Clinical Outcome Study of Transfacet Fusion for Treatment of Herniated Lumbar Discs for Dynamic Stabilization

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Abstract
Objective of the study: The purpose of the present study is to present our experience and clinical results with surgical technique of discectomy and facet joint fusion. Our goal was to achieve pain free and stable back (segmental stability) after lumbar disc surgery and to assess the status of fusion and its relationship with clinical results.

Study design: The proposed study is a prospective clinical study of low back pain/leg pain due to prolapse intervertebral disc treated with discectomy with facet joint fusion (using titanium screws) A case of symptomatic disc prolapse not improving on at least six weeks of conservative management. Clinical and radiological follow up was done up to average of five years.

Method: After laminectomy and disc removal. Denude the facet joint cartilage with help of fine curved curette and fine slivers of bone graft taken from spinous processes are impacted into facet joint space after distracting them with help of spreader. Titanium partially threaded cancellous screws with 2.7 mm drill bit without taping.

Results: Complete fusion across bilateral facets was achieved in 56.2% levels. Partial fusion was achieved in 34.3% levels. No fusion at all was seen in only 3 levels (9.3%). On Applying chi square test between the 4 groups, chi square value came to be 44.92 with p value of < 0.001. This implied that Post-op Oswestry score & clinical results have statistically significant association with status of fusion.

Conclusion: This study demonstrates that facet screw fixation has multiple advantages. The technique is not only easy to implement by placing a small screw through a facet joint without any excessive retraction of neural structures and any distraction of posterior elements thus preserving the segmental stability. It produces excellent clinical results that are comparable to other exhaustive surgical procedures and more bulky spinal instrumentation systems.

INTRODUCTION
When discectomy is performed alone for disc pathologies 30-40% of patients return with recurrent episodes of low back pain/leg pain [1]. These groups of patients have disturbed biomechanics, contributed by loss of disc height thus throwing extra stress laterally on facet joint complex resulting in joint instability, lateral stenosis and hypertrophic changes in facet joints [2].

Disappointing results of simple disc excision have spurred development of various fusion techniques. These concepts aim at restoration of disc height and thereby preserving complex joint function following discectomy [3].

Many different techniques and constructs for surgical arthrodesis of lumbar spine have been used. None of these is without complications and problems. The optimal fusion method would provide reliable osseous union and complete nerve root decompression with minimum morbidity [4].

Pseudoarthrosis, graft resolution or displacement, neurological injury and failure of fixation/hardware are known pitfalls of attempted lumbar fusion. Posterior instrumentation offer advantage of internal fixation but can bring the morbidity of extensive exposure and dissection, increased blood loss and infection rate. Compromise of spinal canal or root foramens with the presence of hardware may cause neurological injury and require further surgery for removal of implant. Moreover cost is a big hindrance especially in developing countries like India.

In order to find a solution between simple discectomy on one side and spinal interbody fusion with or without bulky instrumentation on the other extreme, we tried to find a way whose clinical results should be comparable to spinal interbody fusion but less exhaustive and less time consuming than bulky instrumentation systems and moreover the technique can be used in small hospital set ups in periphery and quite easy to learn by average orthopaedic
The purpose of the present study is to present our experience and clinical results with surgical technique of discectomy and facet joint fusion.

Facet screw fixation as adjunct to various posterior and posterolateral fusion techniques has been described by many previous authors [116, 117]. King and Boucher reported a greater than 90% fusion rate with facet lag screws and posterior bone block. The technique of facet screw fixation is relatively uncomplicated and instrumentation is generally familiar to all orthopaedic surgeons, cost of hardware is trivial and there is minimal associated learning curve. Implementation of facet screw fixation requires no further surgical exposure than that required for simple laminectomy or discectomy.

OBJECTIVES

- To assess the efficacy of facet joint fusion (with titanium screw) in prolapse intervertebral disc.
- To achieve pain free and stable back (segmental stability) after lumbar disc surgery.
- To assess the status of fusion and its relationship with clinical results.

MATERIALS AND METHODS

The proposed study is a prospective clinical study of low back pain/leg pain due to prolapse intervertebral disc treated with discectomy with facet joint fusion (using titanium screws). Study was conducted during the period of May 2002 to April 2007 with average post operative follow up of 5 years.

INCLUSION CRITERIA

- A lumbar disc prolapse associated with significant neurological deficit (as in cauda equina syndrome) or progressive neurological deficit especially bowel and bladder disturbance.
- A case of symptomatic disc prolapse not improving on at least six weeks of conservative management. All lesions were confirmed by radiological examination (plain X-rays, MRI) before operation.

EXCLUSION CRITERIA

- Other associated pathological conditions of spine (instability due to spondyloysis, laminar or facet insufficiency, consequent to previous surgery or anomaly)
- Uncooperative patients and patients with medical or surgical problems contraindicating surgery.

After complete history taking, clinical examination and radiological examination (pain X-rays/MRI); the patients who fulfill the above mentioned criteria were taken up for study. Prognosis was explained and informed consent was taken from participating patients. A separate consent was taken for use of screws for surgery. Pre-op psychiatric assessment and disability scoring using Oswestry Low Back Ache Questionnaire was done in all patients.

SURGICAL TECHNIQUE

Identify the spinous processes of L3, L4, L5 and SI by palpation. Make a midline incision 5 to 8 cm long, centered over the interspace where the disc herniation is located. Incise the supraspinous ligament; then, by subperiosteal dissection, strip the muscles from the spinous processes and laminae bilaterally to expose the facet joints. Retract the muscle with a self retaining retractor and expose one interspace at a time. Verify the location with a roentgenogram so that no mistake is made regarding the interspaces explored. Secure hemostasis with electrocautery, bone wax, and packs. Denude the laminae and ligamentum flavum with a curette. Commonly the lumbosacral interspace is large enough to permit exposure and removal of a herniated nucleus pulposus without removal of any bone. If not, remove a small part of the inferior margin of the superior lumbar lamina. Exposure of the disc at higher levels usually requires removal of a portion of the inferior lamina. Thin the ligamentum flavum using a pituitary rongeur to remove the superficial layer. Detach the ligamentum from its cephalad or caudad laminar attachment using a small curette.

The lateral shelving portion of the ligamentum should be excised. Next, retract the dura medially and identify the nerve root, which is displaced posteriorly. Retract the nerve root, once identified, medially so that the underlying extruded fragment or bulging posterior longitudinal ligament can be seen.

Nerve root usually can be elevated, and the herniated fragment can be teased from beneath the nerve root even when the fragment is large enough to block the entire canal. If the fragment is large as with cauda equina lesions
typically, a bilateral laminectomy is preferred to allow safer removal. Gently, remove disc fragments until the bulge has been decompressed to allow gentle retraction of the root.

Tips of two adjacent spinous processes are removed with help of bone cutter sparing interspinous and supraspinous ligaments. Blunt dissection is carried out bilaterally till both facet joints are exposed at the concerned level and facet joint space is identified. Denude the facet joint cartilage with help of fine curved curette and fine slivers of bone graft taken from spinous processes are impacted into facet joint space after distracting them with help of spreader. Titanium partially threaded cancellous screws (4mm non-cannulated, size from 20-25mm) are passed across bilateral facet joints after prior drilling) with 2.7 mm drill bit without taping. Close the wound with absorbable sutures in the supraspinous ligament with subcutaneous tissue.

**POST OPERATIVE MANAGEMENT**

Physiotherapy was started immediately post-op as and when patient is relieved of pain.

Application of PVC lumbosacral corset on the 3rd day when patient is mobilized out of bed.

A thorough clinical assessment and check X-Ray were done to confirm screw size and location at third day when patient is mobilized.

**Figure 1**

Figure 1: Postoperative x ray

**Figure 2**

Figure 2: Left oblique view post op to check position
Figure 3
Figure 3: Right oblique view post op to check position

Brace to be worn continuously during day for 12 weeks strictly avoiding any forward flexion and strenuous activity.

Patients were reviewed every two weeks following discharge with a thorough clinical assessment each time.

X-rays were done at 12 weeks to quantify fusion across the facet joints. If fusion was seen in X-Ray it was to be confirmed by a CT scan. If no fusion was seen at 12 weeks patient was reviewed every four weekly with X-ray done at each visit till the fusion appears. As and when fusion appeared it was confirmed by the CT scan. Corset was discontinued on radiological evidence of fusion.

Figure 4
Figure 4: CT scan showing complete fusion

Figure 5
Figure 5: CT scan with partial fusion

Thorough clinical evaluation was done at discharge and at each subsequent visit. The pain symptoms were assessed and disability was measured. Patient was evaluated using clinical tests such as SLRT, stretch tests, flexion / extension and lateral bending. List and paraspinal spasm were noted.

Patients were evaluated pre and post operatively with Oswestry Low Back Pain Disability Questionnaire Index.

RESULTS

There were 33 patients in our study group. 3 patients had a follow up of less than five years so were excluded from our study. Study comprised of 30 patients. There were 18 males and 12 females. Most common age group was 36-45 yrs. Average age of presentation was 39 yrs.
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Figure 6
Table 1: LEVEL - WISE DISTRIBUTION OF OPERATED CASES

<table>
<thead>
<tr>
<th>SYMPTOMATIC</th>
<th>NUMBER OF LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3 - L4</td>
<td>2 (6.25%)</td>
</tr>
<tr>
<td>L4 - L5</td>
<td>24 (75%)</td>
</tr>
<tr>
<td>L5 - S1</td>
<td>6 (18.75%)</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
</tr>
</tbody>
</table>

Most common level was L4-L5 in 75% cases. Two patients underwent fusion at two levels.

Figure 7
Table 2: PRE-OPERATIVE OSWESTRY SCORE DISTRIBUTION

<table>
<thead>
<tr>
<th>SCORE (DISABILITY in %)</th>
<th>NUMBER OF PATIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20 (minimal)</td>
<td>0</td>
</tr>
<tr>
<td>20 - 40 (moderate)</td>
<td>6 (20%)</td>
</tr>
<tr>
<td>40 - 60 (severe)</td>
<td>16 (53.33%)</td>
</tr>
<tr>
<td>60 - 100 (crippled)</td>
<td>8 (26.67%)</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
</tr>
</tbody>
</table>

Mean pre-operative oswestry score was 57.33%. More than half of the patients (53.33%) had score between 40 and 60 which means severe disability.

Figure 8
Table 3: POSTOPERATIVE OSWESTRY SCORE DISTRIBUTION at 12 weeks and 5 years

<table>
<thead>
<tr>
<th>SCORE (Disability in %)</th>
<th>Number of patients at 12 weeks</th>
<th>Number of patients at 5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20 (minimal)</td>
<td>22 (73.33%)</td>
<td>19 (63.13%)</td>
</tr>
<tr>
<td>20 - 40 (moderate)</td>
<td>4 (13.33%)</td>
<td>8 (26.67%)</td>
</tr>
<tr>
<td>40 - 60 (severe)</td>
<td>2 (6.67%)</td>
<td>2 (6.67%)</td>
</tr>
<tr>
<td>60 - 100 (crippled)</td>
<td>2 (6.67%)</td>
<td>1 (3.33%)</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

Mean post-operative oswestry score at 12 weeks was 20.1 % which shows an average improvement in oswestry score of 37.23% as compared to pre-operative scores.

Mean post-operative oswestry score at four years was 19.33 %. On applying chi square test and comparing oswestry score at 12 weeks and at 5 years, chi square value came to be 1.89 [ p value = 0.596 ]. This implies that oswestry score did not change significantly in five years postoperatively.

Majority of patients became economically productive after surgery. 73.3% patients returned to their original jobs while 20% were earning after some job modification.

Figure 9
Table 4: STATUS OF FUSION ACROSS FACET JOINTS IN OPERATED CASES AT FIVE YEARS

<table>
<thead>
<tr>
<th>STATUS OF FUSION</th>
<th>NO. OF LEVELS (a = 32)</th>
<th>AVG OSEWESY SCORE AT 5 YEARS IN PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Fusion across both facet joints</td>
<td>18 (56.2 %)</td>
<td>11</td>
</tr>
<tr>
<td>Partial Fusion across one and complete fusion across other facet joints</td>
<td>5 (15.63%)</td>
<td>19</td>
</tr>
<tr>
<td>Partial Fusion across both facet joints</td>
<td>6 (18.73%)</td>
<td>23</td>
</tr>
<tr>
<td>No fusion at all</td>
<td>3 (9.3 %)</td>
<td>50</td>
</tr>
</tbody>
</table>

Total number of levels operated was 32 while total number of facet joints fused was 64.

Complete fusion across bilateral facets was achieved in 56.2 % levels. Partial fusion was achieved in 34.3% levels. ¬No fusion at all was seen in only 3 levels (9.3%).

On Applying chi square test between the 4 groups, chi square value came to be 44.92 with p value of < 0.001. This implied that Post-op Oswestry score & clinical results have statistically significant association with status of fusion.

COMPLICATIONS

One patient had increased sensory deficit post-operatively. One patient had foot-drop, one had toe-drop & one patient had paraparesis. All these patients had partial recovery on conservative management. Screw breakage was seen in two patients. Both of these patients had history of fall in postoperative period. Fusion proceeded despite screw breakage. Screw breakage did not cause any complication. No complication was reported due to improper positioning of screws.
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DISCUSSION

Abnormal inter-vertebral motion leading to unstable segment after surgical removal of disc is a major detrimental factor for results of disc surgery. Surgical removal of the disc and disc space narrowing lead to asymmetrical movements of the apophyseal joints known as articular tropism. It leads to altered sharing of loads between the disc and the facet joints leading to accelerated degenerative changes, lateral recess stenosis and relapse of low back pain.

The long-term study of Loupasis, George A demonstrated a high percentage of unsatisfactory results in patients who had a standard lumbar laminectomy and discectomy 7 to 20 years previously. At an average follow-up of 12.2 years, 36% of patients had unsatisfactory results, and 28% complained of significant pain in the back or leg. Salenius and Laurent reported satisfactory early results in 70% of patients that was decreased to 56% after 6 to 11 years of observation. Frymoyer et al. in a retrospective study with a minimum 10-year follow-up, reported a 38% failure rate because of persistent symptoms or the need for reoperation. Dvorak et al. found that 23% of patients still complained of severe low-back pain and 45% had residual sciatica after 4- to 17-year follow-up. Based on this literature this can be inferred that the early encouraging results of a simple disc excision gradually deteriorate with time over along term follow up. hence disappointing long term results of a simple disc excision has encouraged us to develop a middle path between simple disc excision and more exhaustive interbody fusion techniques with bulky instrumentations.

Posterior elements play an important role in maintaining stability of the spine. In lumbar spine they allow extension, flexion and lateral bending but only a small amount of axial rotation. Primary role of apophyseal joints is to transmit shear forces across the inter-vertebral joint. Inter-vertebral disc in all postures is required to bear most of the inter-vertebral compressive load.

Progressive loss of disc volume augmented by partial discectomy leads to alteration of these biomechanics. Apophyseal joints then play a considerable role in resisting inter-vertebral compressive loads. Thus abnormal loading of the facets occurs, whenever the height of inter-vertebral disc is greatly reduced. Sustained loading could thus produce pain and encourage development of osteoarthritis.

According to a biomechanical study by Kip & Doherty; the facet joint screws provide 64% of the intact stiffness & 58% of the intact strength. Thus facet joint screw fixation has been considered to be strong enough to resist mechanical stresses. Facet screw fixation as an adjunct to various posterior and posterolateral fusion techniques has been described by many previous authors and Magerl have presented a posterior translaminar facet fixation technique with encouraging clinical results and biomechanical studies suggesting very stiff and strong fixation.

A high incidence of failure from this method was reported by Thompson and Ralston but they used this method of fusion in highly unstable situations like scoliosis, spondylolisthesis and tuberculosis but we used it for a stable situation like disc excision with minimal bone removal through a laminotomy.

Isolated facet joint fusion is less rigid fusion as compared to interbody fusions providing only single column fusion as compared to various pedicle instrumentations and interbody fusions which provide a more rigid three column fixations. Due to its less rigidity, it leaves scope for some micromobility anteriorly when the intervertebral disc is loaded while at the same time it prevents collapse of disc height thus acting as a suspension bridge. Thus an isolated facet joint fusion will give a dynamic stability like a disc arthroplasty or intervertebral spacer devices like DIAM/DYNESYS. We have been able to achieve a high rate of successful arthrodesis across facet joints using a simple
technique that does not require removal of faceto-laminar structures; which is important for segmental stability. Our technique does not require excessive retraction of cord and neural structures. It does not require any bulky instrumentation that adds cost to the treatment.

It is a simple and less time consuming procedure that provides good results without added complications. Problems relating to mechanical instability like increased slippage of vertebra, dislodgement of graft or facet laminar flap commonly seen in Posterior Lumbar Interbody Fusion (PLIF) and other fusion techniques were not noted in our study.

This study demonstrates that facet screw fixation has multiple advantages. The technique is not only easy to implement by placing a small screw through a facet joint without any excessive retraction of neural structures and any distraction of posterior elements thus preserving the segmental stability. It produces excellent clinical results that are comparable to other exhaustive surgical procedures and more bulky spinal instrumentation systems.

This prospective study was very encouraging but we recognize that our series is small with limited follow up. Our purpose was to present a unique technique of fusion. Our initial results have led us to continued investigation of discectomy with facetjointfusion.

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