Transcatheter embolization of a Rasmussen aneurysm via pulmonary artery with \textit{n}-butyl cyanoacrylate and iodized oil mixture injection with balloon occlusion

Yukichi Tanahashi, MD, a Hiroshi Kondo, MD, b Marie Osawa, MD, c Takahiro Yamamoto, MD, a Masao Yamaguchi, MD, a and Shigeru Furui, MD, b Tokyo, Japan

We describe a new approach to effective embolization of Rasmussen aneurysm by simultaneous devascularization of the pseudoaneurysm and systemic artery-to-pulmonary artery anastomoses. In our patient, a radiologic workup for hemoptysis revealed a Rasmussen aneurysm. A bronchial arteriogram revealed a pseudoaneurysm via bronchopulmonary artery shunting. A left pulmonary arteriogram did not demonstrate the pseudoaneurysm. A superior lingular pulmonary arteriogram with balloon occlusion showed the pulmonary artery branch, pseudoaneurysm, and bronchial artery via bronchopulmonary artery shunting with retrograde flow. An \textit{n}-butyl cyanoacrylate injection with balloon occlusion achieved complete embolization. This approach may be an effective technique for the treatment of peripheral pulmonary artery pseudoaneurysm. (J Vasc Surg Cases 2016;2:161-4.)

Rasmussen aneurysm is a peripheral pulmonary artery pseudoaneurysm (PAP) that occurs due to erosion of a peripheral pulmonary artery branch in a tuberculous cavity. \(^1\) Rupture of a Rasmussen aneurysm can cause life-threatening massive hemoptysis. \(^2,3\) Angiographically, PAPs, including Rasmussen aneurysms, are often demonstrated on bronchial or nonbronchial systemic arteriograms and sometimes are not demonstrated on pulmonary arteriography due to systemic artery-to-pulmonary artery shunting.

Endovascular treatment has become a common procedure for the management of the Rasmussen aneurysm because of its low invasiveness. Transcatheter embolization via both systemic artery and pulmonary artery for the treatment of PAPs is now recommended. However, recurrent hemoptysis is not rare. \(^2\) We describe here a patient with a Rasmussen aneurysm that was effectively treated by a new approach of transcatheter embolization with \textit{n}-butyl cyanoacrylate (NBCA) and iodized oil mixture injection with balloon occlusion via the pulmonary artery artery approach alone. The patient consented to the publication of this report, and Institutional Review Board approval was obtained for using NBCA as a vascular embolization material.

**CASE REPORT**

A 62-year-old man had suffered from intermittent hemoptysis caused by cavitary tuberculosis and experienced an episode of massive hemoptysis treated with transfusion 3 months before. The recurrence of massive hemoptysis brought him to our hospital. Hemodynamic status on arrival was stable. Blood biochemical findings revealed levels within normal reference ranges, except for a decreased hemoglobin (9.4 g/dL) and albumin (2.6 g/dL) levels.

Unenhanced computed tomography (CT; Light Speed VCT; GE Healthcare, Milwaukee, Wisc) demonstrated high-density fluid collection in the upper lobe of the left lung affected by cavitary tuberculosis (Fig 1, A). Contrast-enhanced CT demonstrated a peripheral pseudoaneurysm in a pulmonary artery branch (superior lingular artery) surrounded by a high-density fluid collection (Fig 1, B), which had not been demonstrated on CT images 3 months earlier. The diagnosis of Rasmussen aneurysm was made and led to endovascular treatment.

A 5F polyurethane catheter (GLB; Terumo, Tokyo, Japan) was advanced to the bronchial artery. A left bronchial arteriogram demonstrated the pseudoaneurysm at the periphery of the left lung probably via systemic artery-to-pulmonary artery shunting at or proximal to the lesion (Fig 2, A). An attempt to advance a microcatheter to the peripheral branch near the lesion was unsuccessful. A 4F Optiflash pigtail catheter (Terumo) was advanced to the left pulmonary artery. A left pulmonary arteriogram did not demonstrate the aneurysm. The superior lingular artery was coaxially catheterized with a 5F polyurethane catheter with a balloon (MP; Terumo) and a 2.7F microcatheter with balloon (Attendant Nexus; Terumo). A selective superior lingular arteriogram with balloon occlusion demonstrated a Rasmussen aneurysm. A bronchial artery branch was also seen in retrograde fashion via bronchial artery-to-pulmonary artery shunting at the lesion (Fig 2, B).

A mixture of NBCA (Histoacryl; B. Braun, Melsungen, Germany) and Lipiodol (Laboratoire Andre Guerbet, Tokyo, Japan) was injected with balloon occlusion at the ratio of 1:3 and totally...
embolized the pulmonary artery branch, the pseudoaneurysm, and the bronchial artery branch in a retrograde fashion (Fig 2, C). A postembolization angiogram demonstrated disappearance of the pseudoaneurysm (Fig 2, D and E). The hemoptysis ceased immediately after transcatheter embolization, without any major complications. There has been no recurrence of bleeding in an 8-month follow-up period.

**DISCUSSION**

PAPs are the main cause of massive hemoptysis of pulmonary arterial origin and are caused by numerous conditions, including neoplasms, bronchiectasis, lung abscess, and acute or chronic inflammatory lung disease. A PAP found in the lung affected with tuberculosis is referred to as Rasmussen aneurysm. The rupture of
PAP causes massive hemoptysis with a mortality rate of >50%.

Recently, multidetector CT angiography has become the imperative diagnostic method for the evaluation of massive hemoptysis. Multidetector CT angiography allows physicians to easily assess the bleeding site and culprit artery, vascular anatomy, and pulmonary artery lesion. Angiographically, PAPs are often demonstrated on bronchial or nonbronchial systemic artery arteriograms. However, they are not always demonstrated on pulmonary arteriograms obtained from the main pulmonary arteries or their branches. This has been attributed to the fact that PAPs in patients with chronic inflammation are formed by erosion of the peripheral pulmonary arterial walls. They tend to involve the adjacent bronchial arterial branches, developing systemic-to-pulmonary artery anastomoses. The direction of flow at the anastomoses is from higher pressure artery (systemic artery) to lower pressure artery (pulmonary artery). This shunting can disturb the opacification of PAPs on pulmonary arteriograms.

Endovascular treatment and resection of the affected pulmonary lobe are the treatments of choice for PAP. Because most patients with PAPs are at high risk for surgical intervention, endovascular treatment has become widespread.

Embolization of systemic arteries alone is not sufficient for the treatment of hemoptysis of pulmonary artery origin due to chronic inflammation, because of enlarged systemic artery-to-pulmonary artery anastomoses. Therefore, embolization with gelatin sponge, metal coil, or NBCA via systemic and pulmonary artery approaches is now the standard embolization procedure for PAP (Fig 3, A and B). However, there are three major problems associated with this embolization procedure. First, as described above, some PAPs are not visualized on the pulmonary arteriogram. Second, selective catheterizations of the supplying arteries are not always possible. Third, it may cause proximal embolization. These may lead to incomplete occlusion of the pseudoaneurysm resulting in recurrent hemoptysis.

Shin et al reported that 33% of patients with PAPs not demonstrated on the pulmonary arteriogram had recurrence. Our approach seems to overcome the noted problems of the standard embolization procedure (Fig 3, C). In our patient, angiography of the pulmonary arterial branch with balloon occlusion clearly visualized the PAP with retrograde filling of the supplying bronchial arterial branch. Embolization subsequently performed with NBCA and iodized oil mixture injection with balloon occlusion achieved continuous retention of the liquid embolic material in the pulmonary arterial branch, PAP, and supplying bronchial arterial branch. Pulmonary and bronchial arteriograms after embolization showed complete disappearance of the lesion. In addition, our new approach does not require selective catheterization of supplying arteries, which is often difficult to achieve when the standard embolization procedure for PAPs is performed.

Several recent reports have demonstrated the usefulness of NBCA and iodized oil mixture under flow control for the embolization of arteriovenous malformation (AVM). However, the purpose of balloon occlusion for the embolization of AVM is essentially different from that of PAP. Balloon occlusion for the embolization of AVM aims to slow antegrade flow to prevent migration of the embolic material. However, balloon occlusion for the embolization of PAP aims at changing the blood pressure gradient of systemic-to-pulmonary artery anastomoses and delivering NBCA and iodized oil mixture through the PAP to the supplying systemic artery in retrograde flow, resulting in total embolization of the pseudoaneurysm and systemic artery-to-pulmonary artery anastomoses. In addition, balloon occlusion allows the operator to accomplish the embolization without fragmented migration of the injected NBCA cast to unintended vessels via anastomoses.

CONCLUSIONS

We present a patient with Rasmussen aneurysm after cavitary tuberculosis, which was successfully treated.
with transcatheter embolization with NBCA and iodized oil mixture injection with balloon occlusion via the pulmonary artery approach. Our method helps to overcome the problems of the current embolization procedure for Rasmussen aneurysm and thereby possibly reducing the recurrent hemoptysis rate after treatment.

REFERENCES

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