

Do stand alone cervical interbody spacers pose any advantage over plate and screws?

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Anterior cervical discectomy and fusion (ACDF) is a well known surgical procedure, currently it has been considered the gold standard for surgical treatment of degenerative disc disease of the cervical spine; good clinical results have been reported performing ACDF with cage alone.

However, controversy remains regarding the incidence of complications, such as cage subsidence, kyphotic deformity, and pseudoarthrosis.¹

To minimize complications some techniques are suggested such as anterior plate fixation after cage placement (ACDF-I).²

The decision to use or not anterior plating must consider complication and surgical revision risk profiles. The aim of this review is to clarify the effectiveness of ACDF with or without the use of anterior cervical instrumentation with plate fixation (ACDFI).

Materials and methods

The criteria we used for selecting studies for the review are the following:

— types of intervention: we analyzed studies using ACDF and studies using ACDFI; moreover we discussed papers comparing the 2 procedures;

— patient selection: patients with myelopathy or nerve root symptoms and signs who did not respond to conservative therapy, associated with disc herniation, and or cervical spondylosis, in a single or multiple vertebral level disease;

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— selection of studies: electronic search was made in the MEDLINE database (PubMed), in the Central Registry of randomized trials of Cochrane database (CENTRAL) and EMBASE;

— surgical outcome described in terms of the intensity of symptoms, intra and postoperative complication rate, fusion rate, sagittal malalignment and cage subsidence, the role of sagittal malalignment vs an increased rigidity of the segment in relation to adjacent segment disease.

Results

Intra-postoperative complication rate

The mortality rate associated with ACDF in literature series is around 0.1-0.18%.³

The overall morbidity rate ranges from 2.17% to 19.3% (8.4%). Smith et al. report in their cohort of single and multi-level ACDF risk of any complication at 2.4%.⁴ The most common complication was the development of isolated postoperative transient dysphagia, which observed in 1.15% to 9.5% of patients (3.3%); Rhin et Vaccaro showed 71% of patients having cervical spine surgery with ACDFI reported dysphagia at 2 weeks follow-up, this incidence decreased to 8% at 12 weeks follow-up.⁵ In a 1576 group patients Anil Nanda *et al.* showed

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no statistical difference in rate of complication between different categories of anterior fusion; post-operative hematoma occurred in 5.6%, symptomatic recurrent laryngeal nerve palsy occurred in 0.1-3.1% of cases. DVT occurred in 0.16% to 0.22% of cases; dural penetration occurred in 0.5%, esophageal perforation in 0.1 to 0.3%, worsening of preexisting myelopathy in 0.2%, Horner's syndrome in 0.1%, instrumentation pull-out in 0.1%, cage extrusion in 0.88% and superficial wound infection in 0.08 to 0.2% of cases.^{6, 7}

Other papers refer an higher rate of complications related to anterior cervical locking plates, 10.7% (2.2-24%).⁸ They can be due to instant malpositions, biomechanical complications, and tracheoesophageal or neurovascular structural injuries. Oblique plating (asymptomatic or radiculopathy and neck pain) was observed in 2.5% of cases. Screw malpositioning or fracture was observed in 2.3%, screw loosening in 1.7% of cases. Plate loosening was observed in 3.2% of cases; triangle fracture was observed in 0.9% of cases and overlong plate placement with consequent adjacent segment degeneration was observed in 0.6% of cases. Kaiser et al., when using autologous bone graft, found out a statistically significant decrease in complication rate with the application of plates (6% vs. 1.3%; $P < 0.0001$).

Post-operative kyphosis, cage subsidence, rate of fusion and pseudoarthrosis

Barlocher⁹ analyzed in a prospective study 125 cases with single level cervical disease; he described that the average range of kyphosis in their 4 comparative groups was 24.2° in anterior cervical discectomy (ACD), 3.3° in ACDF, 12.5° in PMMA and 2.7° after use of plate.

XIE et al.¹⁰ analyzed 42 consecutive patients with monosegmental cervical radiculopathy who failed medical management and randomized to one of three treatment groups: ACD, ACDF, or ACDFI; analyzing segmental kyphosis it was noted that there was no change in sagittal balance in the ACDF or ACDFI groups ($P > 0.05$).

Barsa, in his prospective study, analyzed radiographic data and clinical outcome of 100 consecutive patients with compressive monosegmental cervical radiculo-/myelopathy treated by ACDF; there were 18 (18%) patients with 19 (13.2%) subsided cages in total, but no patients experienced any symptoms a 2 years follow-up.

Wang et al. examined graft subsidence in 80 patients who underwent 1-level surgery (ACDF in 36 and ACDFI in 44). They reported pseudoarthrosis in 2 (4%) of 44 patients who underwent ACDFI compared to 3 (8%) of the 36 who underwent ACDF ($P = NS$). However, the kyphotic change at the fused segment was not statistically different (1.2° with vs 1.9° without plate placement, $P > 0.07$).¹¹

Troyanovich et al. reviewed 47 patients who underwent single level ACDF or ACDFI, 21 and 26 patients, respectively. It was analyzed the pre and post-operative lordosis; After ACDF, the authors reported a 4.2° loss in overall lordosis compared to 0.9° after ACDFI. This difference was not statistically significant. In the ACDF group, lordosis decreased at the fused segment by 2.5° and increased by 5.7° after ACDFI ($P < 0.05$).

Many other authors confirmed that the use of plates in single level allows a better but statistically not significant sagittal alignment and a similar fusion rate, with no clinical difference.¹²⁻¹⁵

Dai et al. (2008) compared PEEK or a carbon fiber cage with or without additional plate fixation ($N = 62$) in 1 or 2 cervical segment. They concluded that there were no clinical differences, but that the fusion rate in the plate group was faster.¹⁶

Hans-Peter W. van Jonbergen, in a 71 patients series threated with ACDF, showed subsidence in 10 cages, but fusion after 6 months in all patients.¹⁷ Cage subsidence occurred in two cases (4.9%) of one-level fusion, five cases (14.7%) of two-level fusion, and one case (12.5%) of three-level fusion, with a significantly increased incidence rate of cage subsidence in multilevel fusions. Excellent or good clinical outcomes were achieved in 76 of 83 (91.6%) with no difference between single or multilevel fusion.

Kaiser et al.¹⁸ reported on 251 patients who underwent ACDFI, comparing them to a historical cohort of ACDF patients. The authors assessed fusion on dynamic radiographs; the observed increases in fusion rates for both one and two-level procedures proved to be statistically significant, fusion was 94% with ACDFI versus 88% with ACDF ($p < 0.03$). For 1-level, fusion was 96% with ACDFI, and 90% with ACDF ($p < 0.05$). For 2-level, fusion was 91% with ACDFI and 72% with ACDF ($p < 0.05$). Caspar et al.,¹⁹ in a retrospectively study, reviewed 356 patients who underwent ACDF (210 patients) or ACDFI (146 patients). With cervical plating, the reoperation rate for pseudoarthrosis was reduced from 4.8%

for ACDF to 0.7% for ACDFI ($p < 0.04$). Repeated operation rates were reduced with plating for both 1-level and 2-level disease over 3 years (1-level: 5.1%, 5.7%, 6.2%; 2-level: 5.0%, 12.8%, 11.2%). Jae keun *et al.*, comparing clinical outcome and radiologic changes in 54 patients who underwent 2-level anterior cervical discectomy and fusion with cage alone (ACDF) and with cage and plate construct (ACDFI),²⁰ found out a shorter fusion duration and a lower subsidence rate with better sagittal alignment than that of cage alone.

We can conclude that plates provide a faster fusion with less cage subsidence and better sagittal alignment. At variance with 2 level disease, this differences are not significant in single level fusion and don't correlate with worst outcome.

Clinical outcome

Nabhan *et al.*²¹ compared Solis cage with Solis cage and Caspar plate (N = 37) and concluded that there were no significant clinical differences between the two groups reporting good outcome in terms of neck and arm pain. Zoëga *et al.* reported a randomized study in 46 patients with 1-level disease (ACDF in 22 and ACDFI in 24). The authors assessed outcome using the Million Index, Oswestry Index, Zung Depression Scale, and VAS. The authors reported improvement with all measures in both groups with respect to neck and arm pain. Arm pain seemed to improve more after plate fixation ($p < 0.02$).²² Bolesta *et al.* reported 40 patients (ACDF in 23 and ACDFI in 17) who underwent 1-level and 2 level surgery. The 2 level surgery was performed in the majority of the ACDFI group. Using Odom's criteria, patients with plating did better with 2-level surgery but not 1-level surgery. Similar rates of nonunion were seen.²³

Mobbs *et al.*²⁴ analyzed 242 patients (ACDF in 130 and ACDFI in 112) who underwent 1(95) or 2-level(140) ACDF. They reported excellent clinical outcomes in the 2 groups, 72 and 78% in the ACDF and ACDFI groups, respectively ($p = 0.31$). However they reported the decrease in the rate of poor outcomes (1% *vs.* 7%; $p < 0.05$) with the use of plate fixation. Fusion rates were $> 90\%$ and similar.

McLaughlin *et al.*²⁵ reported 64 patients who underwent 2-level ACDF (25 patients) or ACDFI (39 patients). Good or excellent results were obtained in 92% of patients who underwent ACDF and 92% of that who underwent ACDFI. However In these

studies, plating improved arm pain after 2-level surgery and improved activities of daily living faster, and it seemed to reduce the incidence of poor outcomes ($p < 0.05$).

In conclusion in 2 level cervical diseases the use of plates seem to reduce arm pain and number of patients with poor outcome; in single level disease there is no significant difference in terms of clinical outcome with the use of plates.

ASD: the influence of sagittal alignment and a rigid construct

The precise cause of ASD remains unknown; unfortunately, only a few studies have reported on ASD comparing ACDF and/or ACDFI. Most of what we can suppose in cervical fusion, is what we already learned for lumbar spine; different studies have corroborated a trend toward instrumentation after lumbar or lumbosacral fusion may lead to an earlier development of ASD.^{26, 27} This can be due to the immediate rigidity produced by instrumentation that causes greater stress in the adjacent levels, leading to accelerated degeneration.^{28, 29} Hilibrand *et al.* in a retrospective study of 374 patients found that symptomatic ASD affected more than one-fourth of patients within ten years after ACDF.³⁰ In contrast Mohamad Bydon and Risheng Xu, reporting 888 patients who underwent ACDF for cervical spondylosis over a twenty-year period at a single institution, found out that the length of instrumented arthrodesis does not correlate with the propensity to develop ASD; a total of 108 had to do again surgery due to symptomatic ASD.³¹ Gyu Yeul Ji *et al.* analyzing 42 consecutive patients who underwent two-level ACDF or ACDFI for two-level cervical disc disease in two years of follow-up, found that the mean intervertebral disc height of an adjacent segment was significantly lower in the ACDFI group than the ACDF.³² In ACDFI this may be due to the increased fixation force provided by the additional plate augmentation, increasing the level of stress generated in adjacent intervertebral discs after surgery.³³ Another and more recent theory learned from the lumbar spine is that abnormal sagittal balance fusion may lead to ASD; after ACDF, kyphosis has been reported to promote ASD.³⁴ Therefore, ACDFI has been applied to maintain proper cervical lordosis. Wen-Jian *et al.* support the idea that the cervical lordosis may be more important for the long-term

clinical outcome than cage subsidence.³⁵ Katsura *et al.* demonstrated in their cohort of 42 patients that a total of 43% of the patients with adjacent-level degeneration had malalignment of the cervical spine, such as kyphosis. In addition, degenerative changes in adjacent intervertebral levels were observed in 77% of kyphosis of the fused segment. This strongly suggests that one of the factors promoting ASD after anterior cervical fusion for degenerative disorders is postoperative kyphotic change.³⁶

Discussion and conclusions

Actually we cannot assess which factor between loss of lordosis and a more rigid segment has more influence in the development of ASD. The use of the plate can help to maintain more lordosis in the fused segment, but may give a more segmental rigidity.

Actually, there is no Class I evidence to make strong recommendation whether to use or not anterior plating.

Reviewing the literature, we can deduce that in single level surgery, the advantages offered by ACDF without plating consist mainly in a shorter operation time, minimal blood loss and relatively greater simplicity when compared to ACDFI with the same functional and clinical outcome. There are weak evidence to assess the efficacy of adding fusion plate fixation in single level fusion although the use of plates improves cervical lordosis and reduce the risk of pseudoarthrosis. Furthermore, the loss of lordosis due to a single level subsidence may not be so significant to justify the use of a more rigid system such as plating. We can conclude that the overall data do not suggest better results with plating in mono segmental anterior spine fusions. Indications for additional internal fixation can be reserved to special conditions with increased instability, such as insufficient bone quality or inappropriate graft placing.

The use of cervical plates can be indicated in 2 or more level disc degeneration, where can improve arm pain (Class II) and improves cervical lordosis (Class II), reduces the risk of pseudoarthrosis (Class III), and reduces the incidence of graft-related complications (Class III).³⁷

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