Relevance of expandable titanium cage for the treatment of cervical spondylotic myelopathy

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Abstract

Background In patients with cervical spondylotic myelopathy, ventral disease and loss of physiological cervical lordosis are indications for anterior approach. As bone graft and titanium cage present many drawbacks, expandable titanium cage has been recently introduced for this indication. The authors present the clinical and radiological outcomes in patients undergoing the placement of an expandable cage in the treatment of spondylotic myelopathy with straight or kyphotic cervical spine alignment.

Methods This was a retrospective review of prospectively collected data. A total of 26 patients underwent cervical corpectomy and reconstruction using an expandable titanium cage and anterior plate between 2005 and 2008. Pain and functional disability were measured using VAS and mJOA preoperatively and at 3 months, 6 months, 1 year and 2 years. Kyphosis was measured using lateral radiographs at the same points of follow-up. Fusion was evaluated on flexion–extension radiographs at 2 years.

Results The mean VAS improved from 4.2 to 1.7 and the mean mJOA increased from 12.85 to 16.04 at 2 years postoperatively ($p < 0.05$). The mean kyphosis angle decreased from 17° to 2° at the last follow-up ($p < 0.05$). The fusion rate was 100 % at 2 years. Three complications were reported including a transient dysphagia, an epidural hematoma and an early hardware migration.

Conclusion Expandable titanium cage is an effective device, which achieves good clinical and radiological outcomes at a minimum 2-year follow-up.

Keywords Spondylotic myelopathy · Kyphosis · Expandable cage · Cervical spine

Introduction

Cervical spondylotic myelopathy is a frequent and treatable cause of cervical myelopathy [1]. Although surgery is generally indicated for patients with severe motor deficits or significant functional disturbance, there is no agreement as to the best approach and reconstruction technique especially for multilevel spondylotic myelopathy. Anterior approach is generally preferred for patients with kyphotic alignment, because the correction of spinal alignment cannot be expected with laminectomy and laminoplasty [2]. After performing decompression, an autogenous tricortical bone graft such as iliac crest or fibula is used to reconstruct the anterior column. This well-known technique can produce a number of complications related to the donor site such as pain, blood loss, hematoma and infection. Moreover, the low compression stiffness of the graft [3] can result in its collapse with late kyphotic deformation of the cervical spine. Cervical titanium cages, first introduced for the treatment of cervical spine tumors [4], were progressively used for degenerative diseases in attempts to reduce the morbidity and complications linked to the autogenous graft [5]. However, their use is technically demanding, especially to adjust the size of the cage to the defect without compromising the endplate integrity. Expandable titanium cages were later developed to facilitate the implantation of the device and to enhance its

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Table 1 Summary of the main demographic data

Variable	Value
Age (range)	60 (38–81)
Sex	
Male (%)	14 (54)
Female (%)	12 (46)
Cervical spine alignment	
Straight (%)	10 (38)
Kyphotic (%)	16 (62)
Number of corpectomy levels (%)	
1	15 (57)
2	8 (31)
3	3 (12)

contact with the endplates. Moreover, it allows a slight distraction during the procedure to reduce a kyphotic deformation [6]. Although expandable titanium cage is increasingly popular, its efficiency is yet to be established. The purpose of this study is to report the clinical and radiological outcomes of 26 patients undergoing cervical corpectomy and reconstruction using expandable titanium cage with 2 years of follow-up.

Methods

Demographic data

We retrospectively reviewed a series of 26 patients in whom an expandable titanium cage was used in the treatment of cervical spondylotic myelopathy at the Lille University Hospital, France, between 2005 and 2008 (Table 1). The study included 14 men and 12 women ranging in age from 38 to 81 years (mean 60 years). All these patients presented a significant disability, and magnetic resonance imaging (MRI) confirmed the diagnosis of spondylotic myelopathy, associated with a straight or kyphotic cervical spine alignment. We excluded all patients who had no significant disability. We also excluded those who had no cervical spine misalignment or had a history of previous cervical spine surgery. In this series, preoperative electrophysiological studies were not performed systematically, and the results did not influence our therapeutic strategy.

Surgical technique

All the procedures were performed using a left-sided approach. An interbody pin distractor system was always used prior to performing the discectomies above and below the affected site. Using Kerrison and Leksell rongeurs to obtain sufficient resected bone graft, the corpectomy was performed. A high-speed drill was sometimes used. The

Table 2 Japanese Orthopaedic Association Score (modified)

Motor dysfunction of the upper extremities
0 Inability to move hands
1 Inability to eat with a spoon, but able to move hands
2 Inability to button shirt, but able to eat with a spoon
3 Able to button shirt with great difficulty
4 Able to button shirt with slight difficulty
5 No dysfunction
Motor dysfunction of the lower extremities
0 Complete loss of motor and sensory function
1 Sensory preservation without ability to move legs
2 Able to move legs, but unable to walk
3 Able to walk on flat floor with a walking aid
4 Able to walk up and/or down stairs with handrail
5 Able to walk up and/or down stairs without handrail
6 Mild lack of stability, but walks unaided with smooth reciprocation
7 No dysfunction
Sensation
0 Complete loss of hand sensation
1 Severe sensory loss or pain
2 Mild sensory loss
3 No sensory loss
Sphincter dysfunction score
0 Inability to micturate voluntarily
1 Marked difficulty with micturition
2 Mild to moderate difficulty with micturition
3 Normal micturition

posterior longitudinal ligament was always removed and the dura mater was widely exposed. The expandable titanium cage (Tecorp®, Scient'x, France) was inserted into the corpectomy site and opened with a slight distraction to reduce the deformity, aided by the pin distractor system. This procedure was realized under fluoroscopic control. The angled end piece was adjusted to the morphology and the angulation of the adjacent endplate. The cage was filled with the resected bone graft harvested from the corpectomy. The cages were all supplemented with anterior plate constructs. None of these patients required posterior decompression or instrumentation. Closed-suction drains were used for 48 h in all patients. They were fitted for a soft cervical collar for 6 weeks.

Outcome assessment

Operative time, blood loss, length of hospital stay and surgery-related complications were noted. Pain and functional disability were quantitatively measured using VAS and the mJOA (modified Japanese Orthopaedic Association Scale) [7] (Table 2). Both VAS and mJOA were measured

Fig. 1 Preoperative MRI of a 62-year-old patient with progressive spondylotic myelopathy (a). A two-level corpectomy and reconstruction of the anterior column was performed using an expandable cage

with a plate (b). The cervical balance was improved from 8° of kyphosis preoperatively to 4° of lordosis postoperatively

preoperatively and acquired during follow-up at 3 months, 6 months, 1 year and 2 years. Anteroposterior and lateral radiographs were performed preoperatively, at 48 h, 3 months, 6 months, 1 year and 2 years. The cervical angulation was defined by the angle created by the normal inferior endplates of C2 and C7 (Fig. 1). Arthrodesis was defined as the absence of motion between the spinous processes on flexion–extension radiographs at 2 years. This criterion was used by many other studies [e.g., 8] because trabeculation and bridging between the adjacent segments through the titanium cage cannot be assessed correctly in all patients. For statistical data analysis, the “paired samples *t* test” was used for normally distributed data. A *p* value <0.05 was considered to be statistically significant. The analyses were performed using SPSS statistical software, version 17 (SPSS Inc.)

Results

The mean follow-up was 30 months (range 24–48 months) and all patients were observed for at least 2 years. No patient was lost to follow-up.

Operative data

Fifteen patients underwent one-level corpectomy, eight patients underwent two-level corpectomy and only three underwent three-level corpectomy (Table 1).

The mean operative time was 125 min (range 80–250 min). The mean estimated blood loss was 280 ml (range 100–950 ml) and no patient required blood transfusion. The mean length of hospital stay was 4.2 days (range 3–9). No complication was reported during the procedure and the hospital stay.

Clinical outcome

The mean VAS was 4.2 (range 0–10) before surgery and decreased to 1.7 (range 0–7) at a 2-year follow-up (Table 3). The difference was statistically significant (*p* < 0.001) compared with the preoperative score (Fig. 1). Only one patient presented with transient worsening of his pain due to hardware migration. The mean JOA score was 12.85 (range 8–17) preoperatively and increased to 16.04 (range 10–19) at 2 years postoperatively. The difference was also statistically significant (*p* < 0.001). One patient,

Table 3 Development of the VAS, mJOA and kyphosis angle

	Preop	3 months	6 months	1 year	2 years
VAS (range)	4.2 (0–10)	2.1 (0–10)	1.7 (0–7)	1.8 (0–7)	1.7 (0–7)
mJOA (range)	12.85 (8–17)	15.1 (10–18)	15.7 (10–18)	16.04 (10–19)	16.04 (10–19)
Kyphosis (deg., range)	17.0 (–2 to 30)	1.4 (–8 to 10)	1.9 (–8 to 10)	1.8 (–6 to 11)	2.0 (–6 to 11)

who presented an epidural hematoma 10 days postoperatively, had worsened condition.

Radiological outcome

Using flexion–extension radiographs at 2 years, a successful fusion was achieved in 26 patients (100 %). The mean kyphosis angle was 17° preoperatively and decreased to 2° postoperatively ($p < 0.001$). The kyphosis reduction was stable during the follow-up (Table 3). The instrumentation improved the deformity in all patients with preoperative kyphotic cervical alignment (Fig. 1).

Complications

One patient experienced postoperative dysphagia, which resolved completely within 6 weeks. One patient presented with a progressive weakness of the upper limbs 1 week after discharge from the hospital. MRI revealed an epidural hematoma and he underwent reoperation for its removal. One month after the initial operation (C5 corpectomy), a patient presented with sudden neck pain (VAS increased from 2 to 7) and weakness of the right upper limb (mJOA decreased from 17 to 15). The radiographs and the CT scan confirmed the hardware migration and the fracture of the vertebra below (the kyphosis angle increased from 0° to 20°). He underwent a C6 corpectomy and reconstruction with an expandable titanium cage and an anterior plate (VAS decreased from 7 to 4 and kyphosis angle from 20° to 4°). He was also fitted for a rigid cervical collar for 6 months. The arthrodesis was obtained and the kyphosis angle remained stable during follow-up (4° at 2 years). Unfortunately, he continued to complain of a weakness of his right arm (mJOA 16 at 2 years). We reported no case of recurrent laryngeal nerve palsy, wound infection, host rejection of instrumentation or recurrent disease.

Discussion

First introduced by Cloward [9] in 1958, surgical treatment for cervical spondylotic myelopathy using the anterior approach has evolved from single-level discectomies and fusion to multilevel corpectomies. Expandable titanium cages represent a new advance, allowing an easier

Fig. 2 Postoperative MRI 2 years after a two-level corpectomy, depicting a wide decompression of the spinal cord

placement and avoiding the morbidity associated with the graft donor site.

This is to the author's knowledge, the largest series of patient undergoing the placement of an expandable titanium cage for the treatment of cervical spondylotic myelopathy with straight or kyphotic alignments.

Technical advantage

Thanks to their adjustable height mechanism, these cages are more easily inserted within the corpectomy channel. As the cage is expanded after its placement, it causes less trauma to endplates. Moreover, it eliminates the need to cut the cage and to dangerously impact it over the spinal cord.

The kyphosis is progressively corrected with the expansion of the device. However, certain precautions must be observed. First, the decompression must be complete before starting any distraction to avoid extra strain on the spinal cord (Fig. 2). Furthermore, the distraction should be gentle, because an overdistracted could alter the anatomical integrity of the endplates and compromise the stability of the cage. It also presents a neurological risk; therefore, a neuro-monitoring could be used for more safety, especially when an important reduction is considered. Recently, there has been an increase in the commercial availability of expandable cages, and we recommend those with shaped [10] and adjustable endplates to create an optimal fit. Moreover, it is likely to reduce significantly the operative time.

Clinical improvement

There is no consensus regarding the ideal treatment of cervical spondylotic myelopathy [11, 12]. In a recent nonrandomized prospective study, Ghogawala et al. [13] reported no difference in terms of functional recovery between patients who underwent anterior or posterior approach. The postoperative mJOA scores in both groups were nearly two points better compared with the preoperative mJOA scores (from 11.60 to 13.54 in the posterior group and from 13.40 to 15.44 in the anterior group). As stated by Bapat et al. [14] “physicians who use both the anterior and posterior approach in management of CSM are capable of providing optimal care because each patient’s case must be individualized”. Usually, anterior approach is preferred in patients with kyphotic deformity. The neurological condition of our patients was also significantly improved postoperatively, which is in accordance with the relevant literature [15, 16]. Lin et al. [17] recently published a retrospective series of 120 patients who underwent ventral decompression for the treatment of symptomatic spondylotic myelopathy. The mJOA was significantly improved from 9.25 preoperatively to 13.86 at 2 years postoperatively. Our results suggest that patients with spondylotic myelopathy associated with a straight or kyphotic alignment, undergoing anterior decompression and fusion using an expandable titanium cage, may have favorable clinical outcomes with regard to neurological status. Patients underwent surgical treatment due to neurological compromise. So for these patients, improvement in pain is not the primary goal of surgery, but it highly contributes to the quality of life. In our series, pain was significantly reduced from 4.2 to 1.7 at the last follow-up, although we have not separated neck and arm pain. Unfortunately, a patient with no medical history and no problem of clotting presented a delayed epidural hematoma. He presented a weakness of his upper extremities and

his mJOA decreased from 15 preoperatively to 13 at 2-year follow-up. Some authors [18] reported a 20 % incidence of dysphagia at 6 months after corpectomy. In our series, only one patient presented a severe dysphagia, which resolved at 6 weeks. As stated by Auguste et al. [6], patients who underwent single or multilevel corpectomy with placement of an expandable titanium cage should not be considered at high risk for postoperative dysphagia.

Sagittal alignment

The ability of expandable titanium cages to reduce kyphosis has been largely reported for the thoracolumbar spine [19]. Auguste et al. [6] reported a series of 22 patients in whom 11 had a preoperative kyphosis. The mean kyphotic correction was 21° from the use of an expandable titanium cage. However, eight patients underwent a combined anterior and posterior approach and instrumentation and only three patients underwent an anterior approach exclusively. In our series, all patients had preoperative misalignment of the cervical spine, which was corrected using anterior approach only. The mean kyphosis correction was 15° and it remained stable during follow-up. However, subsidence of the cage was a very frequent event before a successful fusion was achieved. It was due to the stiffness of titanium in comparison to normal bone, but as it was very small, it did not induce a loss of correction.

Fusion rate

Many studies reported the excellent fusion rate after placement of an expandable titanium cage. Thongtrangan et al. [19] reported a 100 % fusion for 15 patients who underwent tumor resections, and Liljenqvist et al. [20] reported the same rate in 20 patients who underwent placement of the cage in the treatment of osteomyelitis. Auguste et al. [6] reported a 100 % fusion rate for 22 patients, in whom the cage was inserted for the treatment of spondylotic myelopathy in 16 of them. However, many authors recommend the combination of anterior and posterior instrumentation and fusion in cases requiring multilevel grafts [21, 22]. Vaccaro et al. reported 9 % early hardware failure after two-level corpectomies, and 50 % after three-level corpectomies with bone graft and anterior plate. Sasso et al. reported 67 % of early failures after two-level corpectomies with non-expandable titanium mesh cage and anterior plate placement. In our study, 11 patients underwent a multilevel corpectomy and they all experienced a good functional outcome and achieved fusion. Because of the small sample size of patients undergoing multilevel corpectomy, our results must be interpreted carefully. Patients at risk for non-union may benefit from a more stable anterior–posterior construct [10].

Although stability on dynamic radiographs and absence of hardware failure are well-known criteria, we must emphasize that fusion was not analyzed directly due to the difficulty in assessing the presence of bone trabeculation around and in the titanium cage on CT scan.

Conclusion

Expandable titanium cage is an effective device for the treatment of cervical spondylotic myelopathy. It is associated with a good clinical outcome and allows a significant kyphosis reduction in patients with cervical spine misalignment.

Conflict of interest None.

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