directly inhibit sinoatrial conduction, or those that depress sinus automaticity, and thus, promote sinoatrial conduction. The first effect may be stronger in sinoatrial Wenckebach, while the second one, as in our case, may prevail in type 2 second-degree sinoatrial block.

Despite the intermittent low heart rate, our patient was asymptomatic and physically active. The explanation for this is simple and was confirmed by electrocardiographic monitoring. Whenever the sinus discharge rate dropped (as during sleep), sinoatrial conduction normalized because of the slow sinus firing rate. Physical activity, on the other hand, as well as administration of atropine and sympathomimetic agents, improved sinoatrial conduction directly, and thus, also normalized the sinus rate. Based on these observations and the long history of asymptomatic bradycardia, a conservative approach was chosen with check-up at regular intervals and no immediate pacemaker implantation.*

REFERENCES
7 Hariman RJ, Hoffman BF. Effects of ouabain and vagal stimulation on sinus nodal function in conscious dogs. Circ Res 1982; 51:760-68

Magnetic Resonance Imaging of Mediastinal Paraganglioma*

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FIGURE 4. Analysis of events during carotid massage (CM, heavy line) leading to temporary normalization of heart rate (25 mm/s). Continuous recording. Numbers above the tracings represent P-P intervals in hundredths of a second.

MRl of Mediastinal Paraganglioma (Flickinger, Yuh, Behrendt)
The magnetic resonance (MR) findings are presented of a nonfunctioning mediastinal paraganglioma on both T1- and T2-weighted magnetic resonance images. The MR characteristics of this tumor differentiate it from previously reported functioning mediastinal paragangliomas (pheochromocytoma) and from other benign mediastinal neoplasms, although mediastinal bronchogenic carcinomas may produce a similar appearance. (Chest 1988; 94:652-54)

Paraganglioma is a neoplasm arising from paraganglion cells which lie adjacent to sympathetic ganglia and plexuses throughout the body. Paraganglion cells originating at the celiac sympathetic plexus also form the adrenal medulla. Paragangliomas have been found at all levels of the sympathetic nervous system from skull base to pelvis and may be either functioning (producing excess catecholamines, usually called pheochromocytoma) or nonfunctioning. These tumors are known variously as glomus tympanicum and glomus jugulare in the skull base, carotid body tumor in the neck, paraganglioma in the chest, and pheochromocytoma in the adrenal gland and in other sites where they produce increased levels of catecholamines. Eighty-three thoracic paragangliomas of the branchiomeric type (vide infra) have been reported in the literature. Seventy-eight (94 percent) of these have been nonfunctioning and five have been functioning (pheochromocytoma). To our knowledge, this is the first report of the magnetic resonance (MR) imaging characteristics with both T1-weighted (T1WI) and T2-weighted (T2WI) images of a mediastinal paraganglioma.

CASE REPORT

A 44-year-old woman was admitted for left lower lobe pneumonia. Chest roentgenograms showed a 7-cm middle mediastinal mass and pneumonia. Computed tomographic (CT) examination revealed a 7×4×7 cm homogeneous mass in the aortopulmonary window. Bronchoscopy result was negative. The patient had no history or findings of hypertension or cardiac arrhythmia. She underwent an open biopsy of the mediastinal mass which resulted in a diagnosis of non-chromaffin paraganglioma. Results of a 24-hour urinalysis for catecholamines were normal. A thoracotomy was performed. The tumor was adherent to the left phrenic, vagus, and recurrent laryngeal nerves, and extended into the proximal left pulmonary artery and pericardium. The operation was discontinued because the surgeon would not resect the mass without cardiopulmonary bypass.

On referral here, an MR examination of the chest was performed. The coronal T1WI showed a 6×5×6 cm mediastinal mass with homogeneous texture and an intermediate signal intensity (Fig 1), similar to liver. The borders of the tumor were well-defined in relation to the adjacent structures, ie, aorta, pulmonary arteries, epicardial fat, and left ventricle (Fig 1 through 3). On the T2WI (Fig 3), the tumor mass had homogeneous increased signal intensity, moderately less intense than subcutaneous fat. On cardiopulmonary bypass, the patient underwent successful tumor resection.

DISCUSSION

Paraganglion cells derive from embryonic neural crest cells which migrate centrifugally and eventually lie adjacent to sympathetic ganglia and plexuses. The number of paraganglion cells is maximal at birth, after which they undergo progressive involution until puberty. It is believed that paragangliomas arise from residual cells which fail to involute during this time. Extraadrenal paragangliomas are divided into four families as follows: (a) branchiomeric (chemodectoma)—associated with arterial vessels and cranial nerves of the ontogenetic branchial arches; intercarotid (carotid body), jugulotympanic (glomus jugulare, glomus tympanicum), orbital, laryngeal, subclavian, aorticopulmonary, coronary, pulmonary; (b) intravagal; (c) aorticosympathetic—associated with the sympathetic chain and retroperitoneal ganglia, in the abdomen (including the organ of Zuckerkandl), thorax, and neck; and (d) visceral-auto-
The possibility of a tumor being either functioning or nonfunctioning depends on the family to which it belongs.① Adrenal tumors are nearly always functioning (pheochromocytoma), whereas branchiogenic tumors are usually nonfunctioning. Aorticosympathetic and visceral-autonomic tumors are more evenly distributed between functioning and nonfunctioning types. The most reliable preoperative test for functioning tumor is the 24-hour urine for metanephrines.② Histopathologic staining of the tumor specimen for chromaffin has been unreliable in distinguishing between functioning and nonfunctioning types.③ The CT features of mediastinal paragangliomas have been described previously.④,⑤,⑥ Recently, the appearance of an aortoopulmonary window paraganglioma on real-time ultrasound was reported.⑦ Both of these modalities have imaged a homogeneous tumor with uniform soft tissue texture. The relation of the tumor to nearby structures can be defined by both CT and ultrasound to some extent. However, we believe that a careful comparison of the accuracy of CT, ultrasound, and MR imaging in their multiplanar capability to discern the relation of tumor to adjacent vessels and organs is warranted. The MR appearance of a mediastinal pheochromocytoma (functioning paraganglioma) was reported recently and found to provide good definition of the tumor's extent and relation to the aorta, pulmonary artery, pericardium, and heart chambers.⑧ The authors did not describe the T1 and T2 image characteristics of the tumor. Both images they presented appeared to be T2WI, and the intensity of the tumor was similar to or greater than that of subcutaneous fat; the tumor appeared homogeneous.

The MR image, in our case, showed the tumor to be homogeneous and of an intermediate signal intensity on T1WI, similar to liver and more intense than muscle. On T2WI, the tumor was of homogeneous increased signal, moderately less intense than subcutaneous fat. The homogeneous appearance may be important in separating paraganglioma from other benign mediastinal lesions. Benign mediastinal lesions described by MR imaging have been markedly heterogeneous in texture with the exception of cysts and fatty tumors.⑨ Cysts and fatty tumors should be separable from paraganglioma on the basis of combined T1WI and T2WI characteristics. A cyst appears homogeneously hyointense (less intense than muscle) on T1WI and hyperintense on T2WI. A fatty tumor appears hyperintense (similar to subcutaneous fat) on T1WI and also of relatively increased intensity on T2WI (similar to other fat).

Mediastinal bronchogenic cancer does appear homogeneous on MR imaging and has no distinguishing characteristics, of which we are aware, to separate it from paraganglioma. Pheochromocytomas of the adrenal are very intense (greater than fat) on T2WI, distinguishing them from all other benign functioning and nonfunctioning adenomas.⑩ Whether a distinguishing intensity difference will hold true between nonfunctioning paraganglioma and pheochromocytoma in the chest remains to be proved. We hypothesize that a functioning paraganglioma will be of markedly increased intensity on T2WI similar to or greater than that of subcutaneous fat as was suggested in a previous report.④ The nonfunctioning paraganglioma will be of increased intensity on T2WI but less than that of fat as was demonstrated in our case.

REFERENCES