

Presentation by

**Angela Clough**

# MSK Ultrasound

## ‘Lumps & Bumps’

Connective tissue pathology and variants

June 2019

# Objectives

- Review guidelines
  - NICE guidelines and ESSR guidelines
- Review scanning techniques and tips
- Discuss most common lumps & bumps

# NICE Guidelines - 2015

- **Soft tissue Sarcoma**

- Just over 3,000 new soft tissue sarcomas diagnosed each year in the UK
- A full-time GP with a list size of 2000 patients is likely to diagnose approx. 1 person with soft tissue sarcoma during their career
- Occurs in connective tissue – therefore affects many areas of the body
- Five year survival rate dependent upon the site
- Believed that patients present with a mass, that may be painless and may become large

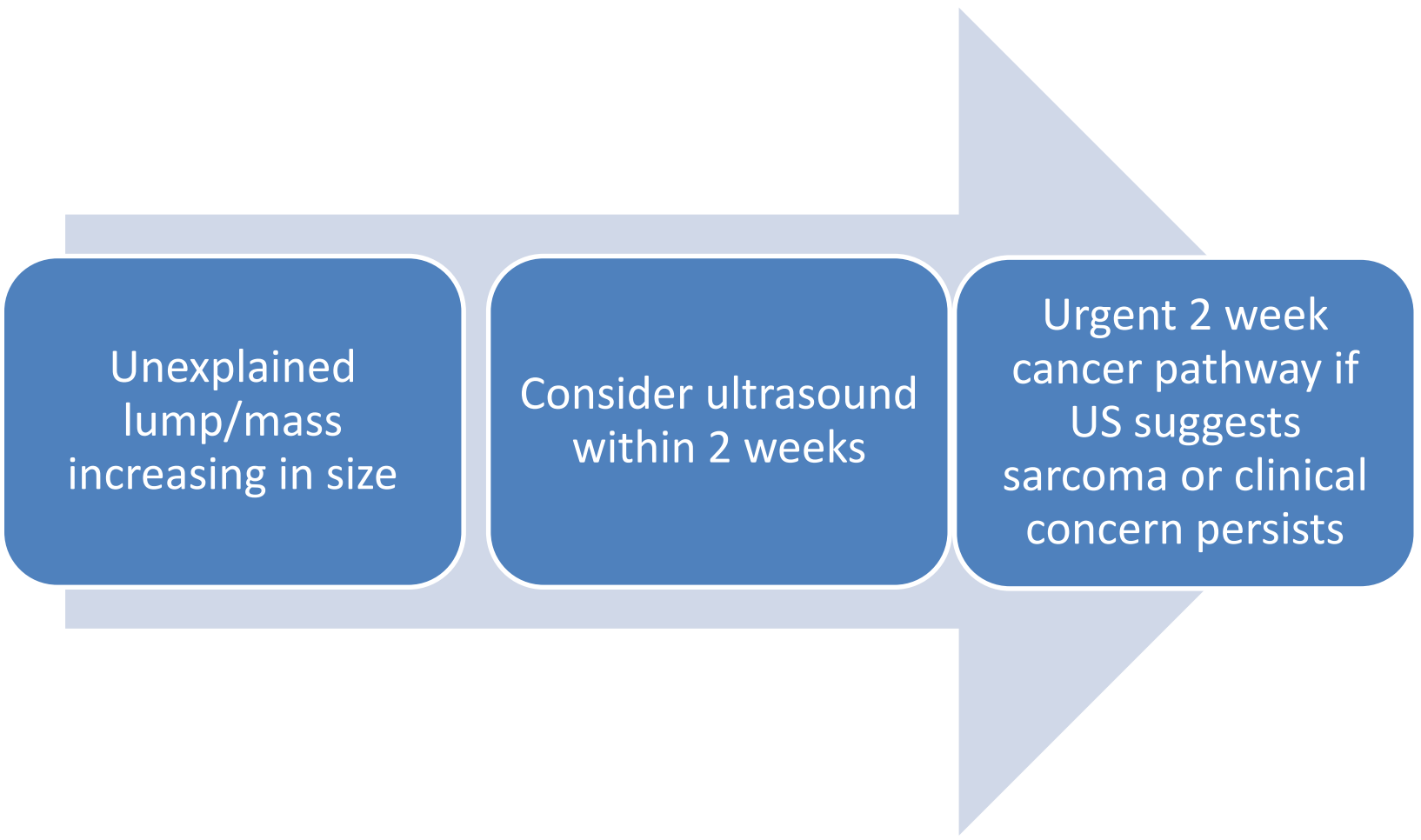
<https://www.nice.org.uk/guidance/ng12/evidence/full-guideline-pdf-74333341>

# Background information

- Sarcomas are a rare diverse group of cancers
- Thought to be embryonic in origin
  - Arising from connective tissue:
    - Bone, cartilage, muscle, blood vessels, nerves and fat
- Bone and soft tissue sarcomas are the 21<sup>st</sup> most common cancer type
  - Bone sarcomas – 27<sup>th</sup> most common type
  - Soft tissue sarcomas (STS) – 23<sup>rd</sup> most common cancer type
- Majority of soft tissue masses most likely benign
  - STS account for 1% of malignant tumours
  - STS increase in frequency with age

<https://www.nice.org.uk/guidance/csg9/evidence/full-guideline-pdf-2188960813>

# NICE Guidelines – 2015 (Adults)



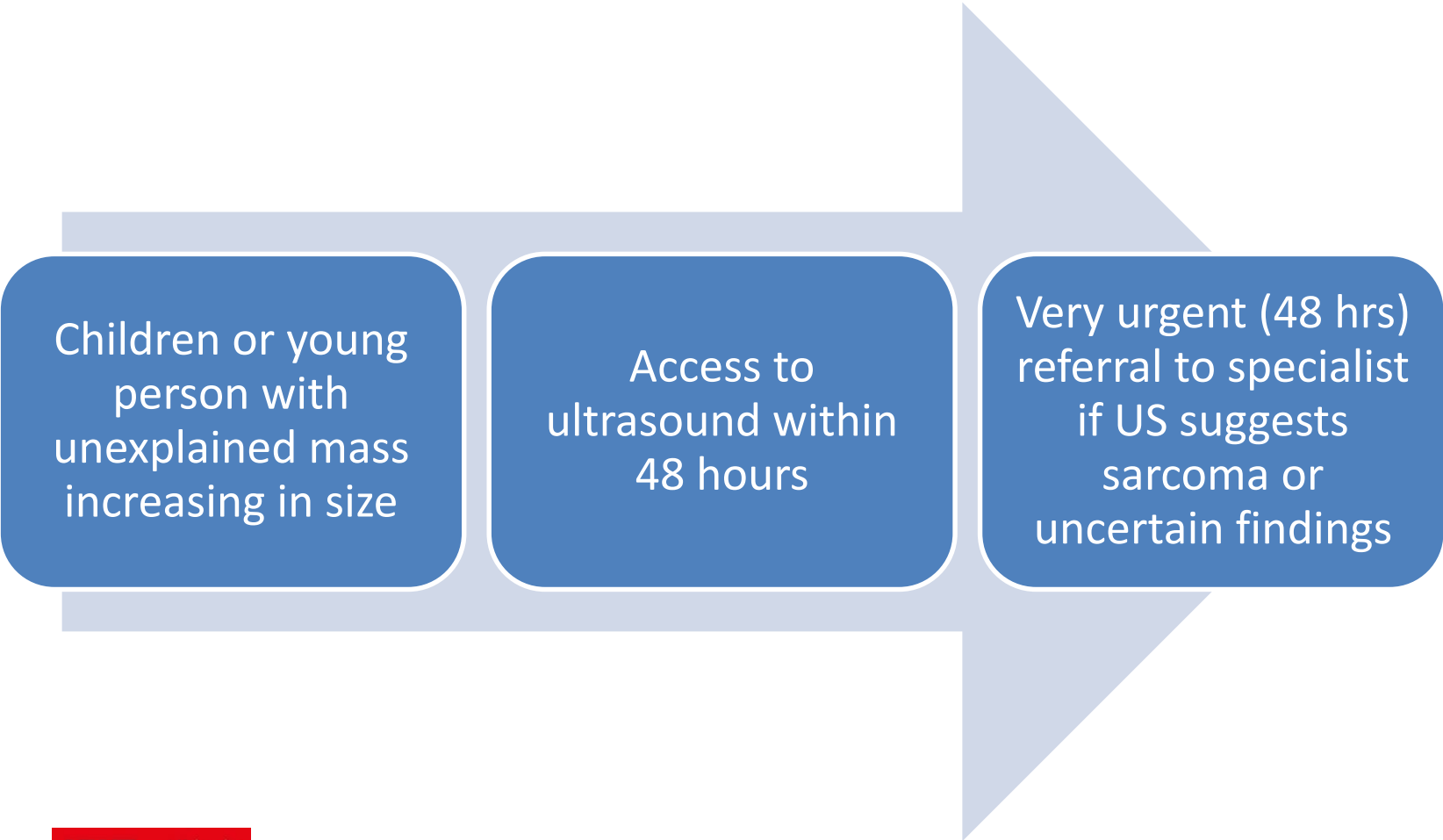
```
graph LR; A[Unexplained lump/mass increasing in size] --> B[Consider ultrasound within 2 weeks]; B --> C[Urgent 2 week cancer pathway if US suggests sarcoma or clinical concern persists];
```

Unexplained  
lump/mass  
increasing in size

Consider ultrasound  
within 2 weeks

Urgent 2 week  
cancer pathway if  
US suggests  
sarcoma or clinical  
concern persists

# NICE Guidelines – 2015 (Children or young people – ages 16-24)



```
graph LR; A[Children or young person with unexplained mass increasing in size] --> B[Access to ultrasound within 48 hours]; B --> C[Very urgent (48 hrs) referral to specialist if US suggests sarcoma or uncertain findings];
```

Children or young person with unexplained mass increasing in size

Access to ultrasound within 48 hours

Very urgent (48 hrs) referral to specialist if US suggests sarcoma or uncertain findings



# The Role of Ultrasound – Why US?

- Extension of the clinical examination
- Clinical ambiguity
  - U/S sinister features or
  - U/S features allowing diagnosis of common benign masses?
- Determine patient management
  - Further imaging or biopsy?
- Patient reassurance / patient + GP vigilance



# Clinical history

- Has there been trauma?
  - Some patients may report trauma that is unrelated and misleading
- Is the patient anticoagulated?
- Is it growing, and how fast?
- Does it change in size depending on position, exercise or muscle contraction?
- Is there a history of oncology or previous surgery?
  - Noebauer-Humann et al, 2015. Soft tissue tumors in adults: ESSR-approved guidelines for diagnostic imaging

# Clinical symptoms & palpation

- Is the lesion painful?
- Is it palpable, and if so, is it hard, soft, fixed?
- Is it moveable against the skin and underlying tissue?
- Are there any skin alterations or pathological vessels?
- Does it discharge?
- Single or multiple lesions?
- Noebauer-Humann et al, 2015. Soft tissue tumors in adults: ESSR-approved guidelines for diagnostic imaging

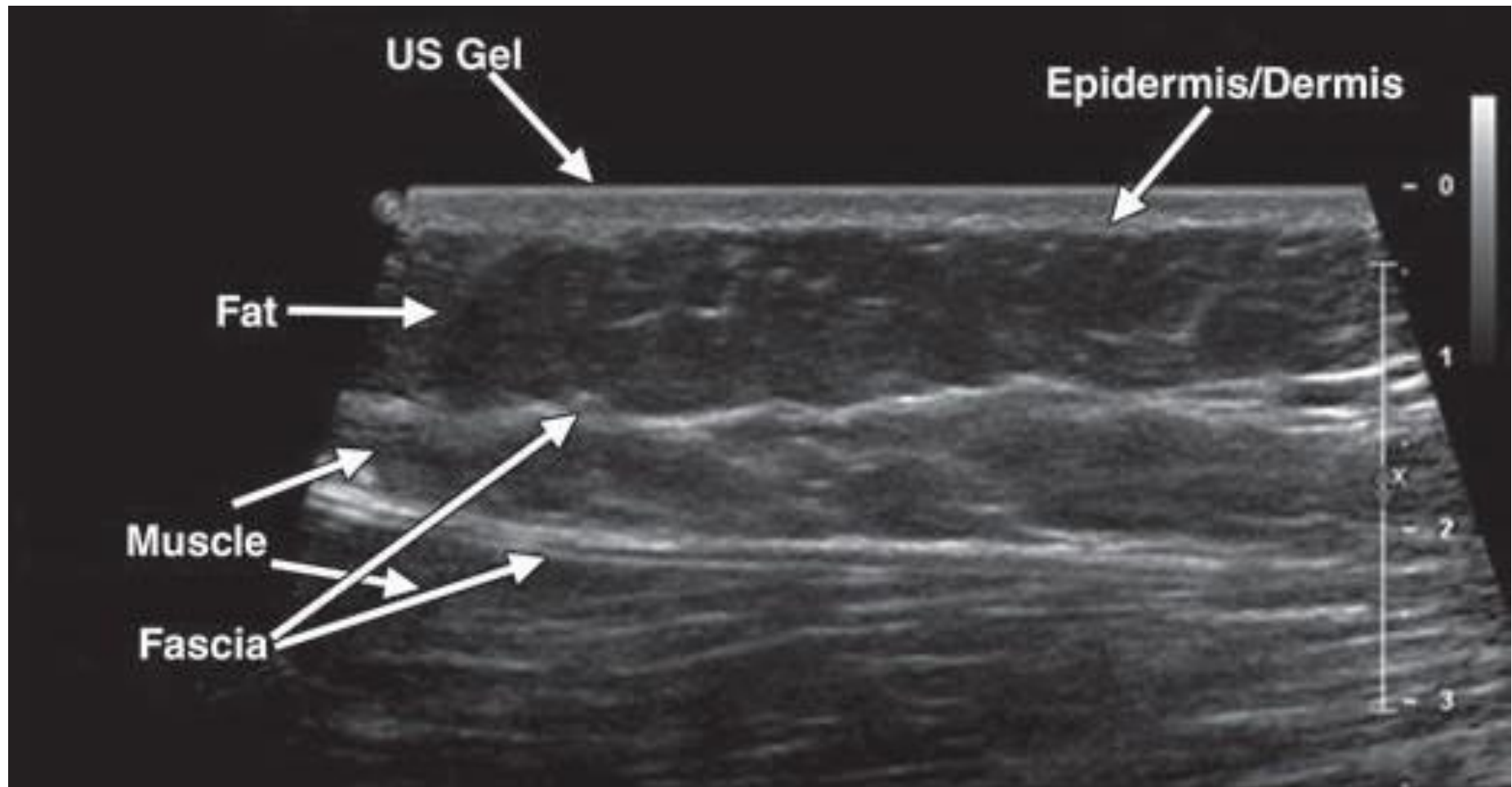
# Approach

- **PRESTO**
  - **P**R – presentation – how long?, pain?, related issues?
  - **E** – elasticity – is the lump soft & mobile
  - **S** – shape – outline, definition (well-defined or not) and size
  - **T** – tissues involved – position and relation to other structures
  - **O** – other – is there calcification? Content? Vascularity?

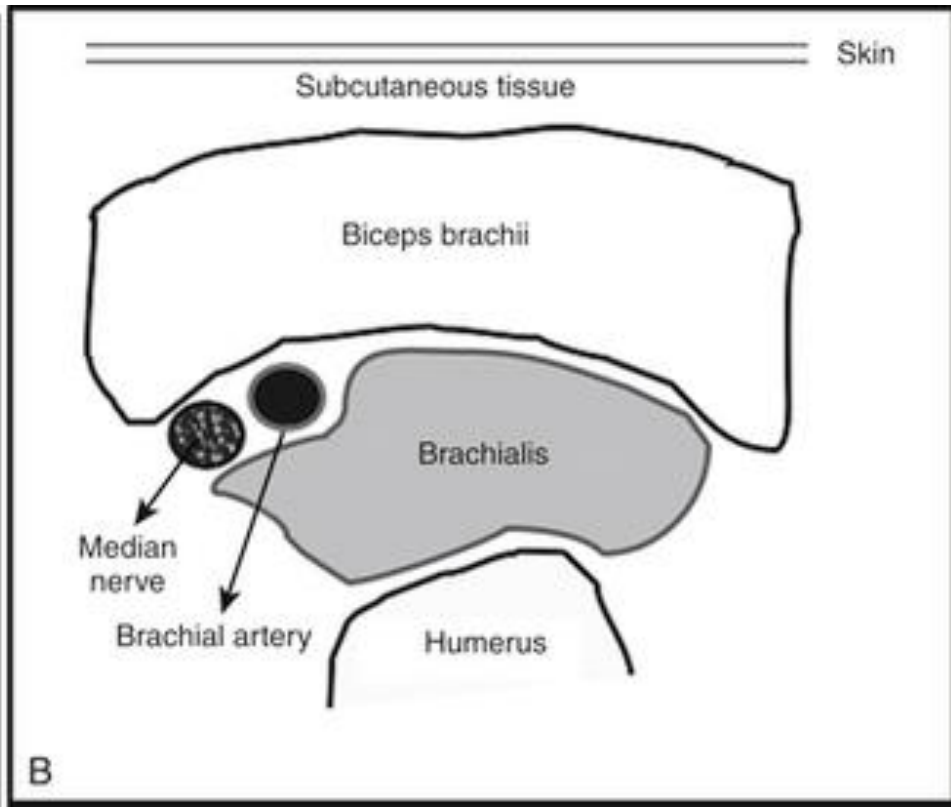
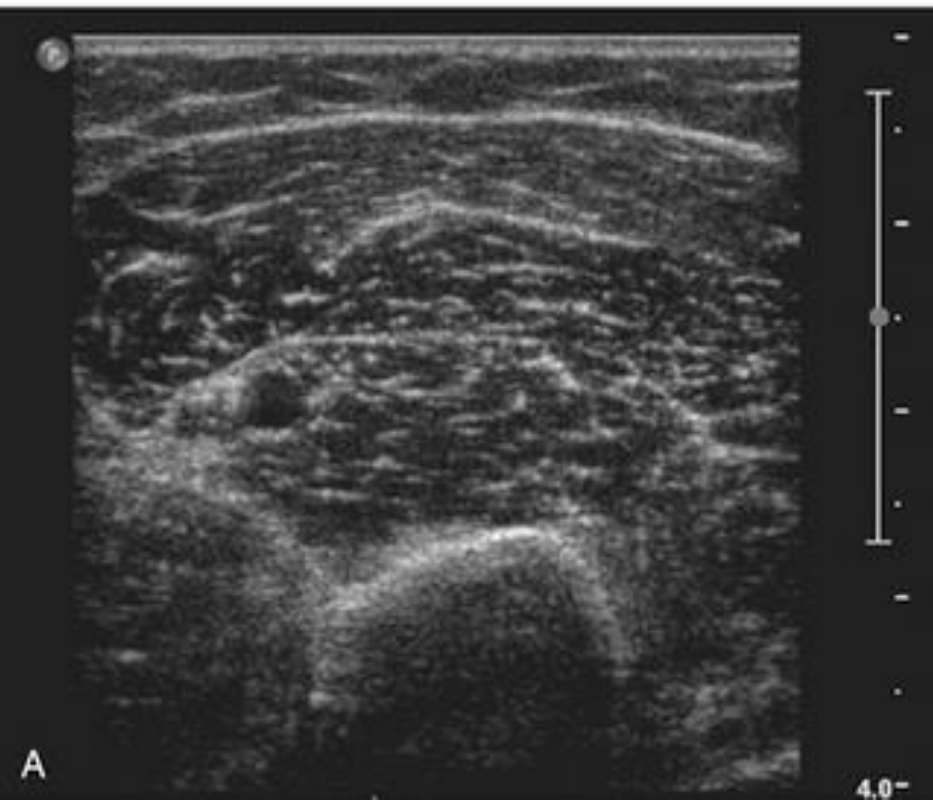
# What should be described on ultrasound?

- Relation to the fascia, e.g. superficial or deep
- Relation to/infiltration of vessels/nerves and if possible bones and joints and other crucial adjacent structures
- Size (in three dimensions)
- Morphology:
  - Cystic, solid
  - Vascularity
  - Presence or absence of necrosis
  - Bleeding
  - Posterior acoustic shadowing/enhancement
  - Calcifications
  - Shape
  - Borders/margins
- Noebauer-Humann et al, 2015. Soft tissue tumors in adults: ESSR-approved guidelines for diagnostic imaging

# Anatomy



# Anatomy



# Features

- **Size and Shape**

- Size alone is not a discriminating factor, however 5 % benign masses > 5 cm
- Sarcomas grow in a centripetal fashion – therefore usually round or ovoid
- Size and shape should always be documented

- **Location**

- Subcutaneous, intramuscular, intermuscular, blood vessels, joints or tendons
- Masses that cross more than one compartment are usually malignant or inflammatory
- However! – STS can be confined to one compartment in early stages!!!

# Features

- **Margin**

- Benign & malignant masses both typically have smooth well-defined borders
- STS compress rather than infiltrate adjacent soft-tissue structures creating a fibrous pseudo capsule
  - There may be a rim of echopoor peri-lesional oedema around malignant masses
- Aggressive or deep fibromatoses often have irregular or speculated borders

- **Echo pattern**

- Varied appearances occur in both benign and malignant masses
- Heterogeneity can occur due to haemorrhage or necrosis (most often seen in STS)



# Features of soft tissue masses

- **Calcification**

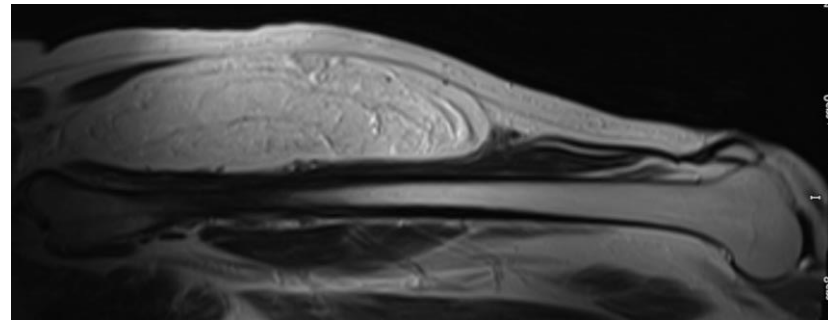
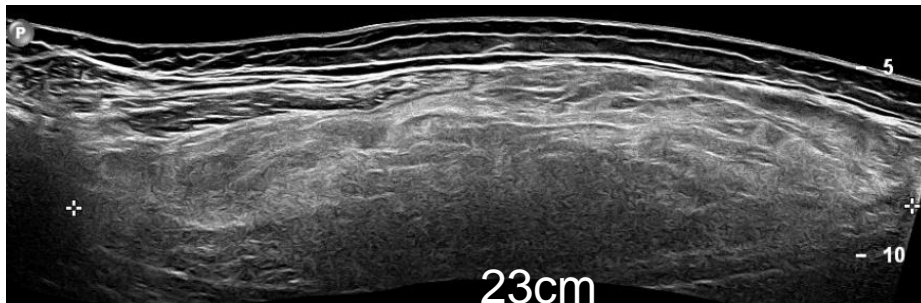
- Varied degree of mineralisation can be present: punctate foci to complete ossification
- Both benign and malignant masses may calcify or ossify

- **Compressibility**

- Sonopalpation may distinguish cystic from solid (+M mode)
- Assess for debris e.g. abscess
- Not all cystic lesions are compressible e.g. ganglions
- Lipomas are usually compressible
- Elastography – emerging technology

# Features - Vascularity

- All masses should be assessed with colour or power Doppler
- Occasionally characteristic vascular patterns can be seen
- There is overlap between benign and malignant tumours
  - Benign schwannomas are often highly vascular
  - Malignant liposarcomas can be relatively avascular



# MRI & diagnosis

- Ultrasound first line of investigation
- MRI and US are complimentary methods of imaging
- MRI reserved for deeper larger soft tissue masses
- MRI also best when US features are indeterminate or non-specific
- MRI reserved for surgical planning
- Biopsy or excision biopsy

# Various types of lumps & bumps

- Lipomas
- Cysts & bursae
- Fibrous tumours
- Pseudo-masses
- Muscle masses
- Inflammatory in origin
- Vascular masses
- Nerve tumours
- Synovial tumours
- Arthritic lesions

# Lipomas

- Soft, fatty lumps that grow under the skin
  - Overgrowth of fat cells
- 1 in 100 people develop lipomas
- Occur anywhere in the body where there are fat cells:
  - Shoulders
  - Neck
  - Torso
  - Back
  - Buttocks
  - Thigh
- Should feel soft and “doughy” to touch
- Usually solitary but can be multiple in 5-15% cases
  - Rare inherited condition called familial multiple lipomatosis
    - <http://www.nhs.uk/conditions/lipoma/Pages/Introduction.aspx>

# Lipomas

- NHS advice – see your GP if the lipoma is:
  - Getting bigger
  - Is painful
  - Feels hard
  - Grows back after being removed
- GP's may refer patients to specialist centres if the lipoma is > 5 cm or painful
- <http://www.nhs.uk/conditions/lipoma/Pages/Introduction.aspx>

# Lipomas – on ultrasound

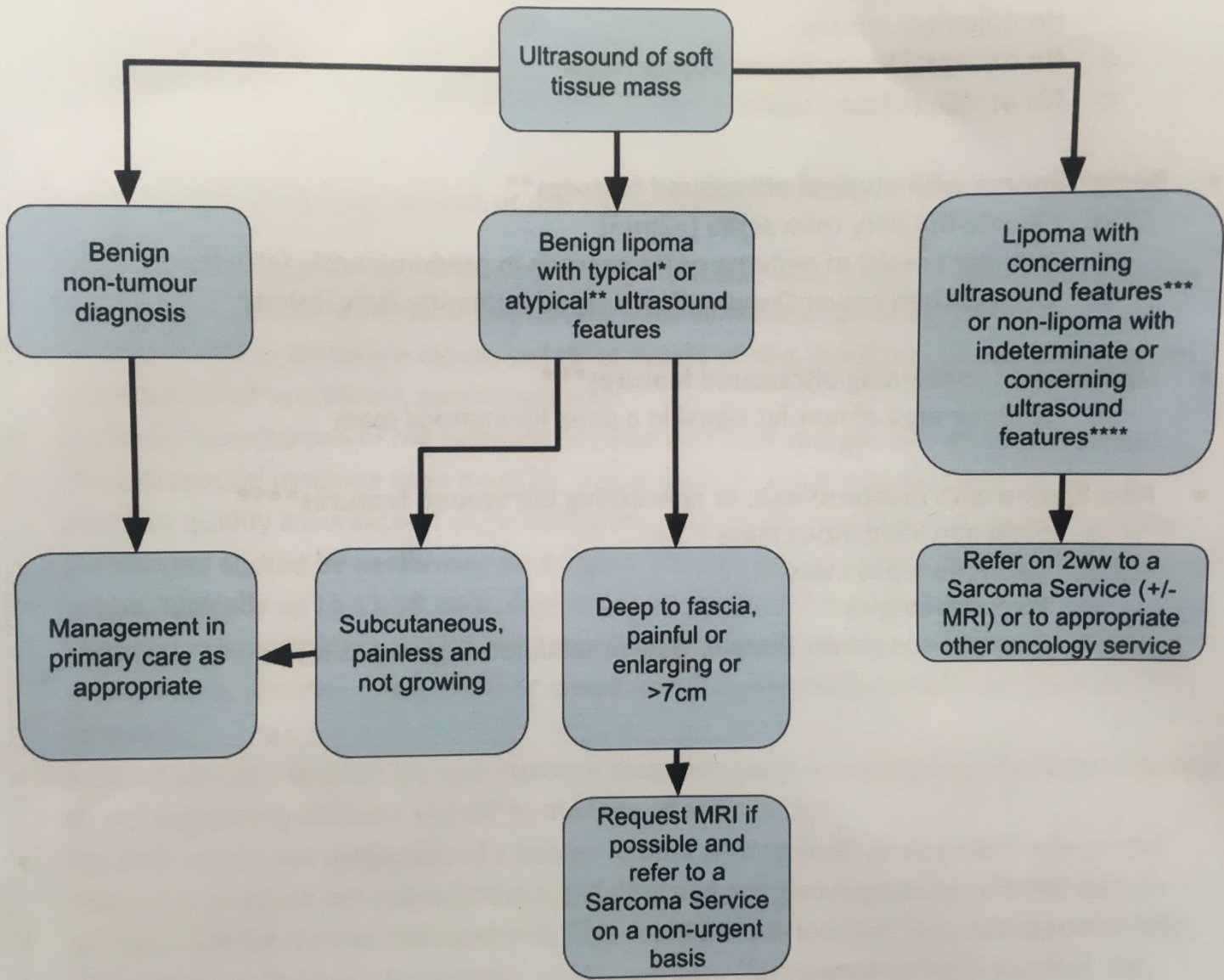
- Ovoid or elliptical
- Avascular on colour Doppler
- Contain short echogenic linear striations running parallel to the skin
- Variable in echogenicity
  - Hyperechoic, hypoechoic or isoechoic
- 80% are < 5 cm in size
- Majority located in the subcutaneous fatty tissue
- Can be intermuscular or intramuscular
  - Deeper lipomas are less common
  - Differentiation from sarcoma can be difficult
  - Recommend MRI for deeper lipomas

# Features that suggest malignancy - liposarcoma

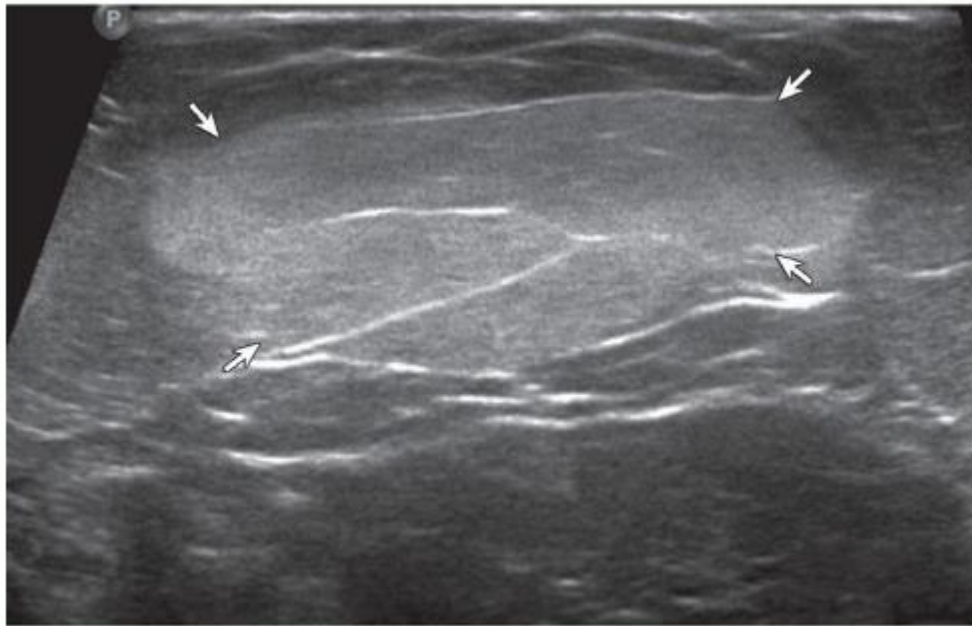
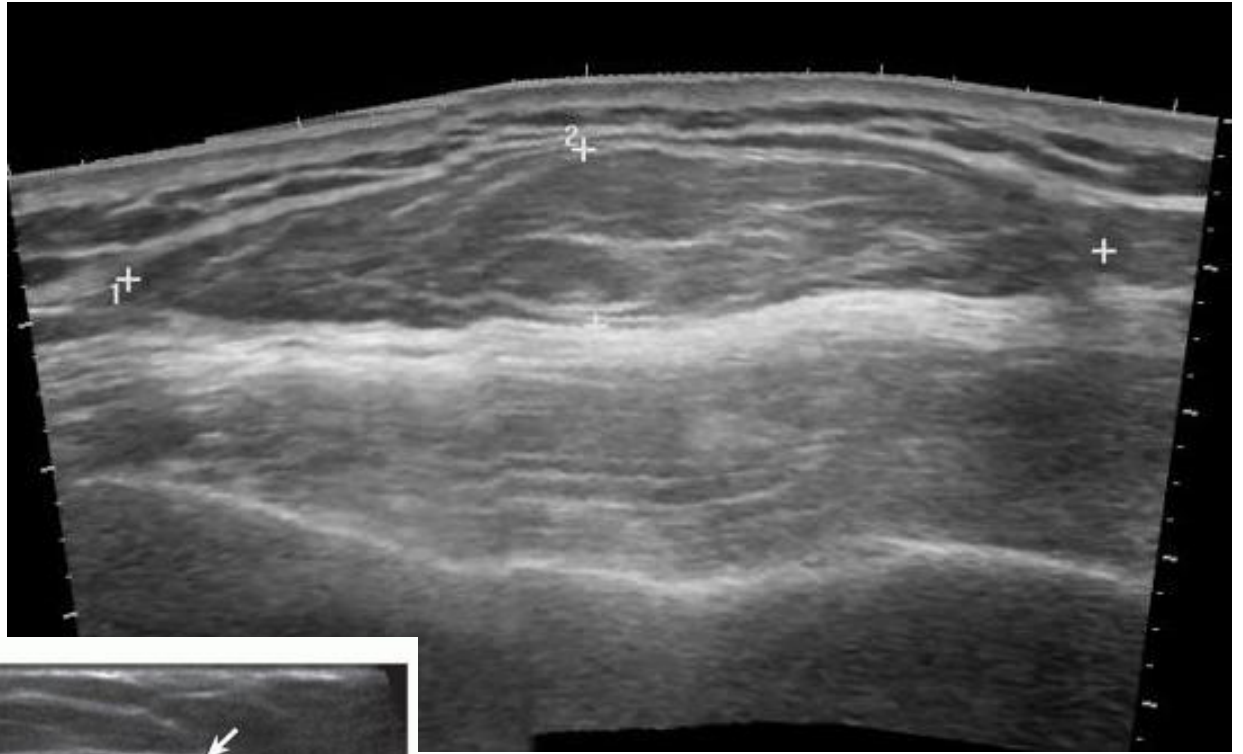
- Patient age -  $> 60$  yrs
  - More common in males
  - Large size -  $> 10$  cm
  - Presence of thick septa -  $> 2$  mm
  - Presence of nodular/globular non-adipose mass-like areas
  - Decreased percentage of fat composition ( $< 75\%$ )
- 
- Paunipagar *et al*, 2010. Ultrasound features of deep-seated lipomas. *Insights Imaging*. 1: pp 149-153



# Guide for U/S Imaging of Trunk and Extremity Tumours (Southmead Hospital)



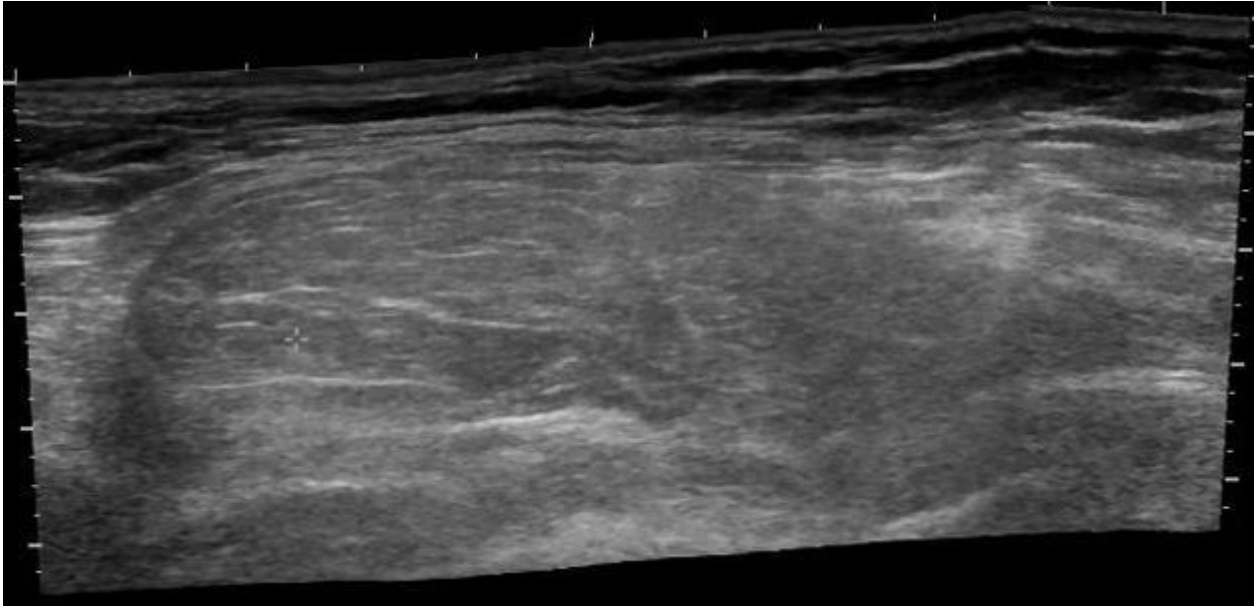
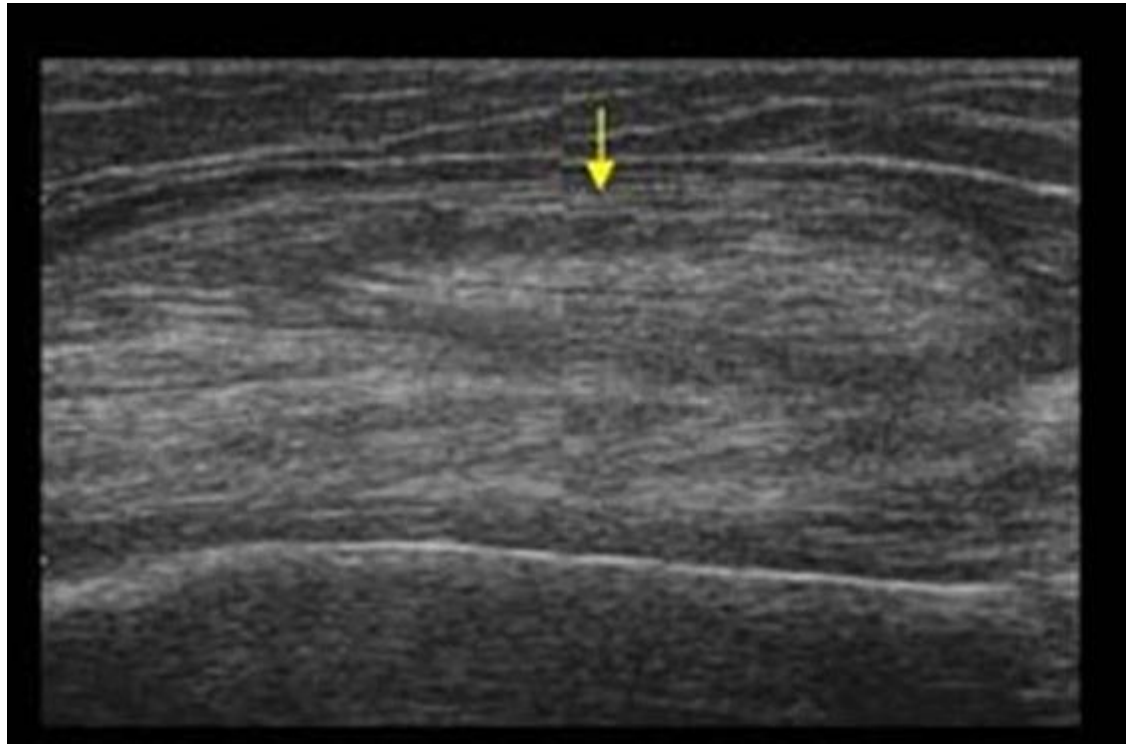
# Lipoma



# Deep lipomas

Deep lipomas can appear isoechoic to the muscle tissue. Can infiltrate the whole muscle belly.

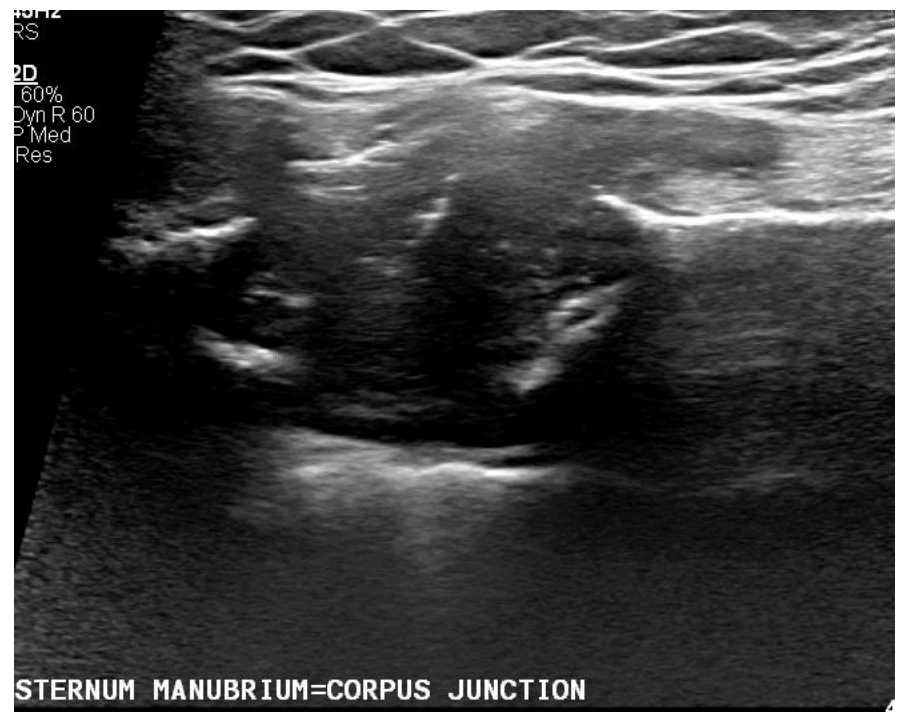
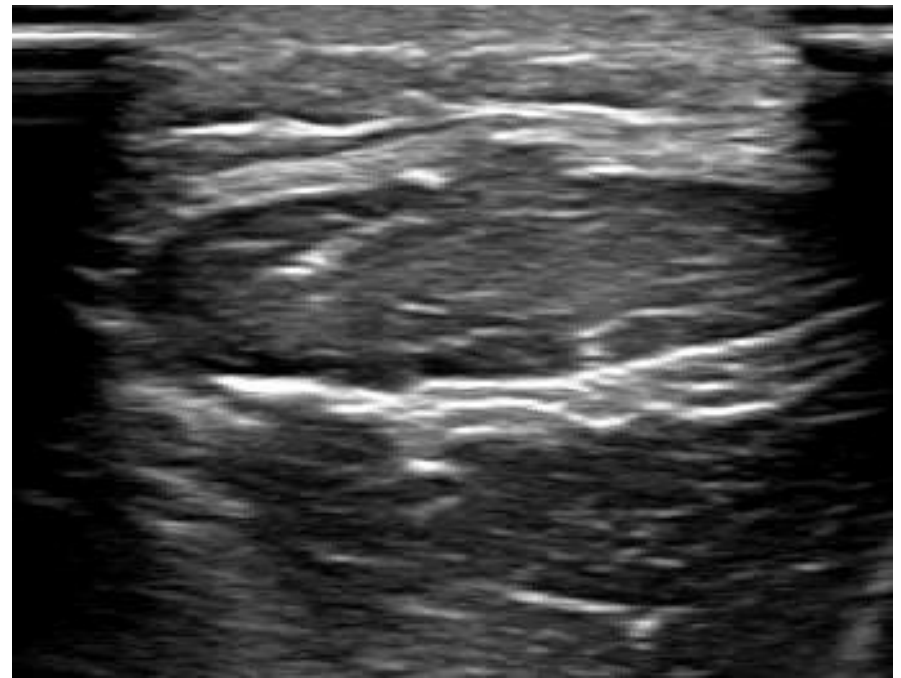
MRI better defines the borders and relationships to neurovascular structures



# Pseudo-masses

- Muscle
  - Accessory muscles – assess for asymmetry on contralateral side
  - Muscle hernias
- Normal but prominent subcutaneous fat that is asymmetrical “Lipohypertrophy”
  - Usually after significant weight loss or gain
- Underlying bone or cartilage
  - Typically rib cage area
- Patient reassurance!

# Muscle hernia



# Joint hernia



# Muscle masses - Haematoma

- **Muscle haematomas**

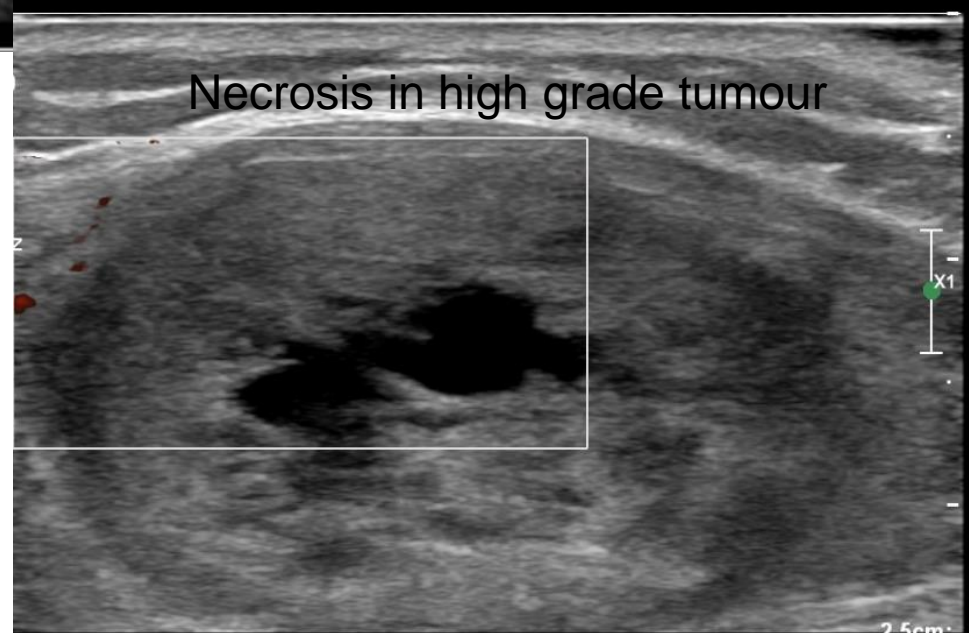
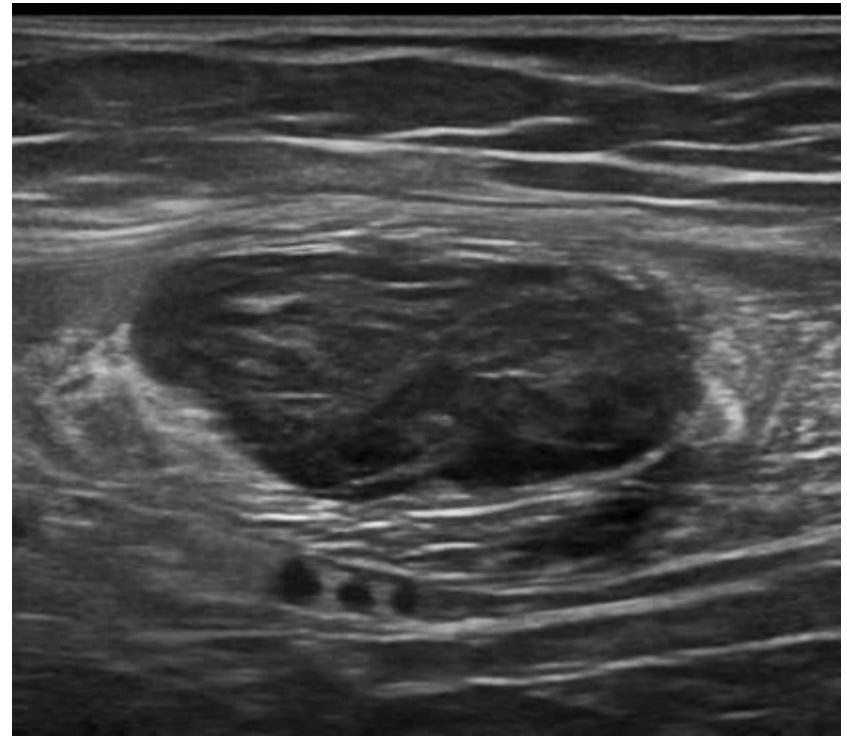
- History of trauma/injury
- Overstretching or contusion
- Spontaneous haematomas in the absence of anticoagulation or injury should raise suspicion of intra-tumoural haematomas within a sarcoma that mimic the haematoma
- **Protocol should recommend follow-up scan 8-10 weeks or MRI**

(An interesting article by Hoshi *et al* (2017) – Clinical features of soft tissue sarcoma presenting intra-tumour haematoma: case series and review literature. *International Orthopaedics*. 41: 203-209 )

- **Ultrasound appearances:**

- Variable according to age of haematoma
- Initially – poorly defined margins and generally hyperechoic
- After 1-2 days becomes hypoechoic
- Matures and becomes heterogeneous but shrinks
- Can liquefy and have cystic components
- Usually avascular
- Can persist indefinitely and remains as a serous cyst like structure

# Haematoma



# Muscle trauma





# Complications of muscle injury

- **Myositis ossificans (MO)–**

- Myositis ossificans traumatica – related to muscle trauma or re-injury of muscle injury
- 50% of cases have been reported with no history of trauma
- Heterotopic non-neoplastic bone or cartilage formation in or adjacent to muscle
- May be painful (although asymptomatic cases have been reported)
- 1 to 2 weeks after trauma there is degeneration and necrosis of the muscle tissue
- 3 to 4 weeks later mesenchymal cell proliferation and bone formation occurs (mature myositis ossificans)
- Differential diagnoses:
- Myositis ossificans progressiva – inherited condition with progressive extra skeletal ossification
- Neurogenic heterotopic ossification where paralysis has been implicated

# Complications of muscle injury – Myositis ossificans

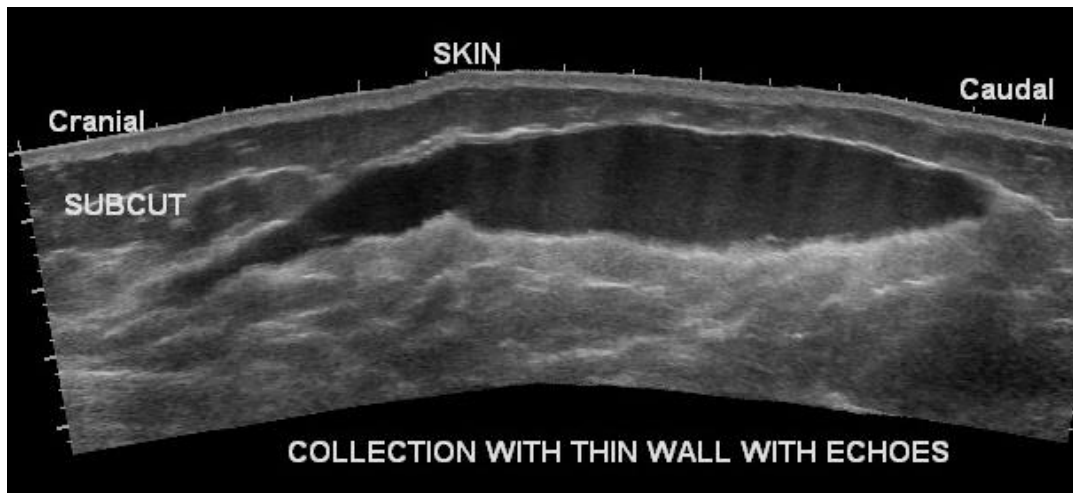


# Ultrasound features of MOT

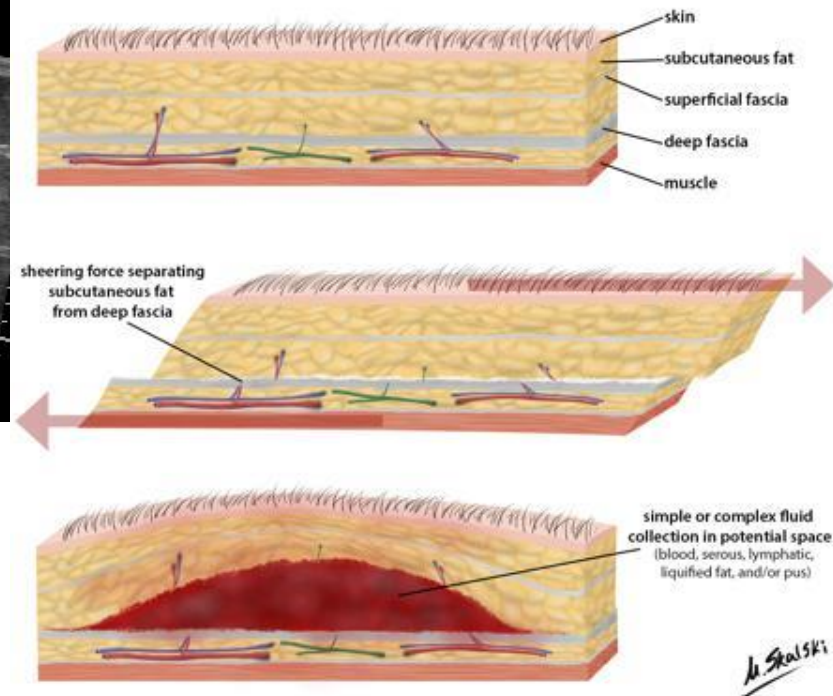
- Ultrasound features can be non-specific
  - Clinical history may be helpful
- Short term follow-up scans may be useful considering the changes that occur
- Early features of MO:
  - Homogeneous hypoechoic well-defined oval shaped mass with thickening of the surrounding muscle belly
  - Hyperechoic lamellar rim
- Late stage features:
  - More defined rim with acoustic shadowing
- Surgical excision is usually performed to avoid recurrence

# Haematomas – longstanding

- Morel-Lavellee lesion:
  - Degloving type of injury – haemorrhage between the subcutaneous fat and musculature - common site is buttocks and thigh
  - - can also be present in calf



## Morel-Lavallée mechanism



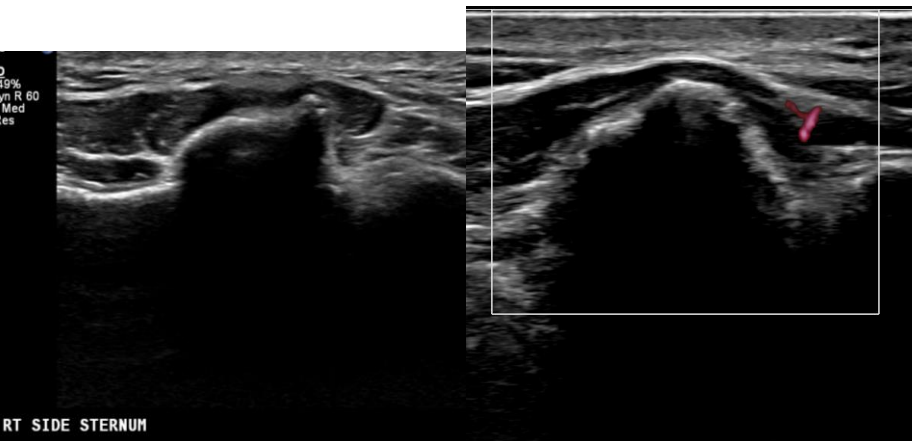
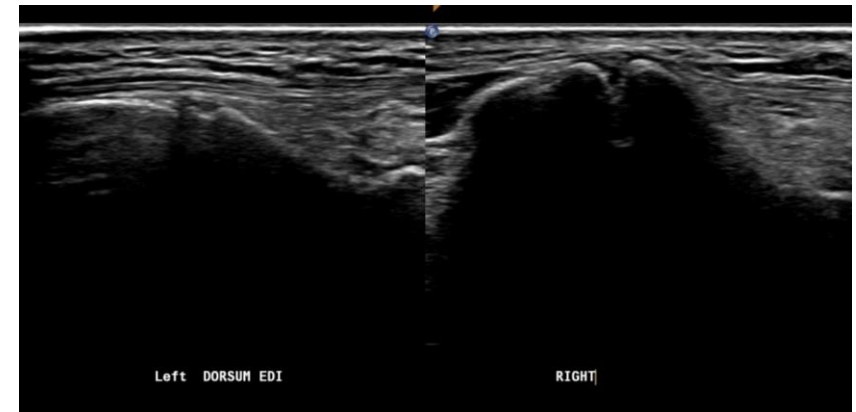
# Synovial osteochondromatosis



- Proliferation and metaplastic transformation of synovium
- Nodules can detach and lie free in joint
- Knee > elbow > hip > shoulder



# Skeletal/cartilaginous lumps



# Soft tissue calcification

## Granuloma

- Well defined round hypoechoic mass
- Variable rim calcification with posterior acoustic shadowing
- Commonly in subcutaneous tissue (often buttocks resulting from previous injections)

Several may coalesce → lobular appearance



Other common reasons include:

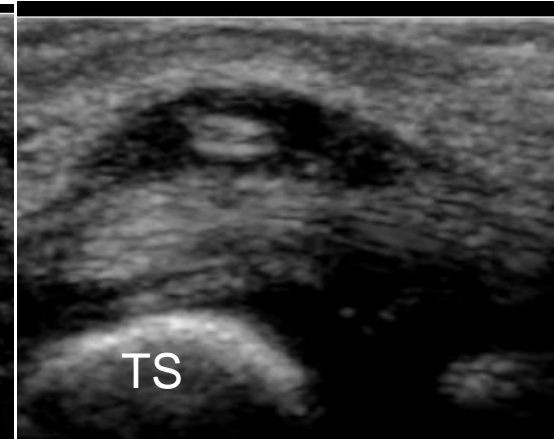
- Phleboliths within venous vascular malformation, gout or pseudogout

Less common reasons include:

- Soft tissue infection, sarcoma, soft tissue chondroma, myositis ossificans, haematoma etc.

# Foreign body granuloma

- Response to foreign bodies
- May see surrounding hypoechoic area of granulation tissue
- Varied degree of vascularity





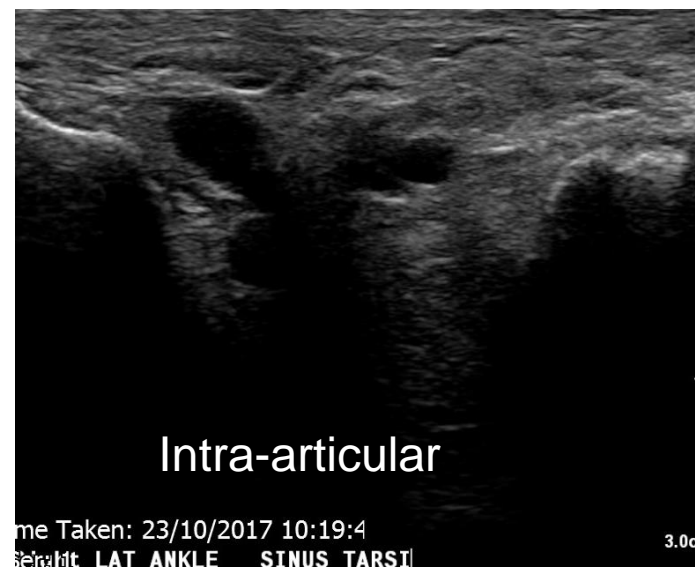
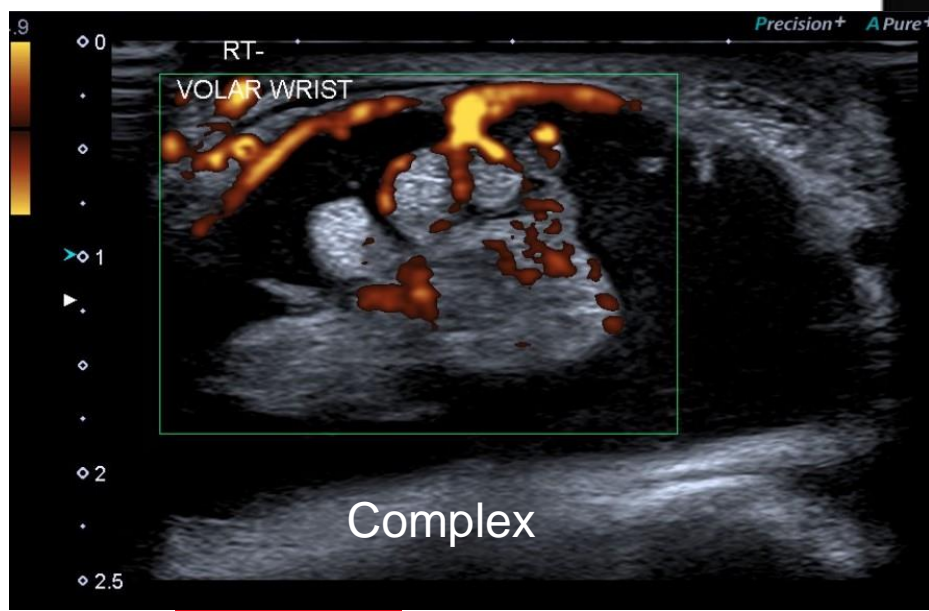
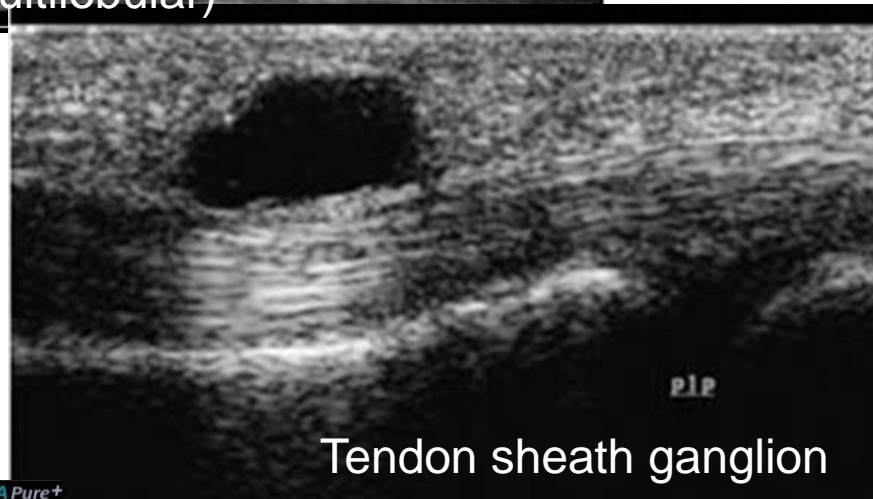
# Cysts and bursae

- Ganglions
- Baker's cysts
- Bursitis
- Epidermoid cysts

# Ganglions

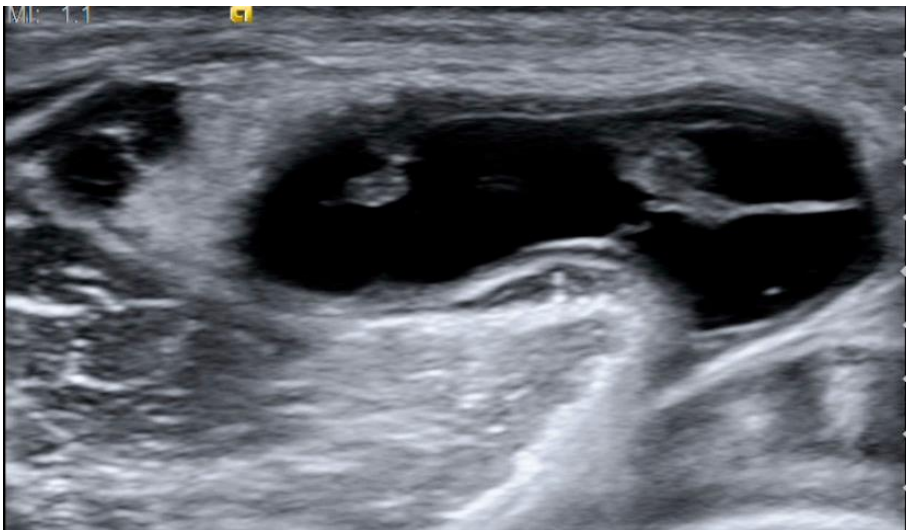
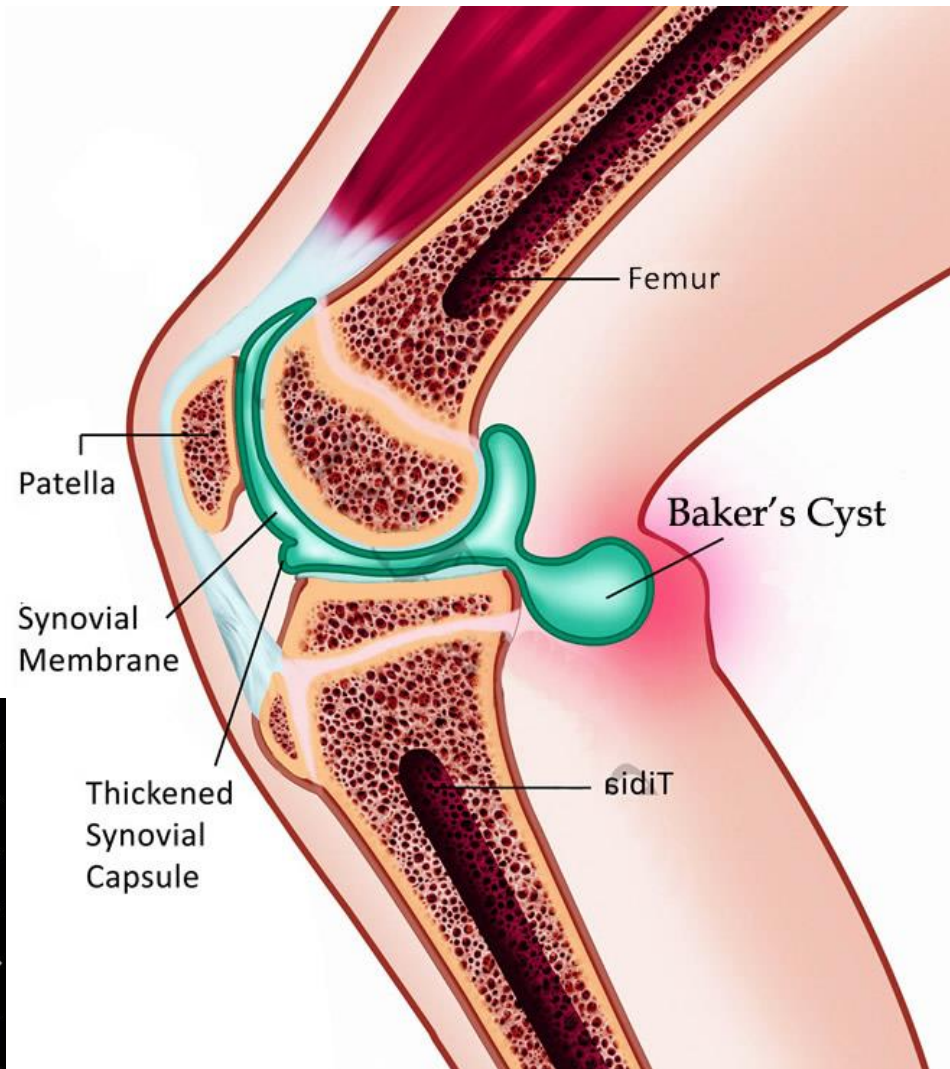
- Uncertain aetiology
  - Probably myxomatous degeneration of periarticular connective tissue
- No synovial layer
- Most commonly seen on hands/wrist and feet
  - Can occur on tendon sheath of fingers
- May be painful
- Vary in size – can be round, elongated or lobulated
- Usually anechoic
  - Internal septa and wall thickening can occur in long-standing chronic ganglia
- Role of ultrasound – try establish point of origin

# Ganglia



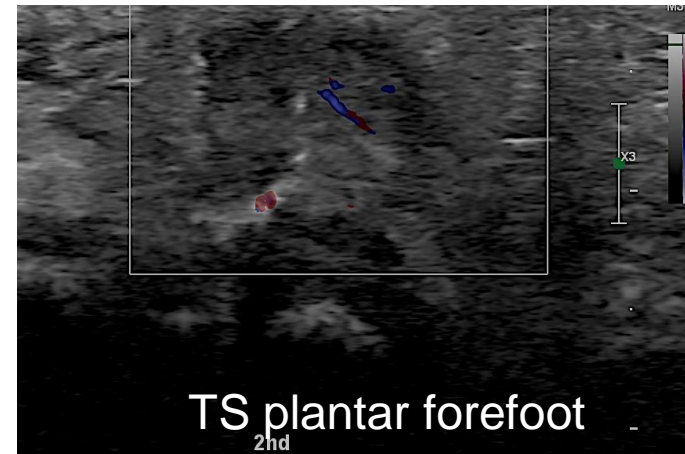
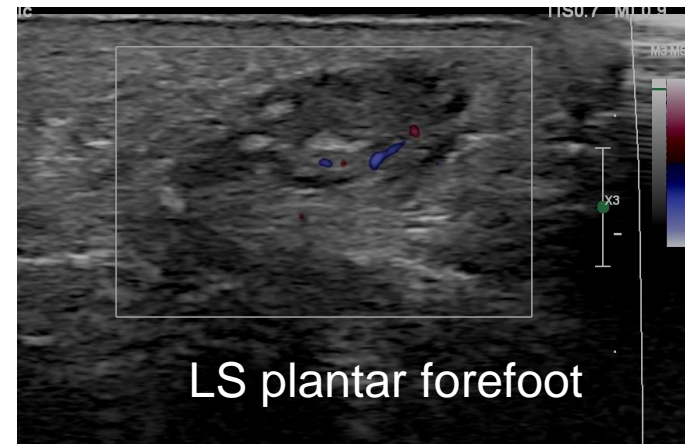
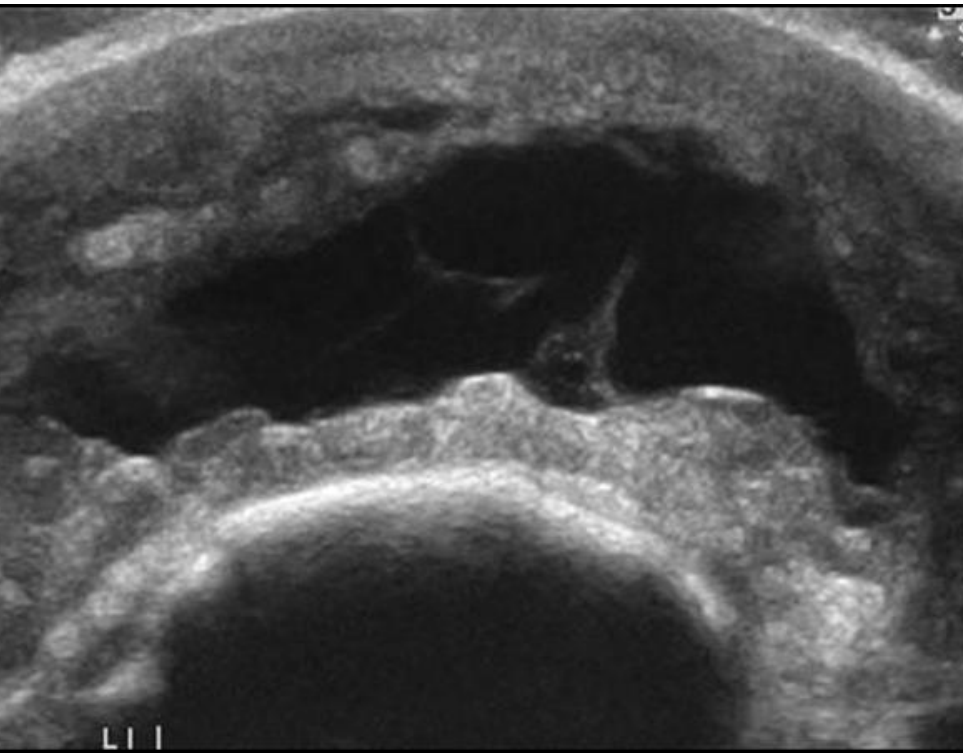
# Baker's cyst

- Has a synovial layer and arises from the joint
- Arises between the medial head of gastrocnemius and semimembranosus tendon
- Related to underlying joint disorder



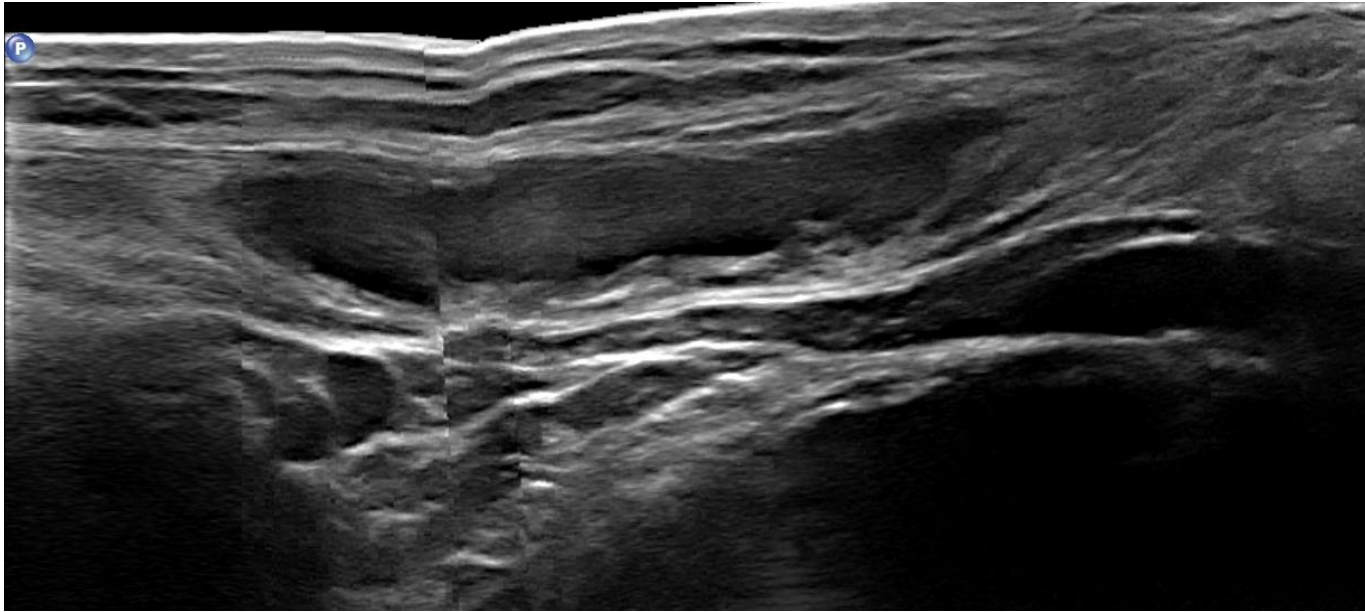
# Bursitis

- Synovial bursae can become enlarged if inflamed
  - Anechoic or
  - echogenic if contains fibrinous exudate or crystal deposition disorders





# Cyst of canal of Nuck

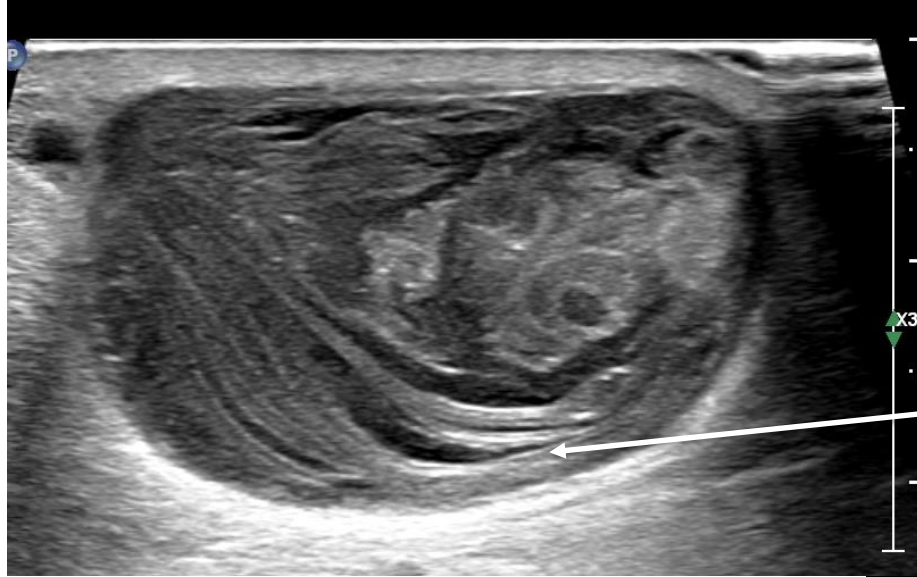


# Epidermoid cyst

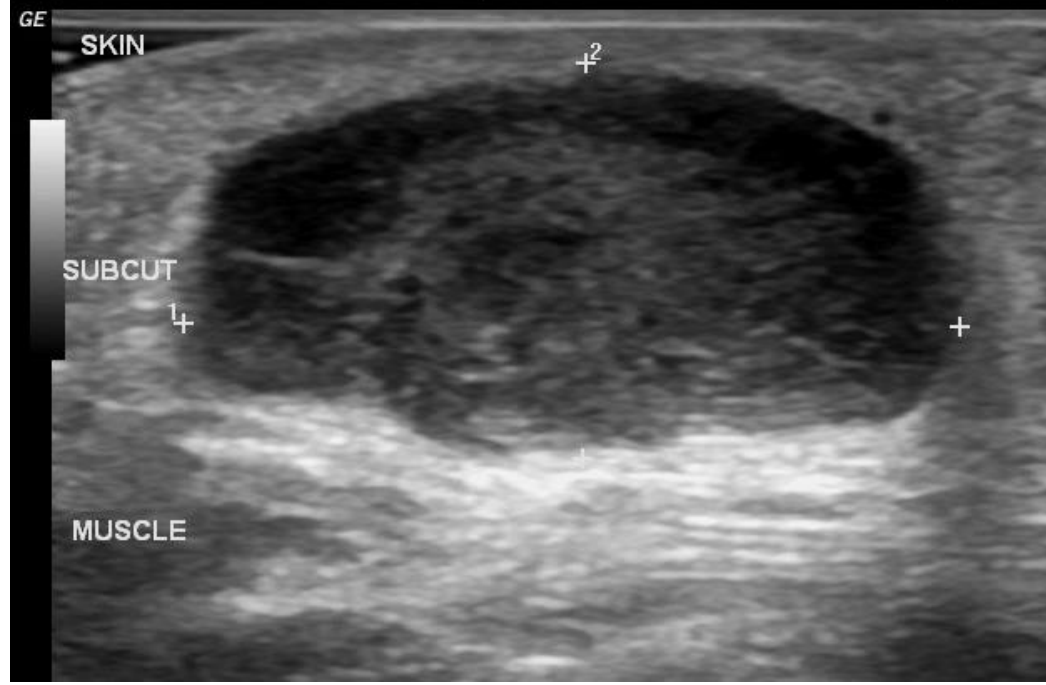
(aka epidermal inclusion cyst, sebaceous cyst)

- Subdermal cystic masses
- Found on head, neck, face, trunk and back
- Usually < 5 cm in size
- U/S appearances depend on maturation + compactness
- Can be anechoic however mostly echogenic when containing keratin +/- cholesterol deposition
- Small punctum can be seen (10%) if originates from sebaceous gland
- Posterior acoustic enhancement
- No vascularity on colour Doppler (unless peri cystic inflammation)
- Hair follicle tumour in scalp = pilomatricoma

# Epidermoid cyst



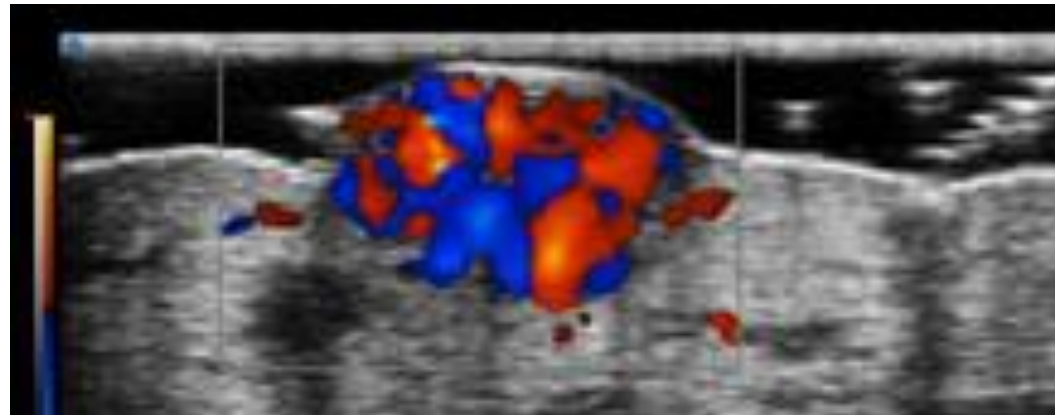
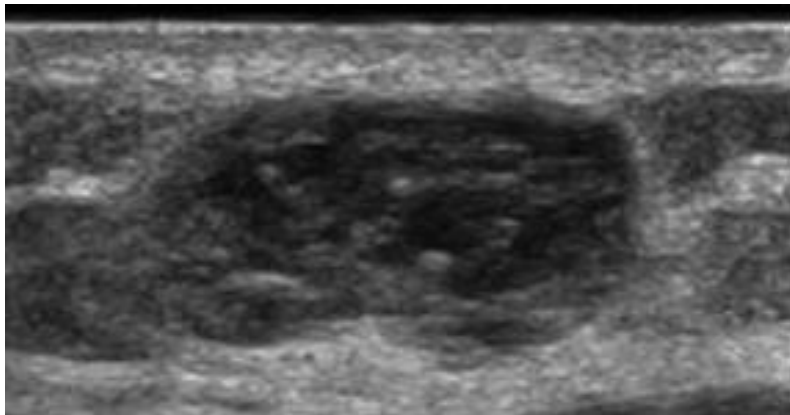
Keratin aggregates +/- cholesterol deposition





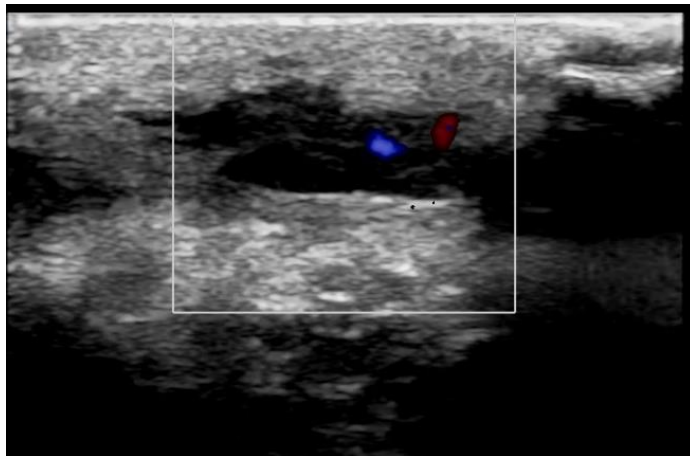
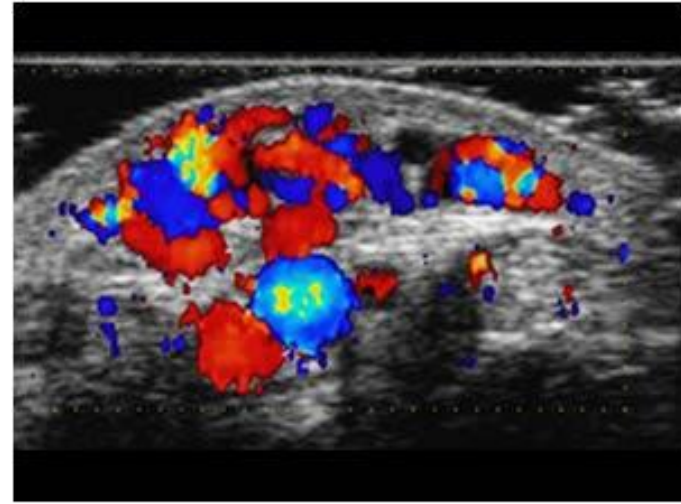
# Vascular anomaly

- **Includes vascular tumours and vascular malformation**
- **Haemangiomas**
  - Lesions with high fat content can be hyperechoic
  - Compressible vascular spaces
  - Usually have some supporting stroma
  - Bluish tinge when superficial lesion
  - Can be difficult to tell from vascular malformation (assess chronological behaviour)

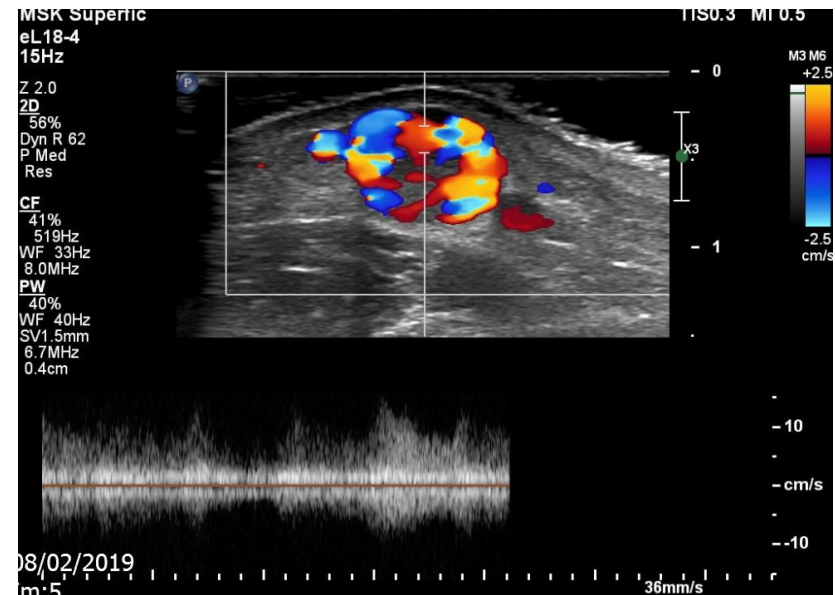


# Vascular malformation

- Arteriovenous malformation
  - high flow, arterial PW
- Venous malformation
  - High or low flow
- Can be superficial or deep



Low flow venous malformation



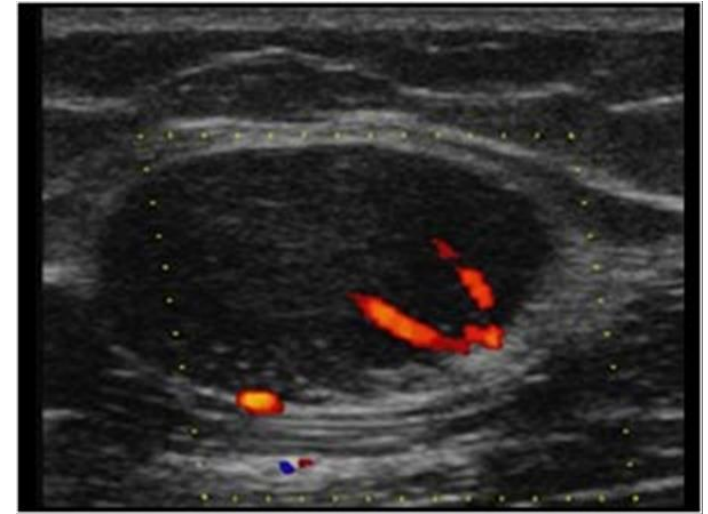
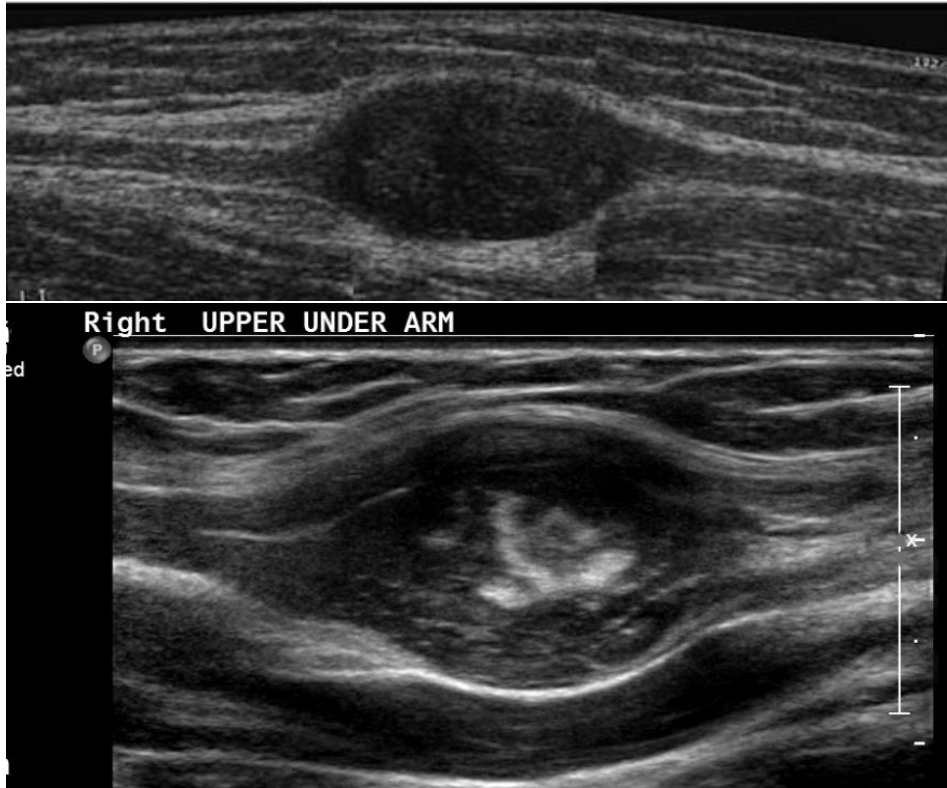
Arterial malformation

# Nerve tumours

- **Schwannomas and neurofibromas**

- Clinically the patient has positive Tinel sign = pain or paraesthesia along nerve area
- Centric or Eccentric to the nerve axis
- Nerve seen entering and exiting the mass (90%)
- Fusiform or oval in shape
- Uniformly hypoechoic mass with moderate vascularity on colour Doppler
  - Cystic degeneration & calcification can be seen longstanding schwannomas (ancient schwannomas)

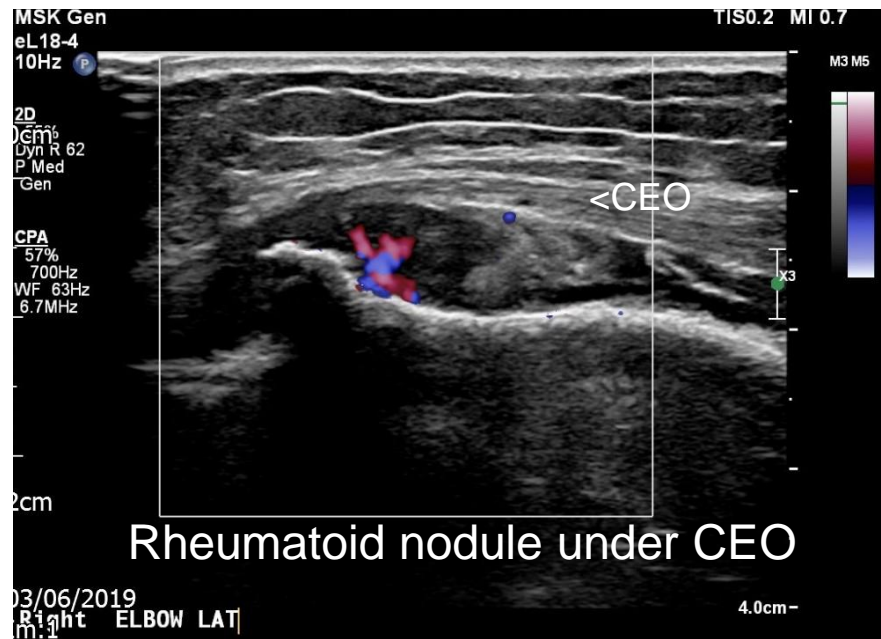
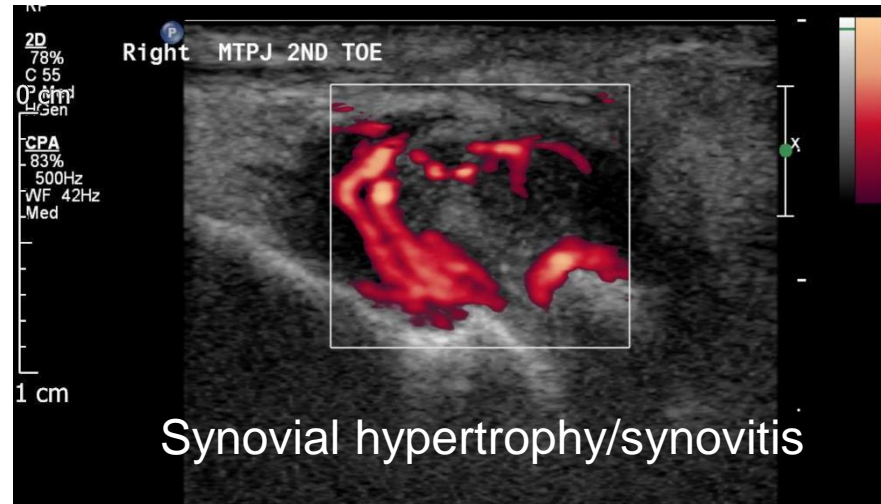
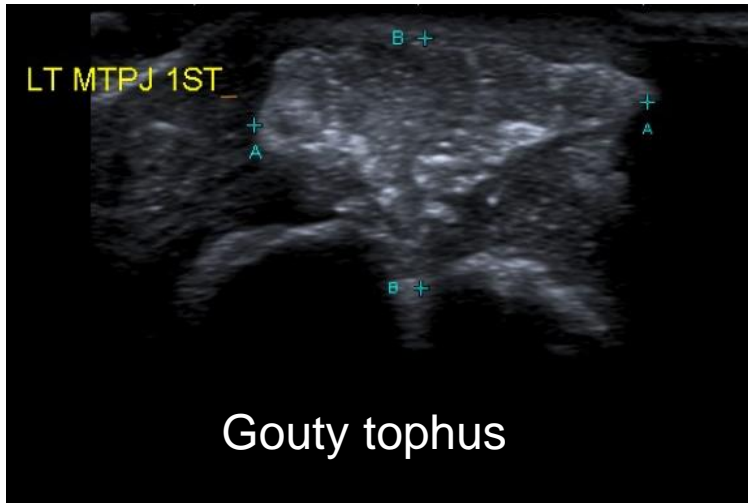
# Schwannoma/Neurofibroma



- Schwannomas more likely to be eccentric, can have cystic degeneration
- Neurofibromas can be multiple with neurofibromatosis
- More important to report on centric eccentric location of tumour to parent nerve as helps surgical planning

**US diagnosis based on a number of features. These US features usually typical enough to make a diagnosis without need for biopsy**

# Arthritis

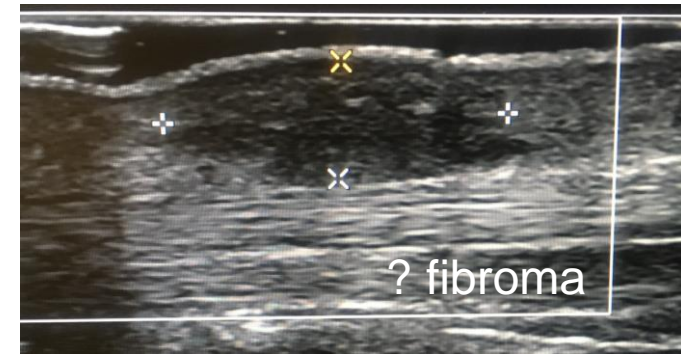
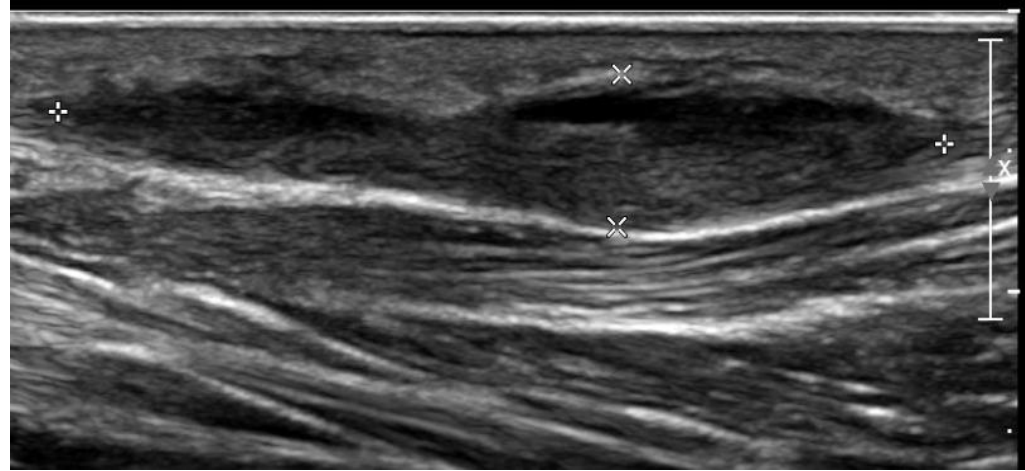




# Fibroblastic proliferation

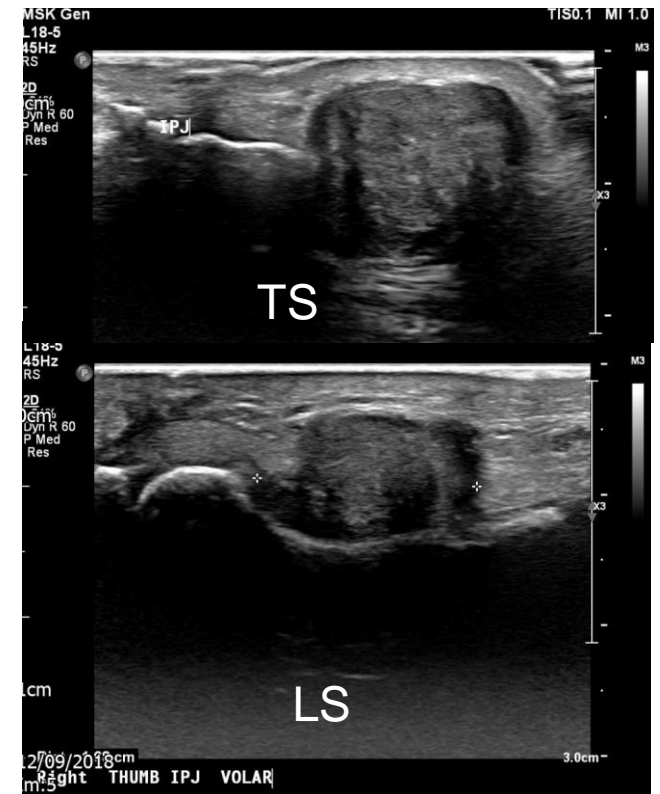
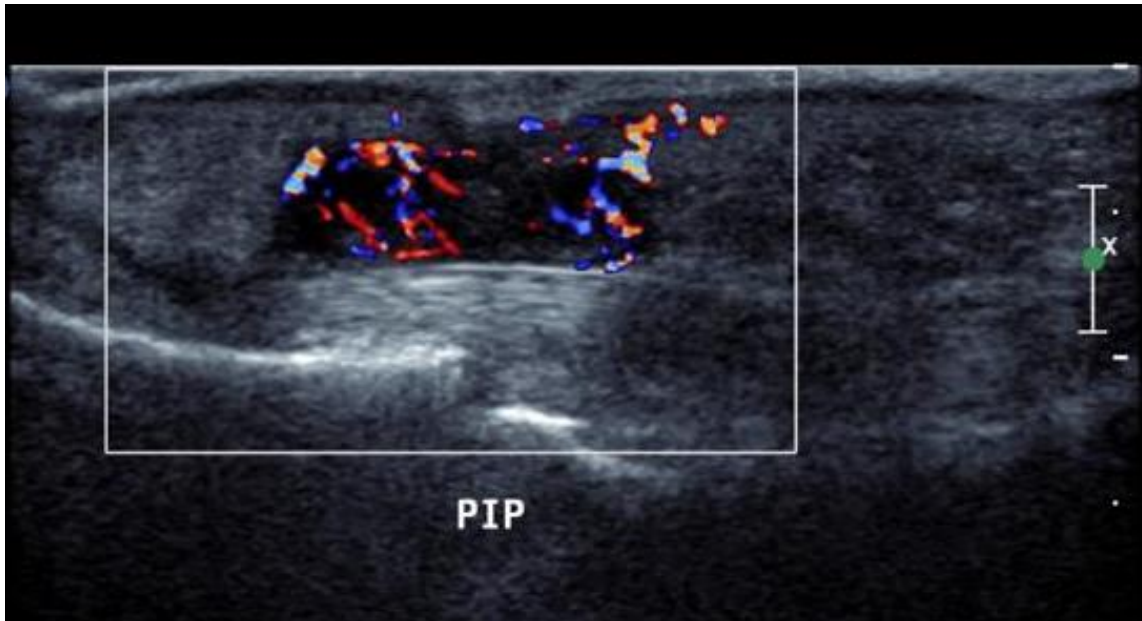
- ❑ Plantar fibromatosis
- ❑ palmar fibromatosis  
(Dupuytren's contracture)
- ❑ Fibroma

- Hypoechoic fusiform shaped masses
- arising from the fascia
- Usually avascular if small
- Larger lesions > 2-3 cm can have some vascularity on colour Doppler



# Synovial tumours

- **Giant cell tumour of the tendon sheath (GCTTS)**
  - Commonly seen in the hands and feet
  - Can mimic ganglion cysts
  - Round or ovoid mass that encircle the tendon
  - Heterogeneous with moderate internal vascularity
  - Large lesions can scallop the underlying bone



# Features suggestive of malignancy

- Lump > 5 cm
  - Lump/mass increasing in size
  - Lump/mass deep to the fascia
  - Pain
  - More common in older patients
- Benign masses may have one or more of these features

[www.nice.org.uk/CG027](http://www.nice.org.uk/CG027)



# Sarcomas

- Typically most sarcomas are large > 5 cm (unless they are superficial)
- Deep
- Heterogeneous
- Hypoechoic (with the exception of liposarcomas = uniformly echogenic)
- Contain areas of necrosis = cystic spaces

# Grading

## Low-grade

- Slow growing cancer cells
- Similar to normal cells
- Less likely to spread, less aggressive

## Intermediate-grade

- Cancer cells growing slightly faster
- Appear more abnormal

## High-grade

- Fast growing cells
- Appear very abnormal
- More aggressive and most likely to spread

# Staging

## Stage 1

- Low grade
- < 5 cm
- Not spread

## Stage 2

- Any grade
- Slightly larger than stage 1
- Not spread

## Stage 3

- High grade
- Not spread

## Stage 4

- Any grade
- Any size
- Has spread to other parts of the body

# Sarcoma centres





- <https://sarcoma.org.uk/health-professionals/sarcoma-specialist-centres>
- <https://sarcoma.org.uk>

# Contrast-enhanced Ultrasound

- A study by Loizides, A. *et al* (2012). Perfusion pattern of musculoskeletal masses using contrast-enhanced ultrasound: a helpful tool for characterisation? *European Radiology*. 22:pp 1803-1811
  - Hypothesised that malignant tumours had markedly central hypoperfusion (central necrosis) compared to benign tumours
  - Used CEUS to prove this theory and perhaps aid in tumour characterisation
  - Used three-feature combination of size  $>3.3$  cm, mass location below the superficial fascia and the perfusion pattern
  - PPV of 86% and NPV of 88%

# Future developments...

- Research perfusion pattern

Type	Perfusion Pattern	Benign	Malignant
P1		1.0	0.0
P2		0.4	0.6
P3		0.2	0.8
P4		1.0	0.0

- Algorithm/App for soft tissue mass features
- Elastography
- 3D

# Summary

- Clinical history of lump
- Evaluate mass in context – age, sex, FH, medical history etc
- Define mass in terms of
  - location
  - size
  - appearance
  - through transmission of sound
  - features determined by dynamic scanning
- Know your limitations - Ultrasound cannot always determine the exact nature of soft tissue lesions
- Offer guidance about pathway – observe, biopsy or excise

# References

- [www.sarcoma.org.uk](http://www.sarcoma.org.uk)
- NICE guidelines for soft tissue masses - [www.nice.org.uk/CG027](http://www.nice.org.uk/CG027)
- Loizides, A. *et al* (2012). Perfusion pattern of musculoskeletal masses using contrast-enhanced ultrasound: a helpful tool for characterisation? *European Radiology*. 22: pp 1803-1811
- McNally, E. *Practical Musculoskeletal Ultrasound*. 2005 Elsevier: Philadelphia
- Jacobson, J. 2013 *Fundamentals of Musculoskeletal Ultrasound*. 2<sup>nd</sup> ed. Elsevier/Saunders
- Allan, P., Baxter, G. and Weston, M. 2011. *Clinical Ultrasound*. 3<sup>rd</sup> ed. Churchill Livingstone: London
- Hoshi, M. *et al* (2017). Clinical features of soft tissue sarcoma presenting intra-tumour haematoma: case series and review of the literature. *International Orthopaedics*. 41: 203-209
- Noebauer-Humann *et al*, 2015. Soft tissue tumors in adults: ESSR-approved guidelines for diagnostic imaging
- Paunipagar *et al*, 2010. Ultrasound features of deep-seated lipomas. *Insights Imaging*. 1: pp 149-153
- Griffith, J *Diagnostic Ultrasound Musculoskeletal*. 2019 Elsevier: Philadelphia