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Surgical strategies in the management of aggressive spinal haemangiomas: Retrospective case series with literature review and a practical treatment algorithm

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ABSTRACT

Purpose: We studied the clinico-radiological features and treatment outcomes of patients with aggressive spinal haemangiomas.
Methods: We undertook a retrospective review of 24 patients with aggressive spinal haemangiomas managed at our centre from 2004 to 2016. The cohort was divided into two groups. Group1 included patients managed from 2004 to 2009 while Group 2 was those treated between 2010 and 2016. Clinicoradiological features and treatment outcomes were studied.
Results: Back pain (24/24) and myelopathy (18/24) were the most common presenting complaints. Over 80% (20/24) of patients, had involvement of the thoracic spine and more than 50% (13/24) had severe spasticity, being Nurick grade 4&5 at presentation. The various treatment modalities used were laminectomy with or without instrumented posterior fusion (10/24), corpectomy with instrumented fusion (10/24) and alcohol injection alone (4/24). Patients who were treated with surgery had significant clinical improvement at follow-up in both groups. Patients who underwent alcohol injection did not have any improvement in symptoms at follow-up. There was a change in our strategy in the later part of the series from a two staged anterior and posterior approach to a single staged posterior-only approach to address vertebral body disease with preoperative angioembolization.
Conclusion: Haemangiomas are benign lesions with locally aggressive behavior in some cases. Results of conservative approaches such as alcohol injection in management of these lesions are discouraging. Aggressive surgical decompression combined with preoperative adjuncts such as angioembolization with or without stabilization reduces intra operative blood loss and results in good neurological recovery even in patients with severe myelopathy.

1. Introduction

Vertebral haemangiomas [VHs], although benign and often incidentally detected on magnetic resonance imaging (MRI), may result in back pain and progressive neurological deficits due to compression of the spinal cord or nerve roots, when they are termed aggressive (Laredo et al., 1986; Fox and Onofrio, 1993; Acosta et al., 2008; Hurley et al., 2008; Gaudino et al., 2015). These aggressive lesions frequently involve all three vertebral columns when conservative measures are often unsuccessful in their management. Surgical decompression with or without adjuvant postoperative radiation is the preferred line of management for these aggressive haemangiomas (Fox and Onofrio, 1993; Acosta et al., 2008). A major limiting factor in the surgical management is the tumour vascularity and considerable intraoperative blood loss, prompting preoperative or intraoperative angioembolization strategies (Pavlovitch et al., 1989; Smith et al., 1993; Premat et al., 2017; Eichberg et al., 2018). We analyzed our experience in managing these challenging tumours over the last 12 years to document the evolution of our treatment strategy and have suggested a practical management algorithm to aid clinical decision making.

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2. Material and methods

This retrospective study, approved by our Institutional Review Board (IRB Min no: 12154), was performed on a historical cohort of 24 patients with aggressive spinal haemangiomas managed in one neurosurgical unit between January 2004 and December 2016. The study cohort was divided into two groups. Group 1 included 13 patients managed between 2004 and 2009 and Group 2 (11 patients) were those managed between 2010 and 2016. The demographic data, presenting symptoms, duration of symptoms, functional status as determined by Nurick grade, details of intervention and outcomes were obtained from the hospital electronic database. The two groups were compared with respect to the clinical and radiological profile, management strategies and outcomes of intervention.

Aggressive haemangiomas were defined as those that demonstrated rapid progression with extraosseous extension and cord compression. The primary outcome measure was the change in functional status measured by the Nurick grade at follow-up. All patients had a spine computed tomograph (CT), MRI and plain X-rays of the region of interest that were reviewed by a radiologist on our Picture Archiving and Communication System (GE-PACS V3.0). Radiological parameters such as the number of lesions, level of spinal involvement and number of vertebral columns involved were documented. In addition, the vertebral involvement was scored using the classification system described by Laredo et al. that gave 1 point for each of the following findings: (1) involvement of the entire vertebral body; (2) extension into the neural arch; (3) cortex expanded and poorly defined; (4) thoracic location (T3–T9); (5) irregular trabeculation; (6) a soft-tissue mass (Laredo et al., 1986).

3. Results

Table 1 summarizes the preoperative clinico-radiological data of the entire cohort of 24 patients. Group 1 consisted of 5 males and 8 females and Group 2 had 6 males and 5 females. The mean age at presentation was not significantly different between the Groups, 31 ± 17.9 years and 36 ± 22.85 years in Groups 1 and 2 respectively (p-0.48).

Back pain was the most common complaint in both groups with a median duration of 11.2 months in Group 1 and 14.3 months in Group 2. Myelopathy was the next most common presentation, seen in 10 (76.9%) patients in Group 1 and 8 (72.7%) patients in Group 2 (p-0.87). The median duration of myelopathy prior to diagnosis was 4.5 months in Group 1 and 6.6 months in Group 2 (p-0.21).

According to the 3-column model described by Denis (1983), eight patients had all three columns involved; eight had only posterior column involvement and the remaining eight patients had involvement of the anterior and middle columns. More than three quarters of our patients (79.2%) showed significant canal stenosis. The thoracic spine was involved in 20 (83.3%) patients and was the most commonly involved site in both the groups.

Preoperative neurological function 13/24 (54.16%) patients had severe myelopathy at presentation and were Nurick grade 4 or 5. There were 8 such patients in Group 1 (61.5%) and 5 patients in Group 2 (45.4%). 5/24 (20.8%) patients were Nurick Grade 3, 2 patients in Group 1 and 3 were in Group 2. Only 6/24 (25%) patients, 3 in Group 1 and 3 in Group 2 presented early in the course of their illness and were Nurick grade 0 and 1 respectively.

Table 1
Comparison of group 1 and group 2 with respect to clinical and radiological profile.

Clinical characteristics		Group 1 n-13	Group 2 n-11	P value
Mean Age (yrs)		31 ± 17.9	36 ± 22.85	0.48
Gender	Males	5	6	
	Females	8	5	
Median duration of symptoms (in months)		4.5	6.6	0.21
Myelopathy		10	8	0.87
Preoperative Nurick grade	Grade 0 and 1	3	3	0.69
	Grade 3	2	3	
	Grade 4 and 5	8	5	
Radiological characteristics				
Level				0.30
Thoracic		12	8	
Lumbar		1	3	
Multiple vertebral level involvement		3	4	0.65
Columns involved (Denis model)				
Anterior and middle		5	3	0.19
Posterior		6	2	
All three		2	6	
Preserved PLL attachment		12	8	0.30
T2 hyperintensity		12	11	1
Preserved T1 hyperintensity		6	7	0.44
Polka-Dot appearance		13	11	1
Epidural soft tissue		13	11	1
Cord/Thecal sac compression		13	11	1
Cord edema		10	5	0.26

3.1. Radiology

All lesions showed vertebral body signal abnormalities and had a "polka-dot" appearance on axial MRI and CT sections (Fig. 1). The lesions were hyperintense on T2w sequences in 23/24 (95.8%) patients. Preserved T1 hyperintense signal was seen in 13/24 (54.1%) patients suggesting a lipid-rich nature of the lesion. In the absence of a T1 hyperintense signal, alternate diagnoses such as plasmacytoma and metastasis were considered. There was extension into the spinal canal in all cases and one consistent feature noted in the majority of the cases was that the soft tissue component protruded into the canal on either side of the posterior longitudinal ligament (PLL) with retained attachment to the bone in the midline in 20 cases (83.33%) (Fig. 1). Cord compression was seen in all patients with thoracic or cervical spine involvement and cord edema was present in 15 patients (62.5%). Vertebral body collapse was seen in 10 (41.6%) patients. The adjacent disc spaces were preserved. We were able to apply the Laredo scoring in 23 patients (1 patient who had vertebroplasty had only plain X rays available) and all patients had a score of ≥3. There was no statistical difference in radiological characteristics of the lesions between the two groups.

3.2. Treatment

3.2.1. Alcohol injection

We had two patients in each group who underwent alcohol injection

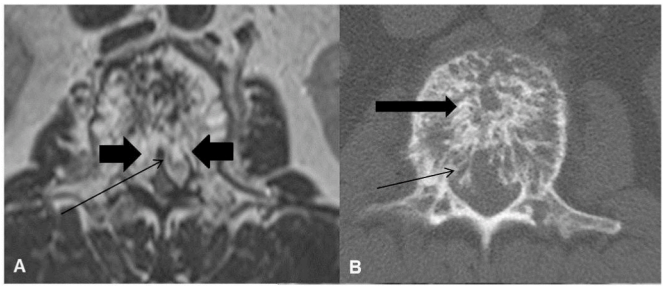

Fig. 1. A T2w axial MRI of the lumbar spine showing an expanded vertebral body with a large epidural component in the spinal canal (two arrow heads) compressing the cord. The posterior longitudinal ligament (PLL) has been elevated in the paracentral location on both sides with a preserved central attachment resulting in a tented appearance (long arrow). B Axial plain CT image showing the polka dot appearance (solid arrow) and the breach in the posterior cortex (long arrow).

directly into the vertebral body under CT guidance. Of the two patients in Group 1, one had the injection for a T9 vertebral body hemangioma but had persistent symptoms at 6 months and X rays showed T9 vertebral body collapse, therefore he underwent vertebral body bone cement injection (Fig. 2). The other patient continued to deteriorate clinically, was advised an open surgery but defaulted treatment and was lost to follow-up.

In Group 2, one patient who presented with spastic paraparesis had been treated with alcohol injection 6 months prior to being seen at our hospital. He reported transient improvement in lower limb sensations following the injection but subsequently deteriorated progressively till he was bedridden at presentation. We did a T11 corpectomy and instrumented fusion following which there was gradual improvement in symptoms and he was ambulant with support at his one-year follow-up (Fig. 3). The other patient was elderly and moribund with 3-column involvement. He was treated with alcohol injection rather than a corpectomy and fusion but had no improvement in symptoms at 10 months follow-up despite repeated intralesional alcohol injections.

3.2.2. *Laminectomy without fusion*

A decompressive laminectomy without fusion was done in 6 patients (46%) in Group 1 and 1 (9%) patient in Group 2. Four patients improved in Group1 and two remained stable at follow-up. The solitary patient in Group 2 remained stable after surgery.

3.2.3. *Laminectomy with posterior instrumented fusion*

None of the patients in Group 1 underwent laminectomy with posterior instrumented fusion while 3 (27%) patients in Group 2 underwent this procedure. Two patients improved and one remained stable at last follow-up (Fig. 4).

3.2.4. *Corpectomy with stand-alone cage*

Two patients in Group 1 underwent corpectomy through an anterolateral retroperitoneal approach; the vertebral tumour along with its soft tissue component was removed using a high-speed drill till normal cortical bone was seen ventrally and laterally. Dorsally the decompression was carried out till the thecal sac was relieved of compression. This was followed by placement of Harm's cage filled with autologous bone graft - one patient improved and the other remained stable at his last follow-up visit.

3.2.5. *360-Degree fusion (two stage anterior and posterior approach)*

Three patients in Group 1 and one patient in Group 2 underwent this procedure that began with an anterior approach in the lateral position followed by a midline dorsal approach after repositioning. We used a thoracotomy for thoracic tumours and a retroperitoneal approach for tumours in the lumbar region. The tumour within the vertebral body was removed with a high-speed drill until normal cortical bone was seen. The soft tissue component was removed using curettes and the decompression continued till the thecal sac was free of tumour. This was followed by a placement of Harm's cage filled with autologous bone graft. Subsequently, the patient was turned prone and via a posterior midline approach pedicle screws were placed two levels above and below the lesion. This was followed by a laminectomy at the level of interest to decompress the cord/thecal sac and the rods placed over the screw heads and tightened. All patients improved significantly at follow-up and there was no evidence of recurrent disease.

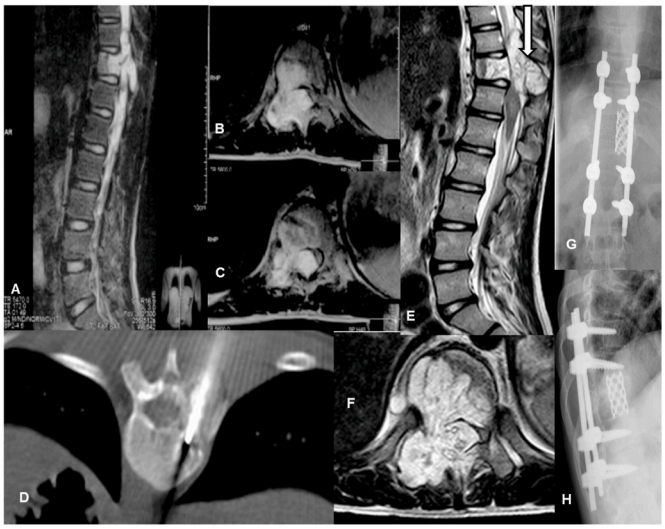

Fig. 3. A 35-year-old male with progressive spastic paraparesis. A: Sagittal T2w MRI showing a hyperintense mass involving the posterior aspect of T11 vertebral body and posterior elements extending into the spinal canal. B & C: Axial T2w images showing destruction of the pedicle and posterior elements on the right-side D: He underwent a CT guided transpedicular alcohol injection. E & F: 6-month follow-up MRI showing disease progression prompting a T11 corpectomy and fusion. G & H: 1-year postoperative X-rays.

3.2.6. *360-Degree fusion through a single-stage posterior approach*

We employed this procedure from 2013 onwards on four patients in Group 2 with thoracic haemangiomas. Angioembolization was done the day before surgery to reduce tumour vascularity. The patient was positioned prone; a midline skin incision was used to expose the laminae two levels above and below the region of interest. Pedicle screws were placed two levels above and below the diseased segment. A costotransversectomy was done at the level of the lesion from the more symptomatic side followed by a laminectomy to decompress the cord. Through the postero-lateral corridor provided by the costotransversectomy, the diseased vertebra was removed using a high-speed large diamond burr for the bony component and blunt dissectors and curettes for the soft tissue component in the spinal canal and the paravertebral space. For some cases, an additional costotransversectomy on the opposite side provided greater access to the

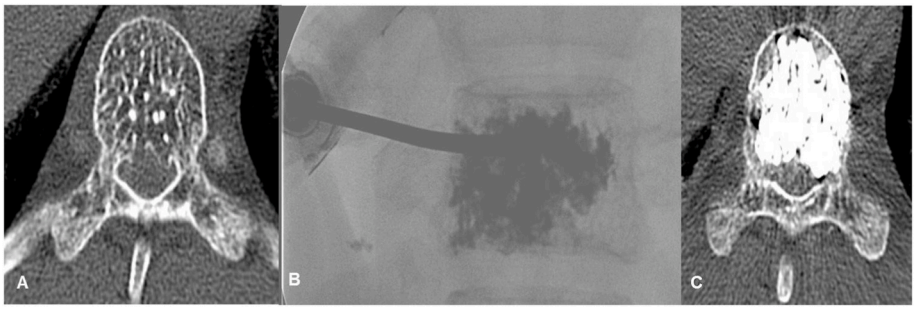

Fig. 2. 65-year-old male who had previously undergone alcohol injection presented with persistent symptoms at 6 months follow-up, A: His axial CT shows a lesion involving the T9 vertebral body having the characteristic "polka-dot" appearance. B: Fluoroscopy guided injection of bone cement into the lesion. C: Post-procedure CT showing the bone cement that is well contained within the lesion.

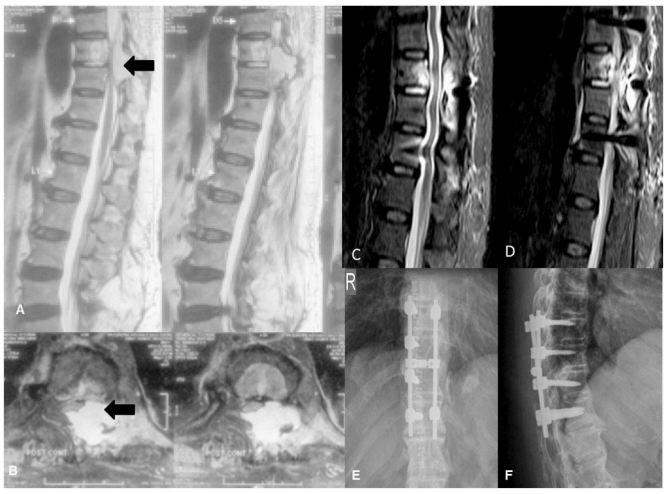

Fig. 4. 56-year-old male with persistent back pain and progressive spastic paraparesis. A: Sagittal T2w MRI showing a hyperintense lesion predominantly involving the posterior columns of T9 vertebral body with extension into the spinal canal. (Arrow) B: Axial MRI showed that the lesion has involved the pedicles and posterior elements on the left side. C and D: Postoperative sagittal MRI showing adequate decompression of the thoracic cord. E and F: Post-operative X rays at 24 months follow-up showing the implant in-situ.

entire vertebral body. A layer of anterior cortex was preserved and a Harm's cage filled with autologous bone graft inserted (Fig. 5).

On completing the ventral bone work the rods were placed onto the screw heads and tightened. The average operating time was 3.6 h (range 2.5–5.5 h) and the average blood loss at surgery was about 1200 ml. These four patients improved postoperatively and remained Nurick 0 or Nurick 1 at last follow-up and were independent for activities of daily living.

We did not have any immediate or late post operative complications in our series. None of the patients in the present series received radiotherapy.

The type of intervention used and the outcomes of intervention at follow-up are summarized in Table 2.

Fig. 5. 35-year-old male with mid-thoracic back pain and paraparesis. A&B: Sagittal and axial T2w MRI showed a hyperintense lesion involving all three columns of the T7 vertebra and causing cord compression by the large epidural component. C: Selective angiogram showing tumour blush. D: Disappearance of tumour blush after embolization. He underwent T7 corpectomy and fusion. E: 12-month follow-up MRI shows adequate decompression of the thoracic cord. F and G: Postoperative X rays at one-year follow-up shows implants in-situ.

3.2.7. *Clinical outcomes (Tables 3 and 4):*

Postoperatively at a median follow-up of 36 months, 4 patients in Group 1 and 2 patients in Group 2 were Nurick grade 0, 3 patients in Group 1 and 2 in Group 2 were Nurick Grade 1, 4 patients in Group 1 and 4 in Group 2 were Nurick Grade 3, 1 patient in Group1 and 2 patients in Group 2 were Nurick grade 4, 1 patient in Group1 and 1 in Group 2 were Nurick grade 5. These findings are summarized in (Table 3 and 4) and (Fig. 6). The median duration of follow-up was 36 months (range 14–142 months). Overall, 15/24 (62.5%) patients, 8 in Group 1 and 7 in Group 2 had symptomatic improvement on long term follow-up, 8/24 (33.3%), 4 in Group 1 and 4 in Group 2 had no change in their neurological status. 1/24 (4.16%) in Group 1 had worsening of symptoms on follow-up. Shorter duration of symptoms (p-0.016) was associated with good clinical outcome.

4. Discussion

Aggressive vertebral haemangiomas are amongst the most challenging tumours to deal with surgically, both for the novice and experienced surgeons, on account of the uncontrollable blood loss that ensues when the lesion is entered. The wide range of definitive surgical procedures and adjunctive therapies adds to the available options that may be chosen based not only on the clinical condition and radiological appearance of the hemangioma but also upon the experience of the surgical team. Our results clearly show a change in strategy over the 12-year period as our collective experience and skills improved to confront this challenging pathology. From stand-alone alcohol injections and vertebroplasty, laminectomy without fusion for posterior disease and a staged corpectomy followed by a posterior surgery for anterior and posterior disease, we now favor a 360° decompression of anterior and posterior compression via a posterior approach alone. In the latter half of the series we also used arterial embolization, as a preoperative adjunct, to reduce tumour vascularity and intraoperative blood loss.

4.1. *Clinicoradiological considerations*

Aggressive VHs demonstrate rapid progression due to cord compression and extraosseous extension into the soft tissues (Laredo et al., 1986; Hurley et al., 2008). This aggressive clinical presentation is probably a consequence of the hemangioma bursting through the bony cortex and occupying the spinal canal with unhindered further expansion and cord compression. Indeed, the majority of patients (54%) in our series were wheelchair or bed-bound due to myelopathy, a feature strikingly different from other series where patients usually had mild to moderate myelopathy (Goldstein et al., 2015; Huang et al., 2020). Nonetheless, poor preoperative neurological grade does not seem to preclude excellent recovery in this benign extradural pathology where relief of severe spasticity by itself improves ambulation significantly.

4.2. *Imaging features*

Aggressive VHs are difficult to diagnose on MRI because of the poor bone imaging afforded by this modality and the hypervascular stroma with very little fat content may show hypointensities on T1w images. Fat predominant VHs are usually dormant; while those with vascular stroma are active and cause progressive deficits (Laredo et al., 1986). Aggressive VHs often mimic sinister pathologies like metastasis, plasmacytoma and multiple myeloma on MRI. Thickened vertical trabeculae seen on CT are pathognomonic of VHs. Clinical and laboratory tests such as, elevated serum calcium, creatinine, serum electrophoresis, anemia, urine Bence Jones proteins help in differentiating aggressive VHs from a myeloma and metastasis (Wang et al., 2018). We have noted that in aggressive VHs the PLL remains attached in the midline and the soft tissue component of the hemangioma lifts the PLL on either side of the midline and extends into the spinal canal causing extradural cord compression resulting in cord edema. All our patients had a score of >3

Table 2
Depicts the types of intervention and outcome of intervention at follow up between Group 1 and Group 2 patients with aggressive VHs.

Intervention	Group 1 n-13	Group 2 n-11	Group 1 outcome			Group 2 outcome		
			Improved	Same	Worsened	Improved	Same	Worsened
Alcohol injection	2	2	0	1	1	0	1	1
Laminectomy without posterior instrumented fusion	6	1	4	2	0	0	1	0
Laminectomy with posterior instrumented fusion	0	3	0	0	0	2	1	0
Corpectomy with stand alone cage (Anterior approach)	2	0	1	1	0	0	0	0
360° fusion (2 stage anterior and posterior approach)	3	1	3	0	0	1	0	0
360° fusion (single stage posterior approach alone)	0	4	0	0	0	4	0	0

Table 3
Postoperative nurick grade outcome between group 1 and group 2.

Variables		Group 1 n-13	Group 2 n-11	P value
Postoperative Nurick grade	Grade 0	4	2	0.87
	Grade 1	3	2	
	Grade 3	4	4	
	Grade 4	1	2	
	Grade 5	1	1	

Table 4
Comparision of pre and post operative functional outcomes.

Nurick grade	Pre-operative	Post-operative	P value
0 and 1	6	11	0.08
3	5	8	
4 and 5	13	5	

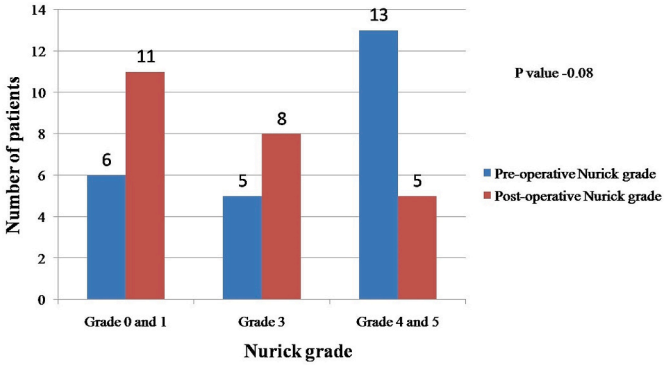

Fig. 6. Bar graph depicting the preoperative and postoperative Nurick grades. The majority of patients had poor neurological function at presentation (Nurick 4,5). The mean preoperative Nurick grade was 3.83 and the mean postoperative Nurick grade was 2.77 with a p value 0.08. The Nurick grade recovery rate (NGRR) was 54.4%.

by the radiological criteria defined by Laredo et al. pointing towards aggressive VHs (Laredo et al., 1986). We were not able to prove the usefulness of this scoring system since our cohort excluded asymptomatic VHs. In our series, as in others, the thoracic spine was the most commonly involved region (Eichberg et al., 2018; Goldstein et al., 2015; Huang et al., 2020).

4.3. Management

The underlying principle in the management of aggressive haemangiomas remains adequate decompression of the dural tube followed by fusion (Nguyen et al., 1987; Fox and Onofrio, 1993; Acosta et al., 2011; Jiang et al., 2014; Vasudeva et al., 2016). Although aggressive VHs are benign lesions the risk of recurrence ranges from 3 to 30% with conservative approaches including alcohol injection, bone cement injection and transarterial embolization (Acosta et al., 2008; Goldstein et al., 2015; Nguyen et al., 1987). Gross total resection, reduces the recurrence rates without the need for adjuvant radiation therapy (Vasudeva et al., 2016).

4.3.1. Posterior column disease

Our findings suggest that laminectomy is an effective treatment option when the lesion involves the posterior elements alone. Up to 80% cure rates can be achieved when laminectomy with or without fusion is used as a stand-alone procedure in lesions involving the posterior elements (Jiang et al., 2014; Vasudeva et al., 2016). The use of posterior stabilization with pedicle screws enabled aggressive disease clearance around the facet joints (Fox and Onofrio, 1993; Nguyen et al., 1987; Vasudeva et al., 2016; Yamazaki et al., 2006). We now reserve laminectomy without fusion to cases where disease is strictly limited to the lamina and spinous process without facetal joint involvement or when surgery is done as a palliative measure to decompress the cord in elderly patients who cannot withstand long procedures. The risk of kyphosis is lower if the facet joints are not violated during the procedure (Yamazaki et al., 2006).

4.3.2. Anterior and middle column disease

For disease involving the anterior and middle columns of the cervical or lumbosacral spine we suggest a resection of the lesion alone (corpectomy) as it is less morbid than en bloc resections and offers comparable local control rates (Goldstein et al., 2015). When dealing with anterior column disease in the cervical spine we use the anterior transcervical approach with the addition of a manubriotomy if the lesion extends to the cervicothoracic junction. We use the retroperitoneal approach for the lumbar spine for tumour resection and anterior column reconstruction. Advantages of the anterior approach include direct access to the tumour, good hemostatic control, good anterior and middle column reconstruction and improved wound healing (Fourney and Gokaslan, 2004). The complications of a pure ventral and ventrolateral approach include atelectasis of lung, pneumonia, pneumothorax, injury to spleen, liver and diaphragm with herniation of intra-abdominal contents (Fourney and Gokaslan, 2004).

4.3.3. Anterior, middle, posterior column disease

Most aggressive haemangiomas involve the vertebral bodies and pedicles, with an epidural component causing circumferential compression of the cord frequently requiring posterior column stabilization and anterior column reconstruction after tumour excision. However, combined anterior and posterior approaches are associated with increased anesthesia time from repositioning, excessive blood loss, prolonged ventilation, respiratory complications and poor wound healing (Street et al., 2007). A single-stage posterolateral approach overcomes these difficulties and is well described in tuberculosis and metastatic tumours of the thoracic spine (Street et al., 2007). Our experience with spinal tuberculosis helped us effectively apply the single-stage approach for haemangiomas. Complications associated with posterior approaches include pneumothorax, haemothorax, pulmonary embolism and poor wound healing (Street et al., 2007).

4.3.4. Transarterial-embolization

In our practice, trans-arterial embolization is done prior to surgery or percutaneous trans-pedicular alcohol sclerotherapy. It has been performed as a sole treatment modality for management of haemangiomas presenting with local symptoms but results have been discouraging in patients presenting with deficits (Smith et al., 1993). Identification of the feeding vessels and selective injection of polyvinylalcohol (PVA) particles into the lesion facilitates shrinkage of the lesion relieving pain and reducing vascularity (Smith et al., 1993; Eichberg et al., 2018; Ng et al., 1997). Embolization is not done if a radiculomedullary artery is identified at the level of hemangioma, to avoid the risk of spinal cord infarction. Patients, who undergo trans-arterial embolization alone, show a delayed improvement as compared to immediate improvement after the surgery, however, the long-term efficacy remains unclear (Eichberg et al., 2018). Our experience in the latter half of the study suggests that arterial embolization is a useful adjunct prior to surgery.

4.3.5. Percutaneous ethanol injection

This modality involves percutaneous CT-guided absolute alcohol injection into the lesion via the transpedicular route (Lonser et al., 1998). The resulting thrombosis and endothelial destruction shrinks the hemangioma and seems to work best to relieve local symptoms such as backache but is not useful when neurological deficits are present (Lonser et al., 1998). Clinicians using this technique need to be cautious during the injection as complications such as severe hypotension, bradycardia and asystole related to alcohol entering the systemic circulation can be fatal (Niemeyer et al., 1999; Yadav et al., 2010; Singh et al., 2011). Other complications include Brown-Sequard syndrome, pathological fracture and paravertebral abscess (Niemeyer et al., 1999; Yadav et al., 2010; Singh et al., 2011). There are reports of successful use of intra-operative alcohol injection combined with decompression and stabilization to reduce blood loss during the surgery (Lonser et al., 1998; Singh et al., 2011). Elderly patients who are not fit for major surgery and those patients with only back pain with an intact posterior cortex might be candidates for alcohol injection with or without vertebroplasty. As better treatment options are available stand-alone treatment with ethanol injection has fallen out of favor.

4.3.6. Vertebroplasty

Percutaneous injection of bone cement (polymethylmethacrylate [PMMA]) has been described as an effective method to relieve pain associated with spinal haemangiomas (Hao and Hu, 2012). Maintenance of vertebral height and micro-fracture stabilization are known to be responsible for the beneficial effects provided by this modality. Huang et al. successfully used a comprehensive treatment strategy that included intraoperative embolization with gelatin sponge particles, vertebroplasty, and posterior decompression with internal fixation (Huang et al., 2020). They reported significant clinical improvement and radiological disease control of Enneking stage 3 thoracic aggressive haemangiomas. Others claim that intraoperative vertebroplasty reduces the tumours blood supply and shrinks the epidural component (Wang et al., 2018; Guarnieri et al., 2009). Vertebroplasty offers no benefit if the lesion has breached the posterior cortex as the cement may expand into the spinal canal and result in cord injury (Ratliff et al., 2001). The use of this modality in one of our patients in whom the CT showed a breach in the posterior cortex of the vertebra is a case in point (Fig. 7).

4.3.7. Intra operative sclerotherapy

The use of intra operative sclerotherapy for management of aggressive VHs is well described. The technique is very useful to managing thoracic hemangiomas and has been described to have several advantages such as drying the lesion and reducing the vascularity, when combined with vertebroplasty reduces the pain caused by instability and also offers adequate decompression. Corniola et al. have reported favourable results in management of aggressive VHs using a combination of percutaneous sodium tetra decyl sulphate embolization, epidural sclerotization and resection of the epidural lesion. We have not used this modality in any of our patients in this series (Corniola et al., 2020).

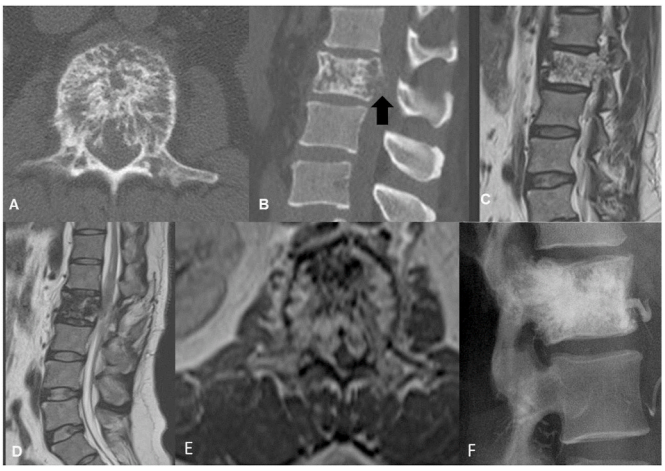

Fig. 7. 45-year-old male with back pain and no neurological deficits. A: Axial CT non-contrast showing the lesion having a characteristic polka dot appearance. L1 vertebral body was involved by the tumour with thinning of the posterior cortex. (arrow) The sagittal CT shows typical corduroy appearance of the lesion with a small component in the spinal canal. C: Sagittal T2 W MRI showing a hyperintense enhancing lesion involving the entire L1 vertebral body with a small epidural component causing spinal stenosis. D & E: Postoperative laminectomy defect with extrusion of the bone cement into the spinal canal. F: Postoperative X ray showing the leakage of bone cement beyond the vertebral body into the canal.

Adjuvant radiotherapy after laminectomy for loco-regional disease control for more extensive lesions has been suggested (Pavlovitch et al., 1989). However, we are not in favor of this approach as radiation may be associated with malignant transformation of vertebral hemangioma and adjacent structures (Beyzadeoglu et al., 2002; Mazonakis et al., 2016). Based on the above observations our treatment strategy is summarized in Fig. 8.

5. Conclusion

Aggressive VHs remain a surgical challenge but may be effectively managed through a thorough clinicoradiological evaluation. Results of conservative modalities such as alcohol injection in management of these lesions have been discouraging. A more radical strategy of pre-operative arterial embolization followed by a single-stage posterolateral approach to decompress the dural tube results in good neurological recovery even in patients with severe neurological deficits at presentation. A shorter duration of symptoms was associated with better clinical outcomes.

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Nil.

Contribution details

Conception and design: Krishna Prabhu, Edmond Jonathan Gandham. *Drafting the article:* Ganesh Swaminathan, Edmond Jonathan Gandham.

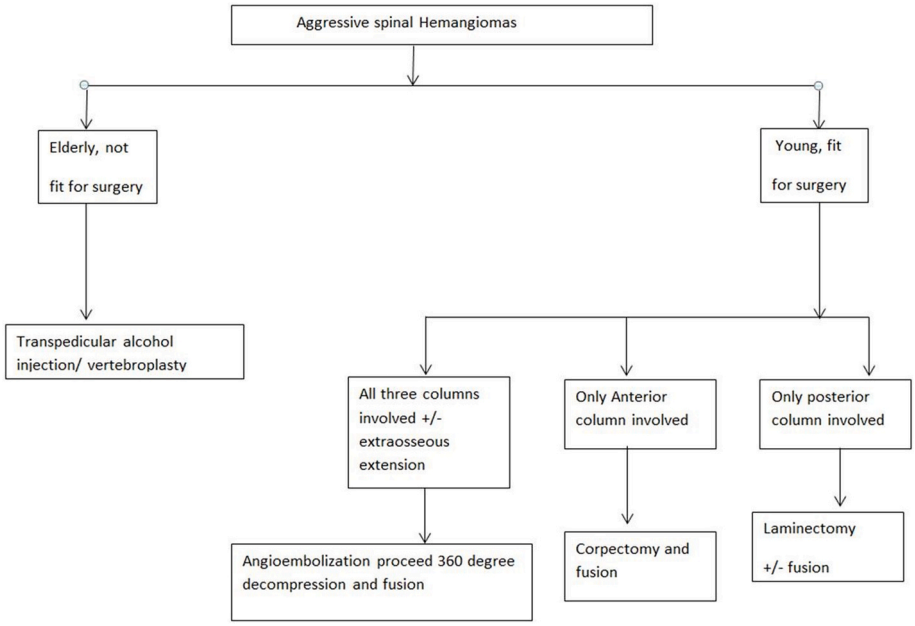

Fig. 8. Treatment algorithm for management of aggressive spinal haemangiomas.

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Declaration of competing interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers; bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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