

Functional outcome of Anterior Cervical Discectomy and Fusion with Anterior Cervical Plating Among Patients of Cervical Disc Disease at a Tertiary Health Care Centre

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Abstract

Introduction: Cervical spondylosis means osteoarthritis of cervical spinal column. The degenerative process mainly affects the vertebrae, neural foramina and the facet joints. It leads to compression of the spinal cord resulting in progressive neural cell loss and neurological deterioration in 40 to 60 % of patients. Cervical myelopathy is a constellation of symptoms and physical findings including motor and sensory abnormalities. Spasticity and paresis are frequently seen. The patient often complains of gait disturbance due to abnormalities in corticospinal tract and spinal spinocerebellar tracts. There is also associated loss of grip strength and finger movements. Anterior cervical discectomy and fusion (ACDF) is a commonly performed procedure to remove a herniated or degenerative disc. An incision is made in the anterior cervical region and the disc is then removed. A graft is then placed to fuse the vertebrae above and below the disc. ACDF was first described by Cloward, Smith and Robinson in 1958 and shortly later by Hirsch in 1960 who described anterior cervical decompression and debated the necessity for inter body fusion. Anterior cervical discectomy and fusion has been widely performed since the late 1950s and is currently recommended in patients in whom the nonoperative modalities for single level or multilevel disease have failed. **Objectives:** To study the functional outcome of cervical discectomy and fusion with anterior cervical plating among patients of cervical disc disease. **Materials and Methods:** 46 patients treated with ACDF with anterior cervical plating were considered in this study. **Results and Conclusion:** All the patients showed significant post-operative improvement in their symptoms and diagnostic scores. Thus, we can conclude that ACDF with anterior cervical plating is an efficient procedure in patients with cervical myelopathic symptoms not responding to conservative treatment.

Keywords: Anterior Cervical Plates, Cervical Myelopathy, Fusion, Kirkaldy Willis, MJOA Score, NURICK

1. Introduction

Cervical spondylotic myelopathy is the most common cause of spinal cord dysfunction in the elderly in the Western world. Stookey, 1928, originally described this

disorder and attributed it to compression of the cord by degenerated disc material¹. Although mechanical compression is the primary pathology in many patients a combination of these static compression along with dynamic factors secondary to motion abnormalities is

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present². A congenitally narrow canal, cord morphology and vascular factors also contribute to myelopathic changes. The normal anteroposterior diameter of canal in cervical region is about 16 to 17 mm. A diameter of less than 13 mm defines a congenitally narrow canal while that of more than 16mm confers a lower risk of myelopathy³. Penning *et al.* reviewed that signs of cord compression developed when the cross-sectional area of the cord decreased by 30 %⁴. The Pavlov ratio which is described as the anteroposterior diameter of canal divided by the anteroposterior diameter of vertebral body at that level indicates a congenitally narrow canal; a ratio of less than 0.8 is considered significant⁵. Hyperextension narrows the canal by protruding the laminae and the ligamentum flavum anteriorly into the canal. Flexion extension movements may produce a change in diameter of canal of upto 2mm. The segment proximal to the stiffened segment is sometimes hypermobile, potentially resulting in myelopathic changes at the hypermobile level. It was Barre *et al.* who first proposed the role of vascular impairment in the role of development of cervical myelopathy⁶. In two separate animal studies it was observed that cervical cord ischemia superimposed on cord compression lead to dramatic increase in symptoms⁷. Vessels most susceptible to reduced blood flow are the intramedullary arterioles that perfuse the grey matter and the lateral columns. The oligodendrocyte is particularly sensitive to ischemic injury leading to its apoptosis and subsequent irreversible demyelination⁸. The diagnosis of cervical myelopathy is usually straightforward because

of its dramatic clinical presentation. There is neck pain, loss of hand coordination, gait disturbances and sphincter dysfunction. There is also associated profound muscle weakness. Reflexes are brisk and may be self-sustaining with ankle clonus. Pathological reflexes may be seen such as:

1. Babinski sign- extension of great toe and fanning of other toes in response to stroking of the sole of foot⁹
2. Hoffman sign- flicking the middle finger into extension leading to clawed flexion of the thumb and other fingers¹⁰ (Figure 1).
3. Inverted supinator reflex- signifies a lesion at c5-c6 level. It includes an absent response of brachioradialis and a hyperactive response of the finger flexor muscles when the radial styloid is tapped. It is caused by intraspinal spread and increased activity of alpha motor neurons below the level of lesion and loss of those at the level of lesion¹¹ (Figure 2).

Two Other Signs can often be Elicited in these Patients

1. Grip and release test- alternating between closing into a fist and full finger extension. Normal frequency is 20 times in 10 seconds¹².
2. Finger escape sign -inability to maintain the fully extended fingers in adduction. There is tendency of the little finger to abduct (Figure 3).

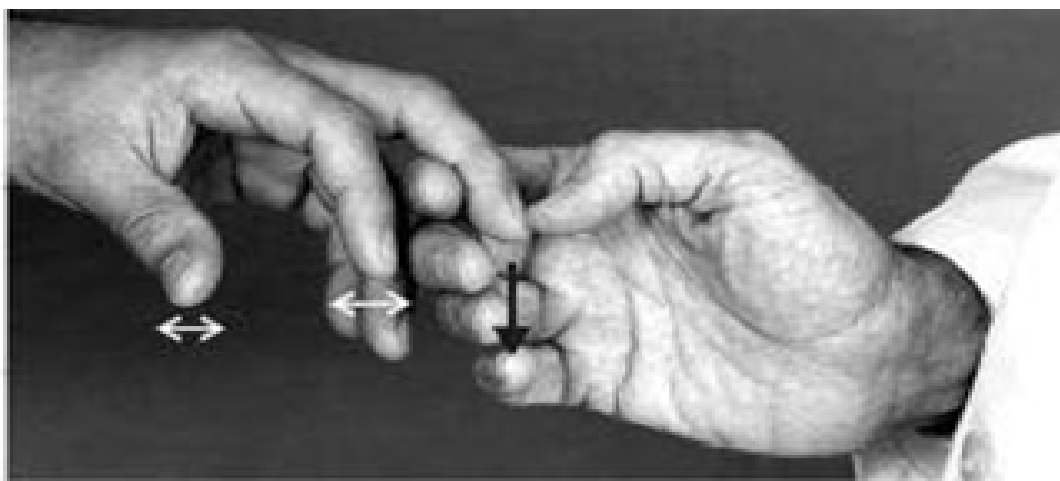


Figure 1. Hoffman reflex.

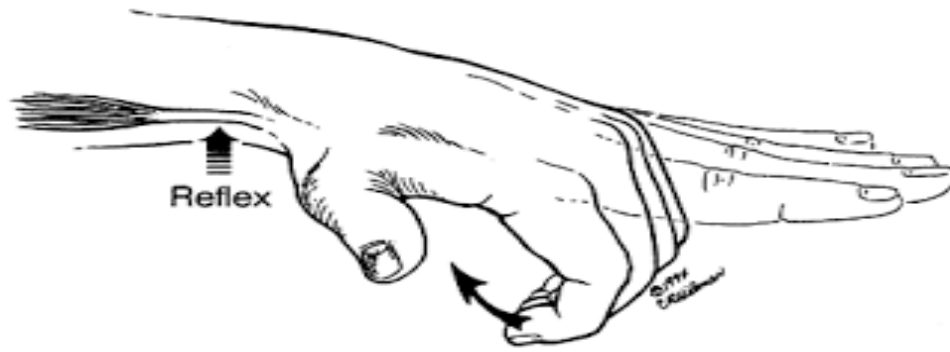


Figure 2. Inverted supinator reflex.



Figure 3. Finger escape sign; Grip and release sign.

1.1 Management Options

1. Conservative Management

Many patients who develop symptoms of cervical spondylosis have a self-limiting course¹³. Spontaneous remission of a cervical disc is a well-known entity and hence the patient is usually managed conservatively for a period of about 6-8 weeks. Radicular symptoms are more likely to resolve spontaneously than myelopathic

symptoms¹⁴. Some patients may experience a progressive decline while others develop a period of disease stability with intermittent exacerbations. Significant motor weakness is an indication for urgent surgical referral; but otherwise a non-surgical regimen is usually followed. The mainstay of treatment is a combination of NSAIDs and cervical traction¹⁵. Traction recommendations are based on body habitus and normal cervical x-rays.

Traction may aggravate the muscle spasm but is useful in reducing the radicular component. Muscle relaxants and analgesics may be added¹⁶. Any coexistent depression or anxiety must be treated too. Psychological disturbances are known to exert statistically significant negative effects on clinical outcomes. Nicotine addiction is also a proven negative impact factor and must be dealt with.

2. Surgical Management

As recommended by Larocca^{17,18} early stabilizations is paramount to halt the worsening of disease and restore alignment of the spine. Surgeries involve anterior and posterior approaches. The surgical choice of an anterior, posterior or combined approach is based on location, extent of compression, previous surgery and the patient's overall condition.

3. Anterior Cervical Discectomy and Fusion (ACDF)

Exposure of middle and lower areas of the spine is commonly done through the anterior approach. A left sided approach is usually taken because of the constant nature of course of left recurrent laryngeal nerve¹⁹. The shorter more lateral course of the right recurrent laryngeal nerve places it more at risk of direct trauma or retraction. A left sided approach medial to the carotid artery and internal jugular vein is thought to minimize the risk of injury

4. Evolution of Anterior Cervical Plates

The first cervical plates were introduced in the 1950s. Initially higher rates of pseudo arthrosis and kyphosis were encountered in multilevel procedures²⁰. Anterior cervical plates have improved significantly in the last 30 years. The fusion rates are now better and incidence of graft dislodgement has decreased.

2. Aims and Objectives

To study the functional outcome of cervical discectomy and fusion with anterior cervical plating among patients of cervical disc disease.

3. Materials and Methodology

Type of Study: Prospective study

No. of Patients (Sample Size): 46

Duration of Study: August 2016 To December 2018

Study Centre: Department of Orthopaedics, Medical College and Tertiary Health Care Centre.

3.1 Inclusion Criteria

1. Patients presenting with cervical myelopathic or radicular symptoms or Both, not responding to conservative treatment.
2. Radiologically confirmed cervical cord compression

3.2 Exclusion Criteria

1. Patients with traumatic injury of cervical spine, infective aetiology (Koch's spine), tumors and congenital anomalies of cervical spine
2. Patients previously operated for cervical myelopathy.
3. Neurological diseases involving the cervical spine leading to the presenting complaints e.g. parkinsonism, multiple sclerosis.

After performing Anterior Cervical Discectomy and Fusion with Instrumentation (ACDFI), postoperatively the patients were assessed for functional outcome using the NURICK grading system and the mJOA criteria at one month, three month and six months.

Additionally, the VAS score was calculated preoperatively and postoperatively at 1m, 3m, 6m follow up. The patients were also graded based on the modified Odom's criteria at 6m follow up.

NURICKS Grading System²¹

- 0- signs or symptoms of root involvement but without evidence of spinal cord disease
- 1- signs of spinal cord disease but no difficulty in walking
- 2- slight difficulty in walking which does not prevent full time employment
- 3- difficulty in walking preventing full time employment but does not require assistance
- 4- able to walk with assistance
- 5- bedridden

Modified Japanese Orthopaedic Association Scoring System²²

1. Motor dysfunction scoring of upper extremity

- Cannot move hands -0
- Can move hands but not able to use spoon -1
- Can use spoon but not unbutton shirt-2
- Difficulty in buttoning shirt-4
- Normal -5

2. Motor dysfunction score of lower extremity

- Complete loss of sensory and motor function-0

- Sensory function preserved with inability to move limbs-1
- Able to move legs but unable to walk-2
- Able to walk on flat floor but with walking aid-3
- Able to walk and down but with handrail – 4
- Able to walk up and down without handrail but with impaired stability-5
- Mild lack of stability-6
- No dysfunction-7
- 3. *Sensory dysfunction of upper extremity*
- Complete loss of hand function- 0
- Severe sensory loss of pain-1
- Mild sensory loss-2
- No sensory loss-3
- 4. *Sphincter dysfunction score*
- Inability to micturate voluntarily-0
- Marked difficulty in micturition-1
- Mild to Moderate difficulty in micturition-2
- No difficulty in micturition-3

Nurick grading and Japanese orthopaedic association score and its modified version are the most widely used scales for grading degree of impairment in cervical disc disease. Although Nurick grading is simpler to administer it grades the employability of the person and in that

sense is not exactly disease specific. The mJOA system differs from the original JOA in that it only assesses the motor dysfunction in upper and lower extremities, sensory dysfunction in upper extremities, and bladder dysfunction. It does not include sensory dysfunction in lower extremities and trunk. This system focusses on use of spoon instead of chopsticks to evaluate motor function of upper extremities. To study postoperative complications, the patient was assessed after 24 hours and on subsequent scheduled follow up. Any persistent postoperative complications at 6m follow up were documented.

VAS Numeric Pain Rating Scale²³

The Visual Analogue Scale (VAS) consists of endpoints defining extreme limits such as ‘no pain at all’ and ‘severe pain’. The patient marks his/her pain level between the endpoints pre and post operatively (Figure 4).

Modified Odom’s criteria²⁴ - calculated post operatively
 Excellent – all preoperative symptoms and abnormal findings resolved completely
 Good – abnormal findings improved; minimal persistence of preoperative symptoms
 Fair – definite resolution of only some of preoperative symptoms (residual root irritation present with transient

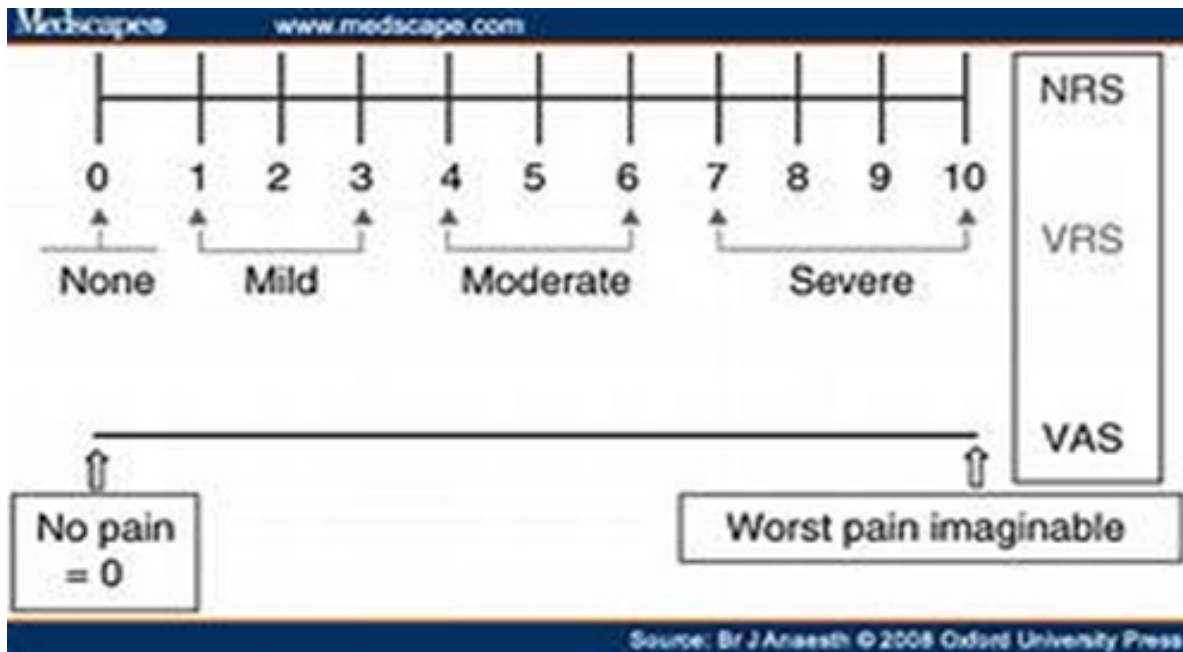


Figure 4. VAS pain rating scale.

pain) Poor – preoperative signs / symptoms unchanged or worse.

Postoperative Protocol

1. Nil by mouth for 6-8 hours
2. All patients are immobilized with a hard-cervical collar postoperatively
3. From the 2nd day patients are allowed assisted bedside sitting
4. Depending on the neurological improvement, gradual out of bed mobilization is started.
5. Suture removal is done on 10th day
6. All patients are followed up at 1 month, 3 months, 6 months post operatively
7. Radiological evaluation is done at 8th to 10th weekpost op. Dynamic xrays are obtained and depending on the status of fusion neck exercises are initiated
8. Chest physiotherapy is started in the preoperative period and continued postoperatively

4. Observations and Results

The following statistical analysis was obtained for each of the variables (Tables 1), Figure 5 to 7 show the comparison of mean MJOA, Nurick, VAS scores pre and post-operative follow ups

1. The within subject effects (main effect – time) scored significantly for MJOA scores
2. The within subject effects (main effect – time) scored significantly for Nurick scores
3. The within subject effects (main effect – time) scored significantly for VAS scores
4. The post Hoc test results were also significant for each of the MJOA, Nurick, VAS scores
5. The patients also demonstrated significant improvement from 1 month postoperatively upto 6 months postoperatively

Spearman’s Rank Correlation is applied to find the nature of relationship between ODOMS criteria and Various Post-operative scores

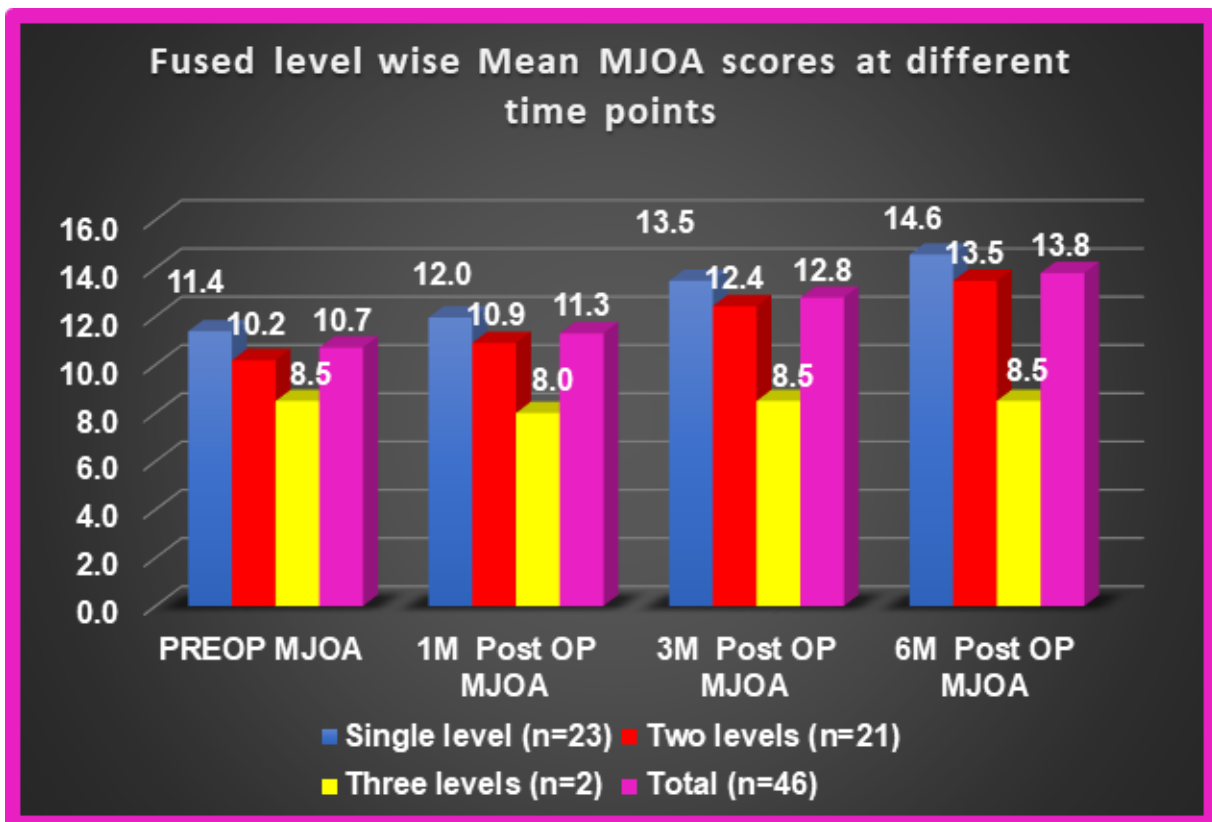


Figure 5. Mean MJOA scores pre and post operatively

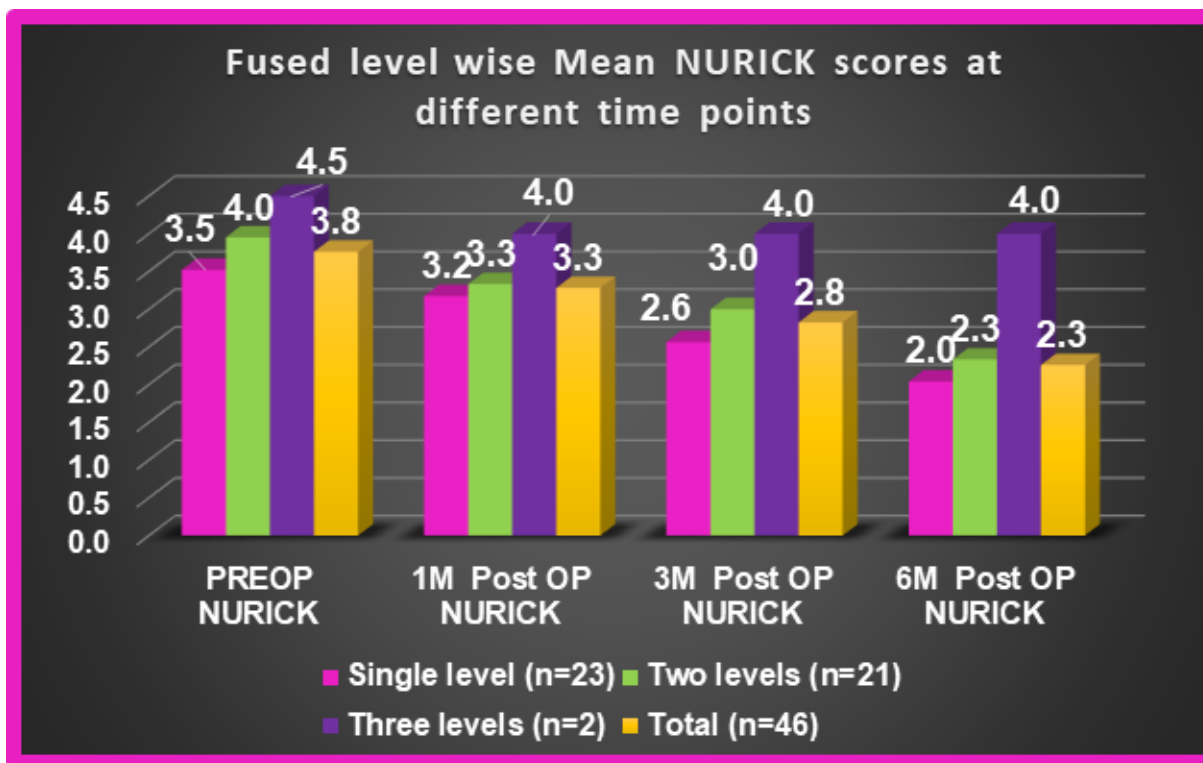


Figure 6. Mean NURICK scores pre and post operatively

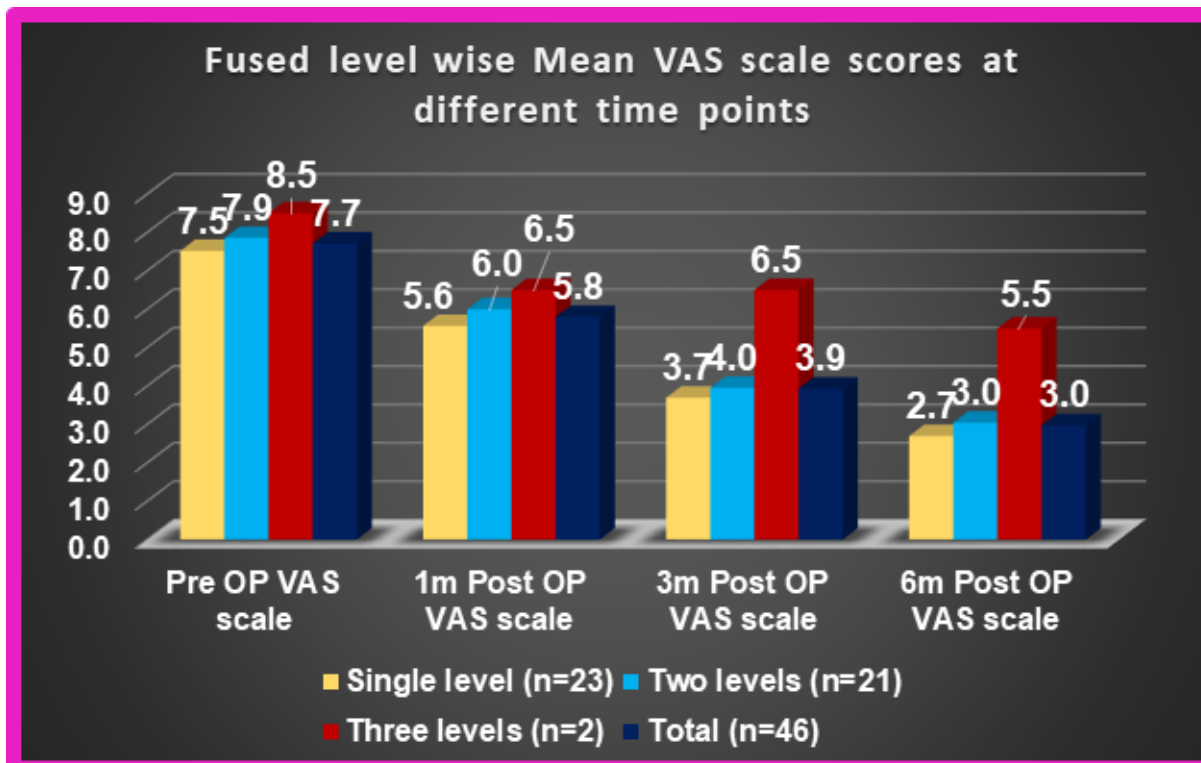


Figure 7. Mean VAS scores pre and post operatively

Table 1. Correlation between ODOM’S criteria and post-operative scores

Spearman’s Rank Correlation			
	6M_POST_OP_MJOA	6M_POST_OP_NURICK	6m_Postop_VAS_scale
Spearman’s rho Correlation Coefficient Between Ranks for ODOMS and	-.366*	.764**	.469**
Conclusion about relationship	Moderate Negative correlation	Strong Positive correlation	Moderate Positive correlation
Sig. (2-tailed)	0.012	0	0.001
n sample size	46	46	46
**. Correlation is significant at the 0.01 level (2-tailed).			
* . Correlation is significant at the 0.05 level (2-tailed).			

5. Discussion

Degenerative cervical conditions comprise a spectrum of disorders ranging from axial neck pain and cervical radiculopathy to cervical myelopathy. In most cases the underlying pathoanatomy starts with degeneration of cervical disc. Abnormal kinematics in the motion segment eventually cause instability and formation of osteophytes ultimately leading to neural compression. Patients with cervical disc disease often seek medical help for relief of pain in arm or neck, weakness and numbness. Apart from those with severely progressed myelopathic changes most patients are treated nonoperatively as a majority of these with radicular symptoms have a self-resolving course. Many cases of acute onset neck pain may arise from muscle or soft tissue sprains but ongoing neck pain is suggestive of spondylotic source.

The immediate goal of treatment is to relieve pain and minimize the disruption of patient’s daily activity. Pain relief medication has to be considered as a temporary measure and regaining lost function has to be ultimate end point to stop treatment and physiotherapy.

Cervical collars are analogous to bed rest being used to conservatively manage lumbar discs. Cervical collars are to be weaned off over 2 weeks and overuse may lead to atrophy of cervical musculature. Extension is usually painful in these patients and collars are to be worn in slight flexion. Ice compression is usually helpful in acute spasmodic states while hot compresses are used once cervical motion is permitted. Traction has failed to show long term benefits but intermittent traction is said to relieve radicular symptoms. Amongst medications the commonly used ones are NSAIDS, narcotics, muscle relaxants, oral steroids and antidepressants. Physical therapy does not significantly alter the course of cervical disc disease. After the initial period of immobilization has elapsed gradual active range of motion exercises are started. Passive exercises are not proven to be of any help clinically. Compared to the lumbar spine, cervical steroid injections are less commonly used. This can be explained to the fact that there is a greater iatrogenic risk in performing cervical injections. In absence of proven benefit nonoperative treatment should be only tried if there is minimal associated risk. In patients with

nonspecific axial pain conservative treatment fairs poorly. Myelopathic symptoms, persistent or increasing radicular pain, gradual neurological worsening are the usual indications for surgical treatment.

The natural history of Cervical Spondylotic Myelopathy (CSM) is usually one of deterioration. Although there is still lack of consensus regarding the aetiology of neuronal damage; direct compression and vascular ischemia have been suggested as potential causes. The clinical findings in a myelopathic case are often subtle to start with and patients in later stages complain of decline in motor skills. Patients exhibit loss of dexterity and gait disturbances. In extreme cases there may be frank paralysis and bowel bladder disturbances.

About 70% patients deteriorate in a stepwise fashion and over 30 % progress to severe disability if not managed appropriately. The excellent outcomes of instrumentation and theoretical advantages of decreased graft migration have made plating an attractive option.

The four basic aims for anterior cervical fixation as outlined by White and Punjabi *et al.*²⁵ are-

1. To restore clinical stability in cases where structural integrity has been compromised.
2. To maintain alignment after deformity correction
3. To prevent progression of deformity
4. To alleviate pain.

Anterior cervical instrumentation was initially used in cervical trauma and its indications have expanded over time to degenerative cases. The addition of anterior plates has shown to improve rates of fusion, improve postoperative mobilization and reduce segmental kyphosis. The plate also acts as a buttress for graft migration. A distance of minimum of 5mm is recommended between the plate and the unaffected disc segment to reduce the incidence of adjacent segment disease. Orozco *et al.* was the first to describe the use of tubular plates and subsequently developed the 'H' plates. These were later modified by Arbeit gemeinschaft fur Osteosynthese (AO) into trapezoidal plates which were widely used across Europe. early devices required bicortical screw purchase and hence had increased risk of dural penetration and neurological deficits. The second-generation plates permitted screws fixed to the implant and convergence in the vertebral body. The latest third generation plates are semi constrained systems that prevent stress shielding and allow subsidence.

Although the anterior cervical approach has been shown to be an effective procedure in cervical myelopathy suboptimal results have been reported. Attempt to fuse multiple levels leads to increased chances of non-union. Non-union is diagnosed by absence of bone growth at the graft host interface and motion on dynamic radiographs. Soft tissue injuries are commonly encountered in the post-operative period. Dysphagia is commonly seen and is attributed to oesophageal dysmotility due to excessive retraction intraoperatively²⁶. Bazaz *et al.* in their comprehensive study concluded that instrumentation does not increase the risk of post-operative dysphagia. Oesophageal perforation rates are usually very low; approximately 0.2%

Injuries to the recurrent laryngeal nerve have been reported due to dissection and soft tissue mobilization. Beutler *et al.* compared the rates of injury to recurrent laryngeal nerve during left and right sided approaches and found no significant difference between the two. Hence some surgeons prefer approaching the spine from the opposite side in a case of revision surgery. In situations where the primary surgery has resulted in unilateral paralysis, approach should be done from the same side to avoid the risk of a bilateral paralysis²⁷.

In the present study we studied a total of 46 patients with cervical compressive myelopathy who were operated with anterior cervical discectomy and fusion with anterior cervical plating. The patients were evaluated preoperatively with MJOA, Nurick, VAS scores. Postoperatively each patient was evaluated at 1m, 3m, 6m follow up and each of the scores was calculated again. Also, postoperatively the modified odoms score was calculated at 6 monthly follow up. Any persisting complications that were present in the monthly follow ups were tackled appropriately and documented.

It was observed that the Nurick and MJOA scores improved significantly over a period of 6 months post operatively. Thus, implying that following ACDF with plating the patients had improved in terms of their employment capacity as well as their day to day activities. The VAS scores of each patient also showed improvement thus indicating a significant amount of pain relief experienced by the patients following the procedure. Amongst the 46 patients, 23 patients had undergone single level fusion while 21 patients had undergone two level fusion. All the parameters showed statistically significant improvement in both of these groups. In the remaining

two patients who had undergone three level fusion, the VAS and Nurick scores showed gradual improvement over a period of 6 months. The average MJOA score in both of these did not worsen either. Post operatively the patients were graded based on the modified Odom's criteria at 6 months. Accordingly, about 54% patients were classified as having a 'Good' recovery suggesting that majority of their preoperative abnormal findings had improved following surgery. The rest of the 43% patients had a 'Fair' recovery, also implying definite relief from some of preoperative symptoms following ACDF and plating. Only 1 patient, a 72-year-old female who had undergone a three-level fusion had a 'Poor' recovery according to the modified Odom's criteria. The relationship between modified Odom's criteria and complications encountered at the end of 6 months was studied. No significant correlation was obtained between the two.

Correlation between post-operative Modified Odom's criteria and other scores showed significant correlation. Patients with reduced post-operative Nurick and VAS scores fared similarly according to Odom's criteria. Similar results were observed in patients with improved MJOA scores post operatively.

6. Conclusion

From our results we conclude that anterior cervical discectomy and fusion with anterior cervical plating is an efficient procedure in patients with cervical myelopathic or radicular symptoms, not responding to adequate conservative treatment.

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