Microsurgical Management of Intraspinal Tumors in the Lumbar Spine: Hemilaminectomy as an Alternative to Laminectomy

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ABSTRACT

Introduction: Laminectomy is the classical surgical technique done for exposure of the spinal cord in the removal of intraspinal lesions. Here, we report a case where multilevel hemilaminectomy has been done to remove a long segment intraspinal tumor extending from D11 to L5.

Case report: A 47-year-old lady who had backache for 5 years, difficulty in walking for 6 month. She came to us with paraplegia (grade 0 power of both lower limbs), decreased sensation of both lower limbs and bladder incontinence. MRI revealed an intradural mass lesion extending from D11 to L5 level. Multilevel hemilaminectomy was performed from D11 to L5 and near total resection of the tumor was done. Postoperatively, patient showed improvement with grade 1-2 power in lower limbs at the end of 3 months.

Advantages of hemilaminectomy: The main advantage of hemilaminectomy is the complete preservation of dorsal static structures of the vertebral column; such as the spinous process, the interspinous and supraspinous ligaments, and the unilateral preservation of the intervertebral joints, laminae, ligamentum flavae and the paraspinal muscles.

Conclusion: It is without doubt that patient morbidity and spine stability is better when surgery is performed through a narrow corridor. It can be concluded that hemilaminectomy is a safe and better alternative to laminectomy in the removal of long segment intradural tumors.

Keywords: Hemilaminectomy, Long segment tumors, Instability.


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INTRODUCTION

Laminectomy is the classical surgical technique done for exposure of the spinal cord in the removal of intraspinal lesions. However, surgical failures have occurred which have been attributed to local tissue trauma and to postoperative instability which has led to a dramatic increase in fusion surgeries. Therefore, microsurgical techniques were developed to reduce postoperative morbidity. The usefulness of hemilaminectomy for the resection of spinal tumors were reported by several authors, but most of the excised tumors were small extending for only a few segments. Here, we report a case where multilevel hemilaminectomy has been done to remove a long segment intraspinal tumor extending from D11 to L5. To the best of our knowledge, nowhere in literature it has been reported the removal of such a large tumor by unilateral multilevel hemilaminectomy.

CASE REPORT

A 47-year-old lady who had backache for 5 years, difficulty in walking for 6 months and said to have undergone some form of traditional Indian method of treatment for the same during this period presented to our department with paraplegia (grade 0 power of both lower limbs), decreased sensation of both lower limbs and bladder incontinence. MRI revealed an intradural mass lesion with enhancing solid component and cystic areas with multiple internal locations in the spinal canal, extending from D11 to L5 vertebral levels. Lesion was seen scalloping on the posterior margins and pedicles of multiple vertebrae (Figs 1 to 6).

The usual treatment modality in such a case would have been a multilevel laminectomy with spinal fusion. However, as the pedicles were also involved, pedicle screw fixation would not be possible and the best way to obtain a stable...

Fig. 1: Sagittal T2 precontrast
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The sensory complaints improved postoperatively after 1 week. At follow-up after 3 months, there is grade 2 power in left lower limb, grade 1 in right lower limb. She is still on Foley’s catheter for bladder drainage (Figs 8A and B).

**DISCUSSION**

The stability of the spine is dependent on the spinal column which provides intrinsic stability, the spinal muscles surrounding it providing dynamic stability and the neural control unit which helps in evaluating and determining the requirements for stability and coordinating the muscle response. There is no method to accurately measure spinal instability. Studies on fresh cadaveric functional units by Panjabi and White led to the development of a checklist for the diagnosis of lumbar spine instability. A point value 5 and more indicates clinical instability (Table 1).

The combination of a vertically oriented facet joint and an exaggerated lordotic posture predisposes the lumbar spine to translational deformation. The relatively vertical
orientation of the disk interspace in the low lumbar region causes an applied axial load to result in the application of a shearing force to the spine. Vertically oriented facet joints are poorly positioned to inhibit this translational deformation. This tendency of the lumbar spine to displace is reined in by the posterior spinal elements which are destroyed in a conventional laminectomy. A brief discussion on spinal biomechanics may help in analyzing the need for conservative methods in spine surgery.

Evaluation of stability of cadaveric lumbar spines after facet sparing and radical laminectomies by Abumi et al concluded that the facet sparing laminectomy yielded a more stable spine. Studies by Teo et al showed that a uni or bilateral facetectomy of greater than 75% markedly altered
the translational displacement and flexibility of the motion segment.\(^6\)\(^7\) Subsequently it has been recommended that when performing a facet sparing laminectomy one has to retain at least 50% of the facet bilaterally and sufficient pars to prevent instability.\(^7\) Lu et al in their study concluded that the posterior elements resist shear better than the anterior column but the anterior column allows for better axial control so the two columns contribute different characteristics to the spine.\(^7\)\(^8\) Quint et al loaded six human spine specimens with pure moments in the three main anatomical planes, recorded load hysteresis curves and measured the neutral zone and range of motion in relation to the extent of resection. They found an increased range of motion for all loading situations and concluded that a laminectomy leads to marked instability.\(^9\)\(^10\)

The integrity of the ligamentum flavum, suprainter-spinous ligaments is known to be crucial for the dynamic stability of the spine.\(^11\) The suprainter-spinous ligament complex has the greatest mechanical advantage as it is farthest from the axis of rotation.\(^12\) Goel et al found that under normal conditions the supraspinous ligament received the greatest force when exposed to an external flexion force across an anatomic segment.\(^13\)\(^14\) The supra and interspinous ligaments resist 19% of the flexion forces with the facet capsular ligaments resisting 39%. Adams and Hutton have also suggested that the muscular attachments to the posterior arch and the insertion of the muscular slips on the facet capsule brace the facets improving their ability to resist displacement. The muscular and truncal soft tissue contribution to flexion resistance are critical because the trunk induced force exerted on the spine in flexion is twofold greater than that required to injure the facet joints.\(^12\)\(^15\)\(^16\) Kanayama et al suggested that in regions lacking this ligamentous support the paraspinal muscles provides compensating stability.\(^17\) The wide retraction and elevation of the multifidus bilaterally during exposure of the lumbar spine can lead to chronic denervation and EMG abnormalities as observed by See and Kraft.\(^18\) Mayer et al demonstrated a decrease in paraspinal strength with concomitant atrophy in postoperative CT scan.\(^19\) Unilateral microsurgical techniques limits ipsilateral atrophy to the level of medial facet border. Also contralateral paraspinal muscles are not involved minimizing the risk of iatrogenic trauma.\(^12\)

In a porcine model study by Tai et al, they found that under flexion the intervertebral displacement following laminectomy is significantly greater than that of lumbar spine in intact form and commented that the integrity of the posterior complex acts as a tension band in flexion. If the integrity of the posterior complex is completely destroyed, it is more likely to develop segmental instability.\(^20\) In a finite element model study Zander et al found that intersegmental rotation increased markedly on flexion after bilateral laminectomy. They also noted that while a unilateral or bilateral hemifacetectomy decreases spinal stability only for loading situations of axial rotation, there were only minor differences between bilateral hemifacetectomy and hemilaminectomy. Resection of posterior bony or ligamentous parts was found to have a stronger influence in the amount of stress in a disk than on their distribution. A degenerated disk is stiffer and thus more stressed. The lack of nucleus incompressibility increases the load to be carried by the annulus. Disk degeneration results in smaller intersegmental rotations and higher stresses at the respective level. They noted that decompressive procedures affect the biomechanical properties less markedly in degenerated than in intact disk and resection of bony or ligamentous posterior elements had only a minor effect on the biomechanical behavior of the adjacent region.\(^9\)\(^10\)

### POST LAMINECTOMY INSTABILITY

Tuite et al reported that 15% of 119 patients who underwent laminectomy for lumbar stenosis required reoperations, but none of them required fusion.\(^21\) Javid et al, found instability of lumbar spine following laminectomy in three (3.8%) of 80 patients with lumbar stenosis which required fusion.\(^22\) C Thome et al reported 9% instrumentation assisted fusion due to instability within the first 18 months following laminectomy.\(^2\) Shenkin and Hash reported six cases of postlaminectomy instability (9.8%) after 3 years of follow-up in 59 patients who underwent laminectomy and facetectomy. They reported 6% and 15% of instability after two level and multilevel respectively.\(^23\) Mullin et al reported that 54% of cases showed radiographic signs of instability after lumbar laminectomy with medial facetectomy.\(^24\) The occurrence of instability after limited facetectomy may be attributed to predisposing factors.

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**Table 1: Checklist by Panjabi and White to diagnose lumbar instability**

<table>
<thead>
<tr>
<th>Elements</th>
<th>Point value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior elements destroyed or unable to function</td>
<td>2</td>
</tr>
<tr>
<td>Posterior elements destroyed or unable to function</td>
<td>2</td>
</tr>
<tr>
<td>Radiographic criteria</td>
<td>4</td>
</tr>
<tr>
<td>Flexion-extension radiographs</td>
<td></td>
</tr>
<tr>
<td>Sagittal plane translation &gt; 4.5 mm or 15%</td>
<td>2</td>
</tr>
<tr>
<td>Sagittal plane rotation</td>
<td></td>
</tr>
<tr>
<td>15° at L1-2, L2-3, L3-4</td>
<td>2</td>
</tr>
<tr>
<td>20° at L4-5</td>
<td>2</td>
</tr>
<tr>
<td>25° at L5-S1</td>
<td>2</td>
</tr>
<tr>
<td>Resting radiographs</td>
<td></td>
</tr>
<tr>
<td>Sagittal plane displacement &gt; 4.5 mm or 15%</td>
<td>2</td>
</tr>
<tr>
<td>Relative sagittal plane angulation &gt; 22°</td>
<td>2</td>
</tr>
<tr>
<td>Cauda equina damage</td>
<td>3</td>
</tr>
<tr>
<td>Dangerous loading anticipated</td>
<td>1</td>
</tr>
</tbody>
</table>

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Naderi et al sought to classify iatrogenic lumbosacral instability based on the etiology:

1. Instability due to preoperative reasons:
   a. Overt instability.
   b. Potential instability due to presence of predisposing factors such as increased facet angle, narrowed intervertebral disk, decrease in lumbar lordosis.

2. Iatrogenic instability:
   a. Due to aggressive decompression involving resection of interspinous/supraspinous ligaments, bilateral resection of more than 50% of facet joint or total unilateral facetectomy, laminectomy extending into the pars.
   b. Due to adjacent level degeneration.
   c. Instability unrelated to primary injury.25

ADVANTAGES OF LESS INVASIVE PROCEDURES

Laminectomy leads to overt spinal instability leading to spinal deformity, epidural fibrosis, the absence of osseus protection for the spinal cord which may lead to progressive myelopathy and postoperative axial pain.11,26 Unilateral approach preserves the facet joints and neural arch of the contralateral side limits postoperative destabilization and protects the nervous structures against posterior scarring.12 Panjabi after studies on lumbar spine fractures treated with external fixator uses ‘a ball in a bowl’ analogy and hypothesizes that a stable spine is pain free while an unstable spine is not.3 Hence, postoperative pain will be reduced following microsurgical procedures as it offers a more stable spine. Although spinal fusion generally helps to reduce certain types of pain, it may also decrease function by limiting patient mobility. Furthermore, spinal fusion may increase stress on adjacent nonfused motion segments accelerating the natural degenerative process of adjacent disks. Pseudoarthrosis, i.e. incomplete or ineffective fusion may result in absence of pain relief. The recuperation time is also lengthy.27 The need for stabilizing fusion surgeries and such untoward consequences may be avoided if microsurgical techniques are used.

In our case as the pedicles were also involved, pedicle screw fixation would not have been possible had we ventured for a laminectomy combined with a fusion technique. Hence a better and safe method for obtaining a stable spine postoperatively was through a minimally invasive technique. Laminectomy also creates a large postoperative dead space.

Postoperative dead space has serious potential consequences. Increased volume to be filled results in increased blood loss and provides an ideal bacterial culture medium. The region is inevitably replaced with scar tissue, thereby complicating or necessitating secondary surgical interventions.12 Dead space is significantly reduced with microsurgical methods.

Some authors have presented advantages of laminoplasty in maintaining postoperative stability and preventing epidural scar formation.11,26, 28 However, this procedure also requires initial disruption of the posterior ligamentous structures of the dorsal spine and postoperative immobilization becomes necessary.1

We also found dural repair made easier with this technique. In this case the dura was repaired with fat graft and fibrin glue.

HEMILAMINECTOMY AS THE RX OF CHOICE

Unilateral hemilaminectomy as a method for microsurgical resection of spinal tumors has been studied extensively. The main advantage of hemilaminectomy is the complete preservation of dorsal static structures of the vertebral column such as the spinous process, the interspinous and supraspinous ligaments, and the unilateral preservation of the intervertebral joints, laminae, ligamentum flavae and the paraspinous muscles.1 Chen et al in a clinical analysis of 542 cases found total resection was possible in 501 cases (92%). They reported no tumor recurrence and no spinal deformity in these patients and concluded that this method can be used for resection of all lateralized epidural, subdural-extradural and some intramedullary tumors.29 Chiou et al recommended hemilaminectomy for any kind of spinal tumor in particular for juxtamedullary lesions because fewer, shorter hospital stay were found in those who underwent hemilaminectomy as compared to laminectomy group.30 Bertalanffy et al in a case report of three patients concluded that hemilaminectomy combined with microsurgical techniques should be given priority over laminectomy in the management of extramedullary lesions. The benefits of this procedure includes better spinal stability, shorter duration of the surgical procedure, reduced blood loss, improved wound healing and less risk for post op infection. It also allows early ambulation and rehabilitation of the patient. However, insufficient exposure is a potential problem but it is always possible to extend the procedure to the contralateral side.1 Longitudinally the incision can be extended to perform multi level hemilaminectomy which is both safer and easier as it provides a safe anatomic plane for extension as desired.12 Mummaneni et al performed laminectomy via mini open transspinous approach in the removal of intradural thoracolumbar tumors in 18 patients and reported lower blood loss, shorter length of hospital stay and reduced disruption of paraspinal muscles.31 Sariglou AC et al evaluated 40 patients with spinal tumors (29 intradural EM, 6 IM, 5 ED) at levels T-17, L-13, C-10) treated with unilateral hemilaminectomy and observed no spinal instability or deformity after 32
months postoperatively.32 Balak N removed an intradural tumor (spinal ependymoma) extending from T12-L2 by unilateral partial hemilaminectomy and concluded that a unilateral approach to intramedullary tumors proved to be a safe and easy method.33 Tredway et al in a study of 6 patients with intradural extramedullary tumors at levels (C-1, T-1, L-4) concluded ID, EM tumors can be safely and effectively treated with minimally invasive techniques.34 Sun et al in a study of 45 patients with Intradural extramedullary tumors treated with unilateral hemilaminectomy at levels (C-21, T-12, L-10, multiple-2) found no spinal deformity or instability at 26 months follow-up.35 Yeo et al in a study of 25 cases treated by unilateral hemilaminectomy (intradural + extramedullary 20, extradural 2, intramedullary 3) at levels (L-12, T-9, C4) having mean central space occupying ratio 69.4 (range 27.8-96.9) reported complete tumor removal in all cases with no instability or tumor recurrence at 21.5 months.11 Xing Su et al in a study of 22 patients with spinal schwannomas treated with hemic semi laminectomy at levels (C-5, T-9, L-8) followed up for 6-36 months reported improvement in patient symptoms and no tumor recurrence or spinal deformity. The size of tumors in their study were small and suggested that tumors in the ventral spinal cord and those adhered to the spinal cord tightly required laminectomy.36

Koch-Weiwrordt et al added a new dimension to spinal tumor surgery when they performed unilateral interlaminar fenestration at one or more levels in 78 patients, including one case where 16 segments were fenestrated, to remove Intramedullary, extramedullary or extradural lesions. They reported complete tumor removal in most patients and no spinal instability after 8 years of follow-up.37 This method is superior to all other microsurgical techniques as provides the narrowest surgical corridor with least biomechanical alterations compared to the rest.

CONCLUSION

It is without doubt that patient morbidity and spine stability is better when surgery is performed through a narrow corridor. It can be seen that hemilaminectomy combined with microsurgical techniques offers a stable spine, better postoperative morbidity, ease in performing long segment surgeries and conversion to laminectomy if required. From our case report it can be concluded that hemilaminectomy is a safe and better alternative to laminectomy in the removal of long segment intradural tumors.

REFERENCES


