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Ultrasound of musculoskeletal soft tissue masses

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Soft tissue masses have a varied presentation. Though all masses cannot be optimally imaged on USG, its easy availability, real-time capability, and cost-effectiveness, as well as the freedom it provides to examine in any direction, make it an automatic choice as a first-line modality. Though Doppler is an exciting modality, it has its limitations and is not always rewarding. USG is more useful for superficially located masses.

The role of USG is to provide information about the extent of the mass, its nature, and its relationship to the surrounding structures. One important aim is to differentiate between a pseudotumor and a true mass lesion. Doppler can provide additional information in selected cases. USG can play a pivotal role in guiding a needle for obtaining a sample for tissue diagnosis. Benign lesions are more common than malignant ones, in day-to-day practice.

As with any other musculoskeletal examination, technical expertise and a sound knowledge of musculoskeletal anatomy are important.

Key words: Musculoskeletal, soft tissue mass, ultrasound

Examination protocol

- The scanning approach varies with the location. For example, lesions of the hand and foot require scanning of the dorsal and ventral aspects, and lesions of the inguinal region or femoral triangle call for an examination in the standing position if a herniation is suspected.
- Dynamic assessment during contraction and relaxation of the structures of interest is essential. This helps in establishing the exact relationship of the mass with the muscle or the tendon. Soft tissue masses in the anterior abdominal wall should also be evaluated during deep inspiration and expiration to define the relationship of the mass with the peritoneum.
- As elsewhere in the musculoskeletal system, compression in cases of certain benign and cystic lesions gives a better yield.
- Split image technique is of help, especially when dealing with certain pseudotumors.
- Doppler assessment is usually restricted to the assessment of perfusion; spectral analysis has a very limited role.

We shall now review the USG features of some commonly encountered mass lesions.

Lipoma

Lipomas are the commonest masses encountered. Typically, their location is subcutaneous, though intramuscular and intermuscular locations are not infrequent.[1] They can be seen in various locations and may be solitary as well as multiple. Usually they are painless. The tumors are well encapsulated and usually displace the surrounding tissues.

On USG, they are usually hyperechoic; however, the echogenecity varies, and they can be isoechoic when in the subcutaneous tissues[2] [Figure 1]. A hypoechoic pattern is less common. The margins are well-defined, and the mass is noncompressible and avascular on Doppler. Subcutaneous lipomas commonly have linear streaks parallel to the skin surface. Localized accumulation of fat can mimic a lipoma on clinical examination, and USG reliably excludes or confirms such cases. Postoperative recurrence of a lipoma is known and is usually due to microscopic infiltration of the surrounding tissues.[3] There can be occasional difficulty in differentiating between a lipoma and a liposarcoma.[4]

Ganglion

About 50 to 70% of soft tissue masses in the wrist region are ganglions.[5] Though they can occur in various locations, such as the ankle, elbow, hip, shoulder, and knee, the wrist and hand are most commonly involved.

Typical USG features include an anechoic or hypoechoic well-defined mass, oval or round in shape. Quite often an anechoic 'duct' is seen leading to the joint [Figure 2]. Internal echoes in the ganglion may mimic a solid mass [Figure 3]. Some ganglions are compressible.

Hemangioma

There are two main types of hemangiomas: cavernous and capillary. The former are more common in adults. Muscular hemangiomas are commonly encountered tumors. Subcutaneous hemangiomas can be strongly suspected on clinical examination.

B-mode features are quite typical. Intramuscular hemangiomas show a combination of echo-rich and echo-

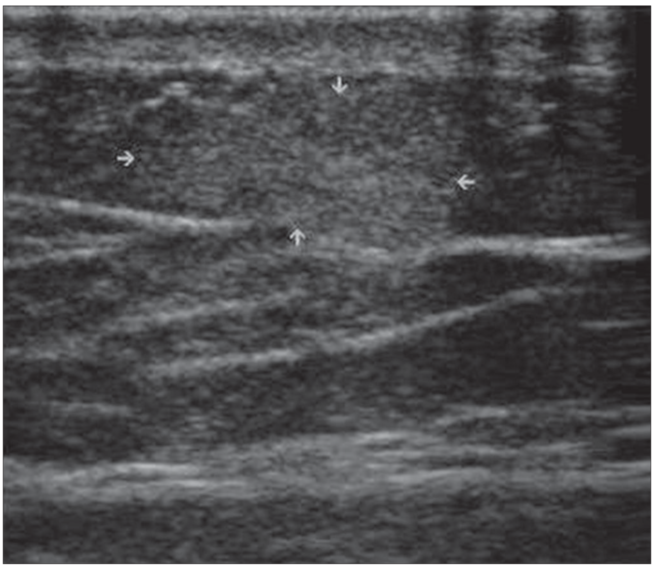

Figure 1: Lipoma. Hyperechoic mass (arrows) seen with a homogeneous echotexture. The longest diameter is parallel to the skin.

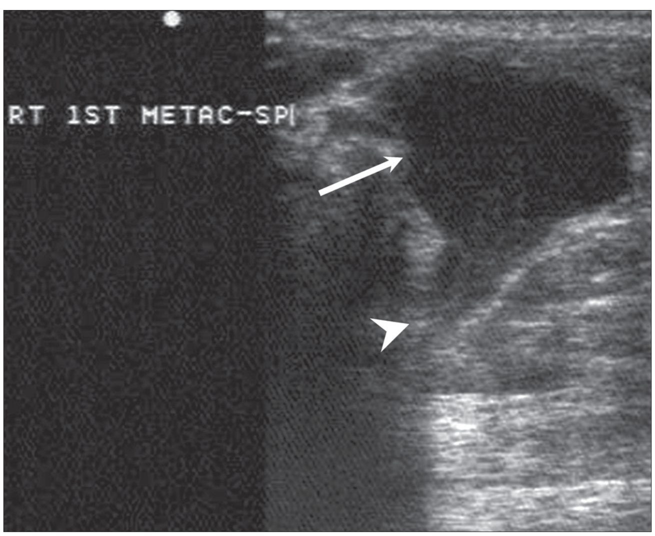

Figure 2: Ganglion. Cystic mass (arrow) seen in the region of the 1st metacarpal bone. Note the posteriorly located 'duct' (arrowhead), pointing towards the joint.

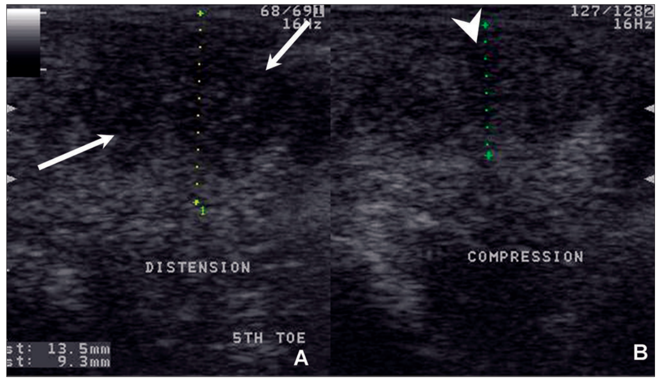

Figure 3 (A, B): Known case of ganglion of the 5th toe. Noncompressed image (A) shows a lesion (arrow) that appears solid because of the presence of internal echoes. The lesion is compressible (B) and flattening of the anterior surface (arrowhead) is seen in response to compression.

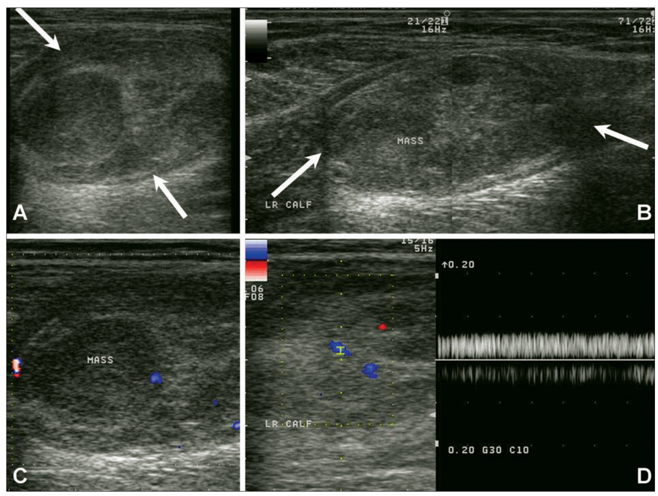

Figure 4 (A-D): Hemangioma. A predominantly hypoechoic lesion in the gastrocnemius muscle, seen on the transverse (A) and longitudinal (B) views (arrows), with a few echo-rich foci. The muscle shows expansion and appears spindle-shaped at the site of the pathology (arrows in B). Low velocity venous flow is seen in the mass (C, D).

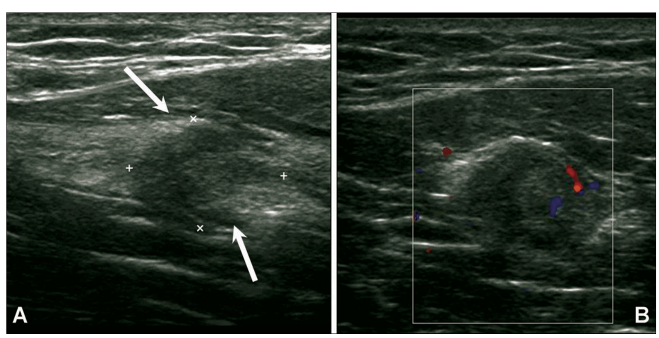

Figure 5 (A, B): Quadriceps hemangioma. The lesion shows fairly well-defined margins (arrows) on a longitudinal scan (A) with poor vascularity on Doppler (B).

poor foci, with margins that are usually not well defined [Figures 4 and 5]. Cystic foci are also known to occur.[6] The presence of phleboliths helps in establishing the diagnosis [Figure 6]. Overgrowth of fatty tissue in hemangiomas has been described and can simulate an angiolipoma.[7] Subcutaneous hemangiomas reveal more cystic or hypoechoic components due to their superficial location.

Color Doppler is of greater help when the tumors are superficially located [Figure 6] and power flow imaging should be routinely done when dealing with such vascular malformations. The vascularity of hemangiomas in neonates is striking, but as age advances, the vascularity is less marked; this is due to hypercellularity during the neonatal period, which reduces with age, with increasing fibrosis.[8]

Flow in hemangiomas is usually of low velocity. Vascularity in deep hemangiomas can be difficult to demonstrate. The vasculature is complex and the tumor size, growth rate, and necrosis, all affect the vascularity. Getting the correct Doppler angle can be difficult because of the variations in

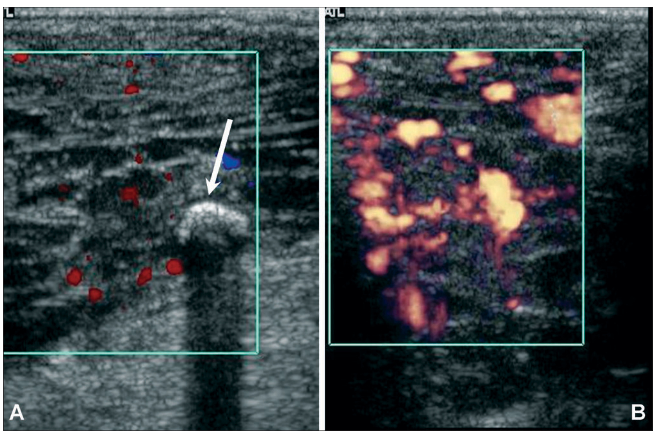

Figure 6 (A, B): Superficial hemangioma/venous vascular malformation. Color Doppler (A) shows an echogenic phlebolith with acoustic shadowing (arrow). Power Doppler (B) shows frank hypervascularity.

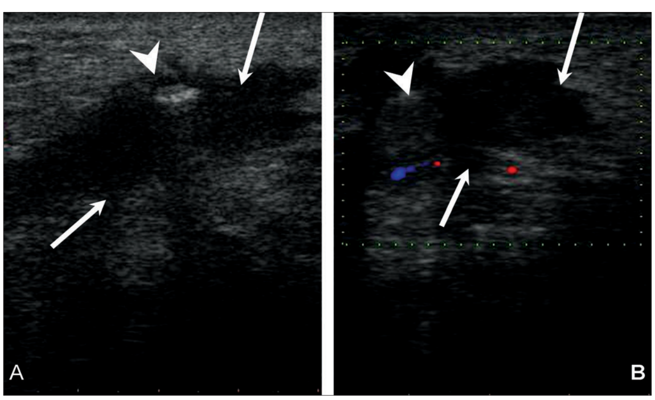

Figure 7 (A, B): Gluteus maximus abscess. Longitudinal (A) and transverse Doppler (B) images show a fluid collection (arrow) in the muscle with echogenic internal contents (arrowheads). Mobility of the echoes was observed in real-time.

the course of the vasculature.[9]

Abscesses and hematomas

Clinical history should help in differentiating between abscesses and hematomas since both often have similar appearances on USG. The echointensity of blood clots in a hematoma changes with age and usually reduces. Abscesses may have a fluid–fluid level and debris is more commonly seen in them. Increased vascularity may be seen on Doppler [Figure 7].

The sensitivity and specificity for the detection of soft tissue foreign bodies are poor, but often improve once an abscess has formed[10] [Figure 8].

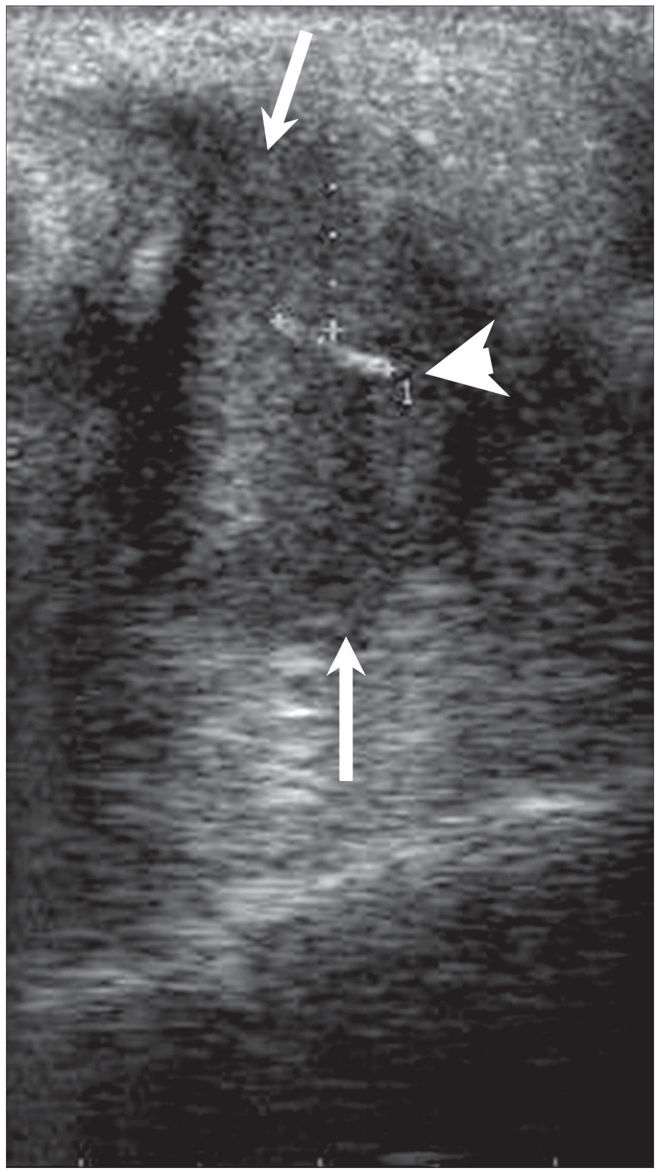

Figure 8: Web-space abscess. A recurrent collection (arrows) is seen after drainage, due to incomplete removal of an associated foreign body (arrowhead).

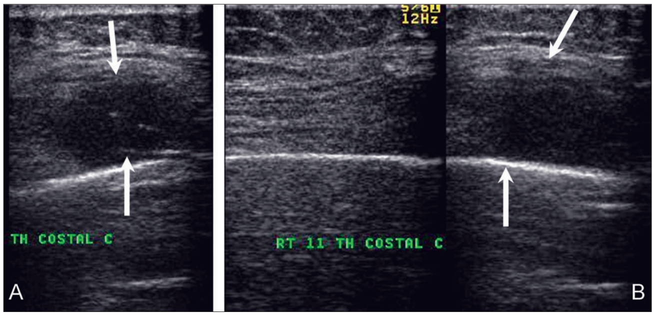

Figure 9 (A, B): Cold abscess of the rib. Transverse (A) and longitudinal (B) images show a collection (arrows) along the rib with debris.

A cold abscess of the rib may present as a lump, commonly seen in the in the region of the costal margins. The presence of debris, rib destruction, and a predominantly cystic mass, are features which help make this diagnosis [Figure 9].

Rectus-sheath hematomas may develop following severe bouts of sneezing, coughing, or convulsions. There is often a history of a bleeding disorder or anticoagulant therapy. These hematomas are usually painful. Their shape depends upon the location. Above the arcuate line, they are usually oval while below the arcuate line, they extend across the midline. Rectus-sheath hematomas following amniocentesis have also been described in the literature.[11]

Nerve tumors

Neurofibroma and schwannoma: These are the two common neural tumors. They are often asymptomatic, and malignant transformation is not common.[12] Malignancy should be strongly suspected when USG shows indistinct margins and adhesions to the surrounding structures.[13]

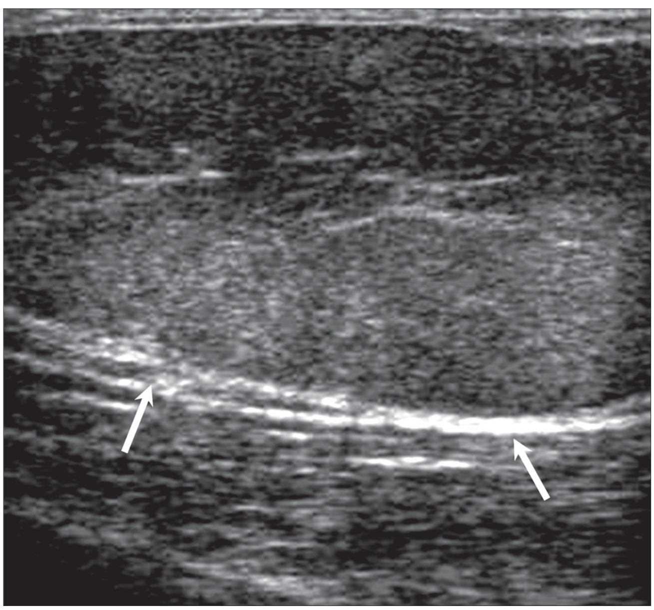

Figure 10: Subcutaneous neurofibroma. The tumor is homogeneous, hypoechoic, and well-encapsulated.

Both tumors are hypoechoic on USG [Figure 10] and relatively avascular on Doppler. Schwannomas may show cystic areas due to degeneration and a few hyperechoic foci may also be noted, depending upon the distribution of collagen tissue within. The nerve passes through the center of the mass in neurofibromas, whereas it is related to the periphery of the mass in schwannomas [Figure 11]. When seen, an echogenic ring in the mass is confirmative of a nerve sheath tumor. Schwannomas are also well encapsulated.

Soft tissue diffuse neurofibromas are commonly seen in children and young adults and deserve a special mention. Their USG features are different from those seen in other focal masses.[14] These lesions have a larger hyperechoic component, their margins are ill-defined, they are more vascular, and often show communicating echo-poor structures. The hyperechoic areas are thought to represent fat, while the echo-poor structures are the neurofibromatous elements.

Morton's neuroma: The commonest location is in the space between the 2nd and 3rd and 3rd and 4th metatarsal heads. It may be multifocal. It may not be palpable. Wearing of tight shoes is a known predisposing factor and women are affected more than men.

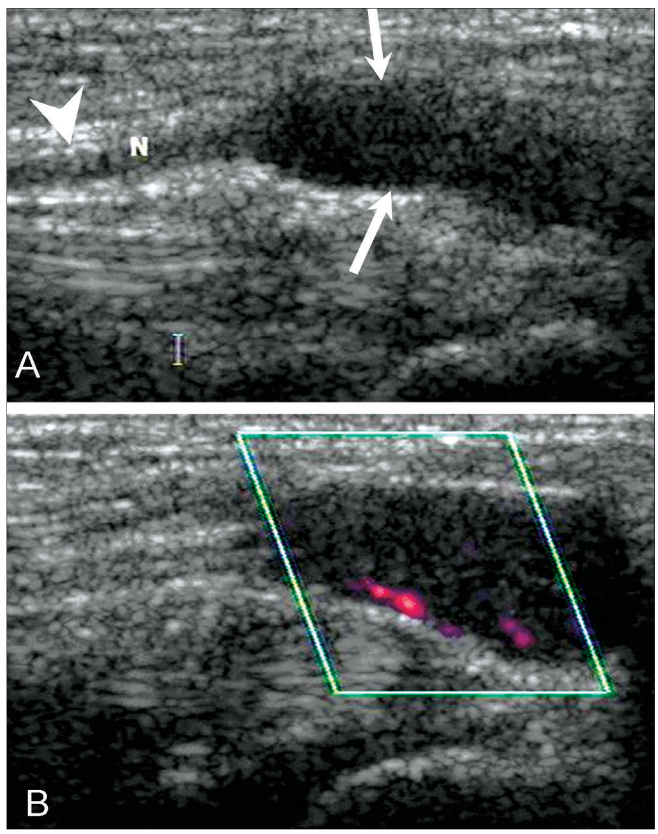

Figure 11 (A, B): Schwannoma of the posterior tibial nerve. Longitudinal grey-scale (A) and color Doppler (B) images show a well-defined, hypovascular mass (arrows). The posterior tibial nerve is seen coursing towards the periphery of the mass (arrowhead).

The tumors are best approached from the plantar surface, though additional scanning from the dorsal surface can be of help if the ideal probe frequency is not available. An important step while scanning from the plantar aspect is simultaneous compression of the interdigital space from the dorsal aspect. On vigorous plantar flexion of the toes, the masses appear more prominent in the superficial dorsal tissues and can be imaged better.[15] The masses are oval, echo-poor and homogenous in texture, and usually less than 2 cm in size.[16]

Plantar fibromatosis

The plantar fascia is ideally examined with high frequency probes, with the foot in dorsiflexion. The fascia is hypoechoic in nature and its thickness usually does not exceed 4 mm. Plantar fibromatosis is a benign condition related to the surface of the plantar fascia, with formation of an underlying mass of fibrous tissue.

On USG, the lesion has an elongated shape and tapers at the ends where it fuses with the fascia. It is usually hypoechoic, with an average size of 5–10 mm, though mixed echogenicity is also seen in a small percentage of cases.[17] Associated thickening of the plantar fascia may be present due to altered weight bearing.[18]

Gout

The small joints of the fingers and toes are the usual sites where gouty tophi occur. The tophi may be echogenic/echo-poor and are surrounded by an echogenic rim.[19] When echogenic, they may be difficult to distinguish from the surrounding fibrofatty tissues, especially in the foot. Irregular hyperechoic bands may be seen over the edge of the cartilage and this has been described as the 'double contour sign'[19] [Figure 12].

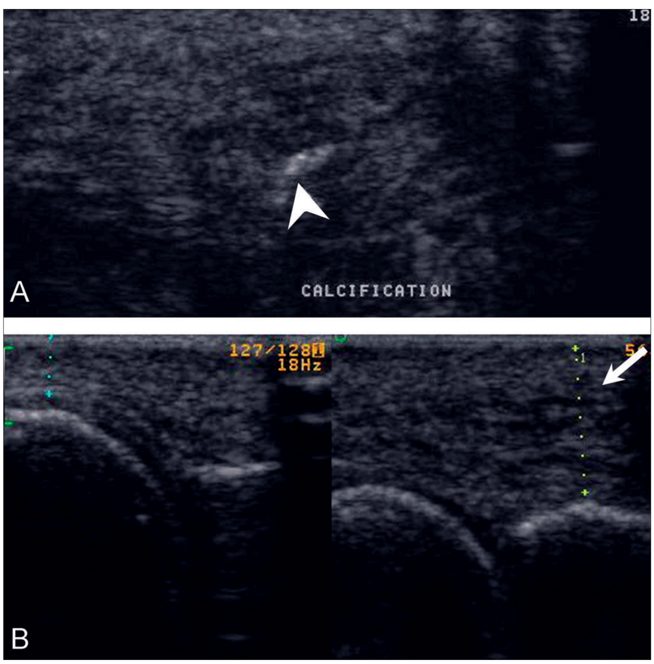

Figure 12 (A,B): Gout. Transverse (A) and longitudinal (B) scans show soft tissue swelling over the lateral aspect of the little toe (arrow). The apparent calcification (arrowhead) seen is the echogenic band.

Malignant tumors

The only role of USG in malignant tumors is to define the extent and relationship of the mass with the surrounding structures. It is usually not possible to assess the histology. Power Doppler may help in monitoring the response to chemotherapy, and persistence of low-resistance flow indicates poor response to therapy.[20,21]

Metastases to the muscles and subcutaneous tissues is not very frequent. The characteristics of the mass depend on the primary tumor [Figure 13]. When hypoechoic, and if a primary is not suspected, the mass may be confused with a hematoma or lymphoma, especially when located in the anterior abdominal wall [Figure 14]. Involvement of unusual sites widens the differential diagnosis, e.g., in the case of a lesion in the masseter, the possibility of a hemangioma or abscess needs to be considered.[22]

Primary lymphomas of skeletal muscles are extremely

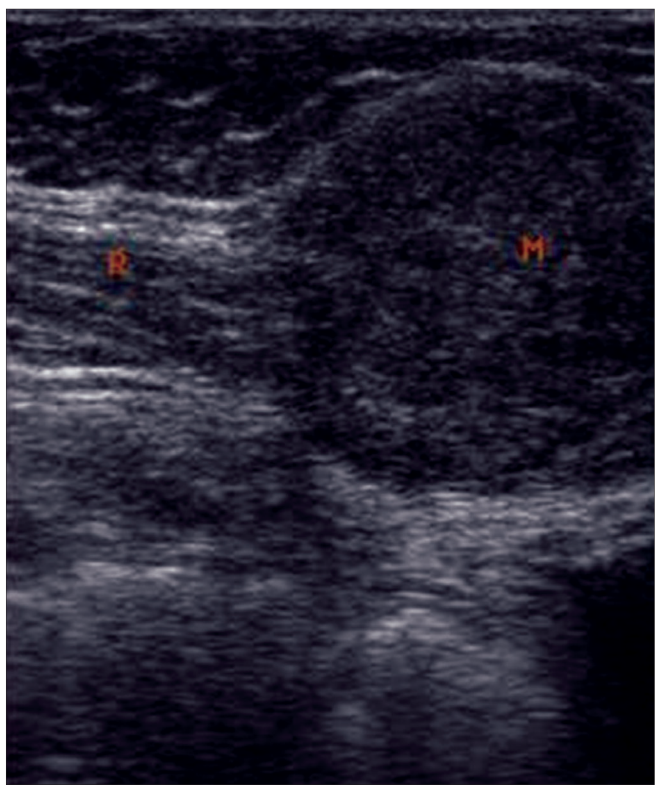

Figure 13: Metastasis in the rectus abdominis muscle. A well-defined, heterogeneous, solid mass (m) is seen within the rectus (r) muscle in a known case of carcinoma ovary.

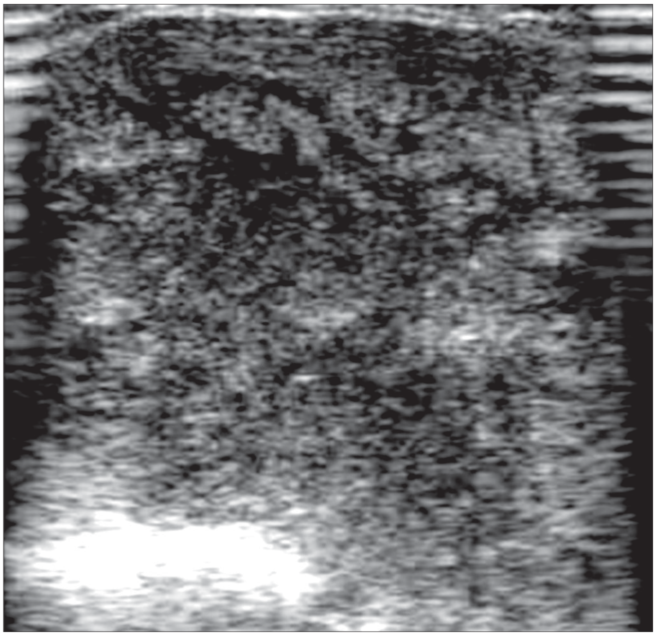

Figure 14: Lymphoma. An ill-defined metastatic lesion is seen in the skin of the anterior chest wall in a seropositive patient. These features are atypical and unusual for lymphoma.

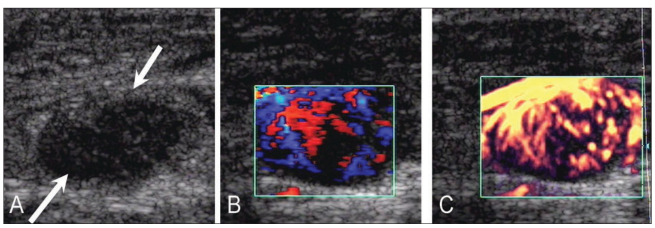

Figure 15 (A-C): Biceps muscle lymphoma. B mode (A), color Doppler (B), and power Doppler (C) images show a homogeneous, hypoechoic mass (arrows) with marked hypervascularity.

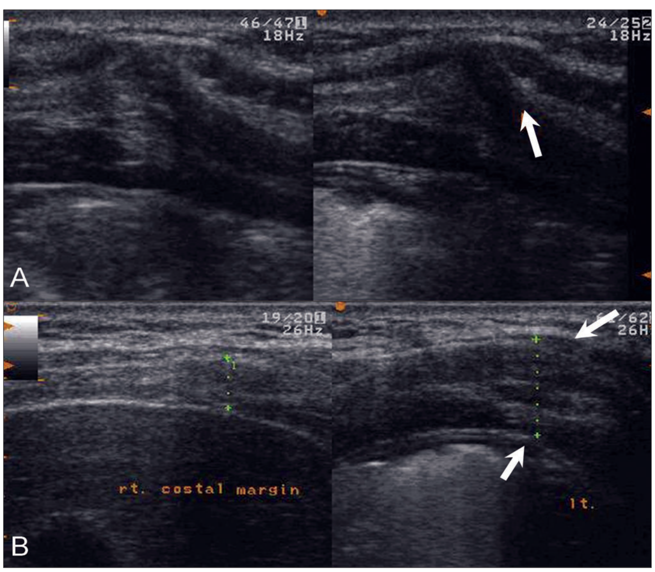

Figure 16 (A, B): Hypertrophied costal cartilage in an 18-year old girl. Longitudinal (A) and transverse (B) images show obvious thickening and hypertrophy of the costal cartilage on the right of these split-screen images, with the normal cartilage on the left. The margins are preserved and there is no rib involvement.

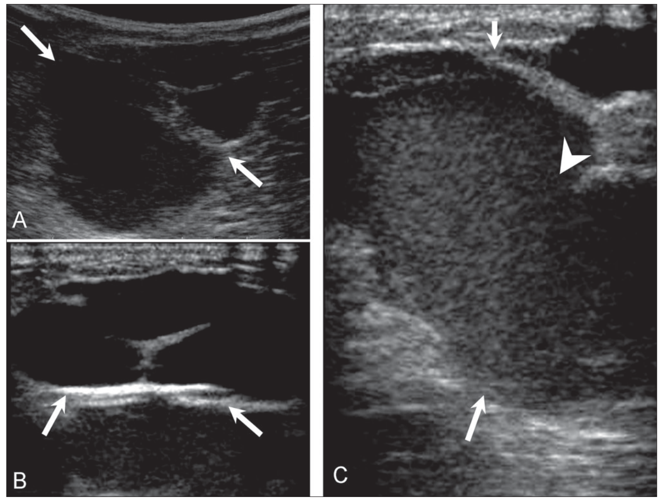

Figure 17 (A-C): Lymphangioma. A septate, multilocular, cystic mass (arrows) is seen located in the subcutaneous tissues (A, B). Bright internal echoes (arrowheads) in one of the components may suggest sediment (C).

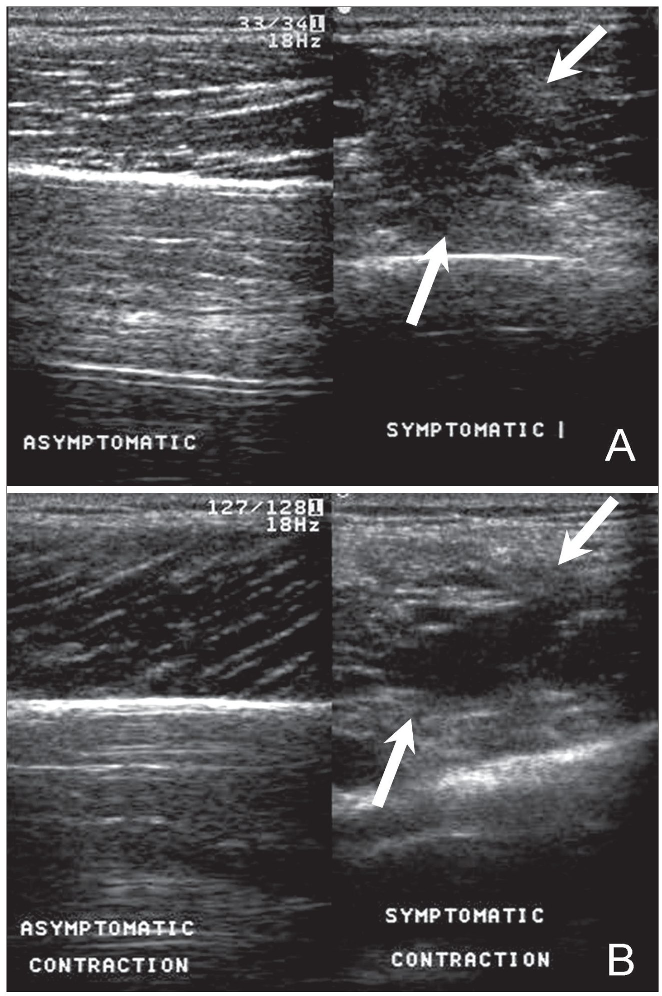

Figure 18 (A, B): Muscle hernia. Images at rest (A) and after contraction (B) show that the hernia (arrows) is less pronounced at rest and more evident during active contraction. In these split-screen images, the normal muscle is on the left and the abnormal on the right.

rare. These tumors are highly vascular, more so than other primary tumors. Doppler may help in diagnosing lymphoma rarely [Figure 15]. Excess transducer pressure on the skin, however, may alter the spectral waveforms and result in a false increase in the resistivity index (RI).[23]

Miscellaneous

Rib abnormalities: Cartilage abnormalities are common in adolescents and usually benign. USG can reliably demonstrate cartilage and rib expansion and soft tissue masses, if any [Figure 16].

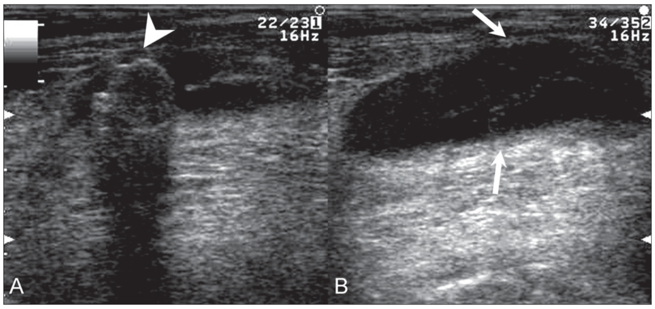

Figure 19 (A, B): Baker's cyst. A large, septate cyst (arrows) is seen on a transverse scan (B), with a loose body (arrowhead) seen more superiorly (A).

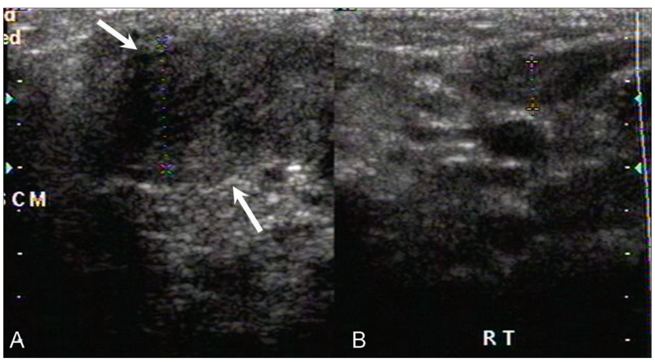

Figure 20 (A, B): Pseudotumor of the left sternocleidomastoid. The split image shows the abnormal (arrows) sternocleidomastoid muscle on the left (A), as compared to the normal muscle on the right (B), in a newborn with torticollis following a normal vaginal delivery. The scan was done on day one of life for a neck swelling which was evident at birth.

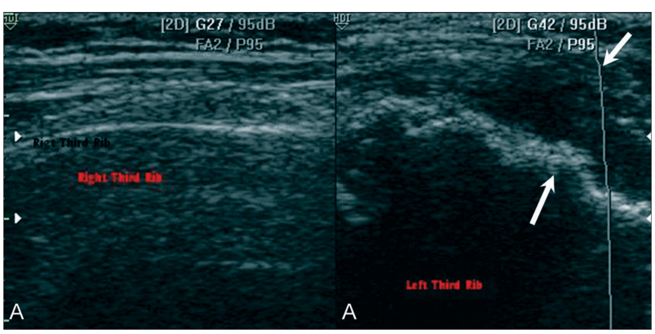

Figure 21 (A, B): Osteochondroma of the left third rib. The rib is eroded and an expansile hypoechoic mass is seen around the rib (arrows) on this longitudinal scan (B) with the normal right third rib (A) for comparison.

Lymphangiomas: Lymphangiomas typically present as septate cystic lesions [Figure 17] in the pediatric age group. USG can demonstrate the extent of the lesion, but when very large, other modalities may be required.

Muscle hernias: Muscle hernias present as small lumps. Better visualization after exercise has been reported. The history often helps in clinching the diagnosis[24] [Figure 18]. B-mode USG accurately demonstrates the herniation. Three-dimensional USG is also helpful.[25]

Baker's cyst: A Baker's cyst often presents as a soft tissue mass. The differential diagnosis includes lymphocele, abscess, popliteal artery aneurysm, and soft tissue neoplasm. Communication with the joint space is usually seen and the cyst may sometimes get infected. Calcification of the cyst is uncommon, but loose bodies are often seen

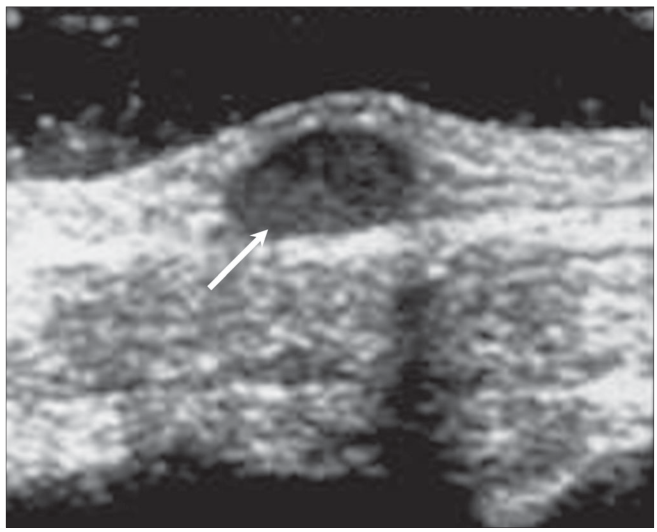

Figure 22: Glomus tumor: A well-defined, predominantly hypoechoic solid mass (arrows) is seen underneath the nail bed. (Image courtesy Dr. S. K. Joshi, Hubli)

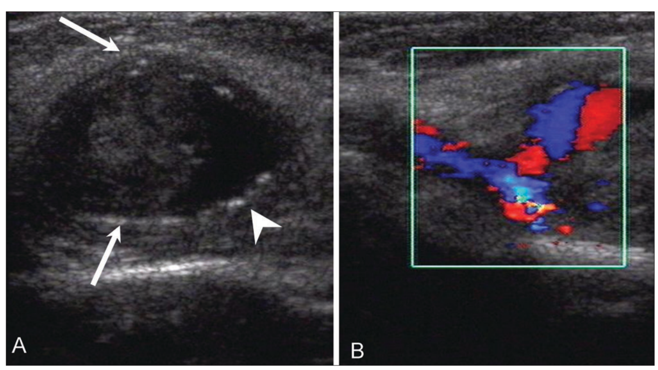

Figure 23 (A, B): Pseudoaneurysm. This patient had a swelling in the arm with no definite history of trauma. The B-mode image (A) shows a complex mass (arrows) with wall calcification (arrowhead). The Doppler (B) shows classic findings.

and show acoustic shadowing[26] [Figure 19].

Pseudotumors: Pseudotumors [Figure 20] are palpable masses that cause discomfort to the patient. They can be present at various locations and the causes include muscle retraction associated with tear, thrombophlebitis, and localized fat deposition. USG helps to exclude a true tumor.

Bone tumors: Though USG is not the modality of choice for these diseases, bone tumors are sometimes incidentally diagnosed during a scan for other purposes [Figure 21].

Glomus tumor: Similar to Morton's neuromas, these painful tumors also have a typical location: the subungual region [Figure 22]. The tumors are hypoechoic and vascular and there may be associated bone erosion.

Pseudoaneurysm: Pseudoaneurysms pose no difficulty in diagnosis. Often they are not clinically suspected and patients present with a history of pain or swelling. Doppler reveals the pathognomic features [Figure 23].

Conclusion

USG is useful in the assessment of soft tissue tumors. It offers basic information about the nature of the mass and its extent and relationship with the surrounding structures. Doppler, especially power Doppler, helps in many conditions. USG guidance for biopsies, abscess drainage, and removal of foreign bodies, is promising and popular. MRI still remains the gold standard for the evaluation of soft tissue masses. The importance of adequate training and the operator's competence cannot be overemphasized.

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