Anterior Cervical Corpectomy versus Multilevel Discectomy and Caging in Cervical Spondylotic Mylopathy

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Abstract: Cervical spondylotic myelopathy (CSM) is defined as spinal cord dysfunction secondary to extrinsic compression of the cord or its vascular supply, or both, that is caused by degenerative disease of the cervical spine. It is the most common type of spinal cord dysfunction in patients who are older than 50 years of age. This is a prospective non-randomized comparative study that was including20 patients complaining of symptoms and signs of cervical myelopathy and radiculopathy. All the patient were enrolled from Neurosurgery Department Outpatient Clinic, Al Azhar Unversity Hospital, and Shbein ElKom Teaching Hospital. The diagnosis of CSM was based on careful history, taking complete physical and neurological examination, radiographic documentation. **The study population was divided into two groups:** Group A: contain 10 patients underwent multilevel anterior cervical discectomy and fusion using interbodyfusion cages (PEEK cages). Group B: contain 10 patients underwent anterior cervical corpectomy and fusion using titanium mesh (Pyra®mesh). Follow up was done clinically and radiologically, immediate postoperative, 3, and 6 months postoperative for all cases. The patients were assessed clinically by Japanese Orthopedic Association scale (JOA). The radiological assessment was done by plain radiography, CT scans, and MRI. The aim of this study was to compare the efficacy of multilevel ACDF using inter body fusion cages (PEEK cages) versus ACCF using titanium mesh (Pyra®mesh) for CSM through evaluating the clinical and radiological outcomes. **From the present study it was noticed that: (1)** Both groups demonstrated a significant post-operative increase in JOA scores, an increase that was maintained at the final follow-up. These findings indicate that both groups achieved adequate decompression of the spinal cord and nerve roots, and that these patients benefited from reconstruction of the spinal column. (2) Both the ACDF and ACCF groups had significantly increased cervical lordosis, but the increase was greater in the ACDF group than in the ACCF group. This is because ACDF can provide multiple points of distraction and fixation in addition to the cage and inter body space shaping. However, ACCF meshmay straighten the cervical spinal column between the remaining vertebral bodies. (3) There was no case with hardware dislodgement in both groups. The union rate was same in both groups. (4) There was no difference between both groups in the incidence of Hardware related complications, but the incidence of wound infection and dysphagia was higher in ACCF group which can be explained by the prolonged operative time and the need for more dissection in this group.

Keywords: Anterior; Cervical; Corpectomy; versus; Multilevel; Discectomy; Caging; Spondylotic Mylopathy

1. Introduction

Myelopathy describes any neurological deficit related to the spinal cord, cervical myelopathy results from compression of the spinal cord usually due to congenital cervical canal stenosis, prolapsed inter-vertebral disc, impinging osteophyte, ossified posterior longitudinal ligament, hypertrophic ligamentum flavum and dynamic instability. Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord dysfunction in the older population **(Kalsi-Ryan, Karadimas and Fehlings, 2013; Moon, Choi and Lee, 2016)**.

Multilevel cervical degenerative myelopathy (CDM), which is characterized by multisegmental spinal cord compression because of cervical spondylotic myelopathy (CSM), ossification of the posterior longitudinal ligament (OPLL), and cervical stenotic myelopathy, is a common spinal disorder all over the world**(Harry Nerkowitz, 2004)**.

Cervical kyphosis, which often leads to the coexistence of OPLL with CSM and cervical stenotic myelopathy, is the result of progressive degeneration of the facet joints and discs**(Denaro *et al.*, 2015)**.

Various surgical approaches to the cervical spinal cord have developed as the clinical syndromes, mechanism of disease and pathological changes that ensue have been better defined**(Sheikh Taha *et al.*, 2015)**.

A posterior approach is the traditional method, and has been the standard route by which the cervical canal and its contents are approached**(Denaro *et al.*, 2015)**. It includes laminectomy, hemilaminectomy, Keyhole laminoforaminotomy and laminoplasty and is indicated where a myelopathy and radiculopathy

coexist, as for aminotomy at one or several levels can be combined with laminectomy. The goal of the foraminotomy is the early relief of brachial neuralgia and neurologic symptoms such as paraesthesiae **(Bakhsheshian, Mehta and Liu, 2017).**

This approach should take place in the midline to avoid injury of the greater occipital nerve lateral to the external occipital protuberance in the roof of the suboccipital triangle, the posterior arch of atlas should not be exposed more than 1.5 cm from the midline because of risk of injury to the 3rd part of the vertebral artery and the suboccipital nerve**(Farrokhi et al., 2016)**.

For a posterior approach to be successful the cervical lordosis should be intact and if affected the laminectomy with lateral mass screw fixation is an alternative**(Farrokhi et al., 2016)**.

Anterior techniques for cervical cord decompression were first developed in the 1950s to address the poor clinical results and the late difficulties of posterior laminectomy procedures**(Chen et al., 2012)**.

The anterior and anterolateral approaches to the cervical spine expose the anterior aspects of the cervical vertebral bodies and intervening intervertebral discs, they are most useful for anterior cervical cord and nerve root decompression through excision of herniated discs, tumors and vertebral corpectomies**(Childress and Becker, 2016).**

They allow exposure of all levels and proper positioning of patients is a key point to give good operative exposure and prevent complications of excessive pressure on neural or vascular structures**(Zhu et al., 2013).**

Many anatomical structures must be handled carefully during this approach as the sternomastoid and omohyoid muscles, the carotid sheath containing the common carotid and internal carotid arteries, the internal jugular vein and vagus nerve, the 2nd part of the vertebral artery, the superior thyroid artery, the superior laryngeal and phrenic nerves as well as the cervical sympathetic chain, the larynx, trachea and esophagus**(Kotani et al., 2013)**.

2. Patients & Methods
Data Selection
Study Design
This study was a prospective non-randomized comparative study.
Study Population
This study was including 20 patients complaining of symptoms and signs of cervical myelopathy and radiculopathy. All the patient were enrolled from Neurosurgery Department Outpatient Clinics, Al Azhar Unversity Hospitals, and Shbein El Kom Teaching Hospital from June 2016 to January2018.

Ethical Committee Approval
After approval of the ethics committee of researches of Al-Azhar University and obtaining written consent from all patients scheduled for surgical intervention.

Inclusion criteria
1. Symptoms of cervical myelopathy and/or radiculopathy.
2. Imaging studies showed degeneration and herniation of cervical intervertebral disc.
3. Multilevel cervical pathology.

Exclusion criteria
1. Ossification of the posterior longitudinal ligament (OPLL).
2. Presence of rheumatoid arthritis, cerebral palsy, tumor, traumatic injury.
3. Spondyloarthritis caused by hemodialysis.
4. Previous cervical surgery, thoracic spondylotic myelopathy and lumbar spinal canal stenosis.

Study Groups
The study population was divided into two groups:
• Group A: contain 10 patients underwent multilevel anterior cervical discectomy and fusion using interbody fusion cages (PEEK cages).
• Group B: contain 10 patients underwent anterior cervical corpectomy and fusion using titanium mesh (Pyra® mesh).

Data Processing
1. History taking: age, sex and patient main complain and duration.
2. Neurological examination.
a) Sensory examination: Sensory level (spinothalamic tract affection) radicular hypothesia or hyperthesia (radiculopathy), and deep sensation.
b) Motor system examination:
Motor power, muscle tone, tendon jerks, clonus and planter response. Motor powers were assessed according to United Kingdom Medical Research Council (MRC, 1978) grading system for muscle strength.
• Grade 0: No voluntary muscle contraction.
• Grade 1: Flicker or trace of muscle contractions, no joint movement.
• Grade 2: Active movement but only with gravity eliminated.
• Grade 3: Active movement against gravity but not against resistance.
• Grade 4: Active movement against minimal resistance.
• Grade 4+: Active movement against moderate resistance.
• Grade 5: Normal strength.

3. Operative segments, operation time, hospital stay, and complications.

4. Japanese Orthopaedic Association (JOA) score to assess the clinical status (see APPENDIX A).

5. The radiological parameters (fusion rate, and cervical lordosis) were examined using anteroposterior (AP), lateral, and flexion/extension plain radiographs, and this including measurement of Cobb's angles.

Establishment of Fusion and Lordosis Difinition
Radiographic fusion was considered present if the following features were observed:

1. No motion across the fusion site on flexion–extension X-rays,

2. Trabeculae across the fusion site,

3. No lucency across the fusion site or around any of the screw sites.

If the fusion was questionable, CT scans were performed.

Cervical lordosis was defined as the angle formed between the lower endplate of C2 and the upper end- plate of C7 by Cobb's method on plain lateral radiographs with the patient in a neutral position.

Time of Assessment
1. Preoperative assessment of clinical and radiographic studies (MRI, CT and Xray).

2. Postoperative assesment immediately after surgery (clinically and radiologically).

3. Postoperative assessment at third month postoperatively (clinically and radiologically).

4. Postoperative assessment at sixth month postoperatively (clinically and radiologically).

Statistical Analysis
Data was analyzed using IBM SPSS advanced statistics version 21 (SPSS Inc., Chicago, IL). Numerical data were expressed as mean and standard deviation or median and range as appropriate. Pearson Chi-square tests were used to compare the incidence of postoperative complications.

Qualitative data was expressed as frequency and percentage. Chi-square test was used to examine the relation between qualitative variables. For not normally distributed quantitative data, comparison between two groups was done using Mann-Whitney test (non-parametric t-test). Comparison between quantitative repeated measures was done using ANOVA with repeated measures. Wilcoxon-signed ranks test (non-parametric paired t-test) was used to compare two consecutive measures of numerical variables. A p-value < 0.05 was considered significant.

3. Results
Demographic Distribution
The mean age of our patients was 47 years ± 14. There was wide range of age 45 years (25-70). The bar graph of age is illustrated in figure 28.
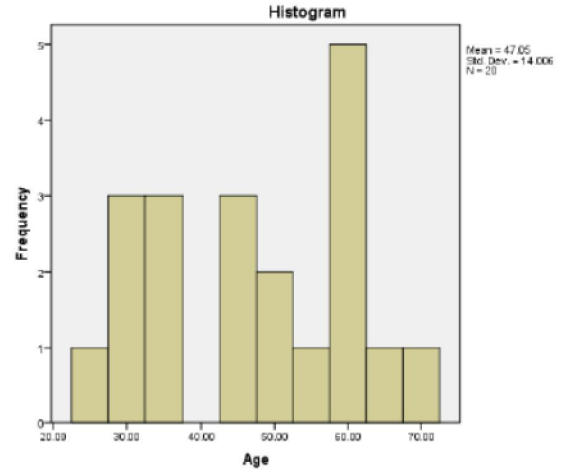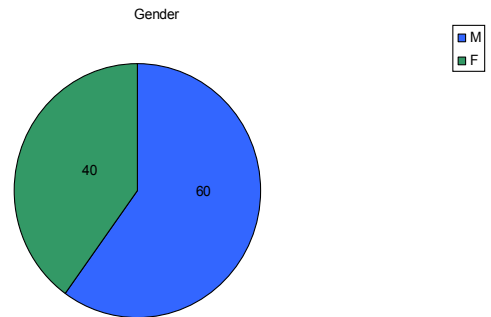

Figure 1: Bar chart of age distribution

The gender distribution showed predominant male over females with 3:2 Males were found 60% (12) while females were 8 (40%). See pie graph

Table 1: Gender distribution in our study

|	Frequency	Percent
M	12	60.0
F	8	40.0
Total	20	100.0

Figure 2: Pie chart of gender

The clinical presentations of study's candidates were variable. The frequency and percentages of all presentations are illustrated in table 5 and figure 30. Quadriparesis and spasticity were frequent among study candidates.

Table 2: Clinical presentations

	Frequency	Percent
Motor dysfunction: Quadriparesis + Bladder dysfunction.	6	30.0
Motor dysfunction: Spasticity	6	30.0
Dysthesia	4	20.0
Brachialgia Bilateral	2	10.0
Brachialgia unilateral	2	10.0
Total	20	100.0
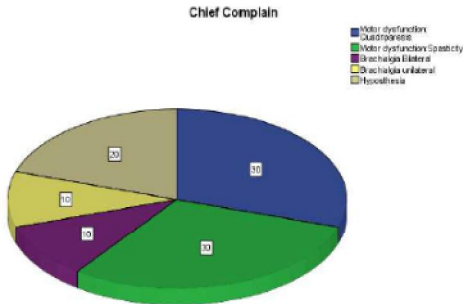
Figure3: Pie chart of chief complains

The duration of symptomatology in our study case was ranging from 1-7 months. The mean and standard deviation was 3.7 months±1.3.
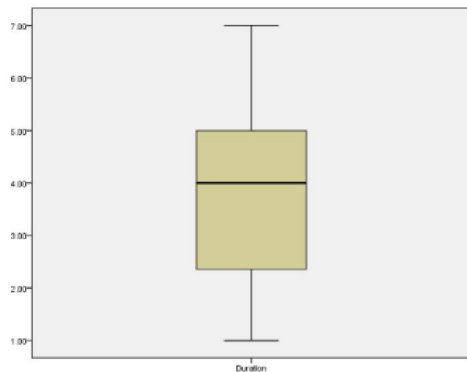
Figure 4: Box-plot of duration

Table 3: Frequency of segments affected.

	Frequency	Percent
C2-C4	1	5.0
C3-C5	5	25.0
C3-C6	2	10.0
C3-C7	2	10.0
C4-C6	1	5.0
C4-C7	5	25.0
C5-C7	3	15.0
C5-T1	1	5.0
Total	20	100.0
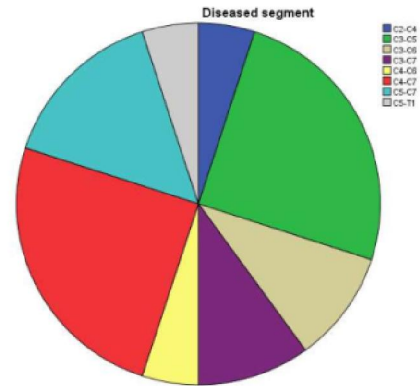
Figure 5: Pie chart of segments affected
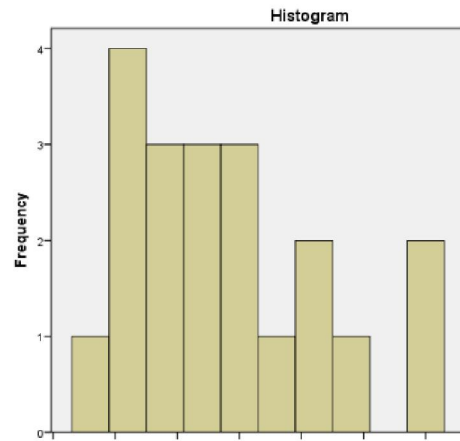
Figure 6: Bar chart of operative hours.
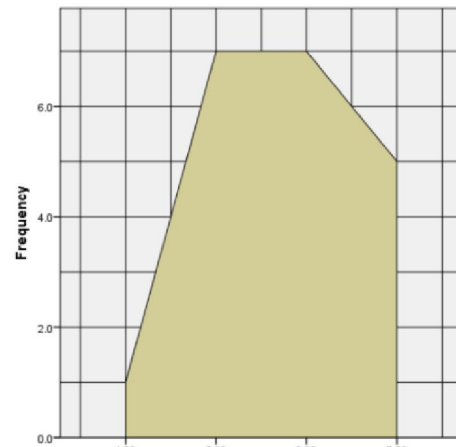
Figure 7: Bar chart of hospital stay

Table 4: Prevalence of complications

	Frequency	Percent
No	13	65.0
Yes	7	35.0
Total	20	100.0
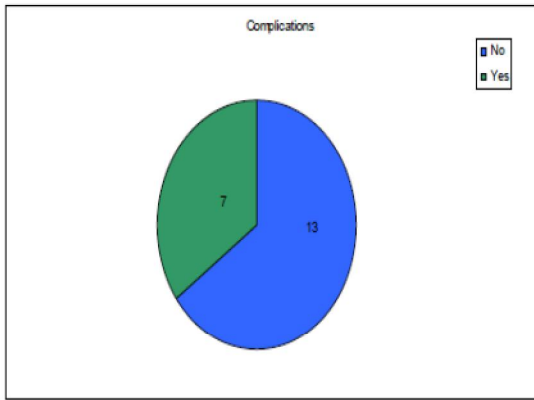
Figure 8: Pie chart of complications' prevalence

The most common level affected in our study was C3 and C4 in 78% of cases. The frequency of segments affected as in the table 6 below.

The operative time (in minutes) was estimated for all surgical procedures. The mean and standard deviation of operative time was 289.8 minutes ±76.8. The mean time when divided by 60 (minutes per hour) showed 4.6 hours.

The hospital stay (in days) was estimated during our survey. The mean and SD of hospital stay was 5.8± 0.9 days. The hospital stay was ranging from 4-7days.

There were prevalent complications in our study procedures. Overall complications was found in 7 cases (35%) (See table 7).
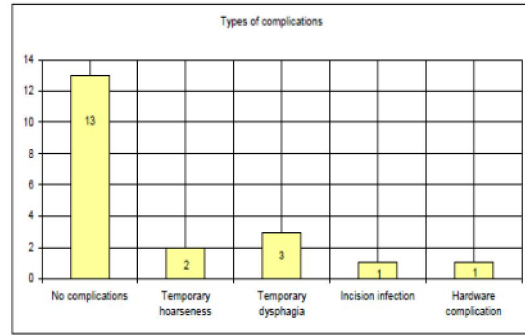
The complications that occurred in our study (in total) were temporary (see table 8). There was no mortality in our study.

Table 5: Types of complications

	Frequency	Percent
No complications	13	65.0
Temporary hoarseness	2	10.0
Temporary dysphagia	3	15.0
Incision infection	1	10.0
Hardware complication	1	10.0
Total	20	100.0

Figure 9: Bar chart of complications

Japanese Orthopaedic Association (JOA) score is widely used to assess the severity of clinical symptoms in patients with cervical compressive myelopathy. In our study the median score preoperatively for all study's participants was 11. The range of score was 10-15. The distribution of curve was skewed to left.
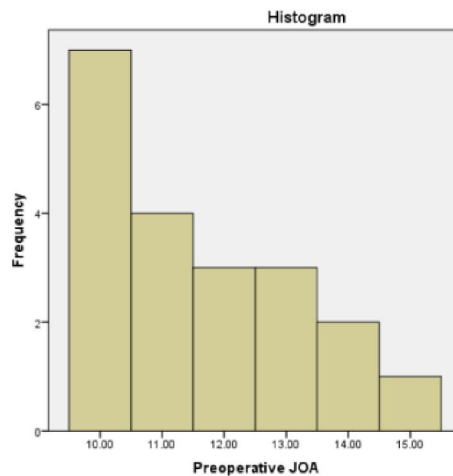
Figure 10: Bar chart of JOA score among our patients

Comparative studies

In this section, we compared both modalities of treatment as regard demographic distribution, clinical and scores perioperatively. Clinical and demographic distributions were compared to delineate the difference between two groups. While scores postoperatively, Cobb's angles and rate of complications were compared to define the success of each modality.

In table 9, both ACDF and ACCF surgeries were compared as regard clinical and symptomatology.

Table 6: Cross tabulation of demographic and clinical symptomatology between ACDF and ACCF.

		Operation											P value	Significance
		ACDF					ACCF							
		Mean	Median	SD	Count	Row N %	Mean	Median	SD	Count	Row N %			
Age		48.6	47.5	14.6			45.5	48.5	13.9			0.621	NS
Gender	M				6	50.0%				6	50.0%	0.675	NS
	F				4	50.0%				4	50.0%		
Chief Complain	Motor dysfunction: Quadriparesis				4	66.7%				2	33.3%	0.225	NS
	Motor dysfunction: Spasticity				1	16.7%				5	83.3%		
	Dysthesia				2	50.0%				2	50.0%		
	Bladder dysfunction				1	50.0%				1	50.0%		
	Brachialgia Bilateral				2	100.0%				0	0.0%		
	Brachialgia unilateral				1	50.0%				1	50.0%		

In table 10, time taking for operation and hospital admission stay length were compared in both groups. There were statistical significance difference between both modalities as regard hospital stay and operative time (0.014 and 0.023) respectively.

Table 7: Difference between ACDF and ACCF as regard operative time and hospital stay

	Operation				P value	Significance
	ACDF		ACCF			
	Mean	Standard Deviation	Mean	Standard Deviation		
Operative time	257.2	56.9	342.4	75.6	0.023	S
Hospital time stay	5.71	0.96	6.9	0.88	0.014	S

The most affected segments were C3-C5 and C4-C7 in both surgeries. The frequency of each diseased segment of both groups is illustrated in table 11.

Table 8: Frequency of diseased segment among ACDF and ACCF patients

		Operation			
		ACDF		ACCF	
		Count	Row N %	Count	Row N %
Diseased segment	**C2-C4**	0	0.0%	1	10.0%
	C3-C5	3	30.0%	2	20.0%
	C3-C6	0	0.0%	2	20.0%
	C3-C7	2	20.0%	0	0.0%
	C4-C6	0	0.0%	1	10.0%
	C4-C7	3	30.0%	2	20.0%
	C5-C7	2	20.0%	1	10.0%
	C5-T1	0	0.0%	1	10.0%

As regard complications, there was no statistical significant difference between two groups in both rate and types of complications (0.113, 0.627) respectively as illustrated in table 12.

Table 9: Difference between ACDF and ACCF as regard complications

		Operation					
		ACDF		ACCF			
		Count	Row N %	Count	Row N %	P Value	Sig.
Yes: No complications	No	7	53.8%	6	46.2%	0.627	NS
	Yes	3	42.9%	4	57.1%	0.113	NS
Complications	No complications	7	57.1%	6	42.9%		
	Temporary hoarseness	2	100.0%	0	0.0%		
	Temporary dysphagia	1	33.3%	2	66.7%		
	Incision infection	0	0.0%	1	50.0%		
	Hardware complication	0	0.0%	1	100.0%		

In table 13 and 14, there were statistically significant difference between preoperative JOA and later postoperative

Table 10: Preoperative and postoperative mean comparison and P value between preoperative and different times of assessment in group of ACDF

	Mean	SD	P Value	Sig.
Preoperative JOA	12.00	1.76	-	-
Immediate JOA	12.00	1.66	**0.013**	**S**
3-Months JOA	13.00	1.70	**0.0001**	**S**
6-Months JOA	14.00	1.81	**0.009**	**S**

Intervals (immediate, 3 months and 6 months) in ACDF and ACCF group.

Table 11: Preoperative and postoperative mean comparison and P value between preoperative and different times of assessment in group of ACCF.

	Mean	SD	P Value	Sig
Preoperative JOA	11.00	1.40	-	-
Immediate JOA	11.00	1.43	**0.06**	**S**
3-Months JOA	13.00	1.55	**0.0002**	**S**
6-Months JOA	13.00	1.91	**0.0065**	**S**

Japanese orthopedic association score was compared four times between ACDF and ACCF. These four times reflects times of assessment. In general, JOA score was inclined over two months later on. At some points, the score may become stable at 3 and 6 months. The mean percentage of JOA score was 15.4% for ACDF and 17.4% for ACCF (see Table 15).

Table 12: Preoperative and postoperative mean comparison between both modalities

	ACDF		ACCF			
	Mean	SD	Mean	SD	P value	Sig.
Preoperative JOA	12.00	1.76	11.00	1.40	0.729	NS
Immediate JOA	12.00	1.66	11.00	1.43	0.885	NS
3-month JOA	13.00	1.70	13.00	1.55	0.945	NS
6-month JOA	14.00	1.81	13.00	1.91	0.677	NS
JOA (%)	15.39		17.40		0.771	NS

As regard Cobb's angle, mean and SD of each procedure was estimated preoperatively and showed no statistically significant difference between two groups (0.067) which reflected homogenous distribution between study's participants. Although, there was no difference in angle correction by either modality at 3 and 6 months interval (0.066, 0.386) respectively.

Table 13: Comparison between ACCF and ACDF as regard Cobb's angle preoperative, 3-months and 6-months interval

	Operation				P value	Significance
	ACDF		ACCF			
	Mean	SD	Mean	SD		
Preoperative Cobb's angle	10.19	2.12	9.59	1.82	0.067	NS
3-Months Cobb's Angle	12.16	2.37	10.89	2.30	0.066	NS
6-Months Cobb's Angle	14.52	2.20	12.97	2.56	0.386	NS

As regard signs of fusion and stability at operated segment, there was no statistical significant difference at either interval between two groups illustrated in table 17.

Table 14: Cross tabulation between ACDF and ACCF as regard osseous fusion

		Operation					
		ACDF		ACCF			
		Count	Row N %	Count	Row N %	P value	Sign.
Osseous fusion at 3M	No	6	50.0%	6	50.0%	0.675	NS
	Yes	4	50.0%	4	50.0%		
Osseous fusion at 6M	No	1	100.0%	0	0.0%	0.5	NS
	Yes	9	47.4%	10	52.6%		
Absence of gap between graft and endplate at 3 months	No	5	45.5%	6	54.5%	0.5	NS
	Yes	5	55.6%	4	44.4%		
Absence of gap between graft and endplate at 6 months	No	1	100.0%	0	0.0%	0.331	NS
	Yes	9	47.4%	10	52.6%		

Correlation studies

There was a positive correlation between the recovery rates and the pre-operative JOA score with recovery rates below 50% in the patients with pre-operative JOA score below 12 in each group. The correlation coefficient was reasonable (r = 0.43); reasonable (r = 0.49) for group **ACDF** but low (r = 0.2) for group **ACCF**, this was statistically significant.

There was a negative correlation between the recovery rates and the number of affected levels with recovery rates below 50% with increasing number of affected levels in each group. The correlation coefficients were low to very low and were statistically insignificant.

Table 15: Factors affecting the recovery rate among patients groups.

Factors	ACDF		ACCF		Patients groups	
	r	p	r	p	r	p
Number of affected levels	-0.31	0.22	-0.032	0.8	-0.25	0.27
Surgical delay time	-0.84	**<0.0001***	-0.7	**0.0001***	-0.79	**<0.001***
Pre JOA score	0.50	**0.021***	0.25	0.1	0.47	**<0.001***

Spearman Correlation, for categorical and non-parametric quantitative data
p value<0.05 = Significant
r = 0–0.2: very low and probably meaningless r = 0.2–0.4: a low correlation
r = 0.4–0.6: a reasonable correlation. r = 0.6–0.8: a high correlation.
r = 0.8–1.0: a very high correlation
N: Number, JOA: Japanese orthopaedic association, P: probability

4. Discussion

Anterior cervical discectomy for cervical spondylosis was initially described in the mid–1950s by **Smith** and **Robinson** and **Cloward** and has been reported with good clinical outcome and fusion rates. In the decades that followed, various modifications of these landmark techniques have been described in the literature, including the addition of cages.

Surgical treatment of multi-level cervical spondylosis is challenging. Type of decompression and the technique of reconstruction are the two important decisions to be made. The types of anterior decompression usually used are multi-level anterior cervical discectomy and fusion ACDF or single-/multi-level anterior cervical corpectomy and fusion ACCF**(Khanna *et al.*, 2017)**.

Although the surgical treatment for cervical spondylotic myelopathy (CSM) has a history going back sixty years, the selection of surgical procedures remains controversial and challenging. The common surgical procedures used include the anterior, posterior, and combined anteroposterior approaches **(Cole et al., 2017)**.

Anterior approaches to the cervical spine are recognized as a reliable and effective method to treat CSM and they have been widely accepted as an appropriate operative procedure. Anterior decompression and fusion can remove the compressive pathology and reconstruct the alignment of the cervical spine, yielding good clinical results. The type of decompression and reconstruction technique are the two important decisions to be made**(Lord et al., 2017).**

Anterior decompression and fusion include cervical discectomy with fusion (ACDF) and anterior cervical corpectomy with fusion (ACCF), however, the ideal anterior decompression method is controversial. Although some relevant studies comparing the ACDF and ACCF have been reported, the evidence regarding whether ACDF is superior to ACCF remains insufficient, owing to ambiguous results**(Han *et al.*, 2014)**.

Several studies have demonstrated the superior biomechanical properties of cages in comparison with an autologous bone graft**(Huang *et al.*, 2016)**.

Polyether-etherketone (PEEK) is a semicrystalline thermoplastic with excellent mechanical and chemical resistance properties that are retained to high temperatures. The tensile strength is 90 to 100 MPa and its Young's modulus is 3.6 GPa, which is closely related to that of the cancellous bone **(Lawrence *et al.*, 2013)**.

Previous studies have shown that surgical treatments of two-level CSM using ACDF or ACCF are similar in terms of clinical outcome. However, with regard to the amount of bleeding and radiological results, two-level ACDF was found to be superior to one-level ACCF in terms of operation times**(Yang *et al.*, 2017)**.

Cunningham et al reviewed retrospective cohort studies comparing ACDF, corpectomy, laminoplasty, and laminectomy and fusion as surgical options for CSM from 1980 to January 2008, and concluded that all approaches yield similar neuro-recovery rates. Recently, **Shamjietal** reviewed studies comparing multiple discectomies with single or multiple corpectomy, multiple discectomies with a hybrid discectomy–corpectomy procedure, and multiple corpectomies with a hybrid discectomy–corpectomy procedure, and concluded that all three operative approaches are effective strategies for the anterior surgical management of CSM. However, which surgery is a better option in the treatment of multilevel CSM remains unclear**(Cunningham, Hershman and Bendo, 2010).**

Based on 15 studies and a total of 1,368 cases of multi-level CSM using ACDF or ACCF, **Wen *et al.*, (2015)** conducted a pooled analysis comprehensively assessed the clinical outcomes after surgery. Using pooled analysis from the included studies, they found that although blood loss and numbers of complications in ACDF was significantly less than in ACCF, other clinical outcomes, such as operation time, bone fusion failure, and post JOA scores between ACDF and ACCF for multilevel CSM were not significantly different. Indeed, they found evidence of publication bias, and consistent results are shown in sensitivity analyses.

In a meta-analysis conducted by **Han *et al.*, (2014)**, operation time and blood loss were selected to evaluate surgical trauma. Both the overall and subgroup analyses revealed that although blood loss was significantly higher in the ACCF group than in the ACDF group, the operation time was similar in the two groups. This indicates that, in the treatment of CSM, the surgical trauma associated with ACCF is higher than with ACDF.

Wu *et al.*, (2017) studied the stand-alone titanium box cage for ACDF on57 consecutive patients with 5-year follow-up and found that the clinical and radiological outcome was satisfactory and subsidence caused by non-plating did not affect the long-term clinical outcome.

There are few studies in the literature regarding the stand-alone PEEK cage for interbody fusion in multiple levels ACDF. **Wen *et al.*, (2015)** on studying 84 patients reported that the fusion rate using polyetheretherketone (PEEK) stand-alone cages reaches as high as 97% with lower subsidence.

In another study of stand-alone PEEK cage in 36 cases with aminimum 12-month, follow-up showed no subsidence**(Liao et al., 2008)**.

In the current study cage-assisted fusion in ACDF group allowed restoration of disc space height in all cases with fusion rate 95% at 6 months follow up. The preoperative cervical kyphosis improved in many patient in whom it was lost preoperatively with an average subsidence of 1 mm in 20% of patients. There was no postoperative loss of lordosis in patients with normal preoperative curvature.

As one of the reasons postulated for the high non-union rates after multilevel ACDF is the higher number of fusion surfaces involved, Somesurgeons have advocated the use of cervical corpectomies as an alternative to multiple interbody grafts, citing a decreased rate of pseudarthrosis secondary to fewer graft–host interfaces where fusion needs to occur **(Cunningham, Hershman and Bendo, 2010; Liu et al., 2017).**

Advantages of anterior corpectomy and fusion for multilevel cervical decompression include improved visualization, allowing for a morextensive decompression, and fewer graft-hostinterfaces requiring fusion (compared with segmental anterior cervical discectomy and fusion), theoretically leading to improved rates of arthrodesis **(Cunningham, Hershman and Bendo, 2010)**.

In anterior reconstruction after corpectomy, fibular strut grafts were associated with a non-union rate as high as 41% for allograft and 27% for autograft. However, the use of autograft has significant donor sitemorbidity **(Kaiser et al., 2002)**.

In view of the disadvantages of both allograft and autograft, the Titanium mesh cage TMC designed by Harms in 1986 became an alternative method of reconstruction in these procedures. Titanium mesh cages have been used in anterior reconstruction of the spine for trauma and tumors with adequate results **(Tuchman et al., 2017).**

Riew and Rhee (2002) reported high fusion rates after cervical corpectomies using TMC (up to 100%).

In a 2-year follow up study on subsidence of titanium cage after anterior cervical interbody fusion; **Rumalla et al., (2017)**decided that careful preservation of the end plates and avoiding of over-distraction are very important to avoid significant subsidence.

Most of the studies reviewed have reported higher fusion rates after corpectomy than multi-level ACDF; all using similar reconstruction techniques.

Contrary to these results, on studying 80 patients with anterior cervical discectomy fusion versus cervical corpectomy and fusion using titanium cages in both groups, **Uribe et al., (2009)** found slightly

higher fusion rates after multi-level ACDF than ACCF, they believed that the higher fusion rates in the ACDF group could be due to strict adherence to surgical principles of anterior cervical fusion.

In the current study there was the same fusion rate in both ACDF and ACCF groups. These results are similar to those of **Wang et al., (2016)** who reported similar fusion rates in both multi-level ACDF and ACCF groups using allograft with cervical plating.

The clinical outcome was compared to other series, **Liu et al., (2014)** followed up 75 patients with anterior decompression and anterior spinal fusion done for cervical spondylotic myelopathy for 1 year. They found that 46.7% of patients had improvement of lower limb function and 75.4% patients had improvement in upper limb function.

Hou et al., (2017) studied 55 consecutive patients suffering from cervical spondylotic myelopathy by either laminoplasty or anterior decompression and fusion using autologous iliac crest bone, they found animprovement of the JOA scores in 71% of patients. The mean recovery rate was 55%. These results correlate well with the current study. Prognostic factors for surgical treatment of cervical spondyloticmyelopathy are still controversial.

Luo et al., (2015) reported no difference in neurological recovery for patient's age groups after surgical decompression by anterior cervical corpectomy. However, **Rumalla (2017)** showed post-operative recovery of spinal cord function in the older age group is inferior to that of younger patients.

Cheung et al., (2012) found that older patients had a significantly lower pre-operative JOA score and suggested that was due to the less functional demand of elderly patients compared with younger patients so tolerate more functional loss before seeking medical advice. The recovery rate for older patients with lower pre-operative JOA score was less than that of the younger patients.

These results correlate well with the results of the current study for both groups. There was a statistically significant positive correlation between the recovery rates and the pre-operative JOA score with recovery rates below 50% in the patients with pre-operative JOA score below 12 in each group with reasonable correlation coefficient.

Some studies reported that the duration of symptoms did not affect surgical outcomes. **Cheung et al., (2012)** found there was no significant difference in neurological recovery in patients with different pre-operative durations of symptoms.

Contrary to this result, in a series of long-term results of anterior cervical spondylosis, **Huang et al., (2014)** demonstrated that patients with a longer

duration of symptoms had inferior neurological recovery.

In the study conducted by **Han *et al.*, (2014)** there was a statistically significant negative correlation between the recovery rates and the delay time before surgery with recovery rates below 50% in the patients with delay time more than 12months with high correlation coefficient.

Comparing the results of this study with **Uribe** et al **2009** demonstrated that similar outcomes were noted for improvement in neckpain and brachialgia and improvements were maintained at 1 year, 80consecutive patients were treated with either anterior cervical discectomy fusion or anterior cervical corpectomy fusion with excellent outcome was reported by 83.3% of the patients in group 1 and 79% in group 2.

These results were mentioned was not included in our methodology.

As regarding complications, in the current series, 20% experienced temporary hoarseness of voice, no patient experienced cage extrusion, no esophageal perforations or CSF leak, 30% percent developed postoperative transient dysphagia, and 10% developed superficial wound infection due to non-compliance with postoperative antibiotic administration, these results were acceptable comparable with similar studies and even less than it.

In **Han *et al.*, (2014)** study, they selected the total complications for meta-analysis to evaluate complication-related outcomes, and found a higher incidence of complications with ACCF than with ACDF (OR=0.50, 95% CI=0.35 to 0.73, p=0.0003). Subgroup analysis observed apart from graft related complications is significantly higher in the ACCF group (p=0.005), while other subgroups, namely dysphagia, hoarseness, C5 palsy, infection, cerebral fluid leakage, donor site pain, epidural hematoma and hardware-related complications, were similar between the two groups. There was no heterogeneity between the two groups for total complications for all subgroups (I2=0).

According to **Shriver *et al.*, (2017)** 48% of patients will suffer short-term dysphagia, however **Koller *et al.*, (2007)** observed postoperative temporary dysphagia in 17.6%, and transient hoarseness in 11.8%, this correlates well with the current study.

Some studies have reported that post-operative dysphagia occurs in 2–48% of patients **(Koller *et al.*, 2007; Cunningham, Hershman and Bendo, 2010).**

There were similar rates of dysphagia and hoarseness between the two groups in this meta-analysis; and they are the most common sequelae, these symptoms are frequently transient. The etiology of dysphagia may be multifactorial, including

hematoma formation and prolonged retraction and denervation of the upper esophagus by injury to the pharyngeal plexus **(Uribe *et al.*, 2009)**. The etiology of post- operative hoarseness has been postulated to be related to direct injury to the recurrent or superior laryngeal nerves. Although no patient in our series developed cerebrospinal fluid leak, several published reports describe this problem in corpectomies and were associated with severe spondylosis, multiple re-operations, or ossifiedposterior longitudinal ligament (OPLL) (**Joseph et al., 2009)**.

Considering the most significantly different complications were graft-related, this seemed to be due to technical reasons **(Han *et al.*, 2014; Huang *et al.*, 2016; Wang *et al.*, 2016)**. Some authors consider that ACDF offers more fixation points to hold the construct rigidly in place, but ACCF provide only two points of fixation. The lack of fixation points may therefore be the reason for the higher graft-related complication rates in the ACCF group **(Tuchman *et al.*, 2017).**

A meta-analysis was conducted by **Han *et al.*, (2014)** to determine whether ACDF is associated with better clinical outcomes compared with ACCF. In that meta-analysis, they used strict eligibility criteria. Although no RCT studies were included in the study, all selected studies were of high quality according to the Newcastle Ottawa Quality Assessment Scale (NOQAS) and the baseline variables were similar. Thus, they considered the same parameters as ours clinical outcomes (hospital stay, JOA, VAS, NDI score and Odom criteria), surgical outcomes (operation time, blood loss, and perioperative complications), and radiographic outcomes (rate of fusion, Cobb angle of C2–C7, and segmental angle) were assessed in the meta-analysis.

There was a significant difference in hospital stay between ACDF and ACCF. A shorter hospital stay makes ACDF a better proposition than ACCF. In the meta-analysis of JOA, VAS and NDI, scores were similar in the two groups. However, both groups demonstrated a significant post-operative increase in JOA scores and decrease in VAS scores, an increase that was maintained at the final follow-up. There was also no difference in Odom criteria between the two groups. These findings indicate that both groups achieved adequate decompression of the spinal cord and nerve roots that were compressed by herniated discs or osteophytes, and that these patients benefited from reconstruction of the spinal column. The current study was showing same results.

In this case-series, both the ACDF and ACCF groups had significantly increased lordosis of C2–C7 and fusion segments, but the increase was greater in the ACDF group than in those with ACCF. Some studies have reported that ACDF can provide multiple

points of distraction and fixation in addition to the graft and interbody space shaping, and can also restore alignment by pulling the involved vertebral bodies toward the lordotic ventral plate. However, ACCF grafts may straighten the cervical spinal column between the remaining vertebral bodies **(Liu et al., 2011)**. The current study was showing same results.

Conclusion

ACCF did not yield superior results than ACDF in management of multilevel CSM, but on the contrary ACDF are superior to ACCF as it has shorter hospital stay and operative time, less blood loss, and increased cervical lordosis. On the light of this ACDF using interbody fusion cage is a better alternative for the surgical management of multilevel CSM.

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