



Safety and outcomes of preoperative embolization of intracranial hemangioblastomas: A systematic review



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ABSTRACT

Introduction: While preoperative embolization is often reserved for large and highly vascular tumors in order to minimize blood loss, its safety and efficacy in the treatment of hemangioblastomas (HB) is unclear. We present the largest systematic review focusing on the safety and outcome of preoperative embolization of intracranial HB.

Materials and methods: To identify all cases of preoperative embolization for HB, a literature search was conducted via Medline (OVID and PubMed), Scopus, Embase, and Web of Science. Studies that were in English, included intracranial hemangioblastomas treated with preoperative embolization and provided sufficient disaggregated clinical data for each patient were included. Historical control patients with non-embolized intracranial HB undergoing resection were similarly identified.

Results: A total of 111 patients that underwent preoperative embolization of HB prior to planned resection were identified. Patient age ranged from 12 to 72 years, with a cohort of 63% males and 36% females. Nine studies comprising 392 non-embolized patients were included as controls. Gross total resection was achieved in 83.7% of embolized and 95.6% of non-embolized patients. Intraoperative blood transfusion was required in 15.3% of embolized and 0.51% of non-embolized controls, while rates of post-operative hemorrhage were 8.4% and 1.6%, respectively. Complication rates from embolization were 11.7% and following consequent surgery were 20.7%.

Discussion: Embolization did not increase rates of gross total resection, decrease estimated blood loss, or decrease incidence of complications. Not only does embolization fail to mitigate surgical risks, the embolization procedure itself carries significant risk for complications. Embolization should not be standard of care for intracranial HB.

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1. Introduction

Hemangioblastomas (HB) are benign, highly vascular tumors that comprise up to 2.5% of CNS neoplasms [1]. Common locations for these lesions include the cerebellum (44–72%), brainstem (1–6%), and spinal cord (13–44%) [2]. Most lesions arise sporadically, although nearly one-third of patients with these tumors have von Hippel-Lindau disease (VHL) [2]. There is a strong association of spinal cord HB with VHL, but lesions that arise in the cerebellum are more often sporadic [3]. The optimal treatment for

symptomatic HB is surgical resection, while radiotherapy may be reserved for patients that are not surgical candidates. In cases of large, highly vascular tumors, surgical resection may be challenging due to a risk of high intraoperative blood loss. For these select tumors, preoperative embolization is sometimes employed. The goal of feeding vessel embolization prior to surgery is to minimize intraoperative blood loss, thereby increasing the likelihood of a safe and maximal surgical resection. Materials utilized for embolization include non-absorbable particulate agents, liquid embolic agents, and embolic coils (Table 1). In HB, the most common materials reported in the literature include PVA, Onyx, and n-BCA. Indications for preoperative tumor embolization have been outlined by guidelines proposed by the Society for Neurointerventional Surgery (Table 2) [4]. Additional criteria include large tumors (>3 cm) with well-defined arterial feeders that are not accessible surgically [5,6].

While there are numerous studies that focus on the preoperative embolization of intracranial HB, nearly all studies are either

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Table 1
Classification of Embolization agents.

Category	Agents
Non-absorbable particulate agents	<ul style="list-style-type: none">– Polyvinyl alcohol particles (Cook Medical, Bloomington, IN)– Trisacryl gelatin microspheres (Embospheres, BioSphere Medical, Inc, Rockland, ME)– Hydrogel microsphere w/polymer coating (Embozene; CeloNova BioSciences, Inc, Newnan, GA)
Absorbable particulate agents	<ul style="list-style-type: none">– Absorbable bioprosthetic gelatin sponge (Gelfoam, Pfizer, New York, NY)
Liquid embolic agents	<ul style="list-style-type: none">– Ethylene vinyl alcohol (EVOH) copolymer (Onyx: eV3 Endovascular Inc, Irvine, CA) <i>n</i>-butyl cyanoacrylate (<i>n</i>-BCA: Trufill; Codman Neurovascular, Inc, Raynham, MA)

Table 2
Guidelines for preoperative embolization per Society for Neurointerventional Surgery².

Indications for pre-operative tumor embolization
1 To control surgically inaccessible arterial feeders
2 To decrease surgical morbidity by reducing blood loss
3 To shorten the operative procedure time
4 To increase the chances of complete surgical resection
5 To decrease the risk of damage to adjacent normal tissue
6 To relieve intractable pain
7 To decrease expected tumor recurrence
8 To allow better visualization of the surgical field with decreased overall surgical complication

case reports or small retrospective series without comparison of outcomes to non-embolized controls. Published experience with embolization of these rare tumors is therefore limited, and its role in the standard of care remains unclear. Here, we report the largest systematic review on this topic to date to elucidate the efficacy, safety, and outcomes of preoperative embolization for HB, and to compare the outcomes to non-embolized historical controls.

2. Methods

2.1. Literature search

Two researchers (LA, WC) performed independent literature searches of Medline (OVID and Pubmed), Scopus, Embase, and Web of Science utilizing the search terms “hemangioblastoma” AND “embolization” to identify all cases of intracranial HB that underwent preoperative embolization. The search was limited to English language literature. No publication date limitation was imposed on the study. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were applied to this review. The protocol for this systematic review was not registered. Exclusion criteria included studies that did not embolize preoperatively, did not mention the embolization agent used, or did not have sufficient outcomes for embolized cases. Only intracra-

Table 3
Summary of patients with embolized and non-embolized hemangioblastomas undergoing surgical resection.

	Embolized	Non-embolized Controls
Total		
Studies	23	9
Patients	111	392
Sex		
Males	70	192
Females	40	162
Age (years)	12–72 (range)	38.8 (mean)
Mean Tumor size		
Diameter (cm)	1.9–4.5	1.7–4.1
Volume (cm ³)	n/a	0.9–2.4
Tumor location		
Cerebellum	83.8%	57.9%
Brainstem	13.5%	41.1%
Other	2.7%	1.0%

nial lesions were considered. Spinal and orbital HB were excluded. Tumors associated with aneurysms were also excluded.

To identify historical controls comprising patients with intracranial HB, a Pubmed search of English language literature utilizing the search terms “hemangioblastoma”, “surgery,” and “cranial” was performed. Only studies comprising patients undergoing resection of intracranial HB without prior embolization were included. Studies comprising fewer than 20 patients or lacking adequate information on postoperative outcomes or follow up were excluded.

2.2. Data collection and analysis

Key data was collected, including patient demographics, tumor features, VHL status, solid vs cystic components, times from embolization to surgery, extent of resection (EOR), estimated blood loss (EBL), embolic agents used, morbidity, and mortality. Cases were disaggregated when possible and analyzed within the context of historical controls comprising studies of surgery alone for intracranial HB. Patient demographics and tumor characteristics were compared between the two treatment arms. Outcomes evaluated between embolized and non-embolized patients included EOR, EBL, rates of hemorrhage and hematoma, and postoperative morbidity and mortality. Only mortality related to either the embolization procedure or operative complications was included within the analysis.

3. Results

3.1. Demographics

Review of the literature for studies of HB with preoperative embolization revealed a total of 23 studies consisting of 11 large cohort retrospective studies and 12 case reports. (Tables 3 and 4) From these studies, 111 patients that underwent preoperative embolization of HB prior to planned resection were identified. Patient ages ranged from 12 to 72 years. The cohort consisted of 70 males (63%) and 40 females (36%). Gender for one patient was not reported [7].

For historical controls, 9 studies met inclusion criteria. (Tables 3 and 5) There were a total of 392 patients that did not undergo preoperative embolization of HB prior to planned resection. Of studies reporting gender, there were 192 males (54.2%) and 162 (45.7%) females. Mean age was 38.8 years.

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