

## Absent Pulmonary Uptake on $^{99m}\text{Tc}$ MAA Perfusion Lung Scan Due to Severe Right-to-Left Shunt

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**E**XTRAPULMONARY accumulation of  $^{99m}\text{Tc}$  macroaggregated albumin (MAA) is rarely seen on perfusion lung scan, and has been reported in less than 4% of a study population of nearly 380 patients.<sup>1</sup> It occurs when the agent bypasses the lungs due to a right-to-left (R-L) cardiac or pulmonary shunt, when it is shunted to the portal vein before reaching the right atrium and ventricle of the heart, and when the agent is degraded to a submicron-particle size. When a pharmaceutical problem is excluded, extrapulmonary uptake implies unusual hemodynamics with a shunt.

Absent pulmonary uptake on  $^{99m}\text{Tc}$  MAA perfusion lung scan with concomitant extrapulmonary accumulation is indicative of major R-L shunt. A case is reported in which a major but clinically unsuspected shunt was diagnosed from the scan findings. Other causes of extrapulmonary uptake are also presented.

### CASE REPORT

A 30-year-old man, hospitalized and treated for brain abscess, was referred for a lung scan due to postoperative dyspnea and a high clinical suspicion of pulmonary embolism (PE). On scan, no significant amount of agent was visualized in either lung field, with virtually all of the agent demonstrated in the brain, the kidneys, and the spleen (Fig 1). The scan was nondiagnostic for PE, but a major R-L shunt was reported. Anomalous drainage of the superior vena cava (SVC) to the left atrium (LA) was ultimately diagnosed on echogram and surgically repaired. Furthermore, embolectomy from the right pulmonary artery was also performed. While the shunt was correctly diagnosed, the scan failed to diagnose the pulmonary embolism, as there was no demonstrable lung perfusion. As suggested by Brendel et al, had the agent been injected distally, through a leg vein, an interpretable lung scan might have been obtained.<sup>2</sup>

When inferior vena cava (IVC) and/or bilateral iliac vein obstruction occurs, collaterals may de-

velop due to the increased pressure gradient between the inferior epigastric vein and portal venous system. The venous collateral pathways in IVC obstruction include paraumbilical shunting towards the liver. When SVC obstruction occurs, collateral pathways may include the internal mammary, the azygos, the lateral thoracic, and the vertebral venous pathways. These may lead to systemic venous-pulmonary venous communication and abnormal extrapulmonary accumulation of  $^{99m}\text{Tc}$  MAA towards the high systemic blood flow organs, ie, the brain and kidneys.<sup>1</sup> The hemodynamic significance of the shunt may be anywhere along the spectrum between minor to major and its quantification may be inferred from the perfusion scan.<sup>2</sup>

Causes of systemic venous-pulmonary venous communication seen as abnormal extrapulmonary accumulation of  $^{99m}\text{Tc}$  MAA with cerebral, splenic, and renal uptake on  $^{99m}\text{Tc}$  MAA lung perfusion scan include:

### *Common Causes of R-L Shunt*

1. Congenital heart disease
  - a. Single ventricle<sup>1</sup>
  - b. Ventricular septal defect (VSD)<sup>1</sup>
  - c. High atrial (sinus venosus) septal defect (high ASD)<sup>2</sup>
  - d. Anomalous drainage of SVC into left atrium without septal defect<sup>3-5</sup>
  - e. Persistent left SVC connected to the left atrium<sup>6</sup>

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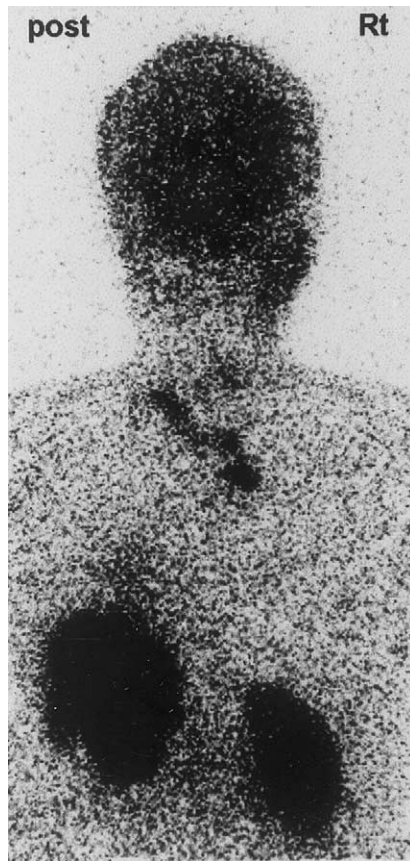
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0001-2998/04/3402-0008\$30.00/0

doi:10.1053/j.semnuclmed.2003.12.007



**Fig 1. Posterior view of head, thorax and abdomen: Extrapulmonary distribution of Tc99m MAA is seen in high systemic blood flow organs (brain, kidneys, and spleen) with no significant pulmonary uptake. Slight stagnation of agent in the left brachiocephalic vein is also apparent.**

2. Superior Vena Cava (SVC) Syndrome
  - a. Due to malignancy with tumor invasion of thoracic wall leading to anastomosis between systemic and pulmonary venous circulation<sup>1,7,8</sup>
  - b. Due to infection (tuberculosis, histoplasmosis, pyogenic mediastinitis)<sup>7</sup>
  - c. Due to thrombophlebitis of the innominate veins or SVC<sup>7</sup>
  - d. Due to fibrosing mediastinitis<sup>9</sup>

#### *Rare Causes of R-L Shunt*

1. Pulmonary atriovenous (AV) fistula<sup>1</sup>
2. Congenital bronchogenic cyst<sup>1</sup>
3. Cirrhosis with severe hypoxemia due to micro-vascular shunts<sup>10,11</sup>
4. Complication of sinus venosus-type ASD repair<sup>12</sup>

#### REFERENCES

1. Kume N, Suga K, Uchisako H, et al: Abnormal extrapulmonary accumulation of <sup>99m</sup>Tc-MAA during lung perfusion scanning. *Ann Nucl Med* 9:179-184, 1995
2. Brendel AJ, Larnaudie B, Lambert B, et al: Unsuccessful lung scan due to major right-to-left shunt through a sinus venosus septal defect. *J Nucl Med* 26:1029-1034, 1985
3. Rosenkranz S, Stablein A, Deutsch HJ, et al: Anomalous drainage of the right superior vena cava into the left atrium in a 61-year-old woman. *Int J Cardiol* 64:285-291, 1998
4. Park HM, Smith ET, Silberstein EB: Isolated right superior vena cava draining into left atrium diagnosed by radionuclide angiocardiology. *J Nucl Med* 14:240-242, 1973
5. Ezekowitz MD, Alderson PO, Bulkley BH, et al: Isolated drainage of the superior vena cava into the left atrium in a 52-year-old man: A rare congenital malformation in the adult presenting with cyanosis, polycythemia, and an unsuccessful lung scan. *Circulation* 58:751-756, 1978
6. Sherfat M, Friedman S, Waldhausen JA: Persistent left superior vena cava draining into the left atrium with absent right superior vena cava. *Ann Thorac Surg* 11:160-164, 1971
7. Wilson ES: Systemic to pulmonary venous communication in the superior vena caval syndrome. *Am J Roentgenol* 127:247-249, 1976
8. Hutchins WW, Kirchner PT, MacMahon H: Perfusion lung scan in superior vena cava obstruction: Demonstration of venous collaterals and systemic-pulmonary venous shunt. *Am J Roentgenol* 138:754-756, 1982
9. Kistler AM, Silverman ED, Sharpe MB, et al: Superior vena cava obstruction in fibrosing mediastinitis: Demonstration of right-to-left shunt and venous collaterals. *Nucl Med Commun* 12:1067-1074, 1991
10. Keren G, Boichis H, Zwas TS, et al: Pulmonary arterio-venous fistulae in hepatic cirrhosis. *Arch Dis Child* 58:302-304, 1983
11. Shijo H, Hisano S, Sasaki H, et al: Detection of pulmonary telangiectasia using dynamic pulmonary perfusion imaging in patients with liver cirrhosis. *Clin Nucl Med* 14:179-182, 1989
12. Murad M, Sami SA, Hashmi R, et al: Rare complication of sinus venosus-type atrial septal defect repair. *Eur J Nucl Med Mol Imaging* 30:1315, 2003