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Localization of Technetium-99m Pertechnetate in Peripheral Nerve Tumors

Kevin J. Koch, Aslam R. Siddiqui, Henry N. Wellman, and Robert L. Campbell

Department of Radiology, Division of Nuclear Medicine, and Department of Surgery, Neurological Surgery Section, Indiana University School of Medicine, Indianapolis, Indiana

Technetium-99m pertechnetate scintigraphy in three patients with pathologically proven peripheral nerve tumors (six in total) demonstrated its ability to assess accurately the size, location, and the extent of all lesions. Pertechnetate localized only in areas of abnormal nerve involvement and all lesions were better seen in delayed images than the earlier ones. Pertechnetate imaging appears to be a promising method of noninvasive evaluation of clinically evident and occult tumors of peripheral nerve origin.


Technetium-99m ($^{99m}$Tc) in the form of sodium pertechnetate (pertechnetate) has a variety of uses in clinical nuclear medicine. When administered intravenously, pertechnetate normally localizes in the salivary glands, thyroid, choroid plexus, gastric mucosa, and in the genitourinary tract. Pertechnetate often demonstrates vascular or hypervascular lesions; however, this localization is transient and related to blood-pool activity. Prolonged retention or active accumulation after administration of sodium perchlorate is rare in locations other than central nervous system (CNS) lesions and genitourinary tract. Some conditions causing abnormal localization of pertechnetate are ectopic gastric mucosa, such as Meckel's diverticulum and Barrett's esophagus, small bowel obstruction due to intussusception, inflammatory bowel disease, hemangioma, and, in rare instances, soft tissue neoplasms (1).

The value of pertechnetate brain scanning in evaluation of patients with intracranial pathology is well-documented (2-4). The accumulation of pertechnetate in brain tumors is at least in part due to breakdown of the blood-brain-barrier in the involved regions. Passive and/or active accumulation of the radiotracer by the tumor cells, especially acoustic neuromas, also has been demonstrated (1,2). On the premise that peripheral nerve tumors can occasionally share common intrinsic characteristics with primary CNS neoplasms, we have attempted to detect peripheral nerve tumors using whole body pertechnetate imaging. Here we report three patients with histologically proven peripheral nerve tumors (neurofibrosarcoma, neurilemmoma, and neurofibroma) in which there was active accumulation of pertechnetate.

METHODS

Each patient was premedicated with 500 mg of potassium perchlorate orally prior to i.v. administration of ~20 mCi of $^{99m}$Tc]pertechnetate. Initial dynamic sequence images were obtained, immediately followed by blood-pool images over areas of interest. Additional early images were obtained over the chest and abdomen. Whole-body images in anterior and posterior projections were obtained at ~2½ hr after injection. Additional static images were performed over the areas of interest as determined by the whole-body scans. In one patient, single photon emission computed tomographic (SPECT) imaging also was performed. Images were obtained employing a low-energy, parallel hole, all-purpose collimator and large field-of-view gamma camera.

CASE REPORTS

Patient 1

A 40-yr-old female presented with a 6-wk history of numbness, tingling, and weakness of the right upper extremity. At the age of 24, she had received radiation therapy to the right cervical and supraclavicular regions for Stage IA Hodgkin's disease. Physical examination revealed flaccid paralysis, anesthesia, and muscular atrophy suggesting brachial plexus dysfunction. Magnetic resonance imaging and CT revealed an intradural tumor at C-5 to T-2 level. An aggressive malignant
schwannoma was partially resected at surgery. This was followed by six courses of chemotherapy with some improvement in symptomatology. Three weeks later, she returned complaining of progressive weakness and paresthesia in the right upper extremity. A cervical pantopaque myelogram revealed a large intradural extramedullary mass causing near complete block at the T-2 level. Pertechnetate scintigraphy was performed. Dynamic study and 5-min postinjection (blood-pool) images appeared normal (Fig. 1A). Delayed images (Fig. 1B) demonstrated abnormal areas of tracer accumulation in the cervical cord and right supra and infraclavicular regions. SPECT images demonstrated intense uptake of radionuclide in the cervical cord region and in the region corresponding to the right brachial plexus (Fig. 1C). A biopsy was performed and histologic examination revealed radiation-induced neurofibrosarcoma.

Patient 2

A 26-yr-old white male was admitted for evaluation of suspected peripheral nerve tumors. Five years prior to admission, he noted a lump posterior and superior to his right knee in the distal right thigh. The mass gradually grew in size and eventually became tender. Two years prior to admission, surgical exploration revealed a tumor involving the sciatic nerve; the tumor was not excised, and grossly appeared to be a neurofibroma. Shortly after surgery, the patient noted two new masses, one on the medial aspect of his right mid-upper arm and the other posterior and inferior to the right knee, in the calf.

On physical examination, fairly well-localized soft-tissue masses were confirmed in the areas described above. Pertechnetate scintigraphy was performed, with delayed images showing intense accumulation of the radioactivity in the right medial upper arm, right distal thigh, and right proximal calf (Fig. 2). No additional abnormal areas of uptake were seen.

At surgery, the right upper extremity tumor was noted to be arising from the right median nerve. The excision took several hours, and it was elected not to attempt concomitant removal of other tumors during the same surgical procedure. Histologic examination revealed neurilemmoma (Schwannoma). Three days later, the lower extremity tumors were excised and both were neurilemmomas.

Patient 3

A 38-yr-old white male with a history of excision of numerous peripheral nerve tumors in the past, presented with a painful, well-circumscribed mass in the right popliteal fossa with extension into the distal thigh and proximal calf. Previously excised tumors were a neurofibroma involving the left posterior tibial nerve, schwannoma involving the left sciatic nerve, a neurofibroma on the dorsum of the right foot, and a neurofibroma involving the left saphenous nerve. Physical examination revealed a firm, tender mass in the right popliteal fossa, mild hypalgesia and hypesthesia in the right foot, and an irregular cafe-au-lait spot on the inner aspect of the right foot. Diffuse freckling of the entire body was present, and there was ill-defined brown pigmentation over the anterior aspect of the distal left thigh. The patient was diagnosed as having the segmental form of neurofibromatosis. Pertechnetate scintigraphy was obtained. Dynamic study revealed a vascular lesion posterior to the right knee. Delayed images demonstrated tracer accumulation in the soft tissues of the right popliteal fossa, posterior distal right thigh, and posterior
proximal right calf (Fig. 3). The mass was excised and confirmed as neurofibroma.

DISCUSSION

Peripheral nerve tumors may be solitary or multiple and may involve any peripheral nerve, nerve root, or peripheral nerve root ganglion (5). Schwannomas (neurilemmomas) of the peripheral nerves usually involve sensory branches; however, motor branches also can be affected. Initial clinical presentation usually is in the fifth decade of life; but sometimes these tumors are encountered at an earlier age, particularly in association with von Recklinghausen’s neurofibromatosis. Malignant transformation of peripheral schwannomas is rare, and ~50% of these patients have von Recklinghausen’s disease. Neurofibromas may develop along any of the cranial nerves, peripheral nerves, as well as the nerve roots or dorsal root ganglia. In rare instances, they can be solitary, but more often, they are multiple, especially in von Recklinghausen’s neurofibromatosis. Neurofibrosarcoma is a rare, highly infiltrative and aggressive neoplasm of neuronal origin that can arise in the central or peripheral nervous system. Neurofibrosarcomas can be induced by previous radiation therapy, whether in the central or peripheral nervous systems.

To our knowledge, pertechnetate has not been reported previously to localize actively in benign and/or malignant peripheral nerve tumors. Reports of uptake of $[^{99m}Tc]$diethylefletriamjlepent@cetic acid by soft-tissue tumors (soft-tissue sarcomas, uterine leiomyoma, and neurofibromas) have recently appeared in the literature (6,7).

Using pertechnetate scintigraphy, we were able to localize and define the extent of every tumor in all three patients. The exact mechanism of pertechnetate localization in these tumors is unknown at present. Identification of some of these lesions on initial dynamic sequences most likely is due to blood-pool phenomenon. Late tracer accumulation, after significant clearance of the vascular and background activity, appears to support a hypothesis for some sort of passive or active accumulation by the tumor cells in question. In the first patient, the lesion was not seen on the initial dynamic study or on the 5-min postinjection (blood-pool) image, but rather was detected only on delayed images, indicating slow blood pooling due to increased capillary permeability or active accumulation.

Pertechnetate imaging appears to be a promising method of noninvasive evaluation of clinically evident and occult tumors of peripheral nerve origin. Further work is needed to assess sensitivity and specificity of this technique and to understand the mechanism of uptake.
**FIGURE 3**
Posterior (A) and lateral (B) images of left knee, obtained 2 hr after i.v. administration of pertechnetate demonstrate increased activity in left popliteal fossa, distal posterior left thigh, and proximal posterior left calf.

**REFERENCES**


