

Unusual Concentration of Tc-99m methylendiphosphonate in Rhabdomyosarcoma

Arie Franco^{1*}, Patrick Ryan Henderson¹, Colleen Hope McDonough²

1. Department of Radiology, Georgia Health Sciences University, Augusta GA, USA

2. Department of Pediatrics, Georgia Health Sciences University, Augusta GA, USA

* **Correspondence:** Arie Franco M.D., Ph.D., Georgia health Sciences University, Department of Radiology, 1120 15th Street, Augusta, GA 30912, USA

(✉ afranco@georgiahealth.edu)

Radiology Case. 2012 Sep; 6(9):29-34 :: DOI: 10.3941/jrcr.v6i9.1144

ABSTRACT

Extrasosseous accumulation of bone-seeking agents is rare, but has been previously reported in pediatric sarcomas and neuroblastomas. We present an unusual case of a 5-month-old male with an abdominal mass observed clinically by his parents and referring pediatrician. Contrast abdominal computerized tomography confirmed the presence of a large pelvic mass that was diagnosed pathologically as embryonal rhabdomyosarcoma. A bone scintigraphy that was performed for staging of the disease revealed accumulation of the radiopharmaceutical in the tumor. There was no evidence for skeletal metastatic disease. This case further demonstrates the nonspecificity of soft-tissue tumor uptake on bone scintigraphy.

CASE REPORT

CASE REPORT

A 5-month-old male was admitted to our institution with an abdominal mass that was observed clinically by his parents and referring pediatrician. The abdominal computerized tomography confirmed the presence of a large pelvic mass (figures 1, 2) that was diagnosed as embryonal rhabdomyosarcoma. The mass did not demonstrate calcifications on CT. A bone scintigraphy, performed for staging of the disease, revealed accumulation of the radiopharmaceutical in the tumor. No metastatic lesions were noted. (figure 3). The patient had chemotherapy and surgical resection of the tumor and is currently on remission.

DISCUSSION

Rhabdomyosarcoma is a malignant tumor that represents 5% of all childhood cancers [1]. In adults, rhabdomyosarcoma is rare, accounting for only 3% of the soft-tissue sarcomas [2]. The incidence of rhabdomyosarcoma is 6 cases per 1,000,000 per year in children and adolescents younger than 15 years.

Rhabdomyosarcoma is known to be more common in boys and in white children [3].

In younger children rhabdomyosarcoma most often arises from the genitourinary tract, particularly from the bladder, prostate, and paratesticular, uterus and vagina [3]. In older children the tumor arises mainly from the neck, orbits, and extremities. In sonogram the tumor has heterogeneous variable nonspecific echotexture. The solid component of the lesion has been described as hyperechoic or hypoechoic and may contain sonolucent foci [4]. In CT the mass has usually heterogeneous appearance and enhances heterogeneously. Low attenuation usually represents necrosis. On MRI the mass has low signal on T1-weighted sequence and high signal on T2-weighted sequence. The mass usually heterogeneously enhances. A bone scintigraphy is usually performed during staging to screen for metastatic lesions. It is unlikely that bone-seeking radiopharmaceutical will concentrate in the tumor.

The current classification for rhabdomyosarcoma includes embryonal (with the less common subtype botryoid and variant spindle cell) which have an intermediate to superior prognosis,

alveolar (with a poorer prognosis), undifferentiated sarcoma (also with a poorer prognosis), and sarcoma not otherwise specified [4]. Although rhabdomyosarcoma shares certain imaging characteristics with other soft-tissue sarcomas, it has been reported that there are rather unique features at presentation which should make the radiologist consider the diagnosis. In a previous study, it was shown that tumor heterogeneity is more prominent in alveolar and pleomorphic subtypes of adult rhabdomyosarcoma. These subtypes were also noted to have extremely high signal on T2 and STIR MRI [5]. Contrary to adult rhabdomyosarcoma where alveolar rhabdomyosarcoma demonstrated more heterogeneity in cross sectional imaging, rhabdomyosarcoma in the pediatric population demonstrates no significant difference in attenuation between the alveolar and embryonal subtypes [6].

Diagnosis of rhabdomyosarcoma depends on recognition of differentiation toward skeletal muscle cells. The proteins myoD1 and myogenin are transcription factor proteins normally found in developing skeletal muscle cells which disappears after the muscle matures and becomes innervated by a nerve. Thus, myoD1 and myogenin are not usually found in normal skeletal muscle and serve as a useful immunohistochemical marker of rhabdomyosarcoma [7].

The differential diagnosis depends on the location of the tumor. The differential diagnosis for abdominal or pelvic rhabdomyosarcoma may include teratoma, neuroblastoma, Wilms tumor, lymphangioma, and lymphoproliferative disorders. The differential diagnosis of rhabdomyosarcoma that originated from the extremities although may be the same, but tumors that are more common in the extremities such as osteosarcoma, Ewing's sarcoma or synovial sarcoma need to be included. The imaging findings of most tumors that are included in the differential diagnosis list include heterogeneous variable nonspecific sonographic echotexture. Lymphoproliferative disorder demonstrates on sonography conglomerate of lymph nodes. Lymphangioma is seen on sonography as an anechoic cystic septated mass. Most of the solid tumors that are included in the differential diagnosis list demonstrate heterogeneous low attenuation on CT with variable enhancement. On MRI these tumors demonstrate low T1-weighted signal and high T2-weighted signal. Most of the tumors that are included in the differential diagnosis list do not demonstrate accumulation of bone-seeking radiopharmaceuticals, unless there are calcifications or bony elements in the tumor, such as in teratoma.

Treatment for rhabdomyosarcoma consists of chemotherapy, radiation therapy and sometimes surgery. Surgery to remove the tumor may depend on the location of the tumor.

Accumulation of bone-seeking agents in rhabdomyosarcoma is rare, but has been previously reported [8, 9, 10]. Accumulation of bone-seeking agents has also been observed in many benign and malignant tumors such as breast cancer [11] and liver tumors [12]. The mechanism of uptake of bone-seeking agents in rhabdomyosarcoma is not completely understood, but in our case it is suggested that phosphate compound binds to a damaged mitochondria in necrotic

tumors [13]. Microcalcifications might have been produced due to ischemic changes and altered capillary permeability of the tumor. Dystrophic microcalcifications are not always detected in CT, but the link between these calcifications to ischemic and necrotic changes is well demonstrated [14].

Uptake of bone-seeking radiopharmaceuticals by pediatric tumors is very nonspecific. It is seen in neuroblastomas and in neural-crest tumors [15]. Our case further illustrates the nonspecificity of soft-tissue tumor uptake in pediatric patients to include rhabdomyosarcoma.

TEACHING POINT

Concentration of bone-seeking radiopharmaceuticals in soft tissue tumors is nonspecific and a rare event. It was described in neuroblastomas and in neural-crest tumors. We observed this unusual concentration of Tc-99m methylenediphosphonate in rhabdomyosarcoma. This may be explained by dystrophic calcifications that were produced in a necrotic tumor that are not always seen in CT. Nuclear radiologists should be aware of this rare event.

REFERENCES

1. McCarville MB, Spunt SL, Pappo AS. Rhabdomyosarcoma in pediatric patients: the good, the bad, and the unusual. *Am J Roentgenol* 2001;176:1563-9. PMID: 11373233
2. Weiss S, Goldblum JR, editors. *Enzinger and Weiss's soft tissue tumors*. St. Louis, MO: Mosby; 2001. p. 785-835.
3. Agrons GA, Wagner BJ, Longeran GJ, Dickey GE, Kaufman MS. Genitourinary rhabdomyosarcoma in children: radiologic-pathologic correlation. *Radiographics* 1997; 17:919-37. PMID: 9225391
4. Newton Jr WA, Gehan EA, Webber BL, et al. Classification of rhabdomyosarcoma and related sarcomas: pathologic aspects and proposal for a new classification. *Cancer* 1995; 76: 1073-85. PMID: 8625211
5. Allen SD, Moskovic EC, Fisher C, Thomas JM. Adult rhabdomyosarcoma: cross-sectional imaging findings including histologic correlation. *Am J Roentgenol* 2007; 189: 371-7. PMID: 17646463
6. Franco A, Lewis KN, Lee JR. Pediatric rhabdomyosarcoma at presentation: Can cross-sectional imaging findings predict pathologic tumor subtype? *Eur J Radiol* 2011; 80: e446-e450. PMID: 21306853
7. Kumar S, Perlman E, Harris CA, Raffeld M, Tsokos M. Myogenin is a specific marker for rhabdomyosarcoma: an immunohistochemical study in paraffin-embedded tissues. *Mod Pathol* 2000; 13(9):988-93. PMID: 11007039
8. Sohn MH, Lim ST, Jeong YJ, Kim DW, Jeong HJ, Yim CY. Tc-99m MDP uptake on bone scintigraphy by a giant rhabdomyosarcoma involving the lower extremity in an

elderly woman. *Clin Nucl Med.* 2010 Feb; 35(2):130-1. PMID: 20090468

9. Casara D, Bonazza A. Rhabdomyosarcoma concentrating Tc-99m MDP. *J Nucl Med.* 1983 Nov;24(11):1082-3. PMID: 6226769

10. Nishikawa J, Machida K. [Accumulation of 99mTc-MDP in rhabdomyosarcoma].. *Rinsho Hoshasen.* 1980 Dec; 25(13):1413-4. PMID: 6226812

11. Berg GR, Kalisher L, Osmond JD et al: Tc-99m diphosphonate concentration I primary breast carcinoma. *Radiology* 1973; 109: 393-394. PMID: 4355069

12. Ghaed N, Marsden J: Accumulation of Tc-99m diphosphonate in hepatic neoplasm. *Radiology* 1978; 126: 192. PMID: 619406

13. Shen AC, Jennings RB. Kinetics of calcium accumulation in acute myocardial ischemic injury. *Am J Pathol.* 1972; 67:441-452. PMID: 5033258

14. Kalantari F, Miao D, Emadali A, Tzimas GN, Goltzman D, Vali H, Chevet E, Auguste P. Cellular and molecular mechanisms of abnormal calcification following ischemia-reperfusion injury in human liver transplantation. *Mod Pathol.* 2007 Mar;20(3):357-66. PMID: 17334330

15. Howman-Giles RB, Gilday DL, Ash JM. Radionuclide skeletal survey in neuroblastoma.. *Radiology.* 1979;131(2):497-502. PMID: 441341

FIGURES

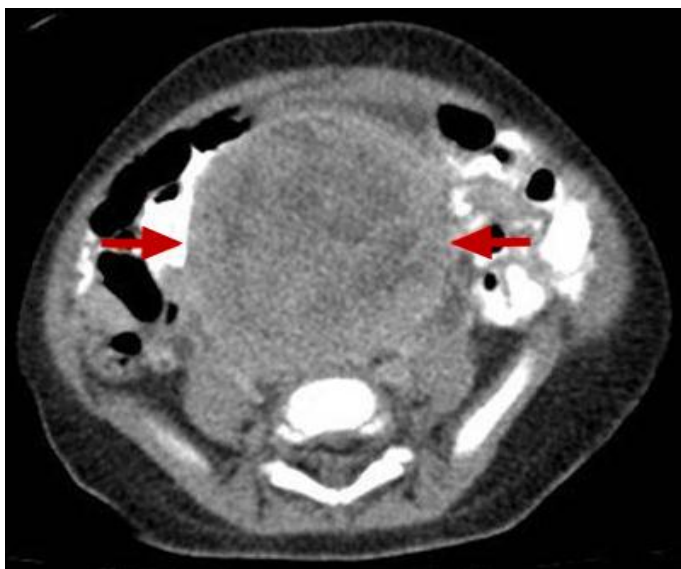


Figure 2: 5-month-old male with embryonal rhabdomyosarcoma. Coronal CT of the abdomen and pelvis obtained following the oral administration of 360 cc of diluted Omnipaque and intravenous administration of 15 cc of Omnipaque-240. The CT demonstrates heterogeneous low attenuation pelvic mass (arrows). The low attenuation represents necrosis. Macro calcifications are not visible; however, necrosis may contain micro calcifications beyond the resolution of the CT.

Figure 1 (left): 5-month-old male with embryonal rhabdomyosarcoma. Axial CT of the abdomen and pelvis obtained following the oral administration of 360 cc of diluted Omnipaque and intravenous administration of 15 cc of Omnipaque-240. The CT demonstrates heterogeneous low attenuation pelvic mass (arrows). The low attenuation represents necrosis. Macro calcifications are not visible; however, necrosis may contain micro calcifications beyond the resolution of the CT.

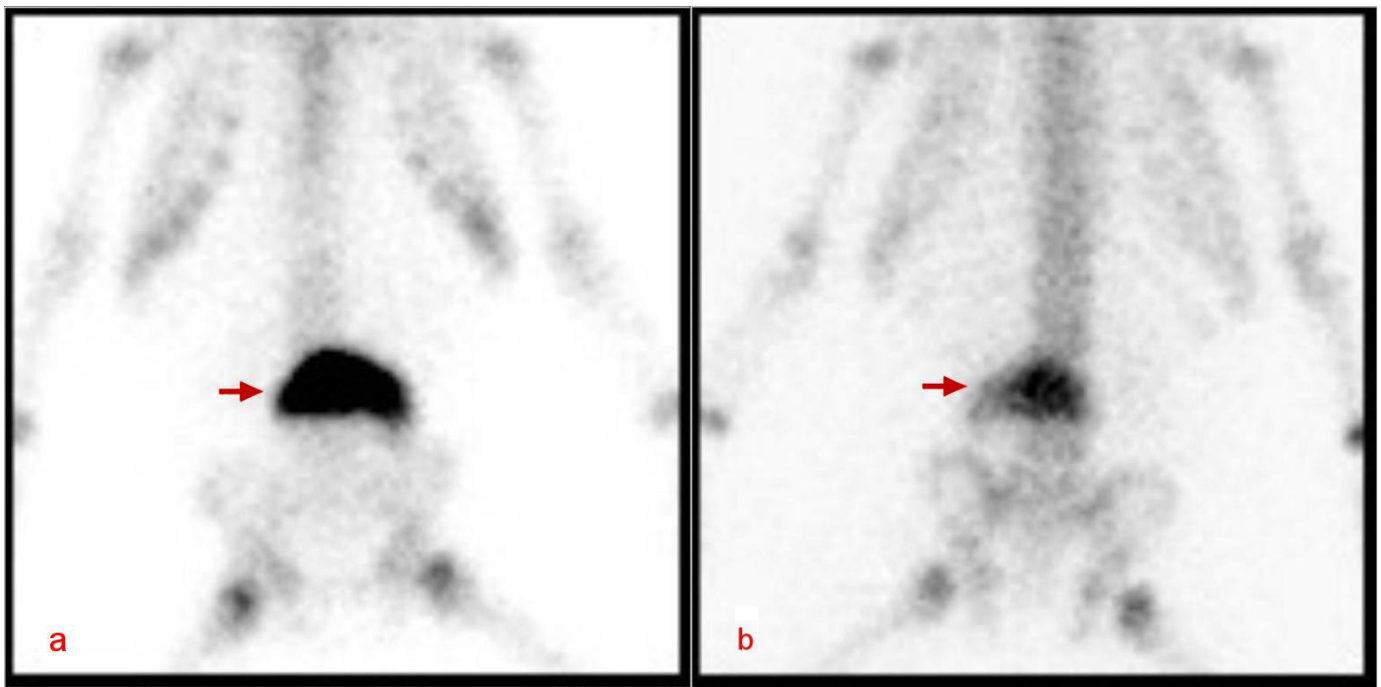


Figure 3: 5-month-old male with embryonal rhabdomyosarcoma. Delayed bone scintigraphy in anterior (a) and in posterior (b) view performed 2 hours following the administration of 1.9 mCi of Tc-99m methylenediphosphonate reveal extraosseous accumulation of the radiopharmaceutical in the abdominal mass diagnosed as embryonal rhabdomyosarcoma. There are no osseous abnormalities.

Etiology	Unclear
Incidence	5% of childhood cancers. 6 cases per 1,000,000 per year.
Gender ratio	More common in boys.
Age predilection	Children and adolescents younger than 15 years.
Risk factors	Genetic and environmental factors
Treatment	Chemotherapy, surgical resection of the tumor and radiation therapy.
Prognosis	Prognosis depends on the subtype. Prognosis is worse in the alveolar subtype than in the embryonal subtype.
Finding in imaging	Heterogeneous mass on CT. MRI shows low signal in T1; high signal in T2 and heterogeneous T1 enhancement.

Table 1: Summary table for rhabdomyosarcoma

	Sonographic findings	CT findings	MR findings	Nuclear medicine findings
Rhabdomyosarcoma	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture 	<ul style="list-style-type: none"> Low attenuation heterogeneous mass with heterogeneous enhancement 	<ul style="list-style-type: none"> Low signal in T1; High signal in T2. Heterogeneous enhancement in contrast T1. 	<ul style="list-style-type: none"> No tumor uptake of bone-seeking agents. Bone uptake if there are osseous metastatic lesions.
Teratoma	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture 	<ul style="list-style-type: none"> Low attenuation heterogeneous mass with heterogeneous enhancement. Calcification and fat may be seen. 	<ul style="list-style-type: none"> Low signal in T1; High signal in T2. Heterogeneous enhancement in contrast T1. Calcification and fat may be seen. 	<ul style="list-style-type: none"> No tumor uptake of bone-seeking agents, unless there are calcifications or bony components.
Neuroblastoma	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture 	<ul style="list-style-type: none"> Low attenuation heterogeneous mass with heterogeneous enhancement. Calcification may be seen. May cross the midline and extend to the neural foramina 	<ul style="list-style-type: none"> Low signal in T1; High signal in T2. Heterogeneous enhancement in contrast T1. Calcification may be seen. May cross the midline and extend to the neural foramina 	<ul style="list-style-type: none"> Tumor concentrates MIBG. Bone seeking agents and MIBG may concentrate in metastatic bone lesions.
Wilms tumor	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture 	<ul style="list-style-type: none"> Low attenuation heterogeneous mass with heterogeneous enhancement. Originates from kidneys and the claw sign may be seen. May invade the renal vein and the inferior vena cava. 	<ul style="list-style-type: none"> Low signal in T1; High signal in T2. Heterogeneous enhancement in contrast T1. Originates from kidneys and the claw sign may be seen. May invade the renal vein and the inferior vena cava. 	<ul style="list-style-type: none"> No tumor uptake of bone-seeking agents. Bone uptake if there are osseous metastatic lesions.
Lymphoproliferative disorders	<ul style="list-style-type: none"> Usually there is no discrete mass. Large or conglomerate of lymph nodes may be seen. Hepatosplenomegaly may be seen 	<ul style="list-style-type: none"> Usually there is no discrete mass. Large or conglomerate of lymph nodes may be seen. Hepatosplenomegaly may be seen 	<ul style="list-style-type: none"> Nodes or conglomerate of lymph nodes high signal in T2. May enhance in T1. 	<ul style="list-style-type: none"> No tumor uptake of bone-seeking agents. Bone uptake if there are osseous metastatic lesions.
Lymphangioma	<ul style="list-style-type: none"> Anechoic cystic septated mass 	<ul style="list-style-type: none"> Low attenuation cystic mass with septation with no enhancement 	<ul style="list-style-type: none"> Cystic septated mass low signal in T1 and high signal in T2. The septations may enhance. 	<ul style="list-style-type: none"> No tumor uptake of bone-seeking agents.
Osteosarcoma	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture. Usually originates from the bone and periosteal reaction may be seen 	<ul style="list-style-type: none"> Usually originated from the bone. Periosteal reaction is seen. Soft tissue invasion may be seen 	<ul style="list-style-type: none"> Low T1 signal and high T2 signal. Enhancement of tumor seen in T1. 	<ul style="list-style-type: none"> Concentration of bone seeking agents within the tumor
Ewing sarcoma	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture. Usually originates from the bone and periosteal reaction may be seen 	<ul style="list-style-type: none"> Usually originated from the bone. Periosteal reaction is seen. Soft tissue invasion may be seen 	<ul style="list-style-type: none"> Low T1 signal and high T2 signal. Enhancement of tumor seen in T1. 	<ul style="list-style-type: none"> Concentration of bone seeking agents within the tumor
Synovial sarcoma	<ul style="list-style-type: none"> Heterogeneous variable nonspecific echotecture 	<ul style="list-style-type: none"> Low attenuation soft tissue mass 	<ul style="list-style-type: none"> Low T1 signal and high T2 signal. Enhancement of tumor seen in T1. 	<ul style="list-style-type: none"> No tumor uptake of bone-seeking agents. Bone uptake if there are osseous metastatic lesions.

Table 2: Differential diagnosis table for rhabdomyosarcoma

ABBREVIATIONS

CT = Computerized tomography
MDP = Methylendiphosphonate
MRI = Magnetic resonance imaging
Tc-99m = Technetium-99m

KEYWORDS

Rhabdomyosarcoma; Bone scintigraphy; Tc-99m methylendiphosphonate; Tc-99m MDP

Online access

This publication is online available at:
www.radiologycases.com/index.php/radiologycases/article/view/1144

Peer discussion

Discuss this manuscript in our protected discussion forum at:
www.radiolopolis.com/forums/JRCR

Interactivity

This publication is available as an interactive article with scroll, window/level, magnify and more features.
Available online at www.RadiologyCases.com

Published by EduRad



www.EduRad.org