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Clinical Study

Reoperation rate after anterior cervical discectomy and fusion using standalone cages in degenerative disease: a study of 2,078 cases

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Abstract

BACKGROUND CONTEXT: Over the last two decades, there has been a rapid increase in the use of cervical spine interbody fusion cages. Reoperation rate remains an important determinant of procedural efficacy and safety.
PURPOSE: To evaluate the rate and reasons for reoperations in cervical spondylosis patients undergoing anterior decompression and fusion using stand-alone cervical interbody fusion cages.
STUDY DESIGN: A retrospective study of 2,078 consecutive cases of degenerative cervical spine disease undergoing fusion using stand-alone cages.
PATIENT SAMPLE: Between January 2005 and December 2014, 2,078 patients underwent anterior cervical decompression and fusion using stand-alone cages in our institution.
OUTCOME MEASURES: The reoperations were analyzed and classified into early (during the first 90 days postoperatively) and late (after 90 days) reoperations. The rate and the causes of reoperation in both groups were reported and the results were compared.
METHODS: In 1,558 patients, a short segment fusion (≤2 levels) was performed, while the remaining 520 patients underwent a long segment fusion (≥3 levels).
RESULTS: The overall incidence of reoperation was 5.63%. The rate of early reoperations was 2.07%, mostly due to postoperative hematoma, and the rate of late reoperations was 3.56%, mostly due to adjacent segment disease. Revision due to pseudarthrosis was performed in 0.58% of cases. The early reoperation rate was significantly higher in the group with a long segment fusion, while the late reoperation rate was significantly higher in patients undergoing a short segment fusion.
CONCLUSION: Following anterior cervical decompression and fusion with a stand-alone cage, the overall incidence of symptomatic pseudarthrosis is low. Patients undergoing long segment fusion should be closely observed in the early postoperative period as they have a higher early complication rate. On the other hand, long segment fusions have a lower incidence of adjacent segment disease over the years.

Keywords: ACDF; Cages; Cervical; Fusion; Reoperation; Spine; Standalone

Introduction

Anterior cervical discectomy and fusion (ACDF) has been considered the gold-standard surgery for cervical degenerative disorders [1,2]. Since the initial description by Robinson and Smith in 1955 [3], the technique of anterior arthrodesis has been refined [4]. Usual ACDF techniques often involve the use of autologous tricortical iliac bone

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graft together with anterior cervical instrumentation, which could lead to postoperative dysphagia and adjacent-level ossification development as well as donor site pain [1]. These deficiencies have favored the ongoing development of cage technology with a rapid increase in the use of cervical spine interbody fusion cages in view of their theoretical ability to avoid these hazards [4]. Since the reoperation rate is usually considered to be an indicator of the efficacy and safety of any surgical technique, many authors studied the rates and causes of reoperations after anterior cervical spine fusion [1,5–11]. However, many of these studies are likely underpowered due to insufficient sample size and the variety of surgical procedures applied. Other studies including a large number of patients are register-based, including relatively heterogeneous procedures performed in many centers. Furthermore, publications dealing with reoperations after ACDF using stand-alone cages are scanty. The purpose of this study was to evaluate the rate and reasons for reoperations in cervical spondylosis patients undergoing anterior decompression and fusion using stand-alone cervical interbody fusion cages.

Material and methods

Between January 2005 and December 2014, patients presenting with symptomatic cervical spine degenerative disease were surgically treated in our department through ACDF using stand-alone titanium interbody cages filled with minimally invasively harvested iliac bone graft. The indication for surgery in these patients was a degenerative disorder presenting with one or more of the followings: persistent axial neck pain for more than 6 months not responding to conservative treatment, persistent cervical radiculopathy, or cervical myelopathy despite 6 weeks of conservative treatment. In cases of radiculopathy presenting with motor deficit, an operative treatment was done without delay. Patients presenting with newly diagnosed cervical myelopathy or a recent progression of a pre-existing myelopathy were immediately operated without preoperative conservative treatment. Patients with previous cervical spine surgery, cervical spondylodiscitis, post-traumatic cervical spine instability, as well as rheumatoid arthritis patients with cervical stenosis and instability were not included in this study. In all patients, ACDF was performed using the same titanium rectangular cage (Medicage cervical, MEDICON), which was developed in 2005 by the senior author (H.B.) (Fig. 1).

Surgical technique

The patient was placed supine with mild neck extension after induction of general endotracheal anesthesia. A right-sided approach was performed via a transverse or longitudinal incision. The platysma was split in line with its fibers. The prevertebral fascia and longus colli muscles were mobilized to visualize the uncovertebral joints. The operative levels were confirmed using fluoroscopy and

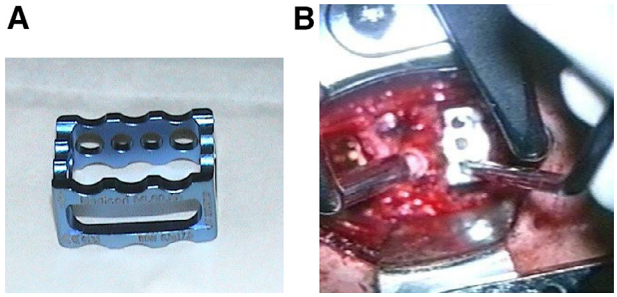

Fig. 1. (A) The cage applied in all of the 2,078 patients. The cage is introduced press-fit without fixation. (B) Intraoperative picture of the applied cage. Notice that through the open design of the implant, the dura can be seen without the need for imaging during application.

appropriate discectomy was performed starting from the most cranial level. Caspar pins were used to apply distraction as needed. With the aid of an operating microscope, the posterior longitudinal ligament was excised. This was followed by removal of the posterior osteophytes to decompress the spinal cord. The nerve roots were decompressed with meticulous foraminotomies when needed. After adequate decompression, the titanium rectangular cage was placed in the distracted intervertebral space under microscopic visualization of the dura, facilitated by the open design of the implant. After verification of the correct position by fluoroscopy, the end plate areas not in contact with the footprint of the cage, thus not weight bearing, were decorticated through the openly designed implant to provide an optimal bed for fusion. Thereafter, all cages were filled with cylinders of autogenous iliac bone graft harvested in a minimally invasive technique with the aid of a special drill-trocar instrument. At the end of the procedure, a wound drain was inserted and the platysma was sutured followed by subcutaneous adaptation. The skin was then closed using Steri-Strips.

Method of data collection and analysis

The patients enrolled in this study were divided into two groups: “group A” had a short segment fusion (one or two levels) and “group B” had a long segment fusion (three or more levels) (Fig. 2). During the follow-up period, patients who had reoperations were collected. A secondary surgical intervention of any type, at any level, was considered a reoperation. The reoperations were documented and

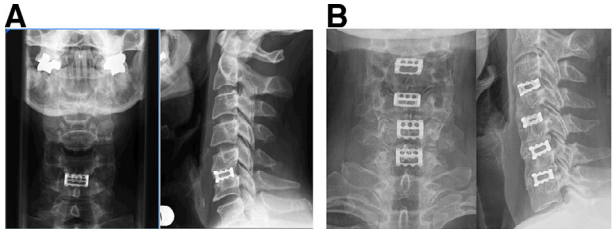

Fig. 2. (A) An example of group A patients undergoing short segment fusion. (B) An example of group B patients with long segment fusion.

classified into two types: "Type 1" were reoperations during the first 90 days postoperatively (early reoperations), and "Type 2" were reoperations after 90 days postoperatively (late reoperations). The rate and the causes of reoperation in both groups were reported and the results were compared. After the reoperation, the patients were continued to be followed up.

The data were collected and statistical analysis was performed using Statistical Package for Social Sciences (SPSS/version 20) software. Arithmetic mean, standard deviation, chi-square test, and *t* test were calculated. The level of significance was 0.05.

Results

Demographic data

The study included 2,078 consecutive patients with a mean age of 56.79 years (SD±10.86) (range between 24 and 88 years) (Table 1). There were 1,033 males (49.7%) and 1,045 females (50.3%). In 765 patients, one level was fused, in 793 two levels, in 380 three levels, in 133 four levels, in 6 patients five levels, and 1 patient underwent 6 levels fusion. The mean postoperative follow-up was 37.81 months (SD±16.05) (ranging between 24 and 95 months).

Group A included 1,558 patients with a mean age of 55.5 years (SD±10.83), consisted of 767 males (49.2%) and 791 females (50.8%), with a mean follow-up of 38.26 months (SD±16.3). Group B included 520 patients with a mean age of 60.51 years (SD±9.78), consisted of 286 males (55%) and 234 females (45%), with a mean follow-up of 36.34 months (SD±15.2). The two groups were more or less homogenous with no statistically significant difference regarding the demographic data.

Reoperations

A total of 117 reoperations were recorded presenting a total of 5.63%. The clinical evaluation of this group of patients showed a mean VAS of 7.8±2.5 and a mean NDI of 21.4±8.6 before the revision surgery, which improved in the last follow-up to a mean of 3.4±2.6 VAS and a mean of 10.8±6 NDI. These changes were statistically significant (t=3.4, 4.2 and p=.01, .03, respectively). The reoperations were divided into 43 early reoperations (2.07%) and 74 late reoperations (3.56%).

Table 1
Demographic data of the patients enrolled in this study

	Group A	Group B
Number of patients	1,558	520
Age	55.5 years±10.83	60.51 years±9.78
Gender		
Females	791	234
Males	767	286
Number of revisions	80	37
Age of revised patients	57.4±12.8	65.3±6.2
Gender		
Females	45	18
Males	35	19
Early revisions	22	21
Late revisions	58	16
Numbers of operated levels	1,765 one level and 793 two levels	380 three levels and 133 four levels

Early reoperations

The most common cause for early reoperation was postoperative hematoma, which was reported in 24 patients (1.15%) (prevertebral hematomas in 14 patients (0.67%) presenting with dysphagia and dyspnea, and intraspinal hematomas in 10 patients (0.48%) presenting with a transient neurologic deficit). In all patients, a closed negative pressure suction system was used. The revisions performed for hematoma were necessary in the first 24 hours in 20 patients and after 48 hours in 4 patients. A detailed analysis of the preoperative medical history showed that in 18/24 of these patients (75%), a long-term anticoagulation therapy was taken due to cardiac and/or pulmonary diseases, and it was stopped before surgery, so that the preoperative prothrombin time was normal in all patients. On the other hand, the overall rate of preoperative long-term anticoagulation therapy was 12% (250/2078). The risk to have postoperative hematoma was significantly higher in patients with a history of long-term preoperative anticoagulation (p=.012, X^2 =2.43), while parameters like age, gender, blood loss, and operative time did not have a significant effect on the rate of postoperative hematomas. The other causes of early revision surgery were cage dislodgement in seven cases (0.3%) (three of them with posterior displacement and four with anterior displacement), cage subsidence necessitating posterior stabilization in six cases (0.28%), persistent stenosis due to inadequate decompression presenting with residual radiculopathy in four cases (0.19%), superficial wound infection in one case (0.04%), and esophagus injury in one patient (0.04%).

Late reoperations

The causes of late reoperations were as follows: symptomatic adjacent segment disease (ASD) in 62 patients (2.98%) (10 patients within the first year, 21 within the second year, 10 patients within the third year, and 31 patients after 3 years to a maximum of 9 years after the primary operation), and symptomatic pseudarthrosis in 12 patients (0.58%) operated after a time lapse ranging between 12 and 30 months postoperative. All cases with symptomatic pseudarthrosis were treated via posterior fusion together with lateral mass fixation and achieved fusion at the end of follow-up without anterior revisions.

Comparison of groups

In the short segment group A, there were a total of 80 reoperations presenting 5.13%. These were divided into 22

early reoperations (1.41%) and 58 late reoperations (3.72%). On the other hand, patients in the long segment group B underwent a total of 37 reoperations presenting 7.1%. These were divided into 21 early reoperations (4.02%) and 16 late reoperations (3.08%). The details of reoperations are shown in Table 1.

In the long segment fusion group B, there were significantly more early reoperations, while in the short segment fusion group A, there were significantly more late reoperations. (p=.002).

Patients in group B had significantly more postoperative hematomas requiring revision surgery (p=.026), and significantly more symptomatic pseudarthrosis (p=.045), while patients in group A had significantly more symptomatic adjacent segment disease requiring surgical reoperation (p=.011). There was no significant difference between the two groups regarding cage dislodgement, cage subsidence, or revisions due to rest spinal canal stenosis (Table 2). Further detailed analysis of group B revealed 380 patients with 3-level fusion, and 140 patients undergoing ≥4-level fusion. The later subgroup with a mean age of 66.5±10.54 years was significantly older than the subgroup undergoing three-level fusion (t=3.24, p=.02), reflecting the degenerative nature of the disease. The early reoperation rate was 5.4% and 4.02%, while the late reoperation rate was 1.5% and 4.02% in the ≥four-level group and three-level group successively. The difference between these two subgroups was statistically significant regarding the late reoperation rate only (t=2.48, p=.05). All cases with adjacent segment disease in group B were in the three-level fusion subgroup and none in the ≥four-level fusion subgroup.

Discussion

Several authors have previously analyzed reoperations after surgery for cervical degenerative disc disorders. Park et al. published in 2016 a national population-based cohort study about reoperation rates after surgery for degenerative cervical spine disease [9]. They included different surgical procedures in their work and reported an overall reoperation rate of 3.31%. The value for the anterior fusion procedures performed in 8,143 patients was 2.48%. However, they did not differentiate between discectomy and corpectomy procedures. Furthermore, they did not report either about the number of levels operated anteriorly or the applied surgical technique. A larger study including 50,926 ACDF cases was published by Kelly et al., who analyzed the California's Office of Statewide Health Planning and Development discharge database between 2003 and 2010 [1]. They reported an early reoperation rate of 3.35% and a late reoperation rate of 2.7%. However, they included only single-level ACDF cases and again, they did not report about the applied surgical technique. To the best of our knowledge, the current work represents the largest single-center clinical study in the literature reporting about reoperation rates after ACDF in degenerative cervical disc disease using standalone cages involving 2,078 patients. The obtained values compare well with register-based publications with huge number of cases. Our documented early and late revision rates were 2.07% and 3.56%, respectively. All operations in our study were performed in a single institution applying the same surgical technique and the same cage. A markedly higher value of 11.6% was found by Puvanesarajah et al., who reported about 34,867 patients from the PearlDiver database undergoing ACDF [6]. Their high reoperation rate might be due to the selection criteria in their search, as they included only cervical myelopathy patients.

Table 2
Differences in the type of reoperations between the two groups

Reoperation		Group A	Group B	Total	p
Early	Hematoma	11	13	24	.026*
	Cage dislodgement	5	2	7	.652
	Cage subsidence	3	3	6	.068
	Persisting spinal stenosis	2	2	4	.265
	Wound infection	1	0	1	-
	Esophagus injury	0	1	1	-
Late	Adjacent segment disease	53	9	62	.011*
	Pseudarthrosis	5	7	12	.045*
Total		80	37	117	

* p values are statistically significant.

Early reoperations

The most common cause for early phase reoperation in the current study was postoperative hematoma. Epidural hematoma was observed in 0.48% of our 2,078 patients. A meta-analysis of operations for cervical myelopathy in the last decade was performed by Wang et al, in 2017 [12]. They reported a higher complication rate reaching 1.1% for postoperative epidural hematoma. Schroeder et al. studied specifically the point of epidural hematoma after cervical spine surgery by reviewing 16,582 operations in 23 institutions [13]. They found a total incidence of 0.09%, ranging between 0 and 0.76%. However, both studies included heterogeneous groups of surgical procedures.

On the other side, prevertebral hematoma causing dysphagia and dyspnea was reported in 0.67% of our cases. A recent article published by Song et al. evaluated the incidence retropharyngeal hematoma necessitation revision after 785 anterior cervical fusion procedures [14]. They found a slightly higher incidence of 1.15% with no specific preoperative risk factors.

Comparing our short and long segment fusion groups revealed that postoperative hematoma occurred significantly more in patients undergoing long segment fusion (2.5%) than in those with short segment fusion (0.7%). A logical explanation for this difference is the larger exposure area necessary in the case of multilevel fusion as well as the learning curve associated with this type of surgery. Furthermore, our threshold for revision in the case of retropharyngeal hematoma is low, performing revision

rather prophylactically than therapeutically, with the end result of no long-term complications in any of the cases with postoperative hematoma.

Late reoperations

The two causes for a late reoperation in this study were adjacent segment disease and pseudarthrosis. Symptomatic degeneration of an adjacent segment is a common cause for reoperation after cervical fusion and has been studied extensively [1]. Hilibrand et al. reported a symptomatic adjacent segment degeneration rate of 2.9% per year after anterior cervical fusion [15]. Lee et al. analyzed 1,095 patients with anterior cervical fusion and reported a similar value of 2.3% for the occurrence of adjacent segment disease [16]. This fact has been strongly supported by the data in this series, which showed an overall revision rate of 2.98% for adjacent segment disease. Further analysis of our data revealed that patients undergoing short segment fusion had a significantly higher risk for adjacent segment disease (3.4%) than those undergoing long segment fusion (1.7%). Furthermore, patients in group B undergoing revision due to adjacent segment disease had exclusively three-level fusion, while patients undergoing ≥four-level fusion did not encounter this specific problem. This finding is consistent with the published data of Hilibrand et al. and Park et al., who documented that patients with multilevel cervical arthrodesis were less likely to have symptomatic adjacent segment disease than were those who had had a single-level arthrodesis [15,16].

The second cause for a late reoperation was symptomatic pseudarthrosis. This constituted an overall rate of 0.58%. Patients with long segment fusion—as might be expected—had a significantly higher rate of nonunion (1.3%) than those undergoing short segment fusion (0.3%). However, the values reported in both groups compare well with those published in the literature. Shriver et al. performed a meta-analysis for pseudarthrosis rate after ACDF and reported an overall rate of 2.6% [17]. However, they included only patients undergoing plate fixation and the value obtained represented the radiological diagnosis of pseudarthrosis regardless of symptoms. Recently, Li et al. compared long segment cervical fusion using stand-alone cages with and without anterior plating [18]. The occurrence of pseudarthrosis was not significantly affected by the additional anterior instrumentation in their series, confirming the safety of stand-alone cage-assisted fusion in long segment degenerative cervical disc disease.

Limitations of this study

This study has some limitations which have to be pointed out. First, the retrospective nature of the series represents a disadvantage. However, the data of all involved patients were collected in a prospective manner and saved in our department database as access table. This digital database was the base of our retrospective analysis in this work. The second limitation is the use of the reoperation rate as a single factor to evaluate the safety and effectiveness of stand-alone cage-assisted ACDF. However, the rate of secondary surgical interventions after a specific type of surgery is an important evaluation factor for the effectiveness of this technique. This approach has been applied by several authors in the literature [19]. On the other hand, most publications dealing with this factor are based on data recruited from national registers involving heterogeneous implants and a very wide variety of surgeons applying different techniques. To our knowledge, this is the largest study analyzing the reoperation rate after stand-alone cage-assisted ACDF using data collected from a single center applying the same implant and the same surgical technique with a small number of surgeons. Nevertheless, a detailed outcome of the 2,078 patients applying other evaluation parameters will be the subject of ongoing studies.

Conclusion

The overall incidence of symptomatic pseudarthrosis is low and comparable to the literature using additional instrumentation. Patients undergoing long segment fusion should be closely observed in the early postoperative period, as they have a higher early complication rate than those undergoing short segment fusion. On the other hand, long segment fusions have a lower incidence of adjacent segment disease over the years.

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