Use of Expandable Cages in Metastasis to the Spine

Shiveindra Jeyamohan, BS[1], Alexander Vaccaro, MD, PhD[2], James S Harrop, MD[3]
[1]Jefferson Medical College, Thomas Jefferson University, Philadelphia, PA
[2]Rothman Institute, Philadelphia, PA
[3]Department of Neurological Surgery, Thomas Jefferson University, Philadelphia, PA

Abstract

Introduction: Expandable cages have been utilized as an option for immediate spinal stabilization after vertebrectomy. However, long-term follow-up in the oncology population has not been studied, and results remain unclear. This single-institution series of patients represents our success in utilizing expandable cages.

Methods: A retrospective chart review for patients with spinal metastasis treated with expandable cages between 2001 and 2006 was performed with IRB approval. Data regarding date of anterior and posterior surgery, immediate postoperative neurological status versus preoperative status, revision, equipment status, pseudoarthrosis, time to ambulation, and mortality were gathered and analyzed.

Results: Twenty-four patients with metastatic cancer to the spine were studied. Cages were placed from T5-L5, 21 of which were single level. Of the 24 patients, 5 (21%) were neurologically intact pre-operatively and postoperatively. 13 of the 24 (54%) improved postoperatively. The remaining six (25%) illustrated no change in neurologic status. No patients deteriorated. At two years' follow-up, overall patient survival was 79%. Average time to ambulation for patients followed was 11.5 days. No revisions were done for hardware failure, while one revision was performed for tumor progression.

Conclusions: Expandable cages appear to be a valid treatment option for the immediate stabilization of the spine following corpectomy from spinal metastasis. Results indicate that fast recovery, reasonable long-term mortality, and immediate stabilization are achievable with this modality. Consequently, expandable cages should be considered as a valid option in the treatment for stabilization following corpectomy in metastasis to the spine.

Introduction

The spinal column is a frequent site of metastatic disease, particularly from lung, prostate, breast, kidney as the primary sources, whereas primary spinal column tumors comprise a minority of spinal pathology (<2%) [4]. Although patients may present in a variety of conditions, pathologic fractures or increased axial spinal pain are frequent issues. Surgical treatment for this disease includes decompression of the neural elements, alleviation of painful symptoms, resolution of mechanical instabilization, and resection of the oncologic burden[2]. Surgical treatment options for patients with progressive neurologic deterioration include anterior, posterior or combined decompression with subsequent spinal reconstructions.

Expandable cages have recently been utilized as a treatment option for spinal reconstruction after vertebrectomy, particularly in the trauma population[1]. With increased familiarity of these devices, cages are now being utilized after corpectomy from tumor metastasis, but data regarding this treatment option is lacking[2-3]. Vertebral body replacement with expandable cages may provide several potential theoretical advantages such as permitting optimal anatomic placement in addition to concurrent correction of spinal deformity. This manuscript consists of a retrospective review of clinical data from expandable cages after corpectomy in spinal metastatic disease. The hypothesis was these devices would be well tolerated and thus a treatment option in this difficult patient population.

Clinical Materials and Methods

Between June 2001 and November 2006, twenty-four consecutive patients were retrospectively identified through a chart review that underwent expandable cage reconstruction for metastatic disease with pathologic fractures. Patient research protocol was approved through an institutional IRB. Inclusion criteria included: age greater than 18 years of age, corpectomy between T4 and L5, pathology confirmed metastatic disease. Data points included in the analysis were: age, level of metastasis, primary tumor histology, functional outcome, time to ambulation, need for re-operation, and other perioperative complications. Neurologic examination was performed utilizing the ASIA grading system with motor graded on a six-point scale (0-5) and sensation on a three-point scale (0,1,2) for both pin-prick and touch sensation. Postoperative imaging was taken in all cases to evaluate structural stabilization and

Figure 1
A pediatric Expandable cage sample
(courtesy Medtronic, used with permission)

Figure 2
MRI implanted cage

ensure relief of cord compression if present preoperatively. Additionally, all patients were followed up for minimally two years, and data regarding re-operation, morbidity from surgery, and mortality were gathered.

Results

Mortality, demographics and level of surgery are summarized in Table 1. All reconstructions were performed between T5-L5. Data was further broken down into level of surgery and resultant mortality (Table 1). Twenty-one patients had single level decompressions, whereas three were multi-level reconstructions. Neurologic examination was recorded as intact pre- and post-operatively in five patients (21%), whereas thirteen (54%) improved postoperatively, and six (25%) exhibited no change. No patients deteriorated postoperatively as a result of surgical intervention. Average time to ambulation for followed, pre-operatively ambulatory patients was 11.5 days (range 3-25 days). No revisions were done due to hardware failure; one case, however, required re-operation secondary to tumor progression**.** No clinically significant correlations were determined, however several trends were observed.

Interestingly, five of the patients who expired had metastasis to the thoracic area, whereas none of the lumbar metastatic patients expired at two years. Of the thoracic metastatic lesions resulting in death, primary tumors included one renal, two lung, one breast, and one squamous carcinoma of the neck. Lumbar metastatic lesions included one renal, one chordoma, one adrenal, and one melanoma. Additionally, in four of the five patients, mortality occurred by two months post-operatively, with the fifth at eight months. The remaining surviving patients were all alive at two year follow-up. Females tended to have metastasis to the thoracic vertebrae (12/13), whereas metastasis for males had less predilection (7/11). This was of borderline significance (p=0.08). Lastly, whereas conventional wisdom dictates that older patients would expire at rates greater than their younger counterparts, this series fails to elicit such an association; deceased patients were, on average, only 3.4 years older at surgery than surviving patients, and this was not statistically significant (95% CI = -13.7 to 20.5 years).

Table 1. Mortality, Surgical and Demographic Data

Mortality	N	Average age at surgery ± standard deviation	Gender	Level of Surgery
Living	19	61.8 ± 15.5	9 M, 10 F	14 T, 5 L
Deceased	5	65.2 ± 14.0	2 M, 3 F	5 T

Discussion

There is limited literature on the use of expandable cage for spinal disorders. Further, studies detailing their application in spinal reconstruction after corpectomy secondary to tumor metastasis are even more lacking.

Schmeider *et al.* analyzed cervical expandable cages in augmentation of anterior cervical decompression and fusion, and found that the Wing Cage illustrated comparative stability to historical controls after two years of follow-up despite some subsidence into the adjacent vertebra. Cervical constructs, however, are not comparable to thoracic and lumbar spine biomechanics due to greater loads and forces[5].

Uchida *et al.* reported with the utilization of vertebral body replacement in the osteoporotic population at the thoracolumbar spine. The conclusions of their study was that expandable cages are useful in replacement devices for compressed and fractured vertebral bodies, particularly for reconstruction of vertebral bodies without significant loss of vertebral height.[6] Fortunately in this series, there was limited vertebral body height loss, structural deformity and angulation despite pathologic fractures. Pflugmacher *et al.* further describe advantages of expandable cages in the thoracolumbar spine. Since the cages are able to expand *in vivo*, there is excellent opposition of the contact with the opposing vertebral endplates and optimal fit at the fusion site. This affords improved transfer of loads, which theoretically decreases instrument failure rates associated with subsidence and pull-out. Studies have also illustrated that the constructs can be further strengthened by the additional bone graft augmentation.[7]

This series is currently the largest collection of vertebral body replacement usage after corpectomy in patients with tumor metastasis to the spine. Expandable cage use after corpectomy appears a valid treatment option for immediate stabilization in the neoplasm population. Hardware failure and spinal column destabilization were not present in our series of twenty-five patients, which supports the results published by Thongtrangan, *et al.*[2] This indicates that a combined anterior corpectomy with cage with posterior fusion provides adequate structural support for the compromised spine, while allowing for sufficient relief of cord compression. These results also support the twenty-one patient series published by Shen *et al.*[3]

Shen's series evaluated twenty-one patients who underwent anterior and posterior resection and reconstruction from a single posterior extracavitary approach. They found an average age of 60 years old, but found an average 6.8 month survival in expiring patients, which mirrors our results. They found that in vivo expansion of the cage allows for reconstruction without sacrificing any spinal nerves[3].

Thongtrangan *et al.* reported in his series of 15 patients reported decreased pain and an average kyphotic angle correction of 20 degrees. They also found that a Frankel grade lower than D was improved by at least one full grade. Finally, they found that all patients achieved immediate stability postoperatively with no significant complications, similar to our series[2].

Surgical experience with expandable cages after corpectomy in the spinal metastasis population has illustrated several advantages over traditional graft and fusion techniques. This equipment proved improved application and opposition into the destabilized spinal column with potentially fewer complications and decreased operative times. Additionally, these constructs provide instantaneous stability to the spine upon application of the device. Since they are expanded *in vivo*, we also find that this aids in protecting nerve roots from impingement or disruption.

These procedures are palliative in nature, providing for relief of compression, pain, or correcting immediate instability, which the expandable cages provide. In the traditional graft and fusion technique, an immediate fusion cannot be achieved; rather, the natural healing process must be allowed to transpire before a full, stable fusion can occur. With cage placement and fusion, the construct appears to provide a greater degree of stability thus providing the arthrodesis to mature in this radiated unfavorable environment.

This provides adequate strength of the spinal column to allow for prompter rehabilitation and resumption of normal activity, without waiting for months in a compromised state awaiting adequate fusion. Overall, this study is limited in the small size and the heterogeneity of the population. Larger trials may need to be repeated in the future to obtain significance in terms of survival in short vs. long term and mortality of lumbar vs. thoracic tumor metastasis.

Conclusion

All such pathologic fractures from metastatic disease treated with expandable cages achieved instantaneous stability and none experienced hardware failure. Although some required re-operation related to tumor progression, no equipment issues/peri-operative/post-operative complications necessitated further surgical intervention. Cage use in tumor metastasis provides ample stabilization and relief of cord compression and proved easier to install in our experience. Furthermore, since the construct expands into the joint space itself, we feel it provides a superior correction of deformity compared to traditional allograft, screws/rod, or plated fixation. Several trials have also indicated that such equipment is structurally stable according to biomechanical analytical studies. Thus, expandable cages are a valid treatment option in such high-risk patients.

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