Use of Permanently Placed Metal Expandable Cages for Vertebral Body Reconstruction in the Surgical Treatment of Spondylodiscitis

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abstract

This is a retrospective study of 15 patients treated for spondylodiscitis with implanted metal cages. The purpose of this study is to investigate the outcomes of patients treated with permanently placed metal hardware in vertebral body reconstruction for spondylodiscitis. The use of metal implants in the face of infection has classically been discouraged in orthopedic literature because of the ability of bacteria to form biofilms on metal surfaces. Traditional treatment of spondylodiscitis has been aggressive debridement followed by reconstruction with bone grafts. Expandable metallic cages made reconstruction of these defects significantly easier. However, concern exists that metallic implants affect the resolution of infection. A search of the authors’ patient database from 2005 to 2009 revealed 21 patients with spondylodiscitis treated with anterior debridement and reconstruction with an expandable metallic cage. Fourteen patients (15 cases) had sufficient documented clinical follow-up and were available for review. Resolution of infection was determined by evaluating symptoms, laboratory data, and final radiographic result. Of the 15 cases, all had clinical resolution of infection with an average follow-up time of 25 months. An average loss of 1.9° of correction was observed when comparing final follow-up radiographs with initial postoperative radiographs. Radiograph review revealed no extensive osteolysis around the hardware or progressive collapse. These results suggest that the use of expandable metal cages maintains alignment while not perpetuating infection. The spine appears to provide a unique environment that permits the use of metal implants in the setting of infection.
Spondylo­dis­ci­sis is most commonly treated nonope­ra­tive­ly with the use of long-term antibi­otics.1–8 Surgical indica­tions are limited to failure of med­i­cal man­age­ment, neurol­o­gi­cal com­promise, spinal insta­bil­i­ty, an epis­te­ma­sis, or intract­able pain.9–14 Much controversy exists regard­ing sur­gi­cal treat­ing with instru­men­ta­tion because the use of metal im­plants in the set­ting of infec­tion has been clas­sically dis­cour­aged in orthope­dic liter­a­ture due to the ability of bacteria to adhere to metal sur­faces and form biofilms that are impen­etra­ble to antibi­otics and host im­mu­ne responses.15 This limited the early sur­gi­cal man­age­ment of spon­dy­lo­dis­ci­sis. In 1956, Hodgson and Stock16 were the first to pioneer the sur­gi­cal treat­ing of spon­dy­lo­dis­ci­sis, specif­i­cally Pott’s dis­ease, describ­ing aggres­sive debride­ment and recon­struc­tion with autograft and no instru­men­ta­tion. How­ever, although this tech­nique was effective, it was diffi­cult to recon­struct large defects in the anterior col­umn. This led to the accep­tance of al­lograft in the treat­ing algo­rithm.

Al­though al­lograft had the ability to span large defects, the sta­bil­ity it offered to the con­struct was ques­tion­able. This treat­ing required the patient be ei­ther on bed rest or in a brace for long peri­ods of time. Treat­ing then trended toward cir­cumferen­tial proce­dures with pos­te­ri­or instru­men­ta­tion and fusi­on be­cause the pos­te­ri­or instru­men­ta­tion was not in con­tact with the in­fected anterior field. In some cases, in­vesti­igators pro­posed do­ing the an­terior and pos­te­ri­or proce­dures as part of a sin­gle stage, whereas oth­ers elec­t­ed to de­lay the pos­te­ri­or por­tion to allow for a peri­od of rest and antibi­otics.17,21

With the ad­vent of ex­pan­dable metal cages, recon­struc­tion of these de­fects has be­come sig­nifi­cantly easier. The con­tro­ver­sy regard­ing plac­ing metal di­rectly into an in­fected set­ting is still rele­vant. Some re­trospec­tive data sug­gest that this strat­egy in spine sur­gery is safe.9,13 How­ever, to the au­thors’ knowl­edge, no North Amer­i­can cen­ter has pub­lished a case se­ries purely regard­ing the use of ti­taniu­m mesh cages in the sur­gi­cal man­age­ment of spon­dy­lo­dis­ci­sis.

Materials and Methods
After gain­ing ap­proval from their in­stitu­tional re­view board, the au­thors con­duct­ed a search with­in their sur­gi­cal da­tabase for all pa­tients charged with CPT code 22851 from 2005 to 2010. This code is de­fined as the ap­pli­ca­tion of inte­rver­tebral biomech­ani­cal de­vice (eg, syn­thet­ic cage, thread­ed bone dowel, methyl­meth­acr­yl­ate) to vertebral de­fect or in­ter­space. This search re­vealed 300 pa­tients. Op­er­ative re­ports for each pa­tient were then sur­veyed and only those pa­tients who had a metal in­ter­ver­tebral cage placed in the set­ting of spon­dy­lo­dis­ci­sis were in­cluded, yield­ing 21 pa­tients. The search was then fur­ther nar­rowed to those pa­tients with at least 6 mon­ths of cli­ni­cal fol­low­up, yield­ing 14 pa­tients. One of these 14 pa­tients under­went 2 proce­dures for 2 sepa­rate cases of osteo­myel­i­tis 2 years apart, with sig­ns of res­olu­tion of the first in­fected site fol­low­ing sur­gery prior to the onset of the sec­ond in­fected. The pa­tient was in­cluded as 2 cases. Of these 15 cases, the fol­low­ing data were docu­ment­ed: age at sur­gery, level(s) of spon­dy­lo­dis­ci­sis in­volvement, cul­ture re­sults, and type of sur­gery (anterior stand­alone or cir­cumferen­tial). Radi­og­ra­phic loss of cor­rec­tion was also evalu­ated using post­op­er­ative and fol­low-up films, and these data were avail­able for 14 the 15 cases. Res­olu­tion of in­fected sur­gery was also docu­ment­ed by re­view­ing fol­low-up clin­i­cal notes regard­ing symp­tom re­solu­tion, nor­mal­i­za­tion of lab­o­ra­tory data (ie, eryth­ro­cyte sed­i­men­ta­tion rate and C-re­ac­tive pro­tein; these were only avail­able for some pa­tients), and anal­yzing final radi­og­ra­phic re­sults.

Sur­gi­cal proto­col for cage in­ser­tion af­ter debride­ment is as fol­lows. The height re­stor­a­tion need­ed for the in­volved verte­bral bod­ies based on the av­er­age of the nor­mal vertebral bod­ies above and below the osteo­myel­i­tic bod­ies was tem­plat­ed. A vari­ety of cages were avail­able in­traop­er­a­tive­ly above and below the tem­plat­ed size. A lam­inos­pre­ader was placed in the de­fect and ex­panded un­til ade­quate ten­sion was ob­tained and the size of the cage was ad­justed accord­ing­ly. Cages were cho­sen that could be in­serted with re­lative ease but could be ex­panded to at least the height ob­tained with the lam­inos­pre­ader. The cages were then ex­panded un­der fluoro­scopy until a fair am­OUNT of ten­sion was ob­tained on the cage to pre­vent extru­sion. Care was taken not to overex­pand the cage and cause splaying of the pos­te­ri­or fac­ets on fluoro­scopy. Pos­te­ri­or hard­ware con­sisted of a stan­dard pedi­cle screw and rod con­struct.

All pa­tients were man­aged med­i­cally accord­ing to the cur­rent guid­elines for the treat­ing of osteo­myel­i­tis in ad­di­tion to their sur­gi­cal treat­ing. This treat­ing was di­rected by the in­fec­tious dis­ease con­sult­ing ser­vice, which was in­volved in each of the cases pre­sented in this study. Treat­ing in­cluded peri­op­er­ative use of broad spec­trum paren­teral antibi­otics, which was nar­rowed to bacte­ria-spe­cific paren­teral antibi­otics after cul­ture re­sults were avail­able. Pa­tients con­tin­ued tak­ing paren­teral antibi­otics for a total of 6 weeks. Pa­tients were pre­scribed oral antibi­otic sup­pres­sive ther­apy for sev­eral mon­ths. Pa­tients in­fected with meth­i­cillin-resis­tant Staphylococcus au­reus (MRSA) in par­tic­ular were treated un­der care of the In­fec­tious Dis­ease ser­vice with in­tra­venous van­comycin and oral rif­amp­in for 6 weeks and then con­verted to oral bac­tri­um or cli­ndami­cin for a vari­able dura­tion of time de­pend­ing on symp­toms. Syn­ex ex­pan­dable cages (Johnson and John­son, Ray­ham, Mas­sa­chu­setts) were used in all cases.

Results
Of the 15 cases with docu­ment­ed cli­nic­al fol­low-up, all cases had docu­ment­ed
Evidence of clinical resolution of infection. Average follow-up time was 25 months (SD, 22 months; range, 6-84 months). Only 1 patient required additional surgery for infection, but the recurrence of infection was not at the original operative site but rather at another vertebral level 2 years after resolution of the original infection. Of these patients, 87% had a positive culture result. The most common pathogens were methicillin-sensitive *Staphylococcus aureus* (MSSA) (40%) and MRSA (27%). Interestingly, 1 case of tuberculosis was also observed.

Table 1 provides all culture results, including the medical comorbidities for each patient in the study. Table 2 shows the initial and follow-up C-reactive protein and erythrocyte sedimentation rate for several patients.

**Abbreviations:** CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; DM, diabetes mellitus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; MRSA, methicillin-resistant *Staphylococcus aureus*; MS, multiple sclerosis; MSSA, methicillin-sensitive *Staphylococcus aureus*; PTE, pulmonary thromboembolism.
For those without these laboratory data available, resolution of infection was determined by radiographic data and symptom resolution. One complication was observed in the cohort population. A patient who was paraplegic required revision of his posterior instrumentation due to Charcot changes and posterior hardware failure. Figure 1 shows sample pre- and postoperative radiographs of a patient who required only an anterior cage. Figure 2 shows the pre- and postoperative radiographs of a patient who required an anterior cage and posterior instrumentation and fusion.

**DISCUSSION**

In 1979, Fountain\(^7\) reported on instrumentation with spinal infection, describing a case of spondylodiscitis treated with anterior debridement followed by posterior Harrington rod placement and fusion with a satisfactory result. In the years following, posterior instrumentation with hooks, rods, and screws following anterior debridement and reconstruction with autograft was reported by several investigators.\(^11,22-27\) The first case reports in which anterior instrumentation was placed in the setting of infection were presented in 1983 by Kostuik.\(^28\) He described 2 patients with spondylodiscitis managed with anterior debridement, autograft, and Dwyer-Hall or Harrington instrumentation with no recurrent infection.\(^28\) In 1997, Dietze et al\(^9\) reported the next case series in which anterior instrumentation was placed in the setting of infection. Following aggressive debridement and arthrodesis, they placed Caspar vertebral body plates in 4 cases of cervical spondylodiscitis. They also reported no recurrent spinal infections during the follow-up period.\(^9\) In 1999, Rezai et al\(^13\) reported 57 patients treated similarly for spondylodiscitis, 20 of whom had anterior hardware placed. Only 1 cervical case had a recurrent deep infection, which underwent a repeat irrigation and debridement and eventually went on to fuse without infection.\(^13\) Ultimately, many others have reported the aforementioned ability to place hardware in the setting of spinal infection with little to no ill consequence.\(^12,21,29,30\)

Metallic vertebral body replacement cages have recently gained prominence because they offered a method of cylindrical containment of the bone graft along with providing structural integrity. Expandable cages are particularly useful because they can be resized according to varying defects. Much of the literature regarding their use in the treatment of spondylodiscitis has come from European and Asian centers. In 2002, Hee et al\(^11\) reported a case series of 20 patients treated for spondylodiscitis in which 5 received anterior titanium mesh cages packed with autograft. All patients also received posterior instrumentation and were placed in rigid external orthosis. They noted that the patients who received cages spent less time in the hospital and had lower complication rates.\(^31\) In 2003, Liljenqvist et al\(^32\) followed this up, treating 20 patients with spondylodiscitis by anterior debridement, anterior expandable titanium cage placement with autograft, and posterior instrumentation. He reported no recurrent deep wound infections.\(^32\) Since that time, others have reported similar case series with satisfactory results.\(^33-39\)

The current data demonstrate the safety of titanium interbody expandable cages in the treatment of spondylodiscitis. No local recurrences and no major complications requiring reoperation, aside from the patient who was paraplegic and had Charcot changes, were observed. A small loss of correction was noted due to subsidence of the cage within the adjacent endplates. However, this amount of subsidence was not associated with any instability or increased morbidity. In fact, the subsidence of even standalone cages was minimal. In patients with longer follow-up, the subsidence tended to stabilize after a period of time, which likely coincided with fusion.

Perhaps the most interesting cases in this study are detailed below. The patient who developed Charcot spine had longstanding T5 paraplegia secondary to a gunshot wound 10 years prior to surgery, along with a history of a right transibial

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**Table 2**

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<th>Patient No.</th>
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Abbreviations: CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; NA, not available.
amputation secondary to diabetic sequelae. The patient was admitted with fever, nausea, vomiting, and swelling of his right lumbar back and underwent a staged anterior debridement of L4-L5 disk space and metallic cage placement and posterior spinal instrumentation and fusion L1 to pelvis. He was evaluated in the clinic 1 month postoperatively, at which time radiographic evidence of posterior hardware failure was observed. The patient’s debility and lack of stabilizing musculature may have led to excessive instability for the implanted hardware. The patient received a revision of the posterior instrumentation 2 months following the initial procedure. The failed hardware was removed, and TSRH instrumentation (Medtronic, Minneapolis, Minnesota) along with sublaminar polyethylene tapes that were tensioned and attached to the rods and crosslinks were used to achieve satisfactory stabilization. His postoperative course was uncomplicated, and his fusion has progressed satisfactorily.

The second interesting case was a recent immigrant from the Philippines who presented with a several-month history of progressive back pain and bilateral lower extremity weakness. Imaging suggested infection of L4-L5 intervertebral disk extending into the adjacent vertebral bodies suspicious for tuberculosis. The patient underwent anterior L4 and L5 corpectomies and placement of an expandable cage and posterior instrumentation and fusion L3 to pelvis. The patient was empirically treated with linezolid, rifampin, ethambutol, and pyrazinamide, which was followed by infectious disease specialists in the clinic. Her lower extremity weakness improved postoperatively, and no recurrence of infection was observed.

As mentioned earlier, 1 patient developed a second case of spondylodiscitis (L3-L4) following surgical treatment and seeming resolution of the infection at the initial site (T6-T7). This patient’s initial resolution was suggested symptomatically and radiologically. Two years later, the patient began to have back pain at a new site with increased inflammatory markers, and imaging suggested a new infection site. Methicillin-sensitive S. aureus was cultured from the surgical site in both instances. It is unlikely that direct spread occurred from one site to the other because L3-L4 was not exposed during the first operation and no evidence was found of continued local infection of the first site following debridement and antibiotic treatment. This patient likely remained colonized by MSSA somewhere else in his body, which hematologically seeded the spine later. After the second surgery, the patient’s treatment was guided by the infectious disease specialists, and he has had no further signs of persistent infection at this time.

The current study has the typical limitations of a retrospective study regarding documentation of follow-up data and patient-reported functional outcomes. As is also typical, incomplete preoperative data were available on smoking status and other premorbid conditions. In addition, of the 21 patients meeting the initial investigation criteria, only 14 patients
(15 cases) had sufficient clinical follow-up to be included in the study. In addition to limiting the power of the study, it could also affect the results because future complications experienced by these individuals could not be taken into consideration in the study. For example, recurrence, the need for reoperation, failure of the procedure, massive subsidence, or loss of stability could have occurred in as many as 29% of the total population but would be unaccounted for due to loss of follow-up. Because of these limitations, prospective studies would be useful in the future. Despite the aforementioned limitations, the authors were able to show that the infections cleared with no recurrences in an average follow-up time of 25 months, which suggests safety and efficacy of this approach. Although the current data are supportive of previous studies, it is novel because it is the first North American study to report on this treatment strategy.

**Conclusion**

The surgical management of spondylodiscitis has evolved from no instrumentation to posterior instrumentation alone and now to circumferential instrumentation with or without cages and allograft per surgeon preference. The abundant osteolysis resulting in instability within the anterior, and sometimes middle, column has been the driving force behind this evolution. Retrospective studies continue to show that adding instrumentation to the construct can be done with little risk of recurrent deep infection.

The current data serve to not only support this general concept, but also bolster the previous European and Asian literature regarding the use of titanium mesh cages. It is the authors’ observation that this type of instrumentation can be safely added to the growing list of options needed to help reconstruction for this condition. The authors use instability as the primary criteria for use of this instrumentation approach and apply it only following aggressive irrigation and debridement of all infected and necrotic debris. Concurrent medical management in conjunction with infectious disease specialist is also vital in the treatment of these patients. Prospective evaluation could better define safety, efficacy, and patient-reported outcomes and
compare this method of stabilization to others.

References