

One and Two Level Anterior Cervical Discectomy and Fusion: Analysis of Surgical and Neurological Outcome

*Atef Morsy MD, **Hanan Amer MD

*Assistant Professor of Orthopaedics, Faculty of Medicine, Bani-suef University;

**Assistant Professor of Neurology, Faculty of Medicine, Cairo University

Abstract

Aim of work: to provide a follow up data (neurological and general outcome) on the surgical success of one and two level anterior cervical discectomy and fusion and to determine the effect of plate fixation on the results. **Material and methods:** forty five patients with average age forty four years had anterior cervical discectomy for the treatment of degenerative disc diseases between January 2003 and May 2005. Thirty patients had cervical disc herniation at one level, (66.7%) and fifteen had disc herniation at two levels (33.3%). Fusion and plate fixation was done to twenty one patients and only twenty four had grafting without plate fixation, Thirty five of the patients had radiculopathy and ten had radiculomyelopathy. **Outcome evaluation:** clinical outcome were assessed with neurological assessment of motor power and sensory affection. The verbal rating scale (VRS), Nurick classification system for cervical spondylotic myelopathy and Odom's criteria. **Results:** clinically there were 19 excellent results (42.2%), 17 good (37.8%), 6 fair (13.3), and 3 poor (6.7%) outcomes, there were significant improvement of pain postoperatively in all patients, radiculopathy group improved regarding their motor power but only 40% of patients with radiculomyelopathy had substantial improvement and 60% had partial improvement. There were no statistical difference in the final outcome between patients with single level or patients with two levels herniation $p=0.11$ or between patients who had grafting only or patients who had graft and plating $p=0.53$. Pseudarthrosis occurred in 8.3% of patients without plate fixation and no significant correlation could be detected between pseudarthrosis and age sex or neurological symptoms. **Conclusion:** Anterior cervical discectomy with fusion at one or two segments is a reliable method of management for patients who have cervical radiculopathy or radiculomyelopathy. and the addition of plate fixation did not add to the satisfactory clinical outcome. The rate of recovery of neurological function can be high with careful preoperative neurological and radiological evaluation for proper patient selection.

INTRODUCTION

Cervical spondylosis is caused by a degeneration of the intervertebral discs, which fragment, lose water content, and collapse with normal aging. Disc degeneration causes increased mechanical stress at the cartilaginous end plates at the vertebral body lip. This results in subperiosteal bone formation or osteophytic bars that extend along the ventral aspect of the

spinal canal and, in some cases, encroach on nervous tissue (1).

Spondylotic changes in the cervical spine occur at solitary disc space levels in 15% to 40% of patients and at multiple levels in 60% to 85%. The discs between the third and seventh cervical vertebrae are affected most commonly (1,2).

This degenerative process occurs in middle-aged or elderly patients. It may cause neck pain

syndromes, radiculopathy or myelopathy, Neck pain and stiffness with radiation into the shoulders or occiput may be chronic or episodic with prolonged periods of remission(1).

Acute cervical radiculopathy most commonly occurs without preceding trauma, and it is usually associated with herniation of a disc fragment with or without the formation of spurs. Acute neck and arm pain, paresthesias, and weakness are typical, but one condition may exist without the others (1,3).

Myelopathy due to cervical spondylosis usually develops insidiously, although episodes of abrupt deterioration occurs, patients may report an insidious onset of clumsiness or diffuse numbness in the hands, resulting in worsening of handwriting or other fine motor skills and difficulty with grasping or holding. Physical examination shows exaggerated deep tendon reflexes, clonus, diminished superficial reflexes, and the presence of pathologic reflexes(4,5,6).

In 1955, Robinson and Smith described an operative procedure in which the surgeon removes the cervical intervertebral disc through an anterior approach, without attempting

to remove chondro-osseous spurs(7); arthrodesis is effected by the insertion of an iliac-crest bone graft. Robinson et al. believed that once a solid fusion has been achieved, the spurs will resorb by the normal process of bone-remodeling(8). The success of this procedure depends on thorough decompression and the development of a solid osseous fusion(9).

Since the early 1970's, anterior discectomy and arthrodesis for cervical disc disease became the technique preferred by many orthopaedic surgeons and neurosurgeons. The advantage of the anterior cervical approach includes easy positioning of the patient, and less traumatic approach to the spine. Moreover it allows for decompression of the anterior spinal cord through an approach along fascial planes, also the relative preservation of the stability of the spinal column, and the low prevalence of graft extrusion or migration (4).

Many surgeons found that the usage of the plate helps to prevent late deterioration in the cervical spine alignment obtained at surgery resulting in increased fusion rates and less graft migration (3,9,10).

The purpose of this study was to compare between the effect of

plating and non plating as a fixation method in anterior cervical discectomy for one and two levels of cervical disc disease

MATERIAL & METHODS

Forty five patients suffering from cervical disc prolapse and or cervical spondylosis radiculopathy or radiculomyelopathy were treated with anterior cervical discectomy and or fusion for one or two level cervical disc disease at Bani suef and Cairo University Hospitals between January 2003 and May 2005.

Patients who had any disease of the central nervous system, congenital abnormality in the cervical spin, more than two disc level pathology, or sustained major trauma were not included in the study.

Of the forty five patients thirty one were males and fourteen were females, the average age was 44 years (range 30 to 66) \pm 7.6sd. The duration of follow up ranged form 8 to 24 months, average 13 months.

Thirty patients had cervical disc herniation at one level, (66.7%) and fifteen had disc herniation at two levels (33.3%), (Table 1) six patients believed that the herniation of the disc had been the result of a traumatic episode; it is possible that the trauma may have triggered the symptoms of radiculopathy.

All patients were unresponsive to non surgical treatment that included anti inflammatory drugs, physiotherapy and periods of rest and collar immobilization.

Table 1: The location of disc lesions operated upon

	levels	Frequency	Percent
One level	C 3-4	4	8.9%
	C4-5	5	11.1%
	C5-6	14	31.1%
	C6-7	7	15.6%
Total no		30	66.7%
Two levels	C3-4-5	2	4.4%
	C4-5-6	2	4.4%
	C5-6-7-	11	24.4%
Total no		15	33.3%

Preoperatively all patients had been subjected to general and neurological examination, posteroanterior and lateral plain

radiographs of the cervical spine, and computed tomography CT or a magnetic resonance image MRI to confirm cord compression or root

impingement resulting from problems secondary to disc disease

Clinical evaluation

Thirty five patients had radiculopathy (77.8%) in the form of pains in the neck and/or arm, reflex changes and /or radicular sensory loss with muscle weakness corresponding to the nerve root affected. Ten patients had radiculomyelopathy (22.2%).these patients mainly represented by motor weakness and hyperreflexia difficulty in walking and unsteadiness of gait, no patient had bladder dysfunction.

Symptoms had been present for more than two years before operative intervention in eleven patients, for one to two years in fourteen patients, for six to twelve months in seventeen patients, and for less than six months in three patients.

Thirty three patients had pain in the neck and arm in the form of parasthesia, four patients had pain in the neck with neurological deficits but no pain in the arm, eight patients (all with radiculomyelopathy) had parasthesia in one arm corresponding to the cervical root affected and a sensory level.

Forty two patients had subjective weakness in the arm The degree of weakness was graded with manual muscle-testing methods, with 5

as the highest possible grade i.e. .no weakness (3 extremities 6.7%) thirty four extremities 75.6% received a grade of 4 (the patient could move the arm against resistance) eight 17.8%, a grade of 3 (the patient could move the extremity against gravity):no patient was in grade 2 (the patient could move the extremity when gravity was eliminated) or grade 1(the patient was capable of palpable muscle contraction only).

A decreased reflex corresponding to the compressed nerve root were detected in twenty seven patients 60% no change in reflex occurred in six patients 13.3% and exaggerated reflexes occurred in twelve patients 26.7%

Surgical procedure

A standard transverses skin incision was made which allows exposure of the cervical spine from C3 to C6, landmarks used for skin incision include the hyoid bone at the level of C3, the thyroid cartilage at the level of C4-5, and the cricoid cartilage at C6The carotid sheath was retracted laterally and the esophagus with the trachea were retracted medially. Then the cervical column was exposed and a self- retaining retractors were carefully positioned after the longus coli muscle were elevated. Image intensifier (C

arm) was used to determine the affected level accurately. A complete discectomy at the affected level was carried out and the compressive structures were removed under direct visualization posteriorly and postrolaterally. A tricortical iliac-crest graft that provided a snug fit was used to widen the disc space to a height of at least five millimeters in order to distract the foramen and relieve pressure on the nerve roots. The natural concavity of the end-plates helped to prevent extrusion of the graft either anteriorly or posteriorly.

A plate with appropriate length was selected and positioned for some patients so as the superior and the inferior screw were at the mid portion of the vertebral body

Twenty four patients 53.3% were grafted only, all of them had one level of disc herniation, and twenty one patients 46.7% had graft and plating (6 patients with one level and 15 patients with two levels of disc pathology).

After surgery all patients were instructed to put a hard cervical collar at least four to six weeks postoperatively to achieve immobilization for proper fusion.

Postoperatively, anteroposterior and lateral radiographs were made every four weeks to assess the condition of

the graft and the presence of osseous union.

Outcome evaluation

Patients were assessed clinically as regards pain and neurological function preoperatively and in the first week after operation by: 1-The verbal rating scale :(VRS) which is a reliable and valid pain scale developed from the Visual Analog Scale (VAS) to measure pain intensity in chronic pain patients. Patients were asked to verbally rate his or her level of perceived pain intensity on a numerical scale from 0 to 10, with the zero representing one extreme (e.g. no pain) and the 10 representing the other extreme (e.g. “ the worst pain possible”). The VRS is easily assessed, and can be performed without the need of paper and pen. It is relatively simple to be understood by patients (11,12).

The pain were said to be severe if it ranged from eight to ten, moderate if ranged from four to seven and mild to no pain if ranged from zero to three.

2-Nurick classification system for cervical spondylotic myelopathy was done pre and post operatively (13) for the assessment of neurological function (Table 2)

Table 2: Nurick classification system

Grade	Findings
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 that does not prevent full-time employment
3	Difficulty in walking that prevents full-time employment or the ability to do all housework
4	Able to walk only with someone else's help or with the aid of a frame
5	Chair-bound or bedridden

3-Odom's criteria

At the final assessment the results were classified for the patients according to

the system of Odom et al. (14) criteria for improvement as excellent, good, fair, and poor results.(Table 3)

Table 3: Odom's criteria

Excellent	All preoperative symptoms relieved Abnormal physical findings improved
Good	Minimal persistence of preoperative symptoms Abnormal physical sings unchanged or improved
Fair	Definite relief of some preoperative symptoms Other symptoms are unchanged or improved
Poor	Symptoms and sings are unchanged or exaggerated

Statistical analysis using SPSS for windows was undertaken using the Chi square test for categorical data for comparison of outcome variables and Wilcoxon Signed Ranks Test was used to measure the magnitude of difference between two related samples

RESULTS*Clinical outcome*

Over all, as assessed by the verbal rating scale and Nurick classification system for cervical spondylotic myelopathy most patients improved regarding the severity of their pain and the neurological symptoms. (Table 4 and 5)

Table 4: scores of verbal rating scale pre and post operatively

VERBAL RATING SCALE					
Preoperative			Postoperative		
	Frequency	Percent		Frequency	Percent
moderate	14	31.1%	mild	30	66.7%
severe	31	68.9%	moderate	15	33.3%
Total	45	100.0%	Total	45	100.0%

Table 5: Nutick's grading pre and post operatively

NURICK GRADING SYSTEM					
Preoperative			Postoperative		
	Frequency	Percent		Frequency	Percent
Grade 0	33	73.3%	grade 0	39	86.7%
Grade I	7	15.6%	grade I	2	4.4%
Grade II	1	2.2%	grade II	2	4.4%
Grade III	3	6.7%	grade III	2	4.4%
grade IV	1	2.2%	Total	45	100.0%
Total	45	100.0%			

Patients suffering of radiculopathy perceived preoperatively their pains significantly severer than patients with radiculomyelopathy $P=0.005$, nevertheless no difference were detected in the improvement of pains in both groups post operatively $p=0.8$.

All patients in the radiculopathy group improved regarding their motor power but only four 40% of patients with radiculomyelopathy had substantial improvement and the remaining six 60% patients had partial improvement.

We classified patients according to the surgical procedure

into group1 patients who had discectomy and fusion but without plate fixation (24 patients) and group2 patients in whom cervical discectomy with graft and plate fixation were done (21 patients).

There were highly significant postoperative improvements in the severity of pain and the neurological symptoms in group1 but group2 showed significant improvement in pain but had no significant improvement in neurological symptoms comparing pre to postoperative symptoms. (Table 6)

Table 6 pre and post operative difference in VRS and Nurick's grading system in Group 1 and Group2

	Group1 No.24			Group2 No.21		
	Mean Rank	Z	Asymp. Sig. (2-tailed)	Mean Rank	Z	Asymp. Sig. (2-tailed)
VRS	12	- 4.3	0.000	10.5	- 4.0	0.000
Nurick's grading	4	- 2.6	0.008	2	- 1.7	0.08*

*statistically insignificant difference

Wilcoxon Signed Ranks Test

No statistical significant difference were detected between group 1 and 2 in pain or neurological symptoms and sings (Table 7)

Table 7: comparison between Group 1 and Group 2

	Muscle power	Preoperative VRS	Preoperative Nurick's grading	Postoperative VRS	Postoperative Nurick's grading
P value	0.20	0.32	0.18	0.20	0.48

On reclassification of patients according to the number of level affected [Group A] patients with one level of disc herniation (30 patients) and [Group B] patients with two levels of disc herniation (15 patients) there

were significant improvement of postoperative pain but not in neurological sings assessed by the Nurick classification system in group B patients. (Table 8)

Table 8: pre and post operative difference in VRS and Nurick's grading system in Group A and Group B

	Group A No.30			Group B No.15		
	Mean Rank	Z	Asymp. Sig. (2-tailed)	Mean Rank	Z	Asymp. Sig. (2-tailed)
VRS	14	- 4.7	0.000	8	- 3.5	0.000
Nurick's grading	5	-3	0.003	1	-1	0.31*

**statistically insignificant difference
Wilcoxon Signed Ranks Test*

No statistical significant difference were detected between group 1 and 2 in pain or neurological symptoms and sings (Table 9)

Table 9 comparison between Group A and Group B

	Muscle power	Preoperative VRS	Preoperative Nurick's grading	Postoperative VRS	Postoperative Nurick's grading
P value	0.44	0.06	0.43	0.50	0.83

Utilizing the Odom's criteria for final clinical assessment 19 patients had excellent results (42.2%), 17 good (37.8%), 6 fair (13.3), and 3 poor (6.7%)

No statistical difference were detected in the final outcome between

patients with single level or patients with two levels herniation $p=0.11$ or between patients who had grafting only or patients who had graft and plating $p=0.53$

85% of radiculopathy patients had satisfactory outcome (good to

excellent) compared to 60% of radiculomyelopathy patients with no significant difference $p=0.14$

It was found that 90.9% of patients under the age of 50 years had a satisfactory final outcome results while only 50% of patients above 50 years had the same results with a statistically significant difference between both groups $p=0.006$

Final outcome according to Odom's criteria were significantly worse in patients who had surgery after one year of the onset of neurological symptoms $p= 0.01$

Surgical outcome

Pseudarthrosis occurred in two patients 8.3% of Group I who had unsatisfactory outcome, one occurred at C3-4 and the other at C5-6, no significant correlation were found between Pseudarthrosis and age sex or neurological symptoms. Three patients 14.2% of Group II developed non union all had two level procedure and unsatisfactory outcome

The average amount of graft collapse in non plated patients (Group I) was 2.8 mm compared to the plated patients (Group II) 0.5 mm with significant difference $p < 0.01$

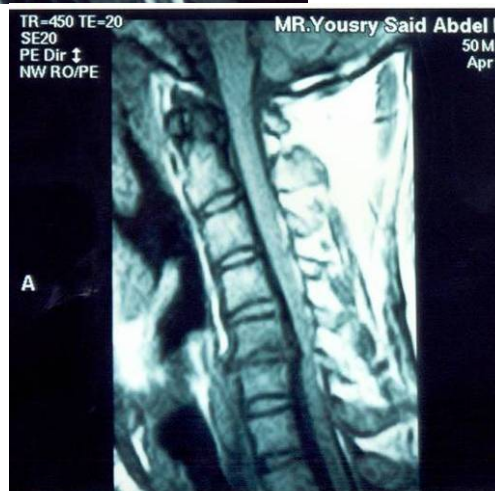
Of the forty five patients twelve 26.6% had temporary post operative dysphagia and nine of them had

harsiness of voice as well, both symptoms resolved in six to eight weeks postoperatively

Post operative neurological complications occurred in two 4.4%. One patient –a forty five year old male- who had radiculomyelopathy (Grade III) weakness, and plate fixation at C4-C5 and C5-C6 suffered of a delayed postoperative recovery due to hypersensitivity to muscle relaxants and developed left hemiplegia with upper motor facial .A computed tomography brain scan was done and revealed no abnormality, two weeks later the weakness improved markedly (Grade IV) with mild facial affection. The other patient –a forty eight year old male- who had a left sided radiculopathy, discectomy was done at C5-C6 with graft fixation, and despite having a good improvement of pain postoperatively he developed a left sided brain stem infarction with right sided hemiplegia and dysphagia twenty days postoperatively proved by magnetic resonance imaging of the brain, with poor final outcome

No complication occurred related to the uses of the cervical plate in the patients. Two patients 4.4% had graft site infection and six patients 13.3% had donor site pain (range 3-5 months).

Case Presentation

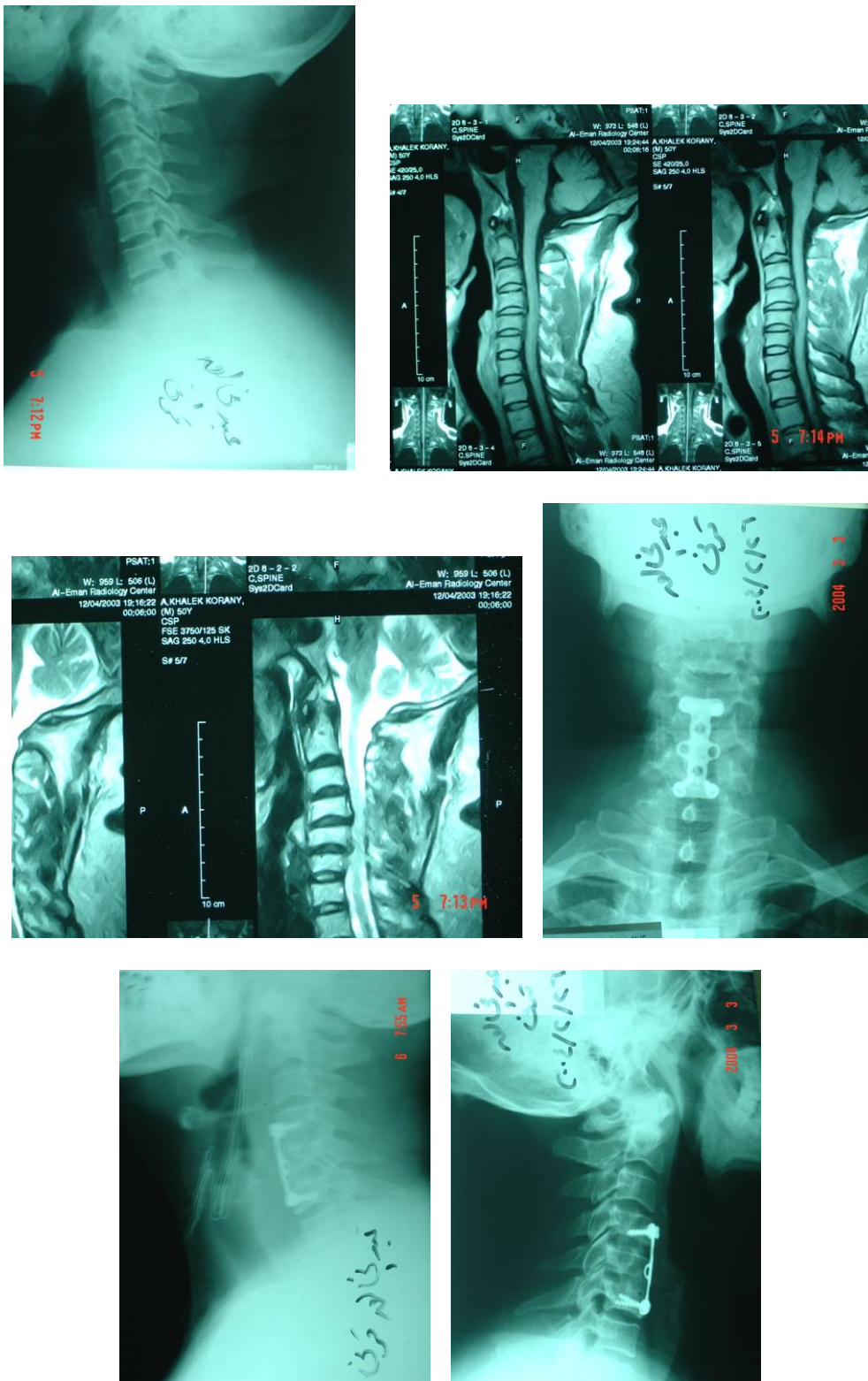


Case No (1): Male 50 old, suffering from C5-6 desck with Left radiculopathy parathesia Grade IV

Surgery:

Discectomy and bone graft one level.

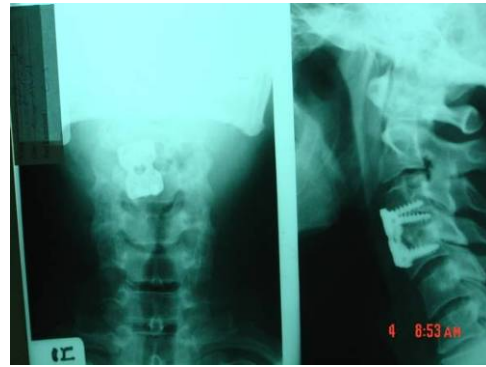
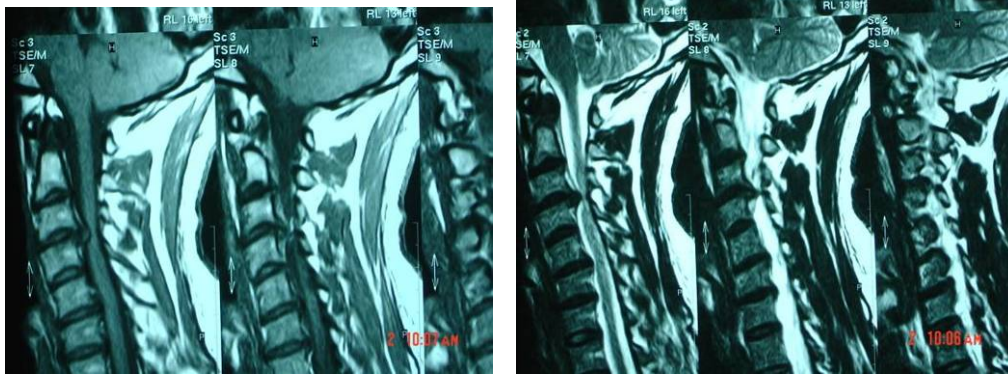
Case (2)



Case (2): Male 51ys with C 4-5-6 Rt radiculopathy hypothesia Grade IV

Surgery:

Discectomy and bone graft + plate fixation

Case (3)

Case (3): Female 38ys, with disc lesion C3-4, with Rt radiculopathy parathesia Grade IV

Surgery:

Discectomy and bone graft + plate fixatio

DISCUSSION

The primary goal of surgical intervention in patients with spondylotic radiculopathy or radiculomyelopathy is appropriate decompression of the roots and the spinal cord to halt neurological deterioration. Both anterior and posterior approaches to the cervical spine allow decompression of the spinal cord and nerve roots, correction

of deformity, and stabilization of the spinal column. Although some surgeons do not consider one procedure superior to the other (15,16), many others prefer anterior cervical discectomy and fusion as it allows for the removal of disc material together with the posterior osteophytes impinging on the spinal cord and nerve roots at or immediately adjacent to the level of the disc space (3,4).

Solid cervical fusion is one of the goals of surgery and using plate for fixation should insure this goal by decreasing the complication of graft dislocation, loss of height and vertebral collapse specially in patients undergoing multiple level fusion(17) moreover cervical plating should increase fusion rate and decrease the time to fusion, improve initial mobilization in post operative period and decrease the need for cervical collar that result in a faster return to normal activities.

In 2002 Bolesta et al reported on forty patients in whom an anterior cervical discectomy and fusion at one or two operative levels was done that successful arthrodesis of single-level procedures occurred in 11 of 16 unplated and 2 of 4 plated fusions. Primary bony union in the two-level group was achieved in 15 of 19 plated patients and did not occur in the single unplated procedure. They concluded that the cervical spine locking plate improved the outcome of two-level procedures to that of uninstrumented one-level fusions(18). However some authors believe that extended anterior cervical discectomy without fusion is a simple and sufficient operation for most cases of cervical degenerative disease (3,19).

In our study all patients had marked improvement of pain and neurological symptoms after anterior discectomy with fusion either with or without plate fixation and the multiplicity of the lesion had no significant effect on the final outcome results, however patients suffering of radiculopathy did have a better satisfactory outcome than patients who had radiculomyelopathy, such results are consistent with other authors who found that patients suffering from radiculopathy had better clinical outcome than patients who had radiculomyelopathy³ (3) even with long follow up periods (20).

We also found that neurological signs as weakness and gait disturbance seems to improve less rapidly than symptoms such as pain in patients with two levels of disc herniation which is consistent with other authors specially in elderly patients (5).

Wang et al. (21) reported on the complications and mortality associated with surgical treatment in patients with degenerative cervical spine disease. That study was a retrospective analysis of the Nationwide Inpatient Sample (a sample of hospital discharges). Over a ten-year period, 0.3% of hospital

admissions were for the treatment of cervical spine disease. Complications based on specific disease codes were present in 3.9% of the patients, with an overall mortality rate of 0.14%. Multivariate analysis identified risk factors for complications, including age (more than seventy-four years), a diagnosis of myelopathy, a posterior fusion alone, or combined anterior-posterior fusion.

It seems that old age and long duration of symptoms before surgical treatment may have a bad influence on the final outcome of our patients, although long term follow up suggests that men tended to have much better results from discectomy than women(5). sex had no significant effect on the final outcome results in our study.

The use of anterior cervical plating for a single level discectomy and fusion is controversial, while some studies showed increasing fusion rates with plating (22) others clarify that plating may hold the disc space in distraction and prevent graft setting which is important in graft consolidation and plate fixation should be reserved for patients unwilling or unable to wear a hard orthosis postoperatively for an extended period of time (23).

In this study although there were significant difference between the average amount of graft collapse between plated and non plated groups no relationship between loss of disc height and final clinical outcome were detected and this is consistent with the findings of Haden et al. 2005 who demonstrated in 140 patients with anterior cervical discectomy without inter body graft or fixation that disturbance of cervical and segmental alignment is common in patients following cervical discectomy but neither loss of disc height nor disturbance of cervical alignment compromised the clinical outcome in the first year following the operation(24).

The rate of pseudoarthrosis in this current study was less than other studies (3,25) probably because we had pseudoarthrosis only in a single level rather than multiple level cervical discectomy

About twenty six percent of our patients had temporary post operative dysphagia. Early postoperative dysphagia after anterior cervical surgery is a well-known phenomenon with so far uncertain known etiology. Lee et al. (26) found that dysphagia was present in >50% of patients at one

month and as many as 15% at two years.

The hypothesis that direct pressure induced by the medial retractor blade on the pharyngeal or esophageal mucosal walls will lead to local ischemia subsequently postoperative hyperemia and swelling of their walls and may result in swallowing disturbance this hypothesis led Oliver et al. (27) to measure the local blood flow inside the pharyngeal and esophageal walls during anterior cervical surgery using a laser Doppler in fifteen patients ,they observed diminished local perfusion in all patients during spreading of the retractor and post-procedure hyperemia was recorded in 46% of the patients. which concluded that local ischemia of the pharynx/esophagus wall may be a crucial step in the development of postoperative dysphagia

CONCLUSION

Anterior cervical discectomy with fusion at one or two segments is a reliable method of management for patients who have cervical radiculopathy or radiculomyelopathy. The addition of plate fixation is a safe procedure and does not result is higher

complications. Although it provides a successful satisfactory relief of neurological deficits and maintains cervical spine alignment, it did not add to the satisfactory clinical outcome. Relief of radicular pain is predictable, and the rate of recovery of neurological function is high. A careful preoperative neurological and radiological evaluation should permit proper selection of patients providing better outcome.

REFERENCES

1. **McCormack BM, and Weinstein PR:** Cervical spondylosis-An update. West J Med 1996; 165:43-51
2. **Clark E, Robinson PK:** Cervical myelopathy; complication of cervical spondylosis. Brain 1956; 79:483-510
3. **Bohlman HH, Emery SE, Goodfellow DB and Jones PK:** Robinson anterior cervical discectomy and arthrodesis for cervical radiculopathy. Long-term follow-up of one hundred and twenty-two patients J Bone Joint Surg Am. 1993; 75:1298-1307.
4. **Rao R D., Gourab K. and David K S.:** Operative Treatment of

- Cervical Spondylotic Myelopathy
Bone Joint Surg Am
2006;88:1619-1640.
5. **Okada K, Shirasaki N, Hayashi H, Oka S and Hosoya T:** Treatment of Cervical Spondylotic Myelopathy by Enlargement of the Spinal Canal Anteriorly, followed by Arthrodesis J Bone Joint Surg Am 1991;73:352-364.
 6. **Rao R.:** Neck pain, cervical radiculopathy, and cervical myelopathy: pathophysiology, natural history, and clinical evaluation. J Bone Joint Surg Am. 2002; 84:1872-81.
 7. **Robinson, R. A., and Smith, G. W.:** Anterolateral cervical disc removal and interbody fusion for cervical disc syndrome [abstract]. Bull. Jo/ins hopkins Hosp. 1955; 96: 223-224.
 8. **Robinson, R. A.; Walker, A. E.; Ferlic, D. C.; and Wiecking, D. K.:** The results of anterior interbody fusion of the cervical spine. J Bone and Joint Surg., Dec.1962; 44-A: 1569-1587.
 9. **Lee C.K.:** accelerated degeneration of the segment adjacent to a lumbar fusion. Spine 1998; 13: 375-7
 10. **An HS, Evanich CJ, Nowicki BH, Haughton VM.** Ideal thickness of Smith-Robinson graft for anterior cervical fusion. A cadaveric study with computed tomographic correlation. Spine.1993; 18:2043 -7
 11. **Breivik EK, Bjornsson GA, Skovlund E.** A comparison of pain rating scales by sampling from clinical trial data: Clin J Pain. 2000 Mar;16 (1): 22-8
 12. **Soyannwo OA, Amanor-Boadu SD, Sanya AO, Gureje O.** Pain assessment in Nigerians--Visual Analogue Scale and Verbal Rating Scale compared. West Afr J Med. 2000 Oct; 19(4):242-5.
 13. **Nurick S.** The natural history and the results of surgical treatment of the spinal cord disorder associated with cervical spondylitis. Brain 1972; 95:101-8.
 14. **Odom GL, Finney W., Woodhall B.** Cervical disc lesions.JAMA1958;18:1273-8
 15. **Ebersold MJ, Pare CM, Quast LM:** Surgical treatment for cervical spondylitic myelopathy. J Neurosurg 1995; 82:745-751
 16. **Wirth F.P, Dowd G.C, Sanders H.F. and Wirth C.:** Cervical discectomy: A prospective analysis of three operative techniques Surg. Neurolo. 2000;53: 340-348
-

- 17. Fenevrough JC, White JI, and Larocca H.:** Fusion rates in multi-level cervical spondylosis comparing allograft fibula with autograft fibula in 126 patients J Spine 1995; 20: 2247-56
- 18. Bolesta M J., Rehtine GR., and Chrin AM:** One- and two-level anterior cervical discectomy and fusion: the effect of plate fixation. Two Hundred Years Ago in Spine J Spine 2002;2: 197-203
- 19. Maurice-Williams R.S., Dorward N.L.:** Extended anterior cervical discectomy without fusion: a simple and sufficient operation for most cases of cervical degenerative disease. Brit. J of Neurosurg 1996; 10, 261 -266
- 20. Williams J L., Allen M B., JR. and Harkess J W.:** Late Results of Cervical Discectomy and Interbody Fusion: Some Factors Influencing the Results J Bone Joint Surg Am 1968; 50:277-286.
- 21. Wang MC, Chan L, Maiman DJ, Kreuter W, Deyo RA.** Complications and mortality associated with cervical spine surgery for degenerative disease in the United States. Spine.2007; 32:342 -7.
- 22. Connolly PJ., Esses SI.,Kostuik JP.:** Anterior cervical fusion: outcome analysis of patients fused with and without cervical plates. J Spinal Disord 1996; 9:202-6
- 23. Samartzis D., Shen FH, Lyon C, Phillips M, Goldberg EJ. and An HS.:** Does rigid instrumentation increase the fusion rate in one-level anterior cervical discectomy and fusion? The spine J. 2004; 4: 636-643
- 24. Haden, N.; Latimer, M.; Seeley, H.; Laing, R:** Loss of intervertebral disc height after anterior cervical discectomy Brit. J of Neurosur, 2005;19: 469-474
- 25. Bolesta M. J. Rehtine G. R. Chrin A. M. Long D.M.:** Three- and four-level anterior Cervical discectomy and fusion with plate fixation: A prospective study. Spine 2000;25 :2040-2046
- 26. Lee MJ, Bazaz R, Furey CG, Yoo J.** Risk factors for dysphagia after anterior cervical spine surgery: a two-year prospective cohort study. Spine J.2007; 7:141 - 7
- 27. Oliver H, Erik F,Max H; Manfred W, Luca P.:** Intraoperative measurement of pharynx/esophagus retraction during anterior cervical surgery. Part II: perfusion European Spine J 2006;15:1839-1843
-

