

Clinical Study

Long-term outcome of treatment of vertebral body hemangiomas with direct ethanol injection and short-segment stabilization

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Abstract

BACKGROUND: Vertebral body hemangiomas with myelopathy are difficult to manage.

OBJECTIVE: The objective of this study was to evaluate the role of intraoperative ethanol embolization, surgical decompression, and instrumented short-segment fusion in vertebral hemangioma (VH) with myelopathy and long-term outcome (>24 months).

CLINICAL MATERIALS AND METHODS: This prospective study included symptomatic VH with cord compression with myelopathy. Pathologic fractures and deformity or multilevel pathologies were excluded from the study. Surgery consisted of intraoperative bilateral pedicular absolute alcohol (<1% hydrated ethyl alcohol) injection, laminectomy, and cord decompression at the level of pathology followed by a short-segment instrumented fusion using pedicle screws.

RESULTS: The study included 33 patients (mean 26.9±13.2, range: 10–68 years, 18 females). The clinical features of the study were myelopathy in all patients (5 paraplegic), sphincter involvement (13), and mid back or lower back pain (7). The preoperative American Spinal Injury Association (ASIA) scores were A (7), B (11), C (6), D (8), and E (1). Majority of the patients had single vertebral involvement (30) and three patients had multiple-level involvement. Six patients underwent surgery earlier (one underwent alcohol embolization). The mean surgical time was 124±39 minutes, and the average blood loss was 274±80 cc. The mean amount of absolute alcohol injected was 14.6±5.7 cc (two patients required 20 and 25 cc). Immediate embolization was achieved in all patients, allowing laminectomy and easy removal of soft-tissue hemangioma. Post surgery, one patient had transient deterioration, and the condition of the rest of the patients improved (sphincters improved in nine patients) at a follow-up ranging 28–103 months (mean 47.6±22.3). Follow-up ASIA scores were E (26), D (4), B (2), and C (1). All patients showed evidence of bone sclerosis and relief of cord compression on follow-up imaging.

CONCLUSIONS: This is the largest study in literature showing excellent improvement, low reoperation rates after ethanol embolization, and short-segment fixation. © 2018 Published by Elsevier Inc.

Keywords:

Absolute alcohol; Ethanol; Outcomes; Pedicle screw fixation; Surgery; Treatment; Vertebral hemangioma

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A pilot study (n=10) earlier has been published earlier in *Neurosurgery*. The pediatric series (n=6) has been published in *Child Nervous System*.

Portions of the study have been presented in various conferences. These consolidated data have not been sent for publication elsewhere.

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Introduction

Vertebral hemangiomas (VHs) are among the most common lesions of the vertebral column but are treacherous and challenging to manage if they become symptomatic (in 0.9%–1.2% of cases) [1–5]. The overall incidence of these lesions is about 10% in normal populations [1–8]. These lesions are most common in women and, region-wise in the thoracic spine and occasionally, may become aggressive. Single vertebral involvement occurs most commonly, although two-level involvements are not so uncommon, even though involvement of a larger number of levels is exceedingly uncommon [1,3–7,9,10]. Various treatment options have been suggested, including embolization followed by complete vertebrectomy [10–17], injection of various “cement”-like materials [18–48], and even radiotherapy [49–52]. Although a complete vertebrectomy technically would excise the tumor completely, the surgery is a major procedure associated with high morbidity and mortality. In contrast, injection of various embolizing and cement-like materials would only temporarily reduce the vascularity with obvious risk of recurrence.

Ethanol embolization [53–62] through a percutaneous route has been shown to be effective but has been associated with a high incidence of pathologic fractures. To counteract this, the authors conducted a pilot study in 2011 [63,64] that reported on the safety, efficacy and feasibility of intraoperative ethanol embolization combined with short-segment fixation. Since this publication, the authors have used this technique in over 33 patients having at least 28 months follow-up. The following study aimed to demonstrate the long-term safety, efficacy, and outcome of this procedure.

Clinical materials and methods

Patient selection

The patients included were those presenting with VH with cord compression and myelopathic features (studied prospectively from June 2006 to 2014). Although we preferred a single-level VH, this was not an absolute indication. Patients with pathologic fractures, deformity, von Hippel disease, or severe systemic illnesses (eg, hypertension or diabetes) were not included in the study. Pure ventral compression was also not a contraindication in our study. Informed consent was provided by the patients, and the study followed the guidelines laid down by Medical Research Council. All the patients underwent a detailed clinical examination, imaging (plain roentgenogram, computed tomography [CT] scans, and magnetic resonance imaging [MRI] with gadolinium). Contrast CT scans of the chest and the abdomen were also performed to rule out von Hippel disease. Consent was provided by all patients to publish this article, including permission to publish their images.

Surgical technique

Most of the cases were performed by the first author, who primarily developed this technique (PSC). The procedure has been described in detail in earlier publications [63,64]. Briefly, the surgery was performed under general anesthesia in the prone position. After the exposure of the affected vertebra, exposure of the vertebrae was also made one level above and below the pathologic vertebra. Once the VH-affected body was identified under fluoroscopy, pedicle screws were placed (one level above and below) into the adjacent healthy vertebrae. After this, two (14–16 gauge) Jamshidi needles were tapped into either pedicles of the affected body under fluoroscopy guidance. The presence of VH was confirmed by rapid oozing or gushing of venous blood from the canulas. After this, absolute ethanol (<1% hydrated) was injected using syringes attached to both needles. This was injected slowly with each bolus not exceeding 0.5 cc. After injection of 2–3 cc on both sides, the syringe was removed and the extent of embolization was checked. After every injection of ethanol, before removing the syringe, it was important to wait for around 2–3 minutes to allow the complete action of ethanol. Generally, embolization occurred instantaneously during the initial injection itself. However, the needle was repositioned in different areas of the vertebral body to allow homogenous embolization of the VH. In addition, while withdrawing the needle, the guide wire was removed every 5 mm, and further ethanol was injected if the embolization was not adequate. To prevent any retrograde leak, the entire procedure of injection of ethanol into the vertebral body was performed under cover of plenty of saline irrigation being provided by the assistant to allow immediate recognition of any retrograde leak. The whole procedure was performed under magnification under an operating microscope. The leakage of ethanol was thus easily identified over the background of the irrigating saline as a streak of fluid within the irrigating saline caused by different specific gravities of the ethanol, emerging between the Jamshidi needle and the bone. In the event of identification of any retrograde leak, the injection of ethanol was halted momentarily and the operative field was generously irrigated with saline, along with simultaneous suction. It is very important to inject the ethanol very slowly and carefully to monitor the cardiac and blood pressure parameters. If there was a drop of blood pressure or occurrence of arrhythmias, the procedure was paused until the parameters returned to normal. Once the embolization was completed, laminectomy and decompression of the soft hemangiomatous tissue was performed. This procedure now becomes almost bloodless. In the earlier cases, we would use an extracavitary approach to excise the ventrally placed soft-tissue compression. However, for the past 3 years, we found that there was no necessity to excise the ventrally placed hemangiomatous soft tissue as it would regress on its own after ethanol embolization. Bone chips taken from the iliac crest were placed between the transverse processes to allow bone fusion. Data pertaining to surgery, including the

operating time, the amount of ethanol injected, blood loss, and any significant intraoperative events, were recorded.

Biopsies were performed either through the Jamshidi needle or from the soft hemangiomatous tissue. After surgery, the patients were kept in the intensive care unit for 1 day and then shifted to the ward.

After discharge, the patients were followed up with MRI and CT scans every 6 months. In addition, monthly follow-up was performed on telephone. Functional clinical outcomes included ambulation status and neurologic status, the latter measured using both the Nurick [65] and American Spinal Injury Association (ASIA) [66] impairment scale classifications. Ambulatory outcome and neurologic status, if improved, were recorded at the first available follow-up date. If ambulatory and neurologic status remained unchanged or worse, the last date that this was observed was recorded.

Results

The clinical features and the surgical details are summarized in the Table.

A total of 33 patients were treated from June 2006 to June 2016 with at least a follow-up of 28 months and were included in the present study. The mean age was 26.9 ± 13.2 years (range: 10–68 years, 18 females). Clinical features included myelopathy in all patients (5 paraplegic patients), sphincter involvement (13 patients), and mid back or lower back pain (7 patients). The preoperative ASIA scores were A in 7 patients, B in 11 patients, C in 6 patients, D in 10 patients, and E in 1 patient. Majority of the patients had single vertebral involvement (30 patients); however, 3 patients had multiple-level involvement (Cases 22, 28, and 31; Table). Six patients underwent surgery earlier. Of these patients, one underwent alcohol embolization at our hospital (Case 32) in 2012. The latter patient, after an initial improvement, started developing weakness of both lower limbs for 6 months. MRI demonstrated a regrowth of soft tissue ventrally. The patient underwent re-exploration repeat ethanol embolization through the transpedicular route. After surgery, the patient improved, and at 30 months of follow-up, the MRI revealed complete regression of the hemangiomatous soft tissue and complete relief of the spinal cord compression. CT scan showed evidence of progression of further bone sclerosis. The



Fig. 1. MRI (Left and Top Right) of a 27-year-old woman who presented with progressive myelopathy (Case 26) showed D10 ventral and lateral compressions on both sides. The CT scan (Bottom Right) showed the typical trabeculae associated with VH. CT, computed tomography; MRI, magnetic resonance imaging; VH, vertebral hemangioma.

Table
Summary of all cases of vertebral hemangiomas

S No.	Age/sex	History: duration (mo)/sensory (±)/motor (±)/others	ASIA score (preop)	FU (mo)	Level	Compression by soft tissue	Surgery	ASIA score (at last FU)	MRI and CT scan at last FU	Complication
1	20/M	5/sensory+/motor+	D	53	D7	(+1)	D7 laminectomy+ethanol D7+D6, D8 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
2	35/M	12/sensory+/motor+/D6–D8, laminectomy done elsewhere earlier	D	62	D7	(+1)	Ethanol D7+D6, D8 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
3	12/F	7/sensory+/motor+	C	68	D3	(+2)	D3 laminectomy+ethanol D3+D3+D2, D4 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
4	25/M	2/sensory+/motor+/mid back pain	A	36	D6	(+2)	D6 laminectomy+ethanol D6+D5 sublaminar hook and D7 pedicle screw fixation	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
5	35/F	24/sensory+/motor+/operated on earlier for vertebral hemangioma elsewhere, procedure abandoned	D	36	D3	(+1)	D2 laminectomy+ethanol D3+D2, D4 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
6	25/F	5/sensory+/motor+	A	67	D8	(+3)	D8 laminectomy+ethanol D8+D7, D9 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
7	30/M	10/sensory+/motor+/bladder and bowel involvement 2 mo	D	61	D10	(+3)	D10 laminectomy+ethanol D10+D9, D11 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
8	15/M	6/sensory+/motor+/bladder and bowel involvement 4 mo	C	36	D12	(+3)	D12 laminectomy+ethanol D12 +D11, L1 PSRF	D	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
9	23/F	Back pain 5 mo Urinary frequency 4 mo	D	31	D12	(+2)	D12 laminectomy+ethanol D12+D11, L1 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
10	40/M	8/sensory+/motor+/previously operated on elsewhere, underwent D6–D8 laminectomy and instrumented fixation with partial excision of the hemangiomatous tissue without alcohol	A	28	D7	(+2)	Re-exploration, D7 ethanol injection only	D	CT: Regeneration of bone with sclerosis MRI: Relief of spinal cord compression	None
11	39/M	12/sensory+/motor+/operated on at our hospital 10 y ago, decompression, instrumented fixation was performed after Spongostan (Ethicon, Johnson & Johnson, Bridgewater, NJ, USA) embolization	D	48 (after second surgery)	D7	(+2)	Re-exploration, D7 ethanol injection only	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None

(Continued)

Table
(Continued)

S No.	Age/sex	History: duration (mo)/sensory (±)/motor (±)/others	ASIA score (preop)	FU (mo)	Level	Compression by soft tissue	Surgery	ASIA score (at last FU)	MRI and CT scan at last FU	Complication
12	16/F	12/motor+/minimal sensory	B	26	D10	(+)2	D10 laminectomy+ethanol D10+D9, D10 PSRF	C	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
13	35/M	12/sensory+/motor+ (paraplegia)/bladder+	A	28	D3	(+)3	D3 laminectomy+ethanol D3+D2 hook and D3 pedicle screws	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
14	26/F	4/severe mid back pain, progressive weakness of both lower limbs, term pregnancy of 30 wk at the time of presentation (Fig. 6)	A	27	D3	(+)3	Ethanol injection+laminectomy+D2 and D4 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of thecal sac compression	None
15	10/F	4/motor+ 10 d	B	60	D6	(+)3	D6 laminectomy+ethanol D6+D5, D7 SPRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
16	14/F	8/motor+paraplegia (2 mo), bladder+	A	102	D8	(+)2	D8 laminectomy+ethanol D8+D7 D9 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
17	20/F	3/sensory+/motor+/paraplegia, bladder and bowel+ (1 mo)	A	26	D3	(+)3	D3 laminectomy+ethanol D3+D2, D4 PSRF	D	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
18	33/F	10/partial sensory+/motor+	C	55	D8	(+)1	D8 laminectomy+ethanol D8+D7, D9 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
19	68/F	42/sensory+ (severe paresthesias)/motor+/bladder (6 mo)	B	98	D9	(+)2	D9 laminectomy+ethanol D9+D8, D10 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
20	31/F	5/sensory+ (paresthesia)/motor+/bladder+	C	30	D4	(+)2	D4 laminectomy+ethanol D4+D3, D5 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	Had postoperative deterioration in power in both lower limbs, improved within 2 wk
21	14/M	3/sensory+/motor+/bladder (2 mo)	B	103	D5	(+)2	D5 laminectomy+ethanol D5+D4, D6 PSRF	E	CT: Regeneration of bone with sclerosis MRI: Relief of spinal cord compression	None
22	16/M	36/sensory+/motor+/underwent D4, D5, and D6 laminectomies and transpedicular decompression elsewhere/ regrowth of tumor, large subcutaneous hemangioma (Fig. 3)	C	74	D1–D7 Maximum compression at D2 and D3	(+)3	D2 and D3 laminectomy+ethanol D2, D3, and D1+D6 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	Transient Intraoperative Hypotension and arrythmia

(Continued)

Table
(Continued)

S No.	Age/sex	History: duration (mo)/sensory (±)/motor (±)/others	ASIA score (preop)	FU (mo)	Level	Compression by soft tissue	Surgery	ASIA score (at last FU)	MRI and CT scan at last FU	Complication
23	17/F	2/motor+/bladder+ (Figs. 4 and 5)	B	58	D5	(+1)	D5 laminectomy+ethanol D5+D4, D6 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
24	45/F	6/severe lower back pain// motor+/sensory+	B	68	L1	(+2)	L1 laminectomy+ethanol L1+D12, L2 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
25	16/M	3/motor+/ bladder+ (1 mo)	B	39	D5	(+1)	D5 laminectomy+ethanol D5+D4, D6 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
26	27/F	6/motor+/bladder/bowel (2 mo) (Figs. 1 and 2)	C	34	D10	(+1)	D10 laminectomy+ethanol D10+D9, D11 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
27	16/F	2/motor+	B	36	D1	(+1)	D1 laminectomy+ethanol D1+C6, C7 lateral mass screw and D2, D3 pedicle screw fixation	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
28	19/M	36/motor+, paraplegia (2 mo), bladder+	A	34	D3–D5	(+3)	D2–D6 laminectomy, D3–D5 ethanol, D2, D6 and D7 PSRF	B	CT: regeneration of bone with sclerosis in D3 and D4 MRI: relief of spinal cord compression	None
29	31/M	12/motor+	B	31	D11	(+1)	D11 laminectomy, D11 ethanol, D10–D12 PSRF	D	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
30	40/F	24/motor+/sensory+/back pain (12 mo)	D	30	D11	(+2)	D11 laminectomy, D11 ethanol, D10–D12 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
31	62/F	4/motor+/paraplegia (4 mo), bladder+	B	29	D5–D6	(+2)	D5–D6 laminectomy, D5–D6 ethanol, D4, D7 PSRF	B	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None
32	17/M	Laminectomy and alcohol injection done in 2012, recurrence of the vertebral hemangioma, 6/motor+/sensory+/mid back pain+	B	30	D7	(+2)	D7 laminectomy done, D7 ethanol injected first in 2012 and then repeated again in 2014	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression initially but showed recurrence of the lesion again	None
33	30/M	3/motor+/upper back pain+	D	28	D3	(+1)	D3 laminectomy, D3 ethanol, D2, D4 PSRF	E	CT: regeneration of bone with sclerosis MRI: relief of spinal cord compression	None

(+), present; (–), absent; 1; single-side compression; 2, both side compression; 3, three-side or circumferential compression; FU, follow-up; PSRF, pedicle screw and rod fixation; M, male; F, female; MRI, magnetic resonance imaging; CT, computed tomography; ASIA, American Spinal Injury Association.

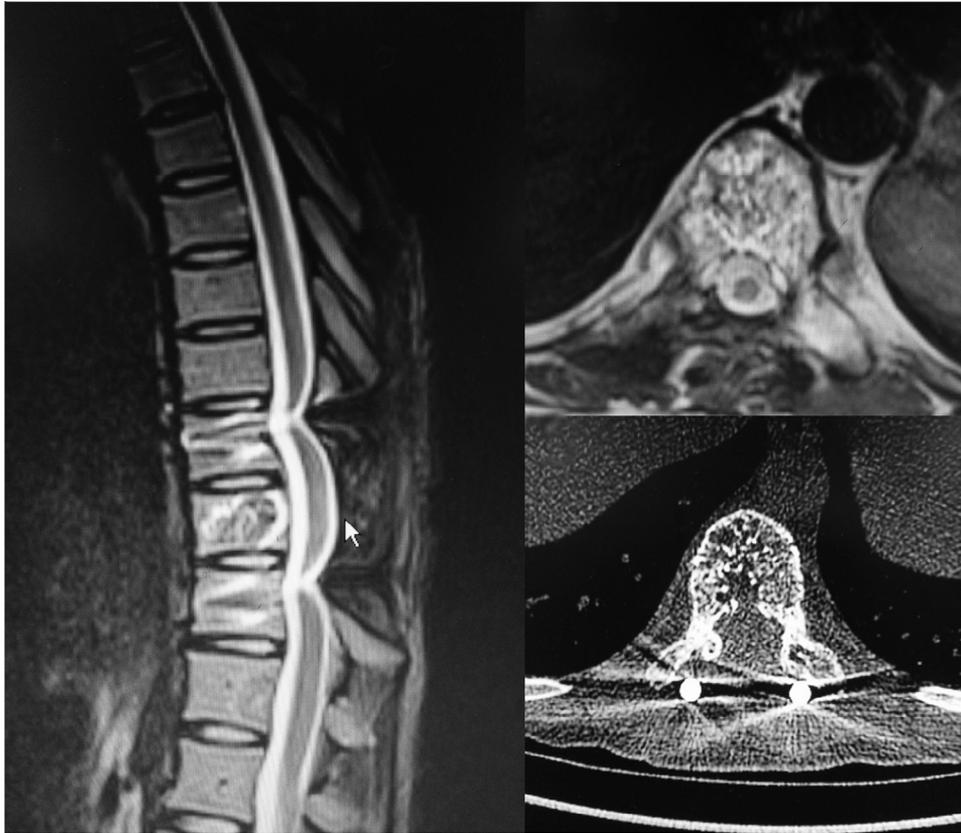


Fig. 2. Follow-up MRI of the same patient as in Fig. 1, who underwent ethanol injection at D10 level, along with pedicle screws at D9 and D11 with rod fixation (Left), showed complete resolution of the soft-tissue component with relief of spinal cord compression (Top Right). In addition, the CT scan (Bottom Right) shows evidence of bony sclerosis (compare with Fig. 1, Bottom Right) especially noticeable in the pedicles. CT, computed tomography; MRI, magnetic resonance imaging.

mean surgical time was 124 ± 39 minutes, with the average blood loss being 274 ± 80 cc. The mean amount of absolute alcohol injected was 14.6 ± 5.7 cc. Two patients required 20 and 25 cc (Cases 28 and 22, respectively; Table), both having multiple-level hemangiomas. Immediate embolization was achieved in all patients, allowing laminectomy and soft-tissue hemangioma removal easily. One patient had transient neurologic deterioration (Case 20, Table). This patient's power deteriorated to 1/5 (MRC grading, UK) in both lower limbs. Immediate CT scan showed pedicle screws in place. The patient was treated with steroids and improved to the preoperative level within 2 weeks. His power improved to near normal at 30 months of follow-up. One patient had a transient hypotension during surgery (Case 22, Table). After copious irrigation with saline and watchful waiting, the patient's condition improved. However, this did not have any impact on the final clinical outcome.

The condition of all patients improved (sphincters also improved in all to various degrees) at a follow-up ranging from 28 to 103 months (mean 47.6 ± 22.3). Follow-up ASIA scores were E in 26 patients, D in 4 patients, B in 2 patients, and C in 1 patient. All patients showed evidence of bone sclerosis and relief of spinal cord compression on follow-up imaging. The Nurick grades were I (30 patients) and II (3 patients) at

the last follow-up. Five patients presented with paraplegia. Of these patients, one had a term pregnancy (30 weeks) (Fig. 6). The ASIA scores of two patients improved to Grade B, those of two patients improved to Grade E, and that of one patient improved to Grade D. Thirteen patients had sphincter involvement, and the conditions of all patients improved to the extent of becoming continent (see Figs. 1–7).

Discussion

Interestingly, one of the first uses of ethanol was to produce angioinfarction of the kidneys for uncontrolled hypertension [67]. It was later realized that ethanol, being one of the most effective embolizing agents but having the disadvantage of a rapid “runoff” into systemic circulation, hence causes systemic side effects if not cautiously used. In addition, its spillover into normal tissues can result in toxic necrosis of tissues [56,61,62].

Pathologically, VHs are benign lesions of the bone, usually of dysembryogenetic origin, or hamartomatous lesions [68–77]. They can be cavernous, capillary, or a mixed type [76,78,79]. Arteriovenous shunting is rare and this has only low-flow channels [76,78,79]. Pastushyn et al. [8] reported that 28% of their patients had a cavernous type of VH, 50% had a capillary

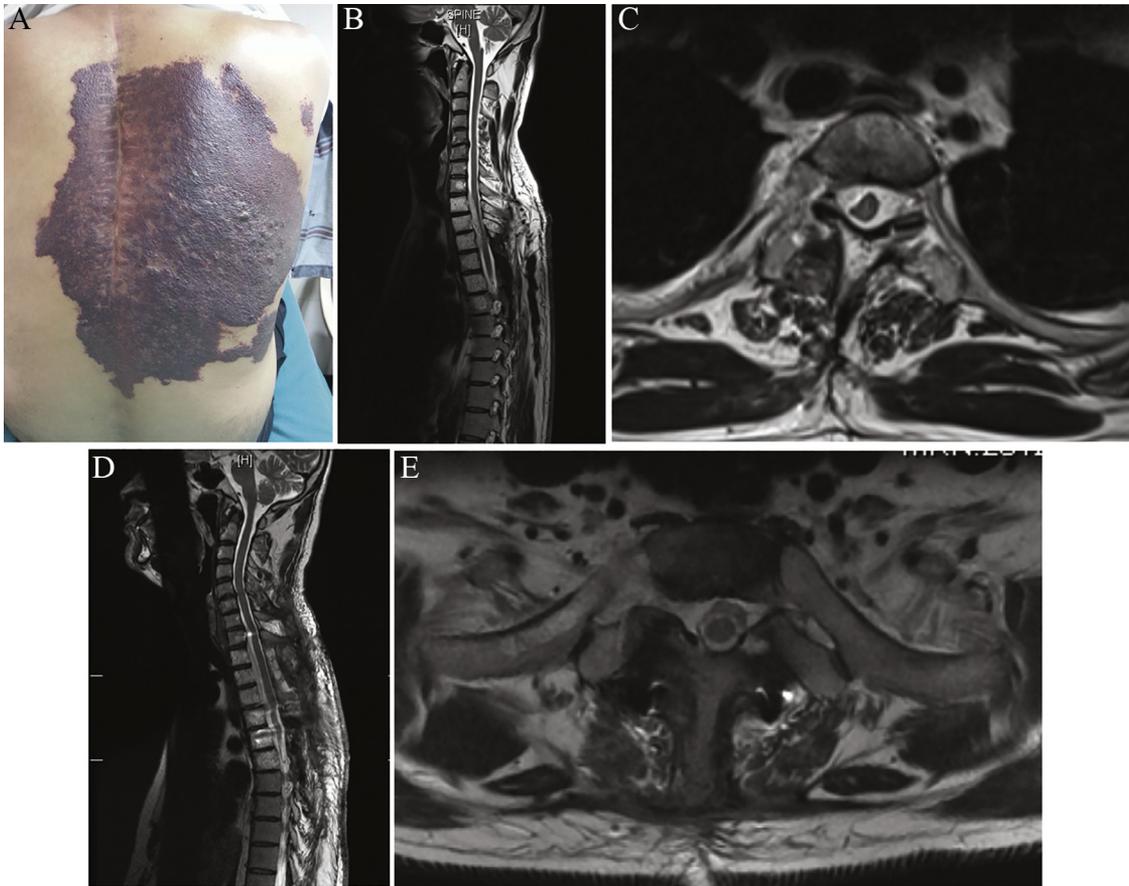


Fig. 3. A 16-year-old boy (Case 22) presented with a large subcutaneous hemangioma (A) and myelopathy. He was operated earlier elsewhere and underwent D4–D6 laminectomy only (B and C). MRI (B) showed multiple hemangiomas from D1 to D7 with maximum compression caused by soft tissue at D2–D4 levels (C). He underwent D2–D3 laminectomy with ethanol injection at D2 and D3 levels. A total of 25 cc was injected. Pedicle screws were placed at D1 and D6 levels with rod fixation (D and E). Follow-up MRI shows complete relief of spinal cord compression (E). MRI, magnetic resonance imaging.

type of VH, and 22% had a mixed type of VH. Such a pathologic architecture provides a relatively safe situation for injection of embolizing agents like ethanol as it would prevent rapid shunting and systemic toxicity (if injected slowly). The presence of low-flow fistulas in VH also would prevent a rapid “wash off” of ethanol, thus allowing its embolizing and sclerosing action to take place locally.

The current accepted strategies for surgical management of VH include vertebrectomy [10–17] (usually with embolization), injection of cement-like substances using either vertebroplasty or kyphoplasty [18–48], and radiotherapy [49–52]. The first technique is fraught with high risk, morbidity, and mortality (up to 6% in some earlier series [8]). There are some cases described where this was performed, even using total circulatory arrest [80]. In comparison, the latter two techniques even though providing much less risk, have the shortcoming of technically not eradicating the disease.

After a pilot study demonstrating the safety, efficacy, and feasibility of VH ethanol embolization and short-segment fixation in adult and pediatric patients [63,64], the authors are publishing this series to demonstrate the long-term outcome of this technique.

In 1994, Heiss et al. [54,81,82] published the first report of VHs treated by percutaneous CT-guided injection of absolute alcohol. Injection of absolute alcohol causes intralésional thrombosis and destruction of the endothelium that composes the hemangioma. Devascularization is followed by shrinkage of the lesion and subsequent sclerosis, which decompresses the cord and nerve roots [54,81].

VH ethanol embolization has the unique advantage of both providing instant embolization and also “killing” the tumor cells [54–64,67]. This could have been perhaps the reason why, in some cases of percutaneous injection of ethanol, the patients developed pathologic fractures [54,81,83]. This correlated with the volume of ethanol injected (>40 mL). In such cases, possibly once the tumor was embolized and underwent necrosis by ethanol, the residual bony lattice unable to support the weight of the body collapsed. To counteract this shortcoming, the authors suggested a short-segment instrumented fixation [11,63,64].

Systemic complication is another major concern of ethanol injection. Niemeyer et al. [58] reported a case of Brown-Sequard syndrome after injection of alcohol for VH. This and the cases of transient deterioration described by others [59,83]

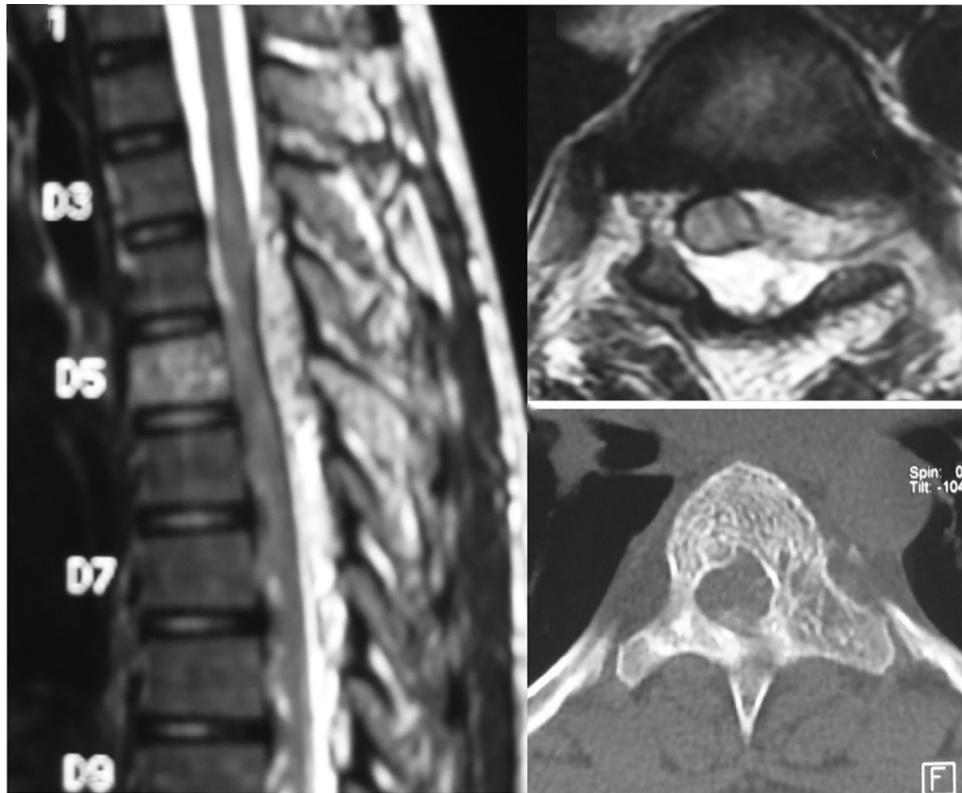


Fig. 4. MRI of a 17-year-old girl who presented with rapidly progressive weakness (Case 25) showed a D5 VH (Left) with soft-tissue compression being maximum at the D4 level. Axial sections showed maximum compression on the left side (Top Right). CT scan (Bottom Right) showed expansion of the left-sided pedicle as well. CT, computed tomography; MRI, magnetic resonance imaging; VH, vertebral hemangioma.

may have been due to a retrograde leak, which cannot be detected during a percutaneous injection. Such manifestations have also been described in a case that had undergone endovascular embolization of VH [84]. Migration of microcoil into the sulcocommissural artery has been postulated as the reason for this. MRI done later demonstrated spinal cord infarct. It is thus possible that a rapid systemic runoff of ethanol into the perforators may have caused similar problems of neurologic deterioration. The current series has one case of transient deterioration after surgery. The patient had developed severe weakness (1/5) after surgery, which improved to the preoperative status after 2 weeks. There was another patient where transient hemodynamic changes were noted during surgery. Apart from these two cases, there were no other long-term morbidities. All patients improved in their weakness as a rule. Even the condition of patients with paraplegia improved significantly (three to ASIA Grades \geq D). Of the six patients who underwent a repeat surgery for tumor recurrence, only one had undergone alcohol embolization 30 months ago. During repeat surgery, transpedicular alcohol injection was given again, leading to an improvement in the patient's condition. Thus, in our experience, the incidence of recurrence has been low. Even if the recurrence did take place, a repeat ethanol injection seemed satisfactory in improving symptoms and in controlling the disease. We of course cannot

comment on longer term outcomes (>10 years' follow-up) at this stage.

The mean amount of absolute alcohol injected was 14.6 ± 5.7 cc. Two patients required 20 and 25 cc, both having multiple-level hemangiomas. Interestingly, Case 22 (Table, Fig. 3), which had the maximum amount of ethanol injected, developed transient intraoperative hypotension. This was well within the limits of what has been recommended in the literature. Although it is difficult to comment, it would be safe to conclude that an amount up to 15 cc should be reasonably safe. We feel that more important would be the use of small increments of 0.5 cc injections during the intraoperative period. We feel that in patients with multiple-level VH, the procedure may be staged.

MRI imaging performed at follow-up showed relief of spinal cord compression in all cases. In addition, CT scan demonstrated bone sclerosis and new bone formation (see all figures). This was a finding that we found in only two cases in our pilot study, but have found consistently in all our cases in the current series. We have not found this finding described in any of the earlier studies even though it may be expected because of 2 reasons: (1) the sclerosing effect of ethanol itself and (2) necrosis and disintegration of the tumor tissue, which now leaves a large space within the bony lattice, providing the same for fresh osteogenesis to take

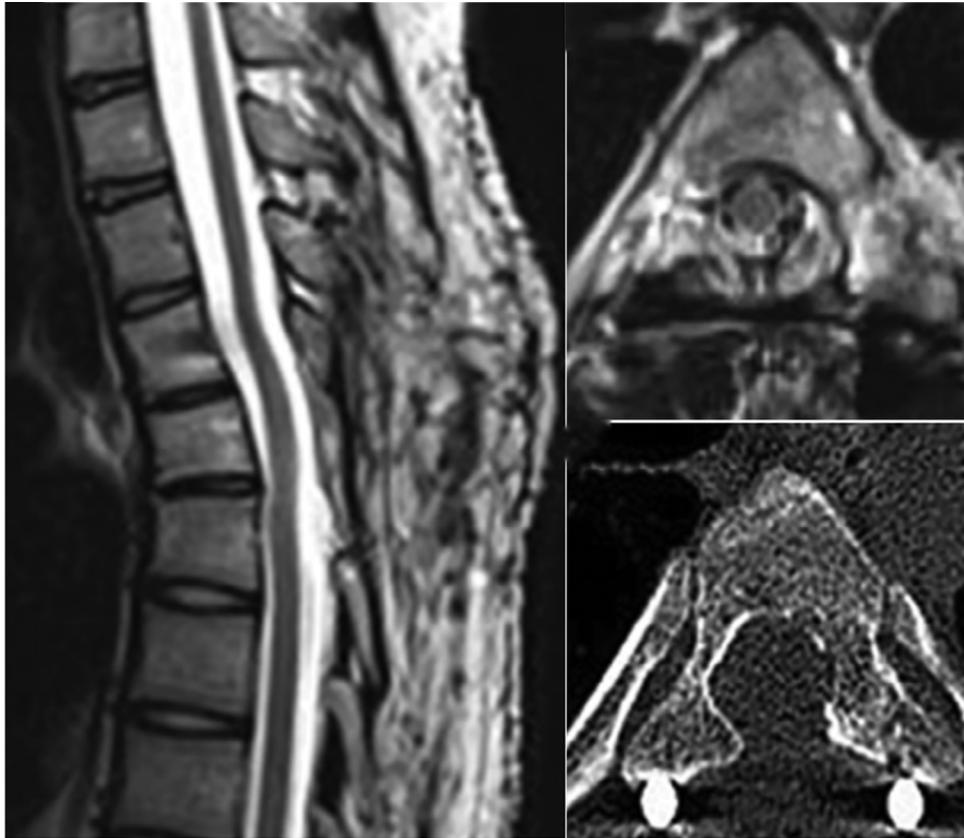


Fig. 5. After ethanol embolization and fixation, there was complete relief of spinal cord compression (Top and Bottom Right) in the same patient as in Fig. 4. The CT scan (Bottom Right) showed regression in the thickness of the affected pedicle, along with evidence of bony sclerosis. CT, computed tomography.

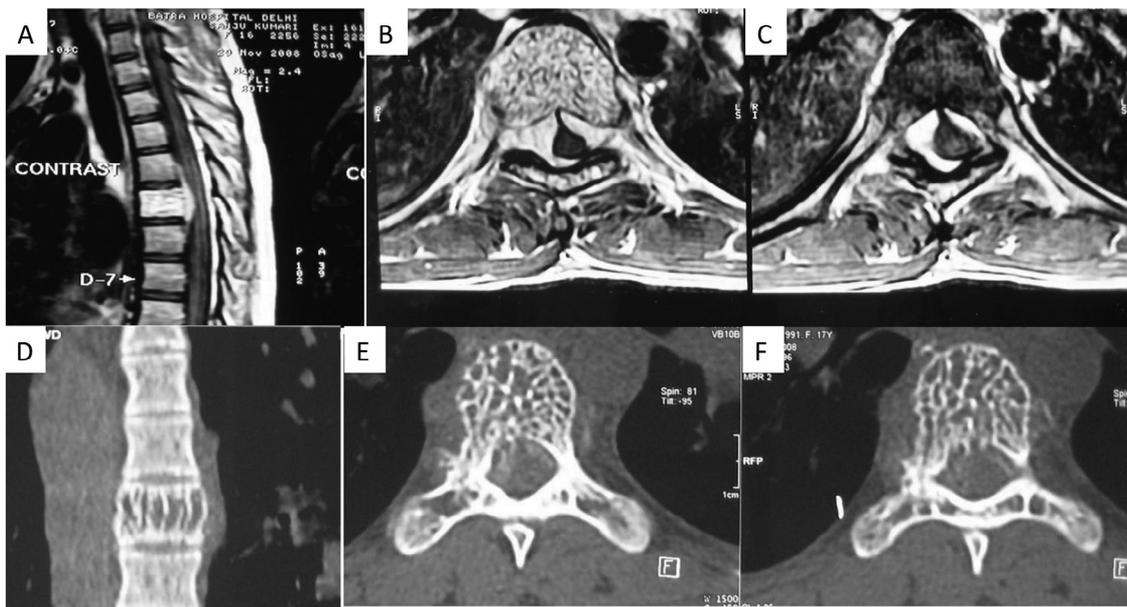


Fig. 6. MRI of a 27-year-old woman at term pregnancy (30 weeks), who presented with paraplegia (Case 14) with VH at the D3 level, showed D5 level VH with ventral and lateral compressions (A, T1 sequence; B, T2 sequence). CT scans (D–F) showed the typical honeycomb appearance with involvement of the vertebral body and the posterior elements as well. CT, computed tomography; MRI, magnetic resonance imaging; VH, vertebral hemangioma.

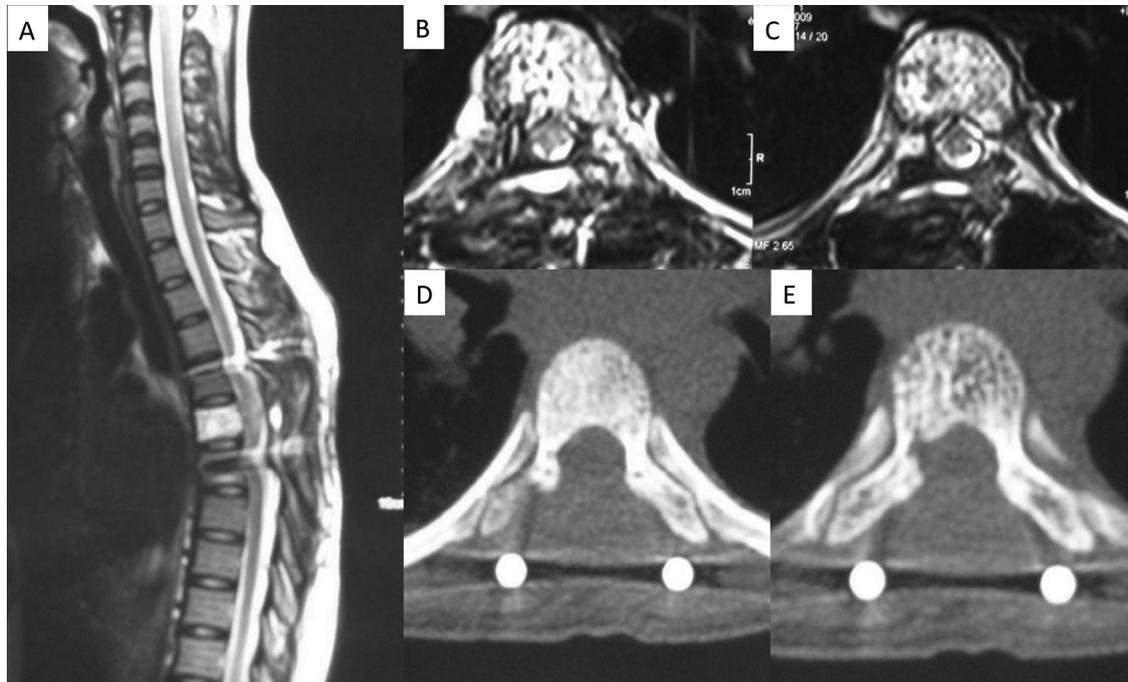


Fig. 7. After surgery (performed in lateral position, with full radiological protection of the baby with lead sheets), MRI performed at 3 months (A, sagittal; B and C, axial sections) on the same patient as shown in Fig. 6 started showing regression of the tumor. The CT scan (D and E) showed significant resolution of the honeycomb pattern, relief of cord compression, and also new bone formation. The patient delivered a healthy boy and was fully ambulant at 16 months after surgery. CT, computed tomography; MRI, magnetic resonance imaging; R, right.

place. However, whatever could be the reasons, ethanol embolization provides very good advantage in this aspect over other conventional embolizing agents. Last, but not the least, it is a highly cost-effective technique (\$1 for 100 cc of ethanol). This definitely has had an impact on our patient profile as a significant number of our patients were economically challenged and were not covered through insurance.

Conclusions

Intraoperative absolute alcohol (<1% hydrated ethanol), combined with surgical decompression of the cord and short-segment instrumented fixation, seems to be a useful (100% improvement in our series) technique in both single- and multiple-level VHs with epidural soft-tissue compression of the cord. It may provide the advantage of reducing the complications of ethanol by providing operative visualization, allowing immediate recovery as a result of surgical decompression and also preventing pathologic fractures. In our series of 33 cases with a long-term follow-up, it has been demonstrated to be safe, effective, and associated with low morbidity. In addition, it has been shown to produce bony sclerosis over a period of time, thus strengthening the bone quality. There has been only one recurrence in our series, which has been effectively treated with ethanol re-embolization. Based on this, we feel that ethanol embolization and short-segment instrumented fixation may be currently one of the best alternatives for the treatment of symptomatic VHs.

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