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REVIEW ARTICLE

Melanotic schwannoma: an 11-year case series

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Abstract Melanotic or melanocytic schwannoma is a rare tumour usually involving spinal nerve roots but can also present at other anatomical locations. Although there are less than 200 cases reported, melanotic schwannomas can have distinctive imaging features but there is limited recent literature on its often characteristic radiological appearances. Recent publication of the largest case series thus far has suggested melanotic schwannoma to be a separate entity to other schwannomata and that its reclassification to a malignant lesion be under consideration. We present a case series over an 11-year period to highlight salient imaging features with reference to the current concerns regarding its malignant potential.

Keywords Melanotic schwannoma · Psammomatous melanotic schwannoma · Sarcoma · Carney complex · Schwannoma · Peripheral nerve sheath tumour · Melanin · Malignant potential

Introduction

Melanotic schwannomas (MSs) are a rare and distinct nerve sheath tumour characterized by melanin-producing neoplastic Schwann cells described in 1932 [1]. Also known as melanocytic schwannoma, less than 200 MS cases have been described, predominantly in case reports, classically affecting the posterior spinal roots, sympathetic chain and intracranial nerve roots with less common primary sites including the peripheral nerves and gastrointestinal tract [2–11].

MS lesions are thought to arise sporadically. They can be subdivided histologically based on the presence of psammoma bodies into psammomatous and non-psammomatous MS [12]. There has been a varying association of the psammomatous group with a clinical syndrome known as Carney Complex, which includes the presence of pigmented cutaneous lesions, cardiac myxoma and endocrine tumours [2].

Spontaneous MS has been primarily thought to be a benign condition with a relatively rare reported propensity to metastasize [9, 11, 12]; however, recent published literature has suggested that MS should be reconsidered as a malignant neoplasm [13] with a greater potential to metastasize. The need to differentiate MS from other melanin producing lesions, most notably conventional malignant melanoma, is also critical due to the differences in clinical management.

There has been limited imaging data on this condition. We present a series of four cases, collected over 11 years at a tertiary referral centre, with histopathological sampling and consensus diagnoses rendered by a multidisciplinary team of dedicated musculoskeletal oncology radiologists, histopathologists and orthopaedic surgeons. We aim to describe the common imaging characteristics with an imaging-specific review of the literature in the context of the recent suggested change in pathological understanding of the condition.

Case series

Case 1 is a previously fit and well 36-year-old woman who presented with a 4-year history of left hip pain. She then complained of progressive symptoms with new radiation of

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pain down the left lateral leg to the little toe. A subsequent lumbar spine MRI demonstrated a large lobular mass lesion which appeared centred on the left L5 nerve root causing expansion and bony erosion of its exit foramen (Fig 1a). There was further invasion of the left S1 sacral promontory. The lesion demonstrated high signal on T1-weighted images with minor heterogenous, predominantly peripheral, lobular post-contrast enhancement (Fig 2a,b). The lesion demonstrated peripheral susceptibility artefact on water sensitive sequences with heterogenous mixed signal intensity on T2-weighted images (Fig 1b). CT obtained for percutaneous biopsy planning revealed faint internal calcification. Biopsy of the mass lesion confirmed the histological diagnosis of psammomatoid melanotic schwannoma. There was heavy melanin deposition on a background of collagenous tissue with occasional bland spindle cells. Occasional psammoma bodies were demonstrated. The patient underwent two-stage removal of a black tumoural mass for debulking of the mass lesion with histology confirmed as melanocytic schwannoma. Follow-up imaging obtained at 4 months demonstrated post-operative changes at the surgical bed with no features of disease recurrence; however, subsequent interval follow-up at 10 months revealed osseous tumour infiltration adjacent to the previous resection site, demonstrating hyperintense signal on T1-weighted images with low signal intensity on T2-weighted images and mild post-contrast enhancement. In addition, a separate osseous lesion with identical pre- and post-contrast enhancement signal characteristics was demonstrated in the left posterior ilium suggestive of a local skip metastatic deposit (Fig 3a,b).

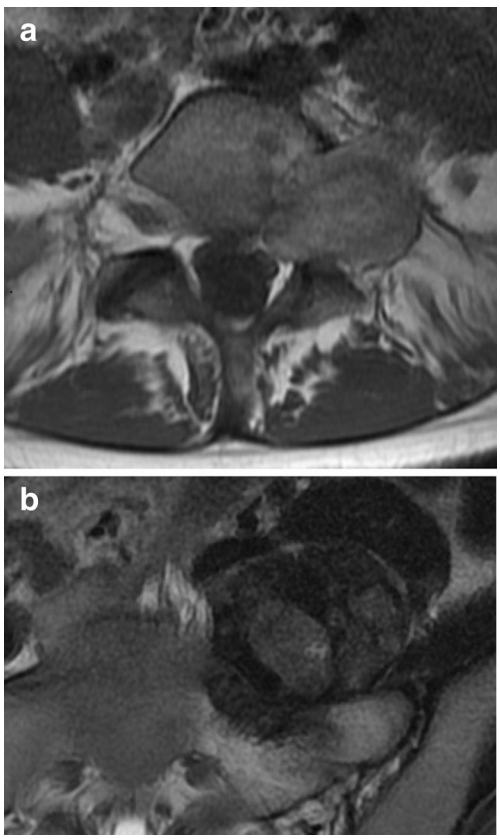

Fig. 1 **a** Axial T1w image of the hyperintense lesion extending into and expanding the left L5 exit foramen. **b** Axial T2w image demonstrating the heterogenous intermediate and higher than intermediate signal related to both intra and extra-osseous (left sacral ala) components of the lesion. Note the peri-lesional oedema-like signal in the adjacent sacral bone marrow

Case 2 is a 30-year-old male who presented with a rapidly enlarging swelling of the posterior right thorax over a duration of 4 weeks, following a potential gym induced injury. Clinically, the lesion was firm and non-mobile. MRI demonstrated a well-defined lesion in the para-spinal musculature of the posterior right chest wall. It was mostly of high signal on T1-weighted imaging with minor low signal septations and no definite post-contrast enhancement of the lesion (Figs 4a, c). The lesion demonstrated high signal on T2-weighted images with peripheral low signal. A slender tongue of mildly hyperintense tissue on both T1 and T2-weighted imaging was noted adjacent to the margin of the primary lesion which demonstrated minor post contrast enhancement (Fig. 4d). The patient underwent percutaneous needle biopsy in line with the standard practice in the evaluation of any soft tissue mass lesion in our tertiary referral sarcoma centre. The histology features supported a diagnosis of necrotic melanocytic tumour favouring a melanotic schwannoma rather than a melanoma (Figs. 5a,c). The samples demonstrated small clusters of mildly atypical round to epithelioid cells with distinct nucleoli, arranged in a nested pattern, with fibrous tissue. Immunohistochemistry revealed that the tumour cells were positive for HMB45 and Melan A, but negative for S100, SMA, desmin, MNF116 and CD31. Surgical excision followed five days later given the recommendations of the biopsy histology (Fig 6). The final surgical histology confirmed the percutaneous biopsy diagnosis of melanocytic schwannoma with evidence of diffuse tumour spreading in the fascial planes. The specimen confirmed focal patchy positivity for S100 with no BRAF V600 mutation detected on real time PCR. The patient underwent a course of local radiotherapy in light of the fascial plane involvement with no evidence of disease recurrence clinically at the 6-month review.

Case 3 is a 20-year-old university student (from Cyprus) who presented with a 4 year history of lower back pain which was worse on the left compared with the right side. MRI demonstrated a heterogenous, predominantly high signal intensity mass lesion on T1-weighted imaging with a peripheral low signal intensity rim involving the S1 promontory and an anterior pre-sacral extra-osseous component extending into the left S1 foramen. The extra-osseous portion of the lesion demonstrated low signal intensity on T2-weighted imaging, whilst the intra-osseous component returned high signal intensity. There was mild-post contrast enhancement observed. A CT scan, performed for biopsy planning, demonstrated a 3-cm

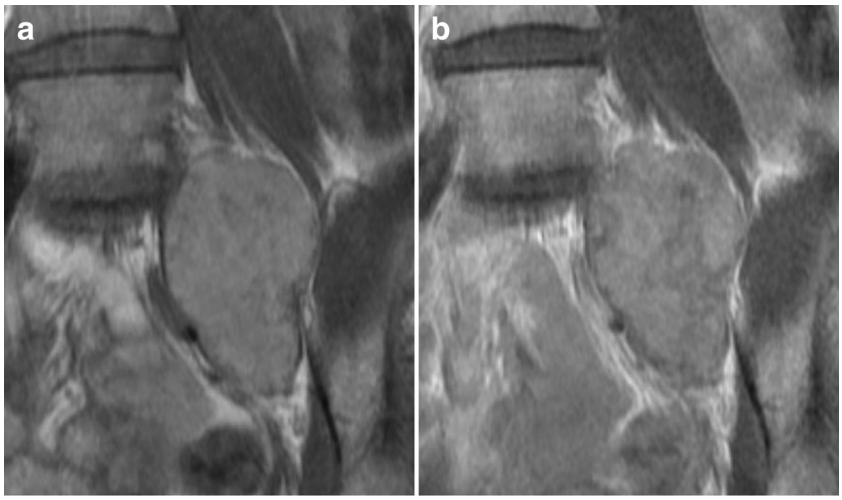

Fig. 2 Pre (**a**) and post (**b**) contrast enhanced coronal T1w fat saturated (FS) images which demonstrate minor predominantly peripheral heterogenous post contrast lesional enhancement.

lytic lesion in the S1 promontory that extended into the left S1 foramen and a percutaneous CT-guided sacral biopsy was undertaken, yielding a histological diagnosis of melanotic schwannoma. Immunohistochemistry showed the lesional cells to be diffusely positive for S100, HMB-45 and Melan-A, and was negative for desmin and pankeratin MNF116. He underwent a partial sacrectomy but was subsequently lost to follow-up.

Case 4 is a 46-year-old taxi driver who presented with a 2 year history of back and left leg pain with intermittent left leg numbness. Imaging findings demonstrated a left L3 foraminal lesion with hyperintense signal on T1-weighted images that caused foraminal narrowing and adjacent vertebral body scalloping. The lesion returned a mildly hyperintense signal on T2-weighted imaging. The patient underwent a 2-stage operation with macroscopic excision of a white, rubbery tumour confirming the histological diagnosis of melanotic schwannoma that was HMB45 positive but only focally S100 protein positive. The tumour was negative for cytokeratins MNF116. At 1-year post-operative imaging follow-up, there was extensive hyperintense signal on T1-weighted imaging consistent with recurrence involving the left psoas major muscle, which was excised with surgical histology confirming local disease recurrence. In this immediate post-operative period he developed right facial weakness with an MRI brain demonstrating a hyperintense mass on T1-weighted imaging at the cerebellopontine angle. He underwent chemotherapy (doxorubicin and ifosfamide) and subsequent gamma knife radio-surgery to the intracranial lesion, which had reduced in size following the chemotherapy, suggesting metastatic disease. The surgical histology of this lesion confirmed the pre-operative working diagnosis of metastatic melanotic schwannoma. The patient underwent local radiotherapy (40 Gy) to the lumbar spine and left psoas major to attempt to control further recurrence at 2 years from original presentation. Six months later the patient developed bilateral 5th and right 6th cranial nerve palsies with CT brain confirming cerebral and meningeal deposits involving the clinically affected cranial nerves. Palliative radiotherapy of 20 Gy in five fractions was delivered but unfortunately the patient died of disease shortly afterwards.

Discussion

Melanotic schwannoma is a rare primary pigmented tumour predominantly of the spinal nerves and paraspinal ganglia with less than 200 cases reported and an overall prevalence

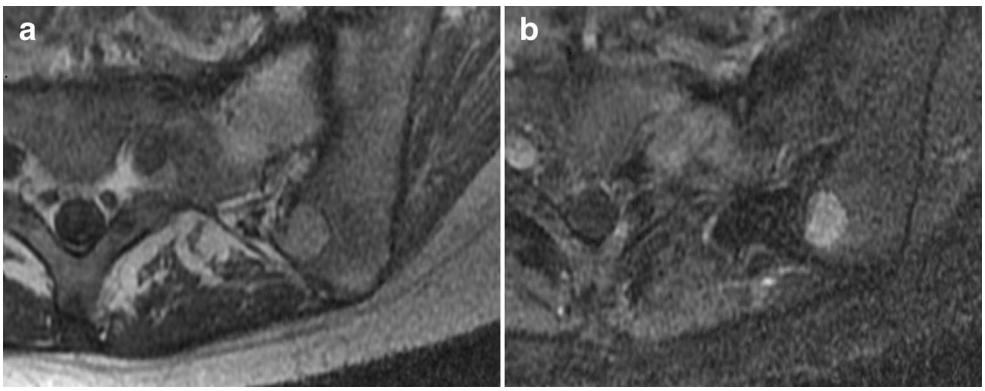

Fig. 3 Axial T1w **a** and axial post-contrast T1wFS images demonstrate the hyperintense satellite lesion in the left posterior ilium with post-contrast enhancement in **b**. Note that an area of post-surgical fibrosis that shows minor enhancement at the anterior left sacral ala and non-enhancing hyperintense fatty marrow in the lateral left sacral ala

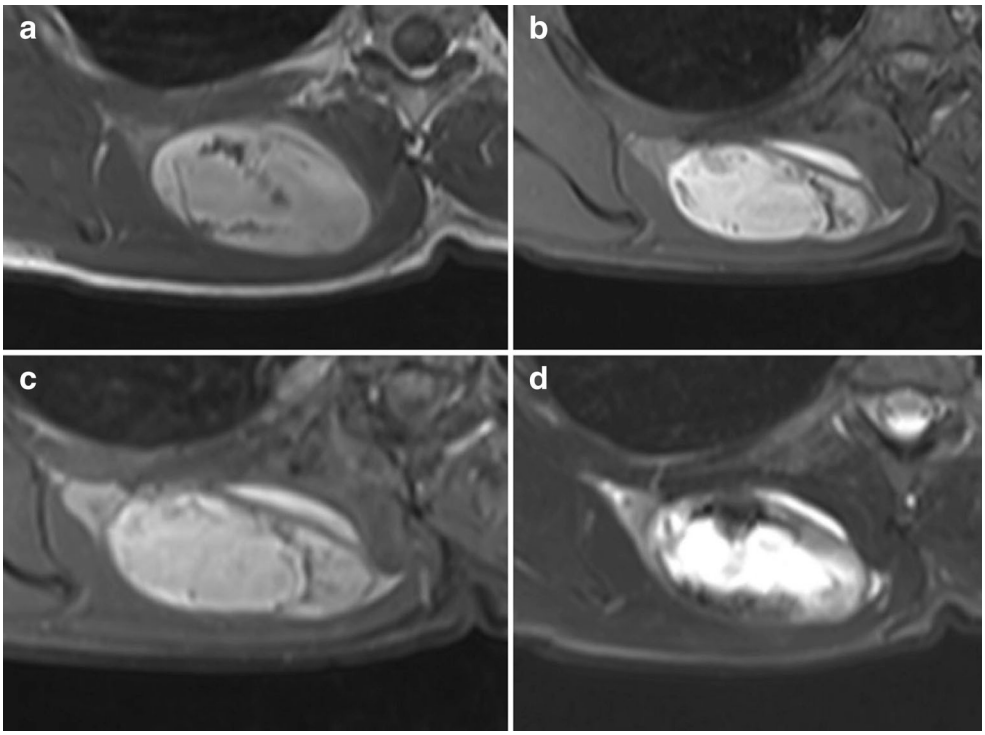

Fig. 4 Axial T1w (**a**), pre- (**b**) and post- (**c**) contrast enhanced axial T1wFS images which demonstrate central hyperintensity with hypointense septae that demonstrate very minor post-contrast enhancement. Axial T2w (**d**) image demonstrating heterogenous hyperintense signal. There is slightly hyperintense signal on both T1w and T2w images that demonstrates post-contrast enhancement at its medial and, more prominently, lateral margins that were proven histologically on the surgical specimen to represent the tumour within the fascial planes

of <1 % of primary peripheral nerve sheath tumours [12]. It is widely accepted that the first description of MS was published in 1932 by Millar [1] which was followed by a few case reports before a case series in 1990 [2] defined distinct histological intracellular structures termed psammoma bodies which differentiated MS lesions into non-psammomatous and psammomatous subgroups, the latter being associated with a condition subsequently named Carney Complex. MS lesions affect male and female patients equally with an average age at presentation of 30–40 years [8, 9, 12].

The most frequent location of lesions are the dorsal spinal nerve roots [12], with other spinal and paraspinal locations including predominantly the sympathetic chain [1] and spinal cord [14]. The most frequent sites of extra-spinal involvement include the gastrointestinal tract and soft tissues [12]. They can also be multiple in presentation in up to 20 % of cases [12, 14, 15].

Anatomical location of the MS lesions may be useful in helping to distinguish it from other melanin-producing lesions such as malignant melanoma and meningeal melanocytoma, in addition to other soft tissue lesions demonstrating hyperintensity on T1-weighted sequences such as alveolar soft tissue part sarcomas. A paravertebral location or clear association with a neurogenic structure would be more typical of MS rather than a meningeal distribution of meningeal melanocytoma. However, histologic features remain more definitive in differentiating between these melanin-producing pathologies with spindled morphology, heavy melanin deposition, presence of psammoma bodies, nuclear pleomorphism and low mitotic rate more suggestive of MS [13].

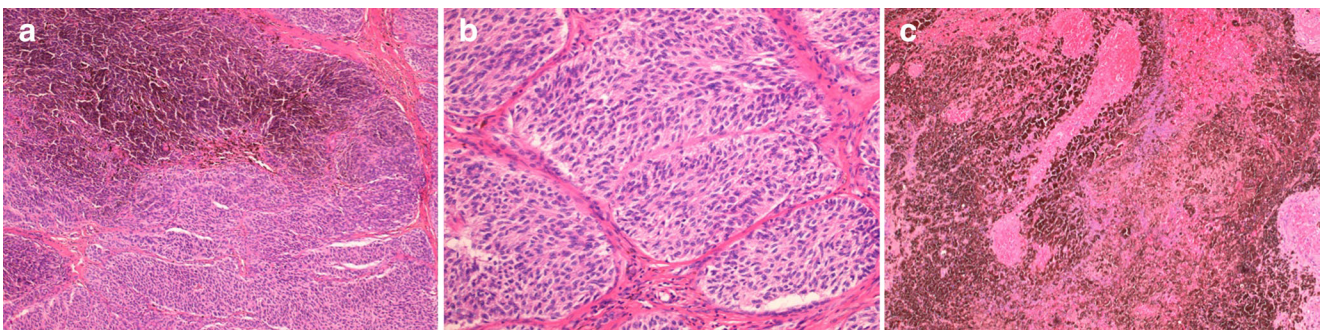

Fig. 5 Photomicrograph of melanotic schwannoma. Low power view showing the typical multinodular growth pattern (**a**; 4× H & E stain); the nodules are composed of spindle cells forming short cellular fascicles. Mitoses are difficult to find (**b**; 10× H & E); the deposition of melanin pigment may be so heavy and diffuse to obscure the cells (**c**; 4× H & E)

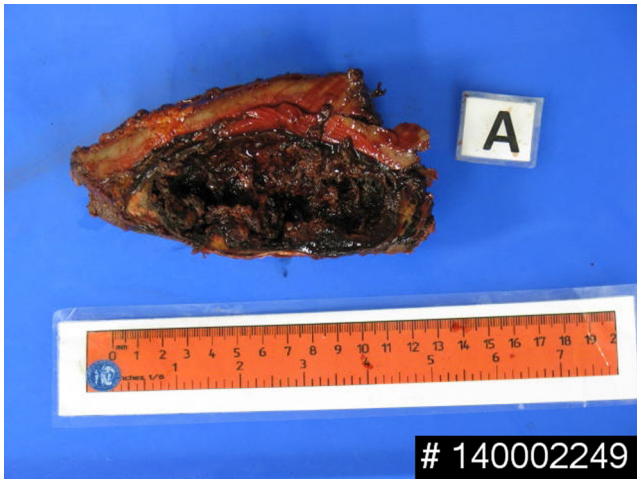

Fig. 6 Gross specimen showing a large brown-coloured tumour, with diffuse areas of haemorrhage

All the lesions within our case series presented in a spinal or paravertebral anatomic location. All of the patients in this series also presented with a solitary lesion with no extra-spinal disease demonstrated. None of the cases described demonstrated the features of Carney Complex.

There have been no large reviews of MS imaging features but they have been widely accepted to have characteristic MRI findings of signal hyperintensity on T1-weighted sequences and hypointensity on T2-weighted sequences based on the paramagnetic effects of their melanin-containing composition [7, 8, 16]. This is in contrast to the typical imaging appearances of hypointense signal on T1-weighted imaging with hyperintensity on T2-weighted sequences of conventional (non-melanotic) schwannomata.

Our case series of histologically proven MS lesions all demonstrate similar expected hyperintense signal on T1-weighted imaging. However, the T2-weighted signal characteristics were far more variable with three cases demonstrating homogenous hyperintensity but another demonstrating heterogenous iso- and hypo-intensity. Short tau inversion recovery (STIR) sequences were available in two cases and were noted to demonstrate an identical very low signal peripheral lobulated rim. Post-gadolinium enhanced images were obtained in three cases, which demonstrated complete variability between each case ranging from homogenous enhancement through heterogenous to no enhancement in one case.

Previously, MS has been viewed as a lesion which follows a predominantly benign course with metastatic disease quoted to occur in 13–26 % of patients despite the apparent benign histological appearances [9]. Recently published literature of the largest case series thus far of 40 MS lesions has suggested that MS is a separate entity to more conventional non-melanin containing schwannoma and is also a lesion with far more malignant potential than previously thought [13]. Torres-Mora et al. have found MS lesions to be aggressive, clinically malignant neoplasms with local recurrence in 35 % of cases and evidence of distant metastases in 42 % [13], much higher than previously published reports of 15 and 26 % respectively [9].

While our much smaller case series cannot be considered representative of the condition as a whole, confirming the rarity of this pathological entity, it does demonstrate a similar proportion of aggressive disease to that recently published. Primary excision of one lesion demonstrated histological evidence of diffuse fascial invasion, which correlated with ill-defined peri-lesional enhancing signal hyperintensity. Of those patients with metastatic disease, one patient had local recurrence with distant intradural metastatic disease, whilst a second patient also had local recurrence and local skip metastatic disease in bone separate to the primary lesion. With regard to the four metastatic tumour sites in these two patients, it is noted that all of the lesions demonstrated imaging characteristics similar to the primary lesion of signal hyperintensity on T1-weighted imaging with mild post-contrast enhancement.

Importantly, we have found no clear differentiating imaging features between the primary lesions with subsequently proven aggressive behaviour on the T1-weighted, T2-weighted, STIR or post-contrast enhanced conventional MRI imaging versus those that have followed a non-aggressive clinical course.

As a result, in the absence of any current established post-treatment management protocols, it would appear that long-term follow-up may be necessary for all patients but particularly in those with aggressive histopathological findings at biopsy or resection and in those with lesions demonstrating enhancing peri-lesional signal abnormality, which may represent local invasion.

Conclusion

Melanotic or melanocytic schwannoma is a rare lesion with distinctive MRI imaging characteristics of homogenous signal hyperintensity on T1-weighted imaging related to its melanin-production. Typically the lesion affects the dorsal spinal roots or sympathetic chain and, therefore, has a predominantly paravertebral anatomic location. We have found the T2-weighted signal characteristics to be more variable than the previously described expectation of hypointensity. MS has recently been shown to have a greater malignant potential than previously believed and our case series appears to support this revised stance with a similar proportion of aggressive disease in our series as has recently been described. We have found no specific discriminating imaging features to differentiate more aggressive lesions from those following a benign clinical course. A paravertebral location, the heavy melanin

deposition and low mitotic activity, considering the striking nuclear pleomorphism and the psammoma bodies, are all features favouring a melanotic schwannoma rather than a malignant melanoma. Information about the clinical history and, in particular, current or previous past pigmented cutaneous lesion is also important in the differential diagnosis. The recognition of a melanocytic schwannoma as a variably malignant lesion is critical to ensure appropriate surgical management and subsequent long-term clinical and imaging follow-up.

Conflict of Interest No conflict of interest

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