

# Gallium and Thallium Scintigraphy in Pediatric Peripheral Primitive Neuroectodermal Tumor (Askin Tumor) of the Chest Wall

Robert Howman-Giles, Roger F. Uren and Stewart J. Kellie

*Departments of Nuclear Medicine and Oncology, The Royal Alexandra Hospital for Children, Sydney, Australia*

A 3.5-yr-old child presented with a large thoracic mass which showed avid accumulation of  $^{67}\text{Ga}$  and  $^{201}\text{Tl}$  was studied. Histology showed a peripheral neuroectodermal tumor of the chest wall typical of the malignancy described as the Askin tumor. The  $^{201}\text{Tl}$  studies were a more accurate method of following tumor response to therapy than  $^{67}\text{Ga}$  scintigraphy.

**Key words:** gallium-67; thallium-201; peripheral neuroectodermal tumors; Askin tumors

**J Nucl Med 1995; 36:814–816**

**P**eripheral primitive neuroectodermal tumors or neuroepithelioma are a more differentiated form of tumor that is classified in the Ewing's sarcoma family (1). Gallium-67 and  $^{201}\text{Tl}$  scintigraphy have been well described in the management of Ewing's tumor in the initial staging and later in follow-up to detect local recurrence of disease and metastases (2,3).

## CASE REPORT

A 3.5-yr-old child was transferred to the hospital for further investigation of respiratory failure and a left-sided thoracic mass 5 days after initial presentation for treatment of suspected pneumonia. On arrival, this intubated, ventilated boy had normal oxygen saturation in  $\text{FiO}_2$  of 0.4 and a hemorinous drainage from two left-sided intercostal catheters. Respiratory examination demonstrated deviation of the trachea to the right, minimal left-sided expansion, a stony-dull percussion note and minimal breath sounds on the left. A chest x-ray revealed a large mass in the left side of the thorax (Fig. 1). Doppler ultrasound showed a lobulated  $16 \times 13 \times 10$ -cm mass occupying the whole left chest with inferior displacement of the diaphragm and spleen. The heart was enclosed by the tumor anteriorly. The tumor was poorly vascularized and the flow pattern in supplying vessels appeared normal, which was confirmed by a CAT scan (Fig. 2). Other staging investigations included bone,  $^{201}\text{Tl}$  and  $^{67}\text{Ga}$  imaging. A  $^{201}\text{Tl}$  scan was obtained after injection of 150 mBq  $^{201}\text{Tl}$  adjusted to body

weight (Fig. 3A). Scanning was commenced within 10 min of the injection. There was moderate uptake of tracer into the tumor which extended throughout the left thoracic cavity. A total-body bone scan with  $^{99\text{m}}\text{Tc}$ -methylene diphosphonate revealed increased uptake in ribs 7, 8, 9 on the right side and rib 10 on the left side. The distribution throughout the remainder of the skeleton was normal. A  $^{67}\text{Ga}$  scan revealed marked avidity in the thoracic tumor (Fig. 3B). No other lesions were detected in the body. Biopsy of the mass on electron microscopy revealed tumor cells that were poorly differentiated and more structurally complex than Ewing's sarcoma. The cells contained moderate amounts of glycogen and free ribosomes. No dense core granules were found, but small numbers of membrane-bound profiles with an electron-dense matrix suggestive of neurosecretory granules were detected. This appearance was highly suggestive of a primitive peripheral neuro-ectodermal lung tumor or Askin tumor (4–7).

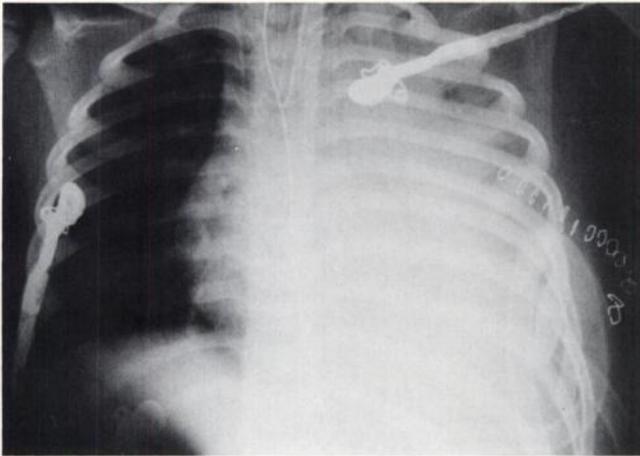
The patient was treated with an intensive multi-agent chemotherapy protocol. Three months later, restaging was performed and showed reduced but persistent uptake of  $^{201}\text{Tl}$  and  $^{67}\text{Ga}$  in the tumor. Further restaging at 6 mo showed a marked reduction in the tumor mass on a CAT scan with a residual mass in the left apex. The  $^{201}\text{Tl}$  scan showed a focal increase within the mass in the left apex, indicating residual active tumor (Fig. 3C). The  $^{67}\text{Ga}$  scan (Fig. 3D) was normal. Thoracotomy was performed to biopsy the residual mass, revealing a small-cell, undifferentiated malignant neoplasm that resembled the original biopsy specimen and was typical of a thoracopulmonary primitive neuroectodermal tumor. The patient continued on chemotherapy, but died 3 mo later. No autopsy was performed.

## DISCUSSION

The differential diagnoses of childhood and adolescent tumors composed of small round cells include a distinctive clinicopathological entity called malignant small-cell tumor of the thoraco-pulmonary region in childhood (1,4–7). This tumor was described by Askin et al. (4) to have features of neural differentiation. Based on morphological, immunocytochemical and ultrastructural evidence, malignant small-cell tumor of the thoracopulmonary region can be considered a peripheral neuroectodermal tumor (PNET) or a specific type of peripheral neuroepithelioma. This tumor arises from the periosteum, soft tissue, extrapulmonary fields of the thoracic wall, including intercostal nerves, and in the lung, with or without rib involvement (4). PNET are distinct entities that have a characteristic pattern of cell

Received Apr. 18, 1994; revision accepted Oct. 17, 1994.

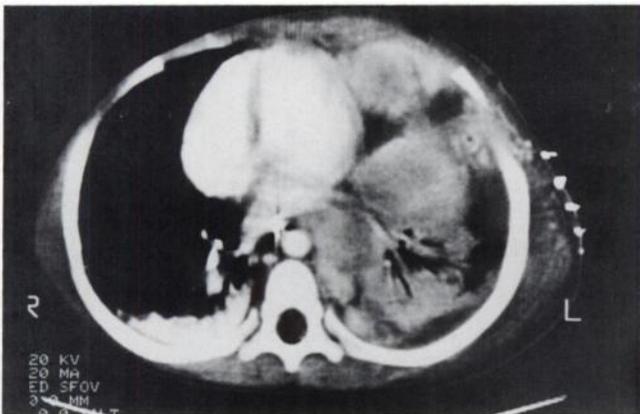
For correspondence or reprints contact: Dr. Robert Howman-Giles, Head, Department of Nuclear Medicine, The Royal Alexandra Hospital for Children, Bridge Road, Camperdown NSW 2050, Australia.



**FIGURE 1.** Chest x-ray shows a large solid mass involving the left thoracic cavity.

surface markers, a distinctive pattern of proto-oncogene expression, a cholinergic phenotype and expresses a consistent cytogenetic abnormality, the reciprocal t(11,22) (q24;q12) translocation. PNET are rare and comprise approximately 5% of tumors in the Ewing's family group of tumors. Clinicopathologic studies of PNET show that the predominant location for the tumor is the chest wall, and males and females are equally affected (4-7). Initial reports indicate a poor prognosis, but there is a much better survival rate with aggressive combined modality treatment or aggressive multi-agent chemotherapy combined with total-body irradiation and autologous bone marrow transplant (1).

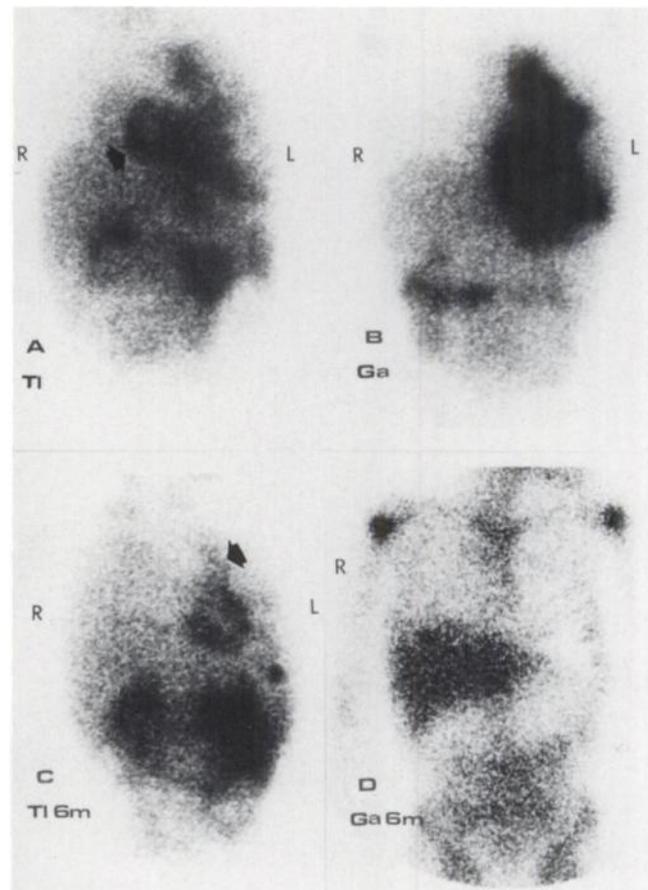
Gallium-67 and <sup>201</sup>Tl scintigraphy have been well described in the management of patients with Ewing's and osteogenic sarcoma (2,3,8-10). The main applications have been in determining the extent of the primary tumor and detecting local recurrences of tumor after treatment. Thallium-201 scintigraphy, however, appears to reflect residual disease or early recurrence more accurately because there is no significant uptake due to the normal bone healing response often seen on bone and <sup>67</sup>Ga scans. Ramanna



**FIGURE 2.** CAT scan shows a large solid mass filling the left thoracic cavity.

et al. (2) compared <sup>67</sup>Ga scans to graded histologic results before and after chemotherapy to determine the percentage of tumor necrosis. Thallium-201 scans correlated better than bone and <sup>67</sup>Ga scans in depicting the percentage of tumor necrosis. Similar data were documented by Stoller et al. (9), who described <sup>201</sup>Tl in primary bone tumors, compared <sup>201</sup>Tl to <sup>67</sup>Ga and correlated the results with MRI. Thallium-201 was found to be the most accurate radionuclide in determining extent of tumor and appeared useful in following tumor response to chemotherapy. Thallium-201 uptake has also been described in pediatric tumors, particularly in patients with lymphoma, primary bone tumors, cerebral tumors and, more recently, soft-tissue sarcomas (11-14). Thallium uptake was described by LaManna et al. in a leiomyosarcoma of the chest wall (15).

Because Askin tumors appear ultrastructurally to be of the Ewing's family of tumors, it is not surprising that there is significant <sup>201</sup>Tl and <sup>67</sup>Ga avidity, as seen in our patient.



**FIGURE 3.** (A) Initial <sup>201</sup>Tl scan (anterior view) shows avid uptake of tracer throughout the left thoracic cavity. There is medial displacement of the heart (arrow). (B) Initial <sup>67</sup>Ga scan (anterior view) shows marked avidity in the thoracic tumor with extension into the left upper abdominal quadrant. This was due to displacement of the diaphragm. (C) Thallium-201 scan (anterior view) at 6 mo restaging shows persisting activity in the left apical mass (arrow), suggestive of active residual tumor. The small focus on the lower left side of the chest is due to activity in the central line port. (D) Gallium-67 scan (anterior view) at 6 mo restaging is normal.

Thallium-201 imaging in this patient played an important role in determining active residual disease, whereas the <sup>67</sup>Ga study had returned to normal.

## REFERENCES

1. Horowitz ME, Malawer MM, DeLaney TF, Tsokos MG. Ewings' sarcoma family of tumors: Ewing's sarcoma of bone and soft tissue and the peripheral primitive neuroectodermal tumors. In: Pizzo PA, Poplack DG, eds. *Principles and practice of pediatric oncology*, 2nd edition. Philadelphia: J.P. Lippincott Co.; 1992:795-821.
2. Ramanna L, Waxman A, Binney G, Waxman S, Mirra J, Rosen G. Thallium-201 in bone sarcoma: comparison with gallium-67 and technetium-MDP in the evaluation of chemotherapeutic response. *J Nucl Med* 1990;31:567-572.
3. Kirchner PT, Simon MA. The clinical value of bone and gallium scintigraphy for soft-tissue sarcomas of the extremities. *J Bone Joint Surg* 1984;66A:319-327.
4. Askin FB, Rosai J, Sibley RK, Dehner LP, McAlister WH. Malignant small-cell tumor of the thoracopulmonary region in childhood. A distinctive clinicopathologic entity of uncertain histogenesis. *Cancer* 1979;2438-2451.
5. Contesso G, Llombart-Bosch A, Terrier P, et al. Does malignant small round cell tumor of the thoracopulmonary region (Askin tumor) constitute a clinicopathologic entity? *Cancer* 1992;69:1012-1020.
6. Linnoila RI, Tsokos M, Triche TJ, Marangos PJ, Chandra RS. Evidence for neural origin and PAS positive variants of the malignant small cell tumor of thoracopulmonary region ("Askin tumor"). *Am J Surg Pathol* 1986;10:124-133.
7. Marina NM, Etcubanas E, Parham DM, Bowman LC, Green A. Peripheral primitive neuroectodermal tumor (peripheral neuroepithelioma) in children. *Cancer* 1989;64:1952-1960.
8. Yeh SDJ, Rosen G, Caparros B, Benua RS. Semiquantitative gallium scintigraphy in patients with osteogenic sarcoma. *Clin Nucl Med* 1984;9:175-183.
9. Stoller DW, Waxman AD, Rosen G. Comparison of thallium-201, gallium-67, technetium-99m-MDP and magnetic resonance imaging of musculoskeletal sarcoma [Abstract]. *Clin Nucl Med* 1986;12(suppl):15.
10. Waxman AD. Thallium-201 in nuclear oncology. In: Leonard M. Freeman, ed. *Nuclear Medicine annual* Raven Press Ltd, New York; 1991:193-209.
11. Nadel Helen R. Thallium-201 for oncological imaging in children. *Semin Nucl Med* 1993;3:243-254.
12. O'Tuama L, Treves ST, Larar JN, et al. Thallium-201 versus technetium-99m-MIBI in evaluation of childhood brain tumors: a within-subject comparison. *J Nucl Med* 1993;34:1045-1051.
13. Howman-Giles R, Uren R, White G, Shaw P. Thallium-201 scintigraphy in pediatric solid tumors [Abstract]. *J Nucl Med* 1993;34:52P.
14. Nadel HR, Poskitt KJ, Flodmark CO. Thallium scintigraphy in childhood neoplasms [Abstract]. *J Nucl Med* 1990;31:939.
15. LaManna MN, Lumia FJ, Feierstein M, et al. Thallium-avid leiomyosarcoma of the chest wall. Case report. *J Nucl Med Technol* 1988;16:189-190.