Hemodynamic activity associated with a paraganglioma of the cauda equina

Case report

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A 53-year-old man presented with a paraganglioma of the cauda equina that caused significant hemodynamic instability during removal. The clinical implications of this phenomenon are discussed.

KEY WORDS • paraganglioma • cauda equina • operative complication

NEOPLASMS of the paraganglion system (paragangliomas) have been documented in several areas throughout the body. Although paragangliomas are commonly found in association with the adrenal medulla, carotid body, and glomus jugulare, they have also been reported in such diverse locations as the liver,17 urethra,26 cerebellopontine angle,17 larynx,3 and duodenum.11

Recently, paragangliomas of the cauda equina have been described as distinct clinical and pathological entities.10,16,23,24,25,27,31 Although paragangliomas contain neurosecretory vesicles, none of the histologically confirmed tumors reported in the cauda equina has displayed a functional capacity. In this report we describe a paraganglioma of the cauda equina that clearly exhibited secretory activity during the immediate preoperative and intraoperative phases of its resection.

Case Report

This 53-year-old man presented with a 1½-year history of progressive back and bilateral leg pain. The pain was described as a constant ache in the lower lumbar area that radiated through the buttocks, posterolateral thigh area, and calves, and into the dorsum of the feet. The discomfort increased with straining maneuvers, prolonged standing, and during the night. There were no motor, sensory, or sphincter disturbances. Over the 3 weeks prior to admission, the pain worsened dramatically. The patient had undergone a tendon transfer in the lower left leg to improve a foot drop. Otherwise, his medical history was negative for cardiovascular disease and symptoms of paroxysmal catecholamine excess, including hypertensive crises or episodes of diaphoresis, palpitations, flushing, or apprehension.

Examination. Physical examination revealed a blood pressure of 150/90 mm Hg and a regular pulse rate of 80 beats/min. Neurological assessment was significant for a shortened, diffusely atrophied left leg. Strength in the right leg was graded as 4+/5 and in the left leg as 4/5 proximally and 3/5 distally. There was a loss of pinprick and light-touch sensation over the lateral malleolus of the left ankle, extending to the dorsum of the foot. The left ankle jerk was absent. Except for mild weakness of the right leg and proximal left leg, all of these neurological findings had been present throughout the patient’s life. Straight-leg raising on the left produced posterior thigh pain at 60°. Examination of the back exhibited paraspinal muscle spasm but no tenderness. There was no evidence of a dysraphic state.

No biochemical or hematological abnormalities could be identified. The electrocardiographic recording was normal. A myelogram revealed a large intrathecal mass opposite the L-3 vertebra. Magnetic resonance imaging confirmed a 5½-cm lesion with heterogeneous enhancement, more peripheral than central. A low-signal area corresponding to vessels was noted above the mass.

Operation. On entering the operating room, the patient experienced transient supraventricular tachycardia (heart rate 130 beats/min). This passed spontaneously and he was placed under general endotracheal anesthesia using vecuronium, fentanyl, sodium thiopental, and isoflurane. The following parameters were continuously

J. Neurosurg. / Volume 79 / September, 1993

451
monitored: electrocardiographic tracing, central venous pressure, blood pressure (via an intra-arterial catheter), oxygen saturation, exhaled carbon dioxide content, urine output, and temperature.

After administration of general anesthesia, the patient's blood pressure was approximately 150/60 mm Hg. When he was placed in the knee-chest position, his blood pressure rose to approximately 200/100 mm Hg; an additional injection of 250 μg fentanyl was given and the pressure gradually stabilized at 150/80 mm Hg. A midline low-lumbar incision was made to expose the posterior L2-4 spinal elements. During the laminectomy, there was a sharp rise in blood pressure with a systolic peak of 210 mm Hg, and 2 mg vecuronium and 100 μg fentanyl were administered. When the laminectomy was complete, the patient's blood pressure returned to normal. Ultrasound studies were performed to localize the tumor, and the dura was opened.

The tumor was immediately obvious as a globular, dark red mass protruding beneath the nerve roots, displacing and compressing the majority of the nerve tissue to the left. When the arachnoid was opened and the borders of the lesion gently explored, the anesthesiologist noted a rapid rise in blood pressure and tachycardia. The manipulations were stopped, with an accompanying decrease in blood pressure; however, with every subsequent handling of the tumor, the blood pressure and pulse rate increased dramatically. This problem culminated with the systolic pressure reaching 230 mm Hg during maneuvers to deliver the entire mass from beneath the nerve roots, at which point the tumor was attached only by a large vascular pedicle originating from the rostral end (Fig. 1). The vascular pedicle was then clipped and transected, leading to a rapid return of hemodynamic stability (Fig. 2). The blood pressure remained at 140/70 mm Hg and no further difficulties were encountered (Fig. 3).

Postoperative Course. The patient had complete resolution of pain and his leg strength returned to baseline. No new neurological deficits developed. He was discharged home and, in view of the gross total removal, there were no plans for adjunctive radiation therapy or chemotherapy.

Pathological Examination. The light microscopic and ultrastructural features of the paraganglioma are illustrated in Figs. 4 and 5. The encapsulated tumor was cellular, vascular, and histologically benign. It contained numerous dilated capillaries, and abundant sinois lined the tumor cells. Many of the capillaries were surrounded by dense fibrous connective tissue. The tumor cells grew in small groups, but only rare examples of clumping cells were identified. In some areas, perivascular rosette-like structures, reminiscent of an ependymoma, were noted. The tumor cells were polygonal with faint basophilic granular cytoplasm due to numerous secretory vesicles that were readily visualized using Bielschowsky's and/or Grimelius' staining methods. Focal neuronal specialization was noted. Avidin-biotin complex immunohistochemical staining of the neoplasm, using aminoethylcarbazole as the chromogen, demonstrated the presence of neuron-specific enolase (polyclonal) and chromogranin A (monoclonal); no labeling by monoclonal antibodies against glial fibrillary acidic protein or cytokeratin AE1/AE3 was seen. Electron microscopic examination showed groups of polyhedral cells surrounded by a basal lamina. Intercellular membrane specializations were sparse. Neith-
er epithelium nor basal lamina separated the tumor cell membranes from the sinusoidal spaces. Fenestrated capillaries were not identified. The majority of the tumor cells contained scant to moderate numbers of large, sometimes pleomorphic, vesicles (0.06 to 0.26 μ in diameter) that contained a single dense core with margins separated from the vesicular membrane by an electron-lucent space 0.015 μ thick.

Discussion

In recent years, reports of cauda equina paragangliomas have accumulated; there are now more than 50 cases recorded in the literature. Their natural history generally appears to be one of slow growth with rare reports of local invasion. This relatively benign characteristic is substantiated by the absence of any reported recurrences following total macroscopic surgical resection.

The histological, ultrastructural, and immunocytochemical features of paragangliomas have been described in detail. Examination of the tumor under light microscopy supports the clinical impression that this neoplasm is benign, although it has been noted that gross characteristics are a better indicator of prognosis. The tumor is renowned for pathological misdiagnosis, with initial reports labeling it a secretory ependymoma, ependymoblastoma, menigioma, and angiofibroma. Ultrastructural findings consistently include the presence of dense-core granules, strong evidence of biogenic amines, and biochemically identified neuropeptides (such as 5-hydroxytryptamine, somatostatin, dopamine, epinephrine, and norepinephrine).

Despite repeated observations of intracytoplasmic dense-core granules and fenestrated capillary epithelial, there have been no reports of functional activity in a histologically confirmed cauda equina paraganglioma. Böker, et al. described the case of a 23-year-old man presenting with pluriradicular symptoms and occasional “flush-like attacks.” A primary intradural tumor was removed from the conus medullaris/cauda equina region; however, a definite histological diagnosis could not be made. The pathological differential diagnosis based on the tumor’s histological appearance included angioblastic menigioma, ependymoma, and angiomatic paraganglioma.

The neoplasm removed from our patient was unequivocally a paraganglioma. The hemodynamic lability of the patient while under general anesthesia was incontrovertibly associated with surgical manipulations of the tumor. This was most evident when the vascular pedicle was clamped, resulting in an immediate return of blood pressure and cardiac stability. The cardiac and vasomotor reactivity was not associated with anesthetic agents. The patient had no history of cardiac abnormality and did not develop any postoperatively. Standard manipulations of the cauda equina and adjacent structures do not produce the changes that we encountered in our patient. The sinusoidal growth pattern observed in the pathology specimen provided clear evidence of a potential pathway for the secretory elements to reach the systemic circulation. The conclusion that the cauda equina paraganglioma in our patient secreted vasoactive agents such as catecholamines into the systemic circulation appears inescapable.

Fortunately, our patient tolerated the episodes of tachycardia and hypertension without consequence. A patient with an underlying coronary artery disease and limited cardiac reserve, however, would be jeopardized if exposed to similar extremes of pulse rate and blood pressure. The increased myocardial workload and potential for catecholamine-induced arrhythmia could be catastrophic. Furthermore, there is evidence that cat-
echolamines can have a direct toxic effect on the myocardium\(^{0.11,33}\) and can increase the release of thromboxane A\(_2\), leading to platelet aggregation and coronary thrombosis.\(^{25}\)

This experience shows that a patient with significant coronary artery disease who presents with a conus medullaris/cauda equina tumor deserves additional consideration. An awareness of the lesion and its potential for producing hemodynamic instability may prevent an intraoperative cardiac disaster. Paragangliomas within the spinal canal cannot be differentiated clinically from other lesions, most notably ependymomas and neurofibromas, and routine radiography adds little to the distinction. However, radioactive metaiodo-benzyl quanidine, through its uptake into neurosecretory granules, has been used to label paragangliomas.\(^{5,16,20,32}\) Although uptake does not imply functional activity, this test would at least differentiate a paraganglioma from other neoplasms. Clearly, this test is not required for every spinal intradural tumor; however, in the patient with cardiac disease and a cauda equina lesion, it may warn both the neurosurgeon and the anesthesiologist. With prior knowledge of a potential catecholamine-secreting tumor, the anesthesiologist can make perioperative anesthetic preparations similar to those for a pheochromocytoma.\(^{24,33}\) Preparations such as these have reduced the perioperative mortality rate of patients with pheochromocytoma surgery from between 13% and 45% to between 0% and 3%,\(^{7,8,24}\)

Conclusions
Paragangliomas of the cauda equina are uncommon lesions. Even rarer, occurring in no more than 2% of cases, are tumors with functional secretory activity. However, when catecholamine release does occur it can be dramatic, causing marked hemodynamic instability. Anticipation by the anesthesiologist and guarded operative manipulation by the surgeon will minimize the risk of paraganglioma removal.

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