CASE REPORT

Use of TRUMATCH® Graft Cage – Long Bone With Masquelet Technique in the Tibia

Joshua R. Blomberg, MD, FAAOS

Segmental bone loss due to trauma remains a challenging orthopedic problem with variable clinical outcomes. The treatment approach varies based on the location, size of the defect, patient physiology, and surgeon skill set. Two relatively common approaches to bone defect management include bone transport and the Masquelet technique. Each of these approaches has advantages and disadvantages, but despite refinement of our surgical techniques, success rates remain around 66% to 90%.[1-4] Furthermore, 18% to 20% will need further surgical intervention to obtain a successful clinical outcome.[2,3] This case highlights the use of TRUMATCH® Graft Cage – Long Bone with the Masquelet technique for treatment of a critical-sized post-traumatic segmental defect in a tibial diaphysis.

1. INTRODUCTION

Bone defects can occur as a result of acute trauma, infection, or neoplastic disease. It is generally understood that surgical management of a bone defect is required when it is of a critical size. A critical size bone defect is defined as a defect too wide to heal spontaneously, or a defect wider than 2.5 times the diameter of that bone on a particular level.[5] Two common limb salvage methods used to address critical size bone defects include bone transport and the Masquelet technique. Bone transport is most commonly accomplished with use of ring fixator, although newer techniques using magnetic transport nails can also be employed for certain defects. Both the ring fixator and magnetic nails work by transporting a segment of healthy bone across a bone defect, docking it at the end of defect, while creating regenerate (new) bone behind it. There are a variety of complications that can arise during a bone transport procedure, including pin site infections, docking site non-union, and poor regenerate formation.[6] Patient tolerance and compliance with ring fixator bone transport is also a significant issue given the significant amount of time it can take to achieve successful bone transport with this technique. The Masquelet technique for management of bone defects involves two treatment stages.[7] The first stage involves thoughtful debridement of the involved bone and soft tissues, followed by insertion of a polymethylmethacrylate (PMMA) spacer into the bone void. Use of antibiotics with the PMMA is controversial, and not recommended by Masquelet.[7] Finally, fixation of the bone around the defect is accomplished using internal or external fixation techniques, followed by soft tissue coverage as dictated by the injury. The second stage then occurs 4 to 8 weeks later depending on the quality of the soft tissue envelope. This stage involves opening of the membrane around the spacer, removal of the PMMA, gentle debridement of the bone ends and inner membrane, followed by bone graft insertion. Iliac crest or Reamer-Irrigator-Aspirator (RIA) bone graft can be used to fill the void, and allograft can be used as graft expander depending on defect size. Careful closure of the membrane is then completed, followed by any augmentation of the bone fixation around the defect. Problems associated with the Masquelet technique include infection and failure of graft incorporation, both of which can lead to nonunion.[7] Settling of the morselized graft can also occur at the proximal margin of the defect, leading to a nonunion at this open seam. These complications require revision surgery which usually involves further debridement and repeat grafting depending on the clinical context.

2. CASE PRESENTATION

2a. Preoperative

33-year-old male presented to the emergency department after jumping off the 4th story of a parking ramp. His injury profile included a severe right open tibia fracture, with acute bone loss. Initial injury radiographs are shown in Figure 1. He also sustained an open distal humerus and contralateral calcaneal fracture. He was otherwise stable.

Figure 1. Immediately post-injury, no fixation

2b. Treatment Course

The patient was taken urgently to the operating room for management of his injuries, which included debridement and irrigation of his open tibia fracture, removal of debris and dead bone, with primary wound closure. A spanning knee external fixator was applied, and the patient was sent to the ICU for recovery. Fluoroscopic images of the tibia after spanning external fixation are shown in Figure 2.

Figure 2. Immediately post-injury, with external fixator stabilization

2b. Treatment Course

Approximately 10 days later, the patient was taken back to the operating room for fixation of his open tibia fracture. He underwent removal of his external fixator, followed by suprapatellar nailing of his tibia after repeat debridement and irrigation. The fracture ends were then prepared with an oscillating saw to create flat cuts proximally and distally. A polymethylmethacrylate antibiotic cement spacer was inserted into the 8 cm defect in anticipation of staged Masquelet bone grafting. Radiographs showing cement spacer placement into the bone defect after nailing are shown in Figure 3. Postoperatively, a CT scan of the entire lower leg was obtained in accordance with the TRUMATCH Graft Cage – Long Bone CT scan protocol. The CT scan was sent to DePuy Synthes, and a custom TRUMATCH Graft Cage – Long Bone that matched the bone defect was created prior to the Masquelet bone grafting procedure. The TRUMATCH Graft Cage – Long Bone created for this defect is shown in Figure 4. Note that the cage has an inner cylinder meant to wrap around the tibial nail, and an outer cylinder which matches the tibial shaft diameter at the defect site.

Figure 3. 10 days post-injury, with tibial nail fixation and PMMA spacer inserted into segmental defect

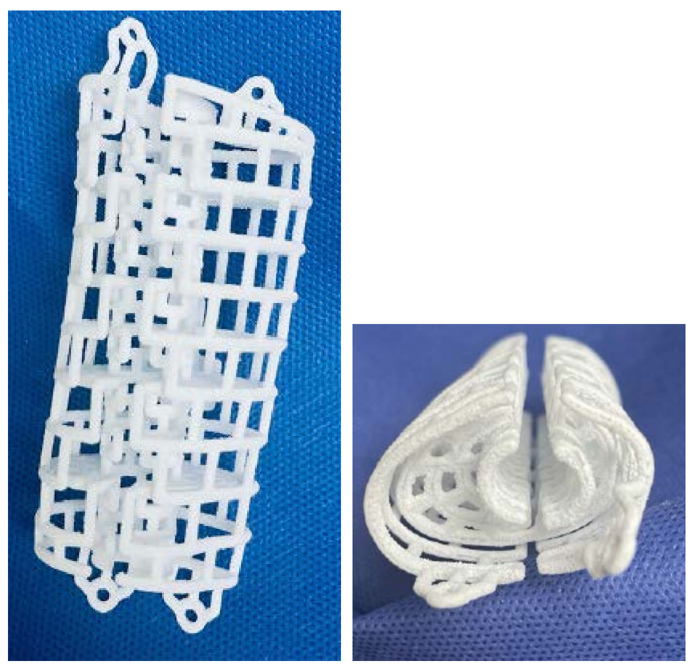

Figure 4. TRUMATCH Graft Cage – Long Bone, patient-specific implant, 3D printed for this case

2b. Treatment Course

Six weeks after cement spacer placement, the patient returned to the operating room for planned bone grafting consistent with Masquelet technique. Bone graft was harvested from the ipsilateral femur using the RIA 2 system. This autogenous bone graft was mixed with allograft to extend the volume. The membrane around the spacer was then carefully incised and the cement spacer was removed. The posterior portion of the TRUMATCH Graft Cage – Long Bone was filled with bone graft on the back table, and then placed into the defect around the nail. The remaining portions of the cage were then filled with bone graft, and the anterior aspect of the cage was closed with running vicryl suture. Radiographic images after cage placement and bone grafting are shown in Figure 5.

Subsequently, the patient was made weight bearing as tolerated on the affected extremity and routine follow-up was successfully completed. Figures 6 and 7 show sequential radiographs of the tibia with the incorporating bone graft and consolidating defect. No graft settling occurred. At the 7-month follow-up, the patient was having no pain in his lower leg or tibia, and the graft was solid to direct palpation. Consolidation and maturation of the graft can be seen.

Figure 5. Immediately post-op

Figure 6. 4 months post-op

Figure 7. 7 months post-op

3. DISCUSSION

Post-traumatic bone defects are complex clinical problems, which usually require multiple surgeries and careful planning to achieve union. Reconstruction of bone defects is most commonly accomplished by use of bone transport or mass bone grafting with the Masquelet technique. The Masquelet technique is most effective in the setting of a healthy soft tissue envelope and requires the development of a robust membrane around the implanted cement spacer. It has been shown to be good option for the treatment of large bone defects secondary to acute bone loss or as a result of chronic infected nonunions.[8] Autogenous bone graft is ideally used to fill the bone void, but it may need to be expanded with allograft based on the size of the defect. Failure of graft incorporation, settling of the graft, and infection are the most common complications seen with the Masquelet technique.[8]

The 3D-printed, patient-specific TRUMATCH Graft Cage – Long Bone in combination with the Masquelet technique was successfully used to treat this patient's critical sized tibial bone defect. The TRUMATCH Graft Cage – Long Bone has an interstitial shelf design that supports the graft and prevents collapse. This can help prevent nonunion at the proximal bone defect seam. The surface of the cage is coated with osteoconductive calcium phosphate, which promotes mineralization at the surface of the implant and is thought to promote more rapid conversion to bone. These two unique properties can ultimately improve the success rate of the Masquelet technique and allow for more reliable treatment of critical size bone defects up to 10 cm* with mass bone grafting. The TRUMATCH Graft Cage – Long Bone is an improvement on the classic Masquelet technique, providing surgeons another tool in the treatment of these critical sized bone defects.

*TRUMATCH Graft Cage – Long Bone is available up to 10 cm in the US per FDA approval as of time of publication. It is available in sizes up to 30 cm outside the US where available.

4. SURGEON PROFILE

Joshua R. Blomberg, MD, FAAOS
Orthopedic Medical Director
ThedaCare Health System – Neenah, WI

5. REFERENCES

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