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Unilateral Hemilaminectomy for the Excision of Intradural Extramedullary Spinal Tumors: A Beginner's Challenges

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ABSTRACT

AIM: To analyze retrospectively our experience of unilateral hemilaminectomy in intradural extramedullary (IDEM) tumors.

MATERIAL and METHODS: This study included 28 patients with IDEM tumors who underwent unilateral hemilaminectomies during the period 2011–2016. The preoperative clinicoradiological data, intraoperative findings, and postoperative outcomes were analyzed using a Microsoft Excel database.

RESULTS: The mean age of the patients was 49.14 ± 12.23 years, and the average duration of symptoms was 11.82 weeks. The tumor distribution in the spine was as follows: cervical spine (14.2%), cervicodorsal spine (3.6%), dorsal spine (39.3%), dorsolumbar spine (10.7%), and lumbar spine (32.1%). Twenty patients (71%) underwent two-level laminectomies, and three-level laminectomies were performed on eight patients (29%). The mean operative time was 4 hours and 40 minutes.

CONCLUSION: Unilateral hemilaminectomy is a safe, minimally invasive procedure for the excision of IDEM tumors. Beginners may face difficulties with this procedure and should ideally take more time than with a conventional total laminectomy because of the narrow operating corridor. As more experience is gained, this procedure will become easier in selected cases.

KEYWORDS: Unilateral, Hemilaminectomy, Spinal cord, Tumors

INTRODUCTION

The incidence of spinal cord tumors is 10 per 100,000 people (19), with IDEM tumors accounting for two-thirds of all spinal tumors (13). Benign tumors like schwannomas (30%) and meningiomas (25%) are the most common types of spinal cord tumors (12). Patients with spinal tumors usually present with back pain, sensory motor deficits, or radicular pain due to the compression of the spinal cord or roots by the tumor (17). Decompression with tumor excision is the most appropriate treatment method (7). The traditional technique of a wide laminectomy is still the most practical and safest method for the excision of IDEM tumors. However, this procedure carries the risk of the development of long-term spinal instability or kyphosis due to damage to the posterior column, and these complications may produce symptoms by compressing the spinal nerves or cord (23). To avoid such complications, a unilateral laminectomy was undertaken by Yasargil et al. in 1991 (22). The unilateral hemilaminectomy has more benefits in terms of postoperative spinal stability compared to the total laminectomy (5). This technique is especially useful when applied to tumors lateralized to one side in the spinal canal. In this paper, we describe our experiences of tumor excision by unilateral hemilaminectomy and discuss the advantages and disadvantages of this technique.

MATERIAL and METHODS

All patients with IDEM tumors who were admitted to our institute and selected for unilateral hemilaminectomy to excise the tumors from July 2011 to March 2016 were included in this study. The size, laterality, number of segments involved, and probable diagnosis based on clinical and radiological features were the criteria for deciding the hemilaminectomy

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approach. All clinical and radiological features were entered retrospectively into a database using Microsoft Excel (Microsoft Corporation, Redmond, WA). Clinical assessments of myelopathy were conducted using modified Nurick grading, and the severity of pain was assessed using a numerical rating scale. All the patients underwent gadolinium-enhanced magnetic resonance imaging (MRI) for radiological diagnosis. Cervical tumors were localized intraoperatively using fluoroscopy in reference to the odontoid process and C7 spinous process. Tumors located in the dorsal and lumbar spines were localized preoperatively with a marker X-ray (i.e., a small coin was affixed at the site of the level of the tumor). This was undertaken one day before surgery and confirmed again by the C-arm in the operating theater immediately prior to painting and draping. All the patients underwent surgery in the prone position. All intraoperative and postoperative complications were recorded. Patients were usually discharged on the third day after surgery if the wound was healthy. An MRI was done at the three-month follow-up to determine the extent of the excision.

Criteria for Unilateral Hemilaminectomy Selection

The location of the tumors in the spinal canal on gadolinium-enhanced MRI was the basis for selecting the patients for this procedure. Only patients with IDEM tumors that were localized to one side and up to three vertebral levels were selected for this procedure. The exclusion criteria were exophytic IDEM tumors, pure intramedullary tumors, central location in the spinal canal, and recurrent tumors even though lateral in location.

Preoperatively, all the patients routinely received 12–16 mg intravenous dexamethasone in anticipation of some spinal cord handling and postoperative cord edema. All the patients were placed in the prone position under general anesthesia. A Wilson spinal frame was used to position patients in cases where the tumor was located in the dorsal or lumbar spine. The frame significantly augments the operating corridor in a limited laminectomy. Neuromonitoring was not used for any patients. The vertebral level was confirmed by a C-arm, and the incision line was marked. A midline skin incision was made, and subperiosteal dissection of the muscles was done on the side of the tumor until the desired level of exposure of the hemilamina was attained. The supraspinal ligaments, interspinal ligaments, and tendinous insertions of the contralateral muscles were retained. The hemilamina at the tumor level was removed using a high-speed drill. In some cases, undercutting of the spinous process was required to allow extra space and instrument maneuverability. A paramedian incision in the dura was made above the maximum bulge of the tumor and extended with the help of two fine-toothed dural forceps. Stay sutures were placed on both sides of the dura for dural retraction. Sometimes it is helpful to tug the ipsilateral dura with the spinal muscle or fascia for wider and more angled exposure. Threaded cottonoids were applied at the cranial and caudal ends of the tumor to prevent blood from trickling into the dural sac. The arachnoid over the tumor was dissected sharply to mobilize it. Initially, intratumoral decompression was done using a Cavitron ultrasonic aspirator (CUSA) or a Penfield dissector in some cases, and the tumor capsule was then gently separated from the surrounding structures and removed. In cases of meningioma, the dural attachments were coagulated. In the case of schwannomas, all attempts were made to save the nerves. Only those nerve fibers that had entered the tumor or were firmly attached to the tumor capsule were sacrificed. In some cases where tumors were ventral to the cord, the dura was cut in a T-shaped manner, and the cord was mobilized by cutting and lifting the dentate ligament for better exposure of the tumor. A partial facetectomy on the involved side was also done in some cases to achieve an adequate angle of visualization. The dura was closed primarily with 5-0 Prolene sutures. As space is limited for a needle to move, we used a 9 mm needle with a 3/8 circle. In most cases, only a two-level hemilaminectomy was performed. Blood transfusions or fixation of the spine was not required for any patients.

Patients with a minimal neurological deficit were made to ambulate the next day. Most of the patients were discharged on the third postoperative day if the wound was healthy. We prescribed a soft cervical collar for 2–3 weeks for neck support for those patients who underwent surgery for a cervical IDEM tumor. We did not apply an LS belt or Taylor's brace for lumbar or dorsal tumors, respectively. All the patients were followed up at two weeks, three months, and six months postoperatively in the Neurosurgery OPD. A clinical assessment of myelopathy was done using modified Nurick grading, and the severity of pain was assessed using a numerical rating scale.

RESULTS

A total of 32 patients were selected for this study based on our radiological inclusion criteria. We had to convert hemilaminectomies to total laminectomies intraoperatively in four cases, which were excluded from this study. A total of 28 cases were therefore included in the study. Males (n=20) were affected more than females (n=8). The mean age of the male patients was 51.35 ± 12.06 years, and that of the female patients was 43.63 ± 10.82 years. The overall mean age was 49.14 ± 12.23 years. The symptoms are summarized in Figure 1 and average duration of them was 11.82 weeks. The mean length of the tumors was 28.78 ± 8.19 mm, the mean width was 10.89 ± 2.63 mm, and the mean thickness was 8.29 ± 2.08 mm. The tumor distribution in the spine was as follows: cervical spine (14.2%), cervicodorsal spine (3.6%), dorsal spine (39.3%), dorsolumbar spine (10.7%), and lumbar spine (32.1%). Seventeen tumors (69%) were approached from the right side, and 11 tumors (39%) were operated on from the left side. The mean operative time was 5 ± 0.8 hours. Twenty patients (71%) underwent two-level hemilaminectomies, while three-level hemilaminectomies were performed on eight patients (29%). Total excision was achieved in 26 cases (92%). Two out of the 28 cases were epidermoid, and in both cases, the capsule was adhering to the conus medullaris, so the capsule was left attached to the conus medullaris.

Post-Operative Complications

Five patients (17%) had postoperative cerebrospinal fluid

(CSF) leak. Three patients improved after the placement of additional sutures over the incision site and by maintaining the prone position. A lumbar drain was put in the remaining two patients for CSF leak. Three patients (10.7%) developed fevers, which were managed conservatively. The mean duration of stay was 5.86 ± 2.5 days. Those patients who had postoperative CSF leaks stayed longer and were discharged after the removal of the stitches when the wound became dry. The average hospital stay of the patients with CSF leak was 12.5 days.

The patients were followed up in the Neurosurgery OPD at two weeks, three months, and six months. The motor weakness in the patients with cervicodorsal myelopathy showed significant improvement at the six-month follow-up. One patient with a modified Nurick grade of 4 improved to grade 1. Four patients assessed as being at grade 3 went down to grade 1, and six patients at grade 2 went down to a zero grade (Figure 2). The mean pain rating scale score of the patients with back pain was 6.1 preoperatively and 2.8 postoperatively. Similarly, the mean pain rating scale score for the patients with radiculopathy was 7.4 preoperatively and 0.44 post-operatively. The mean score for neck pain was 6.7 preoperatively and 2.1 post-operatively (Figure 3). The histopathological diagnoses were as follows: schwannoma 18 (64%), meningioma 8 (29%), and epidermoid 2 (7%). We had six-month follow-ups with 24 patients (86%). Four patients failed to return after three months. No patients had any spinal deformities or instability at the last follow-up.

DISCUSSION

A complete laminectomy is the traditional technique used for the excision of spinal cord tumors (4). However, researchers have pointed out the many long-term complications associated with this procedure, with the most common complication being kyphosis (2). Post-laminectomy kyphosis, especially in children because of their growing bones, leads to anterior compression of the spinal cord and subsequent myelopa-

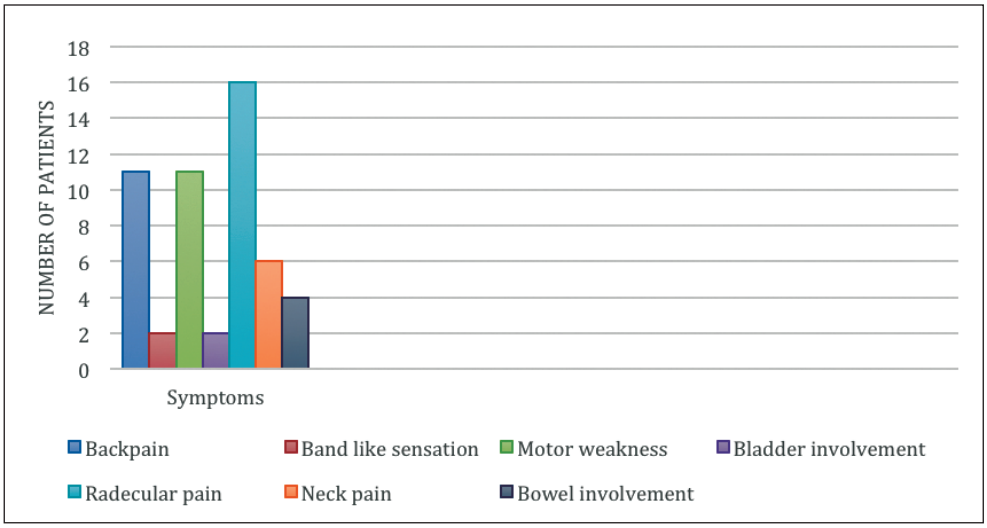

Figure 1: Showing various symptoms of the patients with IDEM tumours.

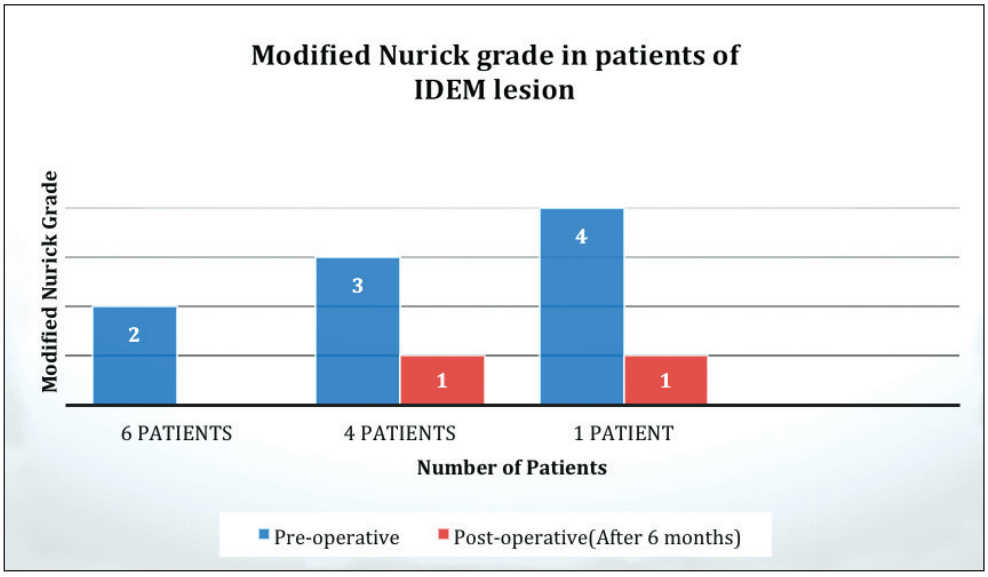

Figure 2: Showing preoperative and postoperative Modified Nurick grade of the patients.

thy (1). Other complications of total laminectomy are spinal instability leading to spinal deformity, epidural fibrosis, the absence of posterior bony protection, and postoperative axial pain. A total laminectomy causes damage to the supraspinal ligaments, interspinous ligaments, and bilateral ligamentum flavum, leading to weakness of the posterior column of the spine (5). Stripping and denervation of the paraspinal muscles are also responsible for post-laminectomy deformities and instability (14). Taking these complications into consideration, some researchers have suggested fusing the spine, primarily at the time of laminectomy, to reduce the risk of spinal instability (15), but this additional procedure would increase the operative time, complications, and sequelae, and result in additional costs to patients, which is undesirable. Other procedures, like laminoplasty and interlaminar fenestration, have been described by different authors (8,21), but these procedures are also not free from complications. The concept of minimally invasive spine surgery evolved to avoid complications, and Yasargil et al. were the first to use unilateral hemilaminectomy for the excision of intradural tumors in 1991 (18). This procedure involves only the unilateral stripping of the muscles at a single or double level. For this reason, a unilateral hemilaminectomy results in fewer injuries to the dynamic dorsal structures of the vertebral column compared with a total laminectomy or even laminoplasty (14,20). Gu et al. suggested that lesions with a transverse diameter of <2 cm that are limited to two spinal segments would be best treated with a unilateral hemilaminectomy (6). The benefits of this procedure are less blood loss, reduced postoperative pain, early mobilization, avoidance of external bracing, a shorter hospital stay, and minimal spinal instability (15,10). The disadvantage of this procedure is a limited working space for surgeons. The operating corridor is restricted by the spinous process medially and the facets joint laterally, which limits instrument maneuverability. This is challenging for beginners and requires a long learning curve. In our initial few cases, we overcame these problems by adopting certain tricks, like tugging the ipsilateral dura with fascia, undercutting the spinous process, and tilting the table towards the contralateral side, to augment exposure and the viewing angle. Yeo et al. suggested a new technique to further enhance exposure, which involves making a liberal lateral cut in the dura and suturing it to the base of the ipsilateral fascia at the base of the facet joint (24). For beginners, it is advisable to start performing minimally invasive surgery in patients with degenerative diseases of the spine such as prolapsed intervertebral disc (PIVD). When they become comfortable operating within a narrow space, then they should start performing this procedure on IDEM tumors. The red flag for beginners with this approach is a ventrally located tumor in the upper dorsal spine. Mehta et al. observed that T1–T4 lesions resulted in the most postoperative neurological complications. This may be because of the high spinal cord-to-canal ratio and precarious blood supply to this area of the cord (13). It may be wise for surgeons to convert this procedure to a total laminectomy without hesitation if they face any difficulties with tumor exposure. In our study, there were 18 cases of schwannoma, and all were completely excised. In most of the middle dorsal locations, we were able to sacrifice the nerve from which the tumor arose without any significant deficit because there is a fair amount of overlapping of dermatomes in this area. It is advisable to make every possible effort to preserve the attached nerve fibers wherever possible. Most authors have emphasized that the preservation of nerve roots compromises the complete removal of the tumor (3), yet in the study by Kim et al., only 23% of the complete excisions of schwannoma with functionally important nerve roots resulted in the development of neurological symptoms (not severe ones) because the nerve roots involved in the tumors had already become dysfunctional (9). There were eight cases of meningioma in our study. Compared to schwannomas, meningiomas are relatively difficult to deal with when performing a unilateral hemilaminectomy because of vascularity, consistency, and broad dural attachment, so the technical pearls for meningiomas are early coagulation of the dural attachment to cease their vascularity

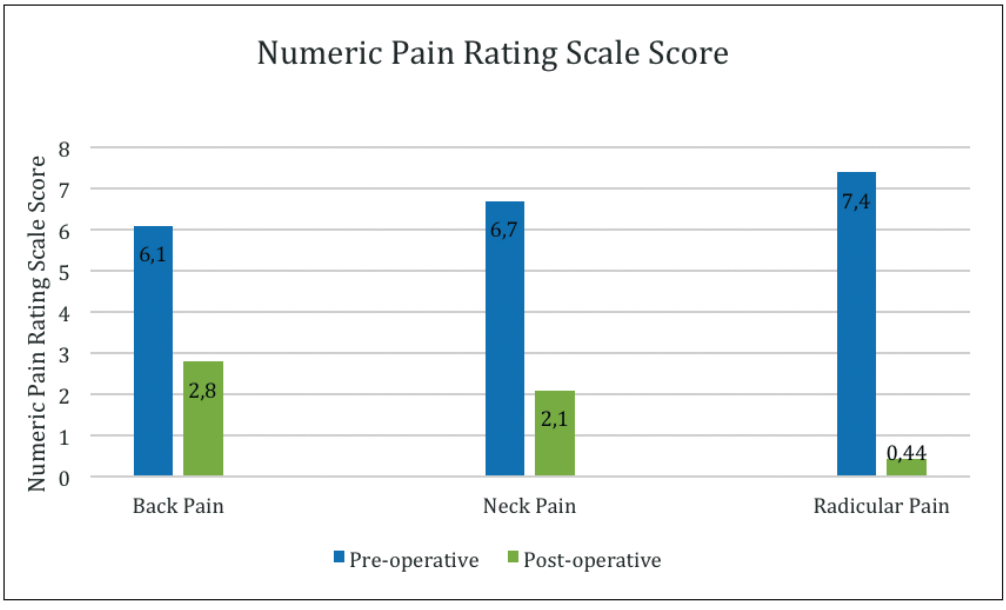

Figure 3: Showing pre and postoperative pain rating score.

and the use of a CUSA for intratumoral decompression to reduce traction on the cord. Dural repair can become difficult in these cases as the dura shrinks after coagulation. We used a fascial graft in three cases of meningioma to repair the dura. Four out of our five cases (80%) of CSF leak were found to involve meningiomas on histopathology, indicating dural coagulation as a possible risk factor for postoperative dural leak. Splitting and the excision of the inner layer of the dura along with the tumor is an alternative technique for spinal meningioma (16), but this method is not commonly used because of a fear of inadvertent tearing of the dura. The mean operative time in our study was 5 ± 0.8 hours compared to 4.6 ± 0.2 hours in the study by KrishnanKutty et al. (11). Our operative time was longer because of our inadequate experience with this technique. Notwithstanding, the operative time gradually reduced as we gained sufficient experience over a period of time. The mean operative time in the schwannoma cases in our study was 4.9 ± 0.7 hours compared to 5.5 ± 0.9 hours in the meningioma cases, which was significant. It clearly indicates that the meningiomas in our series took longer to excise compared to the schwannomas. Among our 11 patients who had motor weakness, six had improved completely at six months. The remaining five patients improved, with modified Nurick gradings of 1 on follow-up at six months. No patients had developed spinal instability up to the last follow-up. At the time of writing, it is too early to comment on postoperative spinal deformities like kyphosis as we require long-term follow-ups to assess the long-term complications.

CONCLUSION

In our experience, the selection of ideal cases is paramount for the performance of unilateral hemilaminectomy, and a small laterally located tumor can be easily excised using this technique without any additional procedure-related complications. By adopting this technique for the excision of such tumors, surgeons can avoid the major long-term complications associated with the total laminectomy procedure, which is conventionally used to excise IDEM tumors. For beginners, unilateral hemilaminectomies may initially appear difficult as the operating corridor is narrow, but as with other procedures, this technique also has a learning curve. From a patient's perspective, this procedure is quite beneficial because there is a shorter hospital stay, minimal postoperative pain, a reduced financial burden, and a lower risk of developing spinal instability.

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