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Disc-Preserving Cervical Discectomy by Trans Osseous Approach: Technique and Intermediate Results

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Abstract

Aim: To describe the novel technique and study the results of Transosseous disc preserving cervical discectomy in patients with posterolateral disc herniation. *Background:* Traditional anterior cervical discectomy followed by fusion may be non-physiological with significant fusion-related complications and adjacent segment degeneration. The functional discectomy technique, which includes removal of only the disc fragments compressing the neural structures while preserving the rest of the disc, may restore the mobility of the involved motion segment. *Materials and Methods:* The study included 24 consecutive patients who presented with upper limb radiculopathy with or without neurological deficits due to single level posterolateral soft disc herniation between August 2006 and June 2009. The patients were aged between 22-54 years. Approach to the herniated disc was through a 4-5 mm circular hole made in the inferior vertebral body with cephalad inclination. The lateral wall of the body was kept intact in all cases. All patients were assessed for clinical and radiological outcomes at regular intervals. *Results:* The mean follow-up duration was 19 months (6-34 months). Radiculopathy symptoms improved in all the patients with mean VAS score reducing from 4.5 to 2.1 following surgery. None had worsening of axial neck pain. There was loss of disc height from mean of 5.8 mm to 5.4 mm and segmental sagittal lordosis from mean of 2.3 to 2.1.The segmental mobility decreased from mean of 4.1 pre-operatively to 3.7 at last follow up. Two patients had intra-operative complications. No late complications reported so far. *Conclusion:* Transosseous discectomy gives satisfactory pain relief with adequate neural decompression in the studied group of patients with preservation of mobility. Long term follow up is needed to assess the mobility and its role in preserving the adjacent segment degeneration.

Keywords: Cervical Disc Prolapse; Transosseous Discectomy; Radicuopathy**.**

Background

Cervical disc prolapse causing upper limb radiculopathy is one of the most common clinical conditions, known for many decades ever since it was first described by Mixter and Barr, in 1934 [1]. Many patients improve in their symptoms with conservative treatment and surgical discectomy and neural decompression was found to give dramatic improvement of pain for patients with failed conservative treatment. Various surgical techniques including anterior and posterior approaches are in practice. Compressive pathological lesions causing cervical radiculopathy including soft disc fragment herniation or spondylotic bony spurs are located anterior to the nerve root and hence posterior laminectomy or foraminotomy for disc removal may be difficult technically without retraction of the neural structures. Therefore anterior approaches are more popular for this anterior pathology. Conventional anterior discectomy in cervical region includes

radical removal of the entire disc followed by fusion. This may be non-physiological as it permanently blocks the movement at the affected motion segment. Also, the short-term dramatic improvement in symptoms of radiculopathy is followed by fusion-related complications [2,3,4] and adjacent segment degeneration in the long term [5,6]. Modern concept of replacement with artificial prosthesis preserves the mobility at the involved motion segment, but currently there are controversies regarding the design of prosthesis and successful long-term results [7].

The concept of functional spine surgery technique, which includes removal of only the pathological elements compressing the neural structures while preserving the rest of the disc may restore the mobility of the motion segment of the spine. The technique of functional disc-preserving cervical disc surgery by anterior microforaminotomy was described by H.D. Jho et al (1996) [8], in which the mobility of the motion segment was preserved. The current authors describe the modified technique and the results of functional disc-preserving cervical discectomy by Trans osseous approach without complete removal of intervertebral disc at the involved level.

Patients and Methods

The study included a final cohort of 24 consecutive patients who underwent Transosseous cervical discectomy between August 2006 and June 2009. There were 16 males, 8 females with a mean age of 43 years (range:-22-54 years).

All of them presented with radicular pain in the upper limb predominantly associated with some axial neck pain caused by cervical disc herniation. Majority of the patients also had dysesthesias and weakness in the distribution of the involved nerve root. All of them were treated initially with conservative measures for at least 6 weeks and surgery was considered only after failure of non-operative management.

Inclusion Criteria

- Single level soft disc herniation that has failed to respond to conservative treatment.
- Unilateral radiculopathy with or without neurological deficits.
- Patients with no cervical instability on pre-op X-rays.

Exclusion Criteria

- Advanced spondylosis with canal stenosis caused by uncovertebral osteophytes.
- Gross collapse of disc height (>50%) pre-operatively.
- Patients with clinically obvious myelopathy and myelomalacia on MRI.
- Patients with previous cervical spine surgery.

Patient Evaluation

All patients were evaluated clinically for severity of pain by a VAS pain score. Functional disabilities and neurological status were assessed by Cervical Spine Research Society questionnaires (Sampath) noted pre-operatively. Radiological evaluation was done by cervical spine X-rays including flexion-extension views and by MRI. Segmental lordosis/ kyphosis angle, mobility, disc height at involved level was noted. MRI showed variable degenerative changes at symptomatic and adjacent disc spaces, depending on the age of the patient and these findings were noted.

Surgical Procedure

The patients were operated in supine position with cervical spine in neutral or minimal extension position. Standard anterior approach to lower cervical spine as described by Southwick and Robinson was used. The whole procedure was performed under microscopic magnification. A right-sided transverse incision at the symptomatic disc level was carried out on all patients and deeper dissection was performed along fascial planes to reach the cervical spine anteriorly. Longus Colli muscle was elevated and mobilized laterally on either side till the uncovertebral joint was seen and self-retaining radiolucent retractors were applied to expose the involved disc completely. The attachment of the annulus to the inferior body anteriorly was identified and was not disturbed.

To approach the herniated disc, a 4 to 5-mm circular hole was made in the inferior vertebral body just below the attachment of annulus and medial to the unco-vertebral joint. A 2-mm size high-speed burr was used for bone removal and a tunnel was made. The exact location of the tunnel through the body was decided based on the location and amount of herniated disc fragment seen in the pre-operative MRI. Contrary to the anterior foraminotomy procedure described by Jho and colleagues, the lateral border of the body was kept intact in all cases. As the intervertebral disc is inclined superiorly in the

sagittal plane, the tunnel also was made with cephalad inclination such that it reaches the disc space after removal of the endplate posteriorly. This would directly lead to the point of disc herniation. Once the bone was drilled off, a hook was gently passed underneath the soft tissues and the posterior annulus was cut. The rent was made bigger by removal of soft tissues using a number 1 Kerrison Rongeur. The disc fragment would be seen usually at this stage and removed after maneuvering gently. After the fragment removal one should be able to see the axilla of the traversing nerve root and a blunt probe can be passed laterally into the foramen to confirm removal of free fragments. Undercutting of the hypertrophied uncovertebral joint is possible under direct visualization till the nerve root becomes free. Epidural bleeding occurring after removal of the fragment was controlled by Surgicel packing.

Post Operative Evaluation and Patient Follow-up

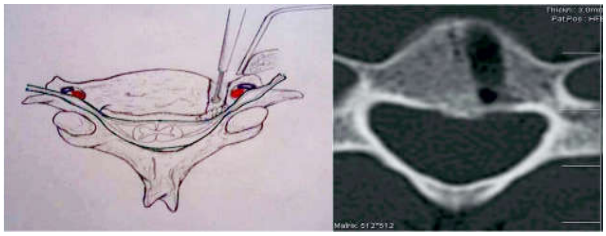

Fig. 1: Axial view of tunnel made in the vertebral body.

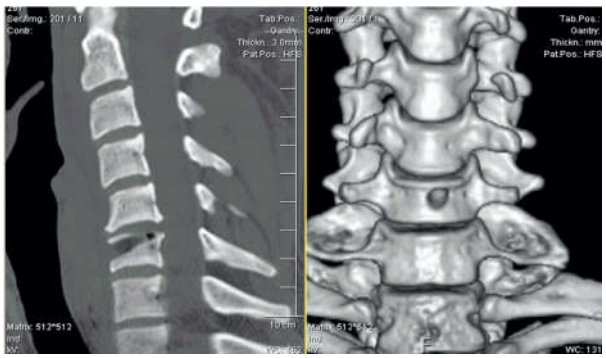

Fig. 2: Sagittal view of the tunnel in the CT scan.

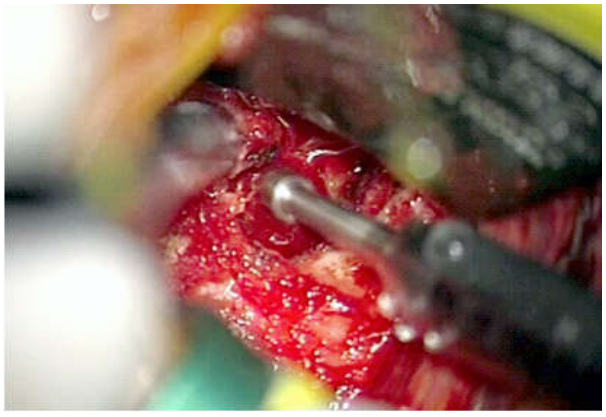

Fig. 3: Intra op picture showing drilling of the body with burr.

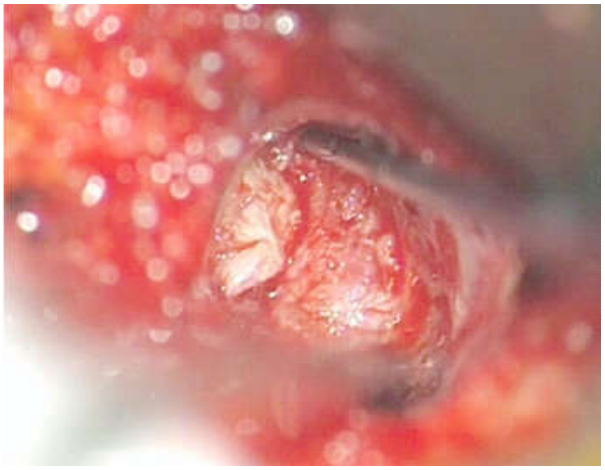

Fig. 4: Removal of herniated disc through the tunnel.

All patients were put on soft cervical collar and mobilized the same or the next day following surgery. Severity of radicular pain was noted and cervical spine X-ray was performed in the post-operative period before discharge. Patients were discharged 1 day after surgery if no complications were noted. Subsequently patients were called for follow-up at regular intervals of 4, 8, 12 weeks, 6 months, 12 months and yearly later. Functional assessment was carried out by Cervical Spine Research Society questionnaires for cervical radiculopathy. Repeat X-ray of cervical spine flexion-extension lateral view taken at 6 months follow-up. For patients who could not come for follow-up in-person, data were gathered from phone contacts and a questionnaire survey.

Results

A total number of 29 patients underwent Trans osseous cervical discectomy for disc herniation from 2006 August to 2009 June. Five patients were not included in the study as they were lost to follow-up after surgery. Among the remaining 24 patients, there were 16 males and 8 females. The mean age was 43 years ranging from 22 to 54 years. All of them had unilateral radiculopathy as their main symptom associated with varying degrees of axial neck pain and sensory motor neurological deficits. Fifteen patients had right side symptoms and 9 had left side symptoms. The most common level operated was the C5-6 disc, followed by the C6-7 level. The mean duration of hospital stay was 2.7 days (2-7 days). The mean period of follow-up was 19 months (12 to 34 months). The demographic data are summarized in the table 1 below.

Table 1: Demographic data

Particulars	Values
Males: Females	16:8
Age: - mean (range) in years.	43 (22-54)
Radiculopathy:- right : left	15:9
Disc involved	
C4-5; C5-6; C6-7; C7-T1	4; 13; 6; 1
Neurological deficits	
Present	18
Absent	06

Clinical and Functional Outcomes

The radicular pain in the upper limbs was improved in all the patients immediately following the surgery. The mean pre-operative pain score assessed by VAS was 4.5 (3-7), which decreased to 2.1(1-4) immediately after surgery and was 0.7(0-2) at 3 months post-operative follow-up. There was statistically significant (P<0.01) improvement in the radicular pain following surgery. None of the patients complained of worsening of axial neck pain when they were enquired 3 months after surgery. Among the 18 patients who had sensory motor deficits, most of them recovered to functional normalcy (16/18). The remaining 2 patients had minimal grip weakness with residual hypoesthesia in hands. None of the patients complained of neck stiffness following surgery. All of them returned to work with minor modifications in lifestyle. There was overall improvement in all the parameters in Cervical Spine Research scores for radiculopathy by 3 months, the details of which are shown in the table 2 below.

Table 2: Pre and post operative cervical spine research society scores in the study gruop.

Parameters	Mean Pre-Op Scores(Range)	Mean Post-Op Scores At 3 Months Follow-Up(Range)	Remarks
Pain severity	3.2 (2-5)	0.7 (0-2)	
Patient satisfaction	4.3 (4-5)	1.6 (1-2)	
Neurological outcome	2.8 (1-5)	0.5 (0-4)	**P<0.005**
Functional status	2.7 (2-4)	3.5 (3-4)	
Activities of daily living	4.1 (3-5)	1.7 (1-3)	

Table 3: Cervical spine research society scores.

Score	Description
	Pain severity
0	No pain
1	Mild
2	Discomforting
3	Distressing
4	Horrible
5	Excruciating
	Patient satisfaction
1	Very satisfied
2	Satisfied
3	Neither satisfied nor dissatisfied
4	Dissatisfied
5	Very dissatisfied
Neurological outcome measures (a score of 0 means no symptoms and a score of 6 means all six symptoms)	
1	Pain in the upper extremities
2	Arm numbness
3	Headache
4	Leg numbness
5	Arm weakness
6	Difficulty walking
Functional status measures (how much of their usual work and social activities patients were still able to perform?)	
1	None
2	Some
3	Most
4	All
Specific activities of daily living (a score of 0 indicates that no activities worsen symptoms and a score of 5 indicates that all five activities worsen symptoms)	
1	Lifting heavy weights
2	Standing for >10 min
3	Sitting for >10 min
4	Driving or riding in a car
5	Lying down

Radiological Results

The radiographs taken at 6 months after surgery were compared with pre-operative radiographs, which showed no significant change in sagittal alignment in most of the patients following discectomy. There were no fractures noted in any patients at the operated level. Mobility at the involved segment was preserved in all but for the one patient who had fusion. However, no patient had signs of instability. Disc height was reduced as compared to pre-op radiographs. Comparative values of radiological findings are shown in the Table 4 below.

Table 4: Pre and post operative radiological assessment.

Particulars	Pre-Op values	Immediate post-operative period.	6 months follow up.	Last follow-up
Mean Sagittal alignment at the involved segment (range)	-2.3° (+1°to–3.4°)	- 2.3° (+1° to -3.4°)	-2.1° (+2° to –2.9°)	-2.1 (+ 2.3°to- 2.9°)
Mean Disc height at involved level (range)	5.8 mm. (4-6mm.)	5.8mm. (4-6 mm.)	5.6mm. (3-6mm.)	5.4mm. (3-6 mm.)
Mean Segmental motion in flexion-extension view. (Range).	4.1° (2-5°)	4.1° (2-5)	3.8° (0-6)	3.7° (0-6)

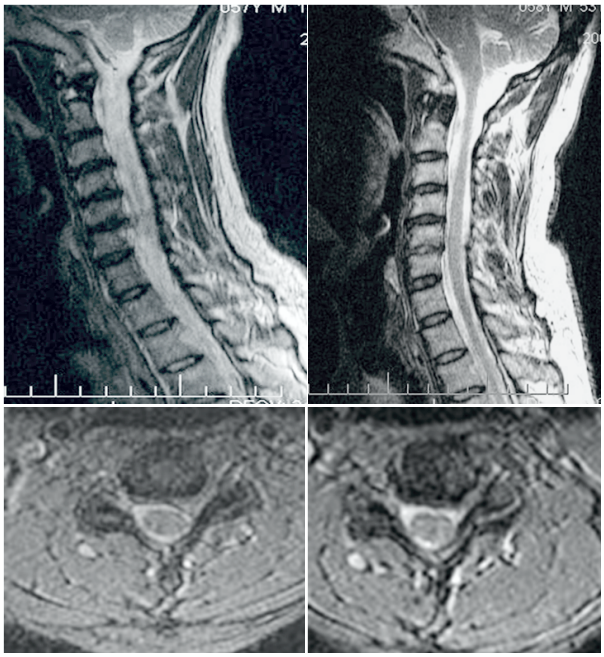

Fig. 5: Pre and post op MRI showing removal of herniated disc.

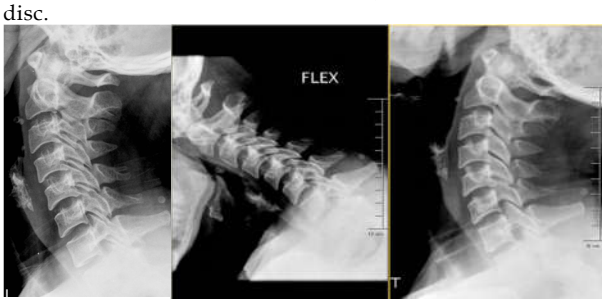

Fig. 6: Follow up radiograph showing no evidence of fusion.

Complications

There were two intra-operative complications noted in this series. One patient had accidental injury to the left vertebral artery at C4-5 level. There was partial tear in the medial wall while elevating the longissimus colli muscle. This was one of the initial patients in the study when the authors were in the learning curve. The tear was sutured after extending the corpectomy and fusion was done in primary sitting. This patient had satisfactory symptomatic relief but the hospital stay was prolonged and had blood loss of 700 ml for which blood transfusion was given. Another patient had Horner's syndrome post-operatively, which resolved after 4 weeks after surgery. There were no late complications noted till date. None of the patients had auto fusion, late fractures, recurrent disc herniation or radiculopathy at the operated level. There were no reports of infection or neurological deficits following surgery and no patient required revision surgery at the same level or at a different level.

Discussion

This study included selective group of patients who had soft disc herniation causing intractable radicular pain, which has not responded to conservative treatment. This pain is generally attributed to nerve root compression and irritation caused by prolapsed disc [9]. Therefore the principle of the surgery is to decompress the nerve root by removal of the prolapsed disc or any other structure causing the compression.

The concept of removal of only the herniated disc with preservation of most of the intact disc could be easily applied in lumbar spine as retraction of the cauda equina through posterior approach was safer than retraction of the spinal cord at cervical level. Because of risk of neurological deficits caused by cord retraction, the posterior foraminotomy in the cervical region did not become the standard procedure except in some cases with far lateral disc protrusion [10,11]. Therefore anterior cervical discectomy and decompression is preferred [12,13,14, 15,16]. The

feasibility of approaching the herniated disc without removal of entire disc by performing anterior foraminotomy without fusion was shown by Jho et al in 1996. This procedure showed successful results comparable to complete discectomy and fusion with the additional advantage of retaining the mobility of motion segment. In addition, there were no graft-related complications.

In the current study, all the patients were relieved of radicular pain and showed significant improvement in the neurological recovery and functional recovery. In the current series no patient required revision surgery for re-exploration of residual disc fragments indicating that adequate decompression was possible without removal of the entire disc. Johnson et al also reported excellent surgical results with anterior microforaminotomy technique. The current technique differs from the technique described by Jho et al in having the oblique tunnel through the bone slightly medial to the lateral cortex and below the attachment of annulus anteriorly.

A thin plate of bone was left intact laterally, which prevents damage to the vertebral artery. This also protects the weakening of anterior and the middle column. In the biomechanical study done by Kotani et al [17], significant changes in stability were observed after sequential uncovertebral joint resection that affected the stability of the functional spinal unit during extension, causing a 30% decrease in stiffness of the functional spinal unit following unilateral anterior foraminotomy. Therefore it is important to retain the lateral support in cases of soft disc herniations that prevents instability following anterior foraminotomy.

All the patients in the study except one who underwent iatrogenic fusion following inevitable partial corpectomy due to vertebral artery injury, showed mobility at the involved motion segment. An average of 90% of pre-operative segmental mobility was preserved till the last follow-up. None of the patients showed abnormal mobility indicating that there was no instability caused by the procedure. The disc height found to gradually decreasing with time but an average of >90% of the disc height was maintained till the last follow-up. The segmental and over all cervical lordosis was well preserved following the procedure. This indicates that the overall biomechanics of the cervical spine is not altered by this procedure which may be advantageous in preventing the progression of cervical spine degeneration. Clinically also, none of the patients so far have reported with worsening of axial neck pain or recurrence of radiculopathy. None progressed to myelopathy clinically so far. However, long term results have to be followed up in order to confirm the benefits of motion preservation in preventing the cervical degeneration.

The authors noted one vertebral artery injury while removing the posterior corner. This was one of the initial cases in the series. The closeness of vertebral artery was difficult to judge till the herniated fragments were removed. Also the anomalous vertebral artery could not be ruled out as a routine angiogram was not done prior to surgery.

This patient needed partial C4-5 corpectomy and fusion primarily. John D. Golfinos et al [18] reported an incidence of 0.3% of vertebral artery injury during anterior cervical decompression in their series and recommended the repair of tear as the optimal treatment.

Limitations

- Adjacent segment degeneration could not be assessed as the duration of follow-up was short and also follow-up MRI was not performed in this study.
- Authors found that there was a steep learning curve in this procedure and the safe application of this technique by all spine surgeons needs to be studied.
- Although there were no reports of body fractures following this technique, further biomechanical studies are necessary to study the strength of the spinal column following Trans osseous approach.

Conclusions

- Transosseous disc preserving cervical discectomy is a useful option to young patients with intractable radiculopathy due to cervical soft disc herniations.
- Adequate decompression of the nerve root and disc fragment removal is possible with excellent relief of radicular symptoms.
- Importantly, it preserves the mobility of the functional motion segment following discectomy without affecting the stability and alignment of the cervical spinal column. This could possibly prevent adjacent degeneration as compared with fusion surgery. However, long-term follow-up studies are essential to evaluate the adjacent segment changes.

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