Preoperative Embolization of Spinal Tumors: A Systematic Review and Meta-Analysis

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Key words
- Embolization
- Meta-analysis
- Spine
- Systematic review
- Tumor

Abbreviations and Acronyms
CI: Confidence interval
EBL: Estimated blood loss
PVA: Polyvinyl alcohol
RCC: Renal cell carcinoma
RCT: Randomized control trial

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BACKGROUND: **Spinal tumors are referred for preoperative embolization to minimize intraoperative blood loss and facilitate surgical resection.**

OBJECTIVE: **To perform a systematic review and meta-analysis and provide comprehensive data on embolization technique, efficacy, and complications.**

METHODS: **A systematic review of PubMed articles was performed with the following inclusion criteria: original studies, studies of ≥10 patients (except Onyx because of the scarcity of available data), embolization through vascular access, and reporting of the embolic agent used. In addition, the manuscript needed to contain at least 1 of the following variables: demographics, tumor type, location, vascularity, degree of devascularization, complications, time to operation, type of operation, estimated blood loss (EBL), and use of blood transfusion.**

RESULTS: **Thirty-seven studies with a total of 1305 patients met inclusion criteria. Renal cell carcinoma was the most commonly embolized tumor, comprising 47.4% (95% confidence interval [95% CI] 39.4–55.4) of all tumor embolizations. The rate of complete devascularization for all tumor types was 68.3% (95% CI 60.0–76.6). There was a significant decrease in operative EBL in more recently published studies compared with earlier studies; however, the rate of complete embolization remained stable. Polyvinyl alcohol and Onyx were associated with similar EBL and rates of complete embolization. The overall complication rate was 3.1% (95% CI 1.2–4.9).**

CONCLUSIONS: **The rapid evolution of neurointervention and spinal tumor embolization has made scientific inquiry and definitive conclusion on the safety and efficacy of the practice difficult. The data supporting the procedure are fragmented and largely based on a multitude of retrospective studies that use varying techniques. Review of the available literature support embolization of spinal tumors as a safe and efficacious treatment adjunct before surgery.**

INTRODUCTION

Resection of hypervascular primary or metastatic spinal tumors can be complicated by excessive blood loss, making safe operative resection technically challenging.[1] Preoperative embolization of such tumors has been shown to reduce intraoperative blood loss and allow for a more complete resection.[2] Embolization of spinal tumors has evolved over the last 25 years. Whereas gelatin products have been used for neurovascular embolization for almost half a century, the advent of embolic agents such as polyvinyl alcohol (PVA) particles, n-butyle-2-cyanoacrylate, and most recently Onyx (ev3 Endovascular, Inc., Plymouth, Minnesota, USA) has augmented the repertoire available to the neurointerventionalist.[3] The rapid evolution of neurointervention and spinal tumor embolization has made scientific inquiry and definitive conclusions on the safety and efficacy of the practice difficult. The data supporting the procedure are fragmented and largely based on a multitude of retrospective studies that use varying techniques. The aim of this study was to systematically evaluate the current body of literature in an effort to define optimal technique, efficacy, and complication rates of preoperative embolization of spinal tumors.

METHODS

A PubMed search through March of 2015 was performed using the terms "preoperative," "embolization," "spinal," and "tumor." Only manuscripts written in English were considered. The citations of identified articles were reviewed, and additional manuscripts were included when inclusion criteria were fulfilled. Four reviewers (C.J.G., M.S., P.H., P.F.) independently assessed the quality of the studies and applied the following inclusion criteria: original studies, studies of a total of 10 or more patients (except Onyx because of the scarcity of available data), embolization through vascular access rather than direct puncture, and reporting of the embolic agent used. Data quality was assessed as follows: Class 1, high-quality randomized control trials (RCTs);

Table 1. Included Studies

Author, year	No. Patients	Age, years: Mean	Age, years: Range	Metastatic Tumors: RCC (%)	Metastatic Tumors: Thyroid (%)	Primary Spine Tumors (%)	Location: Cervical (%)	Location: Thoracic (%)	Location: Lumbar (%)	Location: Sacral (%)	Embolic Agents	Tumor Vascularity: High (Grade III) (%)	Tumor Vascularity: Moderate (Grade I, II) (%)	Complete Embolization (≥80% Reduction in Tumor Blush) (%)	No. Complications: Permanent	No. Complications: Transient/Asymptomatic	Provocative Testing	Interval Embolization to Surgery	Surgery: Corpectomy ± Posterior Decompression/Fusion	Surgery: Posterior Decompression/Fusion Only	Mean EBL, mL	PRBC Transfusion: No. Operations (%)	PRBC Transfusion: Mean PRBC Units
Gellard et al., 1990[6,*]	23	NR	25–74	73.9	8.7	0.0	NR	NR	NR	NR	PVA, GS, coils	NR	NR	80	0	0	NR	1–5 days	18	4	2962	NR	NR
Sundaresan et al., 1990[7]	15	NR	NR	100.0	0.0	0.0	NR	NR	NR	NR	PVA, 95% ethyl alcohol	NR	NR	73.3	0	3	NR	2–4 days	15	0	2200	NR	NR
Olerud et al., 1993[8]	10	61.2	49–75	100.0	0.0	0.0	0.0	40.0	60.0	0.0	PVA, GS	NR	NR	NR	0	1	NR	NR	6	4	4450	NR	NR
Breslau et al., 1995[9]	14	49.6	16–70	50.0	7.1	28.6	14.3	35.7	50.0	0.0	PVA	NR	NR	NR	0	0	1	NR	14	0	NR	NR	NR
Smith et al., 1995[10]	20	50	18–73	70.0	5.0	10.0	10.0	45.0	40.0	5.0	PVA, GS, coils, collagen	NR	N	NR	0	1	1	0–1 day	NR	NR	2320	81.5	5
Vetter et al., 1997[11,†]	38	57	5–70	0.0	21.1	26.3	100.0	0.0	0.0	0.0	PVA, GS, coils	NR	NR	75	2	1	1	1 d	36	0	2400	NR	NR
Hess et al., 1997[12]	17	64.4	55–82	76.5	11.8	0.0	0.0	52.9	47.1	0.0	PVA, coils	NR	NR	88.2	0	0	NR	0–2 days	8	9	2088	NR	NR
Berkefeld et al., 1999[13]	59	NR	NR	45.8	8.5	23.7	NR	NR	NR	NR	PVA, GS, coils	86.4	13.6	81.4	0	1	0	1 day	59	0	2195	NR	4.5
Shi et al., 1999[14]	18	42	16–62	11.1	0.0	77.8	27.8	33.3	38.9	0.0	PVA	NR	NR	44.4	0	0	0	NR	NR	NR	1100	NR	NR
Manke et al., 2001[2,‡]	17	64	47–78	100.0	0.0	0.0	17.6	52.9	29.4	0.0	PVA	NR	NR	58.8	0	0	1	0–2 days	NR	NR	1878	NR	NR
Nader et al., 2002[1]	10	60.5	39–77	20.0	0.0	70.0	0.0	40.0	60.0	0.0	PVA, GS, coils	NR	NR	90	0	0	NR	0–13 days	10	0	2840	NR	NR
Shi et al., 2002[15]	16	41	16–62	12.5	0.0	75.0	6.3	50.0	43.8	0.0	PVA, GS, dextran	NR	NR	31.2	0	0	NR	<10 days	NR	NR	1510	NR	NR
Prabhu et al., 2003[16,†]	51	57.1	NR	58.8	5.9	0.0	9.8	64.7	25.5	0.0	PVA,GS, coils, NBCA	77.8	22.2	83.7	0	2	1	1–8 days	51	0	2586	NR	NR
Guzman et al., 2005[17]	24	69.9	21–80	58.3	16.7	0.0	16.7	41.7	29.2	12.5	PVA, coils	62.5	37.5	91.7	0	0	NR	0–14 days	15	9	1900	NR	NR
Wirbel et al., 2005[18]	20	NR	NR	NR	NR	NR	0.0	NR	NR	0.0	PVA, coils	NR	NR	95	0	2	NR	1 day	20	0	1650	NR	3.1
Gore et al., 2008[19]	4	45.8	36–60	25.0	25.0	50.0	25.0	25.0	50.0	0.0	Onyx, coils, NBCA	NR	NR	NR	0	0	0	1 day (mean)	NR	NR	NR	NR	NR

RCC, renal cell carcinoma; EBL, estimated blood loss; PRBC, packed red blood cells; NR, nor reported; PVA, polyvinyl alcohol; GS, gelatin products (gelatin sponge particles; gelatin microspheres); NBCA, *n*-butyle-2-cyanoacrylate; NOS, not otherwise specified.

*A total of 22 tumors were embolized in 23 patients with 26 tumors.

†A total of 2 patients were not embolized.

‡A total of 20 tumors were embolized in 17 patients.

§A total of 65 tumors were embolized in 58 patients.

||A total of 2 operations were performed in 1 patient.

Continues