



FDG-PET/CT Avid Uptake of a Biopsy-Proven Aggressive Melanotic Schwannoma of the S2 Spinal Nerve Root

Mohammed A. Azab¹ Hamid Abdelma'about Mostafa¹ Oday Atallah²

¹Department of Neurosurgery, Cairo University, Cairo, Egypt

²Department of Neurosurgery, Hannover School of Medicine, Hannover, Germany

Address for correspondence Mohammed A. Azab, MD, Department of Neurosurgery, Cairo University, Cairo, Egypt (e-mail: mohammed.azab@kasralainy.edu.eg).

World J Nuclear Med

Abstract

Background Malignant melanotic nerve sheath tumors (MMNSTs), also known as a melanocytic schwannoma (MS), are a rare type of peripheral nerve sheath tumors including Schwann cells with melanocytic differentiation. Only a few cases of spinal MMNST have been reported in literature. Fluorine-18 fluorodeoxyglucose positron emission tomography/computed tomography (¹⁸F-FDG-PET/CT) could be used to detect these lesions.

Case Description A 70-year-old man with a 6-month history of backache was admitted to our hospital. PET/CT showed a paravertebral soft tissue mass along the spinal nerve at the S2 level with strong FDG uptake, and a nodule with increased FDG uptake in the right lobe of the left liver. A CT-guided biopsy of the S2 lesion was performed. The final diagnosis was spinal MS with hepatic metastasis. The patient received stereotactic body radiation therapy.

Conclusion Herein, we report the PET/CT findings of a case of MS with hepatic metastasis. FDG-PET/CT is helpful in the differential diagnosis of benign and malignant lesions although nonspecific.

Keywords

- ▶ melanocytic schwannoma
- ▶ FDG-PET/CT
- ▶ MMNST

Introduction

Melanotic schwannoma is a very rare variant of schwannoma that represents approximately 1% of all primary peripheral nerve sheath tumors.¹ In 1932, Millar first described this pathology in which Schwann cells can produce melanin based on its common embryological origins with melanocytes.^{1,2} It frequently affects people aged 30 to 40.³ This type of nerve tumor expresses special pathological markers differentiating it from conventional melanoma such as S-100, leu-7, and vimentin.⁴

F18-fluorodeoxyglucose positron emission tomography/computed axial tomography (¹⁸F-FDG-PET/CT) could be used as a tool for diagnosis of this tumor. On FDG-PET,

schwannomas show a high tumor-to-background ratio.⁵ About 22 schwannomas reported in literature showed avid FDG uptake.⁶ However, there is a wide variability of the FDG uptake of schwannoma throughout the literature. In this case report, we report a high FDG uptake of a biopsy-proven spinal nerve melanocytic schwannoma (MS).

Case Description

A 70-year-old man with a 6-month history of backache was admitted to our hospital. PET/CT showed a paravertebral soft tissue mass along the S2 spinal nerve with a strong FDG uptake (maximum standardized uptake value [SUVmax] 9.2) (▶ **Fig. 1**), and a nodule with increased FDG uptake in the

DOI <https://doi.org/10.1055/s-0044-1791694>.
ISSN 1450-1147.

© 2024. The Author(s).

This is an open access article published by Thieme under the terms of the Creative Commons Attribution License, permitting unrestricted use, distribution, and reproduction so long as the original work is properly cited. (<https://creativecommons.org/licenses/by/4.0/>)

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

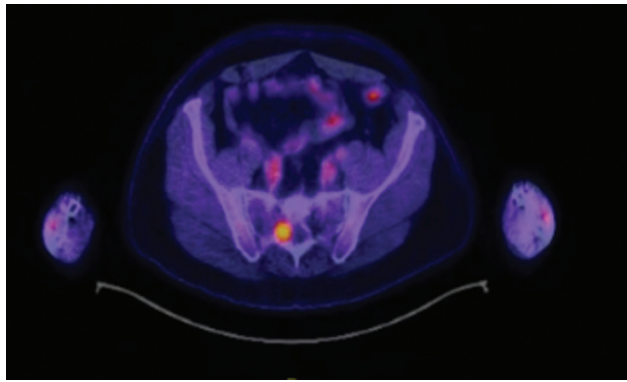


Fig. 1 PET/CT image showed increased FDG uptake in the right S2 nerve root.

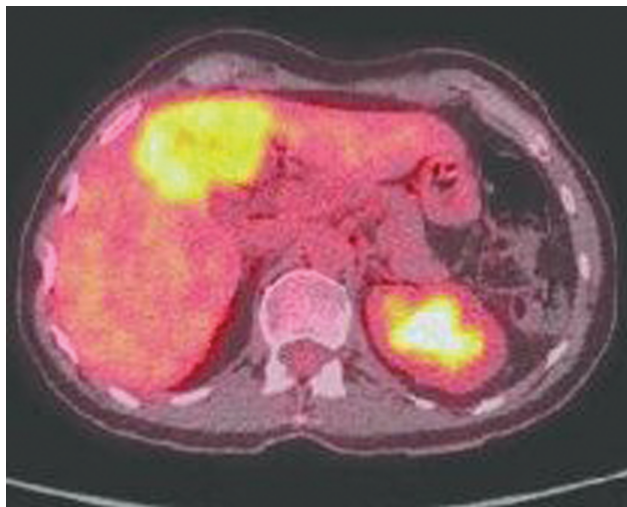


Fig. 2 Positron emission tomography (PET) scan of the liver shows avid uptake in the right lobe of the liver.

right lobe of the liver (►**Fig. 2**). Tumor markers were in the normal range. A CT-guided biopsy of the S2 lesion was performed. Pathological examination revealed spindle and epithelioid cells arranged in interlacing fascicles and nests with accumulation of melanin in neoplastic cells and associated melanin containing macrophages (►**Fig. 3**). The final diagnosis was spinal MS with liver metastasis. The patient received stereotactic body radiation therapy and immunotherapy in the form of nivolumab and ipilimumab. The patient was followed up over 6 months with a regular PET scan and showed a reduction in the SUVmax value to 2.6. He experienced marked improvement of his backache.

Discussion

MSs represent less than 1% of peripheral nerve sheath tumors and predominantly affect both genders equally. It commonly affects the cervical and upper thoracic spinal nerves, but can also arise in other locations such as the orbit, acoustic nerve, and the cerebellum.^{1,2,7} Microscopically, they show bundle-shaped, interleaved, and wheel-shaped spindle cells with melanocytic pigments. There are many theories to explain MS pathogenesis, one of them is explained by the common

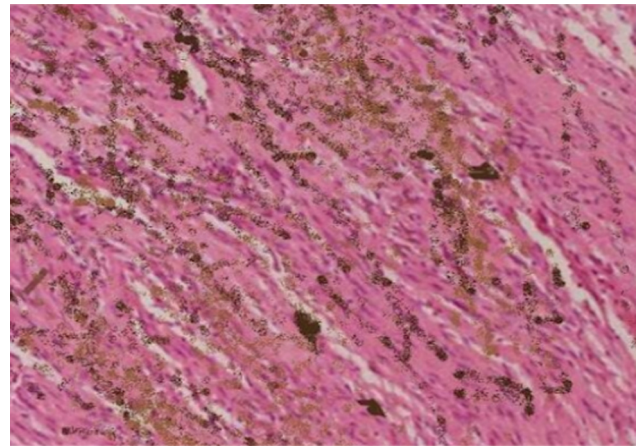


Fig. 3 Hematoxylin and Eosin stained slide showing expansile, cell dense proliferation of neoplastic spindle cells interspersed with neoplastic pigmented cells (200 magnification).

developmental origin of melanocyte and Schwann cells.³ Other possible differential diagnoses include neurofibroma, pigmented dermatofibrosarcoma, melanocytoma, and malignant melanoma.⁵ MS stains positive for S-100, leu-7, HMB-45, and vimentin and negative for glial fibrillary acidic protein, epithelial membrane antigen, and creatine kinase.⁸ magnetic resonance imaging (MRI) has a great role in MS diagnosis because of the paramagnetic feature of melanin. Conventional CT and MRI are potential tools for identifying peripheral nerve lesions and their relationship to nearby structures; however, they are not highly reliable to identify benign from malignant nerve sheath tumors. FDG-PET/CT is a potential tool in differentiating malignant from benign lesions, staging of malignant ones, evaluating the efficacy of chemotherapy and radiotherapy, and has prognostic implications.^{6,9}

Ferner et al reported that semiquantitative FDG-PET/CT analysis by calculating the SUVmax within a malignant peripheral nerve tumor had a statistically significant increase in SUVmax compared with benign lesions.¹⁰ There was a remarkable difference in the SUV uptake between benign and malignant lesions (1.5 and 5.7, respectively). Moreover, the incremental increase in delayed uptake in PET scans could differentiate malignant lesions.¹¹ Chirindel et al used a late acquisition protocol (4 vs. 1 hour) to improve the diagnostic performance; however, it was not efficient for differentiating malignant peripheral nerve sheath tumor (MPNST) from benign peripheral nerve sheath tumors (BPNST).¹² Some authors considered that FDG-PET has limited value for identifying BPNST versus MPNST.^{6,13}

Schwannomas show heterogeneous SUVmax uptake. High uptake with SUV = 12, was evident in a malignant paravertebral schwannoma, while another false positive paravertebral schwannoma showed a high uptake of 6.7 for malignancy.^{14,15} Beaulieu et al found no correlation between uptake and cellularity or proliferative index in schwannoma which makes PET scan ineffective in grading malignant schwannoma.¹³ Assessment of SUV uptake should be carefully considered as it is affected by the heterogeneous consistency and shape of the lesion which complicates interpretation.¹⁶ Overall, there is a wide variation in current

Table 1 Summary of cases with liver metastases

Study id	Case no.	Gender	Age (y)	Primary site	Treatment	Follow-up (mo)/ Outcome
Vallat-Decouvelaere et al (1999) ⁷	1	F	45	T6	Surgery	36/DOD
Torres-Mora et al (2014) ¹	2	F	23	L4	Unknown	44/AWD
Torres-Mora et al (2014) ¹	3	M	47	L3-L4	Unknown	5/DOD
Torres-Mora et al (2014) ¹	4	F	67	T10	Unknown	10/DOD
Shen et al (2021) ²⁴	5	F	29	L2-L3	Chemotherapy	12/AWD

Abbreviations: AWD, alive with disease; DOD, dead of disease; F, female; L, lumbar spine; M, male; T, thoracic spine.

literature regarding this issue, partly due to variations among scanners and scanning protocols.^{16–18} However, the SUVmax threshold of ≥ 3.5 is commonly used as a marker of malignancy, although it may represent false positive results.^{19–21} For the detection of MPNST in neurofibromatosis type 1 (NF1) patients, PET/CT is the most efficient imaging technique.^{20,21} PET/CT imaging alone is not specific enough to diagnose MPNST, and a histopathological analysis remains the gold standard for optimal diagnosis. Brahmi et al evaluated the safety and efficacy of PET-guided biopsy of MPNSTs. They found that it is an effective procedure for diagnosis of NF1-related MPNST.²²

There are several postsurgical management strategies that include radiotherapy, stereotactic radiosurgery, chemotherapy, and immunotherapy.^{2,9,23} Despite the benign behavior of schwannoma, MS showed unpredictable prognosis and tendency to metastasize. To the best of our knowledge, there are only five case reports of MS with hepatic metastasis (► **Table 1**). Shen et al reported a patient diagnosed with MS associated with liver metastasis by 18F-FDG-PET/CT and confirmed with biopsy. The patient was treated with six cycles of Endostar and temozolomide combined chemotherapy and survived for 1 year after initial diagnosis.²⁴ Haleem et al reported a similar patient with pain in S1 distribution diagnosed with schwannoma by MRI and after 12 months confirmed by biopsy and 18F-FDG-PET/CT. The FDG-PET SUVmax was 3.6 in this patient, while in our patient, the SUVmax uptake was 11.5.⁴ In our patient, we did not rely completely on the PET scan results, we biopsied the lesion. There is a wide range of the FDG-PET uptake values of schwannoma, with some studies showing high uptake while others showing a lower uptake. Therefore, we favored biopsying this lesion.

Conclusion

Unlike common schwannomas, MS is a rare type with metastatic tendency and a high recurrence rate. It shows avid uptake on FDG-PET scan as we report in this patient. Stereotactic radiosurgery may be a possible treatment option combined with immunotherapy.

Authors' Contributions

M.A. contributed to designing the idea and manuscript writing, O.A. contributed to the images preparation and

the final review, and H.M. contributed to the literature review, table preparation, and article editing.

Ethical Approval

The research/study was approved by the Institutional Review Board at Cairo University Hospital, number CU1335, and dated January 10, 2024.

Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent.

Conflict of Interest

None declared.

References

- Torres-Mora J, Dry S, Li X, Binder S, Amin M, Folpe AL. Malignant melanotic schwannian tumor: a clinicopathologic, immunohistochemical, and gene expression profiling study of 40 cases, with a proposal for the reclassification of "melanotic schwannoma". *Am J Surg Pathol* 2014;38(01):94–105
- Mouchaty H, Conti R, Buccoliero AM, Conti P. Intramedullary melanotic schwannoma of the conus medullaris: a case report. *Spinal Cord* 2008;46(10):703–706
- Santaguida C, Sabbagh AJ, Guiot MC, Del Maestro RF. Aggressive intramedullary melanotic schwannoma: case report. *Neurosurgery* 2004;55(06):1430
- Haleem S, Mahmoud MH, Singh Kainth G, Botchu R, Hassan MF. 18F-FDG PET/CT scan standardised uptake value (SUV) score for diagnosis, staging and monitoring malignancy in spinal melanotic schwannoma. *J Surg Case Rep* 2022;2022(12):rjac524
- Lieber B, Han B, Allen J, et al. Utility of positron emission tomography in schwannomatosis. *J Clin Neurosci* 2016; 30:138–140
- Ahmed AR, Watanabe H, Aoki J, Shinozaki T, Takagishi K. Schwannoma of the extremities: the role of PET in preoperative planning. *Eur J Nucl Med* 2001;28(10):1541–1551
- Vallat-Decouvelaere AV, Wassef M, Lot G, et al. Spinal melanotic schwannoma: a tumour with poor prognosis. *Histopathology* 1999;35(06):558–566
- Acciarri N, Padovani R, Riccioni L. Intramedullary melanotic schwannoma. Report of a case and review of the literature. *Br J Neurosurg* 1999;13(03):322–325
- Solomou G, Dulanka Silva AH, Wong A, Pohl U, Tzerakis N. Extramedullary malignant melanotic schwannoma of the spine: case report and an up to date systematic review of the literature. *Ann Med Surg (Lond)* 2020;59:217–223
- Ferner RE, Lucas JD, O'Doherty MJ, et al. Evaluation of (18) fluorodeoxyglucose positron emission tomography ((18)FDG

- PET) in the detection of malignant peripheral nerve sheath tumours arising from within plexiform neurofibromas in neurofibromatosis 1. *J Neurol Neurosurg Psychiatry* 2000;68(03):353–357
- 11 Warbey VS, Ferner RE, Dunn JT, Calonje E, O'Doherty MJ. [18F]FDG PET/CT in the diagnosis of malignant peripheral nerve sheath tumours in neurofibromatosis type-1. *Eur J Nucl Med Mol Imaging* 2009;36(05):751–757
 - 12 Chirindel A, Chaudhry M, Blakeley J, Wahl R. 18F-FDG PET/CT qualitative and quantitative evaluation in NF1 patients for detection of malignant transformation—comparison of early to delayed imaging with and without liver activity normalization. *J Nucl Med* 2015;56(03):379–385
 - 13 Beaulieu S, Rubin B, Djang D, Conrad E, Turcotte E, Eary JF. Positron emission tomography of schwannomas: emphasizing its potential in preoperative planning. *AJR Am J Roentgenol* 2004;182(04):971–974
 - 14 Shah N, Sibtain A, Saunders MI, Townsend E, Wong WL. High FDG uptake in a schwannoma: a PET study. *J Comput Assist Tomogr* 2000;24(01):55–56
 - 15 Knight SB, Delbeke D, Stewart JR, Sandler MP. Evaluation of pulmonary lesions with FDG-PET. Comparison of findings in patients with and without a history of prior malignancy. *Chest* 1996;109(04):982–988
 - 16 Enzinger FM, Weiss SW. *Benign Tumors of the Peripheral nerves*. 3rd ed. St. Louis, MO: Mosby; 1995
 - 17 Salamon J, Veldhoen S, Apostolova I, et al. 18F-FDG PET/CT for detection of malignant peripheral nerve sheath tumours in neurofibromatosis type 1: tumour-to-liver ratio is superior to an SUVmax cut-off. *Eur Radiol* 2014;24(02):405–412
 - 18 Salamon J, Papp L, Tóth Z, et al. Nerve sheath tumors in neurofibromatosis type 1: assessment of whole-body metabolic tumor burden using F-18-FDG PET/CT. *PLoS One* 2015;10(12):e0143305
 - 19 Derlin T, Tornquist K, Münster S, et al. Comparative effectiveness of 18F-FDG PET/CT versus whole-body MRI for detection of malignant peripheral nerve sheath tumors in neurofibromatosis type 1. *Clin Nucl Med* 2013;38(01):e19–e25
 - 20 Ferner RE, Golding JF, Smith M, et al. [18F]2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG PET) as a diagnostic tool for neurofibromatosis 1 (NF1) associated malignant peripheral nerve sheath tumours (MPNSTs): a long-term clinical study. *Ann Oncol* 2008;19(02):390–394
 - 21 Martin E, Geitenbeek RTJ, Coert JH, et al. A Bayesian approach for diagnostic accuracy of malignant peripheral nerve sheath tumors: a systematic review and meta-analysis. *Neuro-oncol* 2021;23(04):557–571
 - 22 Brahmi M, Thiesse P, Ranchere D, et al. Diagnostic accuracy of PET/CT-guided percutaneous biopsies for malignant peripheral nerve sheath tumors in neurofibromatosis type 1 patients. *PLoS One* 2015;10(10):e0138386
 - 23 Solomon RA, Handler MS, Sedelli RV, Stein BM. Intramedullary melanotic schwannoma of the cervicomedullary junction. *Neurosurgery* 1987;20(01):36–38
 - 24 Shen XZ, Wang W, Luo ZY. 18F-FDG PET/CT imaging for aggressive melanotic schwannoma of the L3 spinal root: a case report. *Medicine (Baltimore)* 2021;100(08):e24803