximately 1% to 2% of cases [2]. Nowadays, addressing periprosthetic joint infection emphasizes both eliminating the infection and maintaining joint functionality throughout the entire treatment duration. Debridement and implant retention procedures are suitable for early postoperative infections or acute hematogenous infections, while late chronic infections are preferably managed through a two-stage arthroplasty exchange [4]. The two-stage approach is considered a safe method for treating periprosthetic joint infections [7]. After removing the infected implant, debridement and replacing of necrotic and granulation tissue with antibiotic containing cement spacer is a standard therapy to improve the outcome of re-implantation and prevent recurrence of the infection [4]. Either a commercial or hand-made spacer can be used [8]. Commercial spacers have excellent mechanical properties in terms of congruence and strength. The amount of cement and antibiotics in them ensures a uniform release of antibiotics into the surrounding tissues [8]. However, since the amount of antibiotics in them is fixed, it may lead to a lower effectiveness against microbes [8]. Moreover, there are some concerns with regards to their high cost and availability. Thus, we propose a technique whereby a custom-made antibiotic-loaded cement spacer is prepared intraoperatively. Hand-made spacers are used to maintain the length of affected limbs and prevent muscle and soft tissue contracture by inserting bone cement blocks into the joint space [3]. An articulating spacer closely resembles the anatomical structure of a normal joint, ensuring a near anatomical alignment with the remaining bone surface. Simultaneously, it maintains joint space, promotes patient mobility, allows for reduction of intra-/peri-articular hematoma, and minimizes soft tissue atrophy and scar formation [3].

Case Presentation

A 68-year-old female, known to have diabetes mellitus, hypertension, a history of old cerebrovascular accident (CVA), pressure ulcer, renal impairment, and Cushing's syndrome, was admitted to the medical ward due to bilateral lower limb weakness and pain. Laboratory investigations revealed an elevated D-Dimer, and a CT scan indicated adrenal hyperplasia. The patient was also admitted for pneumonia under the medical service and was started on intravenous levofloxacin. Consultation with the orthopedic service was sought for left hip pain and the inability to walk for the past three weeks. Pelvic X-rays revealed a displaced femoral neck fracture. In March 2023, the patient underwent left hip hemiarthroplasty surgery. Postoperatively, the patient performed well but experienced weakness, likely attributed to hypokalemia. Correction of the potassium level, physiotherapy, and walking with a walker were implemented. The orthopedic service provided daily wound care, and the patient was eventually discharged in stable clinical condition. Approximately one month later, signs of periprosthetic joint infection emerged, likely stemming from hematogenous spread from the concurrent pneumonia. Laboratory findings reveal a white blood cell (WBC) count of 7.64, predominantly neutrophils at 87.7%, an elevated C-reactive protein (CRP) level of 50 (normal range <8 mg/l), and an erythrocyte sedimentation rate (ESR) of 58 mm/hr (normal range 0-30). Cultures from both the sputum and the hip joint identified Pseudomonas aeruginosa. Consequently, 1 month after her indexed surgery, the patient underwent bipolar removal, and a cement spacer was applied. No signs of infection were noted, and mobility improved. Unfortunately, the patient passed away about 9 weeks after the surgery due to pneumonia.

Surgical Technique

The patient underwent her first-stage revision 1 month after her left hip hemiarthroplasty surgery. She was positioned in the lateral decubitus position under general anesthesia, and an anterolateral hip approach was used. Significant pus was found deep to the fascia, and the implant was discovered to be loose. Multiple specimens of deep and superficial tissue cultures were sent to histopathology and microbiology laboratories. The specifications of the removed hip implant were as follows: cup size 45 mm, head 28 mm, and cementless stem size 1.0 (UHR Stryker). The hip joint was thoroughly cleaned using jet lavage with 8 liters of normal saline.

After debridement, all old drapes and instrument trays were replaced with clean sterile ones. An antibiotic spacer was constructed on the back table using a 3.5 mm LC-DCP, 2 packs of 40mg gentamicin, low-viscosity antibiotic cement (simplex/staker), and 3 grams of vancomycin powder. The first step involved bending the plate proximally at an angle of 130 degrees, matching the normal neck-shaft angle of the patient (Figure 1). The retrieved implant served as a reference for the correct bending angle. Subsequently, the cement was manually mixed on the back table until reaching a dough consistency (Figure 2). The surgeon then placed a ball of cement on the proximally bent tip of the plate while covering the distal shaft with a thin layer (1-2 mm) of cement. It is crucial not to create irregular surfaces on the plate with cement, as this can complicate the insertion process. Once the customized cement spacer dried, the surgeon conducted trial insertions to identify any bulky areas, subsequently refining them with a bone rasp (Figure 3). Finally, the customized spacer was inserted into the medullary canal, and the stability of the hip was tested both manually and radiologically (Figure 4a, 4b, 5). At the end of the surgery, multilayer closure was performed over a drain, and a sterile dressing was applied.

Figure 1: The infected prosthetic joint of the hip is shown, and the LC-DCP is contoured to resemble the angulation of the infected prosthetic hip joint.

Figure 2: Coating LC-DCP with the cement and antibiotics.

Figure 3: Cement and antibiotics were used to cover the LC-DCP.

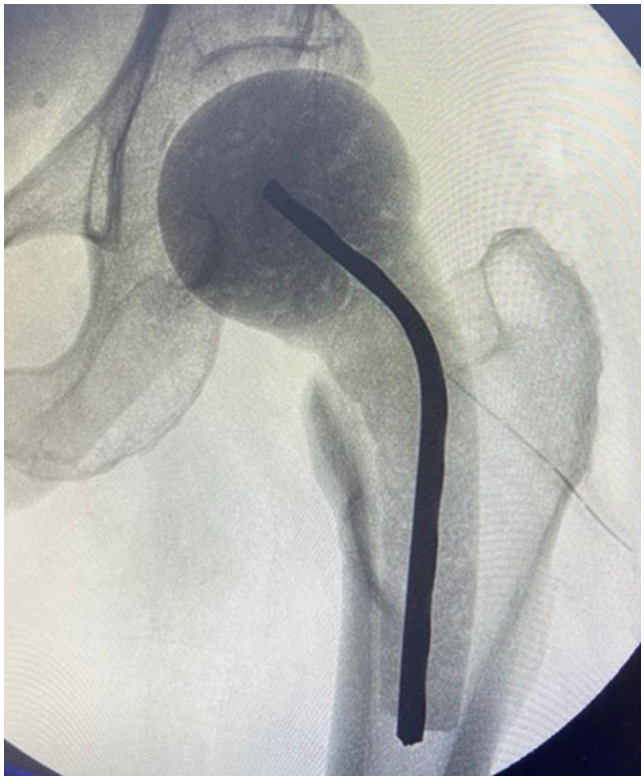

Figure 4 (A): Anteroposterior view of a fluoroscopic images after implanting the antibiotic-loaded cement spacer.

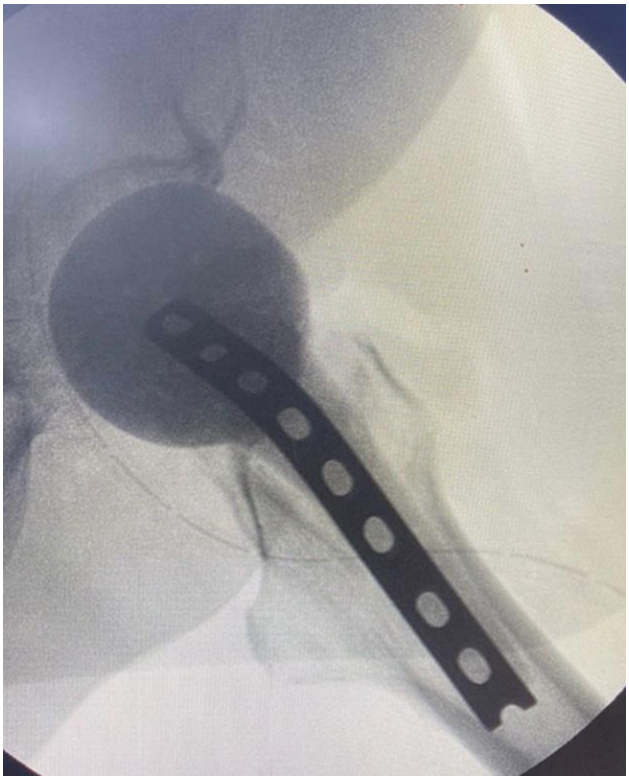

Figure 4 (B): Frog leg lateral view of fluoroscopic image after implanting the antibiotic-loaded cement spacer.

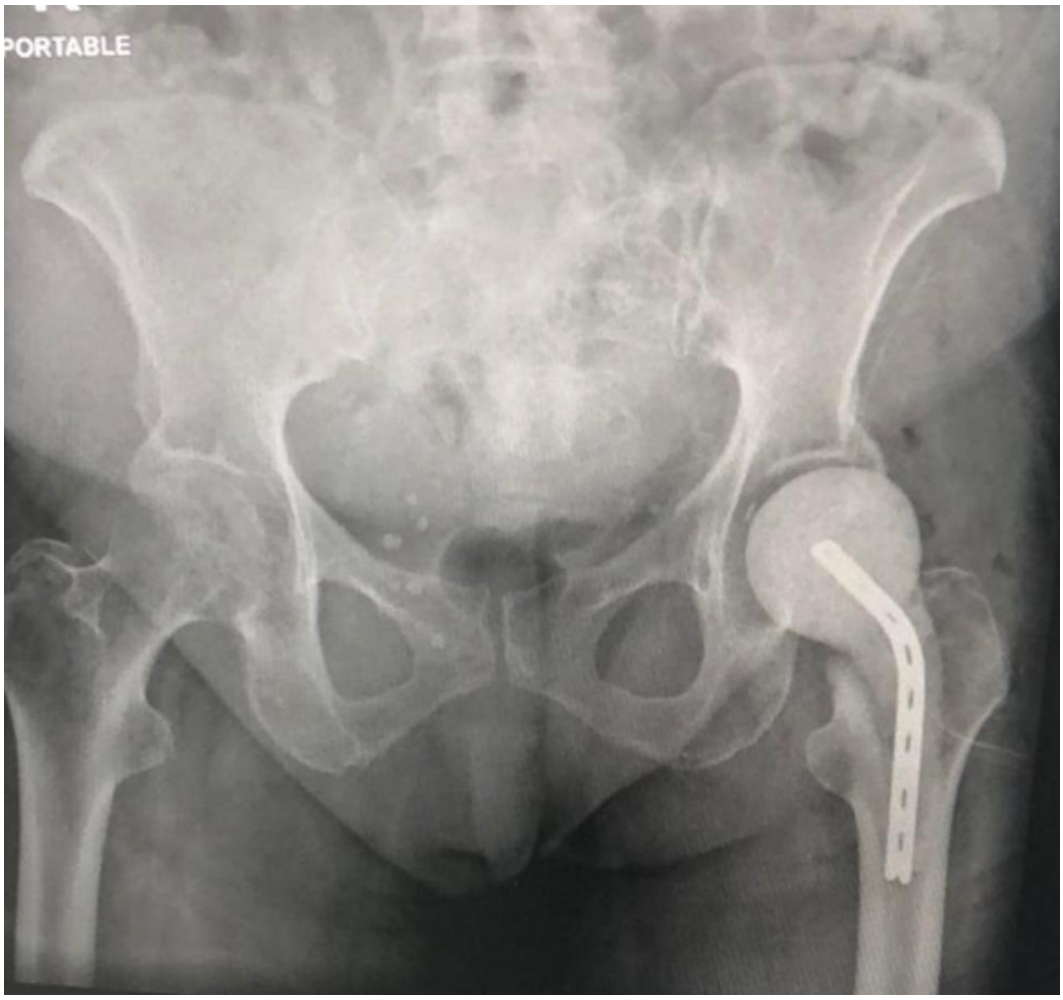

Figure 5: Post operative Anteroposterior view of an x-ray image after implanting the antibiotic-loaded cement spacer.

Discussion

The incidence of periprosthetic joint infection is increasing globally, with two-stage revision being the gold standard for managing such infections [3]. This procedure involves the use of a cement spacer, which can be commercially preformed. Preformed spacers exhibit high mechanical durability [9], and their use has been demonstrated to reduce surgical duration [10]. However, they may be financially inaccessible. Therefore, the objective of this study is to introduce an alternative technique that combines the advantages of a commercial spacer with lower costs, utilizing a hand-made spacer. The materials used in this approach are readily available in hospitals. Compared to standard hand-made cement block spacer, this technique offers improved joint geometry, resulting in enhanced functionality, reduced pain, better range of motion, increased joint stability, optimal tension in muscles and soft tissues, and elimination of dead space. This method allows to preserve patient's leg length as well as good infection control as it allows gradual release of antibiotics. Research conducted by Hsieh and collaborators [11] achieved a high infection control rate of 95.3% through the use of an antibiotic-impregnated hip cement spacer and beads. A study was done to compare the preformed to the custom-made spacers, and the findings revealed that the overall eradication rate was similar in both groups [12].

Other studies have found that the dislocation rate is higher in patients with preformed spacers compared to those with hand-made ones [13]. This difference is attributed to the fact that custom-made spacers can be molded based on individual variables such as physiologic neck varus/valgus, resulting in better articular congruity. Moreover, studies indicate no significant difference in infection eradication between patients with preformed hip spacers and those with hand-made ones [13]. On the downside, the use of hand-made spacers may increase anesthesia time [14]. Moreover, Options for antibiotics are limited, and the ones mostly used are tobramycin, gentamycin, and vancomycin [4]. Daptomycin has also been introduced [14]. A literature review revealed a significantly elevated rate of spacer fractures in the group where surgeons made the spacers compared to the group using preformed spacers. It appears that surgeon-made spacers tend to fail than their preformed counterparts, possibly due to the somewhat uneven process of cement mixing and delivery during spacer preparation and application [13].

Conclusion

Hand-made antibiotic cement-covered spacer, using an LC DCP plate offers a simple and affordable alternative for making articulating spacers to serve the treatment of patients where commercial products are unavailable or financially inaccessible. Arthroplasty for treating infected joints with these spacers promises to make a substantial contribution to the effective eradication of infection, allowing for early motion, and improved life quality prior to a more favorable second-stage reimplantation of a prosthesis.

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