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AJNR Am J Neuroradiol 1995, 16 (8) 1729-1732

<http://www.ajnr.org/content/16/8/1729>

This information is current as
of April 18, 2024.

Cervical Thorium Dioxide Granuloma ('Thorotrastoma')

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Summary: An elderly woman had an expanding cervical mass that entrapped and compressed the adjacent cranial nerves, blood vessels, and muscles. The mass was dense on radiographs, extended from the skull base to low neck in the prevertebral and parapharyngeal tissues, and showed mixed intensity on MR. A previous direct carotid arteriogram with thorium dioxide as the contrast agent suggested the histologically proved diagnosis of a cervical thorium dioxide granuloma ("thorotrastoma").

Index terms: Neck, magnetic resonance; Granuloma; Contrast media, complications

Thorium dioxide (Thorotrast) was introduced as a radiologic contrast agent in 1928 by Radt (1). An estimated 10 000 to 100 000 patients were injected with thorium dioxide worldwide, with approximately 4000 to 5000 patients exposed in the United States (2). Almost all of the injected thorium dioxide is retained within the body; about 60% is deposited in the liver, 19% in the spleen, and 21% in the reticuloendothelial system of the bone marrow (3). The radioactivity of thorium dioxide and its retention in the liver and bone marrow account for the high rate of hepatic neoplasms and blood dyscrasias associated with this agent, use of which was discontinued in the early 1950s.

Case Report

A 64-year-old white woman presented with difficulty breathing and an enlarging left neck mass. On examination, she had inspiratory stridor worsening with phonation, left-sided deviation of the larynx, left vocal cord paralysis, a left Horner syndrome, and a large, fixed left neck mass extending from the mastoid tip to the lower neck.

The patient's medical history was significant for longstanding hypertension and migraine headaches as a child. As part of the evaluation for migraines, the patient had bilateral direct carotid artery puncture arteriograms in 1943. No intracranial aneurysms were seen, and the mi-

graines abated in early adulthood. During a work-up for cerebrovascular disease in the 1970s, the patient was noted to have a left neck mass in the same location as the current lesion. The patient had surgical exploration of her left neck. Although the records from this admission are incomplete, the carotid artery and vagus nerve may have been injured or resected at that time. The mass could not be completely excised because of its invasiveness. Pathologically, the mass was characterized as "granulomatous." This mass grew through the 1970s and 1980s and increasing neck discomfort, difficulty swallowing, and globus symptoms developed.

Imaging evaluation of this patient included a barium swallow, which demonstrated a radiopaque left neck mass (Fig 1A), and compression of the left and posterior aspect of the pharynx, vallecula, and piriform sinuses. There was discoordinated swallowing. A computed tomography (CT) scan showed a peripherally calcified mass in the prevertebral and parapharyngeal tissues with evidence of left tongue atrophy and vocal cord paralysis (Fig 1B). On magnetic resonance (MR), the mass showed mixed intensity on all pulse sequences, thought to represent hemorrhage (Fig 1C-E). A low-intensity peripheral wall corresponded to calcification seen on CT. An MR angiogram did not show the left common, internal, or external carotid arteries (Fig 1F).

Because of continued growth and discomfort of the left neck mass, resection of the lesion was performed. During surgery, the mass was noted to be calcified and fibrotic peripherally with a necrotic center. The carotid vessels could not be identified within the mass. Pathologic examination revealed granulomatous inflammation associated with extensive dense fibrosis, calcification, and the presence of granular brown pigmented foreign material consistent with thorium dioxide deposits (Fig 1G). Thorium dioxide was discovered to be the contrast agent used for the arteriograms in 1943.

Discussion

Local granuloma formation at the site of injection usually occurs 15 or more years after

Received September 12, 1994; accepted after revision November 30.

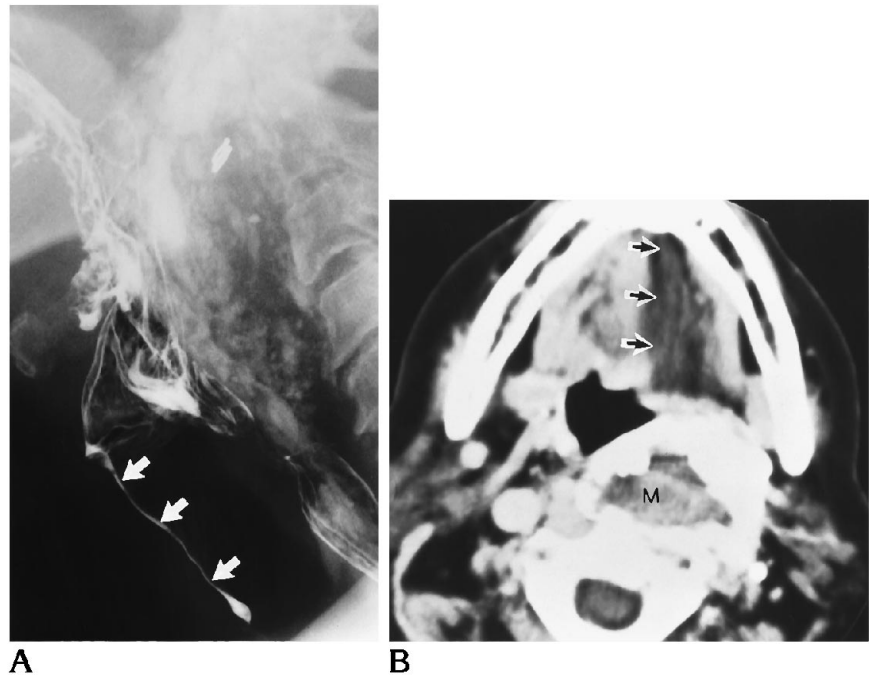
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AJNR 16:1729-1732, Sep 1995 0195-6108/95/1608-1729 © American Society of Neuroradiology

Fig 1. A, On the lateral barium swallow view one sees the posterior pharyngeal wall displaced anteriorly by a calcified mass. Note also that the patient has aspirated (*arrows*) secondary to dis-coordinated swallowing from her cranial neuropathies.

B, The mass (*M*) has a dense rim and is located in the prevertebral space on this contrast-enhanced CT. The ipsilateral carotid artery and jugular vein cannot be identified. The tongue is atrophied (*arrows*) from tumor involvement of the extracranial portion of cranial nerve XII. (*Figure continues.*)



thorium dioxide administration. During intra-vascular thorium dioxide administration, extravasation may occur, initiating a local cellular reaction against the foreign substance and, in time, leading to tissue fibrosis. Thorium dioxide carotid angiography had a 3% to 10% rate of extravasation in patients, in at least 50% of whom thorium dioxide granulomas (“thorotrastomas”) developed (4–6). The cervical mass may entrap cranial nerves IX, X, XI, and XII and the sympathetic chain, resulting in atrophy of respective innervated tissues, pain, cough, hoarseness, vocal cord paralysis, dysphagia, tongue fasciculations, laryngeal edema, dyspnea, and Horner syndrome (7–9). Compression and/or obstruction of cervical blood vessels may induce cerebrovascular insufficiency, vessel thrombosis, vascular erosion, and hemorrhage (9, 10).

Radiographically, nearly every case of a thorium dioxide granuloma has shown extensive hyperdensity, because of thorium dioxide deposition compounded by calcification. Spread from the skull base to the mediastinum is not uncommon, presumably because of the effect of gravity or the lymphatic drainage pathways of thorium dioxide—engulfing macrophages (5, 7, 11). Necrosis within or adjacent to the granuloma, manifested as low density on CT within the hyperdense mass, may occur (11).

Without the history of thorium dioxide exposure, the heterogeneous signal intensity and calcified rim on CT and MR with absent flow on the MR angiogram might suggest the possibility of a thrombosed chronic pseudoaneurysm of the common carotid artery. Pseudoaneurysms have variable MR presentations depending on their size and age and the extent of thrombosis (12). Concentric, laminated rings of hemorrhage in various stages and a lumen of variable patency (recognized by a flow void) are typically seen (12).

Other differential diagnostic possibilities of a mass in this region include calcified tuberculous or fungal infections, myositis ossificans, glomus tumors, and schwannomas. Most patients with granulomatous infections would have systemic symptoms or a definite history of previous infection. It would be rare for such an inflammatory mass to grow without adjacent cellulitic changes or edema in the fat. The calcification that was seen in the thorium dioxide granuloma would not be unusual in retropharyngeal histoplasmosis or tuberculosis. Myositis ossificans would be unusual in the retropharynx where muscle is scarce. Glomus tumors (paragangliomas) usually are isodense on noncontrast CT, have flow voids on MR, and dramatically enhance after contrast. Diffuse calcification and occlusion of the common carotid artery in a

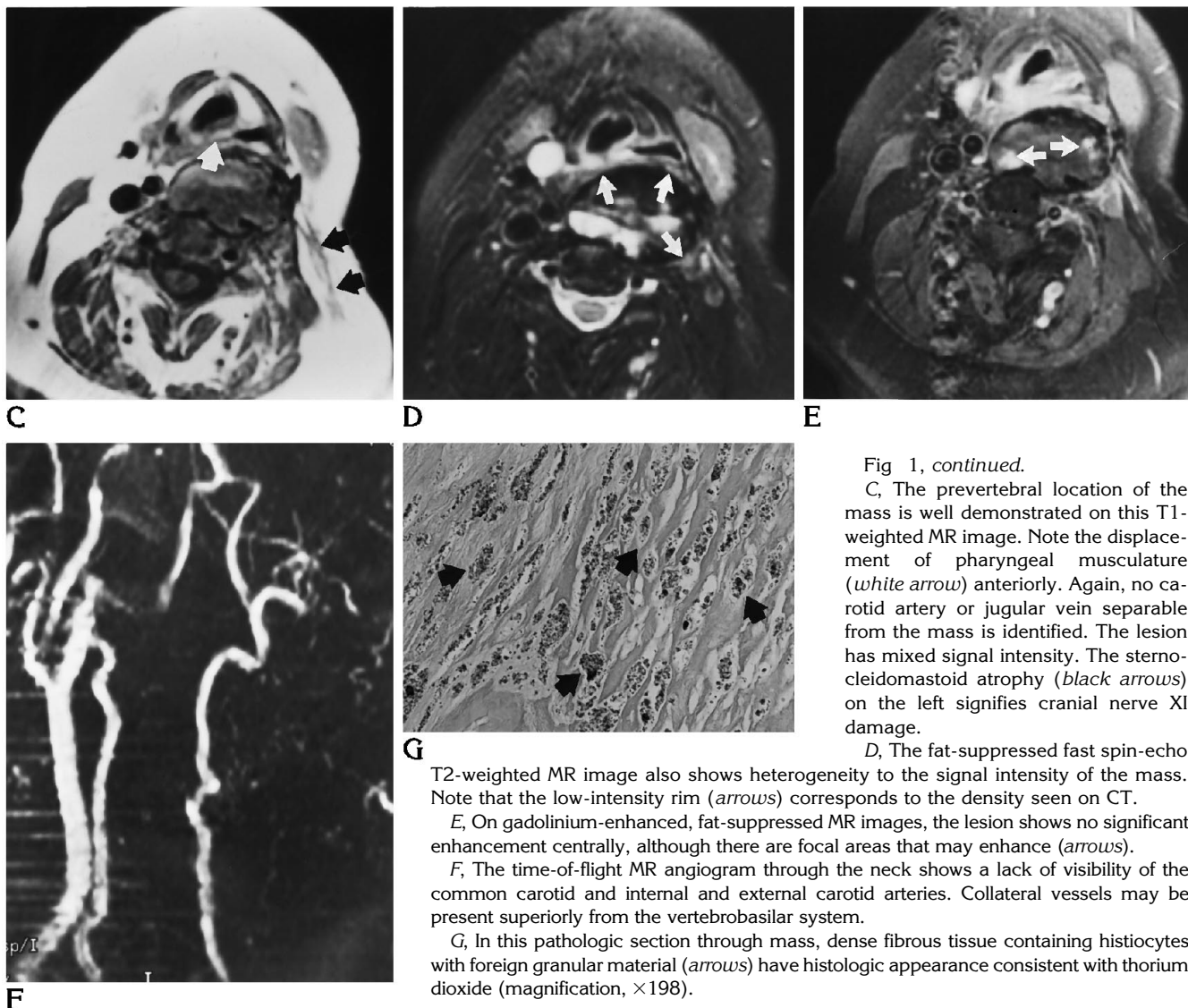


Fig 1, continued.

C, The prevertebral location of the mass is well demonstrated on this T1-weighted MR image. Note the displacement of pharyngeal musculature (white arrow) anteriorly. Again, no carotid artery or jugular vein separable from the mass is identified. The lesion has mixed signal intensity. The sternocleidomastoid atrophy (black arrows) on the left signifies cranial nerve XI damage.

D, The fat-suppressed fast spin-echo T2-weighted MR image also shows heterogeneity to the signal intensity of the mass. Note that the low-intensity rim (arrows) corresponds to the density seen on CT.

E, On gadolinium-enhanced, fat-suppressed MR images, the lesion shows no significant enhancement centrally, although there are focal areas that may enhance (arrows).

F, The time-of-flight MR angiogram through the neck shows a lack of visibility of the common carotid and internal and external carotid arteries. Collateral vessels may be present superiorly from the vertebrobasilar system.

G, In this pathologic section through mass, dense fibrous tissue containing histiocytes with foreign granular material (arrows) have histologic appearance consistent with thorium dioxide (magnification, $\times 198$).

paraganglioma would be uncommon findings. Schwannomas arising from nerve sheaths of cranial nerves IX, X, and XI have a smooth, well-defined round or lobular border, are hypodense on CT, and moderately enhance. They do not usually calcify or occlude vessels.

Another consideration in this case is the possibility of a soft-tissue sarcoma associated with the chronic radiation exposure from the extravasated thorium dioxide. Hasson et al noted that neurofibrosarcomas, fibrosarcomas, angiosarcomas, osteosarcomas, chondrosarcomas, mesotheliomas, and malignant fibrous histiocytomas have been associated with thorium dioxide (13). The growth of the mass with time and the increasing symptoms might have suggested the possibility of a sarcoma. A soft-tissue osteosar-

coma could have been dense, but one would expect a greater degree of enhancement in a sarcoma. Only the chondrosarcomas would calcify so extensively.

In summary, history is worth a thousand images. The remote history of exposure to the agent at cerebral angiography provided the diagnosis of a thorium dioxide granuloma.

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