Antibiotic-Impregnated Polymethylmethacrylate as an Anterior Biomechanical Device for the Treatment of Cervical Discitis and Vertebral Osteomyelitis: Technical Report of Two Cases

INTRODUCTION

The treatment of discitis and vertebral osteomyelitis (DVO) remains a challenge. Options range from conservative management, including bracing and antibiotics, to aggressive debridement and primary reconstruction (1,11,13,24). Although gaining wider acceptance and support in the literature, the use of structural allografts and instrumentation in DVO remains controversial (1,18,22). This is primarily based on the perceived risk of persistent infection related to a devitalized graft and adjunctive use of spinal implants that in turn raises concerns of construct failure. The use of antibiotic-impregnated polymethylmethacrylate (AI-PMMA) has long been used in the orthopedic community for the treatment of osteomyelitis outside of the spine, specifically in infected joints and long bones (8,12,16,25). A biomechanical device that offers immediate stability and the local delivery of antibiotics provides an appealing option in the setting of DVO. This communication reports two patients who underwent anterior cervical decompression for DVO followed by reconstruction with polymethylmethacrylate impregnated with antibiotics (AI-PMMA).
METHODS

Patients
Two patients who presented with symptoms of neck pain and worsening neurological status were diagnosed clinically and radiographically with cervical discitis and osteomyelitis (Figures 1-7). Both had known risk factors for the diagnosis: one patient has a history of multiple sclerosis and Crohn’s disease for which he received steroid therapy for symptom control; the other had undergone a routine dental procedure three weeks prior to admission. In both patients corpectomies were performed to decompress the spinal cord and remove all visible infected tissue. Initially, the patient on steroid therapy was treated with a multilevel corpectomy with placement of a structural autograft strut obtained from his iliac crest followed by placement of an anterior cervical plate (Figure 2). Seven days post-operatively, the patient developed acute increased neck pain and kyphotic deformity. Cervical spine imaging revealed failure of the surgical construct with anterior displacement of the inferior portion of the graft and plate along with subluxation of the C5-C6 facet (Figure 3). This patient subsequently underwent reconstruction with AI-PMMA followed by staged posterior cervical instrumentation.

Surgical Technique
Microsurgical corpectomies were performed at the diseased levels through a ventral approach. Infected bone and disc were removed along with the posterior longitudinal ligament. Any visualized epidural involvement of the infectious process was evacuated and cultured. The superior and inferior endplates were prepared to ensure an optimal surface to seat the graft. Gelfoam was placed over the dura in an effort to provide a buffer from any exothermic reaction that occurs during the curing process of the graft (21). Steinman pins (Smith & Nephew, Memphis, TN) were placed rostral and caudal within the vertebral bodies to help secure the cement against any dislodgement. Prior to implantation, PMMA cement (41 grams) was mixed intraoperatively with one gram vancomycin powder and 1.2 grams tobramycin powder. During implantation, Caspar distraction pins (Aesculp, Center Valley, PA) were placed and the cavity was expanded through distraction to recreate lordosis and widen the neural foramina. The cement was then introduced into the cavity created by the corpectomies and was copiously irrigated while setting to protect against thermal injury to the spinal cord. Care was taken to avoid compromising the neural foramina during placement of the cement. Once the AI-PMMA was set, distraction was removed allowing compression against the AI-PMMA. At this point, an anterior cervical plate was placed (Medtronic, Minneapolis, MN).

Post-Operative Management
Both patients were placed on a six-week course of intravenous antibiotics specific to the etiology of their respective infections under the direction of the Infectious Disease Department. One patient had cultures positive for coagulase negative staphylococcus and was placed on vancomycin; the other had positive cultures for Streptococcus oralis and was placed on ceftriaxone. Adjuvant therapy included the use of a rigid cervical collar in the patient with previous failure for 12 weeks at which time radiographs showed stable anterior and posterior cervical constructs.

RESULTS

Outcome
Both patients were evaluated postoperatively on the basis of working capacity and subjective symptoms following Odom’s criteria (18) (Table I). Both had resolution of their preoperative cervical symptoms and were able to return to their normal daily activities without impairment (Odom’s I). Both remain off antibiotics and have been infection free. Final postoperative C-spine radiographs were obtained for both patients showing radiographically stable constructs without subsidence, one at 36 months and the other at 18 months postoperatively (Figures 4, 5, 8, 9).

Complications
The only complication that occurred was the failure of the initial iliac crest graft construct, which led to the revision

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<tr>
<th>Grading</th>
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<tr>
<td>I (excellent)</td>
<td>No cervical spine symptoms, daily activities not impaired</td>
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<tr>
<td>II (good)</td>
<td>Intermittent discomfort, no significant interference with work</td>
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<tr>
<td>III (fair)</td>
<td>Subjective improvement, but significant limitation of physical activities</td>
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<tr>
<td>IV (poor)</td>
<td>No improvement or worse compared with the condition before surgery</td>
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Table I: Odom’s Criteria for Evaluation of Patients after Surgery on the Cervical Spine

Figure 1: Preoperative T1 weighted, contrast enhanced MRI of cervical spine.
Antibiotic-Impregnated Polymethylmethacrylate (AI-PMMA) and staged posterior instrumentation. No complications from the use of AI-PMMA were encountered.

**DISCUSSION**

Cervical DVO with symptomatic neurologic compromise, radiographic structural instability or intolerable pain from failed medical treatment warrants surgical intervention (1,4,7,10,11,18,22,24) (Table II). When reconstructing the cervical spine in cases involving pyogenic osteomyelitis, the most accepted technique is reconstruction with autologous iliac crest graft often performed in a two-step anterior procedure (10,13,15). This involves an initial debridement surgery followed by placement of a rigid halo device for one week then a second debridement with subsequent fusion. Becoming more prevalent is single setting or staged 360-degree reconstruction (13,15). The concerns with using autologous graft include donor site complications, lack of graft availability due to previous harvest and, as seen in one of our cases, graft dislodgement (13,19). This has led to the use of various allografts including titanium, stainless steel and polyetheretherketone (PEEK) cages (18,22). Allograft use for pyogenic osteomyelitis is gaining wider acceptance with studies from multiple centers refuting concerns that foreign material may lead to persistent infection and construct failure (1,4,10,11,18,20,22,24). However, these implants come at an increased cost that may not be financially feasible in surgical arenas across the world. The rate for allograft implant cages range from $750 USD to $1050 USD compared to $300 USD to $400 USD for antibiotic impregnated PMMA and Steinman pins. In settings where affordability is a reality, AI-PMMA can be an effective alternative to the current industry promoted allograft implants for anterior structural support for surgical treatment of cervical osteomyelitis.

PMMA's use as a biomechanical device in anterior cervical disc decompression procedures has been well documented with stable construct rates reported between 70 and 87 percent and low complication rates (5,6,14). Additionally, the successful use of beaded Al-PMMA as a temporary prophylactic measure for infected joints and long bones has been well described in the orthopedic literature (2,3,17). Local antibiotic therapy has been shown to deliver high concentrations to the infected

<table>
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<tr>
<td>1. Neurologic deficit</td>
<td>Spinal cord compression; Nerve root impingement causing weakness</td>
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<td>2. Biomechanical instability</td>
<td>Pathologic fracture, Sagittal or coronal plane deformity</td>
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<td>3. Failed conservative treatment</td>
<td>Intractable pain</td>
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<td>4. Paravertebral or epidural abscess</td>
<td>Persistent infection</td>
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Table II: Clinical and Radiographic Indications for Surgical Treatment of Cervical Osteomyelitis
region with minimal detection of systemic levels. In animal models, elution is maximal the first day, greatly declines on the second day, and then gradually decreases until stabilization at 5-10 days (9,23). High local concentrations are noted at 10 weeks with low serum levels; the advantage of this delivery system is high local concentrations of antibiotics with no or low systemic toxicity (9,23).

Our described technique using AI-PMMA for the treatment of cervical osteomyelitis is a natural translational and novel application to this knowledge. The large footprint distributes forces over possible compromised bone to increase stability and to decrease the chance of subsidence. As described in our surgical technique section, emphasis must be placed on protecting neural elements during the delivery and curing of the product (20,21).
The technique we describe using AI-PMMA offers immediate structural stability and local delivery of high concentration of antibiotics for less cost than other modalities. Use in these two patients has demonstrated long-term biomechanical stability and long-term infection control. The idea of a readily available, custom built biomechanical device that offers immediate stability with local delivery of antibiotics provides an appealing surgical option in the setting of DVO. Equally appealing is the potential cost savings that could be appreciated compared to the use of allograft cage implants.

REFERENCES