ABSTRACT

Objectives: Minimally invasive spine surgery is gradually being preferred over conventional techniques due to several advantages. Our study was conducted to compare the persistent cervical symptoms and the surgical outcomes between open cervical laminoforaminotomy (O-CLF) and minimally invasive cervical laminoforaminotomy (MI-CLF).

Materials and methods: Between June 2011 and 2013, 14 patients with radicular pain in the upper limb with magnetic resonance imaging (MRI) proven postero-lateral cervical disk prolapse and failed conservative treatment were assigned to either O-CLF or MI-CLF. Neurological examination and visual analog scale (VAS) for upper limb and neck pain was done. Follow-up was done on day 1, 4 weeks and 6 months.

Results: Out of the 14 patients, seven underwent O-CLF and seven underwent MI-CLF. Demographic characteristics and operating time were comparable between the two groups. The mean follow-up duration was 3 months. Mean blood loss was higher in O-CLF group (150 ml) as compared to MI-CLF (30 ml). Postoperative analgesic requirement was also significantly high in the O-CLF group. Length of hospital stay was more in the O-CLF (4.85 days) as against MI-CLF (1.28 days). Visual analog scale scores for radicular pain did not differ between the two groups. However, VAS scores for neck pain was significantly higher in O-CLF at 6 weeks follow-up as compared to the MI-CLF group. Patients who underwent MI-CLF returned to work faster (2.28 weeks) than their O-CLF counterparts (3.42 weeks).

Conclusion: Minimally invasive cervical laminoforaminotomy results in reduction of postoperative analgesic requirements, hospital stay, blood loss, decreased incidence of postoperative axial neck pain and early return to work.

Keywords: Cervical disk prolapse, Cervical laminoforaminotomy, Cervical spine, Minimally invasive, Keyhole foraminotomy, Neck pain, Radiculopathy.


INTRODUCTION

Cervical disk prolapse is a common disorder that results in spinal cord compression causing either myelopathy or nerve root compression causing radiculopathy or both. Cervical radiculopathy caused by a posterolateral soft disk herniation can be managed by either an anterior or a posterior approach. The posterior approach to cervical pathology was originally reported by Mixter and Barr. The keyhole foraminotomy was described by Spurling and Scoville in 1944, almost a decade earlier than the description of anterior approach by Cloward in 1958. Anterior cervical decompression (discectomy or corpectomy) has been the Gold standard for degenerative cervical disk diseases. Even though the anterior approach has become more popular than the posterior approach, the posterior cervical foraminotomy is an attractive option in selected cases. The anterior approach has biomechanical consequences in the form of loss of mobility at one functional spinal unit and development of degenerative changes at adjacent fused segments. Posterior cervical laminoforaminotomy preserves cervical range of motion, minimizes adjacent-segment degeneration, and avoids injury to the vital structures in the anterior part of neck, such as carotid arteries, esophagus and recurrent laryngeal nerves. However, postoperative axial neck pain and spasm, and aggravated facet arthropathy are disadvantages of a posterior procedure. A wider incision and an extensive periosteal muscle dissection, for adequate visualization can induce neck discomfort, which can result in a slower recovery.

Adamson, in 2001, published the first report of microendoscopic laminoforaminotomy. Since then, several reports of minimally invasive laminoforaminotomies, either ‘microendoscopic’ or ‘tubular retractor assisted’, have appeared in the literature. Recent studies have reported lesser blood loss, reduced analgesic requirement and shorter hospital stay in patients, who underwent minimally invasive laminoforaminotomies as compared to an open procedure. The following paper presents the initial results of a comparative study between open methods.
and minimally invasive laminoforaminotomies in a small cohort of patients.

MATERIALS AND METHODS

A total of 14 patients with radiating pain in the upper arm caused by magnetic resonance imaging (MRI) documented cervical posterolateral disk herniation not responding to adequate conservative treatment were enrolled in the study from June 2011 to June 2013. They were randomly assigned to have surgical treatment by either open cervical laminoforaminotomy (group 1: O-CLF—7 patients) or minimally invasive tubular retractor assisted cervical laminoforaminotomy (group 2: MI-CLF—7 patients). The preoperative and postoperative evaluation consisted of confirming the radiological findings of a posterolateral disk herniation, a detailed neurological examination, and a pain scoring for the upper arm and neck using a visual analog scale (VAS). Postoperative evaluations were done on day 1, 4 weeks, and 6 months after surgery.

Surgical Technique

All patients were operated under general anesthesia in a prone position with head fixed on a skull pin head fixator in a slightly flexed position (Fig. 1). The level was marked using intraoperative lateral fluoroscopy.

Open Cervical Laminoforaminotomy (O-CLF)

A vertical 3 to 4 cm midline incision was made after determining the correct level on a lateral radiograph. The midline raphe was dissected up to the spinous processes and ipsilateral subperiosteal elevation of the paraspinal muscle was done laterally approximately up to the middle of the facet joint complex. Using a high speed drill under a microscope, a 1 to 1.5 cm window was created at the junction of the lamina and facet, overlapping both the superior and inferior levels. The ligamentum flavum was resected and epidural venous bleed, if any, was controlled. The exiting nerve root was identified and compressing disk fragment, usually located in the axilla of the root, was removed.

Minimally Invasive Cervical Laminoforaminotomy (MI-CLF)

After marking the level, a 2 cm vertical incision was placed approximately 1 cm off the midline on the symptomatic side. As a first step, we pass the smallest dilator through the incision and carefully direct it toward the desired facet joint complex under fluoroscopic guidance (Fig. 2). We avoid the use of a k-wire as it can inadvertently pierce through the interlaminar space, whereas such chances are minimal with the smallest dilator. After placing the smallest dilator at the desired level, serial dilatation (Fig. 3) was done to finally dock a 18 mm fixed tubular retractor (METRx system, Medtronic Sofamor Danek, Memphis, TN, USA) (Fig. 4), so as to visualise the lamina-facet junction, and the final position of the tubular retractor was confirmed with lateral fluoroscopy. Using a microscope, the remaining soft tissue over the lamina-facet junction is removed using a monopolar cautery. Rest of the procedure was similar to that described under O-CLF.

STATISTICAL ANALYSIS

The SPSS 12.0 statistical software package (SPSS, Inc, Chicago, IL, USA) was used for statistical analysis. Data were analyzed using the paired student’s t-test. A p-value of <0.001 was considered to be statistically significant.

RESULTS

The demographic and clinical parameters of the patients in both the groups (age, sex, number of levels involved, location of the involved segment and symptomatology) are shown in Table 1. Age and sex ratio were comparable in both the groups. Sensory disturbances were the...
predominant presenting symptom in both the groups (71.5% in MI-CLF group and 85.7% in the O-CLF). All patients in the O-CLF group underwent single level foraminotomy whereas two patients in the MI-CLF group underwent two level foraminotomies. The most commonly affected level in both the groups was C6-7.

The surgical time was comparable in both the groups. Incision length in the O-CLF group was longer than that in MI-CLF group. Intraoperative blood loss and the number of intravenous analgesics required in the first 24 hours were significantly lower in the MI-CLF group as compared to O-CLF group. Patients in MI-CLF group were discharged from the hospital at an average 1.2 days after surgery while those in O-CLF group stayed an average 4.8 days in the hospital after surgery (p < 0.001). The average duration taken to return to work was also significantly lesser in MI-CLF group (1.2 weeks) as compared to O-CLF group (3.4 weeks) (Table 2).

Visual analog scale scores were documented separately for arm pain and neck pain on admission (preoperative), 1st postoperative day, 4 weeks and 6 months after surgery. The observations are tabulated in Table 2. Both the groups had similar preoperative arm and neck pain VAS scores. There was adequate relief of arm pain postoperatively in both the groups and this result was sustained at 6 months. Though the neck pain was slightly higher in O-CLF group on 1st postoperative day and, at 4 weeks follow-up, there was a marked difference at 6 months with patients in O-CLF group continuing to have higher incidence and severity of neck pain as compared to patients in the MI-CLF group who had negligible neck pain at 6 months follow-up.

**DISCUSSION**

Posterolateral soft disk herniations, though are more commonly managed by an anterior approach, can also be effectively managed by a posterior approach. Posterior approaches offer several distinct advantages as compared to an anterior approach like preserving motion and thus reducing the risk of adjacent segment degeneration. Moreover, complications specific to anterior procedures like injury to vital structures in the anterior part of neck, injury to the laryngeal nerves and postoperative dysphagia are avoided. The posterior approach offers excellent access to lateral disk herniations and bony foraminal compromise secondary to cervical spondylosis.

With the advent of minimal access techniques and their routine use in treating disorders of the lumbar spine, their application has also been extended to the cervical spine. Minimal access techniques offer several advantages, such as smaller incisions, lesser injury to paraspinal muscles, shorter hospital stays, lesser postoperative analgesic requirement, and faster return to work. Several reports in the literature exist describing the application of minimal access techniques for cervical laminoforaminotomies and comparing them to open techniques.

In this study, we compared a small cohort of open foraminotomies to minimally invasive tubular retractor assisted laminoforaminotomy. The most common operative levels were C5-6 and C6-7. There were no significant
Table 2: Intraoperative, postoperative and clinical outcome parameters compared between the two groups

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1 (O-CLF) (n = 7)</th>
<th>Group 2 (MI-CLF) (n = 7)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating time (hrs)</td>
<td>2</td>
<td>2</td>
<td>NA</td>
</tr>
<tr>
<td>Incision length (cm)</td>
<td>4–5</td>
<td>2–2.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Blood loss (ml)</td>
<td>151.8</td>
<td>47.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>IV analgesic usage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(No. of doses in first 24 hours)</td>
<td>2.85</td>
<td>1.14</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Postoperative hospital stay (days)</td>
<td>4.85</td>
<td>1.28</td>
<td></td>
</tr>
<tr>
<td>VAS arm pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>7.42</td>
<td>6.85</td>
<td>NS</td>
</tr>
<tr>
<td>1st postoperative day</td>
<td>5.2</td>
<td>4.90</td>
<td>NS</td>
</tr>
<tr>
<td>4 weeks postoperative</td>
<td>3.6</td>
<td>3.20</td>
<td>NS</td>
</tr>
<tr>
<td>6 months postoperative</td>
<td>2.0</td>
<td>1.14</td>
<td>NS</td>
</tr>
<tr>
<td>VAS neck pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>7.12</td>
<td>6.25</td>
<td>NS</td>
</tr>
<tr>
<td>1st postoperative day</td>
<td>6.4</td>
<td>4.28</td>
<td>NS</td>
</tr>
<tr>
<td>4 weeks postoperative</td>
<td>5.8</td>
<td>3.0</td>
<td>NS</td>
</tr>
<tr>
<td>6 months postoperative</td>
<td>5.1</td>
<td>1.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Return to work (weeks)</td>
<td>3.42</td>
<td>2.28</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

NA: Not assessed; NS: Not Significant; IV: Intravenous; hrs: Hours; cm: Centimeter; ml: Milliliter; VAS: Visual analog score

differences in operative time or complications between the two surgical approaches. Intraoperative blood loss, intravenous analgesic usage and duration of hospital stay were significantly lesser in MI-CLF group as compared to O-CLF group in our study. In all the cases of MI-CLF, the disk was successfully removed and there was no need for conversion to open. Similar results were reported by Clark et al.17 in a recent review of comparison between open and percutaneous laminoforaminotomies.

Clinical outcome measured in terms of improvement in VAS for arm pain was similar in the immediate postoperative period and was sustained up to 6 months in both the groups. Though the VAS scores for neck pain were slightly higher in the O-CLF group as compared to MI-CLF group in the immediate postoperative period, the difference was not statistically significant. However, VAS for neck pain at 6 months was significantly higher in O-CLF group than MI-CLF group. This could probably be attributed to increase paraspinous muscle injury caused in O-CLF procedures, though such a statement could be confirmed only after comparing paraspinous muscle cross-sectional area or signal changes on postoperative MRI between the two groups. Such a measure was not taken in the present study.

Despite all the recent series comparing O-CLF with MI-CLF have revealed better outcomes with minimally invasive procedures, open laminoforaminotomies can also result in excellent clinical outcomes as described in the series by Tomaras et al.18 They reported incision sizes, blood loss and lesser analgesic requirements and shorter hospital stay similar to several percutaneous laminoforaminotomy series in a large series of 200 open laminoforaminotomy cases. Kim et al also reported that there was a significant decrease in the postoperative analgesic usage and hospital stay. In the study by Kim et al9 there has been a statistically significant difference in incision in the two groups O-CLF 3.6 cm as compared to MI-CLF of 4 mm. They have also described these differences could be clinically relevant as longer incisions will invariably lead to extensive periosteal dissection thus increasing pain, increased analgesic usage and prolonged hospital stay.

Fessler and Khoo19,20 et al observed that the hospitalization time might explain a substantial portion of postoperative analgesic usage. The study conducted by Winder and Thomas et al10 have also revealed that the patients who underwent MI-CLF had statistically significant improvements in blood loss, analgesic usage and hospital stay compared with the O-CLF group. The main limitations of this study are the small number of cases and limited follow-up period. A larger randomized study with postoperative imaging to document paraspinal muscle changes and a longer follow-up period may provide adequate confirmation for the above results.

To conclude, minimally invasive tubular retractor assisted cervical laminoforaminotomy results in better clinical outcomes as compared to open cervical laminoforaminotomy in terms of shorter hospital stay, lesser analgesic requirement, earlier return to work and lesser incidence of long-term neck pain.

REFERENCES

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