Diagnostic and Interventional Imaging (2017) **98**, 307—314

ORIGINAL ARTICLE /*Neuroradiology*

Preoperative embolization of meningiomas with polyvinyl alcohol particles: The benefits are not outweighed by risks

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KEYWORDS
Meningiomas;
Arterial embolization;
Polyvinyl alcohol particles;
Cerebral angiography;
Preoperative embolization

Abstract
Purpose: The purpose of this study was to define the feasibility, the efficacy and the safety of preoperative embolization (POE) of meningiomas using polyvinyl alcohol (PVA) particles.
Materials and methods: Between January 2006 and June 2014, 191 consecutive patients were referred to our institution for the treatment of meningiomas; of these 57 patients were excluded from the study. A total of 64 patients (22 men and 42 women) with a mean age of 58.4 ± 10.8 [SD] years (range: 14—82 years) who underwent POE with PVA particles, achieving extensive (> 90%) devascularization were ultimately included and compared to 70 patients who had surgery without POE. Surgical time and intraoperative blood loss were compared between the two groups. The duration of procedures and complications related to POE were analyzed.
Results: No differences were found between the two groups with respect to intraoperative blood loss. A significant reduction in surgical time was observed for the group who had POE (207.4 ± 79.5 [SD] min vs. 226.9 ± 117.6 [SD] min; $P = 0.028$). In a subgroup analysis, the size and location of meningiomas did not influence these results. The duration of procedures was

Abbreviations: POE, preoperative embolization; PVA, polyvinyl alcohol.

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http://dx.doi.org/10.1016/j.diii.2016.08.006

41.4 ± 10.5 [SD] min. Minor complications related to POE occurred in 3 out of 64 patients (4.7%).
Conclusion: POE of meningiomas using PVA particles is effective in reducing surgical time, when extensive tumor devascularization is achieved. However, radiation exposure, the duration of procedures and complications related to POE with PVA particles do not justify this technique in most patients.

Meningiomas are the most common benign intracranial neoplasms, accounting for 13—26% of all primary intracranial tumors [1]. In the United States, the incidence rate of meningiomas is 7.86 per 100,000 person-years and they are more than twice as common in women as compared to men [2]. Surgical excision of the tumor and its dural base is the treatment of choice for symptomatic meningiomas, allowing optimal opportunity for long-term remission [1].

Over the last four decades, preoperative embolization (POE) of these highly vascularized neoplasms has emerged as a potential adjunct to surgery. Since the first procedure described by Manelfe et al. [3], there has been a remarkable improvement in the technique employed, particularly regarding the development of microcatheters and embolic materials, together with the growing experience of operators.

Potential advantages of POE include reduced intraoperative blood loss, decreased surgical time and increased likelihood of complete resection [4]. To date, various materials, including particles, liquids and metallic coils, have been employed for the embolization of meningiomas. However, the actual advantages and indications of this procedure still remain unclear [5].

The purpose of this study was to define the feasibility, the efficacy and the safety of POE of meningiomas using PVA particles.

Materials and methods

Between January 2006 and June 2014, 191 consecutive patients (129 females; age, 57.3 ± 9.6 years) were referred to our institution, for the treatment of intracranial meningiomas. The decision whether or not to embolize the tumors was taken within a multidisciplinary environment, including neurosurgeons and interventional neuroradiologists, through a risk—benefit assessment. POE was taken into consideration if, basing on the location, size and vascularization of meningiomas, significant intraoperative bleeding was expected. POE was not considered in 28 patients with meningiomas located at the convexity, of a relatively small size (< 2 cm) and poor contrast enhancement on MRI, considered to be easily managed by surgery alone. Detailed data on the enrolment and exclusion of patients from the study are provided in Fig. 1.

Institutional local review board approval was obtained. All patients provided their informed consent for participation in the study and for performing all the required diagnostic and therapeutic procedures. Patients were assigned to one of the two groups (performing POE or directly submitted to surgery) following a simple randomization method. Each patient was attributed a consecutive number from a list of random numbers, ranging from 0 to 1, generated by the Excel 2007 software (Microsoft, Redmond, WA, USA). Patients associated with numbers < 0.5 were submitted to direct surgery, the rest to POE.

For each patient, an experienced neuroradiologist, not involved in the endovascular procedures, estimated the extent of tumor devascularization following embolization, by comparing, the pre- and post-embolization angiographies. Devascularization was classified as complete or extensive, when more than 90% disappearance of the tumor stain was observed. In 14 patients, only partial (< 90%) devascularization was achieved. Finally, 64 patients (42 females, age 58.4 ± 10.8 years), achieving extensive preoperative devascularization of meningiomas, were compared with 70 patients directly submitted to surgery. The same neurosurgical team, with 20 years of experience in tumor surgery, performed the resection of meningiomas.

Demographic information and tumor characteristics, such as location, size, main vascular supply, histology and World Health Organization (WHO) grade, were recorded. Surgical time, intraoperative blood loss, quantified as the number of blood units (either autologous or homologous) transfused during or in the same day of surgery, and the difference in hemoglobin levels between the preoperative and first postoperative blood count, were compared between the two groups. The duration of procedures and complications related to POE were also taken into account.

Embolization procedure

An experienced interventional neuroradiologist performed all the procedures by using a flat-panel digital subtraction angiographer (Philips Integris Allura Xper FD20). Intravenous heparin was not administered. Diagnostic angiography was performed through the transfemoral route, in order to establish the main vascular supply of meningiomas and to select the appropriate vessels for embolization. A microcatheter system was placed in the feeding vessels, as close as possible to the tumor.

Transcatheter embolization was subsequently performed under fluoroscopic guidance, injecting PVA particles (Contour, Boston Scientific, Natick, Massachusetts) 150—250 μm in diameter, suspended in iodinated contrast agent Iomeprol (Iomeron®, 300 mgI/mL, Bracco, Milan,