Surgical treatment for pulmonary artery sarcoma

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Abstract

Objective: Pulmonary artery sarcomas are exceedingly rare and the prognosis for patients with pulmonary artery sarcoma is very poor. We retrospectively reviewed the early and late outcomes after treatment for pulmonary artery sarcoma, and the purpose of this study is to report our surgical experience with this fatal disease.

Methods: Between 1999 and 2007, a total of nine patients (mean age, 47.4 years; M:F = 4:5) underwent operations for pulmonary artery sarcoma at our institution. The tumor was radically resected and every effort was made to remove the tumor as completely as possible. Seven patients underwent surgical resection with the aid of hypothermic cardiopulmonary bypass. The completeness of resection was determined intraoperatively by frozen section biopsy of the resection margin.

Results: There was no in-hospital mortality. No patients suffered from significant complications related to the operation. Follow-up was completed for all the patients with a mean duration of 19.2 months. During follow-up, six patients died with a median survival time of 17.6 months. The cause of death was related to the recurrence of pulmonary artery sarcoma in all cases. The pattern of recurrence was local recurrence and distant metastasis in three and four patients, respectively.

Conclusions: The early outcomes after surgical treatment for pulmonary artery sarcoma were excellent, and the late outcomes in this series were no worse than those in the previous reports. We suggest that the use of cardiopulmonary bypass is important to obtain a complete resection and the completeness of the resection should be confirmed intraoperatively by frozen section biopsy of the resection margin.

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1. Introduction

Primary sarcomas of the pulmonary artery (PA) are exceedingly rare and only a few hundred cases have been reported in the literature [1—4]. Since the clinical symptoms of patients with PA sarcoma (PAS) are often insidious and nonspecific, it is difficult to make an early diagnosis of this uncommon disease. Therefore, PAS is usually detected at an advanced stage, which renders curative resection nearly impossible. As a consequence, the prognosis for patients with PAS is very poor as few patients survive more than a year, regardless of treatment.

Nonetheless, surgery remains the mainstay of treatment for PAS since early radical resection could offer the only chance for a potential cure. There have been few reports regarding the long-term results of treatment for PAS. We retrospectively reviewed the early and late outcomes after treatment for PAS, and the purpose of this study is to report our surgical experience with this fatal disease.

2. Materials and methods

Between January 1999 and December 2007, a total of nine patients underwent operations for PAS at our institution. The operations were performed with curative intent for all nine patients. The medical records were retrospectively reviewed to evaluate the clinical characteristics, operative findings, the postoperative courses and the long-term results. This study was reviewed and approved by the Institutional Review Board of Samsung Medical Center.

2.1. Clinical characteristics

The mean age was 47.4 ± 11.8 years (range, 29—63 years). Four patients were male and five were female. Most patients presented with cough (n = 5) and dyspnea (n = 4) and they also complained of hemoptysis (n = 4) and chest pain (n = 2), with an average duration of symptoms of 4 months (range, 1—7 months). All the patients underwent at least one or two diagnostic tests among computed tomography (n = 8), magnetic resonance imaging (n = 4), echocardiography (n = 8), and pulmonary angiography (n = 1). Based on the findings of the imaging studies, seven patients (patients 3, 4, 5, 6, 7, 8 and 9) were considered to have PAS
(Fig. 1) and of those, chronic pulmonary thromboembolism was also considered in the differential diagnosis of two patients (patients 3 and 5). Two patients were given the presumptive diagnosis of lung cancer (patients 1 and 2). Two patients (patients 3 and 5), who had the possibility of chronic pulmonary thromboembolism, received anticoagulation therapy preoperatively.

2.2. Surgical techniques

The operations were performed via thoracotomy and median sternotomy in three and six patients, respectively. The diagnosis of PAS was histologically proven by frozen section biopsy in all the patients during operation. After confirmation of PAS, the tumor was radically resected and every effort was made to remove the tumor as completely as possible. Seven patients underwent surgical resection with the aid of hypothermic cardiopulmonary bypass (CPB) (patients 3, 4, 5, 6, 7, 8 and 9). Eight patients underwent pulmonary resection, including pneumonectomy in seven (patients 1, 3, 5, 6, 7, 8 and 9) and lobectomy in one patient (patient 2). Partial resection and reconstruction of the main PA using bovine pericardium was performed in four patients (patients 4, 6, 7 and 8). Replacement of the right ventricular outflow tract with an artificial prosthetic graft was performed in two patients (patients 3 and 5). Replacement of the pulmonary valve with an artificial valve was performed in two patients (patients 3 and 5). Partial resection and repair of the superior vena cava with using autologous pericardium was performed in one patient (patient 6).

2.3. Pathologic findings

The size of the tumors ranged from 3.1 to 10.0 cm (mean, 7.0 ± 2.2 cm). The origin of the tumors included the right PA in three patients (patients 6, 7 and 8), the left PA in two (patients 1 and 2), the pulmonary valve to the main PA in two (patients 3 and 5), and the main PA in two (patient 4 and 9). The main PA was involved in four patients, with invasion of the right PA (patients 3, 4, 5 and 9). In five patients, the tumor appeared to arise from the left or right PA with sparing of the main PA (patients 1, 2, 6, 7 and 8). Additional involvement of the lung was observed in seven patients (patients 1, 2, 3, 6, 7, 8 and 9). The histopathologic subclassification included leiomyosarcoma in five patients, malignant fibrous histiocytoma in one patient, intimal sarcoma in one patient and undifferentiated sarcoma in two patients.

The completeness of resection was determined intraoperatively by frozen section biopsy of the resection margin. There were three cases of incomplete resection; two out of the seven patients who received operations under CPB showed positive resection margins for malignant cells on their frozen section biopsy (patients 3 and 4), whereas one out of the two patients who underwent operations without CPB revealed gross findings of the residual tumor (patient 2). The clinical characteristics and pathologic findings of the patients are shown in Table 1.

Fig. 1. Pulmonary artery sarcoma in a 52-year-old man who had no symptoms (patient 7). (A) Axial enhanced computed tomography scan obtained at level of distal bronchus intermedius shows filling defect occupying entire lumen of the proximal right pulmonary artery and some portion of the main pulmonary artery. (B) Coronal reformatted image shows complete occlusion of the right pulmonary artery. (C) This patient underwent right en bloc pneumonectomy and main pulmonary artery reconstruction. Postoperative computed tomography scan obtained 3 months after the operation shows no evidence of the disease.
Follow-up was completed for all the patients with a mean duration of 19.2 months (range, 1.5—45.4 months). During follow-up, six patients died with a median survival time of 17.6 months (mean, 17.4 ± 7.9 months). The cause of death was related to the recurrence of PAS in all cases. The pattern of recurrence was local recurrence and distant metastasis in three patients (patients 2, 4 and 8) and four (patients 1, 3, 5 and 6), respectively. The site of metastasis was lung in three patients (patients 2, 4 and 8) and four (patients 1, 3, 5 and 6), respectively. The operative procedures and postoperative outcomes of patients with pulmonary artery sarcoma

3. Results

3.1. Early results

Table 1
The clinical characteristics and pathologic findings of patients with pulmonary artery sarcoma.

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Age/sex</th>
<th>Initial diagnosis</th>
<th>Histologic subclassification</th>
<th>Size (cm)</th>
<th>Origin of tumor</th>
<th>Lung parenchymal involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63/F</td>
<td>LC</td>
<td>MFH</td>
<td>3.1</td>
<td>LPA</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>36/M</td>
<td>LC</td>
<td>Leiomyosarcoma</td>
<td>6.2</td>
<td>LPA</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>57/F</td>
<td>PAS, CPTE</td>
<td>Leiomyosarcoma</td>
<td>8.2</td>
<td>PV to MPA</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>41/F</td>
<td>PAS</td>
<td>Undifferentiated sarcoma</td>
<td>4.0</td>
<td>MPA</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>39/M</td>
<td>PAS, CPTE</td>
<td>Leiomyosarcoma</td>
<td>6.8</td>
<td>PV to MPA</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>50/F</td>
<td>PAS</td>
<td>Leiomyosarcoma</td>
<td>8.0</td>
<td>RPA</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>52/M</td>
<td>PAS</td>
<td>Intimal sarcoma</td>
<td>8.5</td>
<td>RPA</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>29/M</td>
<td>PAS</td>
<td>Undifferentiated sarcoma</td>
<td>10.0</td>
<td>RPA</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>60/F</td>
<td>PAS</td>
<td>Leiomyosarcoma</td>
<td>8.4</td>
<td>MPA</td>
<td>Yes</td>
</tr>
</tbody>
</table>


3.2. Late results

Follow-up was completed for all the patients with a mean duration of 19.2 months (range, 1.5—45.4 months). During follow-up, six patients died with a median survival time of 17.6 months (mean, 17.4 ± 7.9 months). The cause of death was related to the recurrence of PAS in all cases. The pattern of recurrence was local recurrence and distant metastasis in three patients (patients 2, 4 and 8) and four (patients 1, 3, 5 and 6), respectively. The site of metastasis was lung in three patients (patients 2, 4 and 8) and four (patients 1, 3, 5 and 6), respectively. The site of metastasis was lung in three patients (patients 2, 4 and 8) and four (patients 1, 3, 5 and 6), respectively. The operative procedures and postoperative outcomes of patients with pulmonary artery sarcoma

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Operative procedures</th>
<th>Use of CPB</th>
<th>Complete resection</th>
<th>Adjuvant treatment</th>
<th>Recurrence</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intrapercardial pneumonectomy (L)</td>
<td>No</td>
<td>Yes</td>
<td>Not done</td>
<td>Distant (chest wall)</td>
<td>Died at 18 months</td>
</tr>
<tr>
<td>2</td>
<td>LLL lobectomy, lingular segmentectomy</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>RT</td>
<td>Local</td>
</tr>
<tr>
<td>3</td>
<td>En bloc pneumonectomy (R), RVOT reconstruction, PVR</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>RT</td>
<td>Distant (lung, brain, bone)</td>
</tr>
<tr>
<td>4</td>
<td>En bloc tumor resection, RPA TE, MPA reconstruction</td>
<td>Yes</td>
<td>No</td>
<td>CT, RT</td>
<td>Local</td>
<td>Died at 31 months</td>
</tr>
<tr>
<td>5</td>
<td>En bloc pneumonectomy (R), RVOT reconstruction, PVR</td>
<td>Yes</td>
<td>Yes</td>
<td>CT</td>
<td>Distant (lung)</td>
<td>Died at 20 months</td>
</tr>
<tr>
<td>6</td>
<td>En bloc pneumonectomy (R), MPA and SVC reconstruction</td>
<td>Yes</td>
<td>Yes</td>
<td>Not done</td>
<td>Distant (lung, liver)</td>
<td>Died at 8 months</td>
</tr>
<tr>
<td>7</td>
<td>En bloc pneumonectomy (R), MPA reconstruction</td>
<td>Yes</td>
<td>Yes</td>
<td>Not done</td>
<td>None</td>
<td>Alive at 22 months</td>
</tr>
<tr>
<td>8</td>
<td>En bloc pneumonectomy (R), MPA reconstruction</td>
<td>Yes</td>
<td>Yes</td>
<td>CT</td>
<td>Local</td>
<td>Alive at 45 months</td>
</tr>
<tr>
<td>9</td>
<td>En bloc pneumonectomy (R), MPA and LPA TE</td>
<td>Yes</td>
<td>Yes</td>
<td>Not done</td>
<td>None</td>
<td>Alive at 2 months</td>
</tr>
</tbody>
</table>

CPB: cardiopulmonary bypass; CT: chemotherapy; L: left; LLL: left lower lobe; MPA: main pulmonary artery; PVR: pulmonary valve replacement; R: right; RPA: right pulmonary artery; RT: radiotherapy; RVOT: right ventricular outflow tract; SVC: superior vena cava; TE: thromboembolectomy.

4. Discussion

Primary sarcomas of the PA are very rare and they still remain a subject of case reports [1]. PAS was first described in 1923 by Mandelstamm [2], and since then only a few hundred cases have been reported in the literature [3,4]. In our series, we encountered a total of nine patients with PAS over a period of 8 years and to the best of our knowledge, this is one of the largest single institutional series of PAS patients. Furthermore, there have been few reports concerning the long-term results of treatment for PAS, whereas the late outcomes of all the patients were presented in Table 2.

Since the symptoms are insidious and nonspecific in PAS patients, making an early diagnosis is challenging, apart from this disease’s low incidence [5]. Therefore, the diagnosis can be unnecessarily delayed and so the majority of the cases reported in the literature have been identified at autopsy [6]. In addition, PAS is likely to be mistaken for chronic pulmonary thromboembolism because the clinical manifestations of PAS are remarkably similar to those of pulmonary thromboembolic disease [7—9]. In our series, two out of nine patients underwent reoperation a month after the initial operation. One patient who had pulmonary metastasis seen on follow-up computed tomography (patient 5) underwent metastasectomy 6 months after the initial operation. One patient who developed recurrence at the main pulmonary artery stump underwent reoperation 43 months after the initial operation (patient 8). The operative procedures and postoperative outcomes of the patients are summarized in Table 2.
than a year. Kruger and colleagues [6] reported that the mean survival of patients with PAS is extraordinarily poor as few patients survive more than a year. Kruger and colleagues [6] reported that the mean survival without surgery was 1.5 months after diagnosis, and surgical intervention could only lengthen the survival time to 10 months.

Another reason for the poor prognosis is that most patients with PAS die from metastatic diseases, although most surgeons believe that they had the tumor completely resected. The most common site for distant metastasis is the lung parenchyma, presumably via microsclerotic embolization of tumor from the primary site [11, 12]. In our study, four patients eventually died from distant metastases during follow-up and of those, three turned out to have pulmonary metastasis. Interestingly, a combined heart-lung resection followed by heart-lung transplantation has also been attempted in order to eliminate the potential for pulmonary microembolization [13]. Although theoretically appealing, the surgical outcome was intrinsically limited by the development of extrathoracic metastatic disease. These observations led to interest in performing adjuvant chemotherapy for PAS patients. Some authors have suggested that PAS could be best managed by multimodal treatment [14—17], whereas others have found no effect of adjuvant chemoradiation on the long-term survival of PAS patients [18]. Adjuvant chemotherapy might have been effective against the distal tumor microembolization in those four cases of distant metastases of our series. However, the role of adjuvant therapies is still unclear due to the limited experience with it and it would be unreasonable to generalize the efficacy of adjuvant treatment for PAS patients based on this small series.

Accordingly, surgical resection remains the mainstay of treatment for PAS since complete resection could offer the only chance for a potential cure [5, 14, 19]. Early diagnosis and complete surgical resection is crucial for prolonged survival. No longer can prolonged tumor-free survival be expected without complete surgical resection. Although most patients in our series ultimately died during the follow-up period, the long-term results of surgical treatment in our study were relatively better than those in the previous reports; the median survival time of our cases was 17 months. It is difficult to explain exactly what could have made these results possible. It does not seem that the pathologic nature of PAS in our series was substantially less extensive than that in the previous studies. Since this study is a very small case series and the cases were retrospectively reviewed, it is not easy to discover common features among the cases and to compare our results with those that have been reported previously. Nonetheless, we believe that these satisfactory outcomes might have been possible because we attempted to resect the tumor as completely as possible in every case.

The ideal prerequisite for complete surgical resection would be to make an early diagnosis of PAS before the tumor becomes unresectable. Given the rarity as well as the insidious aspects of PAS, it is of great importance to suspect the possibility of PAS when imaging studies suggest that patients have pulmonary thromboembolism. In the first two cases of our series, the preoperative diagnoses were incorrect and so we had to perform the operations through a thoracotomy without the aid of CPB. Owing to the initial experience, since 2001 PAS was preoperatively suspected in all patients at our institution and all the operations for PAS have been performed with the aid of CPB. When a tumor originates from the main PA or the pulmonary valve, a sternotomy approach with the use of CPB is essential to obtain a complete resection. This might have been possible because we were able to reach a correct diagnosis of PAS and to prepare for it before the operation, with our increased clinical awareness and the recent advances in imaging studies. Furthermore, we tried to confirm the completeness of the resection by performing intraoperative frozen section biopsy of the resection margin. If necessary, we did not hesitate to resect such vital structures as the pulmonary valve or the right ventricular outflow tract, and we replaced those with prosthetic material.

In summary, an early prompt diagnosis is an essential prerequisite for prolonged survival for patients with PAS. Since the clinical symptoms are often insidious and nonspecific in PAS patients, suspicion of the tumor may lead to an early diagnosis. Once a diagnosis is made, complete surgical resection of the tumor is the mainstay of treating patients with PAS. A sternotomy approach with the use of CPB is fundamental to obtain a complete resection and the completeness of the resection should be confirmed by frozen section biopsy of the resection margin during the operation. Although the role of adjuvant therapy has yet to be defined, aggressive multimodal treatment could offer PAS patients additional hope for prolonged survival.

References


