Orthopaedic – Trauma Hospital
and
Sport Medicine Institute

Department of Radiology and Diagnostic Imaging

Director: Dott. Carlo Faletti

TORINO

ORTHOPAEDIC HOSPITAL
and TRAUMA CENTER
TURIN - ITALY

DIPARTIMENTO DI DIAGNOSTICA PER IMMAGINI

The world of soft-tissue masses

WHO classification of soft tissue tumours

ADIPOCYTIC TUMOURS

Benign	
Lipoma	8850/0*
Lipomatosis	8850/0
Lipomatosis of nerve	8850/0
Lipoblastoma / Lipoblastomatosis	8881/0
Angiolipoma	8861/0
Myolipoma	8890/0
Chondroid lipoma	8862/0
Extrarenal angiomyolipoma	8860/0
Extra-adrenal myelolipoma	8870/0
Spindle cell/ Pleomorphic lipoma	8857/0 8854/0
Hibernoma	8880/0
Intermediate (locally aggressive)	
Atypical lipomatous tumour/ Well differentiated liposarcoma	8851/3
Malignant	
Dedifferentiated liposarcoma	8858/3
Myxoid liposarcoma	8852/3
Round cell liposarcoma	8853/3
Pleomorphic liposarcoma	8854/3
Mixed-type liposarcoma	8855/3
Liposarcoma, not otherwise specified	8850/3

FIBROBLASTIC / MYOFIBROBLASTIC TUMOURS

Benign	
Nodular fasciitis	
Proliferative fasciitis	
Proliferative myositis	
Myositis ossificans	
fibro-osseous pseudotumour of digits	
Ischaemic fasciitis	
Elastofibroma	8820/0
Fibrous hamartoma of infancy	
Myofibroma / Myofibromatosis	8824/0
Fibromatosis colli	
Juvenile hyaline fibromatosis	
Inclusion body fibromatosis	
Fibroma of tendon sheath	8810/0
Desmoplastic fibroblastoma	8810/0
Mammary-type myofibroblastoma	8825/0
Calcifying aponeurotic fibroma	8810/0
Angiomyofibroblastoma	8826/0
Cellular angiofibroma	9160/0
Nuchal-type fibroma	8810/0
Gardner fibroma	8810/0
Calcifying fibrous tumour	
Giant cell angiofibroma	9160/0
Intermediate (locally aggressive)	
Superficial fibromatoses (palmar / plantar)	
Desmoid-type fibromatoses	8821/1
Lipofibromatosis	
Intermediate (rarely metastasizing)	
Solitary fibrous tumour	8815/1
and haemangiopericytoma	9150/1
(incl. lipomatous haemangiopericytoma)	
Inflammatory myofibroblastic tumour	8825/1
Low grade myofibroblastic sarcoma	8825/3
Myxoinflammatory fibroblastic sarcoma	8811/3
Infantile fibrosarcoma	8814/3
Malignant	
Adult fibrosarcoma	8810/3
Myxofibrosarcoma	8811/3
Low grade fibromyxoid sarcoma	8811/3
hyalinizing spindle cell tumour	
Sclerosing epithelioid fibrosarcoma	8810/3

SO-CALLED FIBROHISTIOCYTIC TUMOURS

Benign	
Giant cell tumour of tendon sheath	9252/0
Diffuse-type giant cell tumour	9251/0
Deep benign fibrous histiocytoma	8830/0
Intermediate (rarely metastasizing)	
Plexiform fibrohistiocytic tumour	8835/1
Giant cell tumour of soft tissues	9251/1
Malignant	
Pleomorphic 'MFH' / Undifferentiated pleomorphic sarcoma	8830/3
Giant cell 'MFH' / Undifferentiated pleomorphic sarcoma with giant cells	8830/3
Inflammatory 'MFH' / Undifferentiated pleomorphic sarcoma with prominent inflammation	8830/3

* Morphology code of the International Classification of Diseases for Oncology (ICD-O) (726) and the Systematize Nomenclature of Medicine (http://snomed.org).

SMOOTH MUSCLE TUMOURS

Angioleiomyoma	8894/0
Deep leiomyoma	8890/0
Genital leiomyoma	8890/0
Leiomyosarcoma (excluding skin)	8890/3

PERICYTIC (PERIVASCULAR) TUMOURS

Glomus tumour (and variants)	8711/0
malignant glomus tumour	8711/3
Myopericytoma	8713/1

SKELETAL MUSCLE TUMOURS

Benign	
Rhabdomyoma	8900/0
adult type	8904/0
fetal type	8903/0
genital type	8905/0
Malignant	
Embryonal rhabdomyosarcoma	8910/3
(incl. spindle cell,	8912/3
botryoid, anaplastic)	8910/3
Alveolar rhabdomyosarcoma	
(incl. solid, anaplastic)	8920/3
Pleomorphic rhabdomyosarcoma	8901/3

VASCULAR TUMOURS

Benign	
Haemangiomas of	
subcut/deep soft tissue:	9120/0
capillary	9131/0
cavernous	9121/0
arteriovenous	9123/0
venous	9122/0
intramuscular	9132/0
synovial	9120/0
Epithelioid haemangioma	9125/0
Angiomatosis	
Lymphangioma	9170/0
Intermediate (locally aggressive)	
Kaposiform haemangioendothelioma	9130/1
Intermediate (rarely metastasizing)	
Retiform haemangioendothelioma	9135/1
Papillary intralymphatic angioendothelioma	9135/1
Composite haemangioendothelioma	9130/1
Kaposi sarcoma	9140/3
Malignant	
Epithelioid haemangioendothelioma	9133/3
Angiosarcoma of soft tissue	9120/3

CHONDRO-OSSEOUS TUMOURS

Soft tissue chondroma	9220/0
Mesenchymal chondrosarcoma	9240/3
Extraskeletal osteosarcoma	9180/3

TUMOURS OF UNCERTAIN DIFFERENTIATION

Benign	
Intramuscular myxoma	8840/0
(incl. cellular variant)	
Juxta-articular myxoma	8840/0
Deep ('aggressive') angiomyxoma	8841/0
Pleomorphic hyalinizing angiectatic tumour	
Ectopic hamartomatous thymoma	8587/0
Intermediate (rarely metastasizing)	
Angiomatoid fibrous histiocytoma	8836/1
Ossifying fibromyxoid tumour	8842/0
(incl. atypical / malignant)	
Mixed tumour/	8940/1
Myoepithelioma/	8982/1
Parachordoma	9373/1
Malignant	
Synovial sarcoma	9040/3
Epithelioid sarcoma	8804/3
Alveolar soft part sarcoma	9581/3
Clear cell sarcoma of soft tissue	9044/3
Extraskeletal myxoid chondrosarcoma	9231/3
("chordoid" type)	
PNET / Extraskeletal Ewing tumour	
pPNET	9364/3
extraskeletal Ewing tumour	9260/3
Desmoplastic small round cell tumour	8806/3
Extra-renal rhabdoid tumour	8963/3
Malignant mesenchymoma	8990/3
Neoplasms with perivascular epithelioid cell differentiation (PEComa)	
clear cell myomelanocytic tumour	
Intimal sarcoma	8800/3

Soft tissue tumours: Epidemiology,clinical features, histopathological typing and grading C.D.M. Fletcher M. SundaramA. Rydholm J.M. Coindre, FNCLCC, 2001

Epidemiology

Histotype	Incidence	Italy
STS	2/100.000/year	1200-1500
Osteosarcoma	0.2-0.4/100.000	120
S. Ewing	0.1/100.000	40-50
GIST (gastro-intestinal stroma tumors)	1.4/100.000/year	~1000
Aggressive fibromatosis	0.2-0.3/100.000/year	70-100

FOCUS POINTS

1. Site of the lesion and anatomic compartment
2. Morphology
3. Relationship with the adjacent structures
4. Response of the lesion to treatment
5. Relapse

Quali quesiti? Quali metodiche?

Diagnosi differenziale
Stadiazione
Ristadiazione (neoadiuvante)
Follow up

Targeted Imaging
Imaging molecolare

Imaging funzionale
Perfusione (CEUS, TC, RM dinamica),
RM Diffusion
spettroscopia MR

Imaging morfologico
US, TC, angio TC, RM, angio-RM , mdc blood-pool

Imaging

1. Conventional Radiology
2. US
3. CT
4. MRI
5. Angiography
6. Nuclear Medecine

Literature

Only few lesions have typical aspect

lipoma, sub-acute haematoma, neurinoma,

villonodular pigmentous synovitis

Sundaram et all: MR imaging of tumor and tumorlike lesions of bone and soft tissue. AJR 1990; 155: 817-824

Conventional Radiology

A "Must" in the Study of Tumours

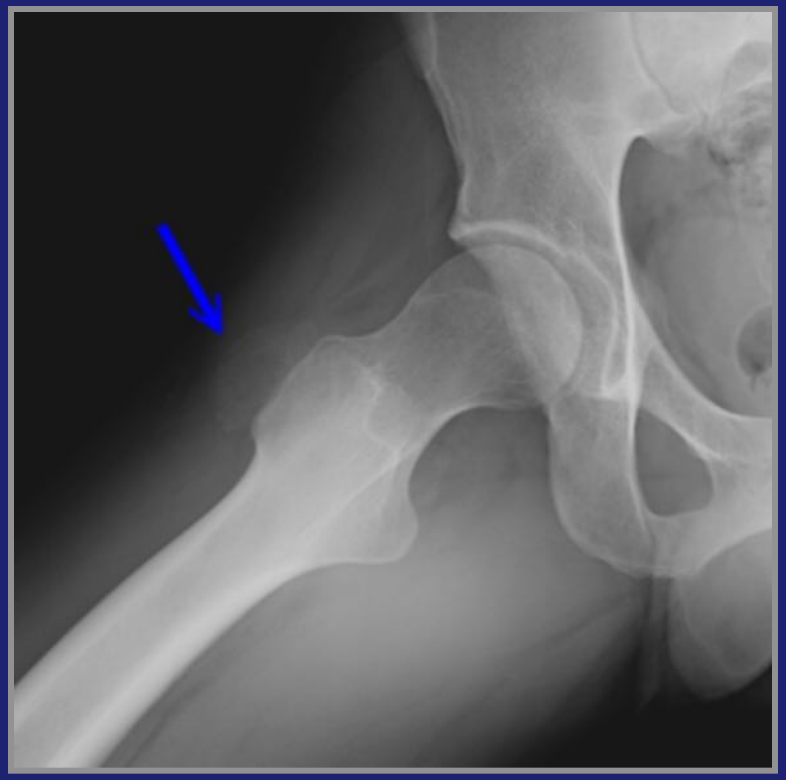
Soft tissue:

Differences in the density of soft-tissues
Presence of calcifications and/or ossifications

Bone:

Cortical erosions
Periosteal reactions
Bone involvement

Conventional Radiology



Different soft-tissues density

Conventional Radiology

Presence of calcifications and/or ossifications

Conventional Radiology

Cortical Erosion

Periosteal reaction

Bone alteration

First of all!

According to the Piedmont ***Sarcoma Group Guide Lines***

A soft-tissue mass

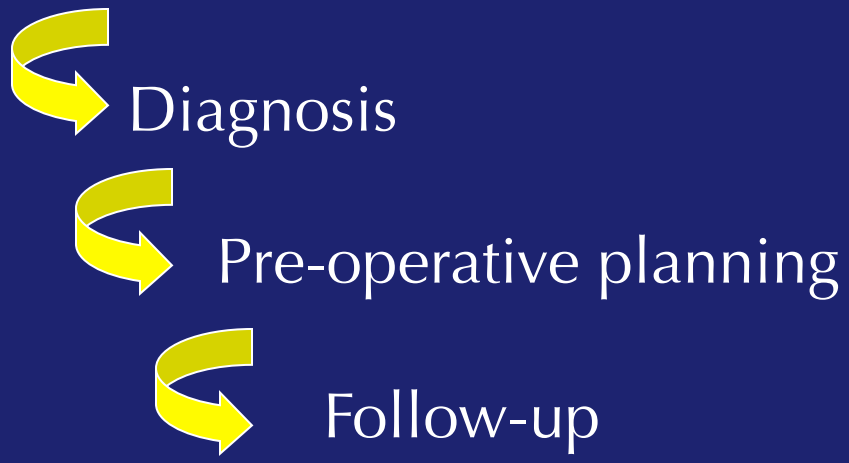
(less than 10 cm)

is studied by …

US

The aim

To establish a diagnostic US protocol
for the study of soft-tissue masses

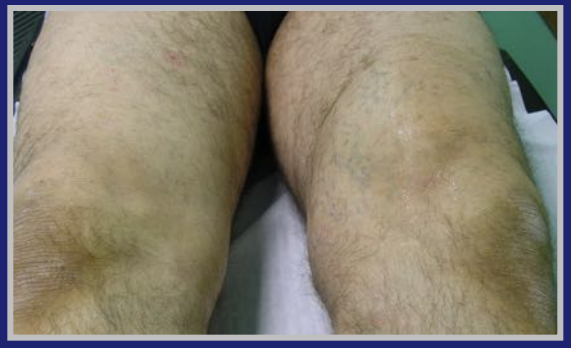


It is often difficult to identify sarcomatous lesions
with quick and inexpensive techniques

cost-effective
easy to perform
well tolerated
non invasive

immediate identification of aggressive lesions

swelling
tenderness
pain

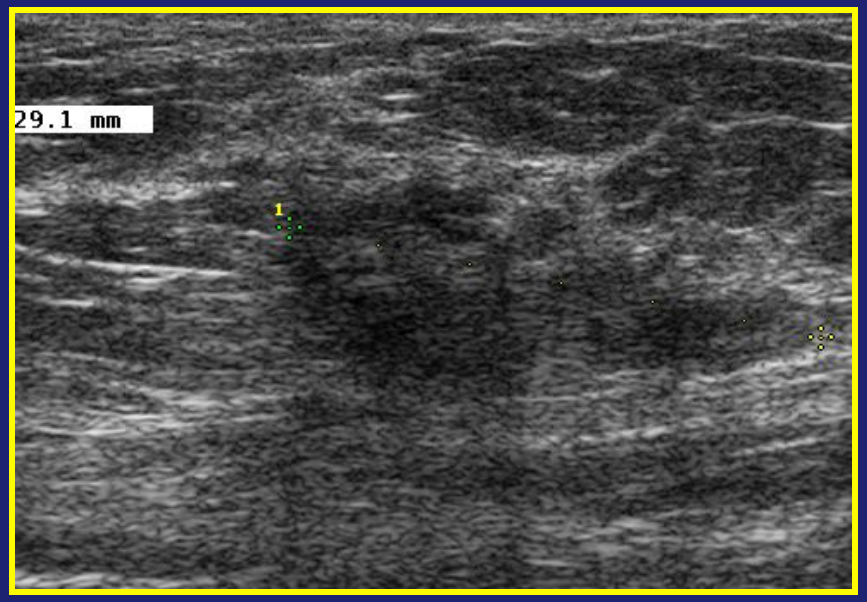


Method and materials

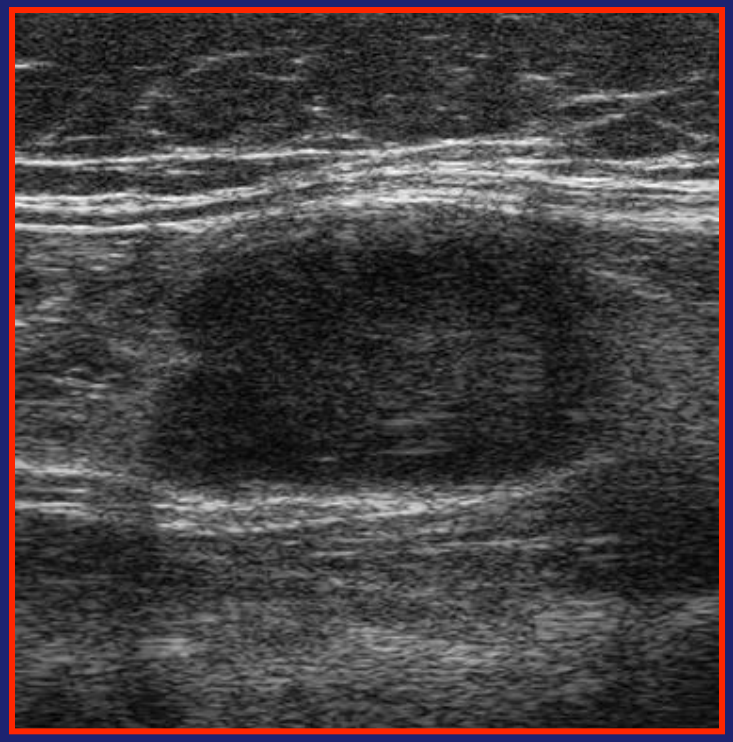
November 2002 - May 2008

The CTO/Maria Adelaide Hospital has investigated 1.164 subjects with soft-tissues masses.

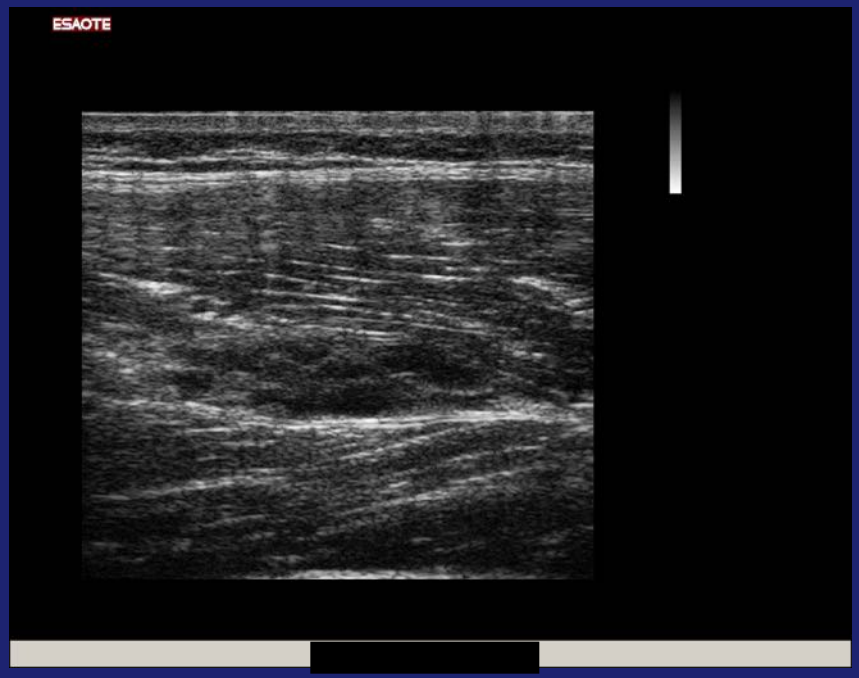
- Age
- Gender
- Site
- Morphology
- Size
- Vascularization



ENDOMETRIOSI



MIXOFIBROSARCOMA



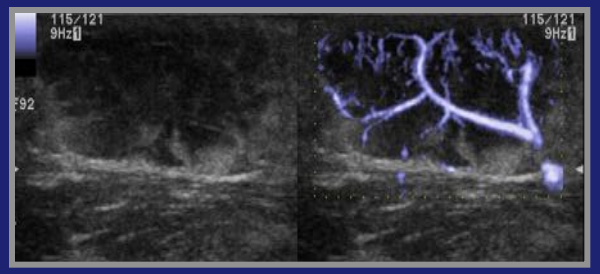
linfoangioma

CD-US

Helpful in assessing the vascularity of soft tissue masses

Adler RS.1999
Boddner G. 2002
Griffith JF . 2004
Hakan I 2006

A combination of vascular characteristics
Specificity 93%



PD

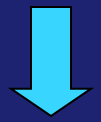
sensibile ai flussi lenti rilevati solo nel macrocircolo
rappresenta un passo avanti nella caratterizzazione

CEUS

Microbolle gassose che rimangono confinate nei vasi, più piccole di un globulo rosso, atossiche, persistenti in circolo ed eliminate con il respiro

con macchine dedicate a basso indice meccanico (**MI**) le microbolle emettono buona risposta armonica senza andare incontro a rottura

durano per lungo tempo in circolo permettendo uno studio in real-time



vera "mappa vascolare" del macro e microcircolo senza passare nello spazio interstiziale

valore aggiunto

Wilson SR, Burns PN. Radiology 2010

Quando ?

•In tutte le lesioni > di cm5

•In tutte le lesioni cresciute rapidamente, anche < di cm5

•In tutte le lesioni dubbie per caratteristiche ecografiche e cliniche

•Controllo post-oper lesioni maligne per D.D fra cicatrice e recidiva

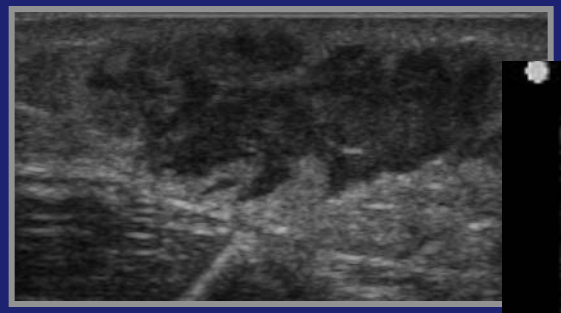
•Per la biopsia al fine di mirare la zona più significativa della lesione

•Controllo lesioni benigne operate plurirecidivate

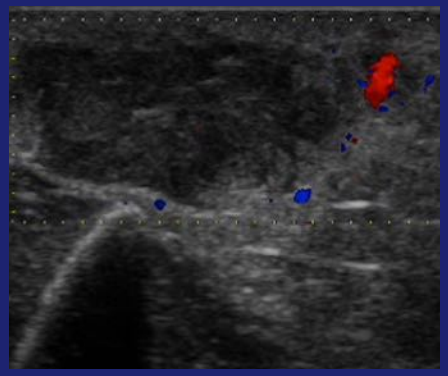
•Controllo di lesioni benigne trattate con terapia conservativa

•Quando il risultato di altre metodiche è in discordanza con la clinica

US



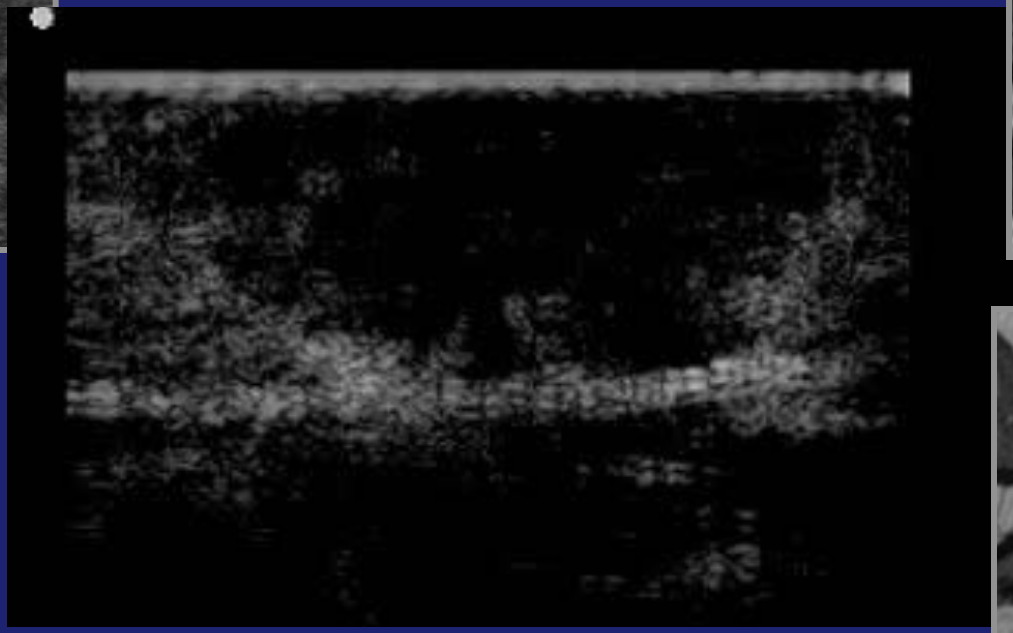
Longitudinale



Assiale

CD-US

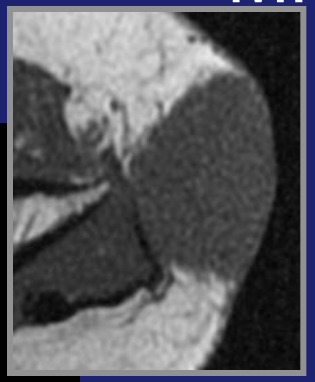
CEUS



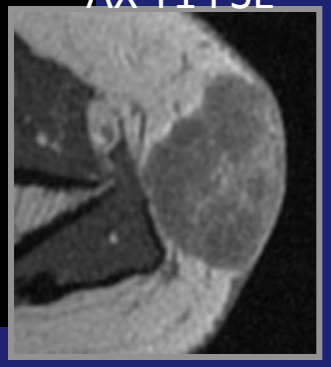
Vascular abnormalities may be missing or not detectable with current technique

Hwart L et all. J Radiol 2007
Goh V et all. Abdom Imaging 2006

MRI



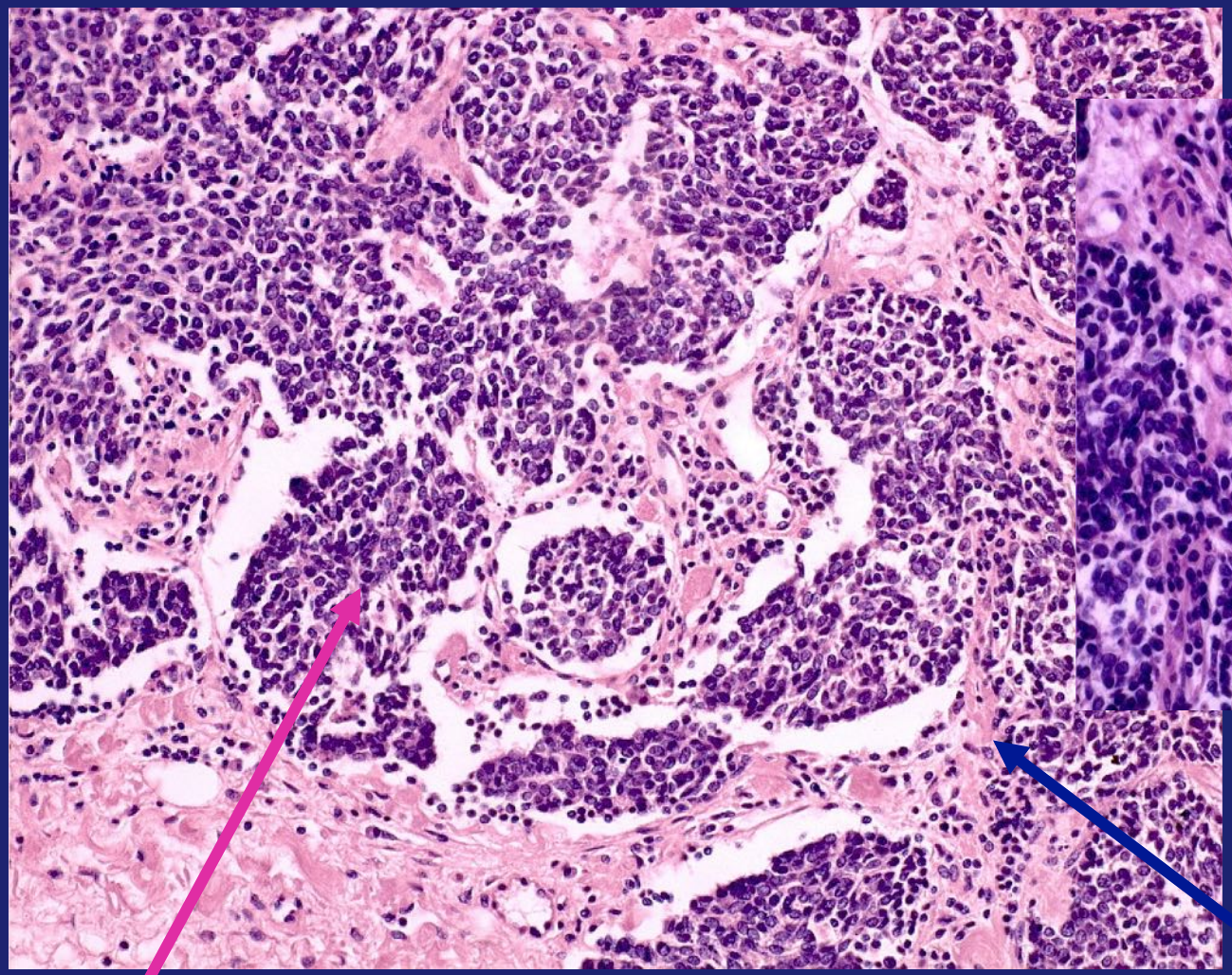
AX T1 FSE

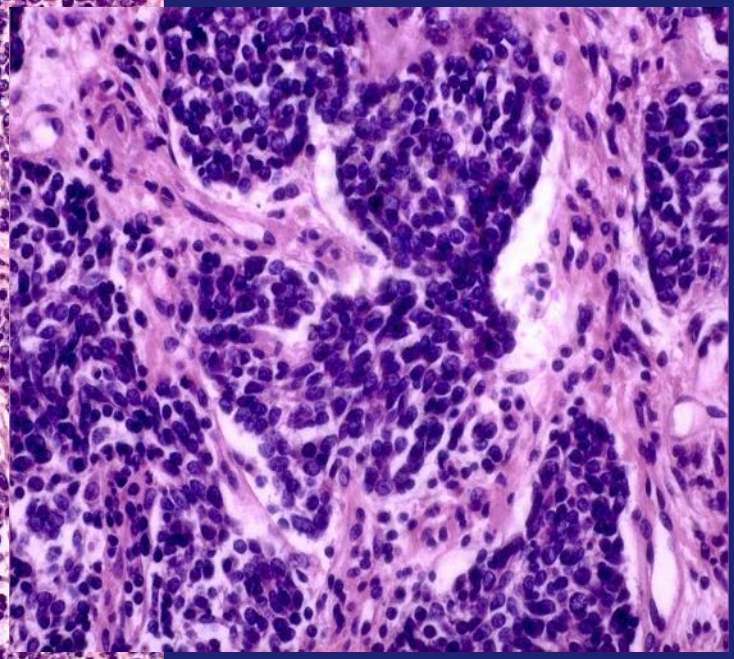


AX T1 FSE MdC

CT and MR tumour enhancement is due to the presence of the contrast product in the interstitial space

Shwannoma maligno



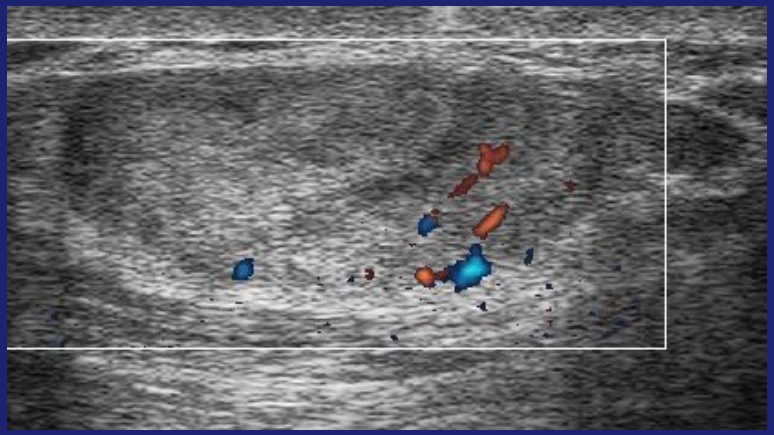


Lacune vascolari malformate ⇒ neoangiogenesi

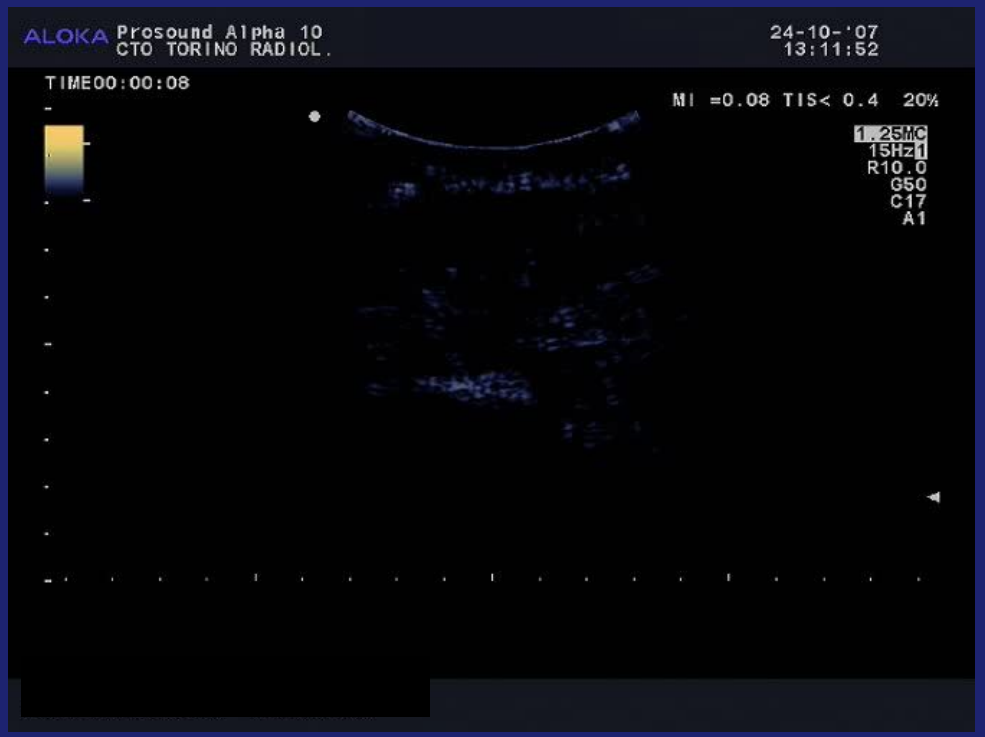
Densità cellulare altissima: un tappeto di cellule

CEUS first stage

Qualitative visual assessment “ by eye”



CD-US



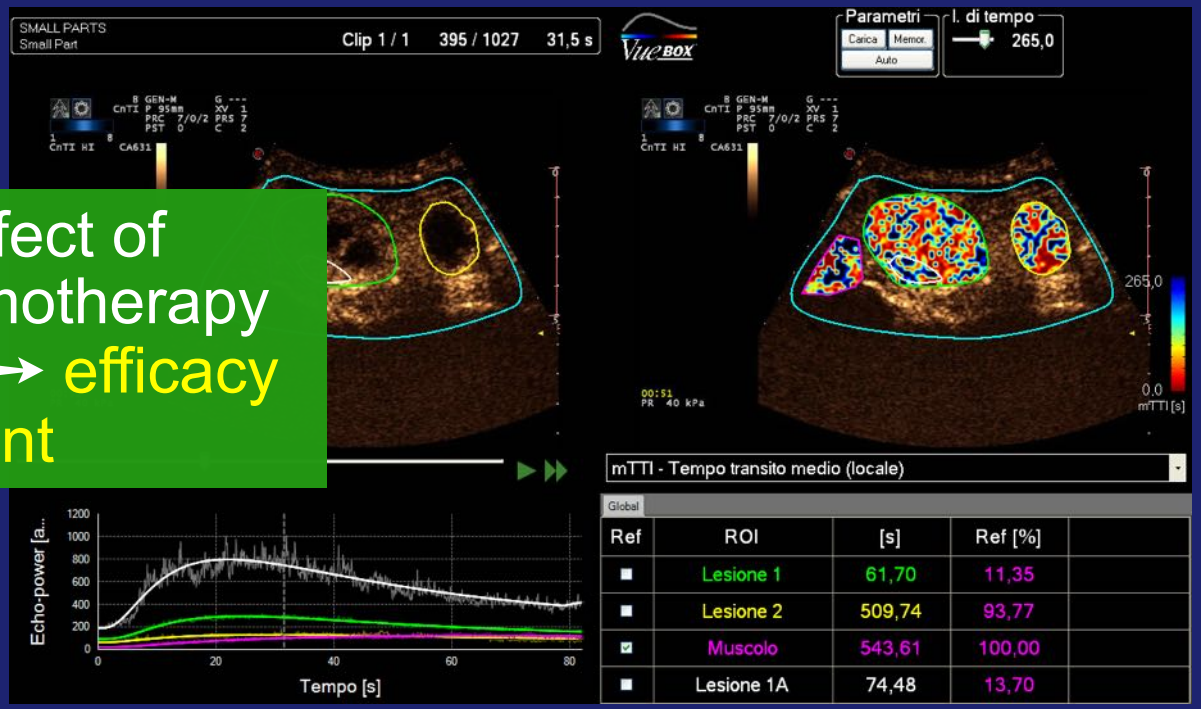
CEUS

myxofibrosarcoma

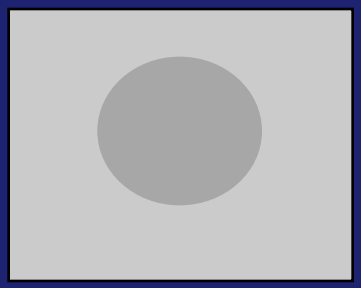
CEUS second stage

Quantitative assessment with a scanner software

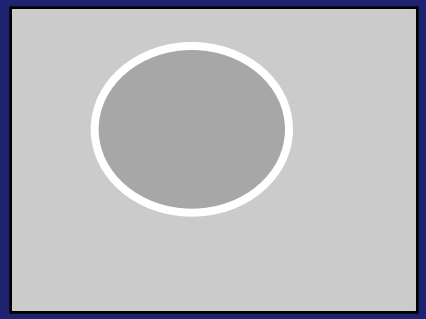
microbubble time-intensity curves



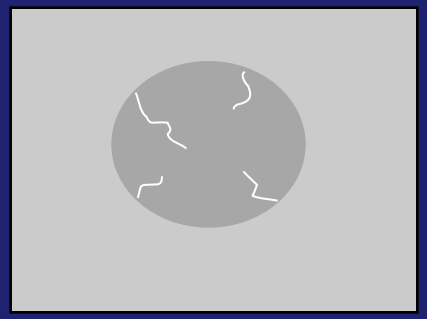
to monitor the effect of neoadjuvant chemotherapy and radiotherapy → efficacy of treatment



Pattern 1



Pattern 2



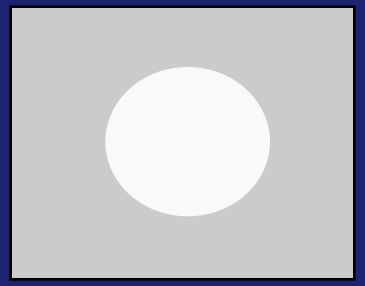
Pattern 3

Pattern 4

White=vessell

Pattern 5

Pattern 6



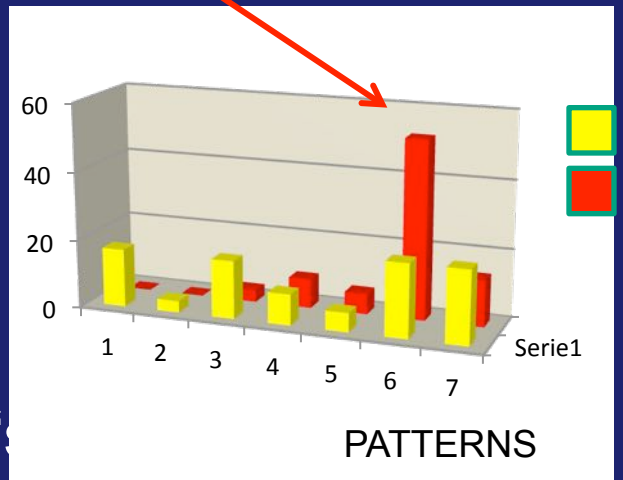
Pattern 7

54 patients: perfusion pattern with size and site is a new diagnostic tool to distinguish B/M

Sensitivity 89%
Specificity 85%
PPV 86% NPV 88%

Loizides A et all.
Eur Raiol 2012

Personal casistic:
205 patients:
117 m 88 b



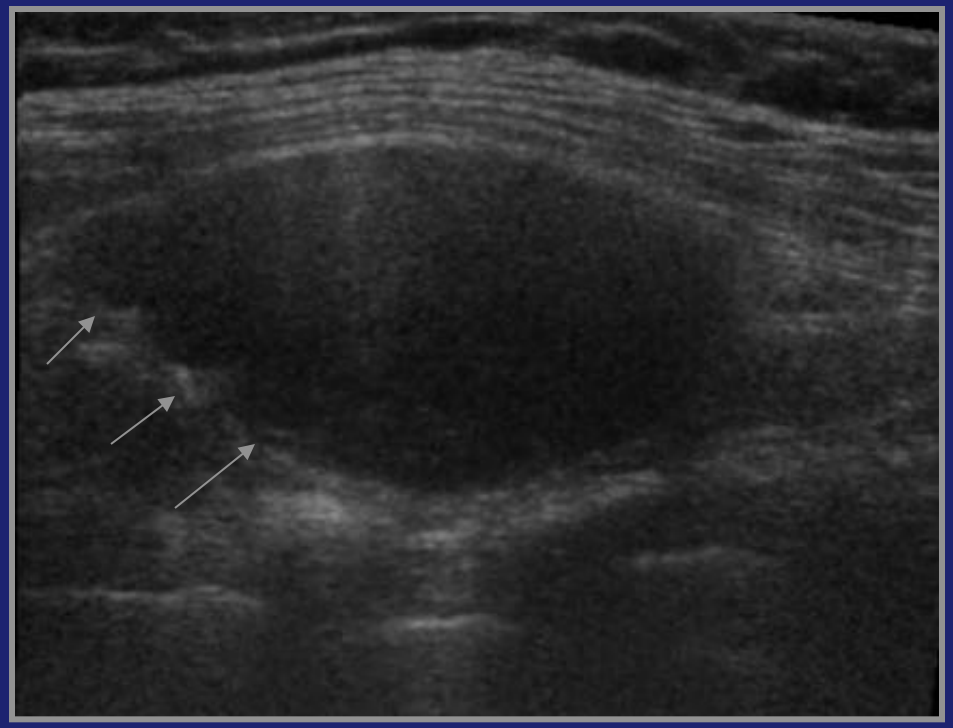
♀ L.D 41 years old

A painless mass, mobile on both superficial and deep planes present in the subscapular region for one year.

Based on site and clinical behaviour preliminary diagnosis:

Elastofibroma or Lipoma

♀ L.D 41 years old



Ext. field

J Radiol 2005;86:1712-5
© Éditions Françaises de Radiologie, Paris, 2005

fait clinique — ostéo-articulaire

Imagerie de l'élastofibrome dorsal

R Alouini (1), M Allani (1), L Harzallah (2), M Bahri (3), C Kraiem (2) et K Tlili-Graies (4)

Original Report

Stefano Bianchi[1]
Carlo Martinoli[2]
Ibrahim F. Abdelwahab[3]
Nicola Gandolfo[2]
Lorenzo E. Derchi[2]
Sandro Damiani[1]

Elastofibroma Dorsi: Sonographic Findings

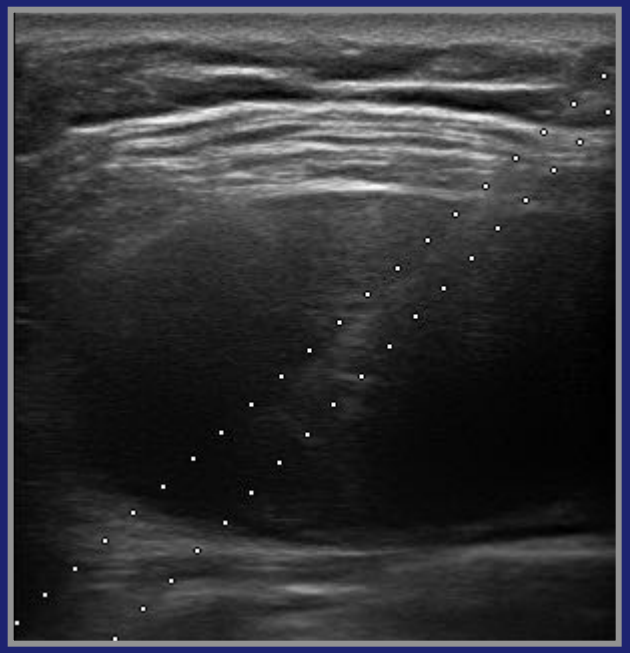
OBJECTIVE. Elastofibroma dorsi is a rare, slow-growing reactive pseudotumor of connective tissue typically located in the subscapular region. We report the sonographic characteristics of three cases of elastofibroma dorsi.

CONCLUSION. The sonographic appearance of elastofibroma dorsi consists of arrays of interspersed linear or curvilinear hypoechoic strands against an echogenic background. These findings reflect the alternating pattern of fibroelastic streaks and fat that is also detected with other imaging techniques and found on pathologic specimens. In the proper clinical setting, a prospective sonographic diagnosis can obviate the need for further imaging assessment and biopsy.

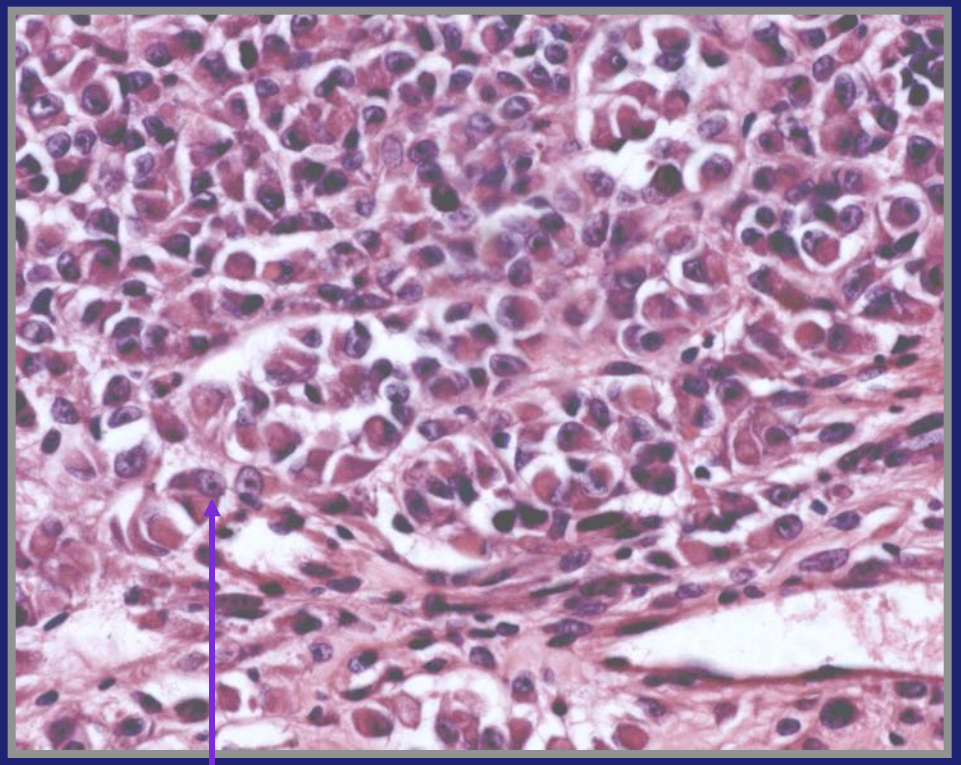
De Marchi A, De Petro P, Faletti C e coll. ***(2003)*** *Echocolor PowerDoppler with contrast medium to evaluate vascularization in lesions of the soft-tissues of the limbs. Chir Organi Mov.2003 Apr-Jun;88(2):225-31*

♀ **L.D 41 years old**

Biopsy



Histology

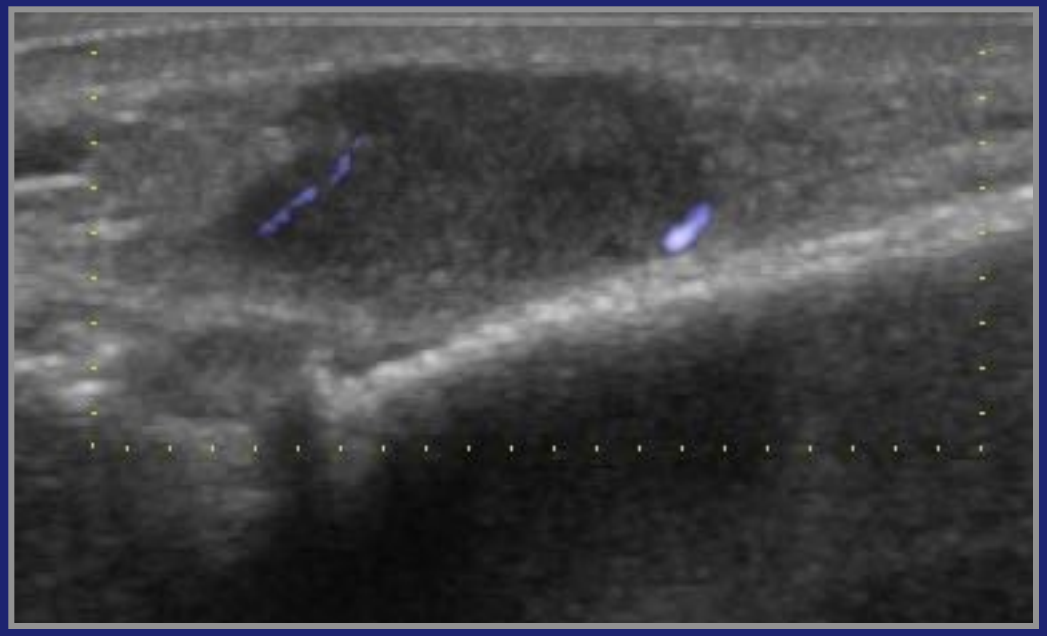


High-grade Sarcoma

Follow-up

Post-excision outcome

an anaplastic leiomiosarcoma excised by inappropriate surgical access



An extremely allergic subject

no c.m.

e-Flow help us to evidence vascularization

Follow-up

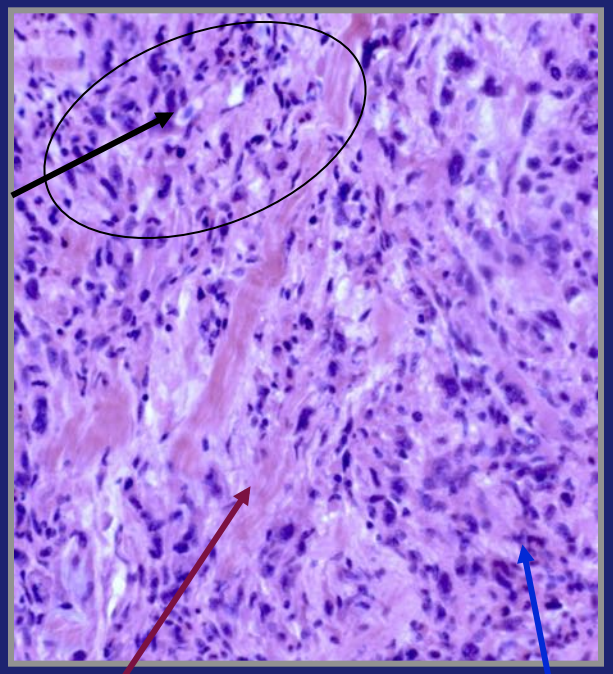

ALOKA CTO Torino
Reparto Radiologia
16-04-'08
11:12:27
MI =0.53 TIS< 0.4 70%
F101
6.00M R3.5 G71 C4
5:PartiM SF 11
Probe:5411
SCI
ALOKA CTO Torino
Reparto Radiologia
16-04-'08
11:16:13
MI =0.41 TIS< 0.4 70%
13Hz
F101
6.00M R3.5 G71 C4
5:PartiM SF 11
Probe:5411
SCI

Follow-up

Cellule neoplastiche

Histology

Biopsy



Fibrosis

Inflammatory Cells

Relapse of the leiomiosarcoma

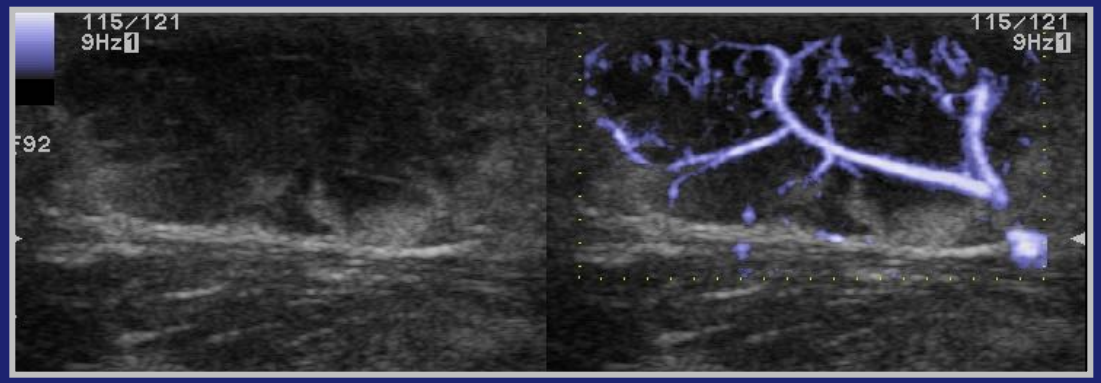
Liu JC, ChiouHJ, Chen WM, Chou YH, Chen TH, Chen W, Yen CC, Chiu SY,Chang CY.**2004** Sonographically guided core needle biopsy of soft tissue neoplasms.J Clin Ultrasound.**2004** Jul-Aug;32(6):294-8.

Our **protocol** is based on the following procedure:

1. B-mode and colour Doppler sonography in basal condition (present on all the units!)

2. Contrast medium (SonoVue®-Bracco) bolus injection with dedicated software (low MI)

3. Ultrasound-guided Needle Biopsy (sterile device on the probe)



"Current imaging techniques provide some non invasive techniques to diagnose and stage suspected soft tissue sarcomas"

but….

"NO single approach is ideal for every tumor"

Knapp ER., Kransdorf MS., LetsonG.D. : Diagnostic imaging update: soft tissue sarcomas- 2005

CT - MR

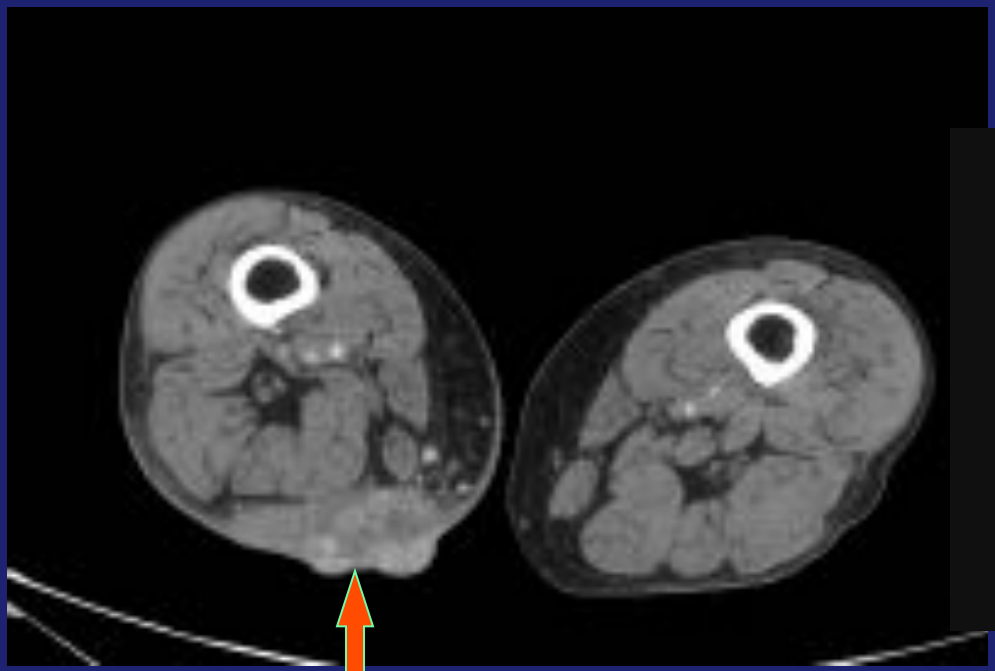
"The bundle, the periostium, the vascular wall areas are barriers against tumour invasion, therefore, a correct evaluation of the surgical margins is essential in the soft-tissue surgery "

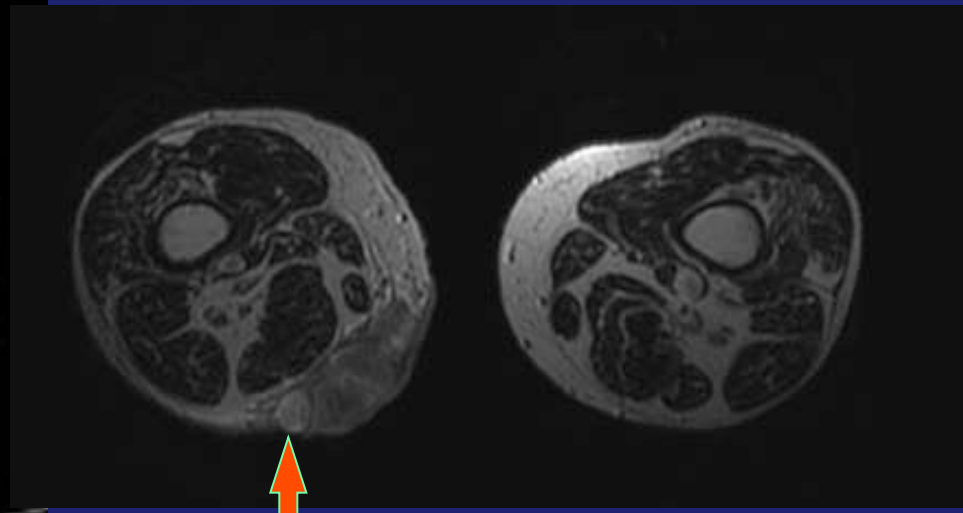
Enneking.W.F.

Compartmentality

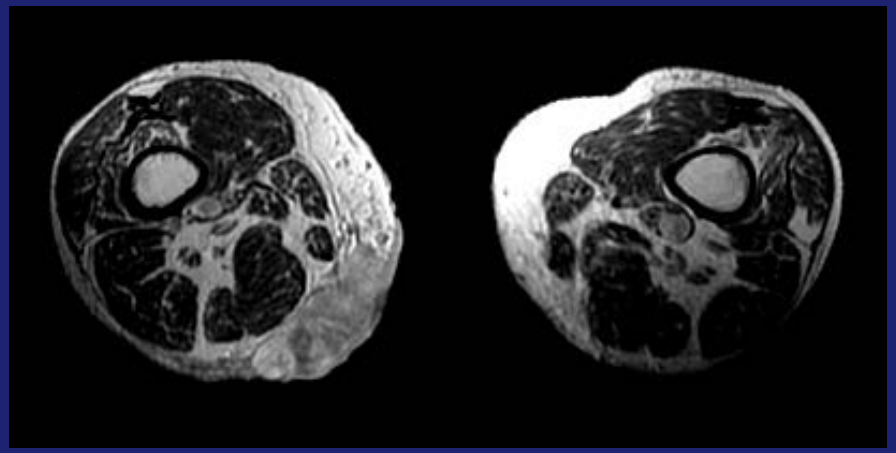
Extra-compartmentality

EXTENSION…

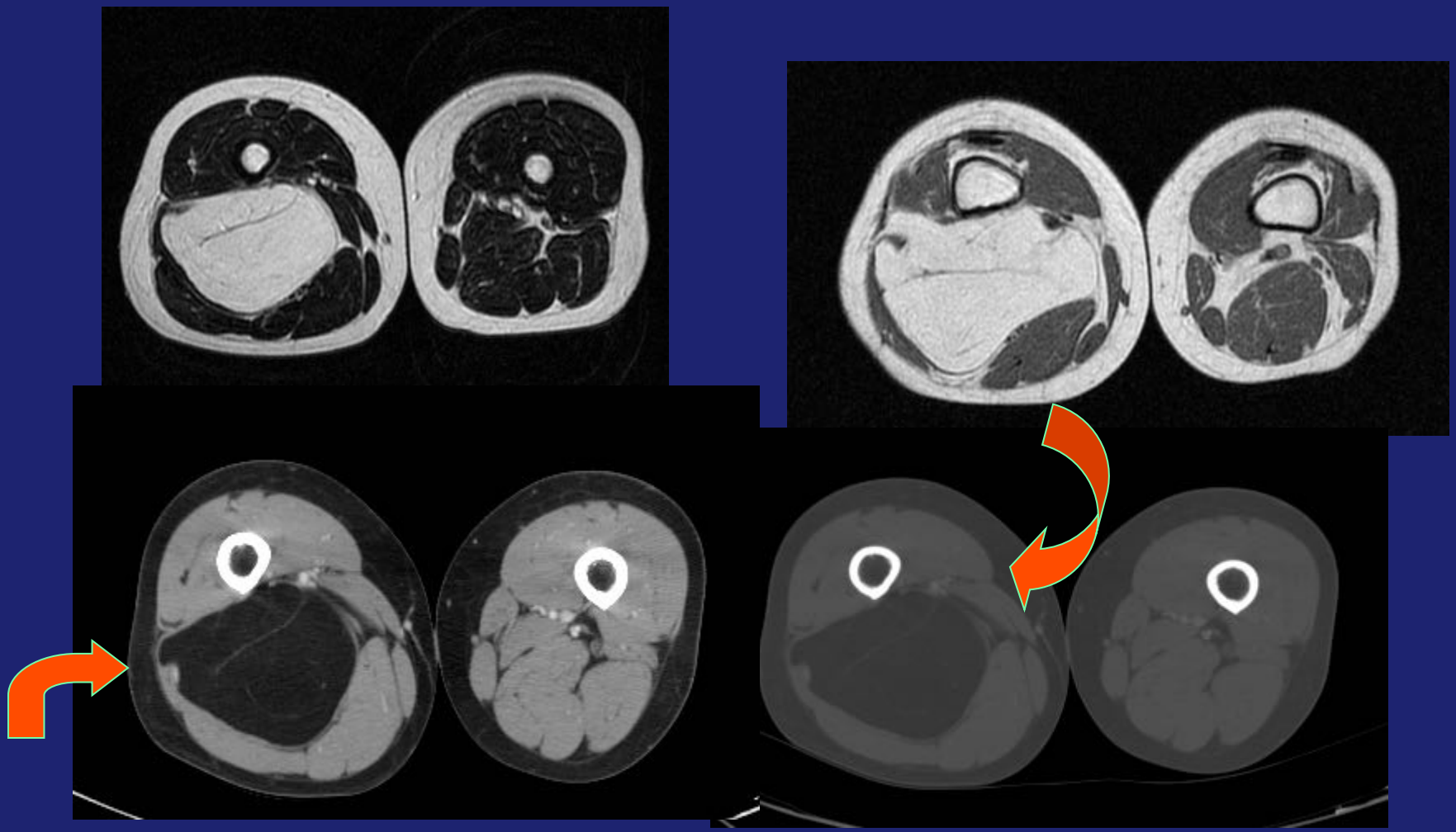




High grade sarcoma

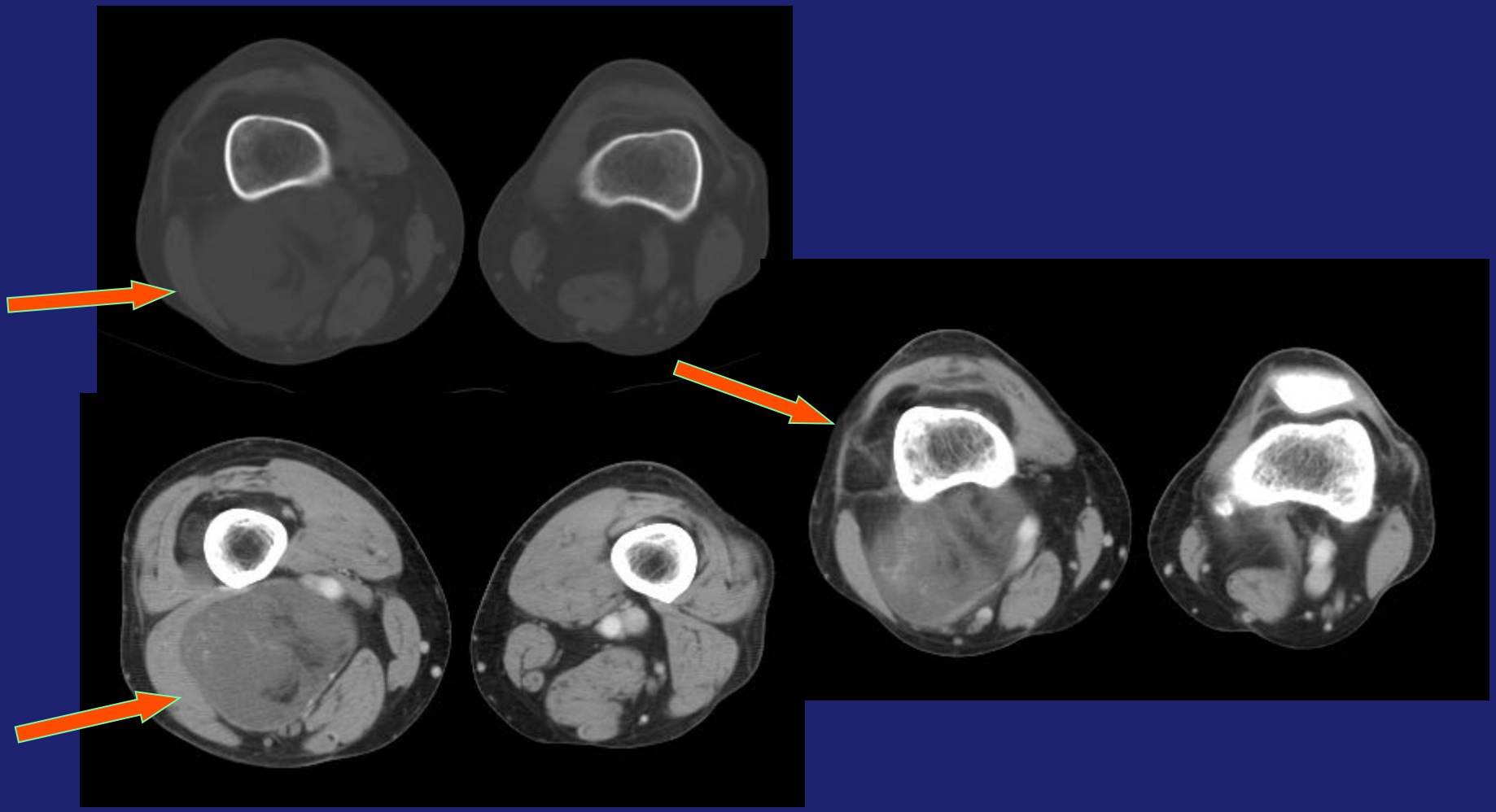


INTRA….



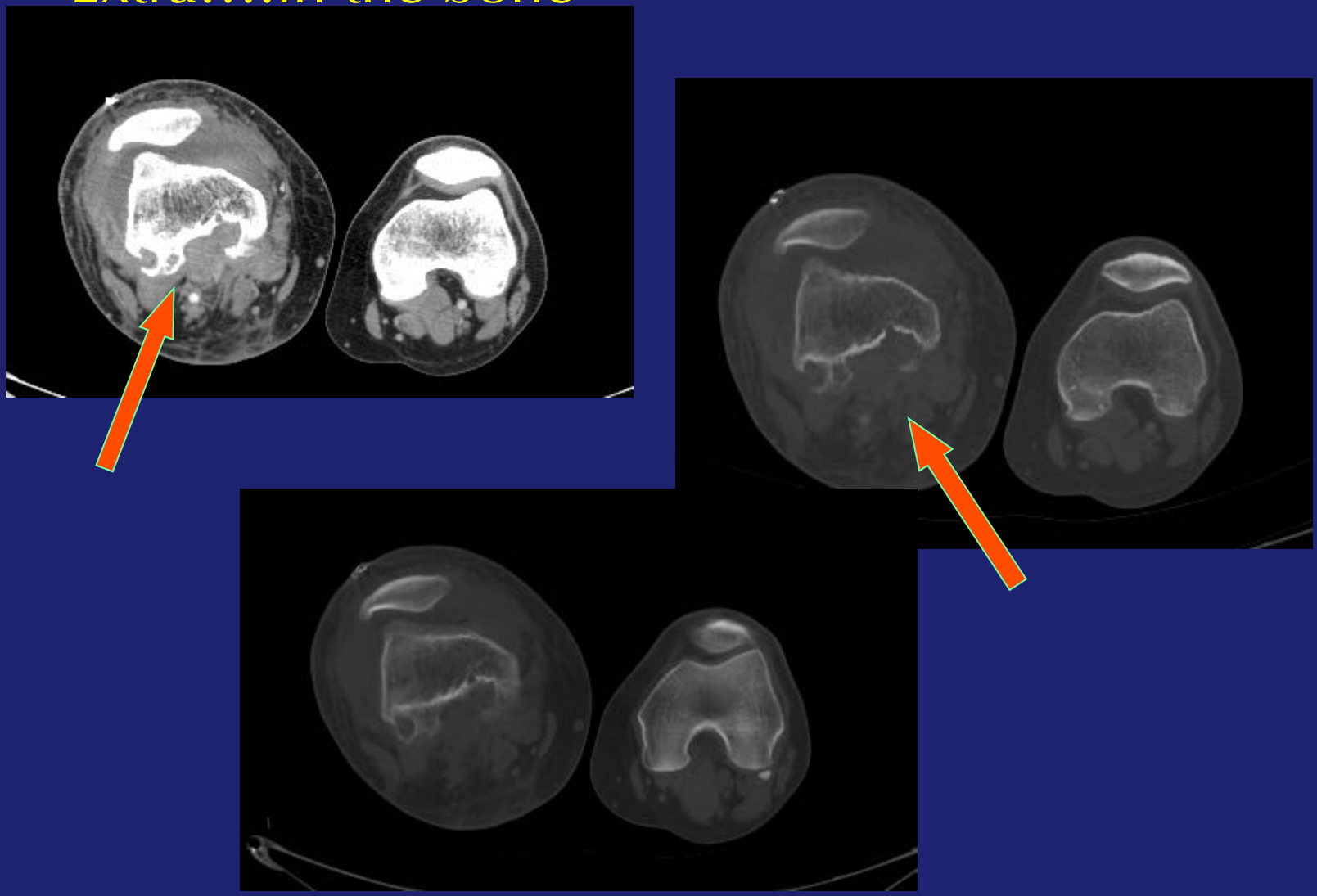
Liposarcoma lipoma-like

EXTRA……in another muscular compartment



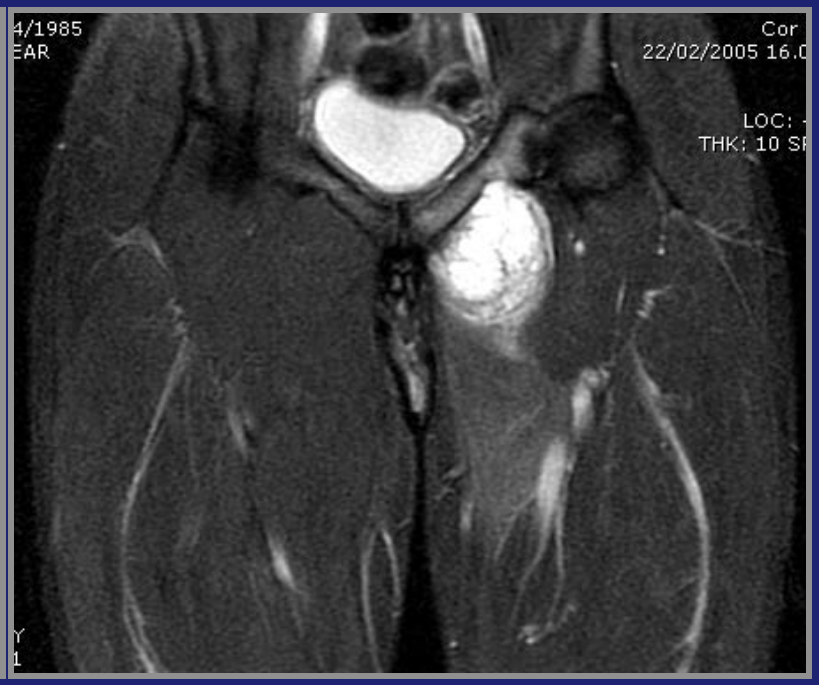
Liposarcoma

Extra….in the bone

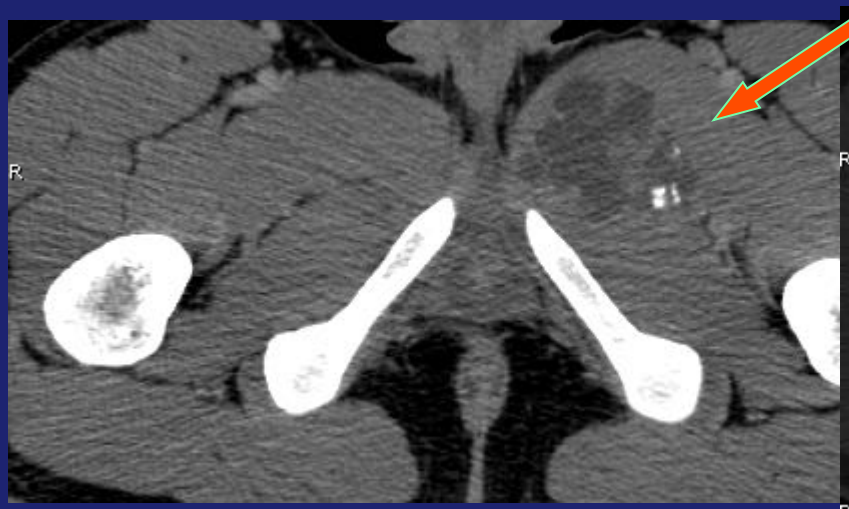


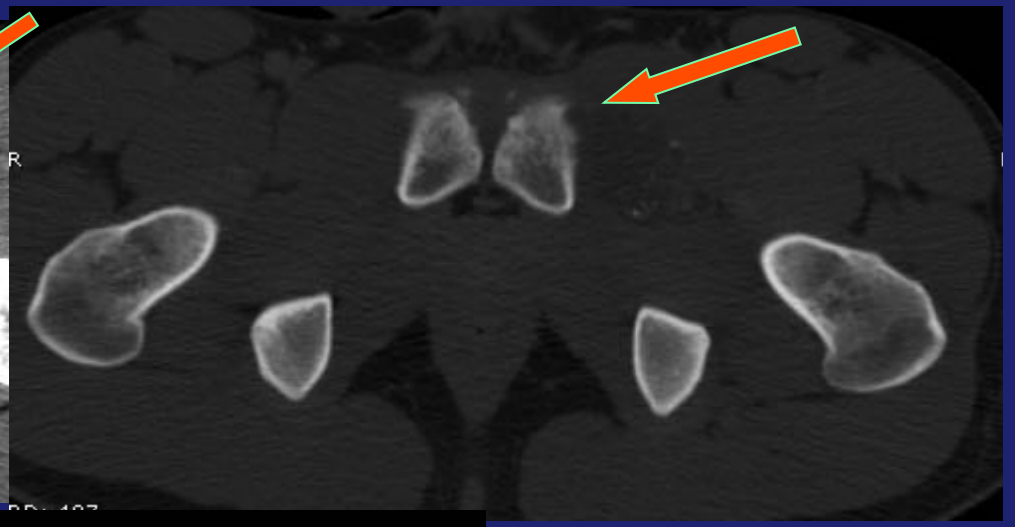
Sarcoma


H
/1985
AR
22/02/2005 16
LOC:
THK: 5


4/1985
EAR
Cor
22/02/2005 16.0
LOC:
THK: 10 SP
Y
1

Calcifications + Erosion

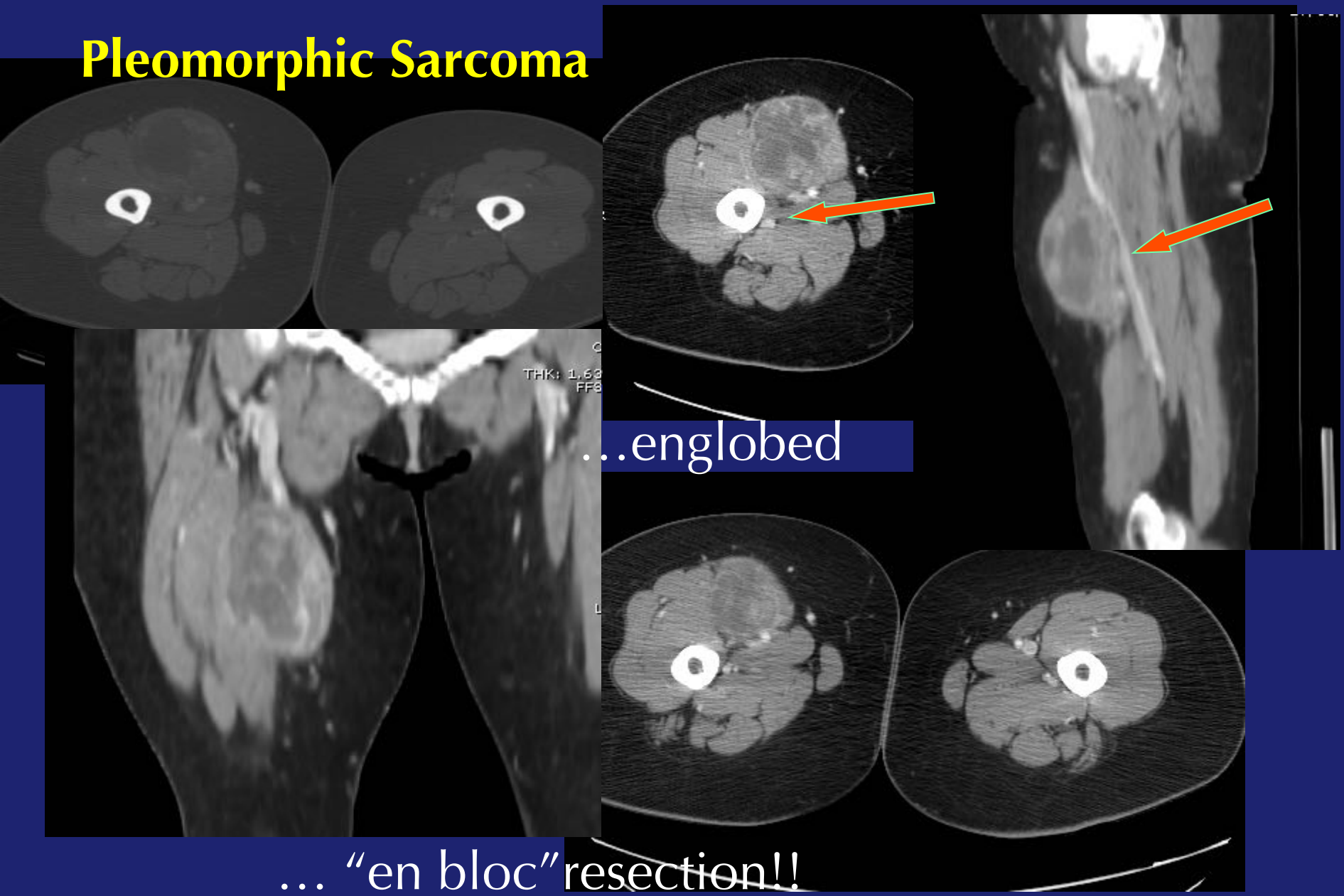




Pubic-bone excision!

NEUROVASCULAR RELATIONSHIP …

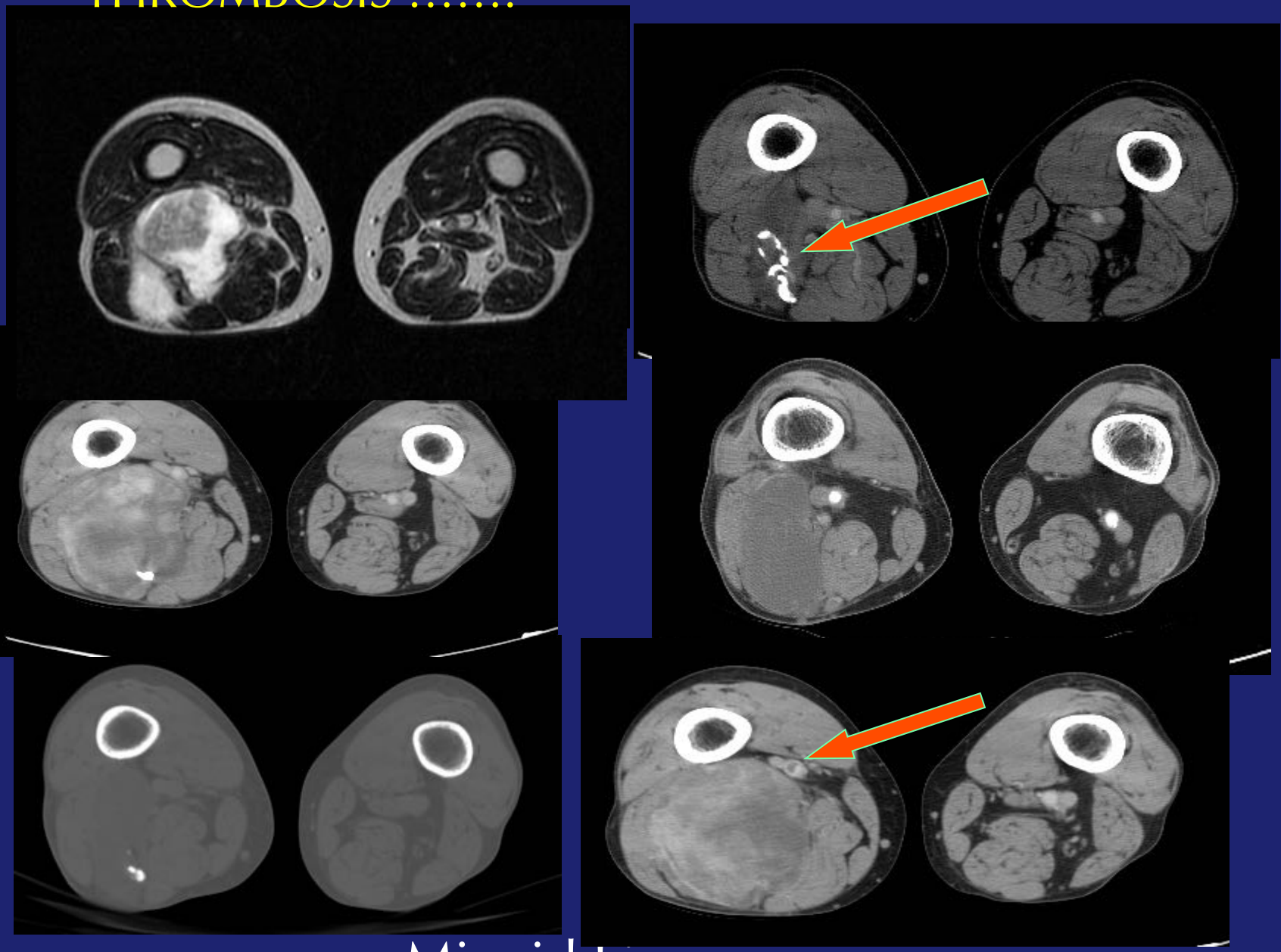
Pleomorphic Sarcoma



…englobed

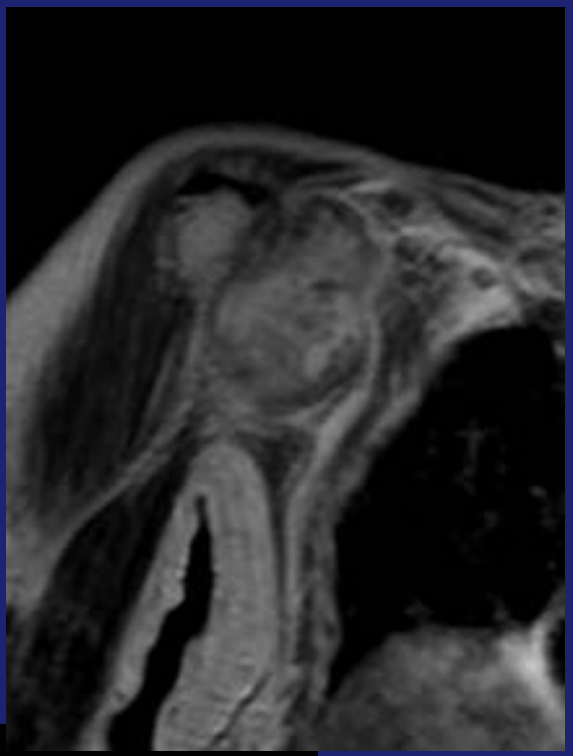
… “en bloc” resection!!

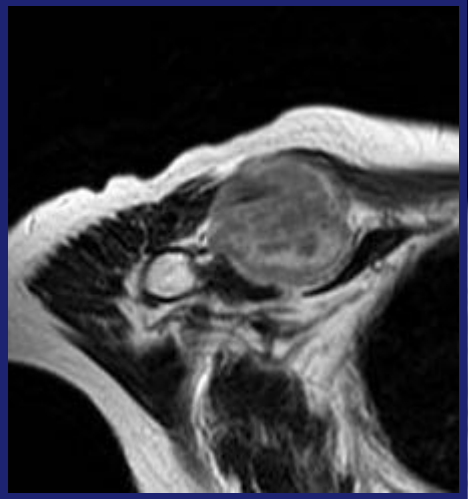
THROMBOSIS …….



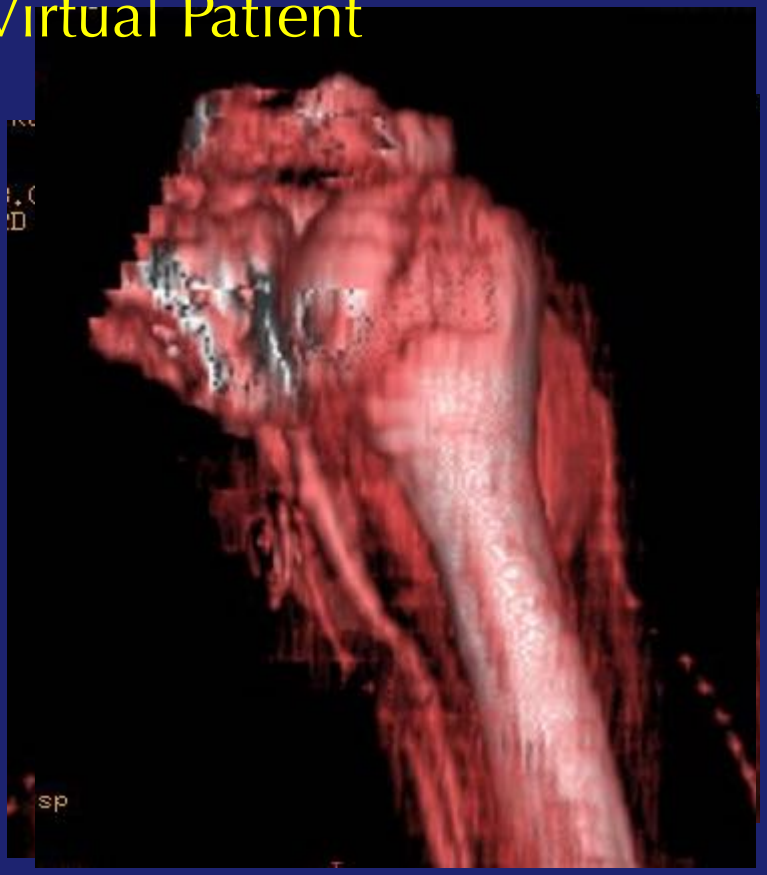
Mixoid Liposarcoma

3D CT

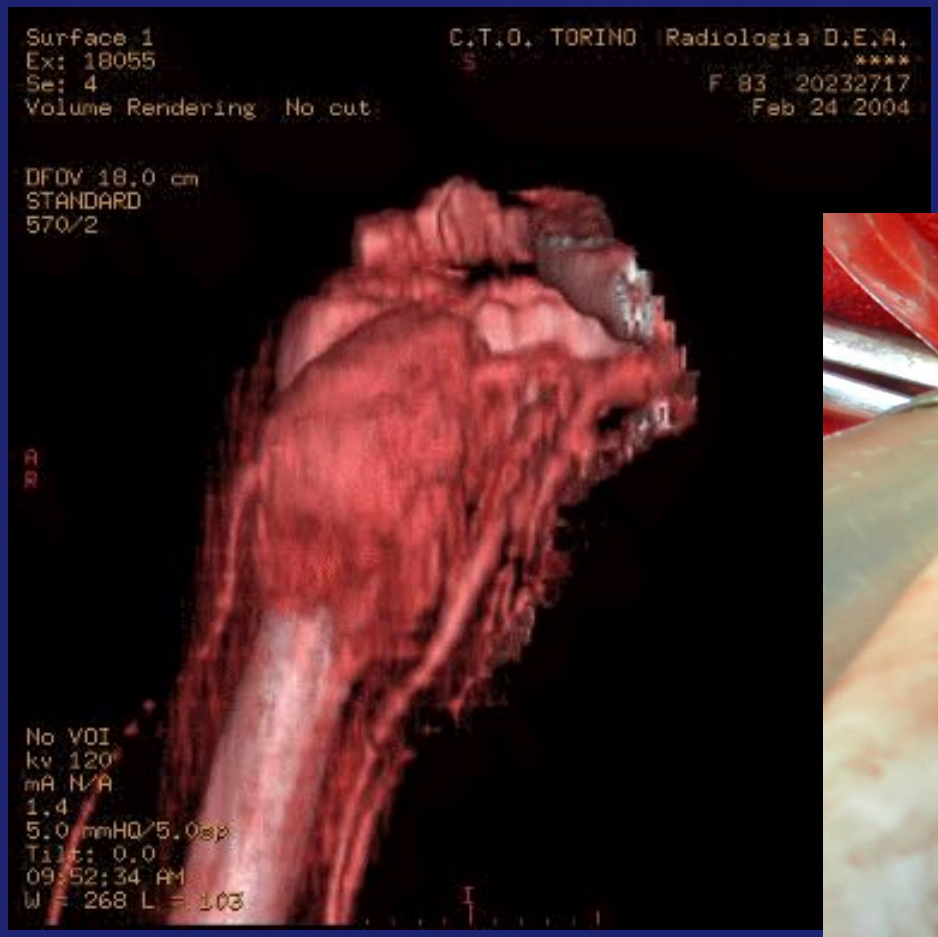


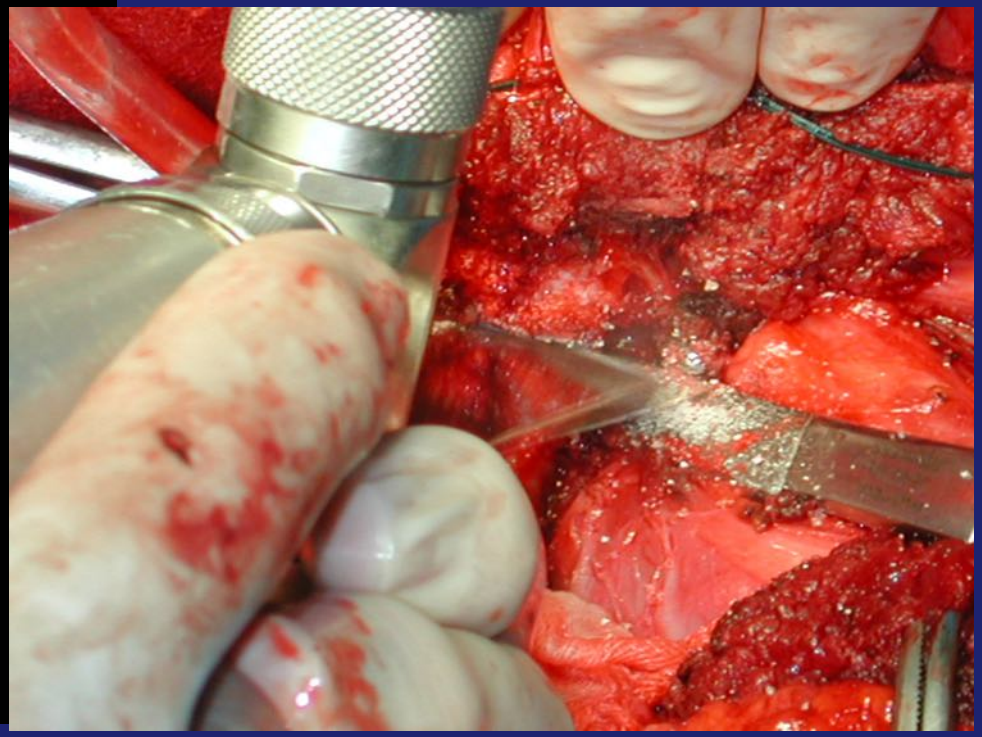


Virtual Patient



Pre-operative Planning



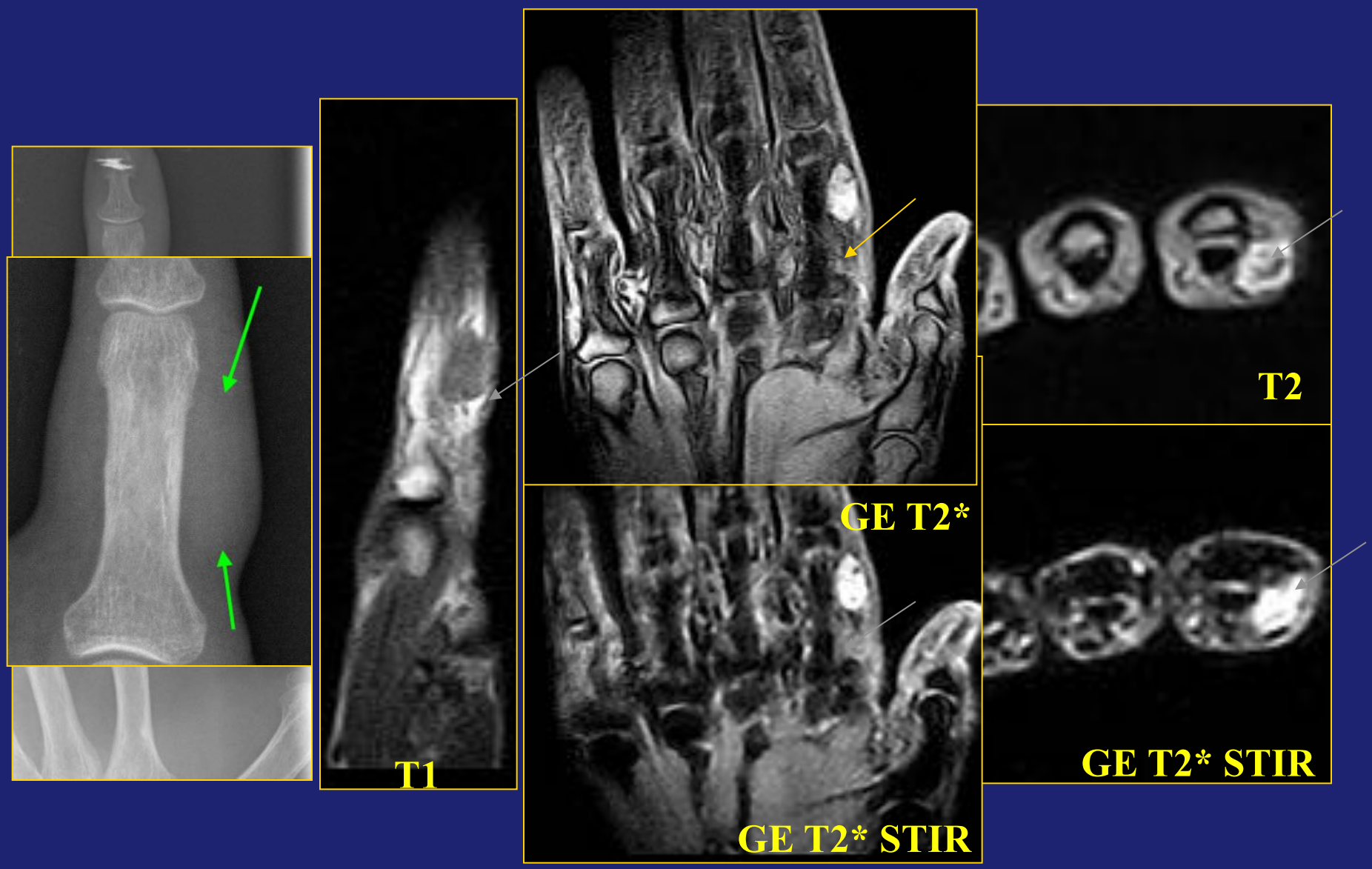


High Grade Sarcoma

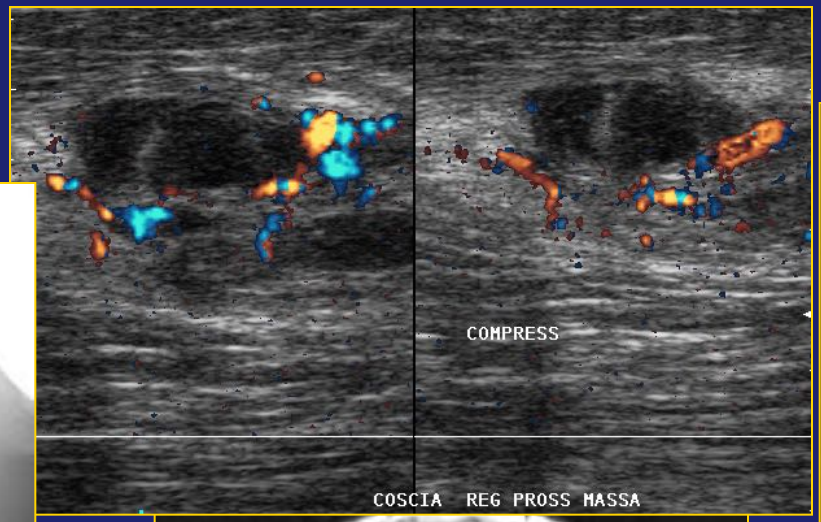
MR

"Gold standard" imaging modality for morphological and qualitative evalutation of tumors

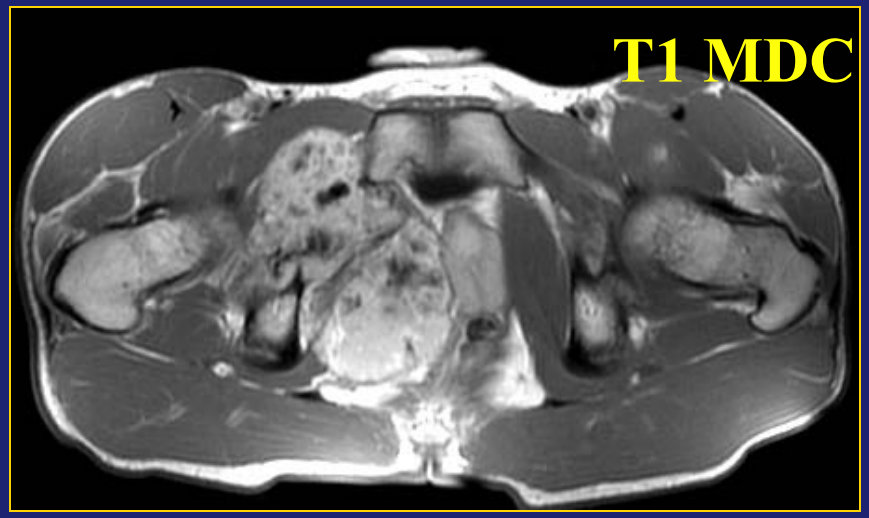
- multiplanarity
- high contrast resolution
- dynamic study



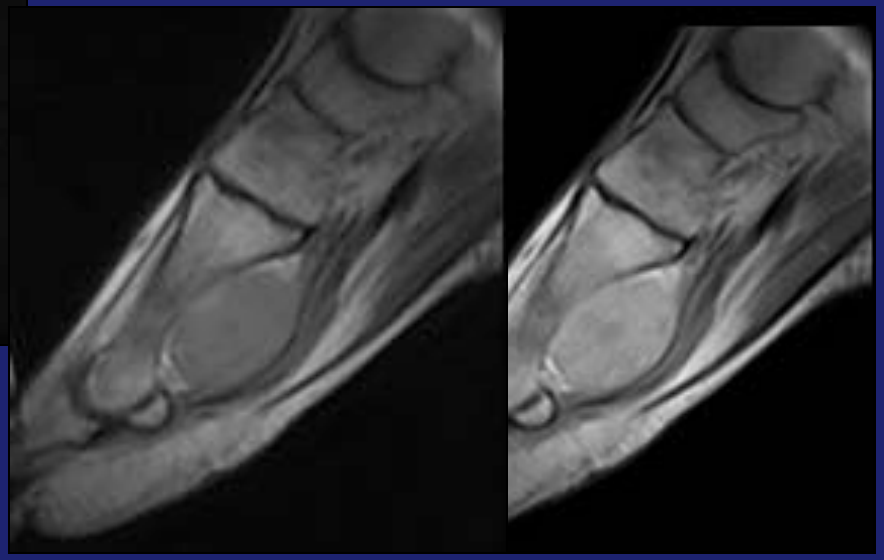
Emangioma



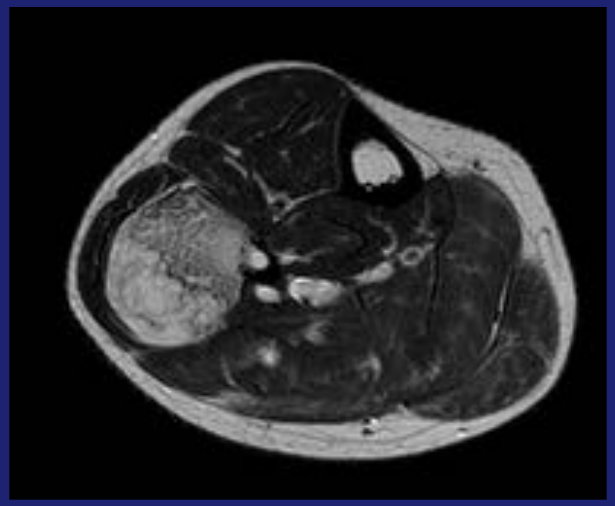
Angioma – MAV

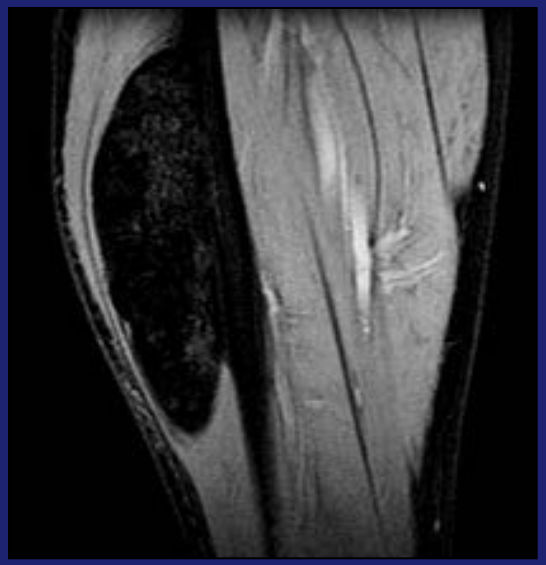


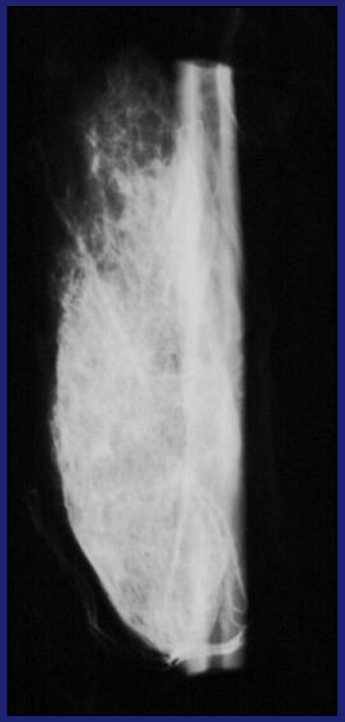
Calcific leiomioma



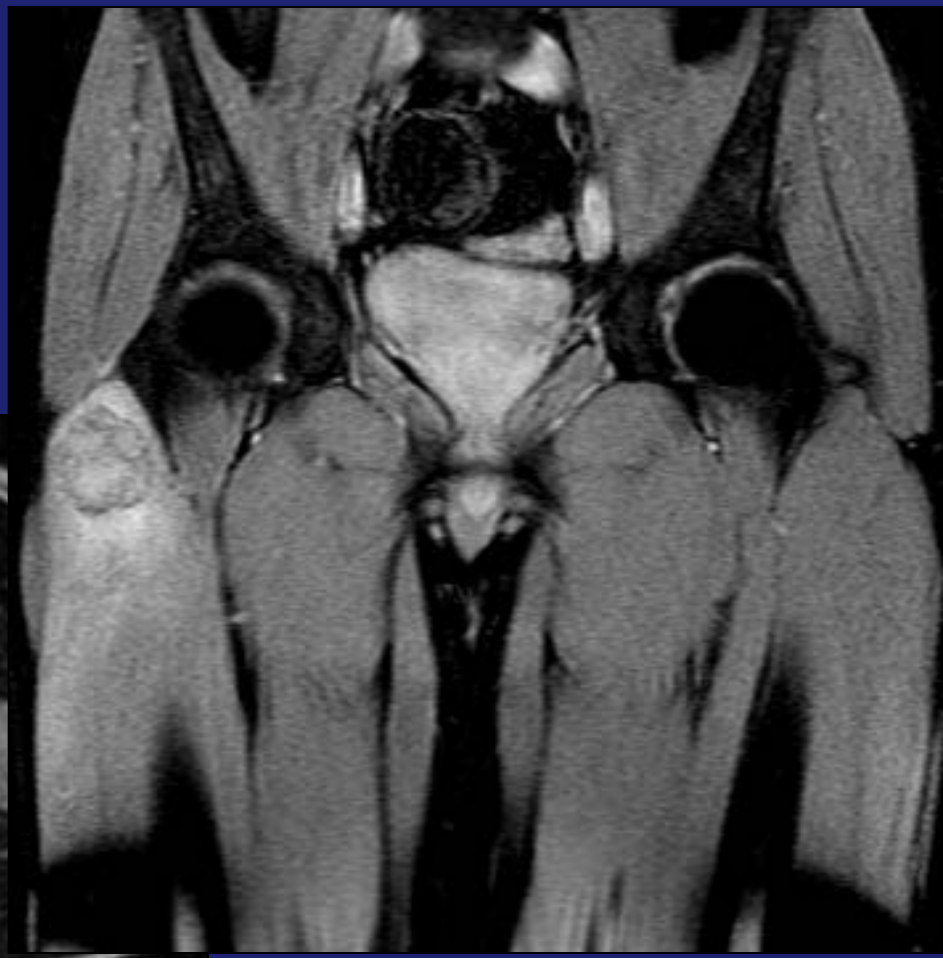
Synovial sarcoma

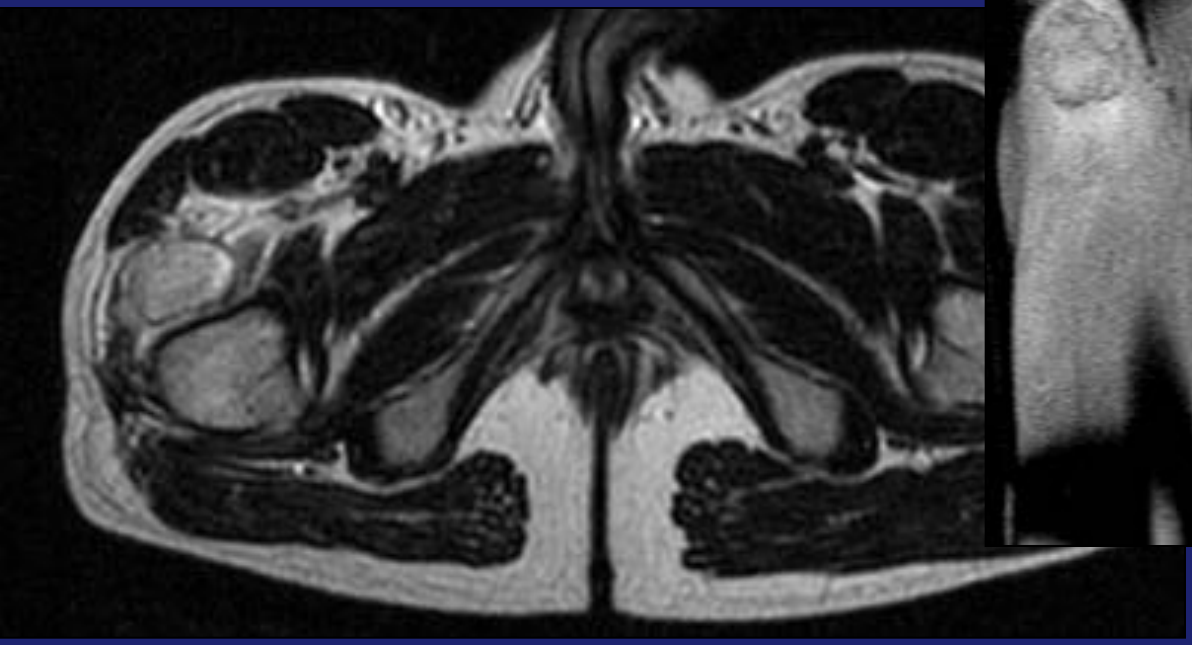




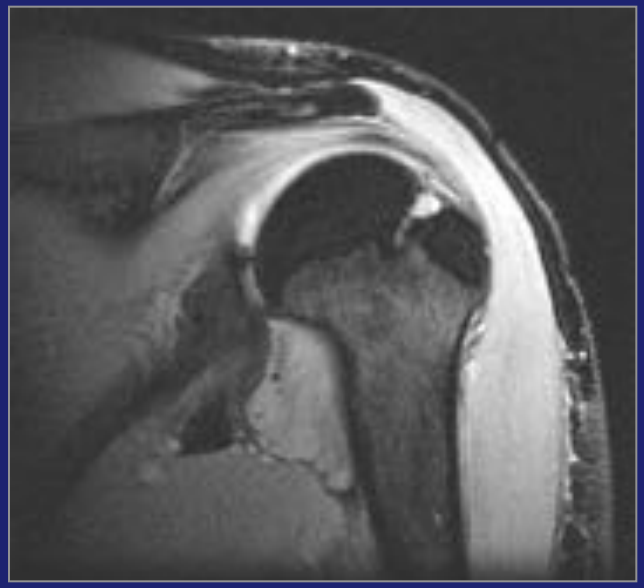


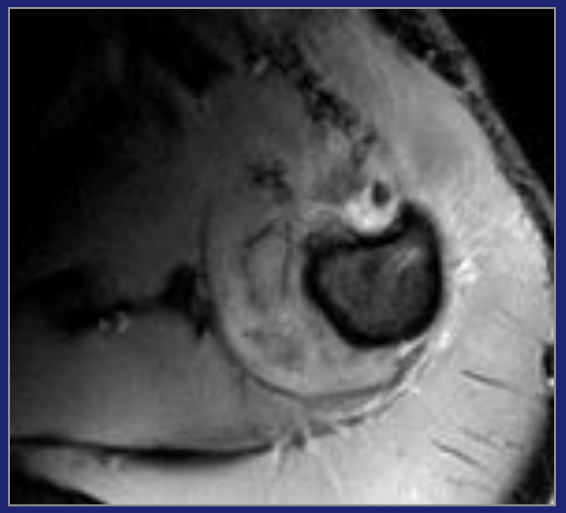
Ossified lipoma (lipoma periosteo?)



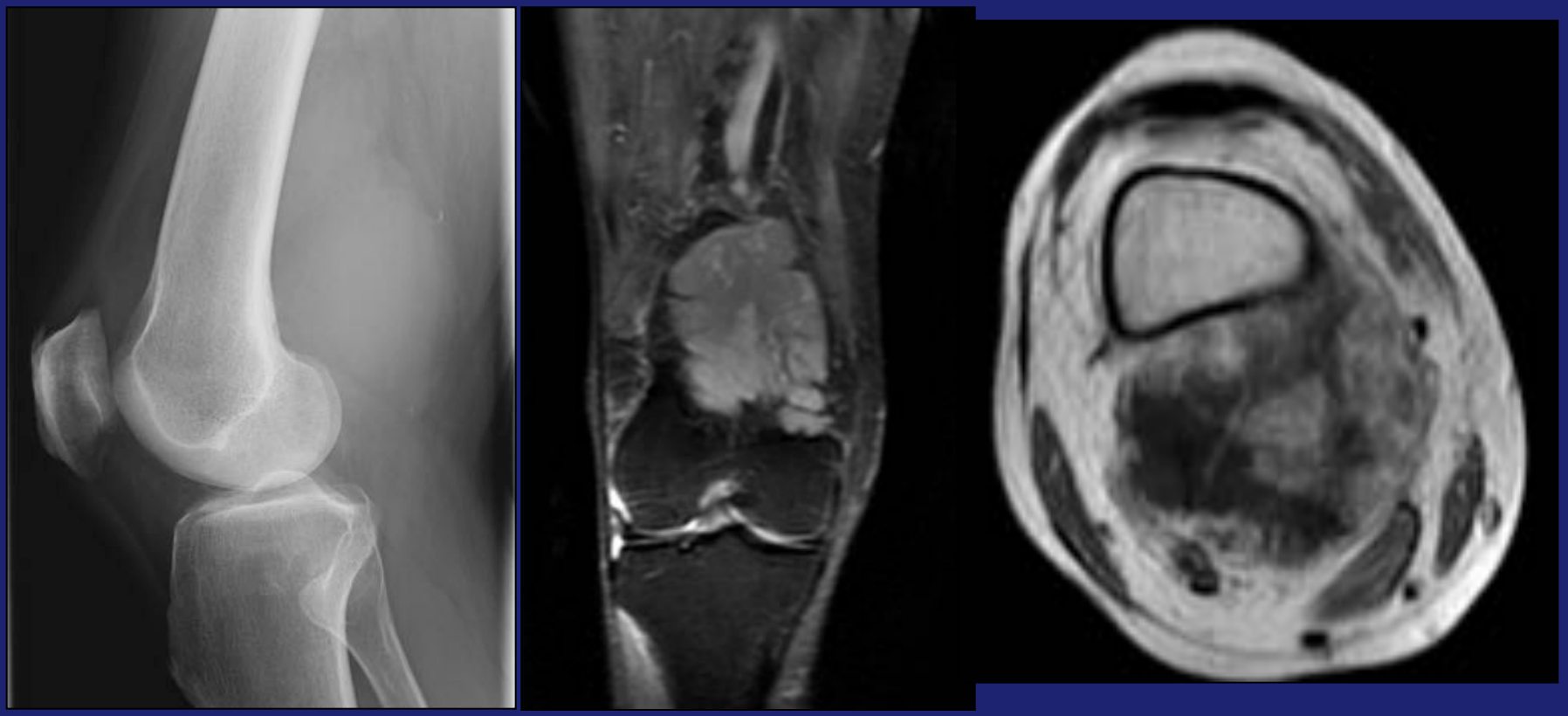


Ossificans myositis

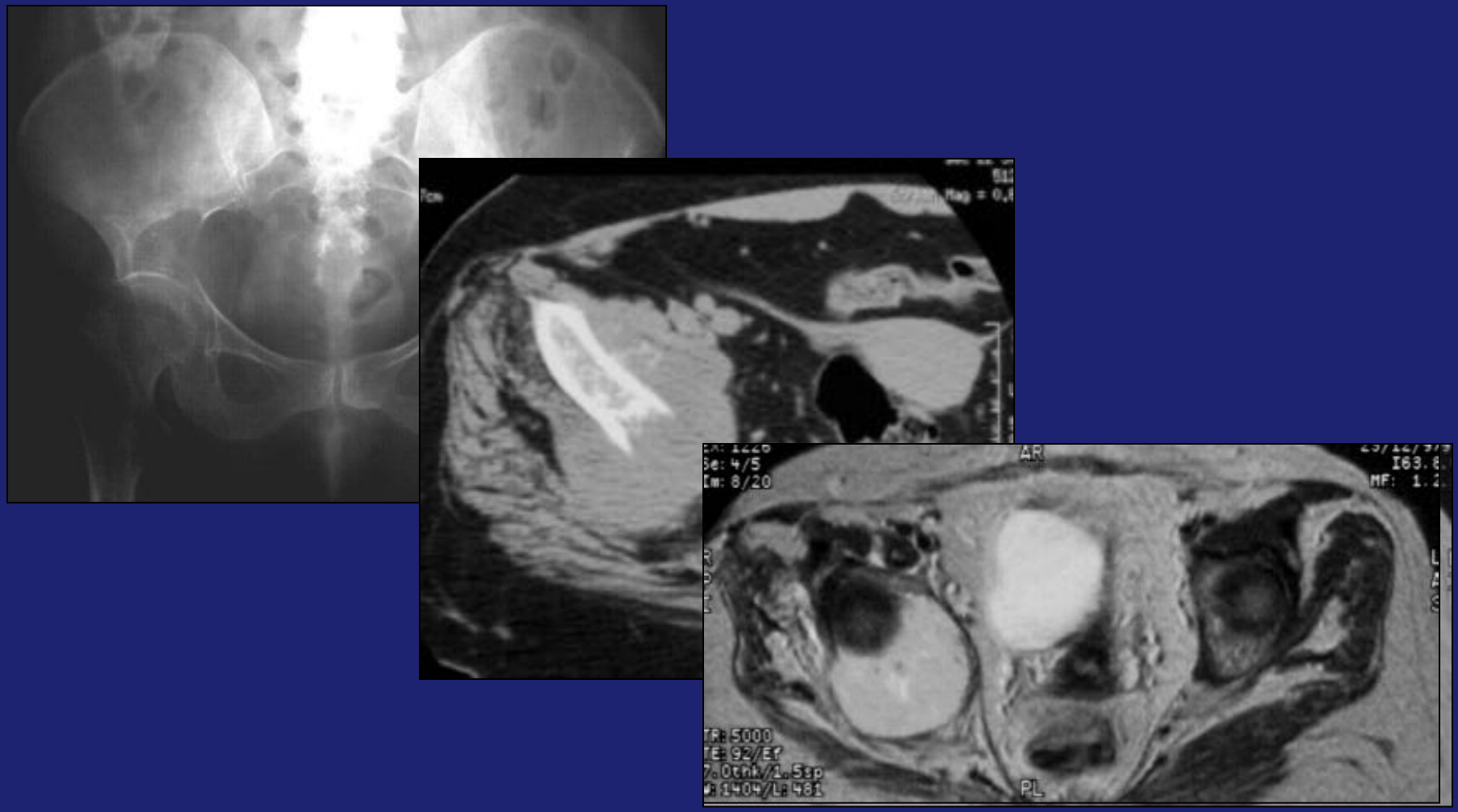




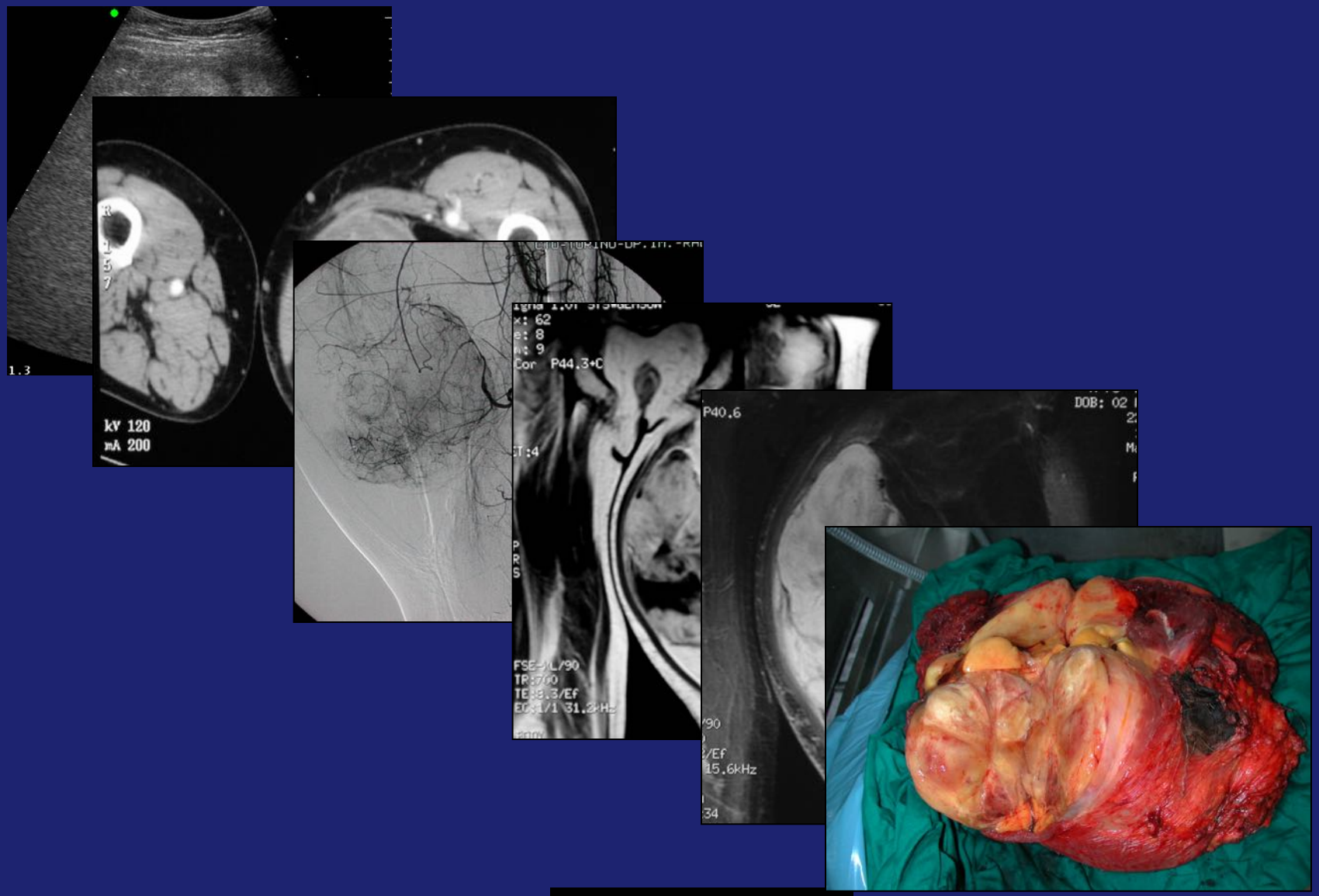
Pigmented villonodular synovitis



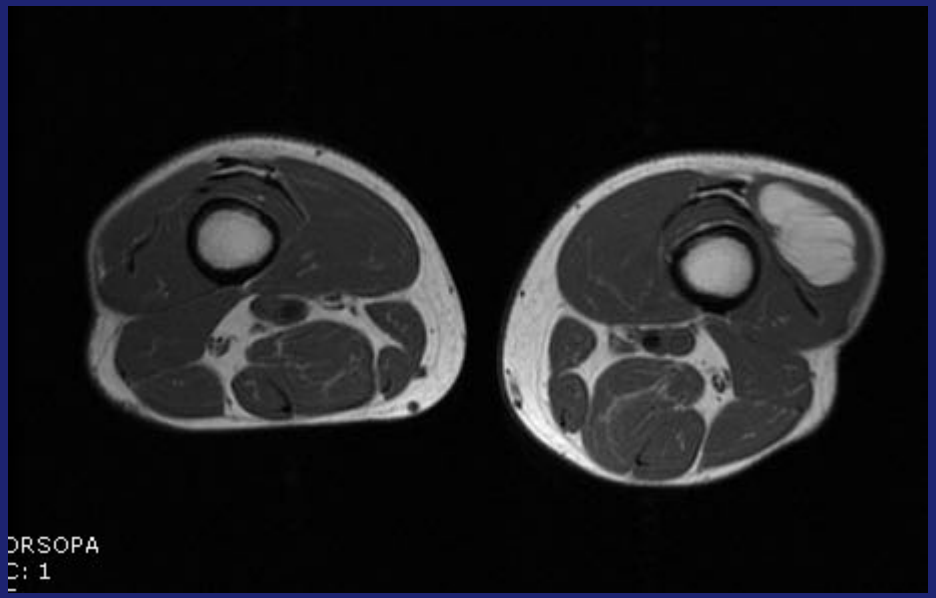
Extra-abdominal aggressive fibromatosis



Neurofibrosarcoma



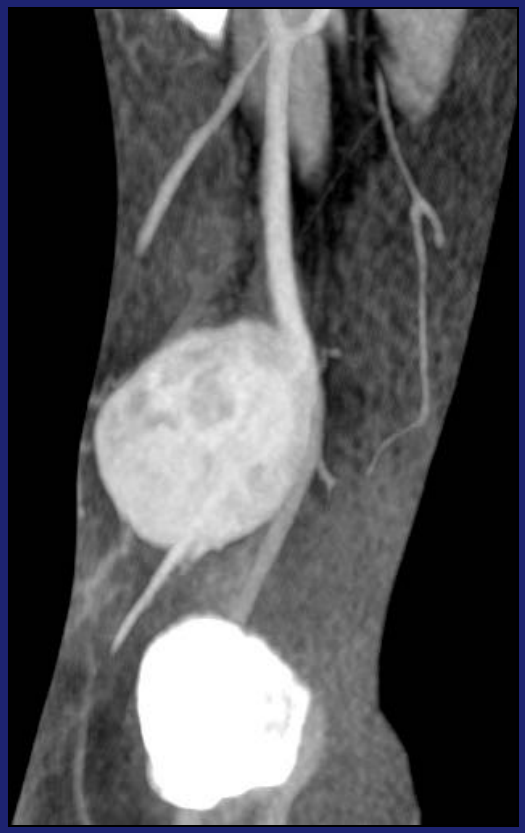
Liposarcoma



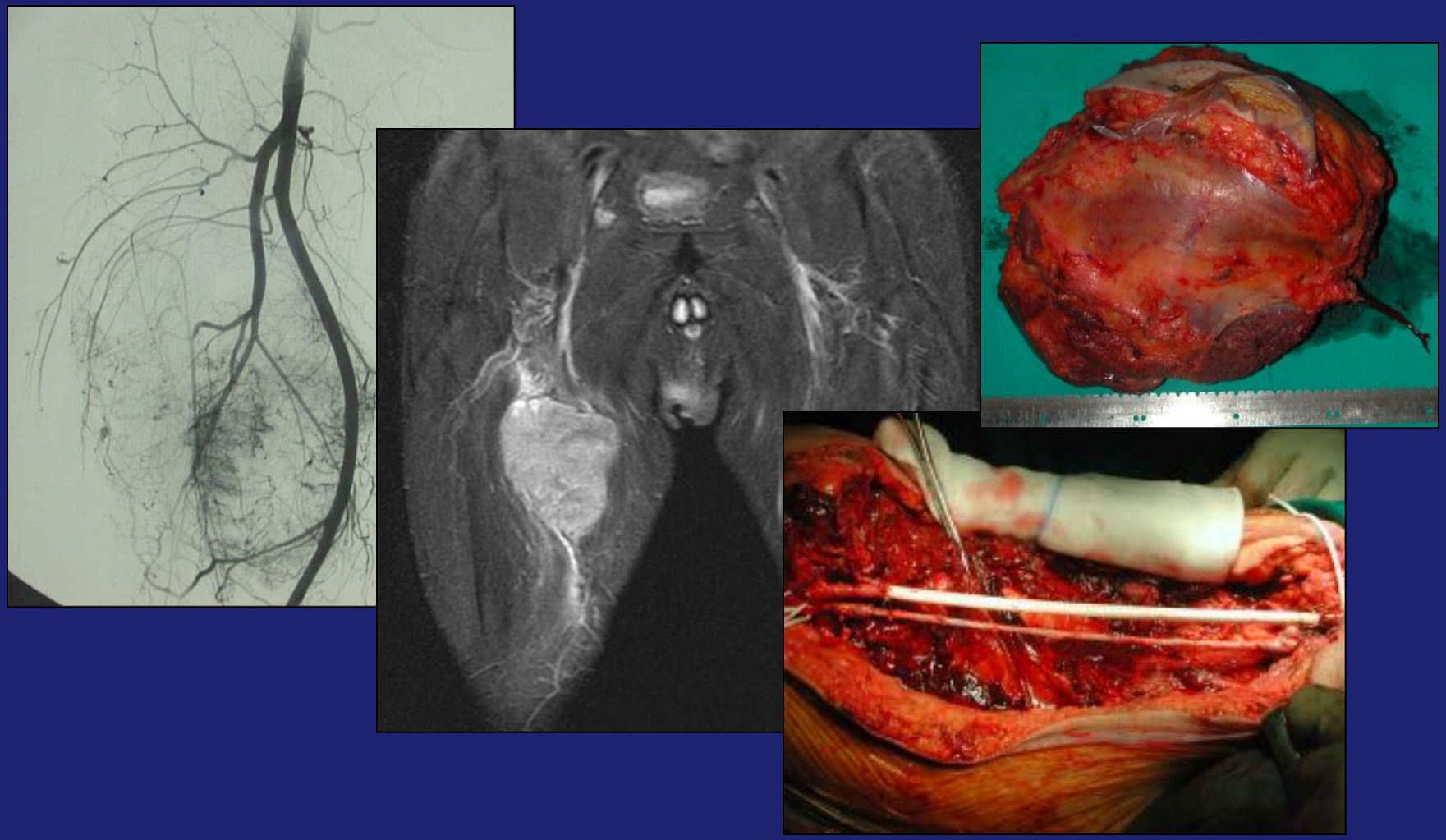
Lipoma → Lipoma like

ANGIOCT

ANGIO-MR:
sequenze 3D ultraveloci:
ricostruzioni multiplanari :
valutazione morfologica



High-grade mixofibrosarcoma



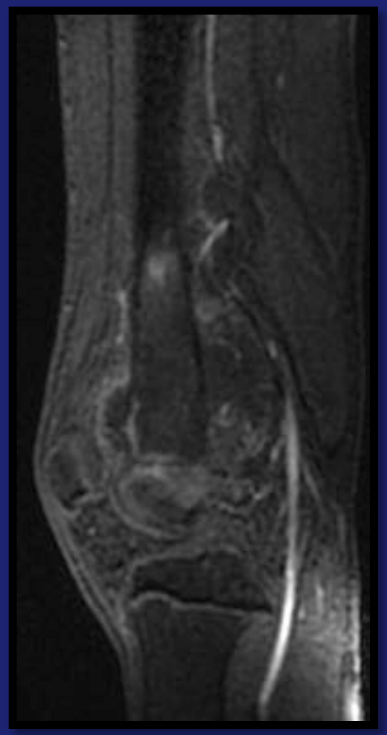
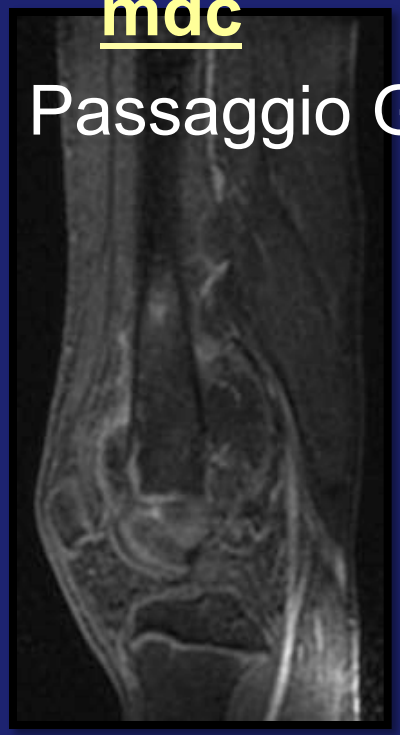
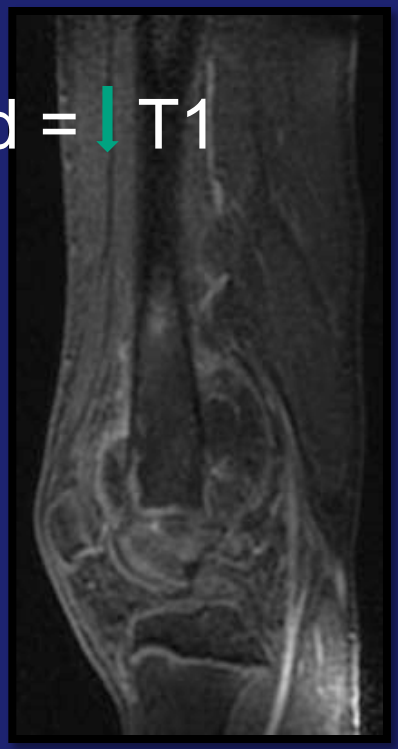
High-grade pleomorphic sarcoma

RM dinamica (DCE MRI: dynamic contrast-enhanced MRI)

Iniezione e.v. mdc standardizzata

Acquisizione "dinamica" delle immagini post-mdc

Passaggio Gd = ↓ T1

Reddick WE et al. **Dynamic contrast-enhanced MR imaging evaluation of osteosarcoma response to neoadjuvant chemotherapy**. J Magn Reson Imaging1995;5:689–694

Guo JY et al. **DCE-MRI pixel-by-pixel quantitative curve pattern analysis and its application to osteosarcoma**. Magn Reson Imaging 2009 Jul;30(1):177-84

Iniezione e.v. mdc standardizzata

- utilizzo iniettore
- dose in fx del peso
- flusso 0,7- 3 ml/sec,

seguiti da almeno 20 ml di fisiologica

MO Leach et al: ***Assessment of antiangiogenetic and antivascular therapeutics using MRI: recommendations for appropriate methodology for clinical trials*****. The British Journal of Radiology, special issue 76(2003),S87-91**

Acquisizione dinamica immagini

- sequenze ultraveloci:
  - ✓ eco di gradiente 3D,
  - ✓ fortemente T1 pesate (TR e TE minimi e gradienti spoiler che abbattono la magnetizzazione residua dopo ogni eco),
  - ✓ FA circa 40° per abbattere il segnale dei tessuti stazionari in cui non è presente la riduzione del T1 determinata dal Gd,
  - ✓ preimpulsi di inversione per presaturare il grasso senza allungare il TA,
  - ✓ tempo di acquisizione < 30 sec per separare la fase arteriosa da quella venosa

  Es: SPGR 3D, LAVA, etc

- acquisizione immagini contemporaneamente o con tempo di ritardo rispetto all'inizio dell'iniezione , calcolandolo con la tecnica del *test-bolus* (sequenze centriche : ritardo=TA, sequenze sequenziali ritardo=TC-1/3TA)

- ripetute continuativamente per i primi 150 sec e poi anche non continuativamente per almeno 8 minuti

Curve Intensità di Segnale – Tempo:

Quali applicazioni? a. Tipizzazione b. Ristadiazione

Reddick WE, Bhargava R, Taylor JS, Meyer WH, Fletcher BD. Dynamic contrast-enhanced MR imaging evaluation of osteosarcoma response to neoadjuvant chemotherapy. J Magn Reson Imaging 1995;5:689–694.

Woude HJ, Verstraete KL, Bloem JL: Muscoloskeletal tumors: does fast dynamic contrast-enhanced subtraction MR imaging contribute to the characterization? Radiology 1998, 208(3):821-8

Woude HJ, Verstraete KL, Bloem JL: Dynamic contrast-enhanced MR imaging of muscoloskeletal tumors: basic principles and clinical applications. J Magn Reson Imaging 1996;6(2):311-21

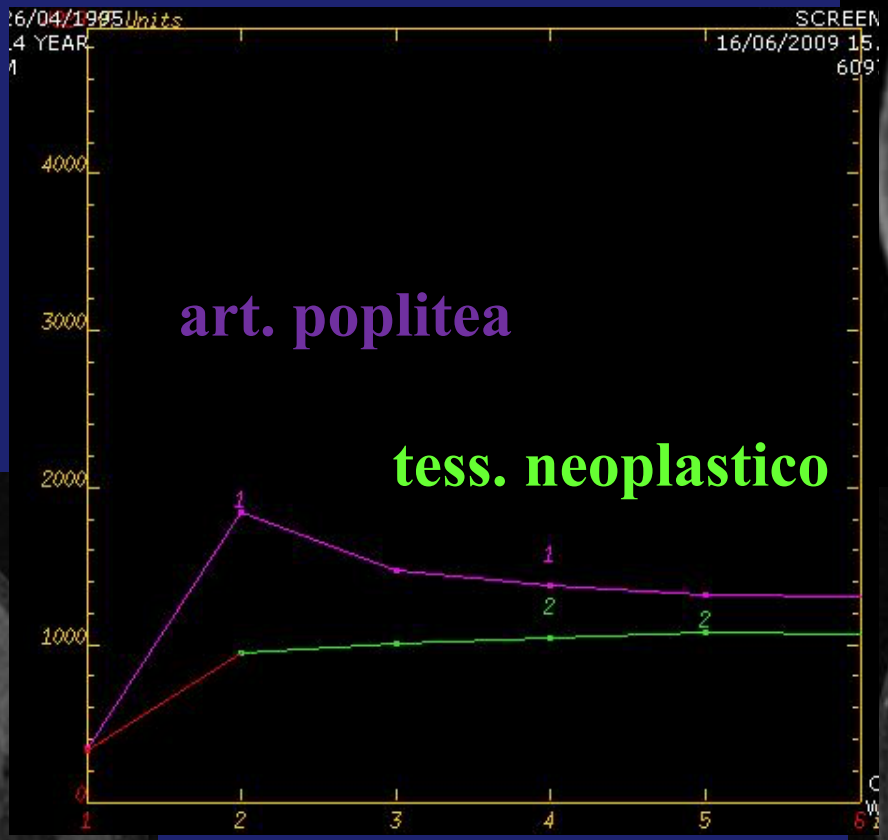
Egmont-Petersen M, Hogendoorn PC, Van der Geest RJ, et al. Detection of areas with viable remnant tumor in postchemotherapy patients with Ewing's sarcoma by dynamic contrast-enhanced MRI using pharmacokinetic modeling. Magn Reson Imaging 2000;18:525–535.

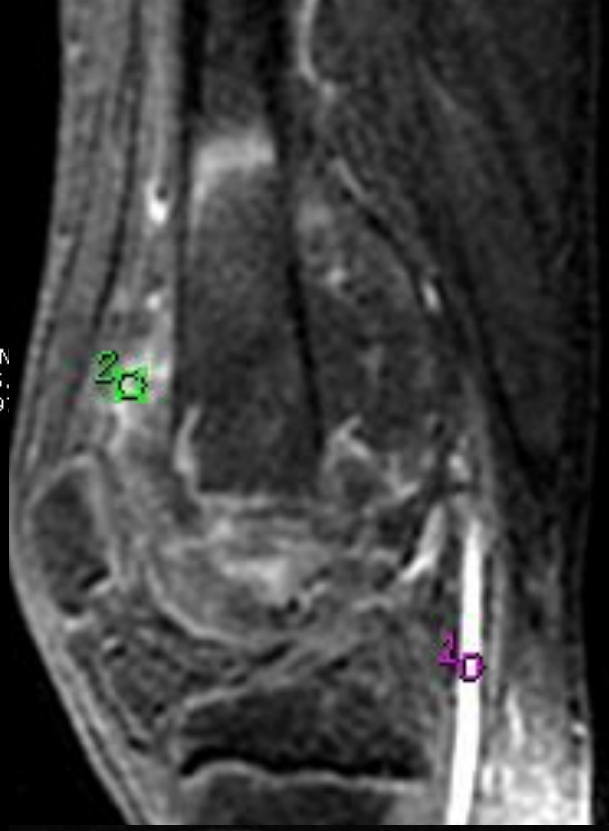
Dyke JP, Panicek DM, Healey JH, et al. Osteogenic and Ewing sarcomas: estimation of necrotic fraction during induction chemotherapy with dynamic contrast-enhanced MR imaging. Radiology 2003;228:271–278.

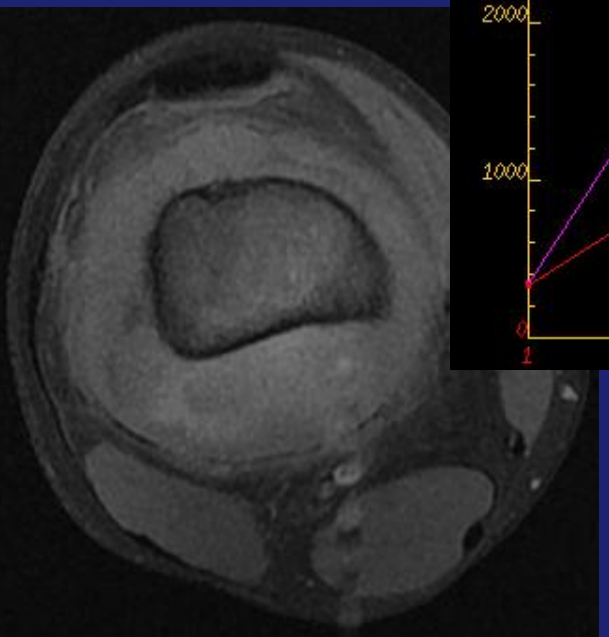
Guo JY, Reddick WE. DCE-MRI pixel-by-pixel quantitative curve pattern analysis and its application to osteosarcoma. Magn Reson Imaging 2009 Jul;30(1):177-84.

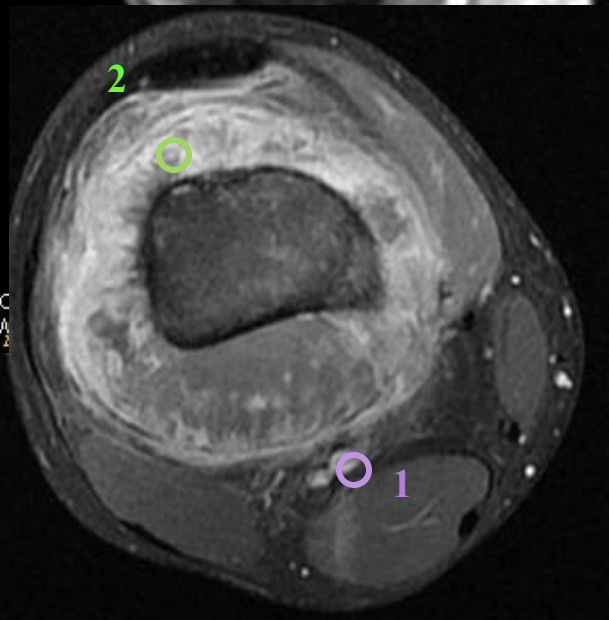
Approccio semiquantitativo:

Curve Intensità di Segnale-Tempo









Approccio quantitativo: Perfusione
Parametri di farmacodinamica per il microcircolo

- Transfer constant (**Ktrans**, min-1): riflette il circolo (perfusione) e il passaggio del mdc attraverso l'endotelio vascolare (permeabilità)

- Initial area under the gadolinium concentration time curve (**IAUGC**, mMGd.min; over first 1.5 min after contrast arrival)

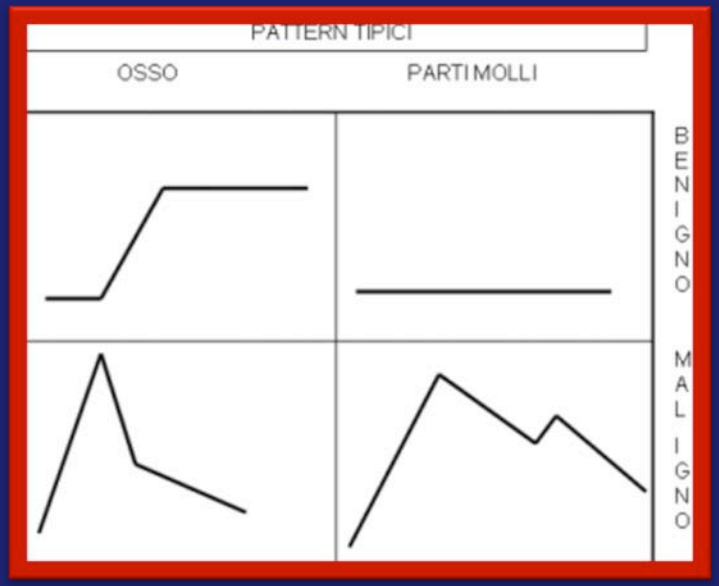
- **V_b :** volume ematico (mdc nei vasi)

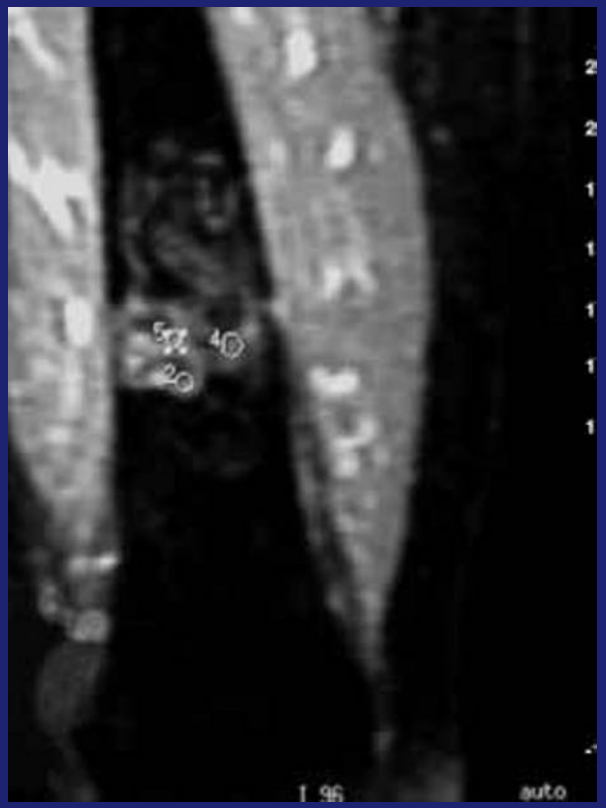
- **V_e :** volume extracellulare (mdc nello spazio interstiziale), dipende dalla cellularità

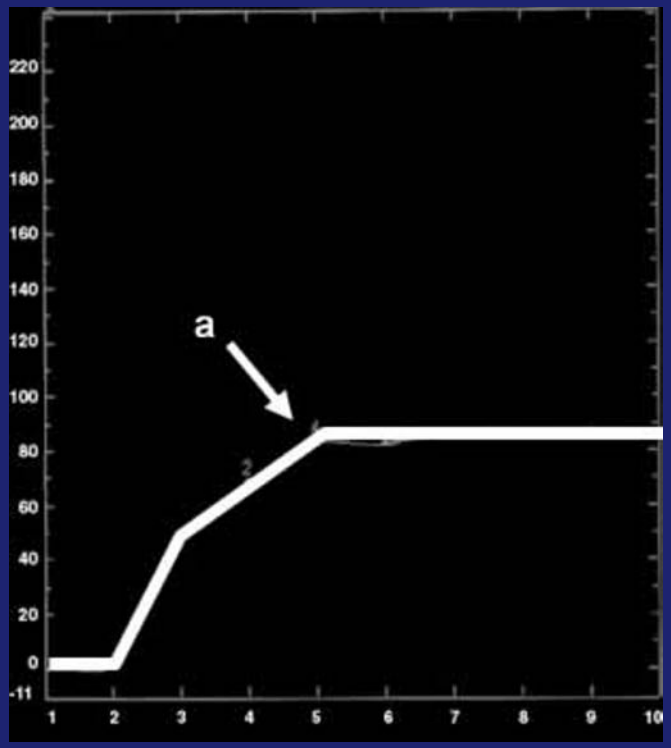
- **PS** : permeabilità dell'endotelio

RM dinamica
a. Tipizzazione

A.Barile, G. Regis, R. Masi, M.Maggiori, A. Gallo, C. Faletti, C. Masciocchi
Musculoskeletal tumours: preliminary experience with perfusion MRI. Radiol med (2007) 112:550–561

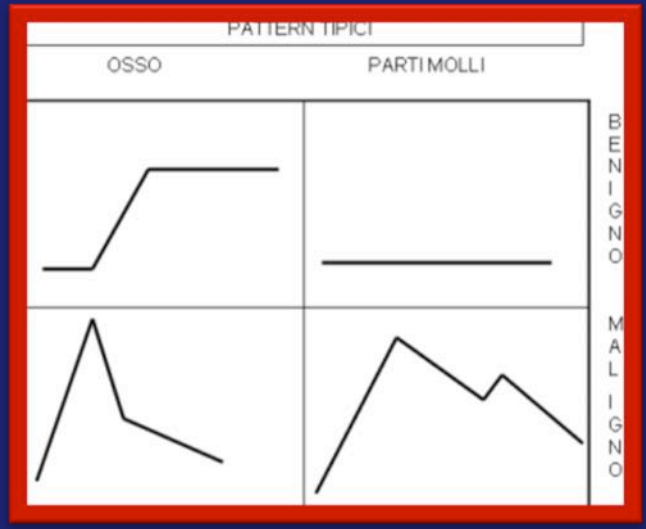


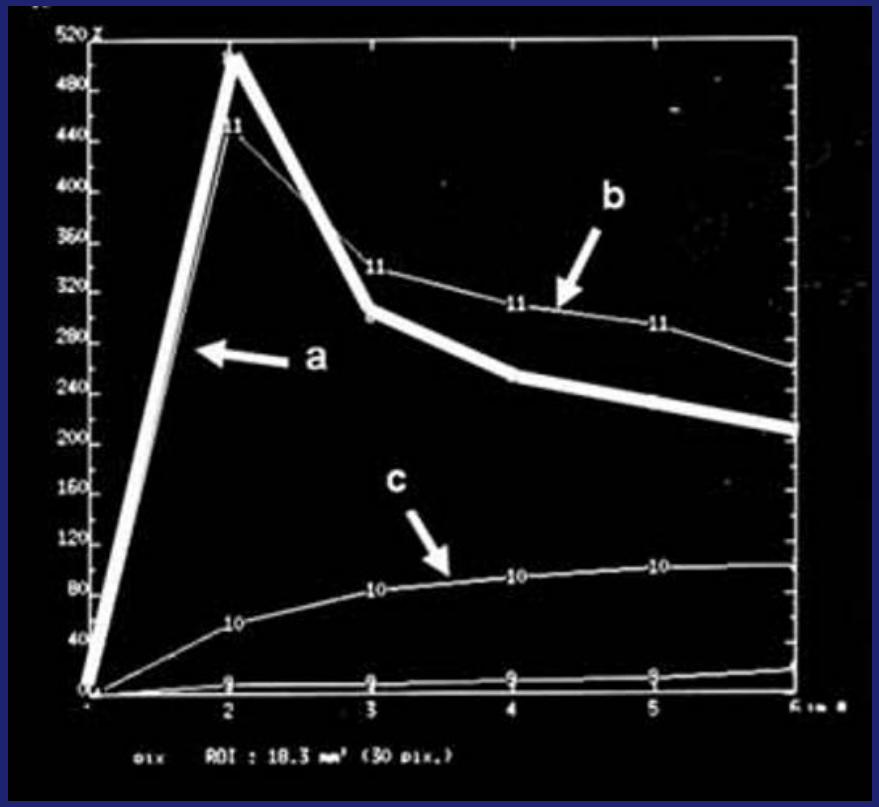


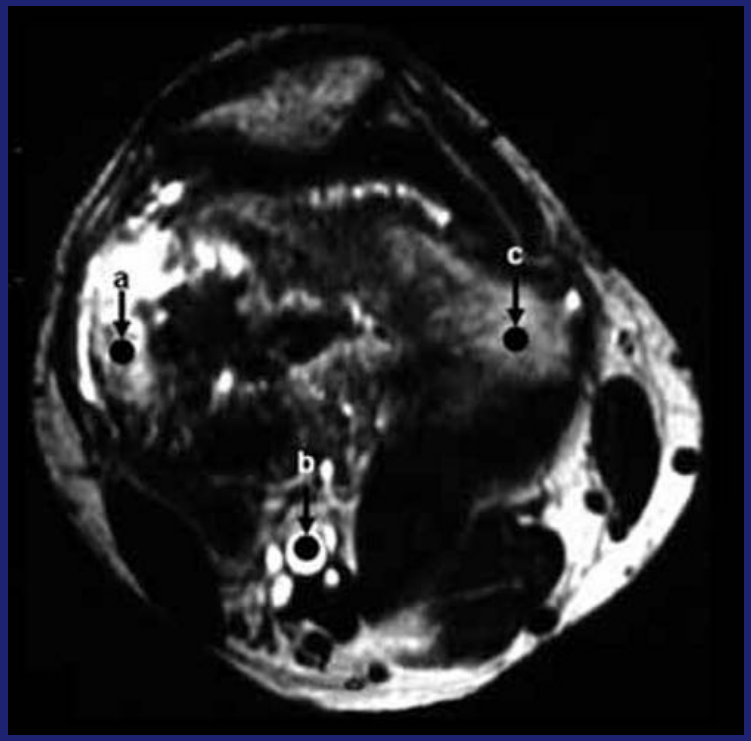


Lesione benigna:
encondroma

Lesione ossea maligna:
Osteosarcoma osteoblastico







RM dinamica:

b. Valutazione della risposta tumorale

Quale valutazione della **risposta tumorale** nei **sarcomi delle parti molli** alla **terapia neoadiuvante?**


VOLUME 25 · NUMBER 13 · MAY 1 2007

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

We Should Desist Using RECIST, at Least in GIST

ABSTRACT

Il **diametro massimo (RECIST)** non può essere l'unico parametro valutato dal radiologo e dall'oncologo

Purpose

Response Evaluation Criteria in Solid Tumors (RECIST) are insensitive in evaluating imatinib-treated gastrointestinal stromal tumors (GISTs). Response by Choi criteria, a 10% decrease in size or a 15% decrease in density on contrast-enhanced CT, correlated well in a small training set of patients who showed response as measured by positron emission tomography, and was more predictive of time to tumor progression (TTP) than response by RECIST. This study was designed to validate these observations in an independent data set.

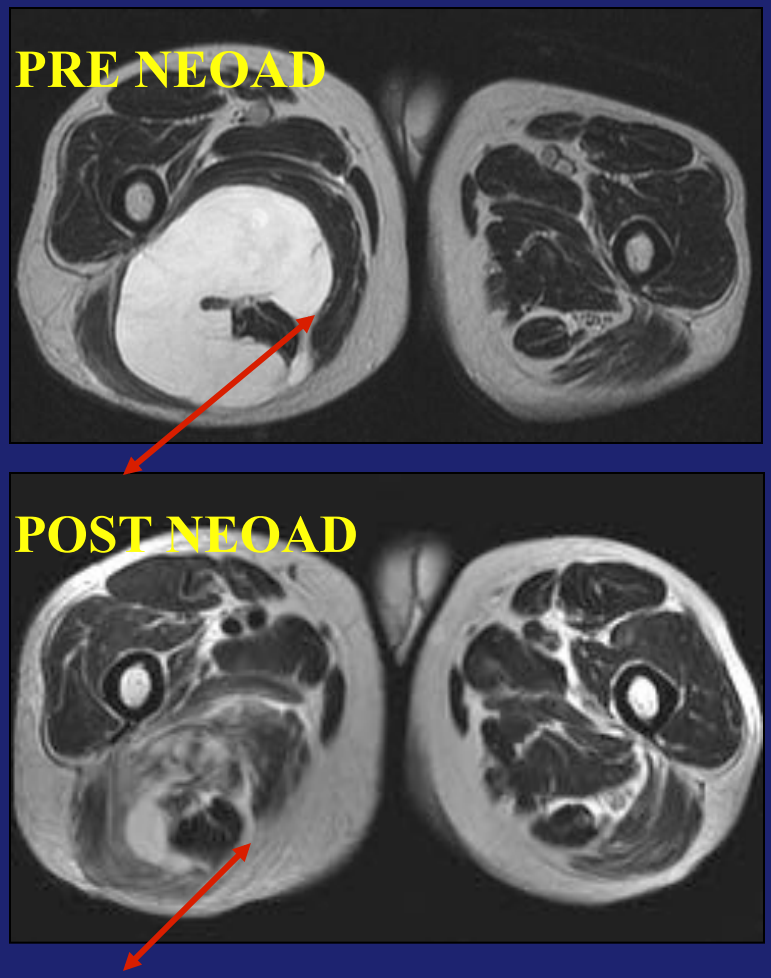
Molteplici strumenti: applicazione **Choi criteria** (valutazione quantitativa del contrast-enhancement in CT e MR)

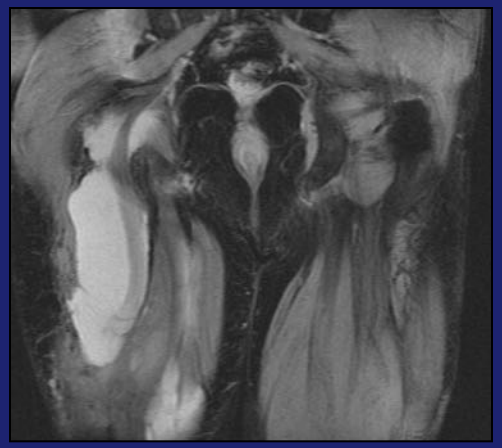
Tumor Response according to RECIST and Choi Criteria

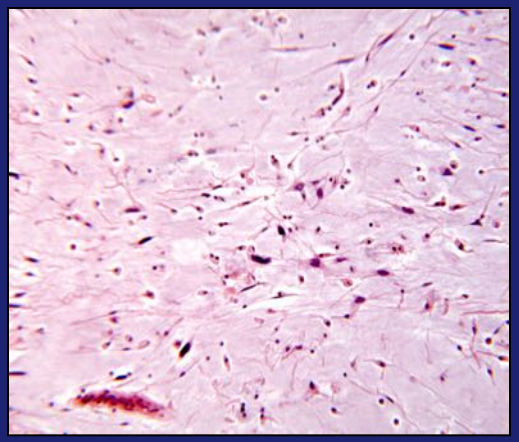
Response	RECIST Criteria	Choi Criteria
Complete response	Disappearance of all lesions	Disappearance of all lesions
	No new lesions	No new lesions
Partial response	≥30% decrease in the sum of greatest diameters	≥10% decrease in the greatest maximal diameter or a ≥15% decrease in tumor attenuation at CT or contrast enhancement at MR imaging
	No new lesions	No new lesions
Stable disease	Does not meet criteria for complete response, partial response, or progressive disease	Does not met criteria for complete response, partial response, or progressive disease
Progressive disease	≥20% increase in the sum of greatest diameters	≥10% increase in the greatest maximal diameter and does not meet criteria for partial response by using tumor attenuation at CT or contrast enhancement at MR imaging or ≥15% increase in tumor attenuation at CT or contrast enhancement at MR imaging and does not meet the criteria for partial response by using tumor size
	New lesion	New lesion
		New intratumoral nodule or increase in the size of existing intratumoral nodule

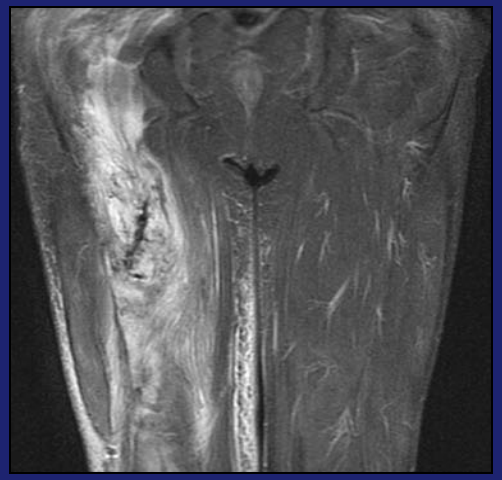
Radiology: Volume 251: Number 2—May 2009 • *radiology.rsnajnls.org* 449

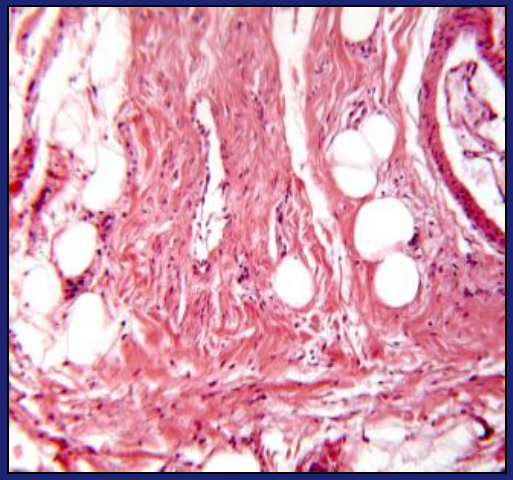
Stacchiotti S: High-Grade Soft-Tissue Sarcomas: Tumor Response Assessment-Pilot Study to Asses the Correlation between Radiologic and Pathologic Response by Using RECIST and Choi Criteria. **Radiology 251 (2): 447-456**











High-grade mixofibrosarcoma

Molteplici strumenti: imaging funzionale

in oncologia msk la maggior esperienza è sicuramente sull'osteosarcoma, ma vi sono alcuni lavori sui sarcomi delle parti molli

1. DCE MRI

Phase I Trial of the Antivascular Agent Combretastatin A4 Phosphate on a 5-Day Schedule to Patients With Cancer: Magnetic Resonance Imaging Evidence for Altered Tumor Blood Flow

By James P. Stevenson, Mark Rosen, Weijing Sun, Maryann Gallagher, Daniel G. Haller, David Vaughn, Bruce Giantonio, Ross Zimmer, William P. Petros, Michael Stratford, David Chaplin, Scott L. Young, Mitchell Schnall, and Peter J. O'Dwyer

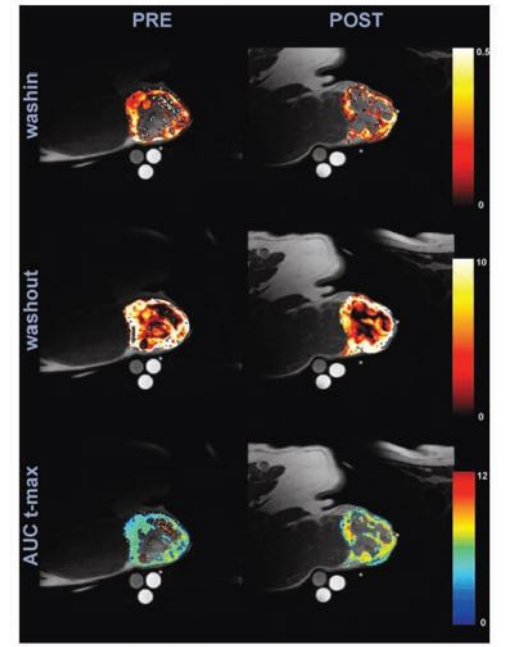
Journal of Clinical Oncology, Vol 21, No 23 (December 1), 2003: pp 4428-4438

9/37 pts sarcoma
Valutazione K^{tr}

Dynamic Contrast-enhanced Magnetic Resonance Imaging as a Predictor of Clinical Outcome in Canine Spontaneous Soft Tissue Sarcomas Treated with Thermoradiotherapy

Benjamin L. Viglianti,[1] Michael Lora-Michiels,[1] Jeanie M. Poulson,[1] Lan Lan,[2] Dahio Yu,[5] Linda Sanders,[2] Oana Craciunescu,[1] Zeljko Vujaskovic,[1] Donald E. Thrall,[4] James MacFall,[3] Cecil H. Charles,[3] Terence Wong,[3] and Mark W. Dewhirst[1]

Clin Cancer Res 2009;15(15) August 1, 2009



NEOPLASIA
www.neoplasia.com
Volume 11 Number 2 February 2009 pp. 102–125 102

Meeting Report

Diffusion-Weighted Magnetic Resonance Imaging as a Cancer Biomarker: Consensus and Recommendations

Anwar R. Padhani*, Guoying Liu†, Dow-Mu Koh‡, Thomas L. Chenevert§, Harriet C. Thoeny¶, Taro Takahara#, Andrew Dzik-Jurasz**, Brian D. Ross††, Marc Van Cauteren‡‡, David Collins§§, Dima A. Hammoud¶¶, Gordon J.S. Rustin##, Bachir Taouli***, and Peter L. Choyke†††

Molteplici strumenti: **imaging funzionale**

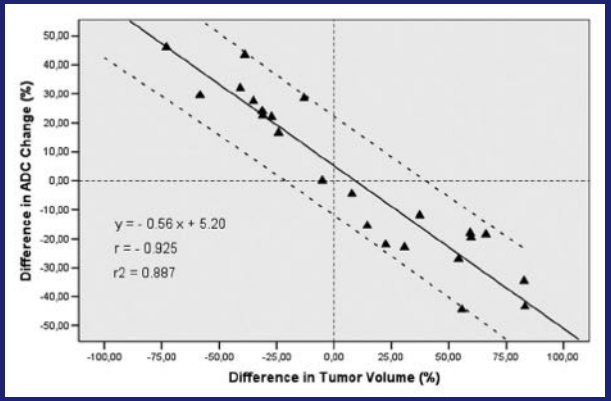
- 2) **DWI**: Diffusion-Weighted Imaging

Diffusion-Weighted Magnetic Resonance Imaging Allows Monitoring of Anticancer Treatment Effects in Patients With Soft-Tissue Sarcomas

Oliver Dudeck, MD,[1,2*] Martin Zeile, MD,[3] Daniel Pink, MD,[4] Maciej Pech, MD,[2] Per-Ulf Tunn, MD,[5] Peter Reichardt, MD,[4] Wolf-Dieter Ludwig, MD,[4] and Bernd Hamm, MD[1]

JOURNAL OF MAGNETIC RESONANCE IMAGING 27:1109–1113 (2008)

Conclusion: DWI can be used as a supplement to morphologic imaging for the evaluation of tumor response to anticancer therapy in patients with soft-tissue sarcomas. As cellular changes are expected to precede morphologic changes in treated tumors, DWI performed at an early stage of fractionated therapy may provide unique prognostic information of its effectiveness.



Apparent Diffusion Coefficient: rappresenta lo spazio percorso da una molecola di acqua nel suo moto stocastico nell'unità di tempo (mm^2/sec) in funzione del mezzo biologico non omogeneo e spesso anisotropo in cui le molecole di acqua diffondono

$$ADC = (lnS_0 - lnS) / b$$

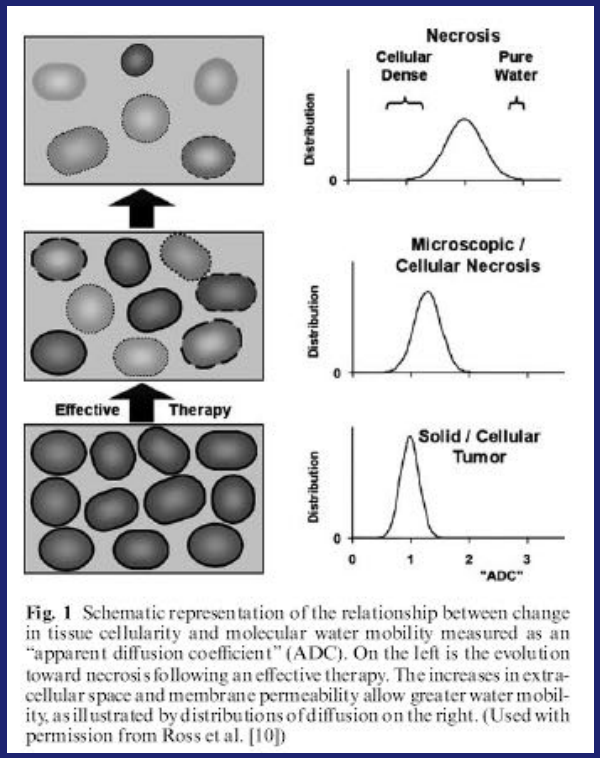


Fig. 1 Schematic representation of the relationship between change in tissue cellularity and molecular water mobility measured as an "apparent diffusion coefficient" (ADC). On the left is the evolution toward necrosis following an effective therapy. The increases in extracellular space and membrane permeability allow greater water mobility, as illustrated by distributions of diffusion on the right. (Used with permission from Ross et al. [10])

B. A. Moffat
D. E. Hall
J. Stojanovska
P. J. McConville
J. B. Moody
T. L. Chenevert
A. Rehemtulla
B. D. Ross

Diffusion imaging for evaluation of tumor therapies in preclinical animal models

MAGMA (2004) 17: 249–259

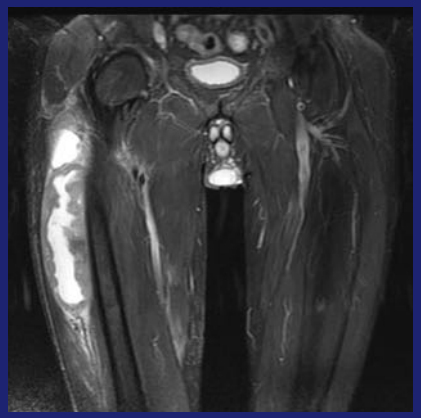
Terapia → Necrosi Tumorale

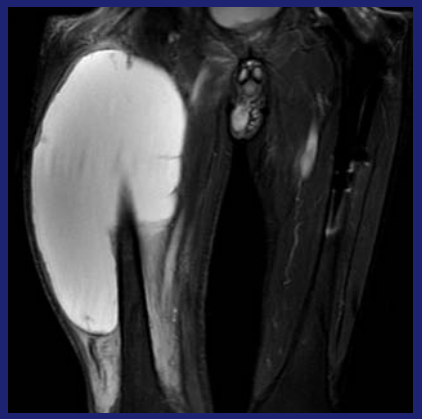
↑ ADC

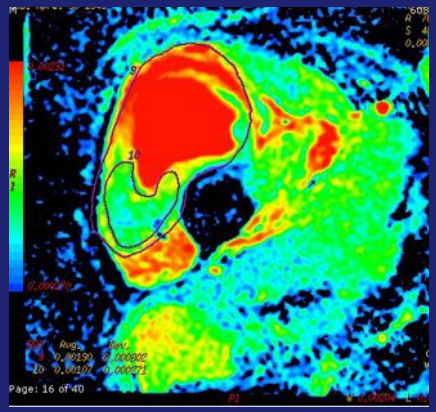
↑ Permeabilità parete cellulare

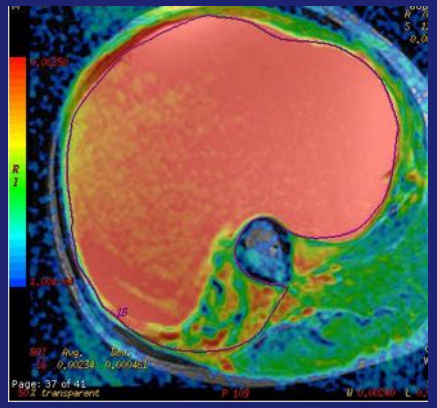
↓ Cellularità

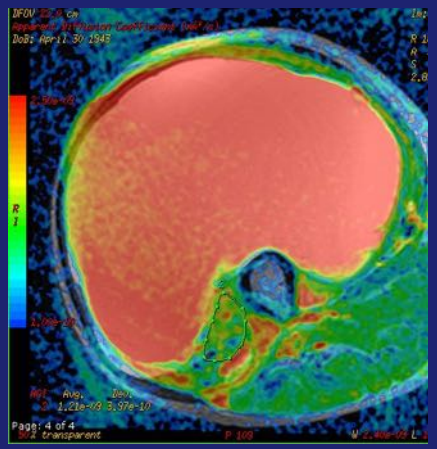
↑ Spazi intercellulari
Acqua spazi intercellulari











Leiomiosarcoma G3:
estesa necrosi
colliquativa post-CTC
(intervallo tra RM 161 gg)
(da 175 mm a 295 mm diam. max)

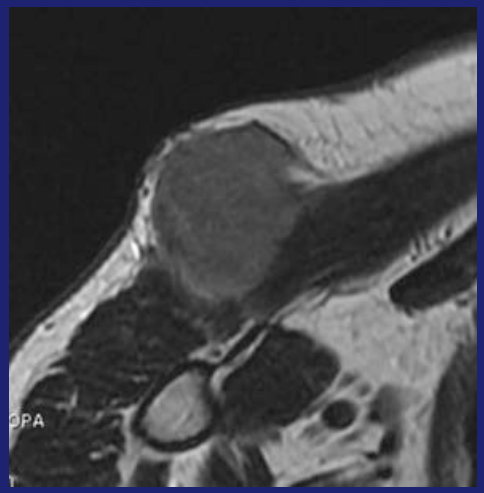
ADC medio "globale:

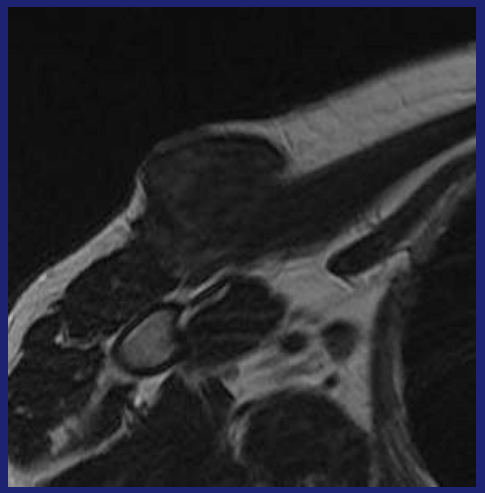
2,00E-03 mm/sec^2
2,36E-03 mm/sec^2

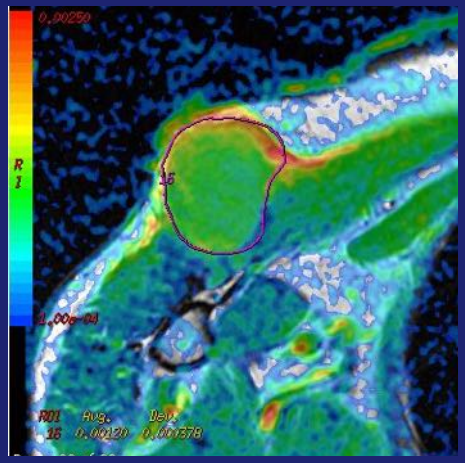
ADC medio "a campione":

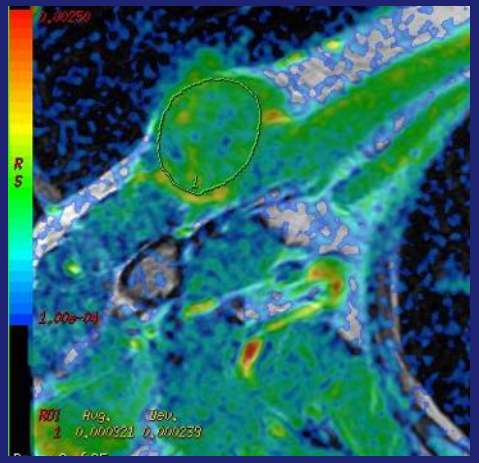
1,04E-03 mm/sec^2
1,21E-03 mm/sec^2

Come interpretare l'aumento dimensionale?
Causato dalla necrosi tumorale
indice di buona risposta?









CASI DUBBI

Sarcoma dedifferenziato (IFM)

Diminuzione dimensionale

Involuzione fibrotica,

Scarsa necrosi colliquativa

(intervallo 85 gg)

(da 57 a 53)

ADC medio "globale"

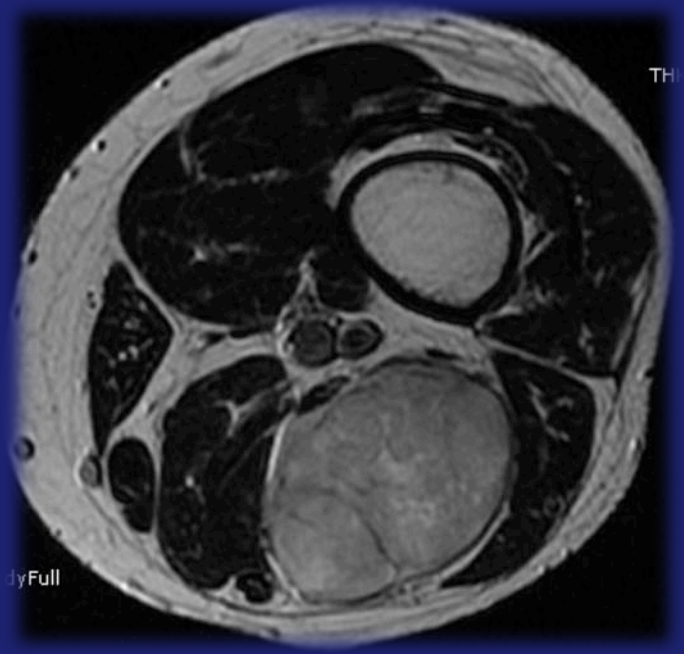
1,00E-03 → 9,21E-04

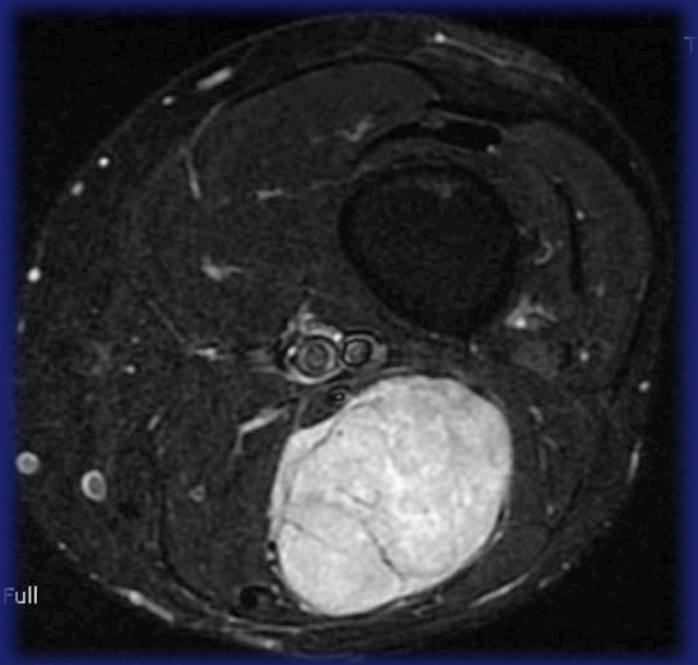
ADC medio "a campione"

1,41E-03 → 1,00E-03

- **Paziente M 38 anni,**
- **Tumefazione coscia sn**
- **Asintomatico**

RM basale

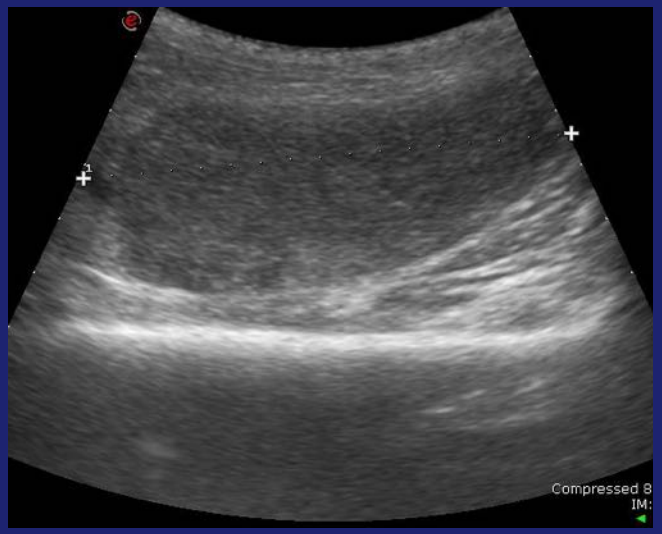


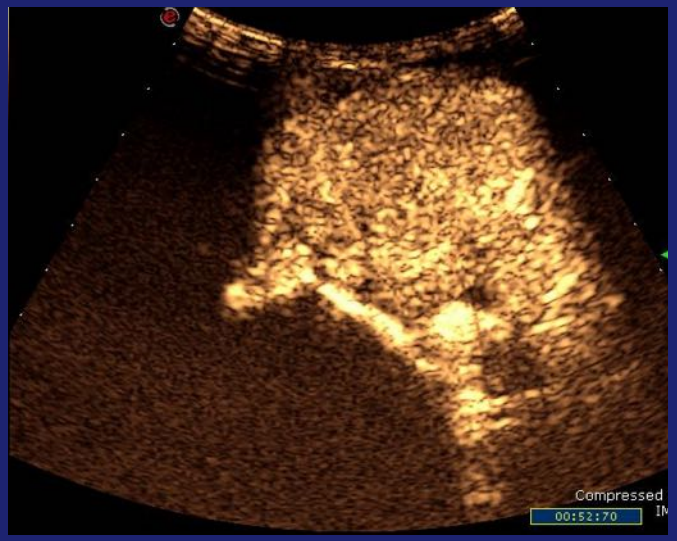


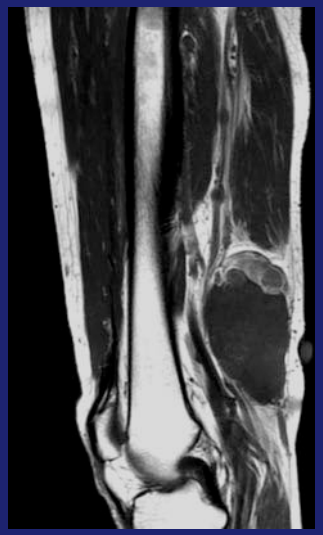
- ax FR FSE T2:
Iperintensa con
aspetto “ zolle”

- ax STIR
Nettamente iperintensa

In corrispondenza della
biforcazione tra nervo tibiale e
nervo peroneo comune



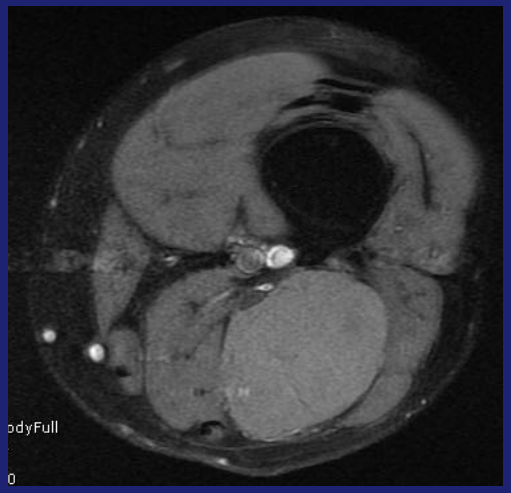


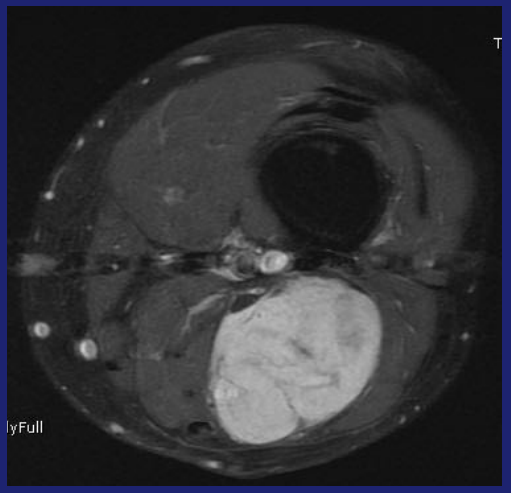


CEUS: dopo mdc ev a 24 sec
si evidenziano vasi che dalla
periferia si portano verso il centro
con distribuzione a carattere
reticolare

- sag FR FSE T1 senza e con mdc:
  Netto contrast-enhancement

- ax FSE fat sat T1 senza e con mdc
  Netto contrast-enhancement



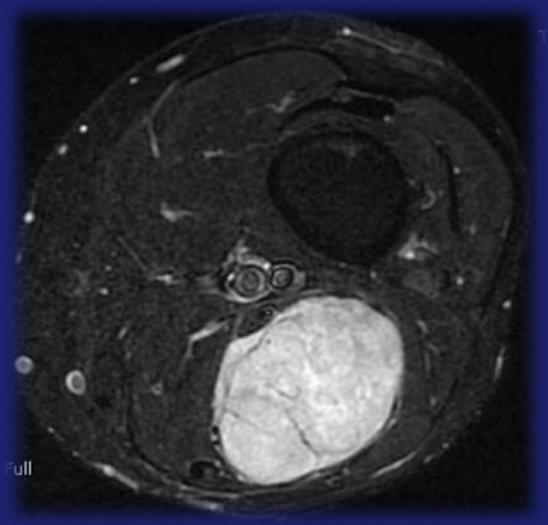


- E’ possibile ipotizzare la linea cui appartiene la massa?

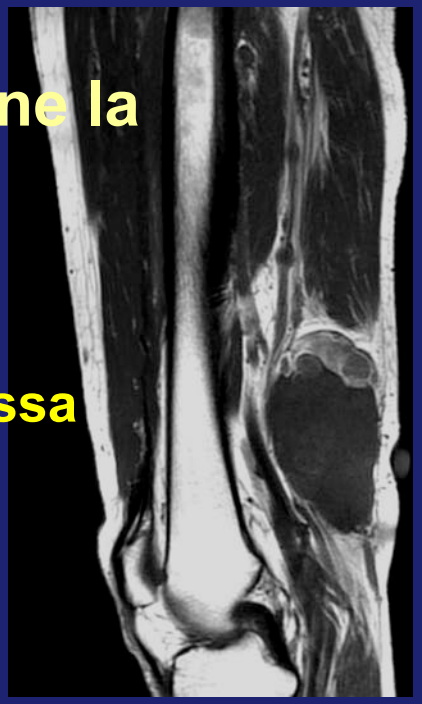
a. sì, è un tumore a matrice mixoide
b. sì, è tumore delle guaine nervose
c. no

- **E’ possibile ipotizzare la linea cui appartiene la massa?**

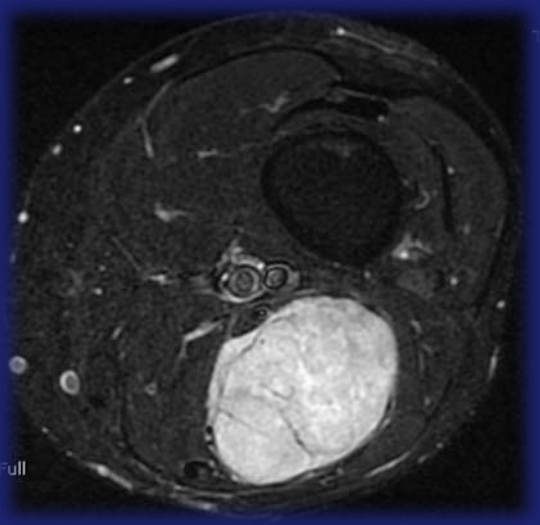
a. sì, può essere un tumore a matrice mixoide, il nervo tibiale non fuoriesce dai poli della massa

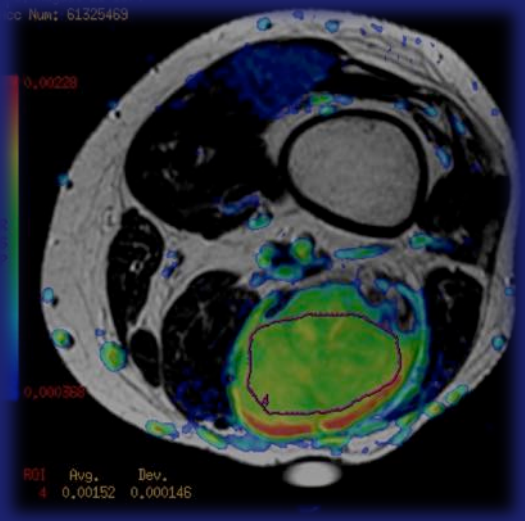


- **E’ possibile ipotizzare la linea cui appartiene la massa?**



- **sì, può essere un tumore a matrice mixoide, il nervo tibiale non fuoriesce dai poli della massa**





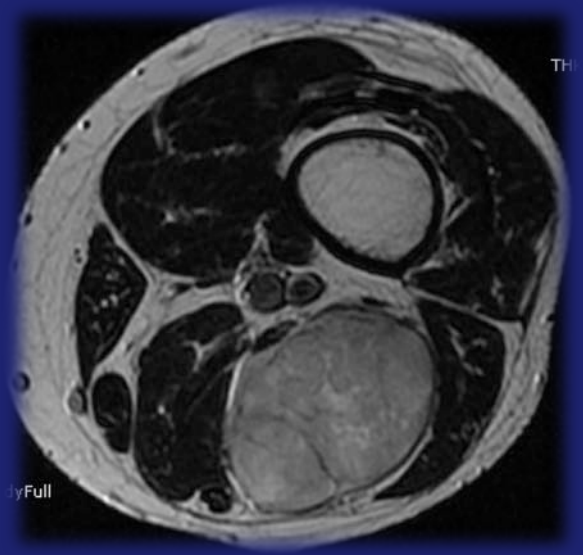
- DWI b 900 mm^2/sec
lesione disomogenea
ADC intermedio
(1,52 sec/mm^2)

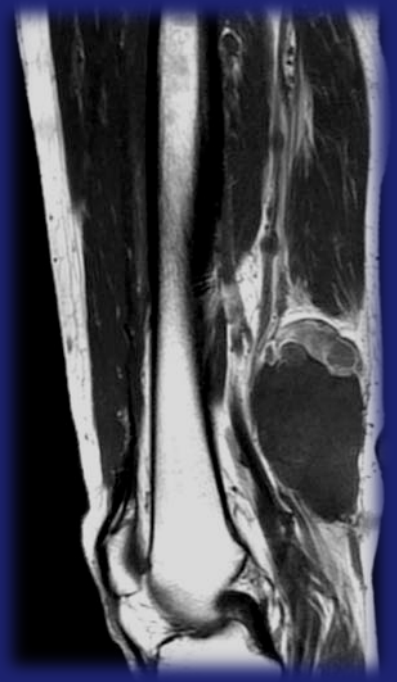
Esame istologico core-needle

Liposarcoma mixoide G3.

G3. maggior cellularità, matrice mixoide meno estesa: valori di ADC inferiori

- Intracompartimentale?
- Extracompartimentale?



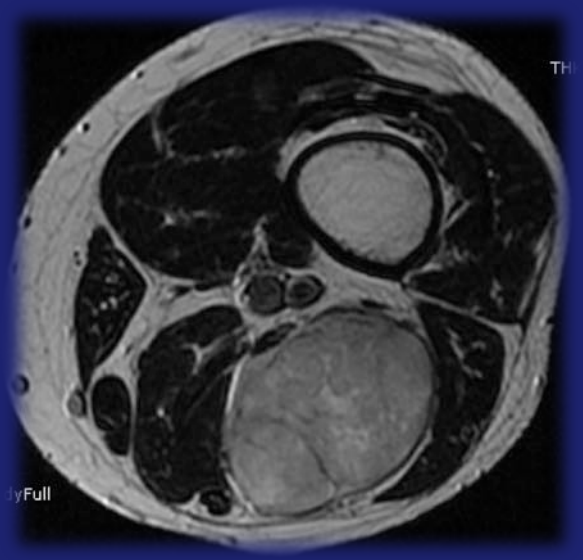


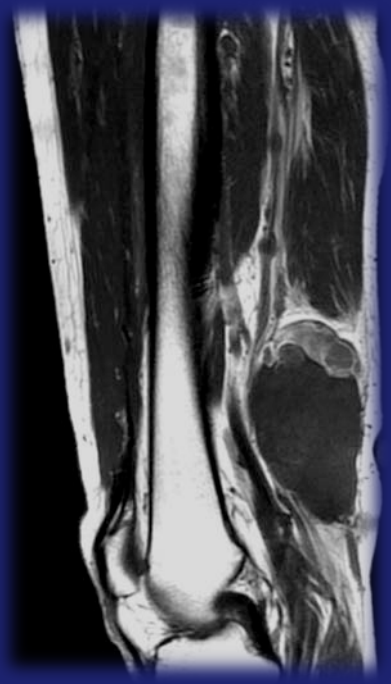
Esame istologico core-needle

Liposarcoma mixoide G3.

G3. maggior cellularità, matrice mixoide meno estesa: valori di ADC inferiori

- Cavo popliteo, intimo contatto con i rami nervosi: Extracompartimentale





- CTC neo adiuvante: netta riduzione dimensionale

Resezione con epinevrectomia

“THE DIAGNOSTIC OF SOFT TISSUE SARCOMAS IMPLIES PRIMARILY A MULTISCIPLINARY APPROACH FOR A STAGE ASSOCIATED THERAPY”…….

Tunn PU, Gebauer B., Fritzmann J., e al.

Chir.2004

" TAKE-HOME" MESSAGE

- X-ray is always necessary
- US is often the first step, but with color-power Doppler (c.m.)
- MR is the gold standard (c.m.,dynamic,diffusion…..)
- CT with c.m. for the presurgical planning

THANK YOU