Intra-Operative Vertebroplasty Combined with Posterior Cord Decompression

A Report of Twelve Cases

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Key words: intra-operative vertebroplasty, embolization, laminectomy, PMMA, fluoroscopy

Summary

Percutaneous vertebroplasty (VP) is a minimally invasive technique for the treatment of vertebral pathology providing early vertebral stabilization and pain relief. In cases of vertebral pathology complicated by spinal cord compression with associated neurological deficits, VP alone cannot be performed free of risks. We describe a combined approach in which decompressive laminectomy and intra-operative vertebroplasty (IVP) are performed during a single session. Among the 252 VP performed in our centre in the past three years, 12 patients (12 vertebral levels) with different pathologies (six symptomatic haemangiomas, two metastatic fractures, four osteoporotic fractures) were treated with an open procedure combined with surgery. All cases were treated with decompressive laminectomy and IVP (mono/bipeduncular or median-posterior trans-somatic access). Five patients with symptomatic haemangiomas were treated with endovascular embolization prior to the combined approach. A visual analogue scale (VAS) was applied to assess pain intensity before and after surgery. The neurological deficits were evaluated with an ASIA impairment scale. In all cases benefit from pain and neurological deficits was observed. The mean VAS score decreased from 7.8 to 2.5 after surgery. The ASIA score improved in all cases (five cases from D to E and five cases from C to D). No clinical complications were observed. In one case a CT scan performed after the procedure showed a foraminal accumulation of PMMA, but the patient referred no symptoms. IVP can be successfully ap-

plied in different pathologies affecting the vertebrae. In our limited series this approach proved safe and efficient to provide decompression of spinal cord and dural sac and vertebral body stabilization in a single session.

Introduction

Percutaneous vertebroplasty (VP), first described for the treatment of symptomatic haemangiomas in 1987¹, is now a commonly used technique for the treatment of several pathologic conditions affecting the vertebrae. The application is relatively simple and minimally invasive, consisting in a percutaneous access for the injection of polymethylmethacrylate (PMMA) directly into the vertebral body mostly through the pedicles². This technique yields good results in terms of early vertebral stabilization and prompt pain relief³⁻⁷ in different pathological entities such as symptomatic haemangiomas, tumours (metastasis, multiple myeloma, lymphoma) and painful osteoporotic vertebral fractures. However, some cases of vertebral pathology may result in spinal cord compression and nerve root involvement, caused either by the presence of a pathologic process invading the epidural space or by a stenotic or reduced spinal canal, leading to neurological deficits. In such cases and also when the loss of vertebral height is greater than 75%^{8,9}, VP alone cannot be performed free of risks. The pre-treatment situation needs to be thoroughly evaluated to avoid the occurrence of complications such as cement leakage, po-

Figure 1 A) Sagittal T2 showing a D5 e D6 metastasis from carcinoma of the thyroid. B) Axial T2 shows spinal cord compression. C) Pre-operative axial CT scan.

tentially causing compressive myelopathy, and pulmonary embolism⁸⁻¹⁰ which can also lead to severe sequelae.

At present, the treatment of choice for medullary decompression is represented by surgery (associated with radiotherapy in case of metastatic disease)¹¹. A surgical approach restores the mechanical integrity of the affected spinal cord tract by decompression of the spinal canal and eventual posterior stabilization of the spine. However, surgery alone entails a number of complications, especially when dealing with elderly, debilitated patients and with difficult instrumental fixation due to osteoporosis¹².

The association of a surgical approach with intra-operative vertebroplasty (IVP) can be a beneficial combination. During the same session, this approach allows spinal cord decompression with laminectomy and tissue debulk-

ing (in case of pathologic process involving the epidural space) and pain relief and vertebral body stabilization, eventually associated with posterior segmental fixation when necessary to achieve post-operative mechanical stability of the spine^{13,14}.

This article reports our experience in the application of this single session technique for the treatment of symptomatic haemangiomas, metastatic fractures and osteoporotic fractures in a series of ten consecutive patients.

Materials and Methods

Among the 252 percutaneous vertebroplasty procedures performed in our centre in the past three years, 12 were done in association with surgery in patients presenting with different

Figure 2 Fluoroscopic antero-posterior images showing the giant haemangioma before (A) and after pre-operative embolization (B).

Figure 3 A) Axial T1 fat-sat post-contrast image at the level of D4. B) Coronal T1 post-contrast image shows strong enhancement of a bulky mass (giant haemangioma) occupying the spinal canal with compression and dislocation of the spinal cord (black arrow) and extending through the neural foramen to the left hemithorax.

Figure 4 Intra-operative fluoroscopic image after PMMA injection into the vertebral body. The surgical devices partially reduce operator visibility.

Figure 5 Post-operative CT scan at the level of D2 showing regular distribution of the cement into the vertebral body.

Figure 6 Post-operative T2 showing D5-D6 spinal cord posterior decompression and D6 metastasis treated by intra-operative vertebroplasty.

vertebral pathologies (metastatic fractures, symptomatic vertebral haemangiomas and osteoporotic fractures) associated with spinal cord compression and/or radicular deficits.

There were six symptomatic vertebral hemangiomas, two vertebral metastases (Figure 1A-C) and four osteoporotic fractures. Patients' ages varied from 29 to 69 years (mean age 57.6). The female to male ratio was 5 to 7.

All patients were investigated preoperatively with CT and MRI (T1-weighted, T2-weighted and STIR sequences were obtained in axial and sagittal planes). Both imaging techniques allowed the assessment of the integrity of the posterior vertebral wall, the morphology of the pathologic vertebral body, the potential presence of bone oedema in osteoporotic fractures and the degree of epidural involvement in metastatic disease and symptomatic haemangiomas. All patients presented with symptoms referable to dorsal cord compression (with a variety of complaints depending on the affected level) and/or cauda equina syndrome or with compressive myelopathy on MR findings. Patients mostly complained of paraparesis and/or sensitivity disturbances; two patients presented with neurological bowel and bladder disturbances.

Preoperative endovascular embolization of the feeding vessels was performed in four of the six patients presenting with symptomatic haemangiomas, in order to minimize the risk of

haemorrhage when removing the epidural fraction of the haemangioma during decompression. The embolization procedure consisted of coaxial catheterization of the feeding intercostal or lumbar arteries with a microcatheter (distal diameter 2.3 F) followed by the injection of polyvinyl alcohol (PVA) particles of 150-350 micron, until devascularization was achieved (Figure 2A,B).

Among the four patients who underwent embolization, one presented with an invasive dorsal haemangioma with a bulky mass extending to the left hemithorax, which was excised during a left thoracotomy before proceeding with laminectomy (Figure 3A,B).

All patients, placed in a prone position for the posterior approach and under general anaesthesia, underwent decompressive laminectomy, followed by removal of the epidural pathologic process, when necessary. In the same operative session IVP was performed under fluoroscopic control (with a digital fluoroscopic C-arm unit). (Figures 4 and 5)

A 13 Gauge trocar needle was used to access the vertebral body through different routes. Either mono/bilateral transpedicular or monolateral posterior trans-somatic approaches were applied. Different approaches were applied as follows: one case via a median posterior trans-somatic access (single needle approach), three cases via a monopedicular access (Figure 6), eight cases via a bipedicular access. In all cases 3.5 to 7 ml of PMMA were injected into the vertebral body. The treated levels ranged from T4 to L4. In two patients two vertebrae were treated at once. None of the procedures was performed on the cervical tract. In six cases (four with osteoporotic fractures and two with vertebral haemangioma) a third surgical phase was also performed consisting in the placement of posterior instrumentation for segmental fixation of the spine.

To assess spinal cord or radicular deficits each patient was rated by means of the ASIA classification. To assess pain intensity a visual analogue scale (VAS) score was applied. These evaluations were made on all patients preoperatively and post-operatively.

Results

The details of each patient who underwent IVP (age, sex, treated level/s, type of disease affecting the vertebrae, pre- and post-operative scores, need for posterior fixation or for pre-

operative embolization or other pre-operative surgical treatment) are summarized in Table 1. All 12 patients referred a marked improvement of symptoms compared to the pre-surgical situation. In all cases benefit from both pain and neurological deficits was observed. According to the VAS score the pain intensity was reduced after surgery in all patients; the mean score decreased post-operatively from 7.8 to 2.5. In all patients who presented with neurological deficits before surgery, the ASIA rating assessment indicated an improvement of symptoms; in half of the patients the neurological deficits completely resolved after surgery. No clinical complications were observed. In one case a short follow-up CT scan showed a left foraminal accumulation of PMMA, but the patient referred no symptoms. The two patients with metastatic fractures underwent adjuvant radiotherapy after surgery.

Mean follow-up time was 33.8 months (range 12-53 months). One patient, treated with IVP for a metastatic fracture from a poorly differentiated primary tumour of the rhinopharynx, followed by adjuvant radiotherapy, died three months after the procedure from primary disease evolution. During follow-up all patients underwent clinical assessment, which revealed either stability or improvement of the post-operative results.

Discussion

Percutaneous vertebroplasty (VP) is a well-established technique in the treatment of several conditions affecting the vertebrae and has become a standard treatment in cases of vertebral osteoporotic and metastatic fractures, as well as in some vertebral symptomatic haemangiomas. However, when medullary compression is present, VP itself could be responsible for worsening the compressive symptoms, due to the potential occurrence of PMMA leakage or posterior bony displacement.

In 1999 Wenger and Markwalder¹⁵ first described the application of a surgically controlled VP in a series of nine patients with vertebral compression fractures. The choice of applying this open approach was made after they experienced the occurrence of posterior leakage of PMMA into the spinal canal in one patient requiring immediate conversion of percutaneous VP into an open surgical approach.

In our experience, we considered applying

Table 1 Summary of all patients who underwent intra-operative vertebroplasty.

PZ	Age, Sex	Type of Lesion	Level	Osteo-synthesis	Other	Approach	VAS pre	VAS post	ASIA pre	ASIA post	mBI pre	mBI post	mBI FU	Complications
1	66, M	Haemangioma	T4	No	Embolization, Left thoracotomy	Monoped Dx	7.3	0	D	E	100	100	100	no
2	61, M	Metastatic (rhinopharynx)	L3	No	/	Trans-somatic	8.2	3	D	E	97	100	n.a.	no
3	29, F	Haemangioma	T4, T10	No	Embolization T4	Bipeduncular	9.4	2.2	C	D	/	/	/	no
4	54, F	Osteoporotic	L4	Yes	/	Bipeduncular	7.4	4.3	D	E	100	100	100	no
5	59, F	Osteoporotic	T11	Yes	/	Bipeduncular	7.3	1	C	D	80	92	95	Yes, left foramen
6	60, F	Osteoporotic	L4	Yes	/	Monoped Sn	7	4.1	D	E	100	100	100	no
7	45, M	Metastatic (thyroid)	T6	No	/	Monoped Dx	7.5	4.6	C	D	70	83	89	no
8	66, M	Haemangioma	T6	No	Embolization	Bipeduncular	6.8	2.2	C	D	60	85	/	no
9	69, F	Haemangioma	T6	No	/	Bipeduncular	5	1	D	E	/	/	/	no
10	65, M	Osteoporotic	T12, L1	Yes	/	Bipeduncular	8	1.2	D	E	95	100	77 (hip)	no
11	60, M	Haemangioma	L2	Yes	Embolization	Bipeduncular	9	4	E	E	100	100	100	no
12	57, M	Haemangioma	D9	Yes	/	Bipeduncular	8	3	E	E	100	100	100	no

intra-operative VP (IVP) for vertebral body stabilization and pain relief in all patients with compressive myelopathy listed for decompressive laminectomy, in order to minimize the risk of increasing the mass effect upon the dural sac and worsening the neurological deficits. The IVP technique enables the operator to have a direct visualization of the spinal canal with a better control of the potential complications, allowing prompt removal of potential cement leaks and, in the meantime, allowing the surgical removal of contingent masses invading the spinal canal.

The type of access for the injection of PMMA into the vertebral body during IVP (trans-pedicular or trans-somatic) can be tailored case by case. In our series, the choice for the best approach was based on different parameters: size and integrity of the pedicles, vertebral level and subsequent possibility to laterally displace the dural sac, which is more easily moved at the lumbar level. We performed cement injection via a median posterior trans-somatic approach in one patient with a metastatic fracture of L3 (originating from a non-differentiated tumour of the rhinopharynx). We preferred the trans-pedicular route in all other patients because in most cases the affected vertebra was at a higher level and the dural sac was not easily displaceable.

Boszczyk et al.¹⁶ described the injection of cement into the vertebral body directly through the posterior wall in 34 vertebrae of 24 patients during the application of a microsurgical approach in osteoporotic burst fractures with neurological involvement. The operator appears to be more confident with a trans-somatic access because the cement diffusion into the vertebral body is more easily controlled, while a trans-pedicular access might appear slightly more difficult also considering that

fluoroscopic images are potentially disturbed by the presence of surgical tools. However, a trans-pedicular approach during IVP makes the operator confident by directly palpating the pedicle and allowing a safe access of the needle.

Some authors have described a two-session approach consisting in cement injection with percutaneous VP or kyphoplasty (KP) followed by a surgical approach or vice versa. Guelbenzu et al.¹⁷ treated one case of vertebral haemangioma causing compression of the spinal cord at T10 level by means of percutaneous VP with subsequent bilateral laminectomy to achieve spinal cord decompression. No complications were observed and the patient's symptoms resolved. Gaitanis et al.¹⁸ more recently described the application of KP in 32 patients with vertebral compression fractures secondary to osteoporosis and to metastatic lesions in which the percutaneous approach was followed by a decompressive laminectomy. Chakrabarti et al.¹⁹ described the application of percutaneous VP in two patients who had previously undergone surgical decompression and posterior stabilization, with successful results despite the presence of the posterior instrumentation in the fluoroscopic images. In our series, the choice of a single session approach in patients with mass effect upon the thecal sac was made most of all, as already stressed, to reduce the risk of worsening the compression, but also for the comfort of patients.

In our opinion, there are limitations to be considered in this open surgical approach. Firstly IVP, compared to traditional VP, can be limited by the presence of surgical tools which reduce the field of view and thus the visibility of the needles on digital fluoroscopic images. In the second place, the C-arm fluoroscopic unit has a limited manoeuvrability in the operating room. These limitations should always be con-

sidered by the operator when performing IVP. However, they become of secondary importance in comparison with the potential risk of complications when performing traditional VP in patients with thecal sac compression.

We have described the application of IVP in a limited number of patients (with different pathologies of the vertebrae), which does not allow us to draw definite conclusions on this technique. Nevertheless we speculate that IVP, in cases of dural sac compression, is safe and feasible in different pathologies affecting the vertebrae without the need to modify the approach according to the type of disease.

The complementary use of surgery and cement injection in a single session yields efficacious treatment of symptoms and restoration of the mechanical integrity of the spine at once, in the setting of a reduced risk of complications, besides being beneficial for the patient's comfort.

Conclusions

We described 12 consecutive cases of patients treated with IVP. In all cases IVP in association with posterior laminectomy allowed adequate cord decompression with prompt pain relief and stabilization of the vertebral body after injection of PMMA, reducing the risk of complications. We did not experience complications in our series, apart from a small asymptomatic cement leakage in a neural foramen. The relatively small number of patients and the variety of diseases affecting the treated vertebrae do not allow us to draw explicit conclusions, but we speculate that in carefully selected cases of vertebral pathology complicated by spinal cord compression, the application of IVP is feasible, safe and reproducible.

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