Ultrasound has Limited Capabilities in Assessment of Bone Tumours: Myth Debunked

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INTRODUCTION

Ultrasound (US) is the modality of choice in the assessment of palpable soft tissue lesions (Catalano *et al.,* 2020; Jacobsen *et al.,* 2022). Soft tissue masses that appear on ultrasound as small in size, superficial in location, homogenous in echotexture or hypovascular suggest benignity (Catalano *et al.,* 2020). Conversely, some features suspicious for malignancy include diameter >5cm, increase in size over time, indistinct margins, heterogenous echotexture and intralesional vascularity (Catalano *et al.,* 2020). Obtaining a clinical history is an important part of the examination (Jacobsen *et al.,* 2022). This should include the patient's age, any history of trauma or malignancy, whether the lesion is painful or if it has changed size since first noted (Catalano *et al.,* 2020; Jacobsen *et al.,* 2022). Painless lesions are more suspicious than those that cause pain (Catalano *et al.,* 2020). If a lesion has suspicious ultrasound or clinical features, a follow up ultrasound, additional imaging, biopsy or surgical intervention is advised (Jacobsen *et al.,* 2022).

US is limited if lesions are located in deeper soft tissue (Jacobsen *et al.,* 2022). The same can be said if superficial palpable lesions are of bony origin rather than soft tissue origin as penetration of ultrasound is limited by cortical bone (Ellmann *et al.,* 2015). Due to differing acoustic impedance between soft tissue and bone cortex, ultrasound only allows the evaluation of bone surfaces (Bianchi, 2020). However, when osteolytic lesions destruct the outer cortex, ultrasound can use the "cortical window" to identify an intra-osseous mass and determine the extent of the tumour in soft tissue (Ellmann *et al.,* 2015; Bianchi, 2020).

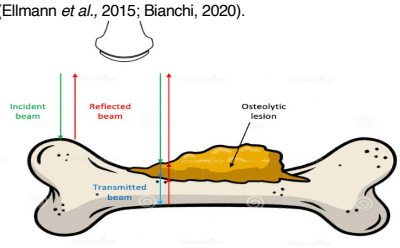

Figure 1 Schematic diagram illustrating interaction of the ultrasound beam with healthy bone compared to interaction with an osteolytic lesion.

Skeletal metastases are observed in 70% of patients with cancer and affects the patient's quality of life (Ellmann *et al.,* 2015). Complications of osseous metastases include pain, pathological fractures and spinal cord compression (Ellmann *et al.,* 2015). Bone metastases are present in one third of patients with advanced renal cell carcinoma (RCC) and is associated with poor prognosis (Chen and Kuo, 2016). Bone metastases in RCC are most commonly osteolytic and reduce bone integrity (Chen and Kuo, 2016). Chest wall metastases are rare and a poor prognostic indicator (Souza *et al., 2013).*

PATIENT BACKGROUND

A 73 year old male presented to the Emergency Department after discovering a swelling three days earlier on the anterior chest at the region of the jugular notch. On examination, the swelling was mildly tender on palpation, not well defined, hard and immobile. A clear and concise medical history was taken which revealed that this patient had no history of malignancy or trauma to this area and that the swelling had slightly increased in size since discovery three days prior. Blood results were normal. An x-ray of the chest and sternum were performed, neither of which detected any abnormalities. A soft tissue ultrasound of the lump was requested for further assessment.

ULTRASOUND EXAMINATION

A linear probe (L2-9) and abdomen preset were chosen for this ultrasound examination. A frequency of 7MHz is used in this preset as it is considered the optimal frequency for both penetration and resolution. A well defined, solid, heterogenous mass was identified which corresponded to the visible palpable lump. With the probe in the transverse orientation, it measured 5.8 cm in the transverse diameter and 4.7cm in the anteroposterior (AP) diameter (Figure 2). A body marker was applied to indicate the exact location of the body under examination.

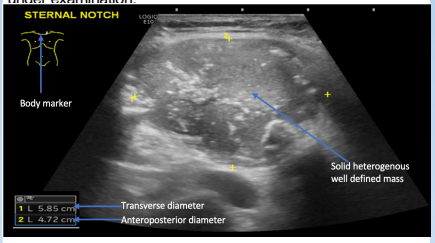

Figure 2 Transverse image of a well defined, solid, heterogenous mass measuring 5.8 x 4.7cm corresponding to the visible, palpable lump.

ULTRASOUND EXAMINATION

Due to the subcutaneous location of the mass, the thyroid preset was then chosen, increasing the frequency to 9MHz to improve resolution. The probe was rotated 90° clockwise and the craniocaudal (CC) length measured 5.47cm (Figure 3).

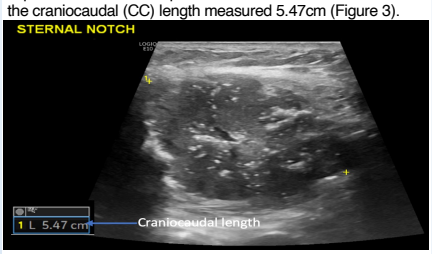

Figure 3 Longitudinal image of the mass measuring 5.4cm in length. The resolution is improved as the frequency is increased.

The lesion was then assessed using colour Doppler to detect if blood flow was present. Care was taken to avoid compressing the lesion which may occlude blood vessels with slow flow and falsely mimic an avascular lesion (Jacobsen *et al.,* 2022). Spectral analysis established high speed, low resistance arterial flow. The peak velocity measured 39 cm/s. This measurement is inaccurate as a result of aliasing and could be rectified by increasing the pulse repetition frequency (PRF) or adjusting the baseline (Figure 4).

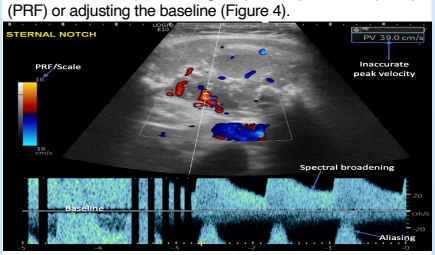

Figure 4 Colour and spectral Doppler analysis of the lesion establishing high speed, low resistance arterial flow.

A lower frequency curvilinear transducer (C1-6) was then used to visualise deeper and evaluate the relationship of the lesion to adjacent structures and extension into the retrosternal space. Figure 5 illustrates the non invading lesion.

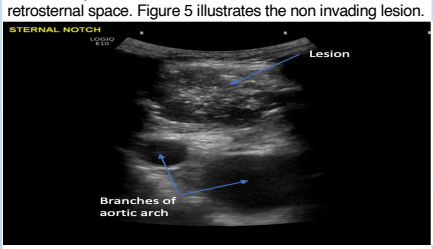

Figure 5 Localised lesion with no invasion of surrounding vasculature confirmed using a low frequency curvilinear transducer.

Despite the lesion appearing encapsulated and confined, sonographic appearances of a vascular, heterogenous, solid mass were concerning for malignancy and presumed by the radiologist to be nodal or thymic in origin.

DIAGNOSTICS

A computed tomography (CT) scan of the thorax with contrast was advised by the consultant radiologist reporting the ultrasound examination to further assess the identified lesion. The expansile mass appeared as a heterogenous enhancing lesion measuring 6.1 x 4.8 x 5.7 cm (Transverse x AP x CC). The mass was located around the distal left first rib at the costosternal joint and extended into the manubrium of the sternum. CT imaging confirmed that it did not extend into the retrosternal space. The lesion is predominantly lytic with associated bony destruction and a surrounding rim of calcification peripherally (Figure 6).

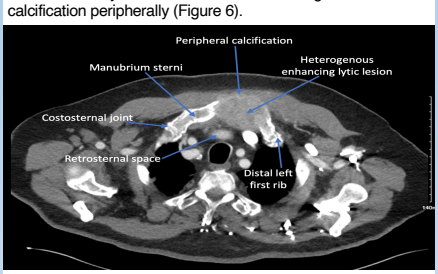

Figure 6 Axial CT slice at the level of the heterogenous enhancing lytic lesion involving the left first rib and manubrium of the sternum.

Lytic lesions were also identified in the vertebral body of T10 and the right fourth rib. Multiple bilateral pulmonary nodules and multilevel mediastinal lymphadenopathy were also evident. It was suspected that these findings were most in keeping with a metastatic process.

DIAGNOSTICS

A CT scan of the neck and abdomen were performed to locate the primary lesion. An irregular enhancing lesion was visualised within the inferior pole of the right kidney, highly suspicious for RCC (Figure 7). Irregular appearance of the right renal vein with filling defect was concerning for tumour involvement.

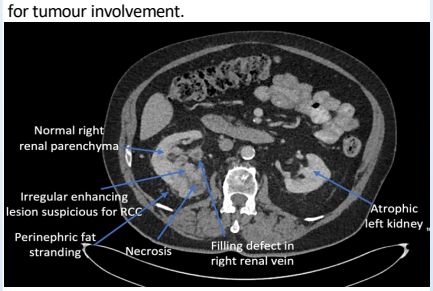

Figure 7 Axial CT slice at the level of the lower pole of the right kidney demonstrating an irregular enhancing lesion associated with cystic necrosis, perinephric fat stranding and renal vein thrombus. Appearances are suggestive of RCC. The contralateral left kidney appears atrophic.

ULTRASOUND GUIDED BIOPSY

A percutaneous biopsy of the bone lesion was performed to confirm metastatic tumour involvement and to decide on optimal treatment (Filippiadis, Mazioti and Kelekis, 2018). Informed consent was obtained prior to the procedure and local anaesthetic (1% lidocaine) was administered subcutaneously. Using a 16G core biopsy needle, a sample was obtained under ultrasound guidance using aseptic techniques and sent to histology (Figure 8).

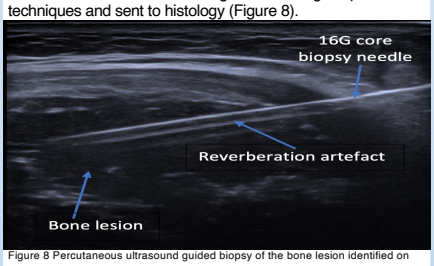

Figure 8 Percutaneous ultrasound guided biopsy of the bone lesion identified on previous ultrasound and CT imaging.

TREATMENT

The biopsy confirmed metastatic RCC to the bone. The patient underwent immunotherapy; a cancer treatment that helps the immune system fight cancer. A CT thorax, abdomen and pelvis (TAP) scan was performed 4 months later to assess response to treatment. Even though the metastatic lesion in the manubrium of the sternum had reduced in size, overall findings were suggestive of progression of disease.

CONCLUSION

The lesion was first identified on ultrasound and subsequent CT imaging confirmed bone metastases from RCC. While the prognosis for this patient is poor, the diagnosis has resulted in the commencement of immunotherapy which will improve the quality and longevity of life. This diagnosis would not have been possible without the multimodality imaging approach. This mass was superficial in location which is often associated with benignity. However, the lesion proved to be malignant which confirms that one sonographic feature alone is not diagnostic for malignancy. All sonographic appearances in conjunction with findings of other imaging modalities and the patient's history need to be considered for an accurate diagnosis.

This case also highlights that superficial lesions identified on ultrasound should not be assumed to be soft tissue lesions. US is considered to have limited capabilities in assessing bone tumours. However, in this case the destruction of the outer cortex by the osteolytic lesion allowed detection of the bone lesion and assessment of the soft tissue involvement.

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