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Preoperative embolization in surgical management of massive thoracic tumors

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Abstract

Background: The surgical excision of a highly vascular giant tumor may be challenging. The aim of this study was to describe our experience with preoperative percutaneous embolization of massive vascular chest tumors before surgical excision.

Methods: From 2009 to 2011, 8 cases of giant vascular thoracic tumor were treated at Assiut University Hospital, Assiut, Egypt, by preoperative embolization of the feeding arteries followed by successful excision after 48 h.

Results: The median age of the 8 patients was 39 years. Embolization of their tumors resulted in a reduction of tumor size, and minimal blood loss was observed perioperatively. Perilesional edema and easy differentiation of ischemic tissue facilitated complete surgical removal of the tumors.

Conclusions: Preoperative embolization of giant vascular thoracic tumors is useful to decrease perioperative blood loss and facilitate total excision.

Keywords

Angiography, embolization, therapeutic, neoplasms, fibrous tissue, pleural neoplasms, treatment outcome

Introduction

Surgery for highly vascular giant thoracic tumors is a major challenging today. Potential hemorrhage, problematic surgical exposure, difficult handling of the tumor, and poor vascular control increase the surgical risk. Rarely, a decrease in tumor bulk can be achieved by induction chemotherapy or radiotherapy, because of the low response rate of some malignancies. A few single case reports of preoperative embolization of pleural or mediastinal tumors have been reported. It has been used before surgical removal of a massive solitary fibrous pleural tumor, a mediastinal hemangiopericytoma, a mediastinal paraganglioma, and an intrapericardial pheochromocytoma, with successful subsequent removal and minimal intraoperative blood loss.[1–4] We describe our experience with the use of preoperative embolization in the surgical management of highly vascular giant thoracic tumors, and review the demographic characteristics, clinical features, results of imaging techniques, complications related to percutaneous embolization, and follow-up.

Patients and methods

There were 3 males and 5 females. Their ages ranged from 12 to 60 years, with a median age of 39 years. The operations were performed at Assiut University Hospital, Assiut, Egypt, between January 2009 and December 2011. The study was approved by the institutional ethics committee, and all patients or their guardians provided informed consent. Tumor identification included a solitary fibrous pleural tumor, an extraskeletal (mediastinal) myxoid chondrosarcoma, an extraabdominal fibromatosis (desmoid tumor), a huge chest wall chondrosarcoma, 3 large thymomas

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with plural extension, and a paravertebral chondrosarcoma.

Preoperative radiological evaluation included chest radiography and computed tomography (CT) (Figures 1 and 2); magnetic resonance imaging and bronchoscopy were not used routinely. The tumor was isolated in all patients. Preoperative CT-guided needle biopsy or open biopsy was performed in most cases. On the basis of CT-angiography and magnetic resonance imaging findings, selective angiography was carried out, showing rich vascularization of all these tumors. The feeding arteries were embolized with particles of polyvinyl alcohol, 150–500 μm in diameter (Contour-PVA Embolization Particles, Target Therapeutics, Boston Scientific, USA). Pre- and post-embolization angiograms are shown in Figures 3 and 4. Selective percutaneous angiography of the subclavian artery, thyrocervical trunk, costocervical trunk, internal thoracic and intercostal arteries was performed frequently in this study. The bronchial arterial origin of the spinal artery was avoided. If spinal supply was noted during a diagnostic angiogram, we could bypass its origin using a microcatheter coaxially through the diagnostic guiding catheter before embolization.

Forty-eight hours after embolization, the patients underwent surgery. Total excision of the tumors was achieved by piecemeal removal, with minimal blood loss, and lymph node removal if indicated. All surgical procedures were performed by the same surgeon. Routine monitoring and anesthesia were used in all patients. The usual surgical approaches were used in this series, including partial sternotomy, anterior and posterolateral thoracotomy, to achieve complete resection according to tumor size and location. Routine postoperative management was carried out, with observation of blood loss and early complications of percutaneous embolization. Histopathological studies confirmed the types and grades of malignancy, and the need for adjuvant therapy.

Figure 1. Chest radiograph of a patient with a massive left-sided solitary fibrous tumor of the pleura.

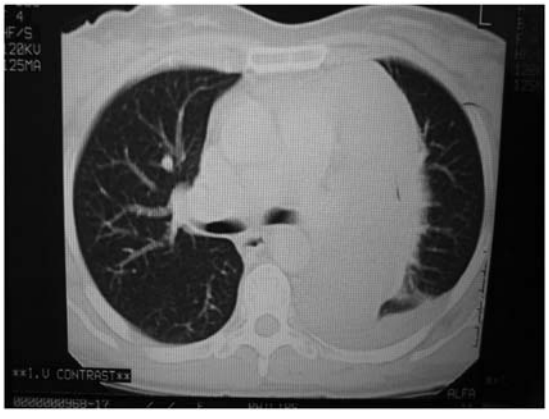

Figure 2. Computed tomography scan showing a left-sided solitary fibrous tumor.

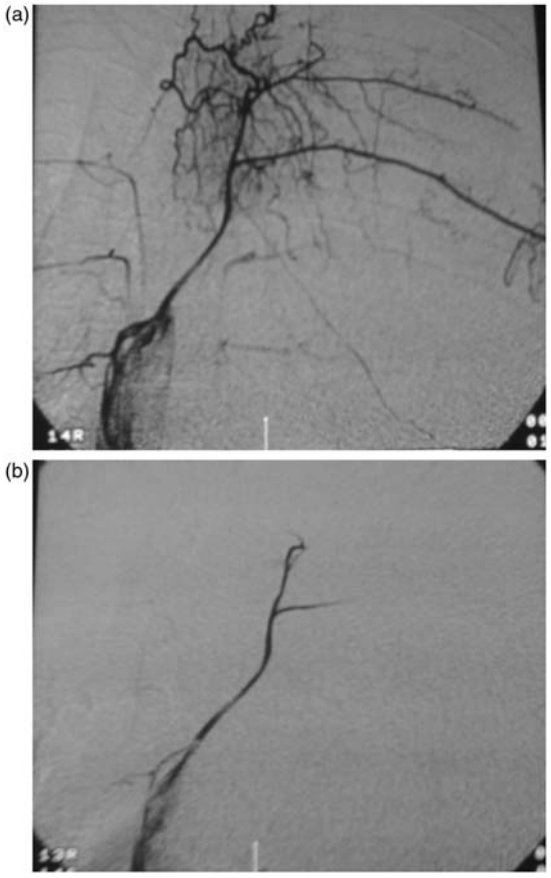

Figure 3. (a) Preliminary angiography showing tumor feeding vessels from a hypertrophic bronchial artery. (b) Postembolization angiography showing no residual blood flow to the mass.

The patients were followed up within 12 months for recurrence of the tumor and late complications of percutaneous embolization.

Results

Predominant presenting signs or symptoms at the time of evaluation for surgical treatment were exertional dyspnea in 5 patients, chest pain in 3, and cough in 2. All 8 cases were treated with one session of preoperative embolization. In the 8 embolization sessions, a total of 24 arteries were embolized (including bronchial and nonbronchial systemic arteries). The average number of arteries embolized per patient was 3. The following arteries were embolized: right bronchial artery (2), left bronchial artery (3), intercostal arteries (9), right internal mammary artery (2), left internal mammary artery (3), inferior phrenic artery (2), and the thyrocervical trunk (3). Different sizes of the embolizing material were used, according to the size of the feeding vessels and the tumor vascular bed. Complete resection was achieved in all patients 48 h after embolization. With this technique, a reduction in tumor size on chest radiography was obtained, ranging from 20% to 30%. In addition, perilesional edema occurred after embolization, which facilitated surgical dissection of the mass from the adjacent structures in all cases. Piecemeal removal of the tumors was carried out with minimal blood loss, which was noticed by minimal blood transfusion requirements and a clear operative field. Two patients presented with fever on the day after the procedure. One patient complained of paresthesia and mild pain in the left forearm, spontaneously subsiding within a couple of days. One patient developed mild facial palsy that may have been due to massive resection of a solitary fibrous pleural tumor. The postoperative courses were smooth, and the patients were discharged home after mean of 10 days postoperatively. They had follow-up periods ranging from 6 to 12 months, without evidence of metastases or local recurrence of the tumor.

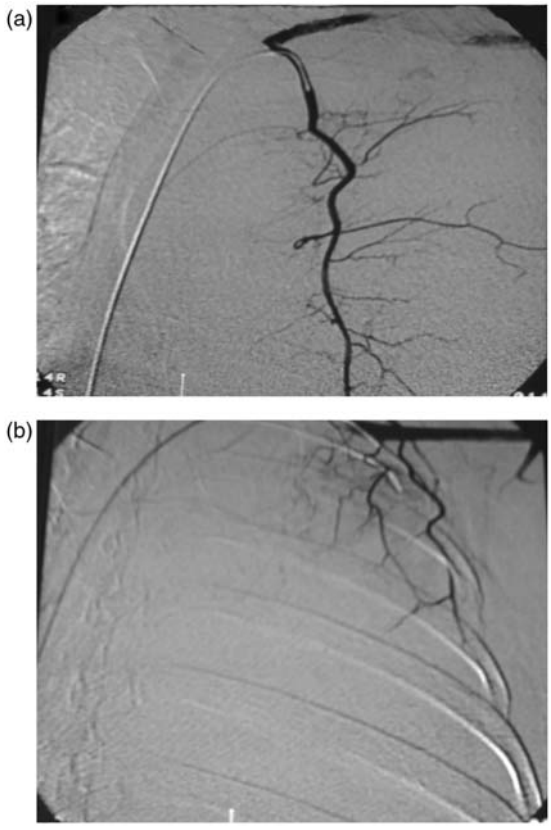

Figure 4. (a) Pre- and (b) postembolization angiograms of the left internal mammary artery, the principal blood supply to the tumor, showing successful occlusion.

Discussion

Remy and colleagues[5] performed the first bronchial artery embolization in 1973 to control hemoptysis. This was followed by a large series by Remy and colleagues[6] in 1977, comprising 104 patients who were treated by embolization of both bronchial and nonbronchial arteries to control hemoptysis. Subsequently, bronchial artery embolization was widely used because unoperable patients could be treated, and others could be stabilized prior to surgery.

Large intrathoracic tumors may reach massive proportions before becoming symptomatic. Their large size may make resection hazardous, particularly when excision in one piece is unlikely and there is a vascular pedicle that is inaccessible via the chosen operative route by virtue of the size of the tumor. Reduction of tumor size is required to allow a complete and safe resection. Decrease in tumor bulk can rarely be achieved by induction chemo- or radiotherapy because of the low response rate of some malignancies. One of the main benefits of preoperative embolization was the reduction in tumor volume that ranged from 20% to 30%. Without preoperative embolization, piecemeal removal of giant thoracic sarcomas may be unattainable because of the risk of severe or lethal bleeding. Forty-eight hours after embolization, the tumor surface can be cut with cautery, without significant bleeding.[7]

Solitary fibrous tumors of the pleura are rare and benign; however, even benign forms can recur many years after incomplete resection.[8] The origin is most frequently from the visceral pleura, with only 20% arising from parietal pleura. Tumors larger than 8 cm are more likely to have a parietal pleural origin and a vascular pedicle.[9] A tumor larger than 10 cm is more likely to be malignant. Nearly half of the solitary fibrous

tumors of the pleura are attached to the pleura by a single pedicle.[10] Solitary fibrous tumors of the pleura can reach massive proportions. Resection is generally curative in all benign cases, and in approximately half of malignant cases.[11]

Angiography can be a valuable investigation to delineate the major feeding vessels in solitary fibrous tumors, which can then be embolized preoperatively. These tumors are attached to the pleura by a highly vascularized pedicle in 38% to 46% of patients, particularly if the tumor is large.[12] Tumor vascularity must be preliminarily assessed by angio-CT scanning. CT performed without contrast medium may lead to a useless angiogram.[13]

The ischemia-induced perilesional edema is another advantage of preoperative embolization, facilitating dissection of the tumor from adjacent structures. Saluja and colleagues[14] suggested that coils should not be used for bronchial artery embolization because they cause proximal occlusion and do not allow repeat embolization if necessary. We agree that coils will prevent repeat embolization of the same artery, and we aim at occlusion of the vascular bed of the tumor, which was achieved using polyvinyl alcohol particles. Polyvinyl alcohol and coils provide permanent occlusion, while gelatin sponge particles are considered to provide temporary occlusion.

It is well documented that bronchial arteries vary significantly in their numbers and sites of origin. More than 70% of bronchial arteries arise from the descending aorta between the levels of the 5th and 6th thoracic vertebrae.[15] Based on a study of 150 human cadavers in 1948, Cauldwell and colleagues[16] defined 4 types of anatomic variation. The most common type is that of a single right bronchial artery with 2 left bronchial arteries (41%). Up to 20% of bronchial arteries may have an aberrant origin (from other systemic arteries), and nearly 10% arise from the anterior surface of the aortic arch or the descending aorta. A spinal artery can originate from a bronchial artery in up to 5% of patients, with the right side being more common than the left. Preoperative embolization of parietal tumors leads to shrinking of the tumor and decreases tension pain, and easily differentiates ischemic tumor tissue from the surrounding tissue, in addition to reducing intraoperative bleeding.[1] Bronchial and nonbronchial arteriography and embolization were well tolerated by our patients. Our results show that this is an effective procedure with which to facilitate dissection of the tumor from adjacent structures and decrease intraoperative blood loss.

None of our patients had major complications. The complications that may result from embolization are transverse myelitis as a result of the use of nonionic contrast agents, more neurotoxic materials, and inadvertent embolization of the spinal arteries.[17] To avoid such neurologic complications, superselective embolization was utilized using a micro catheter coaxially passed through the diagnostic guiding catheter. This refers to embolization of more terminal branches of the arterial tree, beyond the origin of the spinal arteries. Previous studies concluded that by using superselective embolization distal to the spinal or mediastinal branches, neurologic complications could be avoided, and the embolization may be more effective. This is in contrast to the series of Mal and colleagues[18] who observed the following 3 episodes of spinal cord complications: Brown-Séquard's syndrome, which regressed after 4 months without sequelae; paraparesis with spontaneous regression after 2 weeks; and complete paraplegia without regression. If a spinal artery arises from a bronchial artery, we only embolize the distal bronchial artery if we can achieve a stable distal position beyond the spinal artery origin. Other complications that may occur are subintimal dissection, guidewire perforation, and reflux of embolic agents into the aorta without adverse effects. Transient dysphagia, pleuritic chest pain, shoulder pain, and a groin hematoma have also been reported.[19] The follow-up of our patients ranged from 6 months to one year; it revealed that one patient had facial palsy that may have been due to injury of the sympathetic chain during dissection of her massive solitary fibrous tumor of the pleura, and not due to embolization.

Our experience has shown that angiography and embolization are valuable adjuncts in the surgical removal of giant vascular thoracic tumors. Preoperative embolization is useful to decrease perioperative blood loss and to facilitate surgery with achievement of total excision. We recommend angiography of all massive tumors in the chest before operation, particularly when they are so large that piecemeal excision may be anticipated. Bronchoscopy and CT scanning have important roles to determine the site and probable anatomic source of the blood supply to the tumor, prior to the patient undergoing angiography. Percutaneous embolization of huge thoracic tumors may help in patients who are not good surgical candidates, because it leads to shrinking and decreases the size of the tumor. Embolization distal to the spinal artery may significantly decrease the number of complications and may allow complete embolization. Further studies are needed to determine whether any of the various embolic materials currently available is superior in preventing recanalization.

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Conflicts of interest

None declared.

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