Cages or plates for anterior interbody fusion for cervical radiculopathy: single and double levels

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Background
Anterior cervical discectomy and fusion is the gold standard for the management of cervical radiculopathy. Different materials (cages and plates) were used.
Aim
This study is designed to compare the results between cages and plates for anterior interbody fusion for cervical radiculopathy.
Patients and methods
Twenty-four consecutive patients with single-level or double-level cervical radiculopathy that was refractory to conservative treatment were treated surgically. Twelve patients were treated with the stand-alone cage procedure (cage group), and an additional 12 patients were treated with the anterior plating method (plate group). They were selected from Al-Azhar University Hospitals during the period from August 2013 to February 2015.
Results
There was a significant increase of overall complications in the plate group when compared with the cage group. In addition, the overall outcome was significantly better in the cage group when compared with the plate group (outcome was excellent, good, and fair in 58.3, 33.3, and 8.3%, respectively, in the cage group, compared with 8.3, 50.0, and 41.7% in the plate group with the same order). This outcome was confirmed by the Prolo score, which was significantly higher in the cage group when compared with the plate group (8.41 ± 1.08 vs. 7.41 ± 0.99, respectively). Finally, comparing single or double levels in both groups revealed that outcome was significantly better in the cage group when compared with the plate group.
Conclusion
Both cage and plating are good methods for interbody fusion in the treatment of cervical radiculopathy. However, cage is better in the overall outcome, and it reduced overall complications in either single-level or double-level cervical radiculopathy.

Keywords:
anterior discectomy, cages, cervical, plates, radiculopathy

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Introduction

Anterior cervical discectomy and fusion (ACDF) is popularly regarded as the gold standard for the treatment of cervical spine radiculopathy. It had a high success rate in improving preoperative symptoms, and also has a very favorable safety/complication rate. In addition, patients tolerate the procedure well, with little postoperative pain and morbidity when compared with some other spinal operations. However, because the medical treatment of cervical radiculopathy is favorable in the vast majority of cases, surgery is strictly reserved for those who fail medical treatment. Being able to sort cases needed surgical intervention; this would allow patients to get the treatment they need in a proper time, limiting the time of suffering pain, and it may even have economic benefits in terms of earlier return to function [1].

ACDF is found to be a highly efficacious procedure for patients experiencing cervical radiculopathy. The techniques are well described and carried out in a consistent manner. However, to attain fusion, numerous techniques have been developed, each with their unique risk/benefit profile. Successful fusion of bone attributed to structural and biologic factors. The graft implemented in ACDF should exhibit some or all of the following properties: osteoinduction, osteogenesis, and osteoconduction. This enhances the ability to stimulate the production of osteoprogenitor cells to create new bone, and the ability to act as a scaffold for bone formation. Bone

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grafts, interbody spacers, plates, and biologic graft substitutes/adjuncts attempt to fulfill these requisites for fusion via different means [2]. In addition, the success of ACDF depends on a thorough decompression and development of a solid osseous fusion [3,4].

For single-level discectomy with autogenous bone fusion, ACDF can achieve a fusion rate between 92 and 100% [5] with 70–90% neurologic and symptomatic improvement [6,7]. However, in multilevel discectomy, the success rate declines as the number of levels increase [8].

In cervical degenerative diseases, the literature supports a consistent rate of 10–12% nonfusion for single-level anterior discectomy and autogenous bone fusion, 20–27% for two-level fusion, and ~30–56% for three-level fusions [8].

Nonfusion (pseudarthrosis) accounts for 80% of spinal surgery failures [9]. Other complications included graft collapse in 20–30% of multilevel fusion. In addition, kyphosis of the spinal curve often develops in multilevel discectomies with autogenous iliac crest graft fusion [10].

Cervical plate fixation may decrease the micromovement of the cervical spine, enhance the fusion rate, and correct the spinal curve to physiologic lordosis [11]. However, the cage used to correct spinal fusion achieves excellent fusion rates and creates less graft failure in single-level and multilevel discectomies [12,13].

Few reports have focused on the results of multilevel discectomy with interbody fusion.

Aim

The present study was designed to compare the results between cages and plates for anterior interbody fusion for cervical radiculopathy.

Patients and methods

Twenty-four consecutive patients with single-level or double-level cervical radiculopathy that was refractory to conservative treatment (for 1–3 months either medical or combined with physiotherapy) were treated surgically. Twelve patients were treated with the stand-alone cage procedure (cage group), and an additional 12 patients were treated with the anterior plating method (plate group). They were selected from Al-Azhar University Hospitals during the period from August 2013 to February 2015.

Exclusion criteria

Patients with one or more of the following were excluded from the study: (i) cervical trauma within the past 4 weeks; (ii) cervical spine neoplasia; (iii) ongoing cervical infection; (iv) patients unable to care for their own needs; and (v) patients with significant cognitive impairment.

Surgical procedure [14]

Surgical procedures were performed using left anterior transverse approach.

Cage group

After insertion of a cervical spine distracter, complete discectomy and neural decompression were performed. The cartilaginous endplate was removed completely to expose the cortical endplate. The bony endplate was preserved as much as possible to prevent cage subsidence. An appropriate-sized cage was filled with autologous cancellous bone from the left anterior iliac crest through a mini-incision using a special device (trephine technique). The cage size was determined by intraoperative evaluation using a trial cage to confirm initial stability. The cage was inserted into the disc space by using an impactor, and cage stability was confirmed after the distracter was removed. Patients remained in a soft collar for 4 weeks postoperatively.

Plate group

Anterior plating was performed according to the Smith–Robinson technique, in which tricortical autologous iliac bone (open technique) is harvested from the iliac crest and grafted between the vertebral bodies under manual traction. Supplemental anterior unlocked plate fixation was applied.

Radiological assessments

To assess bony union, three different radiological parameters on lateral dynamic radiographs were determined at several times: before surgery; immediately after surgery; and at 3, 6, and 12 months after surgery.

The fused segment angle was defined as the angle formed between the lines drawn parallel to the cranial endplate of the cranial vertebrae and the caudal endplate of the caudal vertebrae. More than 2° motion at flexion–extension was considered to indicate nonunion [15]. The interspinous process distance at flexion–extension was measured between

the tips of both spinous processes. More than 2 mm motion at flexion–extension was considered to indicate nonunion [14]. In addition, radiolucency more than 50% over the anteroposterior distance of the interface between the endplates and implants was defined as nonunion. At 12 months, computed tomography assessment of the coronal and sagittal reconstruction views was also performed. Union was considered to have occurred when bony trabecular orientation was visible. Successful fusion was considered to have occurred when all of the three radiological parameters and computed tomography assessments indicated fusion. Cage subsidence was calculated from the change of fused segment height, which was ascertained using the lengths of lines drawn between the center of the cranial endplate of the cranial vertebrae and the center of the caudal end of the caudal vertebrae. A change of 3 mm or more was defined as significant cage subsidence [16].

The postoperative function and working status were evaluated by the Prolo scale. Scoring ranged from 10 (a perfect result) to 2 (an incapacitated state). The Prolo scale was used, as it is suitable for evaluating radiculopathy, myelopathy, and radiculomyelopathy (Table 1). The summation of clinical outcomes was categorized as excellent (9–10), good (7–8), fair (5–6), and poor (2–4). Excellent and good scales are called satisfactory outcomes. We also compared each group in terms of graft complication, instrument complication, and donor-site complication rates. Blood loss and operation time in each group were recorded [11,17].

Statistical analysis

The collected data were statistically analyzed by statistical package for the social sciences (SPSS version 16; SPSS Inc., Chicago, Illinois, USA). Qualitative data were expressed as frequency and percent distribution, whereas quantitative data were expressed as mean±SD. χ^2-Test and Student's *t*-test were used for comparison of qualitative and quantitative data, respectively. *P* value less than 0.05 was considered significant.

Table 1 Prolo's scale

Grades	Employment status	Functional status
1	Complete invalid	Totally incapacitated
2	No gainful employment	Mild/moderate pain
3	Working but a different occupation	Low level of pain
4	Working part time or limited status	No constant pain but occasional recurrence
5	Working at the previous occupation	Complete recovery

Results

As regards patient characteristics, men represented 75.0% of the cage group, compared with 58.3% of plate group; the mean age of the cage group was 51.33 years compared with 50.67 years in the plate group, and there was no significant difference between cage and plate groups. Operative time ranged from 110 to 310 min, with no significant difference between cage and plate groups (175.0 ± 69.02 vs. 180.83 ± 72.35 min, respectively). Blood loss was increased in the plate group (180.83 ± 72.35 ml) when compared with the cage group (62.50 ± 45.85 ml); however, the difference is statistically nonsignificant. The operated level was single in 66.7% of the case group compared with 75.0% of the plate group, with no statistically significant difference (Table 2).

As regard to outcome, both groups were comparable as regard to donor-site pain at 3, 6, and 12 months postoperative, bony union, fused segment angle at 3, 6, and 12 months postoperatively and preoperative and 6 months postoperative visual analog scale. However, there was a significant increase of overall complications in the plate group when compared with the cage group (6 vs. 0 case, respectively); complications were in the form of hematoma in four cases, dysphagia in one case, and wound infection in one case. All complications were treated conservatively and subsided at the end of the follow-up period. In addition, the overall outcome was significantly better in the cage group when compared with the plate group (outcome was excellent, good, and fair in 58.3, 33.3, and 8.3%, respectively, in the cage group, compared with 8.3, 50.0, and 41.7% in the plate group with the same order) (Table 3).

Comparing single or double levels alone revealed that outcome was significantly better in the cage group when compared with the plate group. However, complication and bony union were comparable between both groups (Table 4).

A sample of postoperative result was presented in Figs. 1 and 2.

Discussion

Cervical radiculopathy results mainly from inflammation of the cervical nerve root because of a lesion that reduces the intervertebral height, which leads to more severe pain and disability [18–20]. In other words, cervical radiculopathy is marked by nerve compression from herniated disc material or arthritic bone that typically produces neck and radiating arm pain or numbness, sensory deficits, or motor dysfunction [21].

Table 2 Patient characteristics and intraoperative data

Variables	Cage group	Plate group	Test	*P* value
Sex [*n* (%)]				
Male	9 (75.0)	7 (58.3)	0.75	0.38 (NS)
Female	3 (25.0)	5 (41.7)		
Age [mean±SD (range)]	51.33±10.13 (35–69)	50.67±8.89 (36–67)	0.17	0.86 (NS)
Operative time (min)	175.0±69.02	180.83±72.35	0.20	0.84 (NS)
Blood loss (ml)	62.50±45.85	85.41±45.79	1.22	0.23 (NS)
Level [*n* (%)]				
Single	8 (66.7)	9 (75.0)	0.20	0.65 (NS)
Double	4 (33.3)	3 (25.0)		
Site [*n* (%)]				
C3–C4	3 (25.0)	1 (8.3)	3.53	0.61 (NS)
C4–C5	2 (16.7)	3 (25.0)		
C5–C6	1 (8.3)	4 (33.3)		
C6–C7	2 (16.7)	1 (8.3)		
C3–C4, C5–C6	3 (25.0)	2 (16.7)		
C5–C6, C6–C7	1 (8.3)	1 (8.3)		

Table 3 Comparison between cage and plate groups as regards outcome

Variables	Cage group	Plate group	Test	*P* value
Donor-site pain				
At 3 mo PO	1 (8.3)	4 (33.3)	2.27	0.13 (NS)
At 6 mo PO	0 (0.0)	1 (8.3)	1.04	0.30 (NS)
At 12 mo PO	0 (0.0)	0 (0.0)	a	
Bony union at 12 mo PO				
Complete	12 (100.0)	10 (83.3)	2.18	0.14 (NS)
Incomplete	0 (0.0)	2 (16.7)		
Complications				
None	12 (100.0)	6 (50.0)	8.0	0.0.046*
Hematoma	0 (0.0)	4 (33.3)		
Dysphagia	0 (0.0)	1 (8.3)		
Wound infection	0 (0.0)	1 (8.3)		
Overall outcome				
Excellent	7 (58.3)	1 (8.3)	7.56	0.023*
Good	4 (33.3)	6 (50.0)		
Fair	1 (8.3)	5 (41.7)		
FSA				
3 mo PO	3.75±8.56	3.33±8.87	0.12	0.91 (NS)
6 mo PO	3.33±9.12	4.58±7.21	0.37	0.71 (NS)
12 mo PO	3.75±9.07	5.83±5.57	0.68	0.51 (NS)
Visual analog scale				
Preoperative	7.08±0.79	7.33±0.77	0.78	0.44 (NS)
6 mo PO	1.17±0.93	1.66±1.30	1.07	0.29 (NS)
PO Prolo scale	8.41±1.08	7.41±0.99	2.35	0.028*

FSA, fused segment angle; mo, month; PO, postoperative.

It had been shown that the annual age-adjusted incidence of radiculopathy is 83 per 100 000 persons [22].

The main goal of treatment in patients with cervical radiculopathy is to relieve pain, improve neurologic function, and prevent recurrences [23]. The gold-standard surgical treatment for cervical radiculopathy is ACDF, which leads to reduction of pain and increased quality of life in the majority of patients [24,25].

The present study was designed to investigate cages versus plates for anterior interbody fusion for cervical radiculopathy.

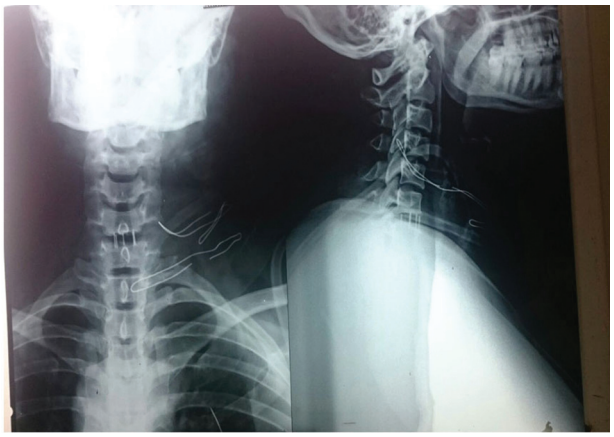
In the present work, men were more affected than women (men represented 75.0% of the cage group, compared with 58.3% of the plate group); the mean age of the cage group was 51.33 years compared with 50.67 years in the plate group, and there was no significant difference between cage and plate groups. These results are comparable to those reported by Eubanks [21], who reported that persons reporting radiculopathy were aged between 13 and 91 years and that men were affected slightly more than women. However, Fujibayashi *et al.*[14] reported equal distribution of male to female affection and mean ages around 50 years.

Results of the present study revealed that cage interbody fusion either in single or double levels had better results than plate as regards overall outcome, complications, and decreased intraoperative blood loss. The effectiveness of cage interbody fusion was reported in previous studies. For example, in a multicenter study undertaken to obtain US Federal Drug Administration approval, in which the cylindrical cage (BAK/C; Sulzer Spine-Tech, Minneapolis, Minnesota, USA) was compared with noninstrumented bone-only fusion, similar success rates were achieved for the two techniques [26]. In the multicenter study, the complication rate associated with ACDF was 20% for the plate and 12% for the cage. In a case series involving 47 patients, 98% of patients treated with the

Table 4 Outcome in cases with double or single levels in both groups

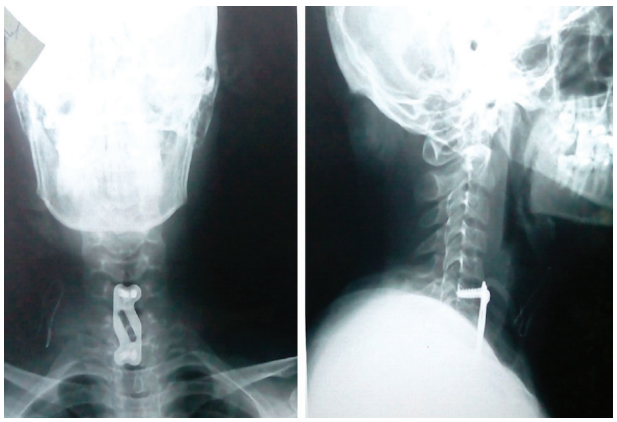
Variables	Cage group	Plate group	Test	*P* value
Single				
Bony union at 12 months				
Complete	8 (100.0)	8 (88.9)	0.94	0.33 (NS)
Incomplete	0 (0.0)	1 (11.1)		
Complications				
None	8 (100.0)	4 (44.4)	6.29	0.043*
Hematoma	0 (0.0)	4 (44.4)		
Dysphagia	0 (0.0)	0 (0.0)		
Wound infection	0 (0.0)	1 (11.1)		
Outcome				
Excellent	4 (50.0)	1 (11.1)	5.76	0.045*
Good	4 (50.0)	4 (44.4)		
Fair	0 (0.0)	4 (44.4)		
Postoperative Prolo scale	8.50 ± 0.92	7.44 ± 1.13	2.11	0.049*
Double				
Bony union at 12 months				
Complete	4 (100.0)	2 (66.7)	1.55	0.21 (NS)
Incomplete	0 (0.0)	1 (33.3)		
Complications				
None	4 (100.0)	2 (66.7)	1.55	0.21 (NS)
Hematoma	0 (0.0)	0 (0.0)		
Dysphagia	0 (0.0)	1 (33.3)		
Wound infection	0 (0.0)	0 (0.0)		
Outcome				
Excellent	3 (75.0)	0 (0.0)	4.95	0.05*
Good	0 (0.0)	2 (66.7)		
Fair	1 (25.0)	1 (33.3)		
Postoperative Prolo scale	8.25 ± 1.50	7.33 ± 0.58	2.18	0.041*

Figure 1



Anteroposterior and lateral, direct postoperative radiograph of C6–7 (cage group).

Figure 2



Anteroposterior and lateral, direct postoperative radiograph of C6–C7 (plate group).

BAK/C cage had achieved solid fusion at an average of 6 months after the operation, but the use of a cervical intervertebral cage in anterior cervical microdiscectomy did not prevent a reduction in the height of the cervical disc space after surgery [27].

A prototype screw-in cage composed of titanium alloy, known as the BAK/C, showed promising results in a prospective study with 2-year follow-up data. A statistically significant difference was found in one-level fusion rates in the cage group compared with the ACDF group (100 vs. 93% fusion rate, respectively). In addition, pain and functional outcomes, measured by the visual analog scale (VAS) and SF-36 scoring systems, showed a significant improvement in the entire cohort, and equivalency between both groups [26].

Another prospective study by Cho *et al.*[28] compared stand-alone polyetheretherketone (PEEK) cages with autogenous iliac crest bone graft (ICBG) with plating and autogenous ICBG without plating in multilevel ACDF. Stand-alone PEEK cages and ICBG plus plating had equivalent fusion rates at 100 and 98%, respectively, which was a significantly higher rate than ICBG alone at 87%. Graft complications, defined as radiographic collapse, nonunion, or dislodgement, were lowest in the PEEK group with no reported complications, compared with 4% in the plated autograft group and 50% in the nonplated autograft group. Clinical outcomes were equivalent in the stand-alone PEEK and plated autograft groups, with both being significantly higher than the nonplated group.

With regard to the efficacy of plate, Wang *et al.*[29] reported using a plate to enhance the spinal stability, to increase fusion rate, and to create the spinal lordosis in two-level fusion.

The blood loss with plating was higher than the cage group, because of more blood loss from vertebral dissecting and drilling in the plate group. Comparable results were reported by Cho *et al.* [28]. In addition, they reported that pain was less in the cage group. The overall complication rates were least in the cage group; the cage group is statistically better than the plate group in total complications ($P < 0.05$). These results are in agreement with that of the present study.

In conclusion, both cage and plating are good methods for interbody fusion in the treatment of cervical radiculopathy. Both maintain cervical stability and lordosis, as well as achieve solid fusion and satisfactory outcomes. However, cage is better in overall outcome and reduced overall complications in either single-level or double-level radiculopathy.

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Conflicts of interest
There are no conflicts of interest.

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