Clinical Neurology and Neurosurgery 115 (2013) 2457–2463

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Preoperative spinal tumor embolization: An institutional experience with Onyx

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ARTICLE INFO

Article history:
Received 9 July 2013
Received in revised form 5 September 2013
Accepted 29 September 2013
Available online 12 October 2013

Keywords:
Onyx
Endovascular
Spine tumor
Preoperative adjunct
Epidural metastasis

ABSTRACT

Background: Preoperative embolization has the potential to decrease intraoperative blood loss and facilitate spinal cord decompression and tumor resection.
Objective: We report our institutional experience with the embolization of hypervascular extradural spinal tumors with Onyx as well as earlier embolic agents in a series of 28 patients.
Methods: A retrospective case review was conducted on patients undergoing preoperative transarterial embolization of a spinal tumor between 1995 and 2012 at our institution.
Results: Twenty-eight patients met the inclusion criteria, with a mean age of 60.6 years. Twenty-eight patients had metastatic tumors. In 14 (50%) patients the metastases were from renal cell carcinomas. Fifty-four vessels were embolized using PVA, NBCA, Onyx, coils, or embospheres. Sixteen patients were treated with Onyx, 6 patients with PVA, 3 patients with embospheres, 2 patients with NBCA, and 3 patients with a combination of embolic agents. The average decrease in tumor blush was 97.8% with Onyx versus 92.7% with the rest of the embolic agents ($p = 0.08$). The estimated blood loss was 1616 ml (range 350–5000 ml). Blood loss was 750 cm^3 on average with Onyx versus 1844 with the rest of the embolic agents ($p = 0.14$). The mean length of stay was 16 days. The mortality rate was zero. Pre- and post-operative modified Rankin Score (mRS) did not differ significantly in the series (3.12 versus 3.10, respectively, $p = 0.9$).
Conclusion: In our experience, the use of transarterial tumor embolization as an adjunct for spinal surgery is a safe and feasible option.

1. Introduction

It is estimated that as many as 10% of cancer patients develop spinal metastases during the course of their disease [1]. The goal of surgical treatment of symptomatic metastatic lesions is to improve the quality of life, preserve neurological function, achieve mechanical spinal stability, and in some cases provide diagnostic tissue for further treatment. Surgery in patients with hypervascular spinal tumors (primary or metastatic) can be complicated by significant intraoperative bleeding. Preoperative embolization has the potential to decrease intraoperative blood loss and facilitate spinal cord decompression and tumor resection [2–10]. A variety of liquid embolic agents have been utilized for presurgical tumor embolization, most frequently polyvinyl alcohol (PVA). More recently, Onyx has emerged as a highly efficient agent for treatment of intracranial and spinal arteriovenous malformations and fistulas [11]. Its use for embolization of spinal tumors, however, has been very limited. In this study, we report our institutional experience with the embolization of hypervascular extradural spinal tumors with several embolic agents in a series of 28 patients. We highlight the safe and effective use of Onyx for spinal tumor embolization.

2. Methods

Institutional review board approval was obtained prior to data collection. A retrospective case review was conducted on consecutive patients who underwent preoperative transarterial embolization of a spinal tumor between 1995 and 2012 at our institution. Patients with intradural tumors were excluded from the study. Patients were selected for pre-operative embolization

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http://dx.doi.org/10.1016/j.clineuro.2013.09.033

based on preoperative consensus of the senior spine surgeons for findings considered high-risk for intraoperative hemorrhage: known tumor histology (renal cell carcinoma, thyroid, melanoma) or pre-operative MRI findings of hypervascularity (flow voids, bright contrast enhancement, intratumoral hemorrhage). Aggressive hemangiomas treated operatively for neurological deficits were also included given the high risk for catastrophic intraoperative blood loss. All of the hypervascular tumors defined above were then evaluated angiographically for further diagnostic purposes or, potential embolization.

2.1. Angiographic technique

All procedures were performed through the transfemoral route under general anesthesia and somatosensory evoked monitoring. Patients were heparinized and activated clotting time was maintained at 2 times the patient's baseline intraoperatively. The angiographic technique has been described previously [12]. A 6 French groin sheath is introduced into the femoral artery, followed by a H1H spinal catheter or a Cobra 2 catheter (Cordis Corp., Bridgewater, NJ). Aortography is undertaken and selective bilateral catheterization of the corresponding segmental arteries (including 2 levels above and below the lesion) is performed. Spinal cord supply, tumor feeding pedicles, and the presence of normal en passage vessels are carefully evaluated. Depending on the conformation and origin of the feeder artery, various preshaped 5F catheters are selected for superselective catheterization including SL10 (Boston Scientific, Natick, MA), echelon 10 (EV3, Plymouth, MN) and marathon EV3 (EV3, Plymouth, MN).

2.2. Embolization technique

Through a superselectively introduced microcatheter, a direct infusion of polyvinyl alcohol (PVA), n-butyl cyanoacrylate (NBCA), embospheres, or Onyx was performed into the branch supplying the tumor. Flow control techniques were often utilized with PVA to make particles flow preferentially into the feeding branches of the tumors, rather than normal tissue. A repeat angiogram was obtained immediately after embolization in all cases to verify the changes in tumor blood flow.

Multiple formulations of Onyx are available in the United States for clinical use. In this study, the low-viscosity agent, Onyx 18, was utilized for most spinal embolizations as it allows for better penetration of the tumor vasculature. Onyx-18 is composed of 6% ethylene vinyl alcohol copolymer and 94% DMSO [13]. The feeding artery was superselectively catheterized with an Echelon 10 (EV3 Endovascular, Inc., Plymouth, MN) microcatheter or Marathon Catheter, as stated above. The microcatheter was then flushed with normal saline, followed by dimethylsulfoxide (DMSO). Next, Onyx was injected until adequate penetration of the tumor was achieved (Fig. 1). A percent obliteration of the tumor blush was obtained from each operative report dictated, as well as preoperative and postoperative percent change of angiographic nidus blush.

2.3. Spinal surgery

Surgical interventions in all cases were performed within 24 h, typically, on the day following the embolization. The goals of surgery were spinal cord decompression, tissue diagnosis, and restoration of spinal alignment and stability. This was performed most commonly through the posterior approach, or alternatively through anterior or combined anterior–posterior approaches. Intra-operative blood loss was estimated by the anesthesiologist.

2.4. Complications

Procedural complications were defined as an adverse event prolonging hospital stay, or readmission within 60 days for a reason felt by the senior authors to be attributed to procedural technique. This data was collected via a retrospective analysis of electronic medical records and were defined as retroperitoneal hematoma, femoral arterial pseudoaneurysm, stroke, myocardial infarction, pulmonary embolism, ileus, arterial dissection, and bleeding at the site of puncture. Additionally, all other complications not attributed to endovascular embolization, such as those due to the morbidity of metastatic disease and decompression spinal fusion surgery were recorded, as well as the hospital length of stay.

Intraoperative blood loss was pulled from anesthesiologist records. Final pathologist reports were pulled from electronic records. Data on contrast usage, type and volume of embolization material, the number of embolized segmental vessels were recorded from intraoperative surgeon reports. Lastly, the percent obliteration as estimated by decrease in the tumor blush as observed by the endovascular neurosurgeon was reported from operative notes.

Specific patient data mentioned above on the use of Onyx embolysate was then compared directly to patients who had been treated with earlier embolization materials.

2.5. Follow-up

Patient follow-up data was evaluated from electronic medical records. The most recent follow-up visit within 90 days of admission was evaluated for neurologic improvement and functional status.

2.6. Statistical analysis

Statistical analysis was undertaken for the treatment groups via a software package (JMP statistical software, edition 9,

Table 1
Baseline patient characteristics.

Patient	Age	Gender	Metastasis	Cell type
1	53	F	Y	Nasopharyngeal CA
2	59	F	Y	Carcinoma, indet.
3	60	F	Y	Thyroid CA
4	57	F	Y	Renal cell CA
5	49	F	Y	Plasmacytoma
6	80	M	Y	Hemangioblastoma
7	41	M	Y	Renal cell CA
8	55	M	Y	Renal cell CA
9	71	M	Y	Renal cell CA
10	68	M	Y	NSCLC
11	65	M	Y	NSCLC
12	68	F	Y	Renal cell CA
13	64	F	Y	Thyroid CA
14	67	F	Y	Renal cell CA
15	83	F	Y	Renal cell CA
16	70	M	Y	Carcinoma, indet.
17	48	F	Y	Carcinoma, indet.
18	58	F	Y	Hemangiopericytoma
19	40	M	Y	Paraganglioma
20	66	F	Y	Renal cell CA
21	52	F	Y	Carcinoma, indet.
22	71	F	Y	Carcinoma, indet.
23	42	M	Y	Renal cell CA
24	70	M	Y	Renal cell CA
25	54	M	Y	Renal cell CA
26	60	M	Y	Renal cell CA
27	64	M	Y	Renal cell CA
28	65	M	Y	Renal cell CA