

## Original Research Article

# Comparative study of anterior cervical discectomy and fusion by anterior cervical plate and stand-alone cervical cage

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## ABSTRACT

**Background:** Anterior cervical discectomy (ACD) was used for management of degenerative cervical disc disorders (DCDD) in previous days. Further research and developments in management of DCDD led to evolution of standard and widely used operative technique as anterior cervical discectomy and fusion (ACDF) by either anterior cervical plate (ACDF-ACP) with bone grafting or stand-alone cage (ACDF-SAC). There is less data available in literature regarding when and where to use ACDF-ACP and ACDF-SAC.

**Methods:** The study was conducted on 20 patients operated in Government Medical College and Hospital and Pacific Hospital and Research Centre, Aurangabad from June 2018 to March 2020. These patients divided into group A - 10 patients, operated by ACDF-SAC which are further divided as group Aa - 6 patients - operated for single level ACDF-SAC and group Ab - 4 patients - operated for two level ACDF-SAC, group B - 10 patients, operated by ACDF-ACP which are further divided as group Ba - 5 patients - operated for single level ACDF-ACP and group Bb - 5 patients - operated for two level ACDF-ACP. Patients evaluated preoperatively and postoperatively using X-ray cervical spine anteroposterior (AP) and lateral views, MRI cervical spine, visual analogue scale (VAS) for pain, Robinson's criteria and Cobb's angle.

**Results:** In our study we found, ACDF-SAC has small incision size, less intraoperative time, easy to carry out for surgeons, less intraoperative complications and better clinical outcome as compared to ACDF-ACP. Whereas only radiological results were better in ACDF-ACP than ACDF-SAC.

**Conclusions:** ACDF-SAC is superior to ACDF-ACP for appropriately selected patients and in well experienced hands.

**Keywords:** DCDD, ACD, ACDF-SAC, ACDF-ACP, Robinson's criteria, Cobb's angle

## INTRODUCTION

ACDF is the surgical technique widely used for management of variety of cervical spine disorders such as single or multiple level myelopathy, DCDD with radiculopathy and various other symptoms, traumatic fractures, herniated cervical discs, neoplastic lesions etc.<sup>1,2</sup> ACDF was invented by Smith and Robinson in 1950, afterword's many modifications of this technique came

into existence.<sup>3,4</sup> Nowadays, ACDF is considered as gold standard surgical technique for single or multiple level DCDD.<sup>5,6</sup> In past days, ACD alone was considered for management of DCDD causing nerve root or spinal cord compressions but it had several disadvantages which were overcome with invention of ACDF.<sup>7</sup>

Young adult men are commonly seen with DCDD due to their jobs which includes daily wagers who lifts heavy

weights, drivers, etc., with cigarette smoking is most frequent confounding factor.<sup>8</sup> Physiological changes in nucleus pulposus led to progressive annular degeneration and hypertrophic changes around facet joints and vertebral bodies is the basic pathophysiology of DCDD.<sup>8</sup> Usually patients presents with neck pain, medial scapular pain, shoulder pain, pain radiating to arm with tingling numbness in fingers, variable amount of motor involvement, rare symptoms like headache and vertigo may be present. Radiologically, they show loss of normal cervical lordosis and narrowing of disc space. These patients primarily treated with conservative management and most of them respond well, but at last when conservative management does not benefit the patient there, we consider ACDF as the treatment of choice.<sup>9,10</sup>

One can do ACDF-ACP or ACDF-SAC for management of DCDD (let it be single level or double level), but before that we should have thorough knowledge about these procedures to choose between them.<sup>11,12</sup> The points that need to be studied to get complete knowledge about these two modalities of treatment are mean incision length, intra-operative blood loss, soft tissue trauma while dissection, operative time, solid fusion rate, maintenance of disc height, screw penetration and backout, chances of adjacent level disease, post-operative kyphosis (can be global or segmental), subsidence rate, pseudarthrosis, post-operative better relief of symptoms, and other intraoperative and postoperative complications involving both operative site and graft harvesting site complications.

Cages that are used for ACDF-SAC are made up of various materials such as stainless steel, titanium, carbon fiber or polyetheretherketone (PEEK).<sup>13</sup> Whereas, plates used for ACDF-ACP are made up of stainless steel or titanium. Our study aims at proving which modality of management among ACDF-SAC and ACDF-ACP for DCDD is superior considering different scenarios. We also aim to help surgeons to get complete knowledge about ACDF-ACP and ACDF-SAC in respect to postoperative relief of signs and symptoms, post-operative rehabilitation, and various complications.

## METHODS

We conducted a prospective study of 20 patients operated in Government Medical College and Hospital and Pacific Hospital and Research Centre, Aurangabad from June 2018 to March 2020. These patients divided into group A - 10 patients, operated by ACDF-SAC which are further divided as group Aa - 6 patients - operated for single level ACDF-SAC and group Ab - 4 patients- operated for two level ACDF-SAC, group B - 10 patients, operated by ACDF-ACP which are further divided as group Ba - 5 patients - operated for single level ACDF-ACP and group Bb - 5 patients - operated for two level ACDF-ACP (Table 1).

Following inclusion and exclusion criteria were set for this study.

### Inclusion criteria

Inclusion criteria were patients with single level or two level DCDD and non-traumatic nerve root or spinal cord compression.

### Exclusion criteria

Exclusion criteria were patients with trauma, patients with infective aetiology and patients with neoplasms.

Standard Smith and Robinson's approach for ACDF was used.<sup>14</sup>

**Table 1: Patients division.**

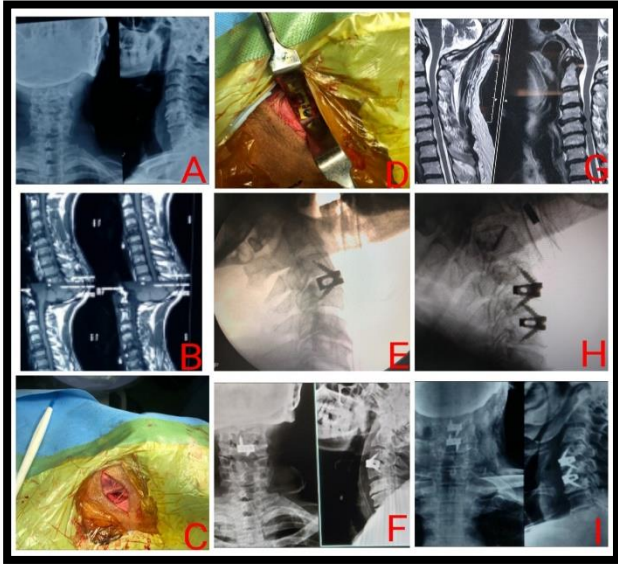
Groups and Subdivisions	Number of patients	Level of DCDD	Operated for
<b>Group A</b>			
a	6	Single level	Single level ACDF-SAC
b	4	Two level	Two level ACDF-SAC
<b>Group B</b>			
c	5	Single level	Single level ACDF-ACP
d	5	Two level	Two level ACDF-ACP

### Surgical procedure

Patient intubated and given general anaesthesia. Supine position given to patient and one bolster is kept below shoulder on the same side of incision. Neck is rotated away from the incision side. Arms tied below level of body to pull shoulders down which gives better fluoroscopy images intraoperatively. Painting and draping done over neck and over iliac blade (mostly on opposite side of incision). One can apply 2-5 kg of weight (depending on the level of DCDD) through cervical tong for maintaining traction in cervical spine during procedure. Carotid triangle is identified and a transverse incision along skin crease at the affected level is made over left side of the neck. We choose left sided approach to avoid injury to the RLN. Superficial dissection carried out by cutting platysma vertically at anterior border of sternocleidomastoid, and blunt dissection continued by retracting sternocleidomastoid and carotid sheath laterally and trachea, oesophagus medially with the help of langenbeck retractor. Blunt dissection carried out by fingers to reach anterior surface of vertebral body. Then disc level is confirmed by visualising artery forceps in C-arm which is kept at the level of affected disc. After confirmation of level for ACDF, osteophytes removed and discectomy done till posterior longitudinal ligament reached, then anterior cord visualised and bilateral foraminal decompression is done. Further, we also removed cartilaginous endplates of the vertebral bodies to

get better fusion rates. We used No. 1 and 2 mm bites pituitary rongeurs and scoop for discectomy. After discectomy procedure we followed two different paths for two different groups of patients.

For group A patients we used stand-alone cage with graft taken from excised osteophytes or if it is not sufficient then we took iliac crest graft for fusion of vertebral bodies (single or double level fusion) (Figure 1).

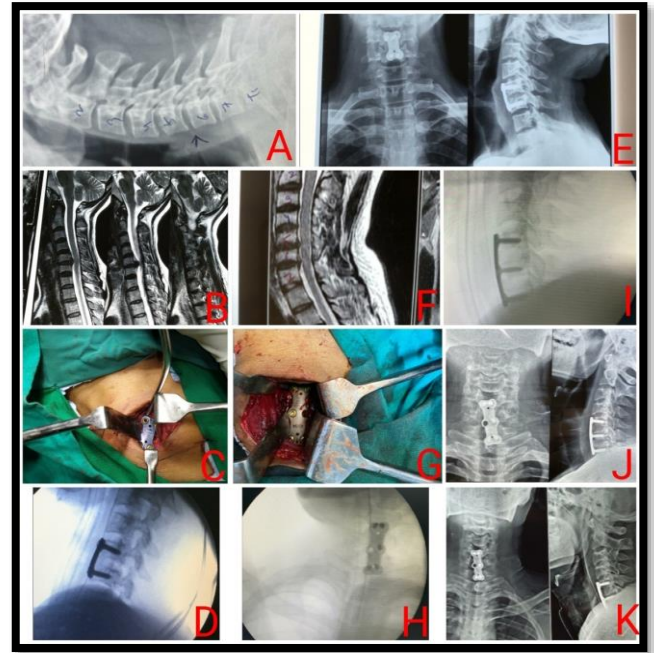


**Figure 1: ACDF-SAC.** (A) and (B) Pre-operative X-ray cervical spine AP and lateral view and MRI cervical spine showing DCDD at C5-C6 level, (C) photograph of incision and superficial dissection, (D) intra-operative photograph showing single level ACDF-SAC, (E) intra-operative fluoroscopy image showing single level ACDF-SAC, (F) post-operative X-ray cervical spine AP and lateral view showing single level ACDF-SAC, (G) MRI cervical spine showing DCDD at C3-C4 and C4-C5 level, (H) intra-operative fluoroscopy image showing two level ACDF-SAC, and (I) post-operative X-ray cervical spine AP and lateral view showing two level ACDF-SAC.

For group B patients we used anterior cervical plating with bone grafting for vertebral body fusion. Iliac crest grafts were taken and moulded to appropriate size by oscillating saw. This graft pieces tightly wedged between intervertebral space where discectomy was performed. While putting graft we increased traction little bit and after its placement into interbody space we released traction to impact bone graft in-between two vertebral bodies. Stability of graft is checked by removing traction to head and flexing neck. After confirmation of stability of graft anterior cervical plate applied and fixed with screws (single or double level fusion) (Figure 2).

Thorough wash given, absorbent gel foam is kept and layered subcuticular closure of wound performed without keeping drain. Also, we gave wash at graft donor site and

layered closure performed. After that clean autoclaved dressing done for wound. Neck immobilized in well-fitting soft cervical collar as we have achieved stable fixation.



**Figure 2: ACDF-ACP.** (A) and (B) Pre-operative X-ray cervical spine AP and lateral view and MRI cervical spine showing DCDD at C5-C6 level, (C) intra-operative photograph showing single level ACDF-ACP, (D) intra-operative fluoroscopy image showing single level ACDF-ACP, (E) post-operative X-ray cervical spine AP and lateral view showing single level ACDF-ACP, (F) MRI cervical spine showing DCDD at C5-C6 and C6-C7 level, (G) intra-operative photograph showing two level ACDF-ACP, (H) and (I) intra-operative fluoroscopy image showing two level ACDF-ACP, (J) immediate post-operative X-ray cervical spine AP and lateral view showing two level ACDF-ACP, and (K) follow up X-ray cervical spine AP and lateral view showing two level ACDF-ACP.

#### Post-operative care

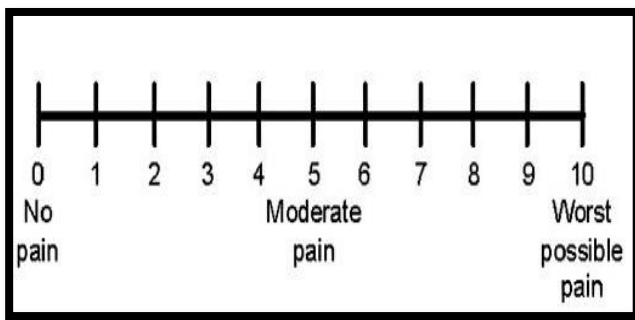
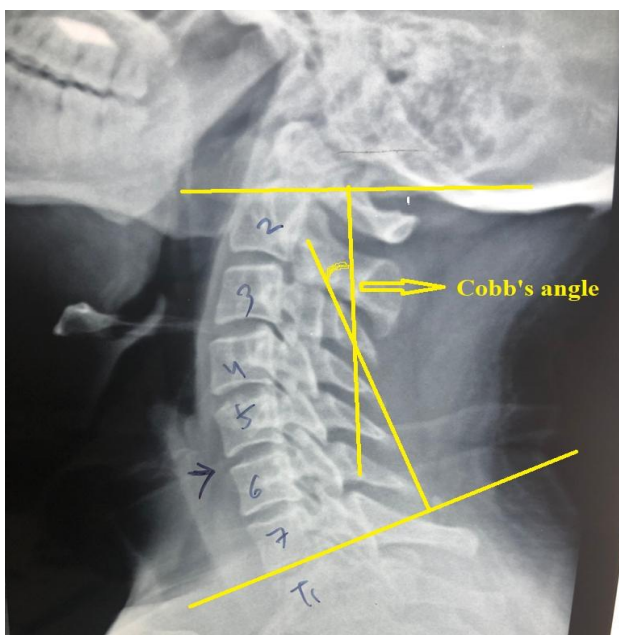
Ryle's tube inserted, patient shifted to ICU and kept nil by mouth (NBM) till peristalsis confirmed on auscultation of abdomen. Then NBM can be released by giving liquid diet through Ryle's tube, simultaneously we kept check on hoarseness of voice and dysphagia. If dysphagia not detected then Ryle's tube removed and oral fluids and semisolid diet given till 7<sup>th</sup> postoperative day. For dysphagic patients, we kept them on Ryle's tube parenteral nutrition till dysphagia recovers. Patient can start walking on postoperative day 2. Check dressing done on postoperative day 3. Suture removal done on postoperative day 14. We advised patients to wear soft cervical collar for at least 3 months postoperatively or until solid fusion is demonstrated on X-rays.



**Table 2: Robinson's criteria.**

Outcome	Pain	Medications	Activity	Work status
Excellent	None	None	Normal	Normal
Good	Mild	Occasional	Normal	Normal
Moderate	Moderate	Frequent NSAID's	Restricted	Limited
Poor	Severe	Oral narcotics	Incapacitated	Disabled

Patients were evaluated preoperatively, immediate post-operatively and at each follow up (at 2 weeks, 4 weeks, 3 months, 6 months, 12 months and 18 months) for extent of disease and deformity of cervical spine and extent of nerve root or spinal cord compression, clinical, and radiological outcomes, with the help of X-ray cervical spine AP and lateral (neutral, flexion and extension) views, and MRI cervical spine. Robinson's criteria, visual analogue scale (VAS) score (Table 2 and Figure 3).<sup>15,16</sup> Cobb's angle (normal value 20-35° lordosis) was used for measurement of global alignment which is measured from superior endplate of C2 to inferior endplate of C7 on lateral X-ray (Figure 4).<sup>17</sup>

**Figure 3: VAS score.****Figure 4: Cobb's angle (gives information about global alignment of cervical spine).**

### Statistical analysis

It is done in SPSS version 25 statistical software, microsoft excel 2007, microsoft word 2007, null hypothesis. Categorical variables were analyzed by unpaired T-test, one-way ANOVA test, Levene's test, Wilcoxon signed rank test wherever appropriate. P value <0.05 was considered significant with 95% confidence interval.

### RESULTS

Mean age of patients included in the study was 35 years. Mean length of incision was 4.5 cm for group Aa, 6.7 cm for group Ab, 6.9 cm for group Ba, and 9 cm for group Bb. Mean intraoperative blood loss observed in our study was 300 ml for group Aa, 350 ml for group Ab, 400 ml for group Ba, and 550 ml for group Bb. Intraoperative blood loss was measured using number of soaked gauze pieces and collected blood in suction machine. Operative time observed in our study was 90±15 minutes for group Aa, 150±15 minutes for group Ab, 150±15 minutes for group Ba, and 180±15 minutes for group Bb. In our study only 16.66% patients from group Aa needed bone harvesting for bone grafting whereas in group Ab, group Ba, group Bb it was 75%, 100%, 100%, respectively. All these four operation related parameters showed no statistically significant difference in our study. But as you see the values, there is obvious picture that ACDF-SAC is better than ACDF-ACP (Table 3).

One-way ANOVA test applied to analysed data and we found that there is no statistically significant difference between groups (Table 3).

Post-operative assessment also needed to delineating results of operative management. So, all patients data were collected for various parameters. Pain assessment by VAS score was shown in Table 4, clinical outcome according to Robinson's criteria was shown in Table 5 and complications were shown in Table 6.

There was a single case in each group Ba and Bb whose symptoms actually worsened after operative management. This was thought to be because of intraoperative injury to the spinal cord and pseudarthrosis leading to aggravation of disease course. Otherwise, in general neck pain, radicular pain and headache were improved along the course of treatment in all four groups (Table 4). Results of VAS score showed statistically significant difference in our study. According to Robinson's criteria, percentage of patients having >good score was more in those who have

undergone ACDF-SAC (83.33%) (Table 5). Unpaired T-test applied to analysed data and we found that there is

statistically significant difference between groups (Table 4).

**Table 3: Operation related parameters.**

Parameters	Group Aa	Group Ab	Group Ba	Group Bb
Mean incision length (cm)	4.5	6.7	6.9	9
Intra-operative blood loss (ml)	300	350	400	550
Mean operative time (minutes)	90±15	150±15	150±15	180±15
% of patients who needed iliac bone graft	16.66	75	100	100
F value	0.251			
P value	0.859			

**Table 4: Results of pain intensity measured using VAS at pre-operative and 6 months post-operative period.**

Pain subtypes	Mean pre-operative vas score of all 4 groups in study	Mean post-operative vas score of all 4 groups in study	T value	P value
Neck pain	8.4	1.2	6.65	0.0013
Radicular pain	7.6	1.8		
Headache	5.6	0.6		

**Table 5: Clinical outcome according to Robinson's criteria.**

Outcome	Group Aa	Group Ab	Group Ba	Group Bb	F value	P value
Excellent	2	0	2	0	0.16	0.92
Good	3	2	2	2		
Moderate	1	1	1	2		
Poor	0	1	0	1		
>Good N (%)	5 (83.33)	2 (50)	4 (80)	2 (40)		

**Table 6: Different criteria's and complications studied.**

Criteria's and complications	Group Aa	Group Ab	Group Ba	Group Bb	P value
Fusion rate N (%)	6/6 (100)	3/4 (75)	5/5 (100)	4/5 (80)	0.90
Mean fusion time (months)	6.5±2	7±2	4±2	5±2	
No. of cases with subsidence	1	1	0	1	
No. of cases with adjacent level disease	0	0	1	1	
No. of cases with change in disc height	1	1	1	1	
No. of cases with screw backout	0	0	0	1	
No. of cases with graft migration	0	0	1	1	
No. of cases with screw penetration into spinal canal	0	0	1	0	
No. of cases with plate and screw breakage	0	0	0	1	
No. of cases with pseudarthrosis	1	0	0	1	
No. of cases with dysphagia	0	1	0	1	
No. of cases with RLN palsy	0	0	0	1	
No. of cases with cage migration	0	1	0	0	
No. of cases with iliac crest graft morbidities	0	0	1	1	
Mean pre-operative Cobb's angle	8±7.4	7±5.5	9±6.7	7±4.2	0.09
Mean post-operative Cobb's angle	14±8.7	12±9.8	16±9.2	14±10.8	

One-way ANOVA test applied to analysed data and we found that there is no statistically significant difference between groups (Table 5).

Considering fusion rate, we found that there was 100% fusion in group Aa, Ba patients and it was 75% and 80% in group Ab and Bb, respectively. Though there was 100% fusion rate in group Aa, we found that fusion time required

in this group was considerably longer than anterior cervical plating cases. Subsidence noted in one case per group in group Aa, Ab, Bb and there was no subsidence reported in group Ba. All three cases which reported subsidence also showed change in disc height plus one case from group Ba also showed change in disc height due to graft migration and implant failure. We found one case of adjacent level disease in group Ba and Bb, each. And there was no adjacent level disease noted in group Aa and Ab. Only one case in group Bb reported screw backout and plate breakage, while other three groups did not report these complications. This complication was managed conservatively as patient did not have increased neck or radicular pain. There was one case with screw penetration into spinal canal in group Ba which was diagnosed on immediate post-operative X-rays, but this patient did not show worsening of symptoms hence reoperation was not considered in this case.

Dysphagia was noted in one case each per group Ab and Bb which was thought to be due to larger incision length, more oesophageal handling and irritation of oesophagus by plate, which was improved over course of postoperative care days. One case in group Bb showed RLN palsy which was also thought to be due to more soft tissue dissection required for two level cervical plate fixations. There was one case with cage dislocation found in group Bb which was managed by re-operating that patient with anterior cervical plating and cage placement. There was one case of pseudarthrosis reported in each group Aa and Bb which was mostly due to lack of fusion at the operated level. Pseudarthrosis led to persistence of neck pain in both cases which were managed conservatively by giving analgesics. We found that there was one case in each group Ba and Bb with iliac crest graft morbidities in the form of mild hernia in group Ba case, which was managed by consulting with general surgeon and discomfort, pain and infection in group Bb case which was managed by reopening of sutures, local debridement, thorough antibiotic wash, longer course of specific antibiotics (2 weeks intravenous and 4 weeks oral) after pus and culture sensitivity report.

Mean Cobb's angle (mean lordotic angle), a radiological parameter also studied preoperatively and postoperatively in every patient. In general, there was improvement in cervical lordosis in all four groups, but statistically there was no significant difference between four groups (Table 6).

Levene's test applied to first 14 criteria studied in table 6 and we found that there was no statistically significant difference between groups. Wilcoxon signed rank test was applied to 15<sup>th</sup> and 16<sup>th</sup> criteria in Table 6 and we found that there was no statistically significant difference between groups.

## DISCUSSION

ACDF is very much effective and one of the most commonly performed surgical procedures for DCDD as it

avoids exposure of spinal canal.<sup>18</sup> Surgeons has wide variety of options as far as fusion part is concerned while doing ACDF. Fusion can be carried out using bone graft which can be autograft or allograft, stand-alone cervical cage, cervical plate with bone graft, cervical plates with artificial cages, etc. Amongst which we used and studied efficacy, radiological and clinical outcome of ACDF-SAC and ACDF-ACP for single level or two level DCDD. ACDF-ACP with bone grafting results in a significantly higher incidence of fusion, better maintained alignment of cervical spine segments, low subsidence and decreased need for second surgery.<sup>19</sup> However, relatively higher complication rates including more soft tissue exposure and handling leading to dysphagia, tracheoesophageal trauma and implant-associated problems such as foreign body sensations, spillage of bone graft into spinal canal leading to aggravation of disease and more incidences of adjacent level disease.<sup>20,21</sup> Considering these shortcomings of cervical plates, there was a scope for research which led to discovery of self-locking stand-alone cage. The stand-alone cage has been used widely in clinical practice, and successful clinical results have been reported in more than one study.<sup>22,23</sup> On the other hand, a cervical cage can be used independently if they are with integrated screws or can be used along with anterior cervical plate as adjuvant. Here they basically act as a substitute for autologous iliac bone grafts avoiding autograft harvesting-related complications.<sup>24</sup> Cervical cages has cubical shape which are used to restore disc height and has space to put small amount of bone graft which further causes osseous fusion.<sup>24</sup> They serve the purpose of internal fixation while, simultaneously giving structural support for the cancellous bone.<sup>25</sup> Due to their structural configuration, cervical cages placement requires less operative time, less soft tissue trauma, spillage of bone graft into spinal canal is almost nil.

In all groups, posterior neck pain, arm pain, and other neurologic symptoms were relieved when compared to preoperative symptoms at final follow-up except for one case in group Ba and Bb, where symptoms actually worsened due to pseudarthrosis and intraoperative spinal cord trauma. A study conducted by Xie and Hurlbert showed no significant clinical difference between the patients operated as ACDF with cage alone and ACDF with plate fixation, although plate fixation showed better radiologic result than ACDF with cage alone.<sup>26</sup> In our study we reported fusion rate of 100% group Aa and Ba, 75% in group Ab and 80% in group Bb. Two cases reported no fusion in our study were the known cases of severe osteoporosis. Where we had started management of osteoporosis in both cases preoperatively. But eventually both cases showed no fusion at the end of final follow up. Baz et al study showed 100% union rate at the end of 1 year in patients operated with stand-alone cage for both single level and double level DCDD.<sup>27</sup> Suchomel et al study showed that there was no significant difference in fusion rates in patients operated with anterior cervical plate with graft for both single level and double level DCDD.<sup>28</sup> Non-union is suspected in patients with complications, late

angulation deformity or implant failure because of material fatigue and it is usually radiologically detected on computed tomography studies. In literature it was shown that, there is a 5-6% rate of nonunion in single-level DCDD, rising to 15% in two-level DCDD.<sup>29-31</sup>

In our study, subsidence was reported in one case each per group Aa, Ab and Bb. This was thought to be due to preoperative osteoporotic changes augmented by implant-vertebral body interface related factors. Joo et al study showed that, 31.81% of cases developed subsidence who were operated with cage alone and 30% of cases developed subsidence who were operated with plate fixation.<sup>32</sup> In our study, one case of adjacent level disease was found in each group Ba and Bb, which was thought to be due to reduced segmental mobility and heightened stress on adjacent level due to rigid plate fixation. 60% of patients in Goffin et al study showed adjacent level changes.<sup>33</sup> There was one case with screw backout and plate breakage in group Bb, and there was one case per group Ba and Bb with graft migration. There was single case with cage migration reported in group Ab. One case in each group Ba and Bb had developed iliac crest graft morbidities in the form of mild hernia in group Ba case and pain plus infection in group Bb case. Such complications were not found in group Aa and Ab because, there we mostly used only local osteophytes as autologous bone graft. One case of dysphagia was reported in each group Ab and Bb. Also, there was one incidence of RLN palsy in group Bb. Both, dysphagia and RLN palsy improved till final follow. Barakat et al study showed that, there were 20% cases of dysphagia.<sup>34</sup> Kilburg et al reported 1.9% of RLN injury in anterior cervical spine surgeries.<sup>35</sup>

There was no statistically significant difference found regarding change in mean Cobb's angle in our study. Oh et al in their study showed no significant difference in the postoperative global and segmental alignment between ACDF-SAC and ACDF-ACP and also, they found that final postoperative kyphosis higher than immediate postoperative, which they believed to be due to the natural aging process.<sup>36</sup>

Short period of follow up and a smaller number of cases has put limit to our detailed assessment of various parameters which are studied in our study. Therefore, we plan to pursue long term follow up study with large number of cases in coming future to get better knowledge about choice of procedure among ACDF-SAC and ACDF-ACP which will eventually benefit budding orthopaedic surgeons.

## CONCLUSION

With our study we conclude that, ACDF-SAC is better than ACDF-ACP considering various aspects such as ease to perform surgery, less intraoperative complications, less operative time and better clinical outcome but at the expense of radiological outcome which is better with ACDF-ACP.

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