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Original Article

Minimizing blood loss with direct percutaneous polymethylmethacrylate embolization before corpectomy for vascular spinal tumors

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ABSTRACT

Background: Standard surgical treatment for vascular spinal tumors, including renal cell carcinomas and hemangiomas, may result in significant blood loss despite preoperative arterial tumor embolization.

Methods: This is a retrospective review of 12 patients who underwent direct percutaneous polymethylmethacrylate embolization (DPPE) with or without feeding artery embolization before partial or complete corpectomy for the resection of vascular spinal tumors (2013–2018). Estimated blood loss (EBL) was compared to the blood loss reported in the literature and to patients receiving standard arterial embolization before surgery.

Results: The mean EBL for 12 patients was 1030 mL; three of 12 patients required blood transfusions. For the single level corpectomies, the EBL ranged from 100 mL to 3900 mL (mean 640 mL). This mean blood loss was not increased in patients receiving only DPPE preoperatively versus those patients receiving preoperative arterial embolization in addition to DPPE (1005 vs. 1416 mL); in fact, the EBL was significantly reduced for those undergoing DPPE alone.

Conclusion: In this initial study, nine patients treated with DPPE embolization alone before spinal tumor resection demonstrated reduction of intraoperative blood loss compared to three patients having arterial embolization with DDPE.

Keywords: Corpectomy, Direct percutaneous embolization, Intraoperative blood loss, Polymethyl methacrylate, Vascular spinal tumors

INTRODUCTION

The surgical resection of hypervascular spinal tumors poses significant challenges due to the risk of substantial intraoperative blood loss. Typically, these lesions are treated preoperatively with super-selective angiography and embolization that includes the selective blocking of specific blood vessels feeding the tumor and reducing the risk of intraoperative hemorrhage.

Nevertheless, these cases still usually involve an average 2.1 L, blood loss.[1-6] Here, we treated 12 patients with direct percutaneous polymethylmethacrylate embolization (DPPE) injections into tumor sites, thus attempting to occlude the tumor's blood supply and minimize intraoperative bleeding.

MATERIALS AND METHODS

In this Institutional Review Board approved study, we retrospectively reviewed the outcomes for 12 patients (2013–2018) undergoing DPPE performed by neurosurgeons with or without additional arterial embolization (i.e., Using Polyvinyl Alcohol –and/or coils). Of note, one additional patient was removed from the study due to an intraoperative vascular injury to the iliac vein. We treated 12 patients averaging 64.8 years of age, all of whom underwent preoperative DPPE before corpectomies for spinal tumors (i.e., nine renal cell carcinoma metastases to the spine, one spinal hemangioma, one metastatic spinal hepatocellular carcinoma, and one metastasis from follicular thyroid cancer). There were eight eight thoracic lesions, three lumbar lesions, and one cervical lesion. There were seven patients with single level vertebral involvement, one with two levels, three with three levels, and one with more than three levels involved [Figure 1]. Of interest, 10 of 12 patients underwent a single level corpectomy [Figure 2].

RESULTS

Treatment with DDPE with/without arterial embolization and number of vertebral levels involved

Surgery included 10 posterior or combined posterior and lateral approaches for corpectomy and two anterior approach surgeries. Three out of 12 patients received preoperative arterial embolization, plus DPPE, while nine had DDPE alone Treatment included one vertebral level in nine patients and two levels in three [Figure 3]. The volume of cement injected during DPPE ranged from 2 cc to 10 cc.

Timing of DDPE

The timing of DPPE injections varied from the day of surgery to 2 days preoperatively (i.e., average of 1 day). The average intraoperative blood loss was 1030 mL (range 100–3900 mL). Blood transfusions, averaging 4 units (packed red blood cells), were necessitated in three patients. The average blood loss in single-level cases was 640 cc, significantly lower than the 3450 mL noted in multilevel corpectomies. Notably, patients receiving preoperative arterial embolization plus DPPE exhibited an average blood loss of 1416 cc, significantly greater than the 1005 cc seen in patients only receiving DPPE preoperatively [Tables 1 and 2].

Table 1: Characteristics of patients.

Patient characteristics	*n* (%)
Age (years)	
Mean	64.8
Range	50–78
Tumor type	
RCC	9 (75)
Hemangioma	1 (8.3)
Hepatocellular carcinoma	1 (8.3)
Follicular thyroid carcinoma	1 (8.3)
Tumor location	
Cervical	1 (8.3)
Thoracic	8 (66.7)
Lumbar	3 (25)
Extent of disease	
Single level	7 (58.3)
Multilevel	5 (41.7)
Prior SRS/XRT	
Yes	4 (33)
No	8 (67)
Preoperative arterial embolization	
Yes	3 (25)
No	9 (75)
Levels with DPPE	
Single level	9 (75)
Multilevel	3 (25)
Surgical approach	
Anterior	2 (17)
Posterior/Lateral	10 (83)
Corpectomy	
Single Level	10 (83)
Multilevel	2 (17)

RCC: Renal cell carcinoma, DPPE: Direct percutaneous polymethylmethacrylate embolization, *n*: Number, SRS: Stereotactic radiosurgery, XRT: External radiation therapy

Table 2: Patient variables relating to embolization procedure and blood loss.

Patient variables	# of patients
Antiplatelet/anticoagulation	
None	9
Antiplatelet therapy	2
Antiplatelet+anticoagulation	1
Time from embolization to surgery	
0 days	1
1 day	10
2 days	1
Amount of cement (mL)	
Range	2–10
Estimated blood loss (mL)	
Mean	1030
Range	100–3900
Number of units of packed red blood cells transfused	
0	8
2	2
4	1
8	1

DISCUSSION

To combat extensive bleeding risk in cases of hypervascular spinal tumor resection, preoperative transarterial embolization using various embolic materials has been utilized (i.e., including detachable coils and injectable embolic agents) [Table 3].[1] Prabhu *et al.* reported a decrease in estimated blood loss (EBL) from 7 L to 8 L without preoperative embolization to 1–3 L postembolization.[7] Numerous other studies show a 30–50% of reduction in EBL post intra-arterial embolization. While transarterial spinal tumor embolization is a relatively safe procedure with generally low reported complication rates of 2–4%, it does carry the significant risks; spinal cord ischemia, along with transient weakness/swelling causing compression of neural elements, aortic dissection, stroke, and skin and muscle necrosis in cases where distal segmental arteries are extensively embolized.[8] In our study, we documented the superiority of DPPE embolization alone (nine patients; average EBL 1005 mL) versus percutaneous preoperative embolization plus DPPE in treating vascular spinal lesions (three patients: average 1416 ML EBL). Although DPPE alone appeared to provide an effective method of preoperative embolization for patients with vascular spinal lesions, this is a very small and extremely preliminary series.

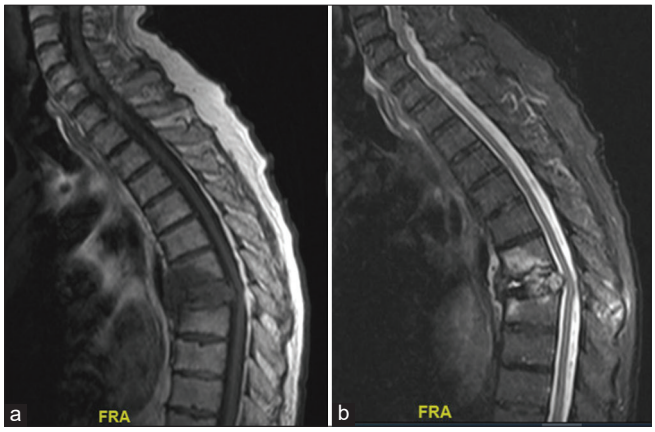

Figure 1: (a) Sagittal magnetic resonance imaging (MRI) thoracic spine with contrast showing metastatic lesion at T7 without enhancement. (b) Sagittal MRI thoracic spine with short tau inversion recovery sequence showing hyperintensity at the affected level, suggesting edema and acute fracture. FRA: Front.

Table 3: Summary of studies on preoperative embolization before spinal tumor surgery.

Study	Year	Type of study	Number of Patients	Intervention	Results
Wilson *et al.*[8]	2018	Retrospective	100	Embolization with PVA	Complete embolization was associated with decreased mean EBL compared to partial embolization (1945 vs. 2319), though not statistically significant.
Awad *et al.*[1]	2016	Retrospective Case Series	37	Direct arterial embolization	Spinal tumor embolization with>90% reduction in tumor blush had significantly reduced blood loss.
Chen *et al.*[3]	2013	Meta-analysis	760	Spinal surgery without preoperative embolization	Spinal tumor surgery is associated with significant blood, estimated at 2180 mL (95% CI 1805–2554)
Prabhu *et al.*[7]	2003	Retrospective	51	Embolization with PVA	More completely embolized lesions bled less during surgery, without statistical significance. No control group.
Manke *et al.*[5]	2001	Retrospective case series	17	Preoperative embolization with PVA versus no preoperative embolization	Patients with embolization had a median EBL of 1500 mL, compared with a medial of 5000 mL in those patients who did undergo embolization.
Breslau and Eskridge[2]	1995	Retrospective case series	14	Embolization with PVA	All patients had technically successful procedures with no complication, with mean EBL of 1.6 L
Olerud *et al.*[6]	1993	Retrospective case series	21	Embolization with PVA, gelatin, or particles versus no embolization.	Average blood loss during posterior spinal tumor surgery for patients after embolization was one-third of blood loss for those without embolization.
Gellad *et al.*[4]	1990	Retrospective case series	23	Preoperative embolization with PVA or coils versus surgery without embolization	Preoperative embolization led to reduced EBL, on average of 1850 mL versus 3500 mL in those with no embolization

PVA: Polyvinyl alcohol, EBL: Estimated blood loss, L: Liter, mL: Milliliter, CI: Confidence interval

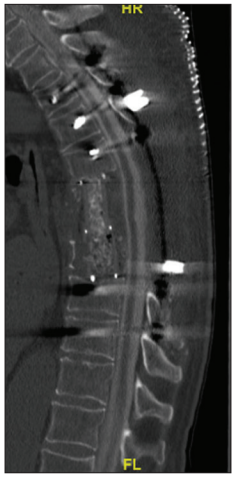

Figure 2: Postoperative computed tomography status post T6–8 corpectomy and T3–10 pedicle screw instrumentation. FL: Lower.

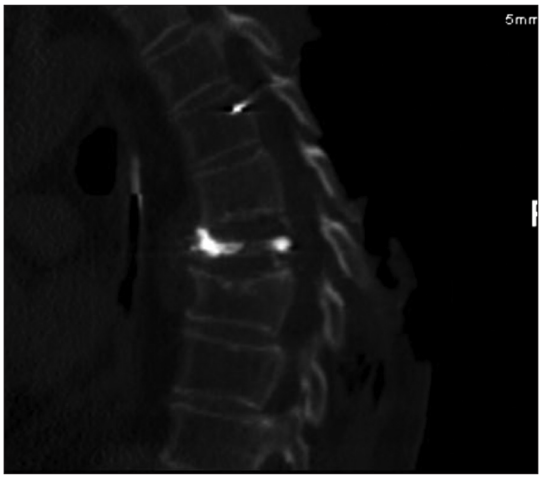

Figure 3: Sagittal computed tomography images of the thoracic spine status post T7 vertebroplasty.

CONCLUSION

In this preliminary case series, nine patients with DDPE alone had significantly reduced intraoperative blood loss compared with those receiving both arterial embolization and DDPE.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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