CT imaging features of skeletal muscle metastasis: A rare tumour group with different patterns

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Abstract

Introduction: Skeletal muscle metastasis (SMM) are rare and can have different patterns on computed tomography (CT). Our aim was to estimate the frequency of the different patterns, primary tumours and localizations of SMM in a large single-centre sample.

Methods: A retrospective search in the database of our radiological institution was performed for patients with SMM. The primary tumour, affected muscles and CT patterns were estimated.

Results: Overall, 104 SMM were diagnosed in 82 patients. In 11 patients (13.4%), SMM were the isolated manifestation of metastatic disease in clinical work up. Regarding primary tumours, gastrointestinal tumours (24.4%), lung cancer (20.4%) and malignant melanoma (13.4%) were identified most frequently. Other malignancies were rare. Most commonly, the trunk musculature was affected (41.3% of the cases). SMM type 1 were identified in 37 cases (35.6%), type 2 in 64 cases (61.5%), type 3 in 2 cases (1.9%) and type 4 in one case (1%).

Conclusions: The present study shows typical imaging appearances of SMM based on a large patient sample in a single centre. SMM has a rare occurrence with several different patterns, which can impose diagnostic difficulties and varies possible differential diagnoses.

Key words: computed tomography; skeletal muscle metastasis; muscle metastasis.

Introduction

Skeletal muscle metastasis (SMM) is a rare occurrence in oncologic patients. The reported prevalence of SMM in autopsy studies ranged from 0.03% to 16%.1 In staging examinations, namely on computed tomography (CT), a frequency of 1.2% was estimated.2 Furthermore, on CT, a classification of SMM including 5 distinctive types was proposed.2 Type 1 SMM represents a homogenous contrast-enhancing metastatic intramuscular lesion. Type 2 is a metastatic muscle tumour with a peripheral contrast enhancement and central hypo-attenuation (abscess-like lesion). SMM with diffuse infiltration and swelling of the affected muscle are classified as type 3. SMM manifesting as intramuscular calcifications are defined as type 4. SMM presenting as intramuscular haematomas are categorized as type 5.2 Most frequently, SMM type 1 and type 2 occurred.2

Regarding localization, most commonly the trunk musculature and the iliopsoas muscles were involved.2-4 Notably, some tumours tend to spread to certain muscles favourably.4 So, breast cancer tend to metastasize more frequently to the extraocular musculature compared to other tumours.4

To date, only few studies investigated imaging features of SMM.2,4-8 Moreover, it is a very heterogeneous disease entity due to different primary tumours, localizations and imaging appearances. Therefore, to better understand this rare tumour entity, there is a need of more patient cohorts.

Our aim was to estimate the frequency of the different imaging patterns, primary tumours and localizations of SMM in a large single-centre patient sample.

Methods

Patient acquisition

A retrospective search was performed in the database of the radiological department of the University hospital of Leipzig from January 2002 to April 2019. The radiological reports were searched for the following keywords:
'muscle metastasis', 'muscle lesion suspicious of metastasis', 'metastatic muscle lesion', and 'intramuscular metastasis'.

Overall, 137 cases were identified with this approach. All cases were re-analysed by two radiologists in consensus (SU and AS with 4 and 16 years of CT experience, respectively). Exclusion criteria were direct invasion of tumours into the skeletal musculature per continuitatem, cases with intramuscular lymphoma or leukaemia, sarcomas, and different benign intramuscular disorders. Thus, 55 cases were excluded, and the final patient sample comprised 82 cases with 104 SMM.

There were 29 (35.4%) women and 53 men with a median age of 64 years, ranging from 27 to 87 years.

**CT technique and image analysis**

Computed tomography was performed in all patients by using multi-slice scanners (Philips Brilliance iCT 256 and Philips Ingenuity 128, Philips Medical Systems, Cleveland, OH, USA). The routine staging CT investigation comprised the following regions: neck, thorax, abdomen, pelvis and proximal thighs. In all cases, weight adapted iodinated intravenous contrast medium was given at a rate of 3.0 mL/s by a power injector, with a scan delay of 30–90 s after onset of injection. Typical imaging parameters were 120 kVp, 1.0 mm slice thickness and a pitch of 0.7.

All SMM were categorized according to the proposed classification, as follows:

- **type 1**: round or oval intramuscular metastatic lesions with homogeneous contrast enhancement;
- **type 2**: abscess-like intramuscular metastatic lesion with central low attenuation and rim contrast enhancement;
- **type 3**: metastatic diffuse muscle infiltration with swelling and inhomogeneous contrast enhancement;
- **type 4**: SMM manifesting as multiple intramuscular calcifications;
- **type 5**: SMM manifesting as intramuscular bleeding.

Figures 1, 2 and 3 show representative cases of the identified SMM for illustration purposes.

The diagnosis of SMM was made on typical CT patterns and follow-up of the identified lesions. In 7 lesions, the diagnosis was confirmed histopathologically after CT guided needle biopsy. All primary tumours were confirmed histopathologically.

**Statistical analysis**

Collected data were evaluated by means of descriptive statistics (absolute and relative frequencies).

**Results**

Overall, 104 SMM were diagnosed in 82 patients, who met the inclusion criteria. While 55 patients (67.1%) had a single SMM, 27 patients had two or more SMM. In 11 patients (13.4%), SMM were the isolated manifestation of metastatic disease, and in 71 patients (86.6%), other distant metastases were diagnosed.

Regarding primary tumours, SMM were derived from the following malignancies: gastrointestinal tumours (24.4%), lung cancer (20.4%), malignant melanoma (13.4%), urogenital tumours (13.4%), different sarcomas (13.4%), breast cancer (3.7%), thyroid cancer (3.7%) and cancer of unknown primary (7.3%; Table 1).

The lesion size ranged from 7 to 96 mm, mean size, 32 ± 22 mm. Most commonly, the trunk muscles were affected (41.3%), followed by iliopsoas muscle (24%) and gluteal musculature (22.1%). Other muscles were rare affected. Table 2 summarizes the localization of the identified metastases.

SMM type 1 was identified in 37 cases (35.6%), type 2 in 64 cases (61.5%), type 3 in 2 cases (1.9%) and type 4 in one case (1%; Table 3).

**Discussion**

The present study reports typical imaging appearances of SMM and re-evaluates the proposed CT classification of SMM.2

To characterize typical imaging patterns of SMM is crucial for differential diagnosis and for the correct treatment planning in oncologic patients.
This is of importance, because the fact that almost half of patients with SMM present without a known malignancy to the surgeon,\(^8\) This imposes great diagnostic difficulties comprising various differential diagnoses and treatment planning.\(^8\) However, in imaging studies, most patients have already other metastases and, consequently, a tumour stage \(4^{2,6}\) which is in agreement with the present patient sample. These differences are caused by asymptomatic lesions in imaging studies, compared to symptomatic lesions presented to the surgeon. Moreover, already metastasized patients are most often not presented to a surgeon for possible resection of the SMM.

In agreement with the literature, we identified a male/female ratio of two-thirds male and a median age of around 65 years.\(^8\)

### Primary tumours

In the present study, the most common primary malignancies were several gastrointestinal tumours followed by lung cancer. According to the previous reports, lung cancer was identified as most frequent primary tumour in patients with SMM ranging from 25.2% to 40%\(^2,4,8\). However, in a recent single-centre study, breast cancer was most prevalent tumour with the reported frequency of 25%.\(^6\) Yet, in the present study, breast cancer was only identified in few patients. Presumably, the wide range of primary tumours is caused by patient selection bias and different local tumour incidences.

### Localization

Regarding muscle localizations, slightly different frequencies were reported in the literature. For example, some authors showed that SMM were located most frequently in the iliopsoas muscle, followed by paravertebral muscles and gluteal muscles.\(^2\) Other muscles were rarely involved.\(^2\) Contrary, Arpacı et al.\(^5\) found that gluteal muscles were most often affected, followed by iliopsoas muscles and paravertebral muscles. However, in a systematic review regarding SMM, most intramuscular
metastases were identified in the thigh and extraocular muscles. In the present analysis, the trunk musculature followed by the iliopsoas musculature was most commonly affected. Presumably, these discrepancies may be caused by different imaging modalities and different scan ranges. In a staging CT, the extraocular muscles and the thigh muscles are only partially covered within the scan range. Furthermore, the differences of reported localizations are also caused by different primary tumours. For example, breast cancer more frequently spreads to extraocular muscles than other primary tumours.4

Patterns of SMM

According to the literature, most commonly identified SMM is type 1, followed by type 2 and type 3.2 Contrary, we identified more type 2, characterized as abscess-like lesions. Our finding, however, is in agreement with those of Arpaci et al.,5 who also found the rim enhancing pattern as the most common one in a sample of 52 patients. Yet, no specific relationships of rim enhancing pattern compared to homogenous contrast-enhancing lesions were stated by the authors.5 Moreover, no calcification or haematoma types were reported in this study.5

In the present study, no SMM type 5 was identified. Presumably, this might be caused by misdiagnosis of intramuscular haematomas as a benign haematoma, which is not associated with the malignant disease. This finding reflects the clinical routine. As another reason, type 5 metastases are rare and, thus, may be not identified in our single-centre cohort.

The proposed classification of SMM also implies to acknowledge possible differential diagnosis of metastatic muscle affection. For example, type 1 SMM can mimic numerous benign lesions, such as muscle haemangioma, intramuscular ganglion and myxoma.2,9-11 For type 2 SMM, the inflammatory abscesses need to be ruled out as a potential differential diagnosis.2 In type 3 SMM, muscle sarcoma or intramuscular lymphoma can show a similar diffuse infiltration of the muscle.2,12,13 Regarding type 4 lesions, calcifications of myositis ossificans, calcific tendinitis, angiomegaly, systemic sclerosis and calcific myonecrosis have to be considered as possible diagnosis.2,14,15 Finally, the intramuscular bleeding/haematoma can mimic SMM and vice versa. Thus, if an intramuscular haematoma occurs in oncologic patents, SMM should be included into the differential diagnosis and histopathology evaluation might be needed to confirm or rule out malignancy.

With increasing use of hybrid-imaging for staging purposes, covering the whole body the frequency of SMM will concordantly increase. Furthermore, most studies about positron emission tomography of SMM reported a high metabolic uptake in SMM.4,16-18

The present study represents a clinical identified frequency of SMM, which might be slightly lower than the true frequency due to discussed reasons, such as scan range and misdiagnosed lesions.

In summary, the proposed CT classification is an easy way to describe SMM in clinical routine and guide diagnostic considerations. Type 2 SMM was identified as more frequent than other types.

There are some limitations of the present study to address. Firstly, it is a retrospective single-centre study with possible known inherent bias. Thus, there might be selection bias in regard of primary tumours. Secondly, histopathology confirmation was only available in few patients.

In conclusion, the present study provides typical imaging appearances of SMM based on a large patient sample in a single centre. Intramuscular metastases have a rare occurrence with several different patterns, which can impose diagnostic difficulties and varies possible differential diagnosis.

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