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CASE REPORT

Spinal hemangiopericytoma: an institutional experience and review of literature

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Abstract
Purpose Hemangiopericytoma is a rare tumor of CNS with potential for recurrence and widespread metastasis, even outside CNS with even rare involvement of spinal cord. This case series presents five patients to evaluate the clinical presentation, radiological features, management, pathology and outcome of spinal hemangiopericytomas.
Methods Between 2004 and 2013, five patients underwent surgery for spinal hemangiopericytoma. Histopathological data were reviewed in all cases and clinical and follow-up details were collected from the data available in our department.
Results There were three males and two females, including one pediatric patient. Three patients had dorsal spine involvement and two patients had involvement of cervical spine. There were two patients with intradural extramedullary tumors, one patient each with pure intramedullary tumor, pure extradural tumor and both intra and extradural tumor. All of them presented with motor weakness. Gross total resection of the tumor was done in three patients. Four patients received post-operative radiotherapy. Histopathology showed anaplastic tumor in four cases with high MIB-1 LI. Most of them were positive for CD34, mic-2 and bcl-2. Three patients who underwent gross total resection improved significantly in the follow-up period. Two patients who underwent subtotal resection expired due to spread of their disease.
Conclusion Spinal hemangiopericytoma is a rare tumor. Strong clinical suspicion is required to diagnose it preoperatively. Gross total resection is the goal and radiotherapy should be given in case of residual tumor or high-grade tumors.

Keywords Hemangiopericytoma · Spine · Surgery · Histopathology · Radiotherapy

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Introduction

Hemangiopericytoma is a rare tumor of central nervous system that has the potential to escape from the CNS and metastasize widely [1]. Initially, it was characterized as angioblastic meningioma and later termed as hemangiopericytoma by Stout and Murray in 1942 [2]. However, in 2007, they were classified as tumors of meninges of mesenchymal origin in 'WHO classification of CNS tumors'. They account for 1 % of all CNS tumors and represent 2–4 % of all meningeal tumors [1, 3–6]. Brain is the commonest location for these tumors and spinal occurrence is a rare event [1]. Till date, only 80 cases of spinal hemangiopericytoma have been reported and most of them are intradural–extramedullary tumors [4, 7–36]. Intramedullary spinal hemangiopericytoma is extremely rare and only five cases have been reported so far [4, 12, 17, 18]. Liu et al. [18] classified spinal hemangiopericytomas in three types and five subtypes—type I is extradural tumor (IA—intracanal, IB—extracanal), type II is intradural type (IIA—extramedullary, IIB—intramedullary) and type III is intradural tumor with extension into extradural and paravertebral area. In our center, we have found five cases of spinal hemangiopericytoma in last 10 years which includes both adult and pediatric patients. In this paper, we have

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evaluated their clinical presentation, radiological features, management, pathology and outcome.

Methodology

In this retrospective review, patients were identified from the biopsy reports of spinal tumors operated between 2004 and 2013. Five patients with spinal hemangiopericytoma were found. Details of the patients were then obtained from the discharge summary and also from the available follow-up data.

Results

From 2004 to 2013, five patients with spinal hemangiopericytoma underwent treatment in our institute. There were three males and two female patients with a mean age at diagnosis of 34 years (12–50 years). Cervical tumors were found in two patients, while dorsal tumors were present in three. Both the cervical tumors were located in the subaxial cervical spine, while in the dorsal level all three tumors were located below D7. All dorsal spine tumors arise de novo as primary tumors. One patient presented with primary cervical hemangiopericytoma, while another patient presented with recurrence of cervical tumor who underwent surgery, in a peripheral hospital 5 years back (Table 1).

All patients presented with motor weakness of variable duration. In four adult patients, the presentation was gradual; while in the pediatric patient, the onset was sudden. Sensory loss was present in one patient. Two of them presented with bladder and bowel involvement. The mean duration of symptoms before presentation was 5.62 months (3 days–12 months) (Table 1).

Pre-operative contrast-enhanced MRI scans were evaluated in all cases. Tumors were found in extradural, intradural–extramedullary and intramedullary locations. The average length of the tumors was 4.3 cm. The MRI of the patient with intramedullary tumor showed intensely enhancing soft tissue mass with cord expansion and proximal syrinx formation. Three IDEM tumors had variable contrast enhancement, well defined plane between tumor and cord parenchyma with variable extension into the neural foramina. One patient presented with extensive involvement of the posterior elements.

All patients underwent surgery as primary treatment. Although imaging features were suggestive of vascular nature of the tumor, pre-operative embolization was not used in any of these tumors. The tumors were approached from posterior aspect either by laminectomy or laminoplasty. Gross total resection was achieved in three cases. Two patients underwent subtotal resections because of high vascularity and cord invasion (Table 1).

Histopathological evaluation shows hemangiopericytoma in all cases. Four of them were anaplastic type. One patient had grade 1 tumor. Frequent mitoses were noticed in all specimens. Rate of mitoses was around 7.6 per 10 HPF. MIB-1 labeling index was very high in all anaplastic cases. Mean MIB-1 labeling index was 16.5 % with a range of 4–35 %. Tumor necrosis was not a common finding in the tumor specimens (Table 2).

Molecular studies revealed immunopositivity for CD34 in four out of five tumors. Similarly bcl-2 was also seen in four patients. Immunopositivity for mic-2 was found in three patients. Vimentin was present in one tumor (Table 2).

The post-operative period was uneventful in four patients. One patient with cervical tumor developed wound infection and CSF leak. He was managed conservatively with antibiotics and discharged after resolution of infection. Post-operative contrast-enhanced MRI was done in all patients. Small residual tumor was found in one patient, even after gross total excision, in the post-operative MRI scan. Patients who underwent subtotal resection also had residual disease in follow-up scans.

Four patients, including patients with residual diseases, who had anaplastic hemangiopericytoma, were given

Table 1 Clinical and radiological characteristics of patients

Case	Age/sex	Location	Type [19]	Presentation	Surgery	Primary/ recurrent	Adjuvant	Follow-up (months)	Outcome ASIA preop/postop
1	50/M	C4–5	IIA	Quadriparesis, numbness in bilateral upper limbs × 4 months	GTR	Primary	RT and CT	23	D/E
2	34/M	D8–10	IIB	Paraparesis, bladder dysfunction × 6 months	STR	Primary	RT and CT	24	D/expired
3	37/F	D7–9	III	Paraparesis, bladder dysfunction × 6 months	GTR	Primary	Nil	12	B/E
4	37/M	C5–6	IA	Quadriparesis × 1 year	STR	Recurrent	RT and CT	60	D/expired
5	12/M	D11–L1	IIA	Para paresis × 3 days	GTR	Primary	RT	9	B/E

Table 2 Histopathological details of patients

Case	WHO grade	Mitoses/10 HPF	Necrosis	MIB-1 LI (%)	Molecular markers
1	Anaplastic, grade III	7	Nil	16	CD34, mic2, bcl2
2	Anaplastic, grade III	7–8	Nil	17	CD34, mic2, bcl2, vimentin
3	Grade I	Rare	Nil	4	CD34, mic2, bcl2
4	Anaplastic, grade III	3–4	Focal	12	CD34
5	Anaplastic, grade III	13	Nil	35	Bcl2

external beam radiotherapy. Chemotherapy was also given to three patients. After adjuvant treatment, patients were routinely followed up after 6 months and then annually. Mean duration of follow-up was 25.4 months (range 9–60 months). At the last follow-up, three patients who underwent gross total excision were healthy and ambulatory and had significant neurological improvement. Contrast MRI done at last follow-up did not reveal any tumor in those patients. Unfortunately, two patients who underwent subtotal resection expired due to spread of their disease (Table 1).

Case 1

A male patient of 50 years presented with slowly progressive ascending quadriparesis for 4 months. Contrast-enhanced MRI showed an enhancing mass lesion at C4–5 level.

C4–5 laminectomy and durotomy were done. A moderately vascular well-encapsulated tumor was found intradurally. The cord parenchyma was not involved. The tumor was adherent to the dura matter. Gross total removal of the tumor along with involved dura was done. Postoperatively, he developed CSF leak which was managed conservatively.

Histomorphological features were suggestive of grade III anaplastic hemangiopericytoma. Immunohistochemical analysis was positive for CD34, bcl-2 and mic-2. The MIB-1 LI was 16 %.

Considering the high grade of the lesion, he received both chemo and radiotherapy as adjuvant treatment. He was regularly followed up for nearly 2 years after surgery. Till the last follow-up, he had significant neurological improvement and was ambulatory. There was no recurrence of the disease in that period.

Case 2

Another male patient of 34 years presented with slow onset progressive paraparesis for 6 months with early onset involvement of sphincter. MR scan with contrast revealed lower dorsal (D8–10) intramedullary tumor with enhancement (Type 2B).

He underwent dorsal laminectomy at D8 and D9 levels. The tumor was highly vascular and had infiltrating margins. It was not easily separable from cord parenchyma and removed subtotally.

Histopathology was suggestive of grade III anaplastic hemangiopericytoma with MIB-1 LI of 17 %. The tumor tissue was positive for CD34, mic-2, bcl-2 and vimentin.

Patient received both chemo and radiotherapy as adjuvant treatment. He was under close follow-up for 24 months. Although he showed neurological improvement initially; he started deteriorating after around 2 years of surgery and died due to extensive spread of the disease.

Case 3

A 37-year-old female patient presented with progressive ascending spastic paraparesis for 6 months and became bed ridden. Pre-operative MRI revealed a well defined tumor with both intradural extramedullary and extradural components at D7–9 level on right side and extending into the D8–9 neural foramina. Cord was pushed to the left side. The lesion was 1.4 × 1.9 × 4.3 cc in size (Fig. 1a, b).

She underwent D7–8 laminoplasty approach and gross total excision of the tumor. The tumor was primarily extradural in location with small intradural and intra foraminal extension at D8–9 level. The tumor was moderately vascular and firm in consistency.

On histopathological evaluation, the tumor specimen was diagnosed as a WHO grade II hemangiopericytoma with a MIB-1 labeling index of 4 %. The tumor cells were positive for CD34, Bcl-2 and Mic2 (Fig. 2).

No adjuvant treatment was given to the patient and she was kept under regular neurosurgical follow-up. Post-operative MRI revealed complete excision of the tumor without any evidence of tumor residual (Fig. 3a, b). At the last follow-up 6 months post-surgery, she improved significantly with normalization of motor power in both lower limbs.

Case 4

A male patient of 37 years who was a known case of cervical hemangiopericytoma presented with recurrence of

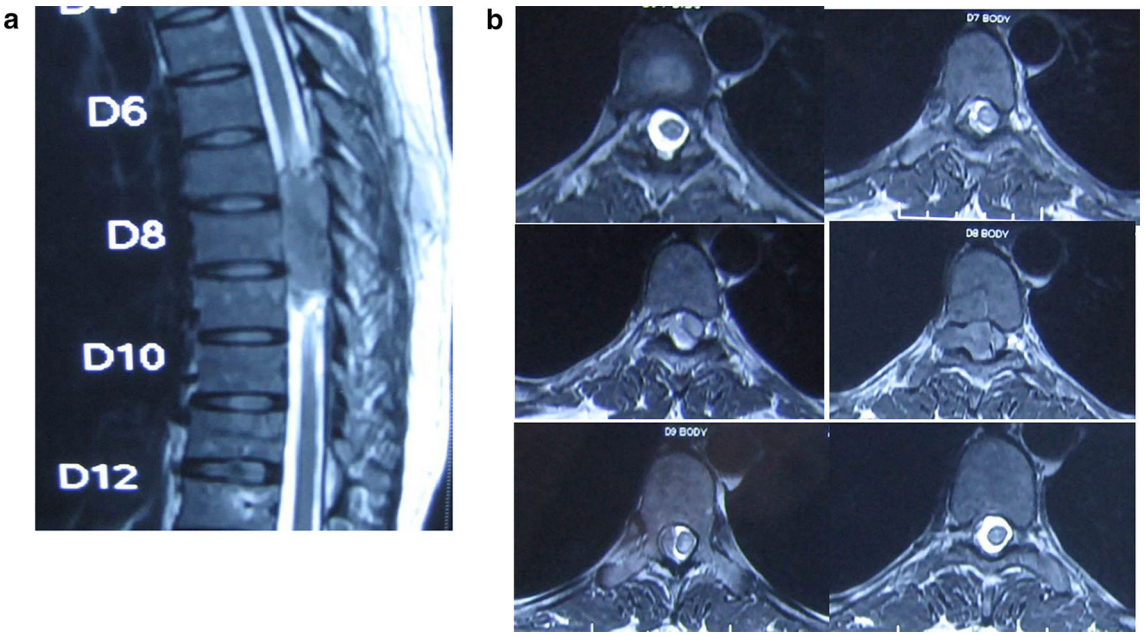

Fig. 1 **a** Pre-operative midsagittal T2WI MRI image of D7–9 intradural extramedullary hemangiopericytoma with extradural extension. **b** Pre-operative axial T2WI MRI image at D7–9 level showing intradural extramedullary hemangiopericytoma with extradural extension extending into D8–9 foramina on the *right side*. Cord pushed towards *left side*

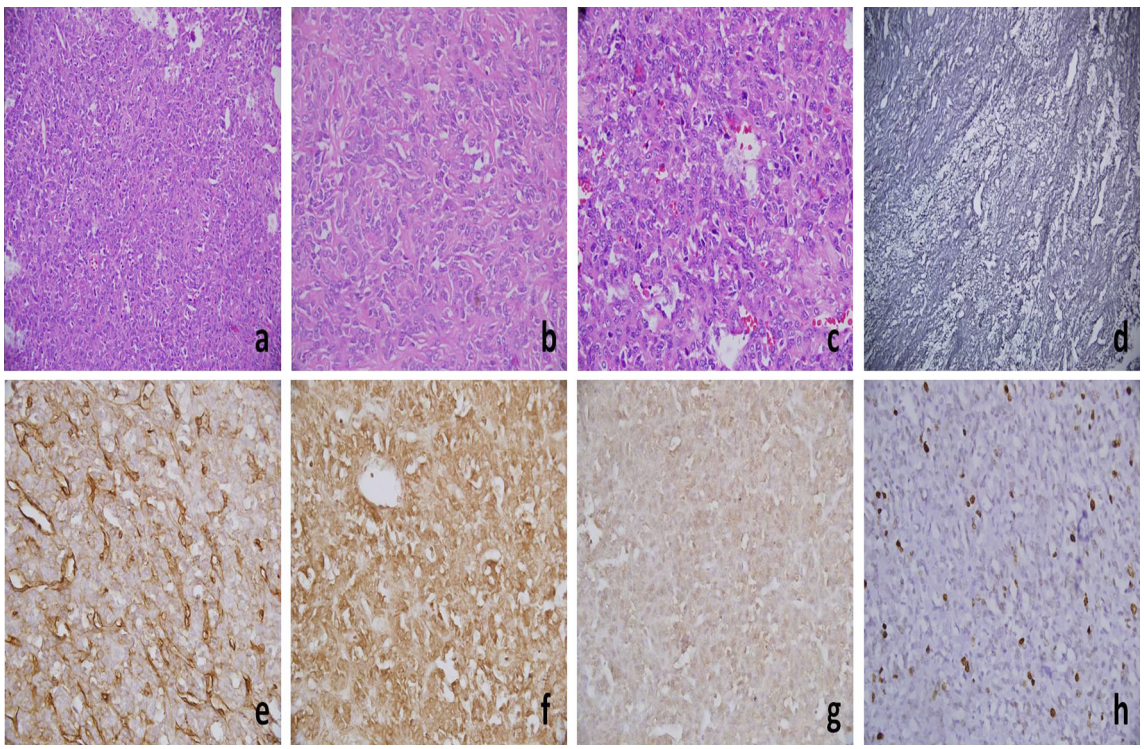

Fig. 2 Histological and immunohistochemical features of hemangiopericytoma **a** highly cellular tumor with monomorphic cells, staghorn vessels (H&E, ×200), **b** higher power showing intervening fibrosis (H&E, ×400), **c** Bizzare spindle cells and an occasional mitotic figure (H&E, ×400), **d** reticulin rich network (special stain, ×200), **e** CD 34 immunopositivity in tumor cells and endothelial cells (IHC, ×400), **f** Bcl2 immunopositivity in tumor cells (IHC, ×400), **g** focal immunopositivity for Mic2 (IHC, ×400), **h** MIB-1 labeling index (IHC, ×400)

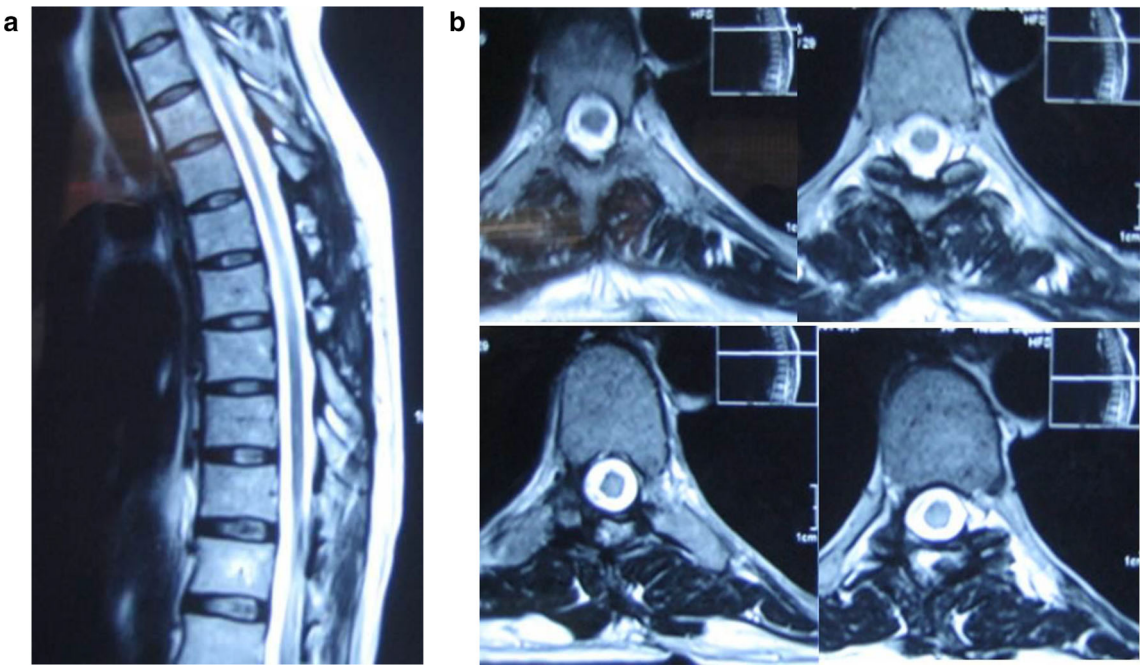

Fig. 3 **a** Post-operative midsagittal T2WI MRI image of the same patient showing complete excision of tumor. **b** Post-operative axial T2WI MRI image at D7–9 level of the same patient showing complete excision of tumor

symptoms with spastic quadriparesis. Initially, he underwent surgery 5 years back and gross total removal of tumor was done. However, no adjuvant therapy was done.

His MRI showed regrowth of tumor at C5–6 level with enhancement. Majority of the tumor was lying inside the intervertebral foramen on the left side.

Surgical intervention was done in this patient with a posterior approach following previous route. The tumor was removed subtotally because of dense scarring from previous surgery and high vascularity.

Histopathology was suggestive of anaplastic hemangiopericytoma in both ancestral and recurrent tumor samples. The recurrent sample was positive for CD34 and had a MIB-1LI of 12 %.

He received chemo and radiotherapy after second surgery and was kept in follow-up for 5 years. However, there was regrowth of the tumor with extensive spread including into the brain and he succumbed to that.

Case 5

Another female patient of 12 years presented with sudden onset paraplegia for 3 days. Pre-operative MRI of spine showed an intradural extramedullary (Type IIA) lesion at D11 to L1 level. It was enhancing on contrast injection.

She underwent D11 to L1 laminectomy. Intraoperative findings were confirmatory to that of MRI. The tumor was moderately vascular and there was no cord invasion. Gross total excision of the mass was done.

Histopathological and immunohistochemical analysis were suggestive of anaplastic hemangiopericytoma grade III with MIB-1LI of 35 % and Bcl-2 positivity.

Considering the anaplastic nature patient was sent for adjuvant radiotherapy and she tolerated that well.

At the last follow-up, patient had significant neurological improvement with normalization of lower limb power. Follow-up MRI did not show any residual disease.

Discussion

Spinal hemangiopericytoma is a rare entity [1]. Until now, not more than 80 cases have been reported in the literature [4, 7–36]. Hemangiopericytomas are aggressive tumors with the potential for widespread metastasis [1]. Although it is considered to arise from mesenchymal cells controversy exists regarding its cell of origin [37, 38]. While some consider pericytes, which are modified smooth muscle cells found around post capillary venules, as the source of hemangiopericytomas; others think that they are more fibroblastic in nature [37, 38]. This tumor is more commonly found in males [1, 18]. Although hemangiopericytomas have been reported in all parts of spinal column, cervico-dorsal region is the commonest site involved (Table 3) [1, 7–36]. Hemangiopericytomas of spine

commonly presents with motor weakness, pain and sensory symptoms (Table 3). Sphincter involvement is relatively rare and late [11, 14, 16–18]. Data from our series also show the similar findings.

Radiologic findings in case of spinal hemangiopericytomas are often non-specific and they share similarities with other tumors [17, 18]. They are usually intradural extramedullary (type IIA), dural based, well circumscribed lesions [17, 18]. Pure intramedullary (type IIB) and pure extradural (type I) tumors are rare [4, 12, 17, 18]. On contrast-enhanced MRI, they usually enhance heterogeneously [7–9, 12, 13, 16–18]. Flow voids are frequent suggesting highly vascular nature of the lesion [17]. They are often misdiagnosed pre-operatively as meningiomas or schwannomas [17, 18]. Rarely, intramedullary hemangiopericytomas are confused with ependymomas and hemangioblastomas [18]. Angiography can be used especially when pre-operative embolization is planned. However, findings are often non-specific and pre-operative embolization in reducing intraoperative bleeding is not very helpful [17, 35].

Surgery is the primary mode of treatment for spinal hemangiopericytoma [18]. Gross total resection should be the goal [8, 35, 39–42, 45]. Some studies have shown better recurrence-free and overall survival after gross total resection of central nervous system hemangiopericytomas [17, 41, 42]. Similar findings were also seen in our study—both the patient who underwent subtotal resection died due to systemic spread of their disease. However, some other studies did not found any clinical benefit or overall and recurrence-free survival benefit after complete resection [18, 31, 35]. Liu et al. [18] cautioned against total resection of spinal hemangiopericytomas in high risk patients especially those with type IB and III tumors.

Radiotherapy, as an adjuvant treatment for CNS hemangiopericytoma, has been found to improve local control and overall survival [35, 39–45]. However, beneficial role of post-operative radiotherapy in spinal hemangiopericytoma is yet to be proven [17, 18]. Effective radiation dose that has been found by most studies is more than 50 Gy [35, 39–41, 45]. In our study, four patients received radiotherapy in the post-operative period. All of them had anaplastic tumor and two of them underwent subtotal resection. Although stereotactic radiosurgery has been used for intracranial hemangiopericytomas, its use in spinal hemangiopericytomas is sporadic and no conclusion can be drawn from the present reports [18, 39, 46]. Use of chemotherapy is rare in such tumors and available literature failed to show any benefit [35, 43, 47].

Hemangiopericytomas once considered as a type of meningioma were grouped as mesenchymal tumors in 2007 WHO classification [7]. They are of two types—grade II or low grade and grade III or anaplastic tumors [7]. These are

Table 3 Summary of previous and present case series of spinal hemangiopericytomas

References	No. of cases	Sex		Site				Type [19]				Surgery			Adjuvant therapy			Follow-up (years)
		M	F	Cervical	Thoracic	Lumbar	Sacral	IA	IB	2A	2B	3	GTR	STR	NA	RT	CT	SRS	
Pitlyk et al. [14]	3	2	1	2	1	0	0	–	–	–	–	–	3	0	0	0	0	0	10–18 years
Harris et al. [23]	2	1	1	2	0	0	0	–	–	–	–	–	–	–	2	2	0	0	4–5 years
Cappabianca et al. [25]	2	0	2	2	0	0	0	–	–	–	–	–	–	–	2	0	0	0	Up to 2 years
Muraszko et al. [26]	3	1	2	0	2	1	0	2	0	1	0	0	1	2	0	2	0	0	Up to 6 years
McMaster et al.[34]	5	–	–	0	4	0	1	–	–	–	–	–	–	–	5	–	–	–	–
Ecker et al. [35]	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
Zhao and Zhao [16] and Liu et al. [18][a]	26	14	12	10	9	7	0	5	5	8	2	6	14	12	0	22	2	2	6.6 ± 6 years
Dufour et al. [11]	4	2	2	1	3	0	0	–	–	–	–	–	3	1	0	1	0	0	2–12.6 years
Wu et al. [32]	3	2	1	2	1	0	0	–	–	–	–	–	–	–	3	0	0	0	–
Shirzadi et al. [17]	4	3	1	1	3	0	0	0	0	2	1	1	3	1	0	2	0	1	1.5–3
Present study (2014)	5	3	2	2	3	0	0	1	0	2	1	1	3	2	0	4	3	0	Mean 2 years

[a] Both studies were from same institute between 1987 and 2010

GTR gross total resection, *STR* subtotal resection, *NA* not available, *RT* radiotherapy, *CT* chemotherapy, *SRS* stereotactic radiosurgery

most commonly intradural–extramedullary tumors with high vascularity and adherence to dura but without involvement of underlying neural tissue [1, 17, 18]. Extradural and intramedullary forms are rare [17]. Microscopically, they display high cellularity with frequent mitoses, loss of architecture, nuclear pleomorphism, and necrosis [1, 5, 18]. Sometimes 'staghorn' vascular channels can also be found in them [18]. Hemangiopericytomas can express a wide variety of markers of mesenchymal tissues like, HLA-DR, CD34, Leu-7, vimentin, S-100 protein, CD99, BCL-2 and factor XIIIa [48, 49]. In the present series CD34 and BCL2 were found in 80 % and MIC-2 in 60 % patients and all the tumor specimens were uniformly negative for epithelial tissue markers like EMA. Unlike meningiomas biologic behavior of hemangiopericytomas cannot be predicted from the MIB-1 LI or DNA ploidy but, we have found a high MIB1-LI level in most of the cases.

Because of its rarity, effective treatment plan and further surveillance program are yet to be decided. Studies have shown a 5-year survival rate and local tumor control rate of 76 % [18, 39, 50]. However, even after surgery and adjuvant treatment, 29 % tumors recur within 2–18 years [14, 16, 18, 50]. Three factors that are thought to be associated with good prognosis are low tumor grade, post-operative radiotherapy and gross total resection of tumor [8, 35, 39–42, 45].

Current recommendation for spinal hemangiopericytoma is gross total resection of tumor, when possible. Although its role is not well established, radiotherapy can be used in the post-operative settings in case of residual or high-grade tumors. Long-term follow-up is required because recurrences are common even after complete resection.

Conclusion

Spinal hemangiopericytomas are rare tumor and are difficult to diagnose and treat, with high recurrence rate. Strong clinical suspicion and increased awareness can help in preoperative diagnosis. Gross total resection should be the goal. Radiotherapy should be given to the patients with high-grade tumors and with residual disease. Recurrences are common even after complete resection and hence long-term follow-up is required.

Conflict of interest None of the authors has any potential conflict of interest.

References

1. Ladha AM, Guthrie BL, Ewend MG (2011) Meningeal sarcoma and meningeal hemangiopericytoma. In: Winn H Richard (ed) Youmans neurological surgery, 6th edn. Elsevier, Saunders, Philadelphia, pp 1426–1449
2. Stout AP, Murray MR (1942) Hemangiopericytoma: a vascular tumor featuring Zimmerman's pericytes. Ann Surg 116(1):26–33
3. Fabiani A, Favero M, Trebini F (1980) On the primary meningeal tumors with special concern to the hemangiopericytoma pathology and biology. Zentralbl Neurochir 41:273–284
4. Kruse F Jr (1961) Hemangiopericytoma of the meninges (angioblastic meningioma of Cushing and Eisenhardt): clinicopathologic aspects and follow-up studies in 8 cases. Neurology 11:771–777
5. Jaaskelainen J, Servo A, Haltia M et al (1985) Intracranial hemangiopericytoma: radiology, surgery, radiotherapy, and outcome in 21 patients. Surg Neurol 23:227–236
6. Kochanek S, Schroder R, Firsching R (1986) Hemangiopericytoma of the meninges: histopathological variability and differential diagnosis. Zentralbl Neurochir 47:183–190
7. Ackerman PD, Khaldi A, Shea JF (2011) Intradural hemangiopericytoma of the thoracic spine: a case report. Spine J 11(7):e9–e14
8. Betchen S, Schwartz A, Black C, Post K (2002) Intradural hemangiopericytoma of the lumbar spine: case report. Neurosurgery 50:654–657
9. Chou CW, Hsu SPC, Lin SC et al (2009) Primary intradural hemangiopericytoma with intramedullary invasion. J Chin Med Assoc 72:536–554
10. Ciappetta P, Celli P, Palma L et al (1985) Intraspinal hemangiopericytomas. Report of two cases and review of the literature. Spine 10:27–31
11. Dufour H, Metellus P, Fuentes S et al (2001) Meningeal hemangiopericytoma: a retrospective study of 21 patients with special review of the postoperative external radiotherapy. Neurosurgery 48:756–763
12. Fitzpatrick D, Mahajan J, Lewkowitz M et al (2009) Intradural hemangiopericytoma of the lumbar spine: a rare entity. AJNR 30:152–154
13. Kashiwazaki D, Hida K, Yano S et al (2007) Subpial hemangiopericytoma with marked extramedullary growth: case report. Neurosurgery 61:1336–1337
14. Pitlyk PJ, Dockery MB, Miller RH (1965) Hemangiopericytoma of the spinal cord: report of three cases. Neurology 15:649–653
15. Someya M, Sakata K, Oouchi A et al (2001) Four cases of meningeal hemangiopericytoma treated with surgery and radiotherapy. Jpn J Clin Oncol 31:548–552
16. Zhao Y, Zhao JZ (2007) Clinical and pathological characteristics of primary intraspinal hemangiopericytoma and choice of treatment. Chin Med J (Engl) 120:115–119
17. Shirzadi A, Drazin D, Gates M et al (2013) Surgical management of primary spinal hemangiopericytomas: an institutional case series and review of the literature. Eur Spine J 22(Suppl 3):S450–S459
18. Liu HG, Yang AC, Chen N et al (2013) Hemangiopericytomas in the spine: clinical features, classification, treatment, and long-term follow-up in 26 patients. Neurosurgery 72(1):16–24 (discussion 24)
19. Schirger A, Uihlein A, Parker HL et al (1958) Hemangiopericytoma recurring after 26 years; report of case. Proc Staff Meet Mayo Clin 33(13):347–352
20. Kriss FC, Kahn DR, Schneider RC (1968) Value of angiography in intraspinal mediastinal hemangiopericytoma. Case report. J Neurosurg 29:535–539
21. Fathie K (1970) Hemangiopericytoma of the thoracic spine; case report. J Neurosurg 32(3):371–374
22. Gerner RE, Moore GE, Pickren JW (1974) Hemangiopericytoma. Ann Surg 179(2):128–132
23. Harris DJ, Fornasier VL, Livingston KE (1978) Hemangiopericytoma of the spinal canal. Report of three cases. J Neurosurg 49(6):914–920

24. Stern MB, Grode ML, Goodman MD (1980) Hemangiopericytoma of the cervical spine: report of an unusual case. Clin Orthop Relat Res 151:201–204
25. Cappabianca P, Maiuri F, Pettinato G et al (1981) Hemangiopericytoma of the spinal canal. Surg Neurol 15(4):298–302
26. Muraszko KM, Antunes JL, Hilal SK et al (1982) Hemangiopericytomas of the spine. Neurosurgery 10(4):473–479
27. Bridges LR, Roche S, Nashef L et al (1988) Haemangiopericytic meningioma of the sacral canal: a case report. J Neurol Neurosurg Psychiatry 51(2):288–290
28. Salvati M, Ciappetta P, Artico M et al (1991) Intraspinal hemangiopericytoma: case report and review of the literature. Neurosurg Rev 14(4):309–313
29. Akhaddar A, Chakir N, Amarti A et al (2002) Thoracic epidural hemangiopericytoma. Case report. J Neurosurg Sci 46(2):89–92
30. Ijiri K, Yuasa S, Yone K et al (2002) Primary epidural hemangiopericytoma in the lumbar spine: a case report. Spine (Phila Pa 1976) 27(7):E189–E192
31. Mohammadianpanah M, Torabinejad S, Bagheri MH et al (2004) Primary epidural malignant hemangiopericytoma of thoracic spinal column causing cord compression: case report. Sao Paulo Med J 122(5):220–222
32. Wu W, Shi JX, Cheng HL et al (2009) Hemangiopericytomas in the central nervous system. J Clin Neurosci 16(4):519–523
33. Moscovici S, Ramirez-DeNoriega F, Fellig Y et al (2011) Intradural extramedullary hemangiopericytoma of the thoracic spine infiltrating a nerve root: a case report and literature review. Spine (Phila Pa 1976) 36(23):1534–1539
34. McMaster MJ, Soule EH, Ivins JC (1975) Hemangiopericytoma. A clinicopathologic study and long-term follow-up of 60 patients. Cancer 36(6):2232–2244
35. Ecker RD, Marsh WR, Pollock BE et al (2003) Hemangiopericytoma in the central nervous system: treatment, pathological features, and long-term follow up in 38 patients. J Neurosurg 98(6):1182–1187
36. Zweckberger K, Jung CS, Mueller W et al (2011) Hemangiopericytomas grade II are not benign tumors. Acta Neurochir (Wien) 153(2):385–394
37. Giannini C, Rushing EJ, Hainfellner JA (2007) Haemangiopericytoma. In: Louis DN, Ohgaki H, Wiestler OD, Cavenee WK (eds) WHO classification of tumours of the central nervous system, 4th edn. International Agency for Research on Cancer (IARC), Lyon, pp 178–180
38. Sundaram C, Shantveer UG, Megha US et al (2010) A clinicopathological and immunohistochemical study of the central nervous system hemangiopericytomas. J Clin Neurosci 17:469–472
39. Guthrie BL, Ebersold MJ, Scheithauer BW et al (1989) Meningeal hemangiopericytoma: histopathological features, treatment, and long-term follow-up of 44 cases. Neurosurgery 25:514–522
40. Kim JH, Jung HW, Kim YS et al (2003) Meningeal hemangiopericytomas: long-term outcome and biological behavior. Surg Neurol 59(1):47–54
41. Soyuer S, Chang EL, Selek U et al (2004) Intracranial meningeal hemangiopericytoma: the role of radiotherapy: report of 29 cases and review of the literature. Cancer 100:1491–1497
42. Schiariti M, Goetz P, El-Maghraby H et al (2011) Hemangiopericytoma: long-term outcome revisited. Clinical article. J Neurosurg 114(3):747–755
43. Bastin KT, Mehta MP (1992) Meningeal hemangiopericytoma: defining the role for radiation therapy. J Neurooncol 14(3):277–287
44. Mena H, Ribas JL, Pezeshkpour GH et al (1991) Hemangiopericytoma of the central nervous system: a review of 94 cases. Hum Pathol 22(1):84–91
45. Combs SE, Thilmann C, Debus J et al (2005) Precision radiotherapy for hemangiopericytomas of the central nervous system. Cancer 104(11):2457–2465
46. Coffey RJ, Cascino TL, Shaw EG (1993) Radiosurgical treatment of recurrent hemangiopericytomas of the meninges: preliminary results. J Neurosurg 78(6):903–908
47. Cohen Y, Lichtig C, Robinson E (1972) Combination chemotherapy in the treatment of metastatic hemangiopericytoma. Oncology 26(2):180–187
48. Kroh H, Figols J, Sobieraj A (1997) Intracranial hemangiopericytomas. Histological and immunohistochemical study. Folia Neuropathol 35(2):121–127
49. Rajaram V, Brat DJ, Perry A (2004) Anaplastic meningioma versus meningeal hemangiopericytoma: immunohistochemical and genetic markers. Hum Pathol 35:1413–1418
50. Sibtain NA, Butt S, Connor SEJ (2007) Imaging features of central nervous system hemangiopericytomas. Eur Radiol 17:1685–1693