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Value of Laminoplasty in Children with Spinal Tumors

Mohamed Reda, MD,[1] Mohamed R Nagy, MD.[2]

Neurosurgery Department, Faculty of Medicine, Cairo University,[1] Children's Cancer Hospital,[2] Cairo, Egypt.

Abstract

Background Data: Post-laminectomy deformities after surgery for the spinal tumors in children are common and affect the functional outcome. Laminoplasty may decrease the incidence of postoperative progressive spinal deformity requiring subsequent fusion.

Study Design: Retrospective clinical case study.

Purpose: To assess the outcome of laminoplasty in children with spinal tumors with special stress on the incidence of postoperative spinal instability.

Patients and Methods: This study included fourteen children who underwent laminoplasty during resection of spinal tumors between January 2013 and September 2014. The Cobb angle was used to detect the development of spinal deformity in the sagittal plane. The modified McCormick scale was used for evaluation of the functional outcome of the patients.

Results: Gross total excision of the intraspinal tumor was achieved in 57.1% of the patients. No patients developed spinal sagittal deformity in a mean follow-up period of 18 months that required fusion. Improved functional outcome was noticed in 71.4% of the patients.

Conclusion: Laminoplasty for the resection of the spinal tumors in children was very valuable in decreasing the incidence of progressive sagittal spinal deformity resulting in better fuctional outcome. (2015ESJ085)

Keywords: Laminoplasty, Spinal tumors, Children, Spinal deformity

Introduction

Spinal tumors in children are difficult to manage because of their clinical presentation, extreme variability of histology and low incidence. They account for 5%-20% of CNS tumors in children.[4] They can arise from nervous tissues, meningeal layers, bones and paravertebral region. Treatment must consider the natural history of the tumor, but when it comes to defining the treatment plan, it is important to evaluate the requirements of a growing spine.[21]

One of the late serious complications after laminectomy in spinal tumor resection in children is spinal instability and deformity mainly kyhpotic deformity that may require subsequent fusion affecting the functional outcome.[5,6,11,18,19]

There are some predictors that increase the incidence of spinal deformity after laminectomy in children including multilevel, junctional zone laminectomy[11] and adjuvant radiotherapy.[5,8] The risk of postlaminectomy instability is highest in the cervical spine and lowest in the lumbar spine.[25]

There is controversy about the value and the benefit of laminoplasty over laminectomy in spinal tumors of the children. Some authors encourage the laminoplasty and document its value to decrease the incidence of developing spinal deformity for children undergoing surgery for spinal tumors through obtaining anatomical reconstruction of the posterior elements[7,15] while other authors found no statistical difference between both procedures in developing spinal deformity.[20]

The aim of this study was to assess the value of laminoplasty in children with spinal tumors and to detect the outcome of the procedure focusing on the incidence of developing postoperative spinal sagittal deformity.

Patients and Methods

This is a retrospective study done on all children admitted in Children Cancer Hospital Egypt (CCHE) with spinal tumors who were operated by laminoplasty during tumor resection in the period between January 2013 and September 2014.

Complete analysis of the patient regarding the age, sex, preoperative neurological examination, anatomical site of the tumor as detected by preoperative magnetic resonance imaging (MRI) spine, surgical procedure, extent of removal, complication, postoperative neurological examination and pathology was done. MRI of the spine was performed with intravenous contrast to demonstrate the solid component and to show the cysts, edema and syrinx cavity if present.

A standard posterior midline approach was used in all patients. After the surgical level was identified by intraoperative C-arm fluoroscopy, a high-speed drill was used to make bilateral gutters in the laminae located over the level of the intraspinal lesion and 1- and 2-mm Kerrison punches were used to cut the laminae. The laminar flap was then lifted up with a clamp in one block. Particular care was taken to preserve the facet joints to reduce the risks of postoperative spinal deformity. Intraoperative neurophysiological monitoring was used in all patients with preserved motor power. The intradural tumors with a clear plane between the tumor and the normal surrounding tissue were carefully dissected and removed under the microscope. In the case of infiltrating tumor, the mass was reduced in volume from the inside as much as possible. After completion of the intraspinal surgery, the laminar flap was repositioned over the original site and fixed in place using strong stitches passed through the bony holes at each edge of the laminae at the top, bottom and the sides (Figure 1). Postoperatively, patients were wearing brace or collar for at least 3 months after surgery to support the lamina until fusion occurred. We didn't use translaminar screw fixation to decrease the incidence of postoperative infection especially that some of the patients required postoperative radiation therapy.

Postoperative MRI spine was done within 48 hours after the surgery to assess the extent of the resection. Gross total resection has been defined as at least 95% tumor removal evidenced by a clean surgical field under the microscope at the end of the surgery and a clear postoperative MRI scan. Then MRI and X-rays of the spine was scheduled after 3 months, 6 months, and annually to detect tumor progression and to evaluate the healing of the laminoplasty and the stability of the spine. The Cobb angle was measured between the superior and inferior limits of laminoplasty and compared between the preoperative and the last follow up MRI to detect the spinal deformity in the sagittal plane. The modified McCormick scale[14] was used for evaluation of the functional outcome of the patients.

Results

Fourteen patients were included in this study, seven males and seven females. The mean age was 5.6 years (ranged from 1 to 11 years).

According to the site of laminoplasty, nine patients had laminoplasty of the dorsal spine, two of the dorso-lumbar spine, one of the cervical spine, one of the lumbar spine and one of the cervico-dorsal spine. The extent of laminoplasty was five levels in five patients, four levels in five patients and three levels in four patients. The tumor was intradural in nine patients including seven patients (50%) with intramedullary tumor and two patients (14.3%) with

intradural extramedullary tumor while the tumor was extradural in five patients (35.7%). Three out of these five patients had extraspinal extension.

Gross total excision of the intraspinal component of the tumor was achieved in eight patients (57.1%) of whom the tumor was extradural in two patients, in other three patients the tumor had paravertebral extension, the tumor was intradural extramedullary in two patients and was intramedullary in one patient. Five patients (35.7%) were operated by subtotal resection while the last patient (7.2%) was operated by fenestration as it was arachnoid cyst. Different pathological examination results were encountered including two pilocytic astrocytoma, two neuroblastomas, two dermoid cysts and one of each of papillary ependymoma, Ewing sarcoma, medulloblastoma spinal seedling, hemangioma, myeloid sarcoma, lymphoma, bilharzioma and arachnoid cyst.

The mean follow-up period was 18 months (range from 6 months to 24 months). The preoperative Cobb angle ranged from -18^0 to 33^0 with a mean angle of 11.1^0. The postoperative Cobb angle ranged from -11^0 to 40^0 with a mean angle of 16.6^0. The difference between the Cobb angle preoperative and postoperative ranged from 0^o to 17^o with a mean different angle of 5.5^o and a mode of 0^o. The mean difference in the Cobb angle in five levels laminoplasty was 7º, in four levels laminoplasty was 3º and in three levels laminoplasty was 6.8º. No cases developed sagittal spinal deformity which required fixation in our study which reflected the value of laminoplasty in the pediatric age group (Table 1, Figure 2&3).

The preoperative median modified McCormick Scale for functional evaluation of the patients was 3 while at last follow up it was 2 with improvement of most of the patients (71.4%). The case of the bilharzioma developed transient post-operative deterioration of his neurological condition after surgery; he recovered within 2 weeks and remained stable during the follow-up period (Figure 4).

Table 1. Pre and PostOperative Spinal Curve (Cobb angle).

Patient	Laminoplasty	PreOp Angle	PostOp Angle	Pre/PostOp Angle Diff.
1	5 levels	3º	20º	17º
2	5 levels	16º	16º	0º
3	5 levels	33º	40º	7º
4	5 levels	6º	14º	8º
5	5 levels	13º	16º	3º
6	4 levels	5º	5º	0º
7	4 levels	14º	25º	9º
8	4 levels	28º	28º	0º
9	4 levels	6º	7º	1º
10	4 levels	25º	30º	5º
11	3 levels	6º	6º	0 º
12	3 levels	-18º	-11º	7º
13	3 levels	12º	26º	14º
14	3 levels	6º	12º	6º
Mean		11.1º	16.6º	5.5 º

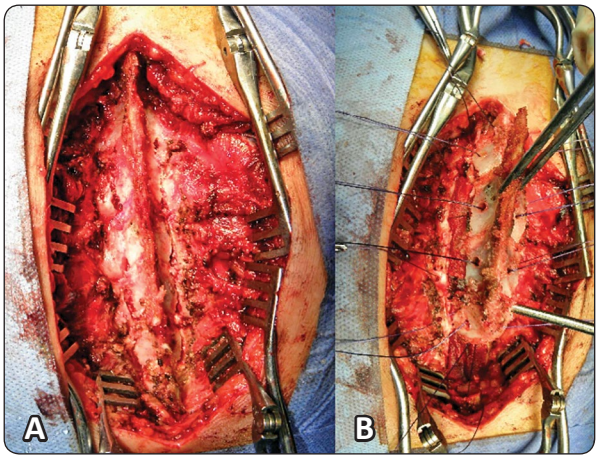

Figure 1. (a) Intraoperative picture shows bilateral gutters in the dorsal laminae which were made by high speed drill. (b) Intraoperative picture shows the way of fixing the laminae after excision of the intraspinal tumor using stitches at the top, bottom and the sides.

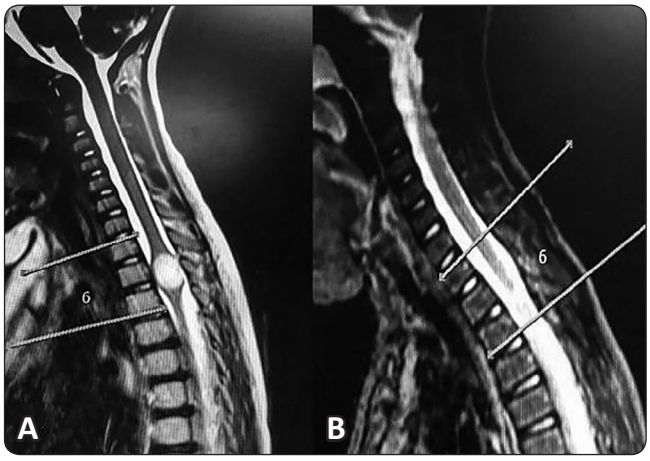

Figure 2. (a) MRI of the cervicodorsal spine showed upper dorsal intramedullary dermoid cyst. The preoperative Cobb angle at the planned three levels of lamionoplasty was 6º. (b) Postoperative follow up MRI cervicodorsal spine done 18 months after surgery showed total excision of the tumor with the Cobb angle at the three levels of lamionoplasty was still 6º.

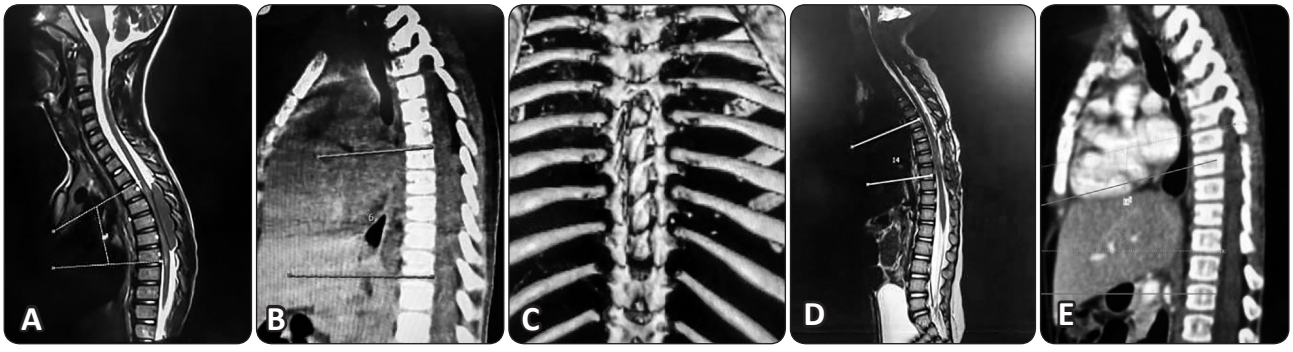

Figure 3. (a,b) Pre operative MRI and CT of the cervicodorsal spine showed extradural neuroblastoma. The Cobb angle at the planned five levels of lamionoplasty was 6º. (c) Postoperative 3D reconstruction CT of the dorsal spine showed the five levels laminoplasty. (d,e) Postoperative MRI and CT of the cervicodorsal spine done at 6 months follow-up showed complete excision of the tumor with the Cobb angle at the five levels of laminoplasty was 14 º.

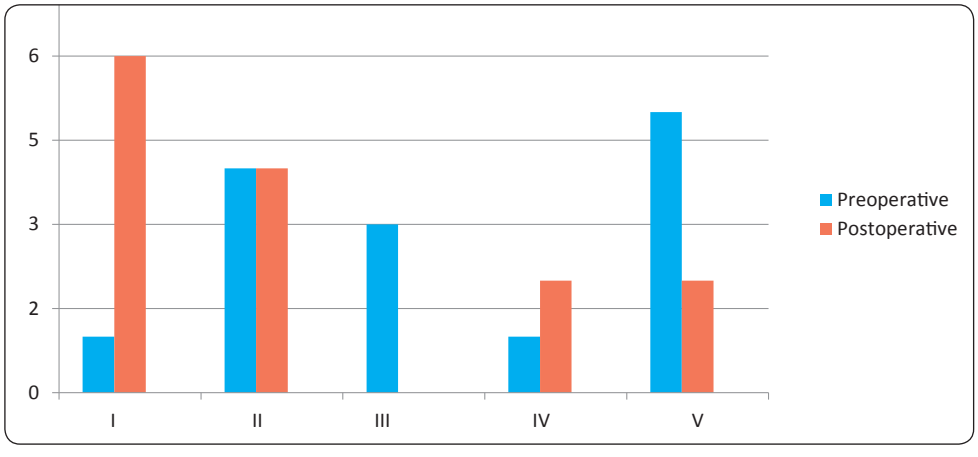

Figure 4.

Functional outcome of the patients according to McCormick Scale score.

Discussion

Spinal tumors in children represent complex pathology because of the heterogeneity in presentation, histology and treatment. Diagnosis can be delayed in many children because of a lack of specificity in clinical presentation and the biological behavior of most intramedullary spinal tumors is of slow progression so they are usually not recognized till they had reached a significant size. It is necessary to both manage the disease and preserve the spinal stability so that the spine can grow normally.[21]

Children have frequently tumors involving multiple spinal levels. Intramedullary tumors in younger children can involve more than six levels[15]. In this study, all patients had at least three levels laminoplasty done. Wetjen and Raffel[22] evaluated the distribution of spinal tumors according to their anatomic location calculated in 10 studies and reported as follows: intramedullary tumors 29.7%, intradural extramedullary tumors 24.6%, extradural 34.5% and other locations 11.2%. In our study, the tumor was intramedullary in seven patients (50%), intradural extramedullary in two patients (14.3%) and extradural in five patients (35.7%).

Surgical resection is the treatment of choice for pediatric spinal tumors. The extent of resection depends on the tumor type because some tumors like pilocytic astrocytoma and ependymoma have a good plane of cleavage and radical resection has low neurological morbidity; others like high-grade astrocytomas are difficult to resect with acceptable morbidity because of poorly defined tumor-cord interface. A conservative approach has been proposed for tumors of the conus medullaris.[3,17] Recent advances in microsurgical techniques, combined with availability of ultrasonic aspirator, Laser, intraoperative ultrasound and intraoperative neuro-physiological monitoring have led to a much more better surgical results of these tumors.[1,23] In this study, gross total excision of the intraspinal tumor was achieved in eight patients (57.1%) with fenestration of one arachnoid cyst (7.2%) while in five patients (35.7%) subtotal excision was done. These results were in accordance with Kumar and Singh series[13] who reported that radical resection has been achieved in 59% of their patients with subtotal resection done in 32%. Our study was very heterogeneous regarding the pathological examination of the tumors. This heterogeneity is well reported in the literature[15] and may lead to difficulty in defining specific treatment protocols. Younger age at diagnosis is associated with a higher risk of aggressive pathology[2] and high grade intramedullary tumors are associated with a worse prognosis.[3,15]

Spinal deformity following laminectomy is a major complication particularly in children. The laxity of the ligaments, the cartilage content in the immature spine and the vectors of spine growth, even oriented by the adjacent segments, probably make the pediatric spine more likely to develop a deformity after a laminectomy[8,15,18,26] than after a laminotomy.[16] Yasuoka et al,[25] reported that 90% of children who underwent laminectomy developed kyphotic spinal deformity. This risk after laminectomy may reach up to 100% when dealing with cervical tumors.[15,24] So laminoplasty has emerged as deformity preserving alternative to laminectomy in children undergoing surgery for spinal tumors with a view to preserve the posterior tension band and to restore the normal anatomy as two thirds of the axial load in the cervical spine is distributed along the posterior elements, including the facet joints.[15]

In our study, the mean difference in the Cobb angle between pre and postoperative MRI was 5.5º (ranged between 0º and 17º) with a zero degree mode which reflected that most of the patients didn't develop any sagittal deformity in the follow-up period and even the patients who developed sagittal deformity it was of a mild degree and didn't require any surgical correction. This outcome was in accordance with many series who reported lower risk of spinal deformity after laminoplasty.[10,15,19]

Yeh et al,[26] found that laminectomy was associated with a worse alignment at the thoracic and thoracolumbar regions after excision of intramedullary spinal cord tumors in children, while laminoplasty reduced this risk. The same conclusion was achieved by McGirt et al,[15] in his study who compared 144 patients who underwent laminectomy with 20 patients who underwent lamionoplasty. They reported that at a median of 3.5 years after surgery, only 1 patient (5%) in the laminoplasty cohort required fusion for progressive spinal deformity, compared with 43 (30%) in the laminectomy cohort (P=0.027) and laminoplasty was associated with a 7-fold reduction in the odds of subsequent fusion for progressive spinal deformity (odds ratio 0.13, P= 0.05). Spacca et al,[21] reported a low risk (3.7%) of secondary spinal instability (five out of 134 patients) that required a surgical treatment after laminoplasty performed during resection of spinal

tumors in children. However, Ratliff and Cooper in meta-analysis conducted in 2003 found that there was no benefit of laminoplasty over laminectomy at the cervical level in adult patients regarding the spinal alignment, incidence of kyphotic deformity and neurological outcome. They reported that the rate of kyphosis for patients undergoing cervical laminoplasty was 10%, while worsening of the cervical curvature was observed in 35% of the patients.[20] Multiple factors may be involved as the higher risk of instability after surgery for tumors might depend on not only the surgery itself but also the adjuvant therapy and the neurogenic effect of intramedullary spinal tumors.[3]

In this study, ten (71.4%) out of the fourteen patients improved neurologically while four patients (28.6%) were stable at a mean follow-up period of 18 months (range 3 to 24 months). A recent study by Spacca et al,[21] reported an improvement of 100 (74.6%) out of 134 children operated for spinal tumors, 10 patients (7.4%) were unchanged and 8 patients (5.9%) had neurologically worsened at the last follow-up (mean 28 months, range 3 months to 13 years). One patient with intramedullary tumor in our study (14.3% of the patients with intramedullary tumors) developed a transient neurological deterioration post-operatively he recovered completely to the preoperative status within two weeks. This temporary neurological deterioration is reported by various authors[9,12] but the risk of permanent neurological worsening appears to be related to the preoperative neurological status.[3]

Conclusion

The goals of surgery for resecting spinal tumors in children should be obtaining tissue for pathological examination, spine and nerve root decompression and preservation of spinal stability. Laminoplasty was a good surgical approach to perform the resection of the tumor with a low risk of late spinal instability which contributed to a better functional outcome in children.

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Address reprint request to:

Mohamed Reda, MD
Department of Neurosurgery, Cairo Medical School, Cairo University, Egypt
Email: Mohamed.reda@kasralainy.edu.eg

الملخص العربي

أهمية إعادة تركيب الصفائح الفقرية في الأطفال الذين يعانون من أورام بالنخاع الشوكي

البيانات الخلفية: استئصال الصفائح الفقرية أثناء استئصال أورام النخاع الشوكي بالأطفال قد يتبعه ظهور متأخر لاعوجاج العمود الفقري. إعادة تركيب الصفائح الفقرية قد يقلل معدل حدوث هذا الاعوجاج بعد الجراحة.

تصميم الدراسة: دراسة حالات إكلينيكيا بطريقة الاستعادة.

الهدف: تقييم مردود إعادة تركيب الصفائح الفقرية في الأطفال الذين يعانون من أورام بالنخاع الشوكي مع التركيز علي معدل حدوث عدم ثبات الفقرات بعد الجراحة.

طريقة البحث: اشتملت الدراسة علي أربعة عشر طفلا أجري لهم إعادة تركيب الصفائح الفقرية أثناء استئصال أورام بالنخاع الشوكي في الفترة من يناير ٢٠١٣ وحتى ديسمبر ٢٠١٤. استخدمت زاوية (كوب) لتحديد ظهور اعوجاج العمود الفقري في المستوي الرأسي. فيما استخدم مقياس (مك كورميك) المعدل لتقييم المردود الوظيفي للمرضي.

النتائج: تحقق استئصال كامل للورم في ٥٧,١٪ من المرضي .متوسط فترة المتابعة كان ١٨ شهرا.لم يعاني أي مريض من اعوجاج العمود الفقري الذي يتطلب تثبيت للفقرات. لوحظ تحسن في المردود الوظيفي في٧١,٤ ٪ من المرضي.

الاستنتاج: إعادة تركيب الصفائح الفقرية أثناء استئصال أورام بالنخاع الشوكي في الأطفال مفيد جدا في تقليل معدل الظهور المتأخر لاعوجاج العمود الفقري مما أدي إلي مردود وظيفي أفضل.