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S Aggarwal, J H Deck and W Kucharczyk

Neuroendocrine Tumor (Paraganglioma) of the Cauda Equina: MR and Pathologic Findings

Shashi Aggarwal,[1,3] John H. N. Deck,[2] and Walter Kucharczyk[1]

Summary: The MR and pathologic features of a case with neuroendocrine tumor (paraganglioma) of the cauda equina are presented. MR showed the tumor to be hyperintense on post-contrast examination and also showed serpiginous flow voids suggesting vessels capping the tumor. A neuroendocrine tumor should be considered in the differential diagnosis of tumors in this location.

Index terms: Cauda equina; Spinal cord, neoplasms; Spinal cord, magnetic resonance

Neuroendocrine tumors (NETs) are so called because they are composed of cells that have neural features of peptide-containing secretory granules and potential endocrine function. This term has largely replaced the term *apudoma* which is derived from the concept, proposed by Pearse (1), of a widely dispersed system of cells displaying *a*mine *p*recursor *u*ptake and *d*ecarboxylation. These cells are located in a wide variety of sites, including the adenohypophysis, thyroid gland, pancreatic islets, gastrointestinal tract, tracheobronchial tree, adrenal medulla, skin, and chemoreceptor system, among others. Many but not all of the NETs arising from these cells produce symptoms caused by hypersecretion of peptide hormones.

We report here the magnetic resonance (MR) findings in a patient with a pathologically proved NET (paraganglioma) of the cauda equina.

Case Report

A 44-year-old woman presented with a 1½-year history of low back pain radiating into her right leg and foot. A computed tomography (CT) scan done at another hospital 1 year previously was reported as showing mild "degenerative changes" in the lumbar spine but was otherwise normal. Treatment by a chiropractor and at the pain clinic at another hospital afforded little relief. The patient's pain continued to progress and a repeat CT scan at another hospital a few weeks before admission was reportedly unremarkable. An attempt at a myelogram resulted in a bloody tap.

At presentation to our hospital, she stated that there had been increasing pain with inability to dorsiflex her right foot and toes for the past few weeks. She denied any bladder or bowel symptoms. On examination, there was slight right leg weakness. The right knee jerk was absent, and the plantar reflexes were flexor bilaterally. There was decreased pin prick sensation in the right L4-L5 distribution and decreased rectal tone.

An unenhanced axial CT scan of the lumbar spine obtained at our institution was interpreted as normal. Myelography was attempted but yielded only a bloody tap. An MR examination of the lumbosacral spine with and without Gd-DTPA (gadolinium diethylene triamine pentaacetate) was then obtained. This revealed an intradural mass extending from below the level of the conus medullaris down to the S1 level (Fig. 1).

Surgical exploration revealed a sausage-shaped, soft, whitish, encapsulated tumor with a cyst in its caudal portion originating from the filum terminale. It had a rich vascularity that was most marked superiorly. A gross total removal of the tumor was achieved. A follow-up MR examination has shown recurrence of a small tumor nodule 2 years and 3 months later (Fig. 2) but, so far, without the return of neurologic symptoms.

Pathology

The excised tumor was composed of epithelial cells with a predominantly papillary pattern (Fig. 3A). The papillae had fibrovascular cores covered by crowded tumor cells having small round nuclei with moderately dispersed chromatin and occasional nucleoli and either vesicular or pale slightly granular cytoplasm. No mitotic figures were present.

Immunocytochemistry showed strong positive staining for neuron-specific enolase and chromogranin, neuroen-

A

B

C
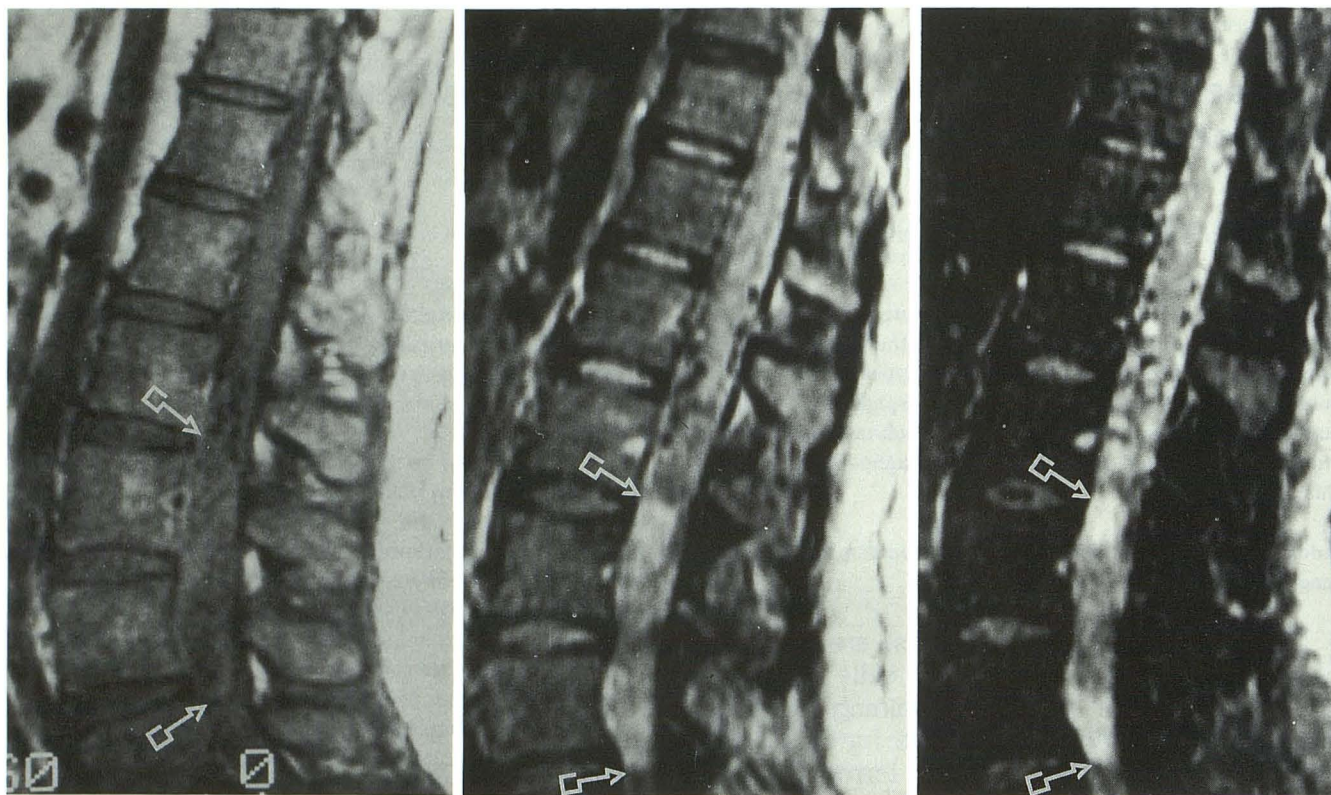
Fig. 1. *A*, Nonenhanced sagittal T1-weighted spin-echo image (600/20/4, TR/TE/ excitations) reveals a large intradural tumor (*arrows*) that is almost isointense to the spinal cord except for a caudal hypointense area.

B, Proton density- (2400/35/2) and *C*, T2-weighted spin-echo images (2400/70/2) reveal bulk of the tumor (*arrows*) to be isointense to the spinal cord, but the superior and inferior poles are markedly hyperintense. The fluid collection in the soft tissues posteriorly is related to a recent attempt at a myelogram.

D, Sagittal T1-weighted spin-echo image (600/20/4) 8 minutes after intravenous injection of Gd-DTPA shows heterogeneous but intense enhancement of the tumor (*arrows*). The superior pole enhances most intensely, whereas the caudal cyst does not enhance. Note the flow void within the prominent vessels related to the superior pole of the tumor (best seen in *A*, *B*, and *C*).
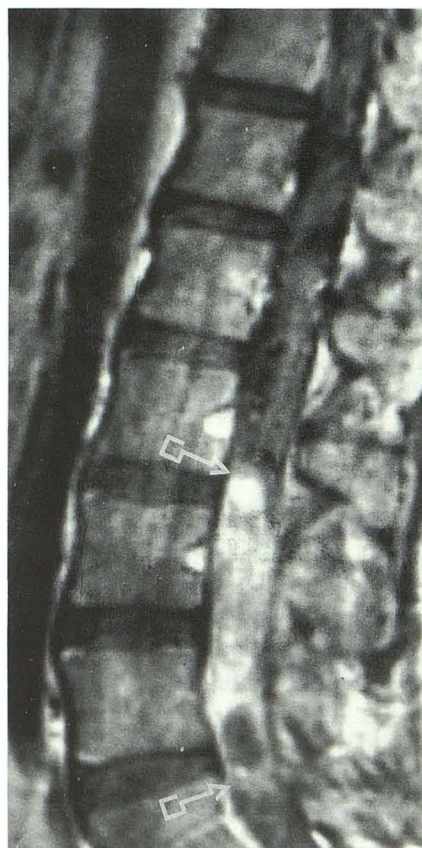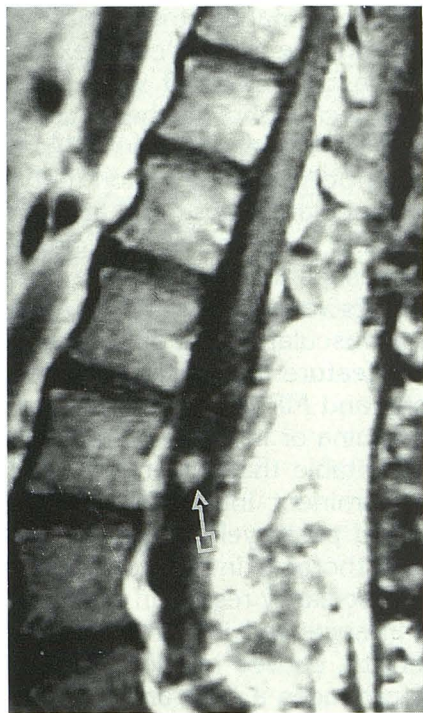
D

Fig. 2. Follow-up MR examination 2 years and 3 months after surgery. Gd-DTPA-enhanced sagittal T1-weighted spin-echo image (467/11) shows a recurrent tumor nodule (*arrow*) at the L3 level.

docrine markers, in the majority of cells (Fig. 3B). Scattered cells were positive for cytokeratin and epithelial membrane antigen, markers of epithelial cells. Tumor cells were negative for glial fibrillary acid protein (GFAP) and S-100, markers for glial cells. Scattered cells were positive for synaptophysin, serotonin, somatostatin, and the α-subunit of glycoprotein hormones; and negative for bombesin, pancreatic polypeptide, insulin, glucagon, gastrin, vasoactive intestinal polypeptide, calcitonin, corticotropin (ACTH), epinephrine, and norepinephrine, all hormones of neuroendocrine cells. Electron micrographs showed the majority of cells to contain membrane-bound secretory granules of variable shape, size, and electron density, often with electron-lucent halos.

Discussion

NETs from a wide variety of sites have been given distinctive names including Merkle cell tumor (skin), oat cell carcinoma (lung), islet cell tumor (pancreas), medullary carcinoma (thyroid), paraganglioma (chemoreceptor system), and carcinoid (gastrointestinal and respiratory tracts). Occasionally, NETs are found at sites where the cell of origin is obscure. The cauda equina is one such site and the NETs reported at this site have been identified as paragangliomas except for a single report of a metastatic carcinoid tumor (2).

Russell and Rubinstein (3) have continued to use the term paraganglioma for all NETs of the cauda equina regardless of their histologic variations or immunocytochemical profile. In fact, the tumor in our patient had certain histologic and immunocytochemical features (absence of S-100 protein and the presence of α-subunit as well as the presence of keratin and the histologic papillary pattern) which may be thought to favor a diagnosis of carcinoid tumor rather than paraganglioma. Nonetheless, most of the pathologic features of the tumor in our patient have been documented in tumors reported as paragangliomas. In addition, the clinical presentation and operative findings were typical of the NET reported to date as paraganglioma. The patient was not known to have a primary NET at any other
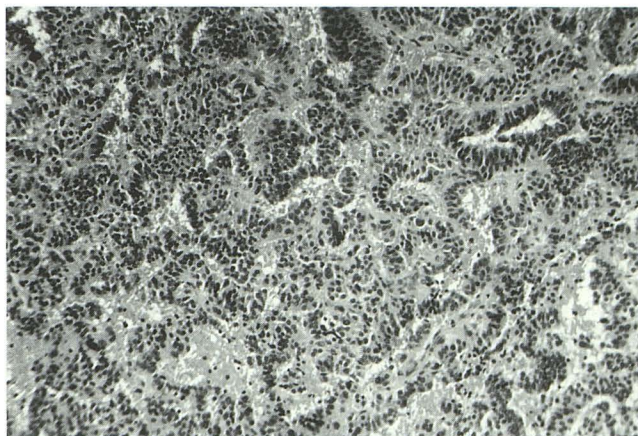
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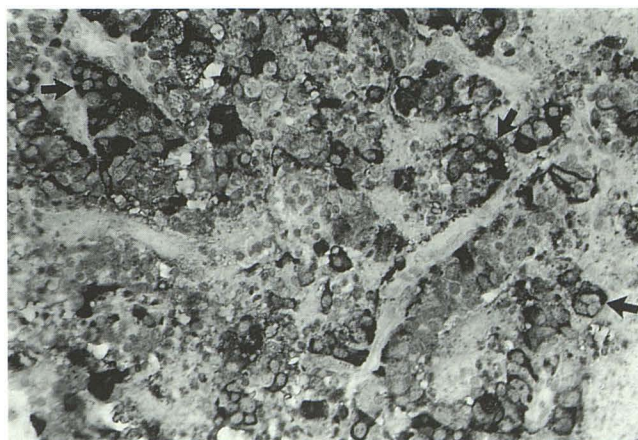
B

Fig. 3. *A*, Photomicrograph of tumor showing architectural features with a predominantly papillary pattern. (hematoxylin-eosin, ×10 objective).

B, Photomicrograph of immunocytochemical reaction for chromogranin (a neuroendocrine marker) showing the dark reaction product in the cytoplasm of many tumor cells (*arrows*), the nuclei remaining unstained (×25 objective).

site at the time of excision nor has one declared itself in the more than 2 years since that time.

Miller and Torack (4) are widely credited with the initial description of paraganglioma of the cauda equina (although the tumor was unrecognized as such by them). However, Solymosi and Ferbert (5) mention that this diagnosis was made at their institution as early as 1964. By 1986, Sonneland et al (6) had collected 56 cases of this tumor from the literature (including 31 of their own) making it a distinct clinicopathologic entity.

In general, paragangliomas of the cauda equina are tumors of midlife (reported age range, 13–71 years) with a slight male predominance (6). The patients usually present with symptoms and signs suggestive of a cauda equina lesion; low back pain with or without associated sciatica is the most common symptom (6). The duration of symptoms may vary from one day to 15 years (mean, 48 months) (6). Cerebrospinal fluid protein levels are frequently elevated. The great majority of these tumors are intradural-extramedullary and encapsulated. Most originate from the filum terminale and, less commonly, from the caudal nerve roots (6). Their size at the time of diagnosis may be up to 10 cm (mean, 3 cm).

Experience thus far with reported cases suggests that prognosis depends less on histology and more on features such as encapsulation and the completeness of excision (6). Subtotal resection or simple biopsy, even if followed by radiation, are often complicated by recurrence that may be more extensive than the original tumor. Recurrences have been noted even more than a decade after the initial surgery, emphasizing the need for long-term follow-up of these patients (6, 7). In our patient, recurrence more than 2 years after an apparently complete surgical removal of the tumor is unusual.

The clinical features of our patient were similar to those previously reported. Myelography was twice unsuccessful and produced only a "bloody tap," undoubtedly because of the needle entering the vascular tumor on both occasions. in the literature, myelography has been reported to show a partial or complete block (6)—a nonspecific finding. The CT scan in our patient was also unhelpful, although it should be noted that intravenous contrast enhancement was not performed.

MR clearly showed the intradural tumor. On the T1-weighted spin-echo images, it was isointense with respect to the spinal cord except for the caudal cyst which was hypointense (Fig. 1).

On T2-weighted images, the tumor was again isointense with the spinal cord except for its cranial and caudal ends that were hyperintense. Except for the caudal cyst, the tumor enhanced markedly after intravenous Gd-DTPA, especially in its superior portion—the region that was most noticeably vascular as observed at surgery. This feature, like the presence of serpiginous vessels capping the superior pole of the tumor, was indicative of its vascular nature.

The hypervascular nature of paragangliomas is a distinctive feature that has been noted on both angiography and MR imaging, be it the tumor in the cauda equina or in the head and neck region (8, 9). It is notable that Silverstein et al (8) also observed prominent intradural vessels on myelography and postmyelography CT in their patient with a thoracic intradural paraganglioma. This hypervascularity results in punctate areas of flow void interspersed in a matrix of increased signal intensity, caused by slow flow and tumor cells, that produces a "salt-and-pepper" appearance on T2-weighted images which is considered to be characteristic of paragangliomas in the head and neck (9). However, this salt-and-pepper appearance was not observed in our case.

The differential diagnosis of a tumor in the cauda equina includes an ependymoma and, less commonly, a meningioma, nerve sheath tumor, or drop or hematogenously spread metastases. Differentiating these tumors on MR (with or without Gd-DTPA) is frequently not possible because of considerable overlap in their imaging findings (10). Like Parizel et al (10), we also found Gd-enhanced T1-weighted images to be diagnostically more useful than unenhanced T2-weighted images. The enhanced scan was particularly useful in accurately delineating the superior and inferior extent of the tumor.

In summary, we have presented the MR findings of a case with NET (paraganglioma) of the cauda equina. MR showed postcontrast enhancement of the tumor and also showed its serpiginous flow voids. The latter were felt to be caused by either hypervascularity of the tumor or compression of veins by the large mass resulting in their dilatation. A (paraganglioma or other) NET, albeit rare, should be considered in the differential diagnosis of an intradural tumor in this location.

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