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# How to make a custom cement spacer for revision shoulder arthroplasty

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## Abstract

Over the years, shoulder arthroplasty has experienced significant growth in its frequency. However, this increase has also been accompanied by a higher incidence of complications associated with this procedure, and consequently, the number of revision shoulder arthroplasty surgeries has increased. Multiple complications have been described that can occur after shoulder arthroplasty surgery. These complications include infection and periprosthetic fractures, with an incidence of 1.1% to 3.8% and 0.9% to 3.5%, respectively. In revision shoulder replacement surgery, the temporary use of bone cement spacers with antibiotics is sometimes necessary, as in the case of staged management of infections and periprosthetic fractures, or sometimes even as definitive treatment. With this in mind, we have developed an easy and reproducible technique for creating custom-made spacers for the treatment of infections and infected periprosthetic fractures in revision shoulder arthroplasty surgery that require a longer spacer stem length.

**Keywords:** Custom Made Spacer; Handmade Spacer; Cement Spacer; Revision Shoulder Arthroplasty

## 1. Introduction

Over the years, shoulder arthroplasty has experienced significant growth in its frequency. Furthermore, prostheses have improved and their indications have expanded; however, this increase has also been accompanied by a higher incidence of complications associated with this procedure and higher rates of revision surgery. Multiple complications have been described that can occur after shoulder arthroplasty surgery. Among these complications, we can find periprosthetic infection, with an incidence ranging from 1.1% to 3.8% after primary shoulder arthroplasty and reaching 15.4% in cases of revision shoulder arthroplasty. Complications such as periprosthetic fractures have also been described, with an incidence of 0.9% to 3.5%, and are also more frequent in revision cases.

Two-stage management remains an important pillar of periprosthetic infection treatment, aiming to eradicate the infection. This treatment essentially consists of: initial surgical removal of the primary prosthesis, extensive debridement, irrigation of the shoulder, and implantation of a bone cement spacer with antibiotics, in addition to administering oral antibiotics to cure the infection. Once the infection is cured, a second surgical procedure involves removal of the bone cement spacer with antibiotics and implantation of a new shoulder prosthesis.

Occasionally, removal of the primary prosthesis requires an osteotomy at the level of the humeral shaft, or a periprosthetic fracture may occur during primary prosthesis removal, which may require a longer spacer. Type B or C periprosthetic fractures according to the Wright and Cofield classification are also suitable for management with a long spacer, provided that the spacer stem extends beyond the fracture site.

In our setting, the second stage of treatment is often not possible, making it necessary to apply a long, functional spacer for an extended period of time or even as definitive treatment if necessary.

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Taking the above into account, the purpose of this work is to demonstrate the technique we have developed to create custom-made long "handmade" spacers for the treatment of infections and infected periprosthetic fractures in revision shoulder arthroplasty surgery.

### 1.1. Presentation of a clinical case

A 63-year-old male patient with a history of HIV and a left shoulder hemiarthroplasty 12 years earlier presented to the emergency department with a Wright-Cofield type B periprosthetic fracture. The admission radiograph revealed complete loosening of the stem, but septic loosening could not be ruled out as the cause of the fracture, given his medical history.

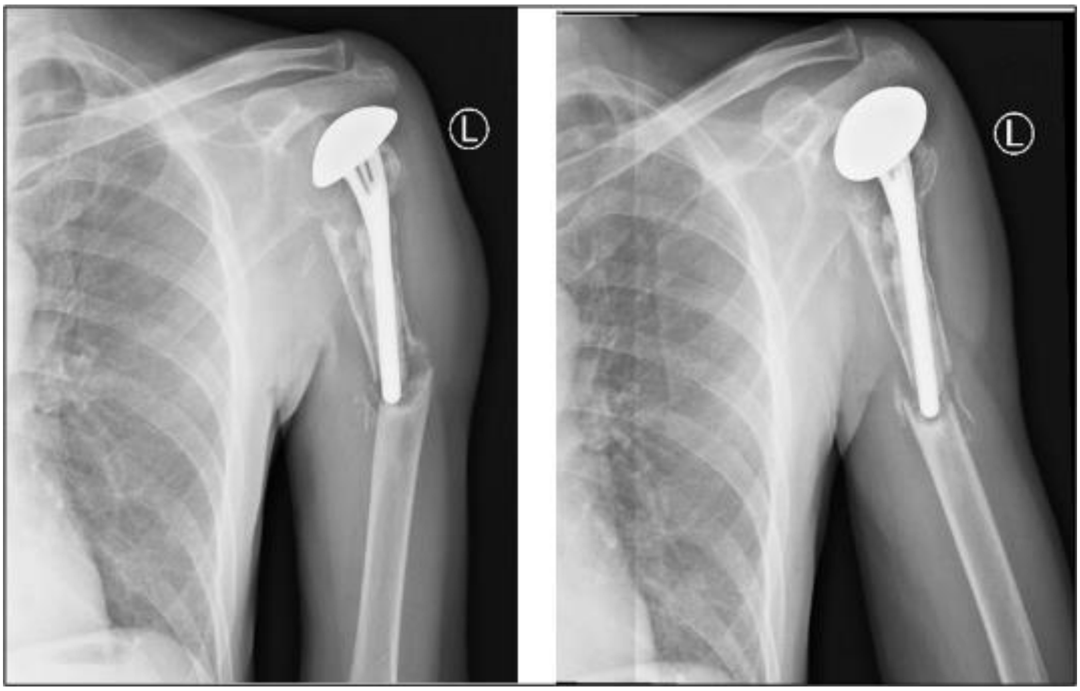


**Figure 1** Left humerus X-ray taken upon admission to the emergency department

Considering the above, it was decided to perform a two-stage management of the Wright-Cofield type B periprosthetic fracture, using a long-acting antibiotic-coated bone cement spacer as the initial surgical procedure. For the purpose of this case, we will describe the surgical technique for creating a long-acting antibiotic-coated bone cement spacer in a developing country where prefabricated or custom-made long spacers are not available.

## 2. Description of the surgical technique

### 2.1. Preoperative planning

In our technique, in addition to the basic equipment for revision shoulder arthroplasty, we require a conventional shoulder spacer, an intramedullary humeral nail with all its implantation instruments, 2-3 units of antibiotic-containing bone cement, preferably slow-setting, a size 36-38 chest tube, a diamond-coated metal-cutting disc saw, and a high-power cutting system (see figures 1, 2, and 3).

### 2.2. Materials for making the spacer

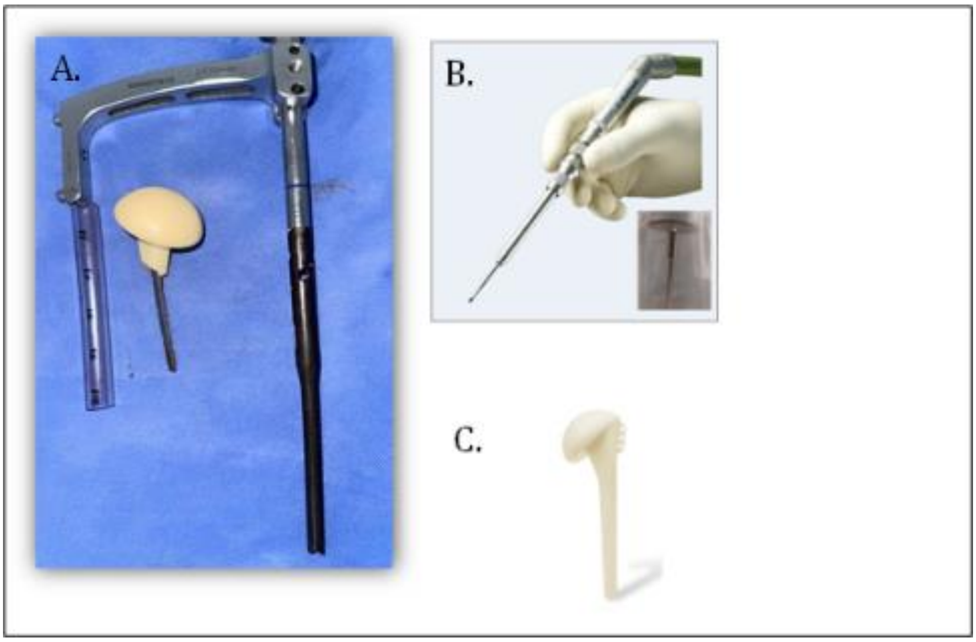


**Figure 2 A** Chest tube, conventional shoulder spacer, humerus intramedullary nail; **B** High-power cutting system, metal-cutting disc saw; **C** Conventional shoulder spacer

## 3. Surgical approach and technique

For revision shoulder arthroplasty procedures, we prefer the deltopectoral approach due to the extensive exposure it allows for viewing all structures and the possibility of extending it to the diaphysis to view the fracture site or, in some cases, performing the osteotomy and implanting our "handmade" long spacer.

Once debridement, cultures have been obtained, and the primary prosthesis has been removed, we proceed to prepare the medullary canal for placement of the long spacer. To do this, we use the humeral nail implant material, gradually reaming the canal to 1.5 cm above the diameter of the nail that will be used as the core of our spacer. We can obtain the spacer length by measuring it in the radiography software and confirm it intraoperatively with a fluoroscopic guide. However, it is preferable for our spacer to be slightly longer than desired, as we can easily cut it later with the metal-cutting saw. (See Figure 4-5).

We must first determine the approximate length of the spacer.

The short spacers available in our setting have a metal core inside the antibiotic coating. We remove the cement mantle and expose the metal core of the spacer. The metal core fits into the slotted hole of the intramedullary nail.

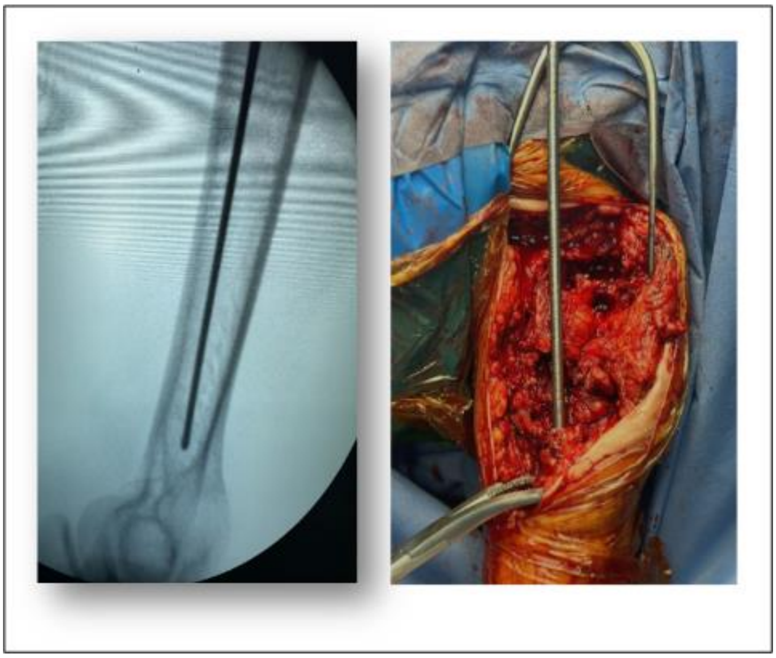

**Figure 3** A Fluoroscopy shows measurement of nail **B** Reaming of the medullary canal of the humerus (The letters A and B are missing from the images in figure 3).

**Table 1** To make a handmade long spacer

| **Cut the humerus nail according to the established measurement with the metal-cutting disc saw.** |
|---|
| Remove the distal cement mantle from the prefabricated spacer to expose the metal core and insert it into the intramedullary nail slot using a male-female socket. |
| Use a chest tube as a mold to coat the nail and the metal core of the cement spacer. |
| Cut the chest tube to the previously calculated length. |
| Fill the chest tube with antibiotic bone cement. |
| Once the cement has the appropriate consistency, insert the spacer and nail into the cement-filled chest tube. |
| After the cement has set, cut the chest tube with a scalpel. |
| We obtain a spacer with a much more robust, firm and functional soul. |

This spacer can be used for the first surgical stage in the treatment of infections or infected periprosthetic fractures or even as definitive management.

Once the spacer is ready, it is implanted antegrade and its proper length is verified with fluoroscopy, with the advantage of being able to cut it if necessary. Once the spacer is implanted, adequate mobility and stability are verified.

**Figure 4** Custom-made long anatomical spacer, cut intramedullary nail, and chest tube used as a mold

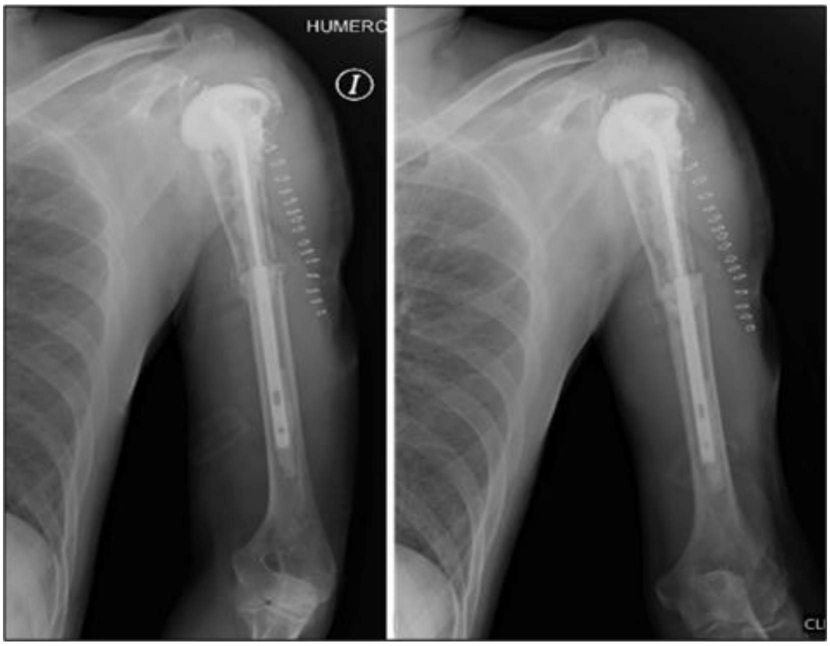

**Figure 5** Immediate postoperative left humerus X-ray

## 4. Discussion

In developing countries or in healthcare institutions where resources are limited, we do not have prefabricated long spacers, custom-made spacers, or molds for the manufacture of long, anatomical antibiotic-coated bone cement spacers that could be useful for the initial stage of treatment for periprosthetic infections or fractures that require them.

Padegimas E, et al. developed non-anatomical (rudimentary, morphology different from a prosthesis) homemade spacers that do not guarantee acceptable shoulder function and even have a higher risk of spacer fracture since the spacer core is a long Steinman nail coated with antibiotic-containing bone cement, or some do not even have a stem. Anatomical spacers (morphology similar to a prosthesis) have advantages over non-anatomical ones, since they confer greater stability to the construct, better joint mobility, and patient tolerance. Furthermore, long spacers allow the local antibiotic to be delivered to the entire medullary canal.

Klosterman et al developed a long, hand-made spacer made from a prefabricated mold and instruments designed for this purpose; however, in their model the core of the spacer is also a long Steinman nail, with a risk of spacer fracture when left as definitive management.

We believe that our spacer is a simple strategy to perform, with basic instruments, without the need for prefabricated molds, and that it could have a lower risk of spacer fracture, considering that the core of our spacer is made with an intramedullary humeral nail of a diameter and strength much greater than that of a Steinman.

## 5. Conclusion

The treatment of periprosthetic infections and fractures represents a major challenge for shoulder surgeons, as staged management often requires strategies and instruments unavailable in our setting. With this in mind, we describe this technique, which can be easily reproduced even in settings with limited instruments or limited resources.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

The authors of this study declare no conflict of interest.

### *Statement of informed consent*

Informed consent was obtained from all study participants.

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