CLINICAL ARTICLE

Thoracic Vertebral Hemangioma with Spinal Cord Compression: Multidisciplinary Surgical Treatment and Follow-up of Six Patients

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Objective: To provide useful insights of multidisciplinary surgical treatment for vertebral hemangioma with spinal cord compression.

Methods: From 2009 to 2014, data on six patients who were diagnosed with cord compression vertebral hemangioma were reviewed and analyzed retrospectively. There were five women and one man with a mean age of 48.6 years (range, 26–68 years). All the patients were treated by multidisciplinary approach, including use of gelfoam, pedicle screw instrumentation, vertebroplasty, and decompression laminectomy. Neurological status and Frankel grades were documented, CT scan and MRI were performed after surgery.

Results: The follow-up period ranged from 8 to 54 months. Mean blood loss was around 367 mL, and the mean surgical time was 2.30 h. All patients had uneventful intraoperative and postoperative courses and reported symptomatic and neurological relief to varying degrees, at an average follow-up period of 23 months. Bone cement distribution was disseminated homogeneously over the affected vertebra and no leakage was observed. All the patients had a complete restoration to Frankel grade E. The postoperative and follow-up imaging showed that the implant was in perfect position, and no recurrence occurred in all patients.

Conclusion: The vertebral hemangioma with cord compression is a challenge to surgeons for therapeutic improvement, and an active involvement of several disciplines as well as performance of multidisciplinary surgical treatment can be crucial in achieving favorable results.

Key words: Hemangioma; Spinal cord compression; Spine; Surgical procedure

Introduction

Vertebral hemangiomas are the most common benign spinal neoplasm, often located in the thoracic and lumbar spine, with a peak incidence of occurrence in the fourth to sixth decades. They are most frequent vertebral tumors, found in 10%–12% of autopsy series^{1,2}. According to the clinical manifestations, spinal hemangiomas are divided into three categories: asymptomatic vertebral hemangiomas, painful vertebral hemangiomas, and compressive spinal hemangiomas³. They can typically remain asymptomatic

throughout life, or symptoms can develop (in approximately 1% of cases), causing local or radicular pain, neurologic deficits, or a combination of both. Hemangiomas affect the vertebral body more often compared with the posterior elements.

Spinal cord or nerve root compression may be due to epidural tumor extension, expanded bone, hematoma, a compression fracture, or anomalous vessels. Cord compression is often progressive but may also occur suddenly in some cases⁴. Multiple options are available for the

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management of symptomatic lesions, including radiotherapy, resection and spinal stabilization, decompressive laminectomy and vertebroplasty, kyphoplasty, transarterial embolization, and intralesional alcohol injection, with each bringing their own advantages and disadvantages⁵⁻¹¹. However, an open surgical approach is the procedure of choice for compressive spinal hemangioma, as the hypervascularity of the lesion can trigger serious complications during surgery, such as profuse bleeding or consumptive coagulopathy^{12,13}.

The objective of this multidisciplinary technique was to: (i) reduce bleeding during surgery; (ii) to stabilize the affected vertebra; (iii) to decompress the spinal cord; and (iv) to minimize the complications during the entire surgical procedure.

Patients and Methods

Patient Information

From July 2009 to April 2014, six patients were treated by multidisciplinary surgery, which included use of gelfoam mixed with contrast medium (omnipaque), pedicle screw fixation, vertebroplasty, and decompressive laminectomy for a total of six thoracic vertebrae affected with vertebral hemangioma. There were five female patients and one male patient, with a mean age of 48.6 years (range, 26–68 years) and a mean follow-up of 23 months (range, 8–54 months). The main symptoms were mild to moderate back pain, tingling sensation, numbness, and weakness of lower limbs¹⁴. Physical examination showed percussion pain in the spinous processes, and neurological examination showed Babinski's sign to be positive in two patients, whereas all patients' sensations decreased below the level of lesion involvement (Table 1). This study was performed with the approval of the local ethics committee.

Imaging Study and Examination

Preoperative investigation included detailed history, thorough clinical examination, and radiographic evaluation consisting of plain X-rays, computed tomography (CT) and magnetic resonance imaging (MRI). The responsible vertebra

was determined according to the imaging studies and physical examination. Preoperative MRI and CT scans demonstrated the characteristic pattern of spinal cord compression to some degree as a result of vascular hemangiomas in all patients. Plain radiographs showed a typical "jail house" or "corduroy cloth" appearance and axial CT scans the typical "polka dot" patterns in all cases. Histological findings for all six patients were helpful to distinguish the type of hemangioma where three were capillary vascular hemangioma and three were cavernous vascular hemangioma.

Surgical Technique

Surgery was intervened under general anesthesia. Patients were placed in the prone position and the body was supported by pads underneath the chest; thus, the pelvis and abdomen were suspended. Under the guidance of C-arm (X-ray scan), the incision site was marked above the affected vertebra. During the surgery all patients were under keen observation through monitors maintaining the arterial blood pressure and oxygen saturation to normal except for one patient (Table 2; Patient 2). This patient was under medication for high blood pressure and was also recorded before the surgery measuring to 210/100 mm Hg, which was managed and maintained during the surgery by an anesthetist.

An adequate amount of gelfoam was scraped into small pieces and was mixed with 20 mL of contrast medium and kept aside. Incisions were marked; henceforth the surgical site was exposed and visualized. Pedicle screws were fixed above and below the affected vertebra before any other surgical procedures were undertaken, after which the gelfoam was injected to the site of the affected vertebral body with a 20-mL syringe (or 18-G needle) through both the pedicles until a back pressure was felt on the fingers and no more gelfoam could be injected (Fig. 1). The leakage of the contrast medium was observed via C-arm X-ray machine. The bone cement paste was prepared for the vertebroplasty, which was always performed under fluoroscopic guidance, with slow and careful injection using a thoracic puncture needle. The amount of bone cement injected varied among each individual, depending on the lesion that had to be treated. Approximately 3–4.5 mL of bone cement was injected. It was sufficient to fill up the lesion and the entire vertebral body without any sign of leakage (Fig. 2). A bipedicular approach for hemangioma of the thoracic vertebra was performed in all six patients. After injecting bone cement, decompressive laminectomy was performed to decompress the spinal cord (Fig. 3). Intraoperative biopsies were taken for histological findings in all cases.

Follow-up and Evaluation

A CT scan was performed within a week after surgery and was repeated after 6 months in all six patients. An MRI was also performed after 6 months in all patients, and after 12 months in five patients. Neurological status was documented upon presentation, during the hospitalization period, and during outpatient visits. The Frankel grade system was

TABLE 1 Preoperative and postoperative Frankel Grade Function of all patients

Preoperation	Number of cases	Postoperation				
		A	B	C	D	E
A	1	-	-	-	-	1
B	0	-	-	-	-	0
C	4	-	-	-	-	4
D	1	-	-	-	-	1
E	0	-	-	-	-	0
Total	6	-	-	-	-	6

No patient in this postoperative Frankel Grade.

Fig. 1 Diagrammatic description of the process of application of gelfoam. (A) Preparation of several pieces of gelfoams and a scalpel. (B) Peeling the gelfoams into small pieces with the scalpel. (C) Mixing the pieces of gelfoams with contrast medium (omnipaque). (D) Injecting the mixture into the vertebral body through syringe.

Fig. 2 A 31-year-old female patient was diagnosed as having T₆ whole vertebral hemangioma. (A) Axial computed tomography (CT) image shows typical polka dot appearance of T₆ vertebral hemangioma. (B, C) CT of chest shows T₆ whole vertebral hemangioma (vertebral body + pedicle + lamina), involving the right side of the rib head, the right side of erector spinae. (D) Sagittal CT image shows the destruction of whole vertebra. (E) X-ray after 1 year shows the bone cement in perfect position without any reoccurrence of the disease. (F) Sagittal CT shows higher density of T₆ vertebral with bone cement. (G) Twelve months after operation, T₂-weighted magnetic resonance imaging demonstrates complete resolution of the soft-tissue hemangioma in the spinal canal.

applied to classify all the patients' conditions preoperatively and postoperatively (Table 1). Each patient was assessed, as outpatients, by means of subjective perception and functional status.

Results

General Results

The epidemiological summary of pathology, management, and outcomes are presented in Table 2. All patients went through the same surgical procedure. Blood loss was approximately 200–600 mL, with a mean value of around 367 mL, which was much less than expected. The mean surgical time was 2.30 h (range, 1.30–3.30 h). After surgery, six patients improved from Frankel grade A, C, or D to Frankel grade E.

Clinical Improvement

All patients experienced immediate relief from pain and neurological symptoms, and five patients were discharged on the fifth postoperative day. One patient who had undergone surgery for bilateral lower limb paraplegia was discharged within 1 week after the procedure. All patients recovered sufficiently to return to their previous activities. At final follow-up, all patients were relieved from pain and had no neurological deficit.

Radiographic Improvement

All patients successfully underwent surgery for the decompression of spinal cord compression, and we could not find any residual tumor after decompressive laminectomy. The postoperative imaging showed the filling obtained have been complete and well distributed. The preoperative imaging of all patients did not show any metastasis of the tumor and postoperative imaging showed no reoccurrences of the tumor. The postoperative and follow-up imaging showed that the implant was in perfect position.

Complications

The clinical course in all six patients was uneventful and no operative complications were identified. No cement leakage was documented.

Follow-up

The follow-up period ranged from 8 to 54 months. Patients were free from pain and neurological symptoms, had experienced significant improvement in terms of functional status, had returned to their prior level of activity, and reported minimal or no residual pain in daily activities. The follow-up imaging showed no reoccurrence of the tumor in all patients (Fig. 4).

Fig. 3 Diagrammatic description of decompression of spinal cord compression. (A) Soft tissue tumor (hemangioma) compresses the spinal cord (red arrows), and trabeculae are thick and fewer in number in affected vertebra (green arrow) in comparison with normal vertebra (blue arrow). (B) Gelfoam is injected through both pedicles (black arrow) in vertebral body. Tumor compresses the cord anteriorly and posteriorly (red arrows). (C) Bone cement is injected after insertion of gelfoam and well distributed all over vertebral body (yellow arrow). The tumor is decreased in size as compared to diagram B (red arrows). (D) No evidence of cord compression is detected after injecting bone cement and laminectomy.

Discussion

Vertebral hemangioma is a benign and usually self-involuting tumor of the blood vessels. The trabeculae in the affected vertebra are thick and fewer in number in comparison with normal vertebrae, and filled with soft tissue tumor¹⁵. This type of tumor is usually noted accidentally when radiographs are being evaluated for other conditions, and rarely due to spinal cord compression, which can alter the neurological functions of the patients^{15,16}. Spinal cord compression can be decompressed by surgery, but the risk of bleeding is high in managing hemangioma, which makes the surgery challenging because it is difficult to visualize the surgical field.

Multidisciplinary surgical treatment (MST) is the combination of several surgical procedures where a sole procedure fails to achieve the ultimate result for the whole process. Here we have introduced several procedures: (i) gelfoam used to minimize bleeding during surgery; (ii) pedicle screw instrumentation and vertebroplasty to stabilize the affected vertebra, and; (iii) laminectomy to decompress the spinal cord because of hemangioma.

The main aim of this technique was to lower the risk of bleeding and to minimize complications during the surgical procedure. Even though in the literature bleeding during surgery has been identified as a major concern for spinal

TABLE 2 The epidemiological summary of pathology, management, and outcomes

Case	Age/ gender	Presentation/ symptoms	Level and type	Neurology	Degree of involvement	Other problems	Bone cement (mL)	Intraoperation bleeding (mL)	Follow- up (months)	Recent follow-up
1.	31/F	Bilateral lower limbs numbness and tingling sensation	T ₆ capillary vascular hemangioma	Sensation ↓ at T ₇ and below	Total vertebra involvement with right head of rib and erector spine muscle	None	4.5	500	20	Asymptomatic/ complete resolution
2.	44/M	Bilateral lower limbs paraplegia	T ₈ capillary vascular hemangioma	Cold sensation below T ₈	Total involvement of the vertebra	Acromegaly, hypertension	4.0	600	26	Asymptomatic/ complete resolution
3.	63/F	Bilateral lower limbs numbness and weakness	T ₆ cavernous vascular hemangioma	Sensation ↓ at T ₆ and below	Total involvement of the vertebrae	None	3.5	200	18	Asymptomatic/ complete resolution
4.	26/F	Bilateral lower limbs numbness and weakness	T ₃ capillary vascular hemangioma	Babinski's sign +; Patellar clonus +	Total involvement of the vertebra body, thecal sac compression	Mayer-Rokitansky- Küster-Hauser syndrome or Müllerian agenesis	3.0	300	54	Asymptomatic/ complete resolution
5.	68/F	Feeling of heaviness left leg > right leg	T ₈ cavernous vascular hemangioma	Sensation ↓ at T ₈ and below	Total involvement of the vertebra	None	3.5	350	12	Asymptomatic/ complete resolution
6.	62/F	Bilateral lower tingling sensation and weakness	T ₉ cavernous vascular hemangioma	Babinski's sign +; Sensation ↓ at T ₉ and below	Total involvement of the vertebrae	Deaf-mute since age of 2 (fever of unknown origin)	4.5	250	8	Asymptomatic/ complete resolution

Fig. 4 A 26-year-old female patient was diagnosed as having T₃ whole vertebral hemangioma. (A) Axial computed tomography (CT) scan shows the “polka-dot” pattern of the hemangioma in T₃ vertebral body created by the vertical coarse bony trabeculae. (B) Axial magnetic resonance imaging shows ballooning of the posterior vertebral body wall and tumor, causing significant compression of the thecal sac. (C, D) High signal of the T₃ vertebral body is seen in the T₁ and T₂ weighted image. (E, F) X-ray 24 months after surgery demonstrates that the height of T₃ vertebral body was maintained and the location of pedicle screw is perfect. (G) Axial CT scan shows T₃ vertebral body is filled with polymethylmethacrylate and there is no tumor recurrence.

hemangioma, few studies have considered the use of gelfoam in surgery. Gelfoam can minimize bleeding effectively and helps with the visualization of the surgical field for further procedures. Surgical time was less than expected in the surgeries reviewed in the present study, without any complications during or after surgery. In our series, all patients experienced a complete remission of vertebral pain within 48–72 h of treatment, without any complications. During surgery, while injecting gelfoam and bone cement to the vertebral body through bilateral pedicles, the extensive tumor was removed in the form of blood loss; therefore, no mass was felt afterwards. Our technique of using gelfoam to minimize bleeding during surgery might not be new but is especially useful for this surgery. During the whole surgical procedure, we found that the blood loss was minimal. This helped the surgery to remain uneventful and complication-free (during the intraoperative and postoperative surgery).

A Gelfoam Sterile Compressed Sponge is a medical device intended for application on bleeding surfaces, as a hemostatic. The sponge can be implanted during surgery and can be completely absorbed within 4–6 weeks. It has hemostatic properties, although its mode of action is not fully understood. Its effect appears to be more physical than the result of altering the blood clotting mechanism. When used in less excessive amounts, gelfoam can be absorbed completely, with little tissue reaction. This absorption is dependent on several factors, including the amount used, degree of saturation with blood or other fluids, and the site

of use. It is capable of absorbing whole blood up to 45 times its weight. Gelfoam embolization of venous channels before cement injection has not been widely used as a technique to prevent leakage. However, routine gelfoam embolization has been shown to be a safe and feasible method during vertebroplasty¹⁷.

We used pedicle screw fixation with a connecting rod to stabilize the affected vertebra. Pedicle screw instrumentations were placed above and below the affected vertebra. Implant instrumentation for vertebral hemangioma during decompressive laminectomy and vertebroplasty has been found to be promising for the stability of the affected vertebra.

Vertebroplasty involves injection of polymethylmethacrylate (PMMA) cement into diseased vertebral bodies to stabilize the vertebral body. Leakage is one of the most common complications, with risk of spinal cord compression. The key to this technique of vertebroplasty is to fill the vertebral lesion completely with PMMA cement to cause an irreversible hardening of the hemangiomatous vessels, thus obtaining an antalgic effect and vertebral stabilization. The injection of cement must be done slowly and carefully. Once cement leakage is detected, the operator should adjust the needle direction or stop the injection immediately. The dose of bone cement depends on the size of the lesion¹⁸. Castel *et al.* found that laminectomy and instrumentation as a sole procedure may fail to relieve the back pain, but when combined with vertebroplasty it can be more

effective¹⁹. Relief of spinal cord compression has been recorded after intralesional injection of ethanol²⁰. However, serious complications have also been encountered after treatment by alcohol injection, including a case report of Brown-Sequard syndrome and pathological fractures caused by osteonecrosis, which has been noted in 21%–29% of patients^{11,20–22}. Percutaneous procedures are described in very few articles for spinal cord compression and the rate of complication is high. Therefore, an open procedure is beneficial for both surgeons and patients during and after surgery²³.

All bone cements and gelfoams on the market fulfill the basic requirements for an orthopedic implant, but there are differences in their properties in terms of different powders, liquids and sponge compositions; therefore, it is up to the surgeon to choose an appropriate material to obtain the optimal result for the patient. MST can improve the quality of life and physical activity of patients with symptomatic and neurological deficits. Most of the pain can be relieved significantly, which reduces the demand for analgesics.

Our study has several limitations as only a small number of patients were studied. Suggesting an ideal management

plan is difficult when the sample size is small. Despite the growing number of articles in the literature discussing the ideal approach for cord compression caused by vertebral hemangiomas, no consensus has yet been reached regarding the optimal management of these lesions. Symptomatic vertebral hemangiomas are rare and cord compressive hemangiomas are even rarer; henceforth, improving the management process and outcomes even in a single patient are important. In the present study, we managed six patients with cord compressive hemangioma and the prognosis to date has been uneventful. However, management recommendations based on a larger group of patients is necessary for future development regarding the treatment of hemangiomas with cord compression.

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