TREATMENT OF LATERAL CERVICAL DISK HERNIATIONS AND STENOTIC SPINAL CANAL CAUSING MYELOPATHY: USING A MODIFIED CLOWARD'S TECHNIQUE IN 335 CASES

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Turkish Neurosurgery 1 :98-105, 1990

SUMMARY :

Between April 1961 and April 1988, the senior author operated upon 299 patients for treatment of lateral cervical disc herniations and upon 36 patients for stenotic cervical spinal canal causing myelopathy employing a modified Cloward's technique in the Buffalo Metropolitan area. Autogeneous bone grafts were used in 324 patients. No bone graft was used after removal of the herniated discs or ruptured fragments of disc from the extradural space in 11 patients. During the first postoperative year, all the patients were examined by the author and x-rayed at the hospital where surgery had been performed. Good to excellent results were noted in 275 (91.9 %) patients with lateral disc herniations and in 32 (88.8 %) patients with myelopathy during the first year. Complications occurred in ten patients; however, nine of these patients recovered fully within three months of surgery. There was only one serious complication of quadriparesis. There was no postoperative mortality.

KEY WORDS :

Anterior Cervical Surgery, Myelopathy, Radiculopathy, Ruptured disc, Stenosis.

INTRODUCTION

Smith (36,42) performed the first recorded cervical disc excision followed by block fusion of the intervertebral disc space through the anterior approach in February 1954. Following in Smith's footsteps, Dereymaeker (9), in May 1955, operated on the cervical disc through an anterior approach employing block bone graft. He based his decision to operate on clinical findings and myelographic examination to localize the level of involvement. However, according to Verbiest (44,45), anterior as well as lateral operations involving the cervical spine were performed by surgeons in the last half of the 19th and the first half of the 20th century. In this country, Bailey (4) started using a block of bone to fuse the cervical spine in 1952 through an anterior apporach in patients with fracture dislocations, tumors, and infections and also in two patients who had developed an unstable cervical spine following posterior laminectomy for disc herniation.

A less emphasized aspect of Smith's (36,42), Hirsch's (22), Cloward's (6,9) and Simmon's (41) publications is their reliance on discogram rather than myelogram in selecting patients for anterior disc excision followed by bone graft. It must be pointed out that Cloward was the first surgeon to go beyond the posterior capsule of the disc, after incising the posterior longitudinal ligament, in search of ruptured fragments.

Cloward's (6) presentation in Chicago in 1960 stimulated the interests of this author and many other neurosurgeons in the country. Before 1961, posterior operations on the cervical spine were performed by many neurosurgeons, including this writer (31), but the availability of Cloward's instruments, designed for anterior operations in the cervical spine, and simplicity of the procedure spurred the acceptance of the anterior cervical spondylotomy with interbody fusion. A great deal has been written about the advantages and disadvantages of the various types and shapes of bone grafts and the comparative merits of the use of autogeneos bone, cadaver bone, bovine bone or synthetic material which indicates the lack of consensus of opinion on this subject (12,20,40, 41,42).

MATERIAL AND METHODS

Criteria for selecting patients for surgical treatment are as follows:

1. Symptoms of cervical radiculopathy, supported by objective findings on neurological examination, which fail to respond to conservative therapy (Tables 1,2,3,5,6).

2. Positive myelogram and/or CAT scan and occasionally MRI consistent with symptoms and findings elicited during at least three preoprative eva-

Tablo : 1

Age and Sex of the Patients

Ages	Number	Female	Male
19-30	30	14	16
31-40	98	46	52
41-50	112	60	52
51-60	72	37	35
61-70	23	12	11
	335	169	166

Table : 2

Symptoms in 299 Patients with Lateral Disk Herniations

Symptoms	Number of patients complaining
1. Pain, radicular	276
2. Sexual impairment	153
3. Weakness of shoulder, arm and fingers	77
4. Numbness of fingers and hands	28

Table : 3

Objective Findings in 299 Patients with Lateral Disk Herniation

Objective Findings	Number of Patients
1. Sensory impairment	271
2. Depressed reflexes	266
3. Atrophy of deltoid, triceps or biceps	27
4. Fasciculation or fibrillation	1

Table : 5

Symptoms in 36 patients with myelopathy

Symptoms	Number of patients with complaints
1. Sexual impotency	35
2. Pain in radicular pattern	32
3. Numbness in arms or legs	17
4. Sphincter disturabnes	12

Table : 6

Objective Findings in 36 patients with myelopathy

Findings	Number of patients
1. Hyperreflexia	33
2. Babinski	29
3. Spasticity	27
4. Sensory impairment	22
5. Neurogenic bladder	10

luations of the patient. Discogram was employed in only 16 patients in the series when findings in the myelogram did not adequately explain the clinical picture. Every patient had one myelogram, and some patients two, during the course of conservative therapy before undergoing anterior cervical disc surgery.

3. EMG with nerve conduction study was used in selected patients to rule out amyotrophic lateral sclerosis as well as to confirm the level of cervical nerve root involvement (Table : 4).

Table : 4

Other Objective Diagnostic Modalities in 299 Patients with Lateral Disk Herniation

Diagnostic Modalities	Number of Patients
1. Corresponding defects in myelogram	282
2. Corresponding CAT scan	75
3. Correlating EMG and nerve conduction	64
4. Correlating MRI finding	14

Prior to 1974, we employed myelographic study as the principal diagnostic x-ray method, in addition to plain x-rays consisting of AP, lateral and both oblique views including 6 foot lateral films, to assess the width of the bony canal (Wolf, 48).

The availability of CAT scan, and recently of the MRI, has simplified the accurate measurement of the anteroposterior diameter of the bony canal and the patients' spinal cord at a given level.

The transverse diameter of the spinal cord at C6 varies from 11.5 to 15.5 mm (32). There is less variation in the diameter of the bony canal at C6 level as we determined by measuring skeletons. We agree with Wolf's (48) conclusion that a one third or more reduction in the AP diameter of cervical spinal cord is significant. After such a determination is made using CAT scan, the neurosurgeon should followup his investigation with myelogram using metrizamide or other water soluble dye to establish the etiology of cervical stenosis (14,1,23,28,27) and the condition of the spinal cord (23).

Intra-operative use of water soluble contrast has also been shown to be useful in delineating the extent of surgical excision of the intervertebral disc space (46).

SURGICAL TECHNIQUE

Surgery in the hip area :

1. A four inch long incision is made 3/4" below the iliac crest parallel to the outer edge of the bony crest.

2. Subperiosteal exposure of the crest along its superior edge and lateral surface is carried out.

3. A large, 20 mm, bone graft containing periosteum at both ends is obtained from the ilium about 1" below the crest 1½" posterior to the superior iliac spine using Cloward's largest bone cutter. Then the periosteum and subcutaneous tissues are approximated in layers with interrupted absorbable sutures and clips are used on the skin.

4. Bone graft is trimmed 1mm to 2mm using #11 blade around the entire circumference of the end which will be inserted into the tunnel. The entire operation in the hip area takes about 15-20 minutes.

Neck Area Surgery :

1. Operative incision is transverse and follows the crease of the skin of the neck extending 3" to 5" and sometimes crossing the midline.

2. Only blunt tipped retractors are used under the long Colli muscles after exposing the anterior surface of the cervical vertebral columm.

3. A #22 spinal needle is inserted into the anterior half of the disc to determine the exact bony level by taking a lateral film. If a small, 8-10 mm opening is planned for exposure of the intervertebral foramen or the lateral recess, it is necessary to obtain lateral as well as anterior posterior films of the cervical spine.

4. Taking into consideration the direction of the intervertebral disc space as shown on the lateral films of the cervical spine, the surgeon can anchor the drill guard so that the tunnel will have the disc space in its center transversely after evacuation of the entire disc material and cartilaginous end plates. A measurement of the depth of the vertebral body is taken so that the tip of the drill will not extend beyond a point 3-4 mm from the anterior surface of the spinal cord. The drill is always used with a guard and its prongs are anchored securely to the vertebral bodies and held firmly by the assistant surgeon.

5. The thin layer of bone along with the posterior longitudinal ligament is removed using diamond burrs, Kerrison rongeurs and small curettes. The author has used the largest drill, 17 mm, in operations at C4-5, C5-6, and C6-7 in the last 300 patients. At C3-4 level it was necessary to use a medium sized drill, 13 mm, in a few patients when the width of the vertebral body was less than 20 mm.

6. The use of the large drill, 17 mm, provides easy access to the intervertebral foramen and the lateral recess after the tunnel has been widened laterally, 5-6mm in its posterior 1/3 using diamond burrs and thin lin Kerrison rongeurs.

7. Vertebral body spreader is not used at all because of the risk of fracturing the rim of the vertebral body and the risk of iniating venous epidural bleeding. Anterior longitudinal ligament is trimmed using #11 blade along the anterior circumference of the drill opening. The anesthesiologist is asked to stretch the neck manually by holding the head behind the ears and pulling upward. This allows enough separation to permit the insertion of the bone graft and to advance it to a point 3-4 mm from the anterior surface of the dura of the spinal cord after careful hemostasis of all the bleeding.

8. Closure of the prevertebral fascia, muscles, and superficial neck fascia as well as subcutaneous tissue is carried out in layers with interrupted absorbable sutures. Clips or tapes are used on the skin.

9. A soft cervical collar is applied to the patient over his neck dressing in the operating room. Most patients are able to discard the collar after 8-10 days provided that they do not drive.

RESULTS

In the group of 36 patients with myelopathy, a history of major trauma, such as falling from great heights or severe automobile accidents, was recorded in only three patients. It was easy to follow these 36 patients in the office because their recovery was slow and they were eager to see their operating surgeon during the followup period.

It is interesting to note that a 39 year old patient who had a spinal stenosis, about 7 mm in diameter, and myelopathy caused by a calcified lesion at C5-6 failed to improve after surgery; whereas another patient, a 55 year old man with a spinal canal, 6-7 mm as determined by MRI and 8 mm as measured by CAT scan, and myelopathy made an excellent recovery and is still employed as a truck driver (Fig. 1,2,3).

One wonders whether anterior block resection (39,49) of vertebrae is really necessary in order to decompress the spinal cord adequately. Decompression of the involved levels, up to three, afforded good relief of symptoms and full recovery in 32 of the 36 patients with myelopathy. If the involvement is more extensive than three levels, there is justification for block resection of vertebrae anteriorly or for posterior laminectomy.

In the lateral disc group of 299 patients, a history of major trauma, associated with the onset of cervical

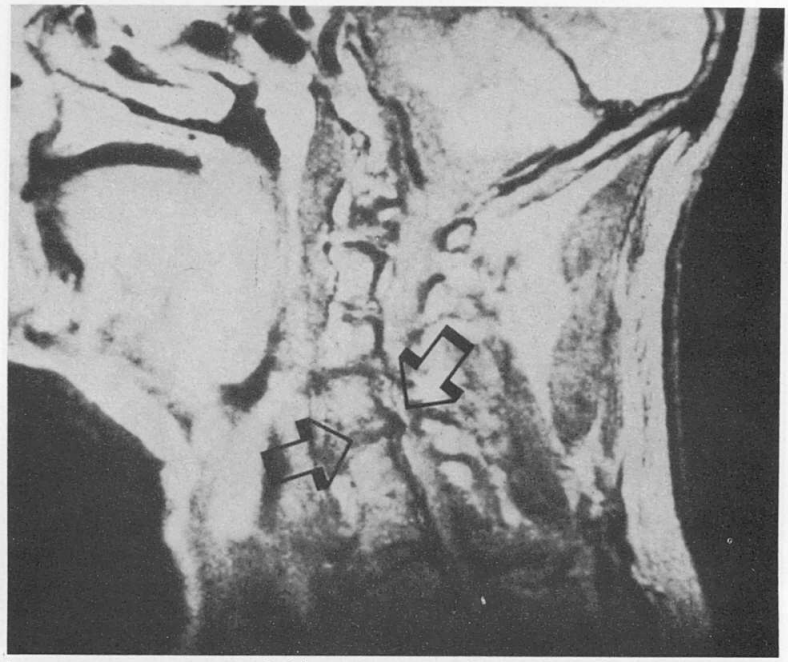

Fig.1 : Cervical spine MRI. Arrow at C4-5 intervertebral disc space points in the direction of the spinal cord which measures 6 mm due to compression by a midline disc and calcification (preoperative).

Fig.2 : Cervical spine C.A.T. scan. Transverse section of C4-5 after metrizamide myelogram showing a central disc herniation and calcification compressing the spinal cord which measures 5-6 mm.

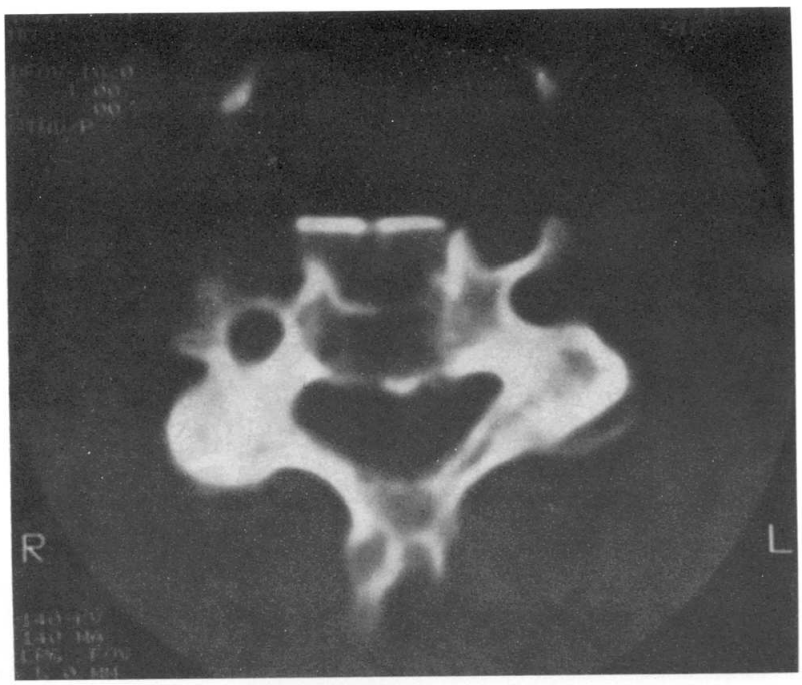

Fig.3 : Postoperative (10 days) C.A.T. without contrast showing C4-5 after removal of a massive herniated disc and placement of dowel bone graft.

radiculopathy, was obtained in 214 patients. Among them was a group with numbness of the fingers, "clumsy hands", as described by Good (17) and England (10) in whom pain played little or no part in their complaints. Neurological findings were restricted to C3-4 and C4-5 nerve roots. There were 14 patients in this group of upper cervical radiculopathy, three of whom had bilateral symptoms. All fourteen patients benefited from anterior cervical disc removal, whether on one side or bilaterally, performed through a 17 mm opening.

While evaluating the results of surgery on a long term basis, we found that patients with good results were not eager to return for another reevaluation; however a persistent followup team effected their return visits on a no fee basis. Those patients returning during the 2nd, 3rd, and 4th years were given a questionnaire to fill out in the office before seeing the operating surgeon. It soon became evident that one third of the returnees to the office, after the first year, either had symptoms related to the lumbar area or had sustained new injuries aggravating the previous symptomology which had existed prior to the operation. Of the 100 patients followed for 5-25 years (mean 12 years), in our series of 335 patients, 74 % were rated good to excellent subjectively and objectively. Whereas during the first year followup, of the 299 patients with lateral disc herniation, there was subjective and objective improvement and satisfaction in 275 (91.9 %) patients. Similar results are reported by Sweet (37) using a Cloward type operation (Tables 7,8,9,10,11).

Table : 7

Followup Period in 335 Patients

Length of time	Number of patients	%
1 year	93	27.7
1-2 years	84	25.0
2-4 years	58	17.3
4-25 years	100	29.8

Table : 8

Operated Levels in 335 Patients

Levels Operated	Number of Cases	
Single		
C3-4	21	
C4-5	54	
C5-6	74	
C6-7	25	174 total
Two		
C3-4, C4-5	5	
C4-5, C5-6	10	
C5-6, C6-7	63	
C6-7, C4-5 or C3-4	72	150 total
Three		
C3-4, C4-5, C5-6	1	
C4-5, C5-6, C6-7	2	
C5-6, C6-7, C3-4	6	
C6-7, C3-4, C4-5	2	11 total
		335 total

Table : 9

Findings at Surgery in 335 Patients

What was found	Patients with Myelopathy	%	Patients with Lateral Disk Herniation	%
1. fragments of ruptured disks	3	8.3	164	48.9
2. Soft disk herniations	3	8.3	64	19.0
3. Hard disk herniations or calcified lesions	30	83.3	71	21.1

Table : 10

Postoperative Results in 299 Lateral Disk Herniations during the 1st year of followup

Results	Number of Patients	%
Good to excellent	275	91.9
Fair to no change	21	7.0
Poor or worse	3	1.0
Total	299	

Table : 11

Postoperative Results in 36 Patients with Myelopathy during one to two year followup

Ruselts	Number of patients	%
Good to excellent	32	88.8
Fair to no change	1	2.7
Poor or worse (including 1 with quardriparesis)	3	8.3
Total	36	

As for the 10 patients who experienced postoperative complications, 9 recovered fully. The only case of quadriparesis, which occurred during the first year of the author's use of the Cloward operation in 1961, recovered some of the function of his arms and legs so that he could walk with the aid of crutches.

Prolapse of the bone graft occured in one patient in whom the dowel graft could not be inserted deep enough because of the extreme fatty makeup of the vertebrae and their tendency to crumble while the plug was being tapped into the bony tunnel. There were two patients with pulmonary embolism who recovered. The remaining four patients had infections of the soft tissues of the neck and hip but recovered completely (Table : 12).

Table : 12

Postoperative Complications in 335 Patients

	Nuber
1. Pneumothorax	0
2. Laceration of esophagus or trachia	0
3. Osteomyelitis	0
4. Laceration of caroid or vertebral arteries	0
5. Non-union of properly placed bone graft	0
6. Recurrent laryngeal nerve palsy	0
7. Nerve root injury	0
8. Mortality	0
9. Pulmonary embolism	2
10. Infection of soft tissues of hip	2
11. Infection of soft tissues of neck	2
12. Prolapse of improperly placed bone graft	1
13. Leakage of cerebro-spinal fluid	1
14. Horner's syndrome	1
15. Spinal cord injury with quadriparesis	1
Total	10*

(*) All of these patients recovered fully in three months except the patient with spinal cord injury.

DISCUSSION

Because the average width at C6-7 between the lateral borders of the vertebra varies from 28-31 mm, based on our measurements of skeletons, and that the medial borders of the vertebral arteries vary from 30-33 mm, there is an adequate margin of safety to use the largest drill, 17 mm. This margin of safety allows the surgeon to obtain the widest possible exposure. The author has consistently used this large opening, 17-18mm, in his last 300 operations.

The standard 8-10 mm opening used by Hankinson (21) and others (29, 36) or the 3-5 mm opening used by Hirsch (22) do not produce instability of the spine which would necessitate the insertion of a bone graft. A 17 mm tunnel, extended laterally in its posterior third, gives complete access to the extra-

dural space including the nerve roots between the vertebral arteries. Uniformity of the size of the bony opening is important (Haines, 19) in comparing various operative procedures with or without bone graft.

The high incidence of ruptured fragments of discs found in our series, 164 cases, (Table : 9) is the result of the following factors : 1) the large number of referrals from which only 4-5 % of the 250-300 patients seen each year because of cervical symptoms underwent surgery; 2) the use of various diagnostic modalities in localizing them; 3) the wide exposure obtained by starting with a 17 mm opening and enlarging it laterally before removal of the entire posterior longitudinal ligament in each case. The absence of similar elements in studies evaluating anterior cervical spine surgery makes any comparison meaningless. In Table : 13 showing the rate of complications in large series of lateral disc herniations operated upon using Cloward's technique or its modifications, we have included the 500 operations performed by Tew and Mayfield (43) although we realize that their series contain cases other than lateral disc herniations.

Table : 13

Complications of Anterior Cervical Spine Surgery for Lateral Disk Herniations

Authors	Number of Operating Surgeons	Operative Cases	Percentage of complications
L.D. Lunsford et al.	ten	295	23.0
J.D. Espersen et al.	many	1106	17.0
J.M.Tew et al	two	500	4.4
D.M. Perese et al	one	335	2.9

Cloward's series was not included because there were only 63 patients with soft disc herniations in the group of 310 reported in 1963. Similarly we did not include Aronson's (1,2,3) reported operations on 88 patients with soft disc herniation in his series of 500 operations patterned after the Smith-Robinson technique. There are other smaller series which we evaluated but did not include in the comparative list of complications (24,29,30,34,35).

In the hands of Scoville (38), posterior cervical approach produced good to excellent results (85 %) in 171 patients who underwent lateral disc surgery and who were followed from 5-33 years.

Several writers (5,18,27) have found in myelopathy cases who underwent anterior as well as posterior cervical spine surgery, that long term followup, 8-20 years, showed deterioration of symptoms and disabilities after 10 years except for the patients with radiculopathy who maintained their improvement after surgery.

Epstein (11) reports that posterior cervical spine surgery in the form of extensive laminectomy produced 86 % improvement during the immediate postoperative period. On the other hand, late complications of posterior cervical laminectomy can be devastating (13,25).

However to analyze the results of operations for myelopathy, it is essential to list patients with dominating radiculopathy separately from those patients with dominating myelopathy. In our series of 36 patients with myelopathy undergoing modified Cloward's operation, all of whom were followed for 1-2 years and some for 25 years, 88.8 % showed good to excellent response to surgery.

Based on our previous study (33), we have included sexual dysfunction experienced by patients presenting themselves for evaluation before surgery. This is an important factor in their lives and we thought it best not to ingore it (Tables 2,5).

Of the numerous ways to advance our knowledge, we believe that two of utmost value are studying the work of others and not forgetting our own mistakes.

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