Fistulectomy as an alternative to segmentectomy for pulmonary arteriovenous fistula

Carsten Schröder, MD,^a Gabriele Fröhlich, MD,^a Claus-Peter Harms, MD,^b Matthias Kleckow, MD,^b and Paolo Macchiarini, MD, PhD,^a Hannover, Germany

Segmentectomy has been recommended as the surgical standard for the management of isolated, large pulmonary arteriovenous (AV) fistula, with minimal morbidity and mortality and low recurrence rates. However, segmentectomy removes some normal lung parenchyma,¹ and this may contribute to an increase in postoperative pulmonary vascular resistance.² We describe a lung-saving operation including a simple fistulectomy for an isolated, large pulmonary AV fistula.

Clinical Summary

A 22-year-old man was referred in March 2000 with a motor weakness of the right hand muscles, dyspnea on exertion, and a solitary left upper lobe nodule. His medical history was significant for left-

sided cerebral ischemia resulting in a complete stroke and chronic motor weakness of the right hand muscles 5 years earlier. He had a transient ischemic attack resulting in an aggravation of his right hand muscle weakness in January 2000. Clinical and physical examination ruled out primary cardiac defects or a hereditary hemorrhagic telangiectasia (Rendu-Osler-Weber disease). Chest radiography showed a single, bilobed nodule in the left upper lobe (Figure 1). Bronchoscopic examination showed no abnormalities. Diagnosis of a pulmonary AV fistula was confirmed by means of a pulmonary angiogram (Figure 2). Transthoracic echocardiography revealed no atrioventricular right-to-left abnormalities and confirmed that the drainage from the pulmonary AV fistula collected into the left upper lobe vein. Right heart catheterization revealed normal pulmonary hemodynamics. Lung ventilation and perfusion scans showed a marginal right-sided predominance (53% vs 47%) but no distribution abnormalities. Although pulmonary function tests showed no abnormalities, the patient's oxygenation was severely affected: PaO_2 57.9 mm Hg, the Paco_2 36 mm Hg, and arterial oxygen saturation 83% with the patient breathing room air. Although the potential advantages of nonsurgical management were extensively discussed, the patient declined a percutaneous balloon or coil embolization and gave his written informed consent for surgical therapy. A preoperative contrast cerebral computed tomogram demonstrated no residual injury.

The operation was performed through a muscle-sparing left posterolateral thoracotomy in the fifth intercostal space via one-lung ventilation. The patient's condition was monitored continuously with electroencephalography using somatic evoked potentials to detect intraoperative neurologic injuries. Once the pleural cavity had been

From the Department of Thoracic and Vascular Surgery,^a Heidehaus Hospital, Hannover Medical School, and Division of Pneumology,^b Celle Hospital, Hannover, Germany.

Received for publication Nov 16, 2000; accepted for publication Dec 18, 2000.

Address for reprints: Paolo Macchiarini, MD, PhD, Department of Thoracic and Vascular Surgery, Heidehaus Hospital, Hannover Medical School, Am Leineufer, 70, 30419 Hannover, Germany (E-mail: pmacchiarini@compuserve.com).

J Thorac Cardiovasc Surg 2001;122:386-8

Copyright © 2001 by The American Association for Thoracic Surgery

0022-5223/2001 \$35.00 + 0 12/54/113742

doi:10.1067/mtc.2001.113742

Figure 1. Plain chest radiograph showing a single nodule in the upper lobe of the left lung in our patient with a persistent neurologic defect and hypoxemia.

Figure 2. Preoperative pulmonary angiogram showing a bilobed AV fistula whose feeding artery and vein arise from the upper lobe vascular branches.

Figure 3. A, Intraoperative macroscopic view of the pulmonary AV fistula (black arrow) located in the subpleural space between the fourth and fifth upper lobe segments. B, Isolation and progressive dissection of the pulmonary AV fistula in the connective stroma plane lying between the wall of the fistula (black arrow) and the bed of the surrounding (white arrows) normal lung. The view is through a posterolateral left thoracotomy.

entered, the only abnormality that we encountered was the pulmonary AV fistula located subpleurally between the fourth and fifth segments (Figure 3, A). To prevent air or thromboembolic events, we dissected the pulmonary artery free and encircled it with tapes proximally at its extrapericardial origin and distally beyond the takeoff of the upper lobe artery branches, as it was the extrapericardial upper

lobe vein. After systemic injection of heparin (0.5 mg/kg), the patient was placed in a 30-degree head-down position, the left lung was excluded, and the previously dissected artery segments and vein were crossclamped. The pulmonary AV fistula was then gently dissected from the surrounding lung parenchyma, and the small feeding arteries and veins were ligated with 4-0 or 5-0 polyglactin (Vicryl;

Figure 4. Postoperative pulmonary angiogram showing a normal distribution of the branches of the left pulmonary artery.

Ethicon, Inc, Somerville, NJ) sutures. Dissection was continued from the fundus of the pulmonary AV fistula to the junction between the origin of the main feeding artery and vein and the adjacent lung parenchymal bed (Figure 3, B). Manipulation of the fistula was limited to the distended part of its wall to avoid migration of emboli at the internal AV capillary interface. After ligation of the major feeding vessels, the entire fistula was then removed. The lung was reventilated, the proximal pulmonary artery clamp was released, and a 14F catheter was inserted into the lumen of the left upper pulmonary vein on suction for de-airing. The venous and distal arterial clamps were then released, the patient was returned to his normal position, and lung hemostasis was controlled. The chest was closed routinely with two chest drains. The patient was extubated in the operating room and his postoperative course was uneventful, with no pulmonary hemodynamic changes. He was discharged 12 days after the operation.

At pathologic examination, the pulmonary AV fistula was composed of a 4×1.5 -cm feeding artery connected to a 5×1.7 -cm ectatic draining vein through multiple holes of varying sizes (0.2–0.4 cm) lying in the AV interface. Seven months postoperatively, the patient was free of symptoms and had a normal pulmonary vascular bed (Figure 4) and arterial blood gases (PaO_2 89 mm Hg, Paco_2 36 mm Hg, and arterial oxygen saturation 97% while breathing room air).

Comments

Contemporary treatment of a pulmonary AV fistula with either surgery or embolotherapy is associated with minimal morbidity and virtually no mortality. It has therefore been recommended that all symptomatic pulmonary AV fistulas more than 2 cm in diameter be treated with

either surgery or embolotherapy. The appropriate management of asymptomatic pulmonary AV fistulas less than 2 cm in diameter is less clear, although the consensus is that those having feeding arteries more than 3 mm in diameter should be occluded to minimize the risk of paradoxical embolization during long-term follow-up.¹

In symptomatic patients, surgery carries at least the same risks as any other thoracic operation, but when properly performed in well-selected patients it has been associated with minimal morbidity and mortality and rare postoperative recurrence.³ Embolotherapy seems preferable in most cases because it avoids the morbidity of a thoracotomy, as well as the 4- to 7-day hospital stay and its associated expenses. Moreover, advocates of embolotherapy claim that the surgical removal of some normal lung parenchyma adjacent to the pulmonary AV fistula may increase pulmonary artery pressure postoperatively even in patients with normal pressure at baseline.^{1,2}

The superiority of surgery over embolotherapy or vice versa is beyond the scope of this article, which presents an original lung-sparing technique as an alternative to segmentectomy for the treatment of pulmonary AV fistula. Its surgical key principles are as follows: (1) to avoid any manipulation of the pulmonary AV fistula until completion of the dissection of the pulmonary artery (proximal and distal to its lobar location) and vein; (2) to place the patient in a 30-degree head-down position; (3) to crossclamp the previously dissected artery segments and lobar vein; (4) to gently dissect the fundus of the pulmonary AV fistula from the adjacent lung parenchymal bed, passing through the identification and ligation of some multiple, small (when present) vessels and the origin of the main feeding artery and draining vein; and (5) reinflate the affected lung with subsequent crossclamp release. The rationale of this technique is that, like open cholecystectomy and excision of varicose veins, pulmonary AV fistulas can be freely dissected from the surrounding tissue because most of them are (sub)pleural and because the uniformly present, albeit scant, connective tissue stroma lying between the fistula and normal lung tissue gives an excellent plane of dissection. Because it spares the normal surrounding lung tissue, the presented technique may also be indicated when other multiple, plexiform lesions are incidentally discovered during surgery.

Conclusions

We described a new surgical technique in a high-risk, symptomatic patient with a large, bilobed pulmonary AV fistula. It includes a fistulectomy without removal of any adjacent lung parenchyma and was performed as an alternative to segmentectomy. It resulted in no morbidity and reversed the patient's hypoxemia.

References

1. Gossage RJ, Kanj G. Pulmonary arteriovenous malformations. *Am J Respir Crit Care Med.* 1998;158:643-61.
2. Moyer JH, Glantz G, Brest AN. Pulmonary arteriovenous fistulas: physiologic and clinical considerations. *Am J Med.* 1962;32:417-35.
3. Puskas JD, Allen MS, Moncure AC, et al. Pulmonary arteriovenous malformations: therapeutic options. *Ann Thorac Surg.* 1993;56:253-8.