Preoperative embolization to reduce morbidity and mortality in hypervascular mediastinal tumor surgery

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ÖZ
Amaç: Bu çalışmada hipervasküler mediastinal tümör cerrahisinde morbidite ve mortaliteyi azaltmak için ameliyat öncesi embolizasyon uygulamalarının etkinliği ve güvenliği değerlendirildi.


Sonuç: Çalışmamız, özellikle aşırı vasküler yapılı büyük çaplı tümör rezeksiyonlarında, ameliyat sırasında kanama kontrolünü sağlamak amacıyla ameliyat öncesi embolizasyonun önemi ve gerekliliğini göstermektedir. Çalışma sonuçlarımız da göre, morbidite ve mortalitenin azaltılması için hipervasküler mediastinal tümör ameliyatlarından önce girişimsel embolizasyonun uygulanması önermektedir.

An'ahtar sözcükler: Castleman hastalığı; mediastinal tümör; paraganglioma; preoperative embolization.

ABSTRACT

Background: This study aims to describe the preoperative embolization procedures to reduce morbidity and mortality in hypervascular mediastinal tumor surgery and to evaluate the efficacy and safety of these procedures.

Methods: Between January 2008 and December 2014, nine patients (5 males, 4 females; mean age 37 years; range 17 to 48 years) with mediastinal tumors underwent preoperative embolization of the feeding arteries before surgery. All patients received a combination of polyvinyl alcohol particles (300-1200 μm) with coils. The criterion for the embolization effectiveness was to reduce intraoperative hemorrhage.

Results: In eight patients, embolization was successfully completed without any complication. The feeding vessels of each tumor were occluded. No symptomatic complications related to embolization were observed. Tumors were totally removed in eight patients. Embolization clearly reduced the severity of bleeding during surgery, lowered the surgical risks due to blood loss, and reduced the difficulty of tumor resections. No intra- or postoperative complication was seen.

Conclusion: Our study highlights the importance and essence of preoperative embolization to control bleeding during surgery, particularly in large-size tumor resections with an excessive vascular nature. Based on our study results, we suggest interventional embolization as a prerequisite before hypervascular mediastinal tumor surgery to reduce morbidity and mortality.

Keywords: Castleman disease; mediastinal tumor; paraganglioma; preoperative embolization.
Mediastinal tumors tend to develop in different types, sizes, and locations with an unknown etiology in most of the cases. Patients do not experience any noticeable symptoms, until the tumor grows and starts pressuring on other organs and, consequently, the symptoms become noticeably for the patient. These tumors should be treated in a timely manner, as they may grow in a larger size and may carry a high risk for the patient. Large thoracic mediastinal tumors have a rich blood supply derived from multiple arteries.\(^1\)

Embolization is used for several purposes including to decrease the tumor size before excisional surgery, to allow surgery by reducing intraoperative hemorrhage, to manage acute hemorrhage, and for palliative care and tumor reduction.\(^2\) Embolization of large hypervascular mediastinal tumors is considered critical in tumor resection, as it mainly decreases blood loss during surgery, provides a clearer operative field for the surgeon, and reduces the associated morbidities.\(^3,4\)

In the present study, we present our experience of preoperative embolization in patients with mediastinal tumors with an excessive vascular nature and to evaluate the efficacy and safety of the embolization procedures.

**PATIENTS AND METHODS**

Between January 2008 and December 2014, a total of 120 patients underwent mediastinal tumor resections in our clinic. Of these patients, nine (5 males, 4 females; mean age 37 years; range 17 to 48 years) received preoperative tumor embolization to control the main feeding arteries. Four patients had an uncompleted surgical resection due to massive bleeding prior to their arrival to our clinic for re-evaluation. In two patients, thoracic computed tomography (CT) images showed large vessel branches. Three patients have a large mediastinal tumor indicating a high risk for an excessive vascular nature.

All patients underwent routine biochemical tests, radiographs, pulmonary function tests, and CT. Based on the CT scans, angiography was carried out to identify the rich vascularization of the tumors in each case. Tumor vascularization on the arterial angiogram

![Figure 1](image-url)
was defined as moderate for three patients and as extensive for six patients. Multiple feeding vessel embolization procedures under local anesthesia in a single session were performed. All catheterizations were performed via a transfemoral approach by the Seldinger technique. A 6F to 8F catheters were used. The suspected feeding arteries were delineated and followed by super selective catheterization one by one. Various particle embolization agents (Contour embolization particles, Boston Scientific, Natick, MA, USA; Embosphere, Biosphere Medical, France; Embozone, San Antonio, TX, USA) with a diameter ranging from 300 to 1200 μm were injected using an appropriate contrast medium mixture. Embolization started with small-sized particles and followed by larger-sized ones to occlude capillary bed and feeding arteries. After complete occlusion was achieved, one or more 0.018-inch fibered platinum microcoils (Vortex, Boston Scientific, France; Tornado, Cook Inc., Bloomington, IN) were deployed at the proximal part of the main artery to prevent recanalization until the operation. Ranging from 48 h to five days after embolization, the patients underwent mediastinal tumor resection. Total excision of anterior mediastinal tumors was performed using sternotomy, while the others were performed through posterolateral thoracotomy.

The study protocol was approved by the Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital Ethics Committee. A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Embolization was completed in eight patients (Figure 1), while partial embolization was performed in one patient. The reason for partial embolization was the sharp angulation of one of the feeding arteries (Figure 2).

Figure 2. (a) A posteroanterior chest X-ray showing a left mid-upper zone mass. (b) A contrast-enhanced computed tomography scan showing multi-septated heterogeneous mediastinal mass occupying the anterior mediastinal space and extending to left anterolateral region. (c) Digital subtraction angiography showing multiple tortuous feeding arteries originating from left subclavian artery. (d) After coil and particle embolization of the main feeding arteries, minor feeding arteries became more prominent.
The detailed information for each procedure is summarized in Table 1. In nine embolization cases, a total of 12 arteries were embolized. The most common artery which was embolized was the right branchial artery. The complaints following embolization were often mild, while only four patients recorded pain. The detailed clinical characteristics of patients are summarized in Table 2. The lesions were located at the anterior mediastinum (n=3), at the middle mediastinum (n=3), and at the posterior mediastinum (n=3). There were three cases of teratoma, three cases of Schwannoma, two cases of Castleman disease, and one case of paraganglioma. The mean tumor diameter was 9.2 (range, 3 to 15) cm.

The removal of the tumors was carried out with minimal blood loss with clearer operative field and shorter length of surgery in patients undergoing preoperative embolization. Four patients did not receive any intra- or postoperative blood transfusion, while two patients received two units and the other two patients received one unit of blood transfusion. However, one patient with partial embolization received a total of 12 units of blood transfusion. The mean length of stay in the hospital following surgery was 6.2 (range, 4 to 10) days.

**DISCUSSION**

The first arterial transcatheter paraffin and petroleum embolization was reported by Dawbain in 1904 with the aim of hemorrhage management. In 1960, Luessenhop and Spence introduced the artificial embolization technique, which was methylmethacrylate.
embolization in the carotid artery to avoid arteriovenous malformations. In 1972, Rösch et al. for the first time, performed artery embolization to treat uterine myomata. In 1975, Gianturco et al. used wool coils for the first time. In 1991, Guglielmi et al. introduced detachable coil (GDC) embolization as an alternative method for the treatment of selected aneurysm patients. Since then, embolization is a common and, at the same time, popular procedure used in various surgeries.

Preoperative embolization of large mediastinal tumors is considered critical in tumor resection, as in most cases, large mediastinal tumors have a rich blood supply derived from multiple arteries. Surgery of highly vascular thoracic sarcomas can be risky, as it is amplified by potential hemorrhage and poor vascular control. In addition, the most optimal treatment choice for paragangliomas is surgical resection following preoperative embolization due to their high vascularity. Although Castleman disease is unusual, critical bleeding is often experienced during surgery due to the hypervascular nature of the tumor.

There are many cases reported in the literature showing that the surgeons were unable to complete tumor resection operations due to massive bleeding. Neuroendocrine tumors are highly vascular in nature, and many patients experience intraoperative hemorrhagic complications. Morandi et al. reported that, during right thoracotomy, the mass which was reported as a hemangiopericytoma was highly vascularized and massive bleeding from the tumor tissue occurred during the dissection. Therefore, they were only able to perform a biopsy procedure and, then, planned arterial embolization.

Furthermore, there are several cases which resulted in mortality due to severe bleeding during tumor resection. Aydemir et al. reported a patient with a giant (15 cm) solitary fibrous tumor supplied by multiple intercostal arteries and an aberrant artery branched off the celiac trunk in his subdiaphragmatic region in whom embolization failed due to a high number of arteries. The authors decided to control possible bleeding by inducing total circulatory arrest through cardiopulmonary bypass. Although cardiopulmonary bypass was completed successfully, the patient died due to massive bleeding.

In conclusion, complete embolization before hypervascular mediastinal tumor surgery is necessary to reduce intraoperative bleeding effectively, to provide a clearer operative field for the surgeon, and to allow a complete surgical resection. It also lowers the mortality risk. Based on our study results, it is evident that preoperative embolization is a safe, beneficial, and valuable preoperative adjunct in the treatment of large thoracic mediastinal tumors with an excessive vascular nature. We suggest that there is also a high need of three-phase computed tomography for the final evaluation and highly recommend angiography of all massive chest tumors before any scheduled operations.

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