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The Role of Unilateral Hemilaminectomy in Benign Intradural Spinal Tumor Surgery

Benign İntradural Spinal Tümör Cerrahisinde Unilateral Hemilaminektominin Rolü

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ABSTRACT

Objective: Hemilaminectomy can be used to treat different space-occupying lesions, whether intradural, extramedullary, intramedullary, or extradural. In this study, We have investigated to illuminate the role of hemilaminectomy in benign spinal cord tumors, which occupy the spinal canal.
Materials and Methods: 15 patients with spinal tumors who were operated on with hemilaminectomy were included in the evaluation. The hemilaminectomy method was chosen based on the size, laterality, number of segments involved, and possible pathologies. The demographics of the subjects, as well as their operating reports, histological results, pre- and postoperative images, and follow-up information, were examined. Frankel grade classification was used to assess the neurological status on admission and during follow-up.
Results: The mean age of the patients was 48.4 years. Nine of the patients were male and 6 were female. According to tumor localization, 3 of them were cervical, 7 were thoracic, and 5 were lumbar. 4 of them were meningiomas, 6 were ependymomas, and 5 were schwannomas. One patient was worse than the pre-operative, and the post-operative grades of the remaining 11 patients were similar to the pre-operative grades. Post-operative imaging showed that gross-total resection was achieved in all patients.
Conclusion: If used correctly and with a reasonable learning curve, limited unilateral hemilaminectomy can offer enough access to the dural sac, allowing for safe resection of nearly all spinal intradural and extradural lesions. Because it takes less time to operate than a standard laminectomy, it is better for older or high-risk patients.

Keywords: Spinal tumor, hemilaminectomy, Frankel

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ÖZ

Amaç: Hemilaminektomi intradural, ekstramedüller, intramedüller veya ekstradural olsun farklı yer kaplayan lezyonların tedavisinde kullanılabilir. Bu çalışmada, spinal kanalı işgal eden iyi huylu omurilik tümörlerinde hemilaminektominin rolünü aydınlatmaya çalıştık.
Gereç ve Yöntem: Değerlendirmeye hemilaminektomi ile opere edilen spinal tümörlü 15 hasta dahil edildi. Hemilaminektomi yöntemi boyut, lateralite, tutulan segment sayısı ve olası patolojilere göre seçildi. Deneklerin demografik özellikleri, operasyon raporları, histolojik sonuçları, ameliyat öncesi ve sonrası görüntüleri ve takip bilgileri incelendi. Başvuru ve takip sırasında nörolojik durumu değerlendirmek için Frankel sınıflaması kullanıldı.
Bulgular: Hastaların ortalama yaşı 48.4 idi. Hastaların 9'u erkek, 6'sı kadındı. Tümör lokalizasyonuna göre 3'ü servikal, 7'si torasik ve 5'i lomberdi. 4'ü meningiom, 6'sı ependimom ve 5'i schwannom idi. Bir hastanın postoperatif Frankel skoru preoperatife göre daha kötüydü, kalan 11 hastanın ise postoperatif skorları preoperatiflere benzerdi. Postoperatif görüntülemeler, tüm hastalarda gros-total rezeksiyona ulaşıldığını gösterdi.
Sonuç: Doğru ve makul bir öğrenme eğrisi ile kullanılırsa, sınırlı tek taraflı hemilaminektomi dural keseye yeterli erişim sağlayarak neredeyse tüm spinal intradural ve ekstradural lezyonların güvenli rezeksiyonuna izin verebilir. Standart bir laminektomiden daha az zaman aldığından, daha yaşlı veya yüksek riskli hastalar için daha iyidir.

Anahtar Kelimeler: Spinal tümör, hemilaminektomi, Frankel

INTRODUCTION

Spinal tumors are uncommon and occur in 1-2.5 persons per 100,000. Intradural spinal cord tumors are typically accessible by laminectomy, which allows for better vision. Interlaminar fenestration, laminotomy, and hemilaminectomy (HL) have also been used. Apart from full resection, pre-morbid, preoperative, and postoperative general clinical condition, tumor grade, and location are all predictors of surgical outcomes [1-3]. The goal is to do a thorough resection with minimally invasive procedures while minimizing iatrogenic damage that might result in postoperative problems [3-5]. Although laminectomy provides appropriate exposure, it has been associated with postoperative problems such as hematoma development, spinal deformity, dural constriction owing to epidural scarring, and restricted access in the event of reoperation, all of which can result in a poor outcome. To replace laminectomy and reduce the risk of postoperative instability and deformity, less invasive techniques have been used. Bickham [6] described osteoplastic laminotomy, which was used by Raimondi [1] and Parkinson [7]. It has also been advised that a decompressive laminectomy be performed first, followed by fusion [2]. In 1991, Yasargil et al presented a study on a group of 100 patients who were treated with HL for spinal tumors or arteriovenous malformations [8]. Bertanalfy proposed in 1992 that for removal of extramedullary lesions arising in the spinal canal, HL combined with microsurgical methods should be preferred to simple laminectomy. Following that, HL has been used to treat different space-occupying lesions, whether intradural, extramedullary, intramedullary, or extradural [4,9-11]. In this retrospective study, we investigate the profiles of spinal cord tumors that could be removed through a unilateral HL. We would like to illuminate its role in benign spinal cord tumors, which occupy the spinal canal. Some technical tips on overcoming the narrow surgical corridor are also discussed.

MATERIALS AND METHODS

Patient Population

Fifteen patients who underwent minimally invasive HL surgery due to spinal lesion were included in this study. The HL method was chosen based on the size, laterality, number of segments involved, and possible pathologies. The demographics of the subjects, as well as their operating reports, histological results, pre- and postoperative images, and follow-up information, were examined. Frankel grade classification was used to assess the neurological status on admission and during follow-up [12]. Preoperative dynamic X-rays were used to assess possible instability; preoperative CT scans were used to determine

whether the intervertebral foramen was enlarged or not; contrast-enhanced MRI was used to show the side, size, and location of the suspected tumor in all cases; and magnetic resonance angiography was used to determine the relationship between the tumor and the vertebral artery in cervical spinal cord lesions. A postoperative MRI was used to evaluate the extent of the lesion excision.

Surgical Technique

Preoperative steroids were given starting one day before surgery and continuing up to three days thereafter. The night before the surgery, X-Ray imaging or MRI was obtained to properly pinpoint the levels involved.

The patient was intubated in the operating room. Electrophysiologic monitoring was performed using MEP and SEP electrodes. Transcranial electrical stimulation of the motor cortex was used to record MEPs, with the stimulating electrodes implanted on the scalp (hand or leg area). The external anal sphincter, as well as the abdomen of the muscles of the upper and lower limbs, were used as recording electrodes.

The tumor level was determined using the C-arm after the patient was placed in a prone posture. Following the procedures utilized for unilateral HL or discectomy, a midline skin incision was made, followed by unilateral subperiosteal muscle dissection and lamina exposure. The dural sac was revealed by drilling the lamina, including the base of the spinous process while maintaining the facet joint. Before making a dural incision, intraoperative ultrasonography can help detect the lesion.

Because the surgical field is so narrow in unilateral HL, it poses a problem. We used several practical technological approaches to get around this. The combination of undercutting of the base of the spinous processes with concurrent oblique tilting of the operating table to the contralateral side provided an adequate view for the extradural and intradural procedures. The lateral dural tacking procedure, which involves tacking the ipsilateral dural border and suturing it at the base of the muscle or fascia at the facet joint rather than lifting or suspending it, was also used. Internal debulking or piecemeal resection helps in the dissection of solid tumors. Prior to resection, if a tumor had a cystic component, the cyst was punctured and aspirated. Cottonoids applied to the upper and lower poles helped to prevent blood clots from spreading too far down the spinal canal. Because of the narrow window, using an intraoperative ultrasonic aspirator was not useful. To avoid adhesions, a gelatin sponge was put on the subdural area before dural closure. After that, a 4-0 vicryl running suture was used to approximate the dural sac. The needle utilized was a non-cutting 3/8 of a circle 8 mm needle, which provides for easy movement in tight places without causing huge dural holes. The incision site was draped after the muscle layer, subcutaneous tissue, and skin were closed.

Patients were usually discharged on the second or third postoperative day after waking and ambulating within a few hours of surgery.

RESULTS

15 patients with spinal tumors who were operated on with HL between 2021-2022 were included in the evaluation. The mean age of the patients was 48.4 years. Nine of the patients were male and 6 were female. When these tumors were examined according to their localization, it was observed that they were distributed in 3 cervical, 7 thoracic, and 5 lumbar regions. Of these tumors, 9 were intradural extramedullary localized and 6 were intradural intramedullary localized. 4 patients had pre-operative neurodeficiency. When examined according to tumor pathologies, 4 meningiomas, 6 ependymomas, and 5 schwannomas were

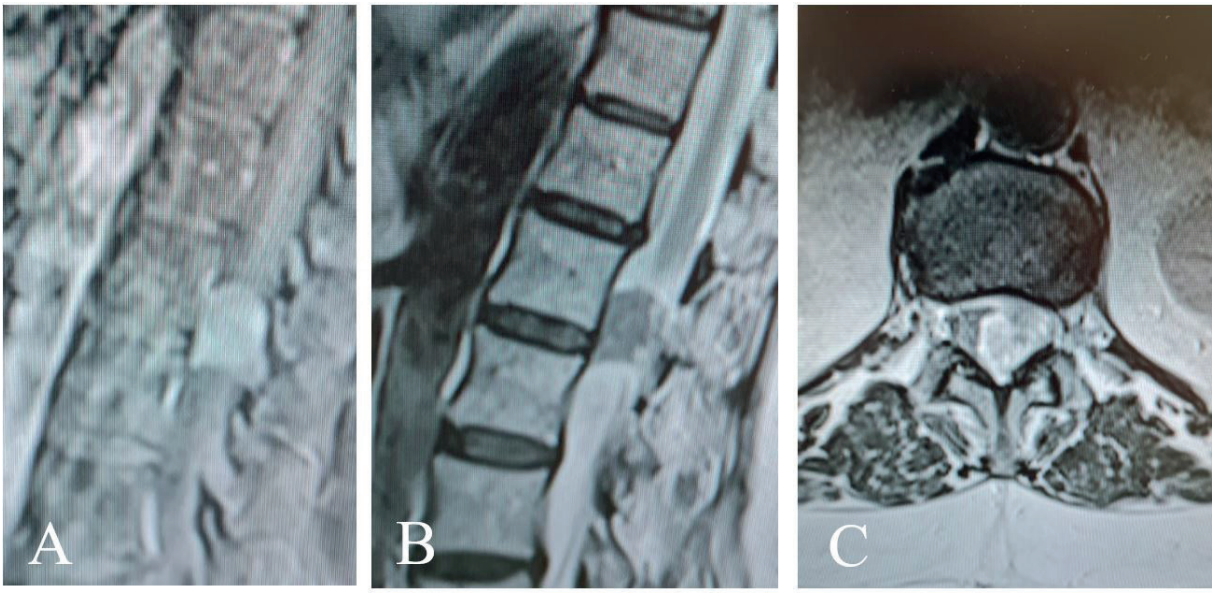

Figure 1. Preoperative MR images of a patient with thoracic schwannoma A. Sagittal Postcontrast T1 B. Sagittal T2 C. Axial T2

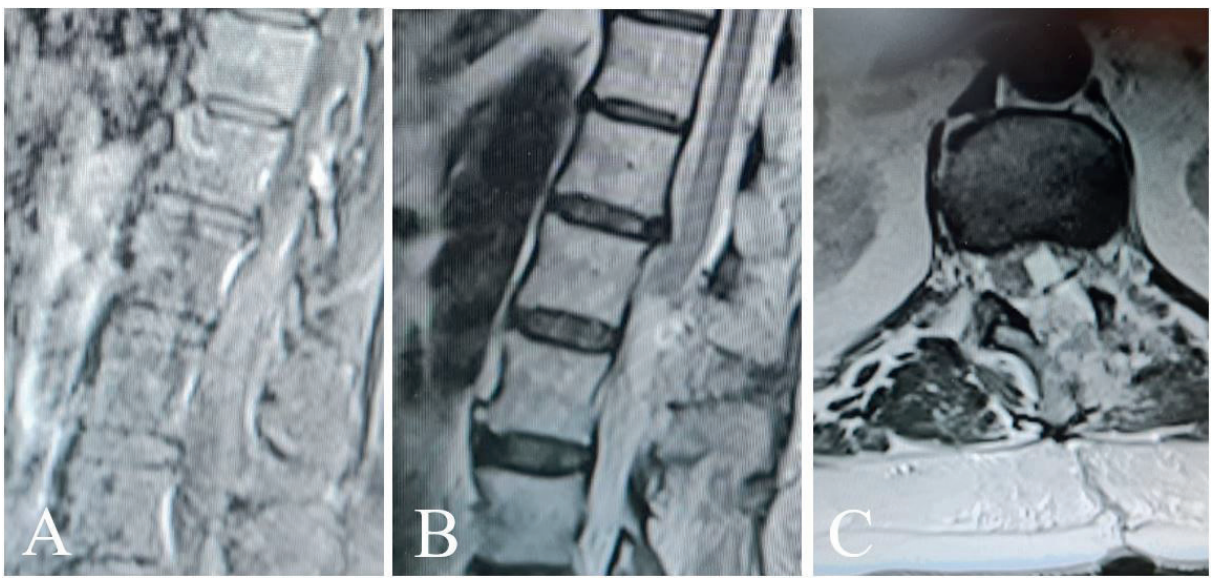

Figure 2. Postoperative MR images of a patient with thoracic schwannoma A. Sagittal Postcontrast T1 B. Sagittal T2 C. Axial T2

observed. Surgical decompression levels were 1 in 8 patients, 2 in 6 patients, and 3 in 1 patient, respectively. Pre-operative and post-operative Frankel grades of the patients were evaluated. The preoperative Frankel grades of the 15 patients were E in 11, D in 1, C in 2, and B in 1; postoperatively Frankel grades were E in 11 D in 3, and C in 1. It was observed that the post-operative Frankel grade of 3 patients was better than the pre-operative, One patient was worse than the pre-operative, and the post-operative grades of the remaining 11 patients were similar to the pre-operative grades. Post-operative imaging showed that gross-total resection was achieved in all patients (Table 1).

Table 1. Characteristics of operated patients

Number	Age	Sex	Symptom	Location	Level	Pathology	Pre-op Frankel	Post-op Frankel
1	36	M	Pain	Intramedullary	C2	Meningioma	D	C
2	25	F	Numbness, pain	Extramedullary	C3- C4	Meningioma	E	E
3	49	F	Pain	Intramedullary	C4- C5- C6	Ependymoma	E	E
4	64	F	Pain	Extramedullary	T7- T8	Meningioma	E	E
5	54	M	Numbness, pain	Extramedullary	T12	Ependymoma	E	E
6	61	F	Pain	Extramedullary	T2	Meningioma	E	E
7	66	M	Numbness, pain	Extramedullary	T1- T2	Schwannoma	E	E
8	55	F	Weakness, numbness	Intramedullary	T11	Ependymoma	C	D
9	57	M	Weakness, numbness	Extramedullary	T8-T9	Schwannoma	C	D
10	60	M	Weakness	Intramedullary	T1	Ependymoma	B	D
11	44	M	Pain	Intramedullary	L1- L2	Ependymoma	E	E
12	14	M	Pain	Intramedullary	L2-3	Ependymoma	E	E
13	66	F	Pain	Extramedullary	L3	Schwannoma	E	E
14	39	M	Pain	Extramedullary	L1	Schwannoma	E	E
15	36	M	Pain	Extramedullary	L4	Schwannoma	E	E

DISCUSSION

Bickham [6] was the first to describe osteoplastic laminotomy, and this procedure was advocated by Raimondi [1] and Parkinson [7] to lessen the danger of postlaminectomy spinal instability and deformity. Yasargil et al used HL in a series of malignancies and AVM patients in 1991 [8]. In 1992, Bertanalfy showed that, when compared to traditional laminectomy, HL coupled with microsurgical methods should be favored for extramedullary lesions [13]. Spetzger et al reported 3 intramedullary cavernoma who were treated by HL [14]. Sarıoglu et al performed unilateral HL on intradural extramedullary, intramedullary, and extradural malignancies, and observed no complications [10,15]. Oktem et al reported similar outcomes [10,15]. In patients with cervical spinal cord malignancies, Asazuma et al compared expanded open-door laminoplasty, standard laminectomy, and HL. In comparison to expansive open-door laminoplasty and traditional laminectomy, HL had a lower rate of cervical curvature type worsening. However, no significant difference in pre- and postoperative cervical curvature indices or range of motion was seen in either group [9]. Bian et al evaluated at 16 patients who had intramedullary cavernous malformations that were identified histologically. All of the patients had unilateral HL and tumor resection using microsurgery. During the follow-up period, none of the patients developed spinal deformity or instability [11]. The sagittal Cobb angle was assessed pre- and postoperatively following HL surgeries on extramedullary or extradural malignancies by Nagawa et al, and no significant deterioration was seen [16]. A modified HL was also done, with no signs of instability [17,18]. Iacogenelli et al. reported a series of 30 patients with intradural extramedullary spinal meningiomas who were at least 70 years old. They state that a less invasive method had the same probability of total tumor removal as a laminectomy or laminotomy group while offering a better postoperative course [5]. In 16 patients with thoracic intraspinal malignancies, Li et al performed in situ restorations of vertebral laminae to HL. They noted less postoperative problems, such as cerebrospinal fluid leakage, pseudomeningocele, spinal deformity, and instability, as a result of this surgery [19]. The biomechanical changes as a result of surgical alteration for treatment of intradural tumors at C3-6 using multilevel laminectomy, multilevel HL, and unilateral multilevel interlaminar fenestration with or without unilateral graded

facetectomy were studied using a modified nonlinear finite element model of the intact cervical spine (C2-C7) developed by Xie et al. When compared to laminectomy, the less invasive techniques of unilateral multilevel interlaminar fenestration and multilevel HL substantially preserved the cervical spine's flexion motion (more than 48%), as well as the preserved motion and minimal risk of postoperative spinal instability [20,21]. In their research, Gu et al reported 16 patients with intradural extramedullary tumors who were treated with unilateral HL, mentioning limited invasion, decreased bleeding, and spinal stability as benefits of this technique [22]. For intraspinal malignancies, Millward et al compared laminectomy (34 patients) to HL (22 patients). There was no difference in time of surgery, resection completeness, complication rate, or Frankel-grade improvements. However, the HL group had a shorter post-operative stay, requires fewer analgesics, and has less post-operative kyphosis [23]. Pompili et al evaluated at 97 individuals who had an intradural extramedullary tumor and were operated on with a restricted HL approach. No patient required external bracing due to early or late spinal deformity or instability [24].

If performed properly and with a reasonable learning curve, limited unilateral HL can provide adequate access to the dural sac, allowing for safe excision of nearly all intraspinal lesions.

Since we started performing unilateral HL for the removal of spinal cord tumors, we have successfully removed all consecutive cases of spinal cord tumors. Although some writers advocated unilateral HL for intradural extramedullary tumors, for intramedullary tumors, they recommended total laminectomy [25,26].

Intraspinal lesions were, however, grossly removed with unilateral HL in our study. Because the thoracic spine has the smallest canal width, tumor removal with unilateral HL in the thoracic region was thought to be more difficult than in the cervical or lumbar regions, because the surgical corridor from the skin surface to the spinal canal is shallower. To observe the contralateral side of the spinal canal, it may be helpful to tilt the operating microscope or operating table.

CONCLUSION

If used correctly and with a reasonable learning curve, limited unilateral HL can offer enough access to the dural sac, allowing for safe resection of nearly all spinal intradural and extradural lesions. Because it takes less time to operate than a standard laminectomy, it is better for older or high-risk patients. Less discomfort, a shorter hospital stay, and fewer postoperative problems including cerebrospinal fluid leaking, pseudomeningocele, spinal deformity, and instability make this treatment a helpful tool in the arsenal of spinal surgeons.

Conflict of interest: There is no conflict of interest in our study.
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REFERENCES

1. Raimondi AJ, Gutierrez FA, Di Rocco C. Laminotomy and total reconstruction of the posterior spinal arch for spinal canal surgery in childhood. J Neurosurg 1976; 45(5):555-60. https://doi.org/10.3171/jns.1976.45.5.0555
2. Simeone F. Spinal cord tumors in adults. Neurological surgery 3rd ed Philadelphia: WB Saunders Co 1990: 3531-47.
3. Yasargil M, Antic J, Laciga R, De Preux J, Fideler R, Boone S. The microsurgical removal of intramedullary spinal hemangioblastomas. Report of twelve cases and a review of the literature. Surg Neurol 1976; (3):141-8.

4. Mobbs RJ, Maharaj MM, Phan K, Rao PJ. Unilateral hemilaminectomy for intradural lesions. Orthop Surg 2015; 7(3):244-9. https://doi.org/10.1111/os.12184
5. Iacoangeli M, Gladi M, Di Rienzo A, Dobran M, Alvaro L, Nocchi N, et al. Minimally invasive surgery for benign intradural extramedullary spinal meningiomas: experience of a single institution in a cohort of elderly patients and review of the literature. Clin Interv Aging 2012; 7:557. https://doi.org/10.2147/CIA.S38923
6. Bickham WS. III. Technique of exposure of the spinal cord and canal; osteoplastic resection and laminectomy. Ann Surg 1905; 41(3):372. https://doi.org/10.1097/00000658-190503000-00003
7. Parkinson D. Replacement laminotomy. Surg Neurol 1977;8(4):277-9.
8. Yaşargil M, Tranmer B, Adamson T, Roth P. Unilateral partial hemilaminectomy for the removal of extra-and intramedullary tumours and AVMs. Adv Tech Stand Neurosurg 1991; 113-32. https://doi.org/10.1007/978-3-7091-6697-0_3
9. Asazuma T, Nakamura M, Matsumoto M, Chibo K, Toyama Y. Postoperative changes of spinal curvature and range of motion in adult patients with cervical spinal cord tumors: analysis of 51 cases and review of the literature. Clinical Spine Surgery 2004;17(3); 178-82. https://doi.org/10.1097/00024720-200406000-00003
10. Öktem I, Akdemir H, Kurtsoy A, Koç R, Menkü A, Tucer B. Hemilaminectomy for the removal of the spinal lesions. Spinal Cord 2000; 38(2):92-6. https://doi.org/10.1038/sj.sc.3100963
11. Bian L, Bertalanffy H, Sun Q, Shen J-K. Intramedullary cavernous malformations: clinical features and surgical technique via hemilaminectomy. Clin Neurol Neurosurg 2009; 111(6):511-7. https://doi.org/10.1016/j.clineuro.2009.02.003
12. Frankel H, Hancock D, Hyslop G, Melzak J, Michaelis L, Ungar G, et al. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. Spinal Cord 1969; 7(3):179-92. https://doi.org/10.1038/sc.1969.30
13. Bertalanffy H, Mitani S, Otani M, Ichikizaki K, Toya S. Usefulness of hemilaminectomy for microsurgical management of intraspinal lesions. Keio J Med 1992;41(2) :76-9. https://doi.org/10.2302/kjm.41.76
14. Spetzger U, Gilsbach J, Bertalanffy H. Cavernous angiomas of the spinal cord clinical presentation, surgical strategy, and postoperative results. Acta Neurochir (Wien) 1995; 134(3):200-6. https://doi.org/10.1007/BF01417690
15. Sarioğlu AÇ, Hanci M, Bozkuş H, Kaynar M, Kafadar A. Unilateral hemilaminectomy for the removal of the spinal space-occupying lesions. Minim Invasive Neurosurg 1997; 40(02):74-7. https://doi.org/10.1055/s-2008-1053420
16. Naganawa T, Miyamoto K, Hosoe H, Suzuki N, Shimizu K. Hemilaminectomy for removal of extramedullary or extradural spinal cord tumors: medium to long-term clinical outcomes. Yonsei Med 2011; 52(1):121-9. https://doi.org/10.3349/ymj.2011.52.1.121
17. Sun C, Meng X, Xie S, Yu Y, Yang H, Wu B. Unilateral hemilaminectomy for patients with intradural extramedullary tumors. J Zhejiang Univ Sci B 2011; 12(7):575-81. https://doi.org/10.1631/jzus.B1000402
18. Purvines SH, Pritz MB. Cervical hemilaminectomy reconstruction. Spine (Phila Pa 1976) 2000; 25(10):1278-82. https://doi.org/10.1097/00007632-200005150-00013
19. Wen-Sheng L, Chuan C, Hui W, LIANG C-F, Lun L, Ying G. Hemilaminectomy Approach Combined with in situ Restoration of Vertebral Laminae for Thoracic Intraspinal Tumors. Turk Neurosurg 2013; 23(5).
20. Xie T, Qian J, Lu Y, Chen B, Jiang Y, Luo C. Biomechanical comparison of laminectomy, hemilaminectomy and a new minimally invasive approach in the surgical treatment of multilevel cervical intradural tumour: a finite element analysis. Eur Spine J 2013; 22(12):2719-30. https://doi.org/10.1007/s00586-013-2992-1
21. Xie T, Qian J, Wu X, Lu Y, Hu G, Luo C. Unilateral, multilevel, interlaminar fenestration in the removal of a multisegment cervical intramedullary ependymoma. Spine J 2013 ;13(7):747-53. https://doi.org/10.1016/j.spinee.2013.02.048
22. Gu R, Liu J, Xia P, Li C, Liu G, Wang J. Evaluation of hemilaminectomy use in microsurgical resection of intradural extramedullary tumors. Oncol Lett 2014; 7(5):1669-72. https://doi.org/10.3892/ol.2014.1949
23. Millward CP, Bhagawati D, Chan HW, Bestwick J, Brecknell JE. Retrospective observational comparative study of hemilaminectomy versus laminectomy for intraspinal tumour resection; shorter stays, lower analgesic usage and less kyphotic deformity. Br J Neurosurg 2015; 29(3):390-5. https://doi.org/10.3109/02688697.2014.1003026
24. Pompili A, Caroli F, Crispo F, Giovannetti M, Raus L, Vidiri A, et al. Unilateral laminectomy approach for the removal of spinal meningiomas and schwannomas: impact on pain, spinal stability, and neurologic results. World Neurosurg 2016; 85:282-91. https://doi.org/10.1016/j.wneu.2015.09.099
25. Mannion RJ, Nowitzke AM, Efendy J, Wood MJ. Safety and efficacy of intradural extramedullary spinal tumor removal using a minimally invasive approach. Operative Neurosurgery. 2011;68(suppl_1):ons208-16. https://doi.org/10.1227/NEU.0b013e318207b3c7
26. Zong S, Zeng G, Du L, Fang Y, Gao T, Zhao J. Treatment results in the different surgery of intradural extramedullary tumor of 122 cases. PloS One. 2014; 9(11):e111495. https://doi.org/10.1371/journal.pone.0111495