MRI of malignant testicular lesions

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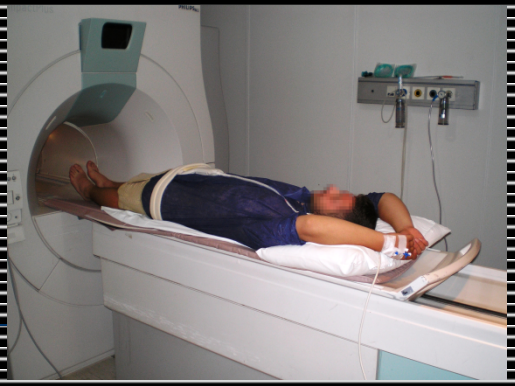
MRI of the scrotum



- a worthwhile **second-line imaging diagnostic tool** for testicular pathology
- **reduce the incidence of unnecessary surgical explorations** by better lesion characterization
  - ✓ simultaneous imaging of both testes, paratesticular spaces, and spermatic cords
  - ✓ high contrast and spatial resolution
  - ✓ adequate tissue characterization
  - ✓ absence of radiation exposure
  - ✓ **functional information**

DCE MRI

DWI

DTI

MTI

SPECTROSCOPY

MRI of the scrotum is mainly recommended

- characterization of testicular lesions **(primary)**
- local staging of TGCTs **(primary)**
- characterization of the histological type of TGCTs **(in selected cases)**
- differentiation between TGCTs and non-germ cell neoplasms **(evolving)**

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MRI of the scrotum: Recommendations of the ESUR Scrotal and Penile Imaging Working Group

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Intratesticular masses: Benign vs malignant

- **in patients with equivocal US findings, MRI is recommended as a second-line technique for characterization of intratesticular masses (Grade C)**

  - ✓ **confident characterization of the benign nature of intratesticular masses**

  - ✓ **MRI may provide important information in the preoperative characterization of the histological nature of various benign intratesticular mass lesions** in terms of morphological information and by showing the presence of fat, fluid, haemorrhage, fibrous tissue and solid contrast-enhancing tissue **(LE2)**

Intratesticular masses: Benign vs malignant

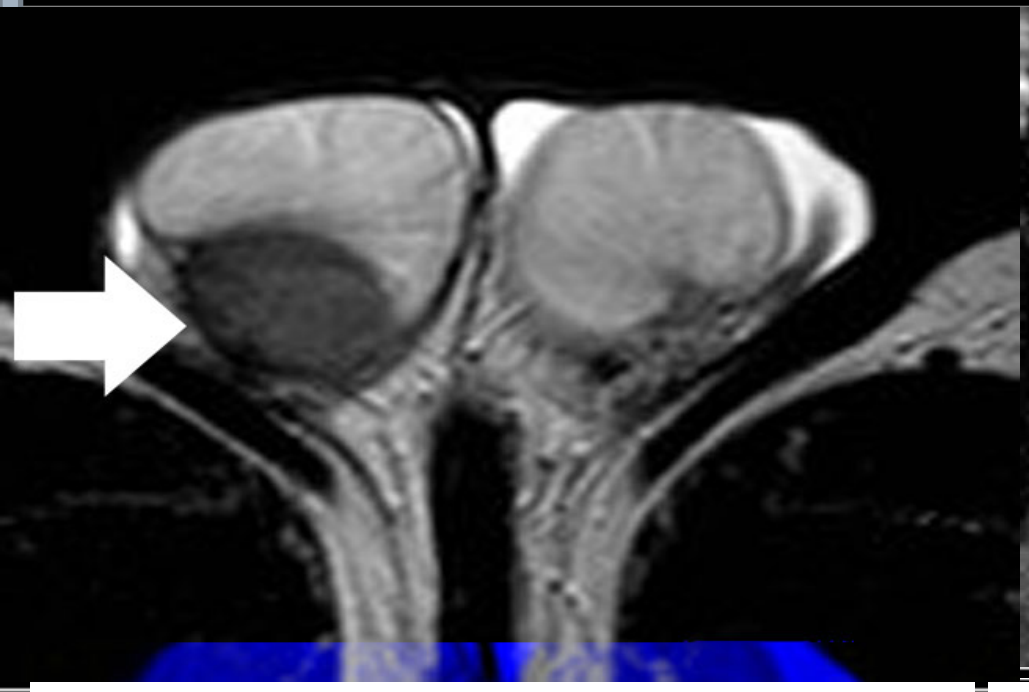
- decrease the number of unnecessary radical surgical procedures

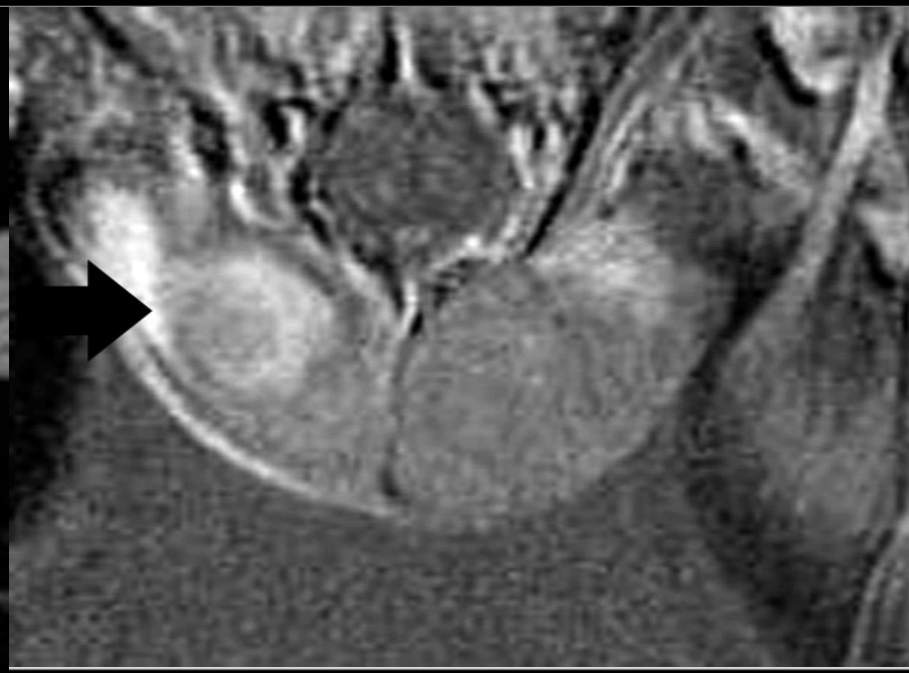
- mainly as a problem-solving tool when US findings are equivocal **(LE4)**

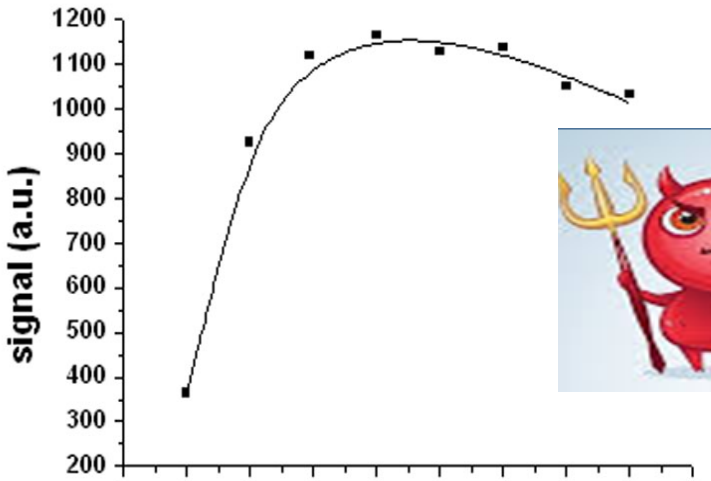
Typical MRI findings of TGCTs

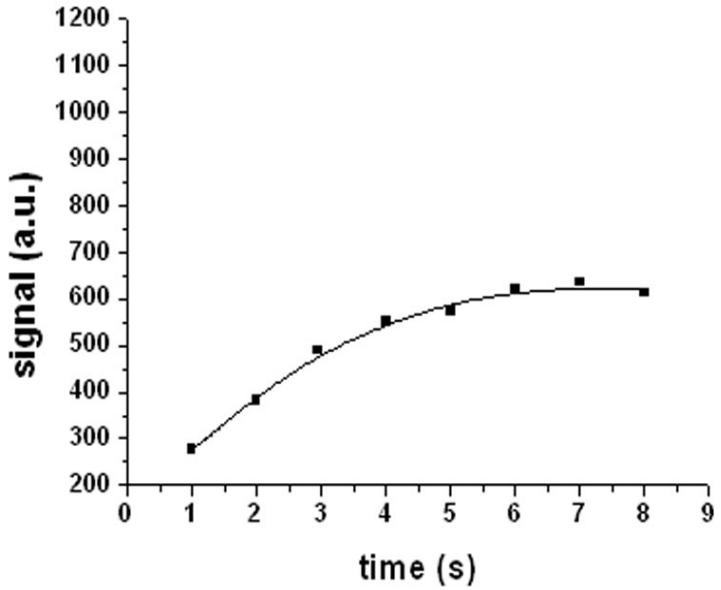
Primary	Secondary
mainly isointense on T1WI	areas of hemorrhage and/or necrosis
low or heterogeneous T2 signal	invasion of the testicular tunicae
restricted diffusion, low ADC	extension to the paratesticular space and/or the spermatic cord
heterogeneous contrast enhancement	
type III TSI curve	

Testicular seminoma

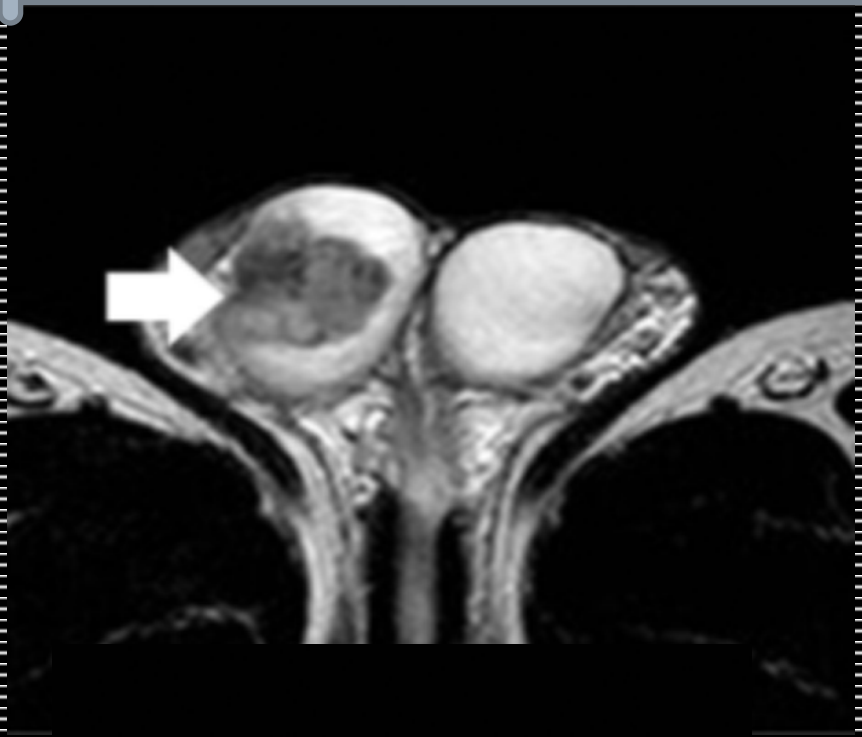


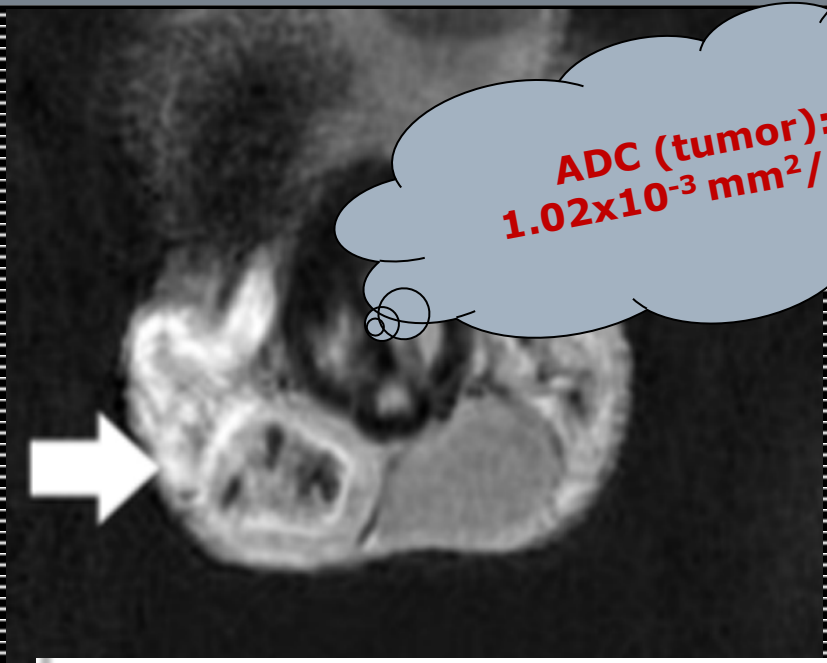




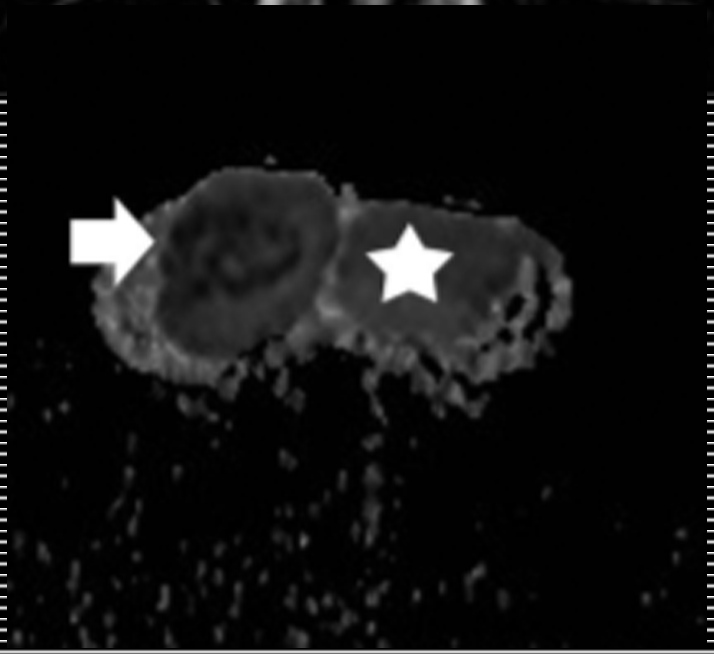


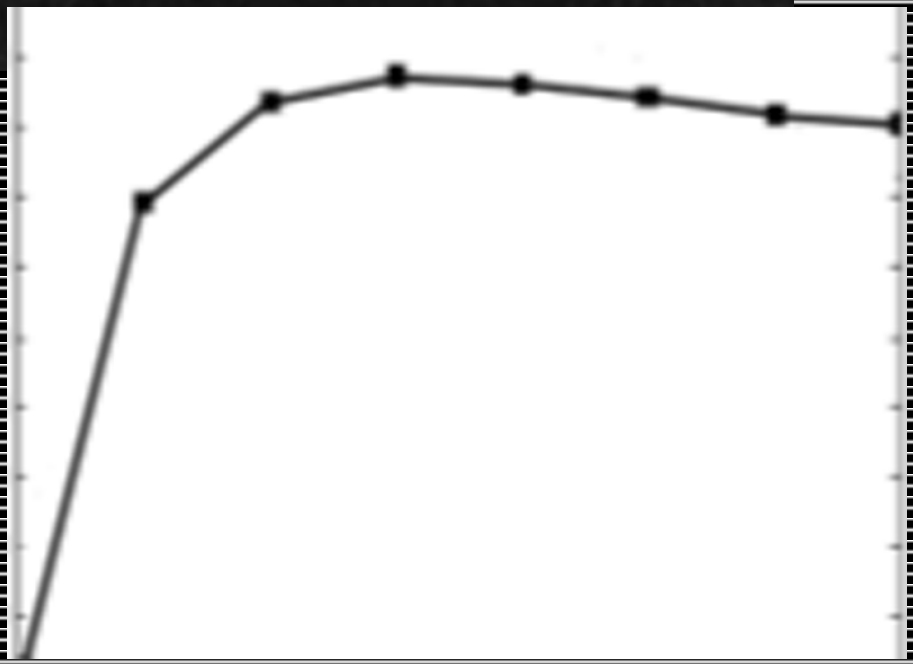
Embryonal carcinoma





ADC (tumor):
$1.02 \times 10^{-3}\ mm^2/s^{-1}$





Local staging of TGCTs

- **MRI is recommended for local staging of TGCTs (Grade C)**

Local staging of TGCTs: when to perform MRI

- **In patients who are candidates for organ-sparing surgery**
- although organ-sparing surgery is not indicated in the presence of non-tumoural contralateral testis, it can be **attempted in special cases with all the necessary precautions**
  - ✓ synchronous bilateral testicular tumours
  - ✓ metachronous contralateral tumours
  - ✓ tumour in a solitary testis, normal pre-operative testosterone levels
  - ✓ tumour volume < 30% of TV
  - ✓ small US-detected, nonpalpable intratesticular lesion; **the incidence of benign definitive histology is high: 80%**
  - ✓ patients with symptoms of gynaecomastia or hormonal disorders

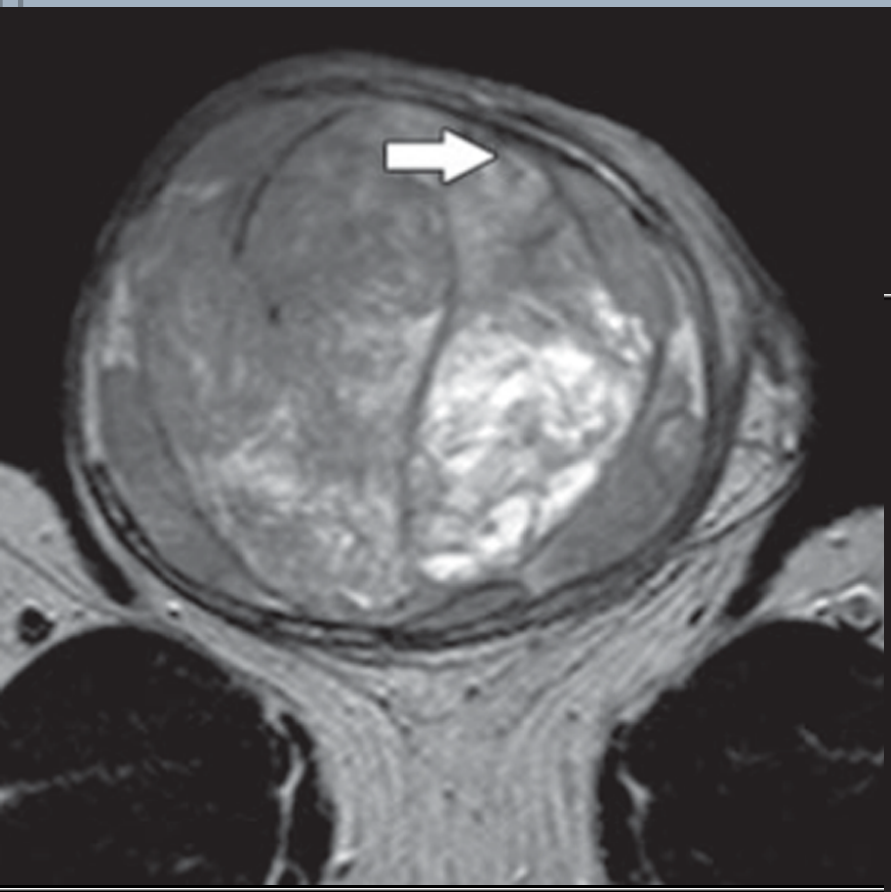
EAU guidelines 2016

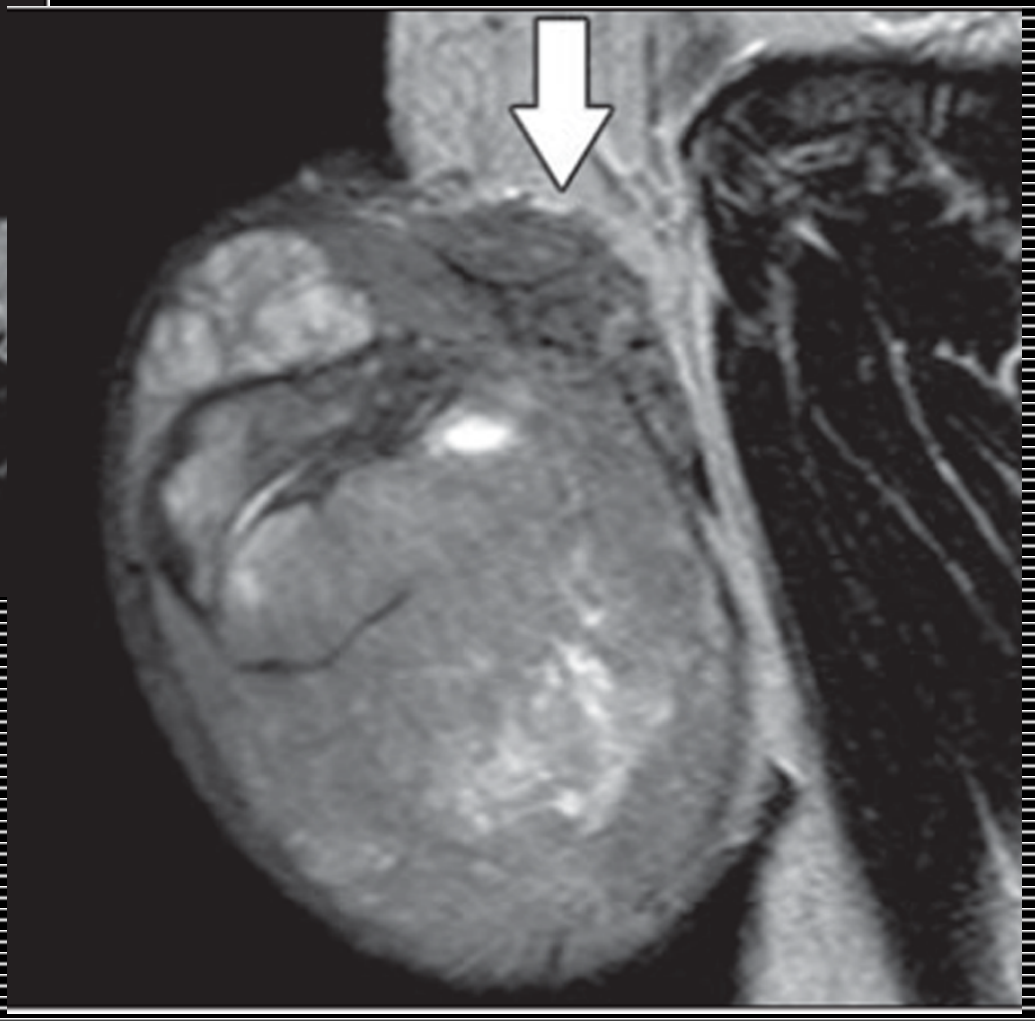
Local staging of TGCTs: MRI information

- preoperative evaluation of the local stage T
- tumour dimensions
- possible invasion of rete testis, paratesticular space and/or spermatic cord
- presence of a pseudocapsule **(LE4)**

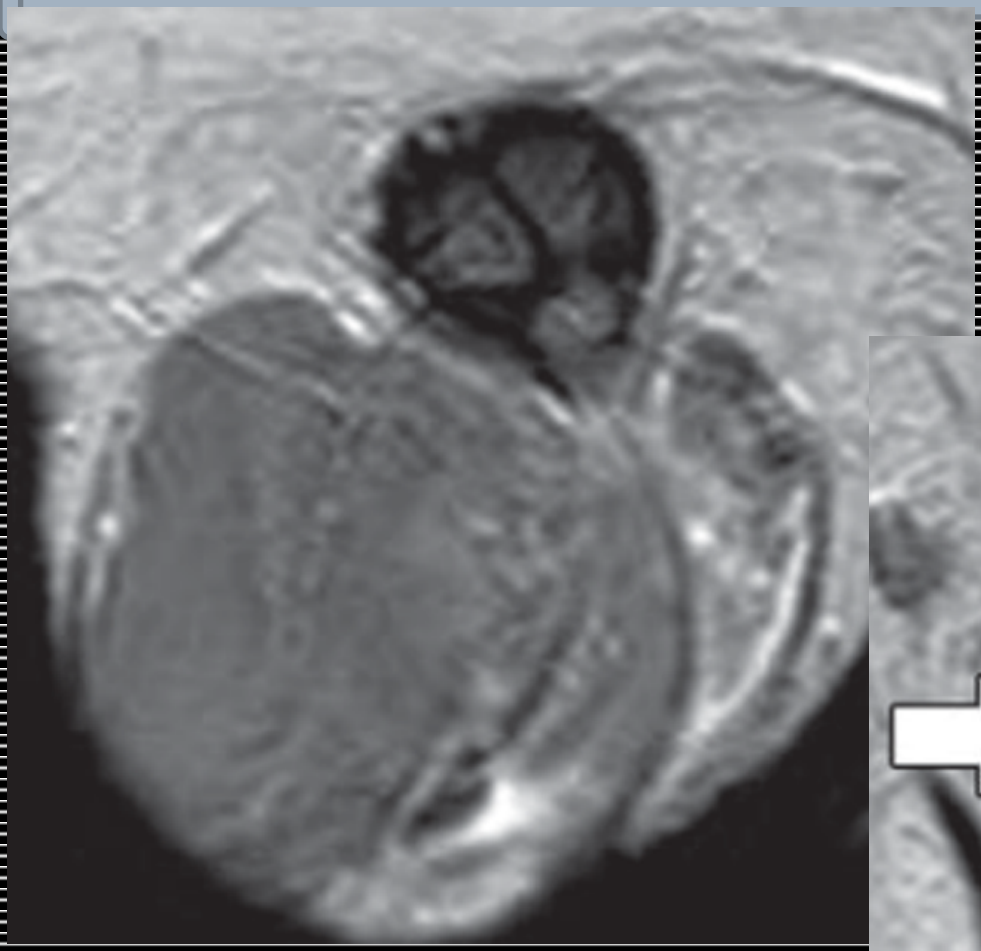
- include DWI in all three planes

Nonseminomatous germ cell neoplasm, pT2





Seminoma, pT3



Characterization of the histologic type of TGCTs

- **MRI is recommended to differentiate seminomas from nonseminomatous testicular neoplasms in selected cases (Grade C)**

  - ✓ in cases of disseminated disease and/or life-threatening metastases: chemotherapy is the first treatment

EAU guidelines 2016

Characterization of the histologic type of TGCTs

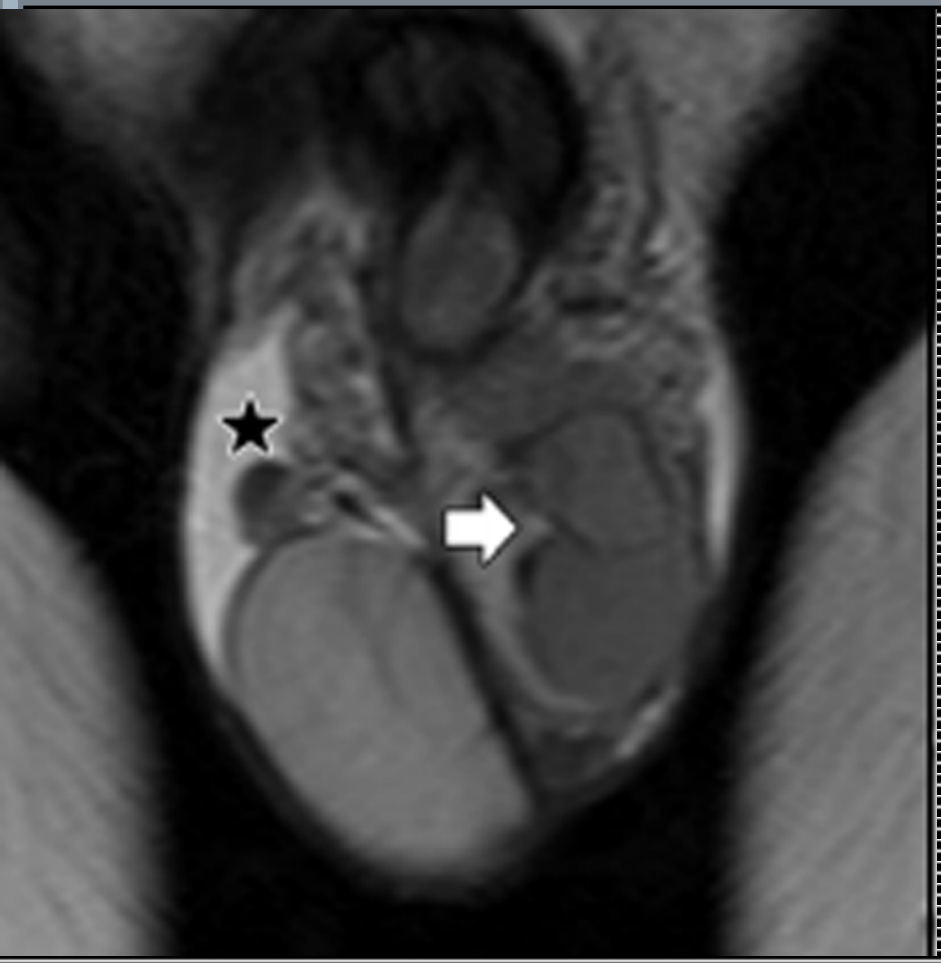
- **conventional MRI features:** closely correlate with the histopathologic characteristics of TGCTs **(LE4)**
- **ADC:** additional tool **(LE4)**

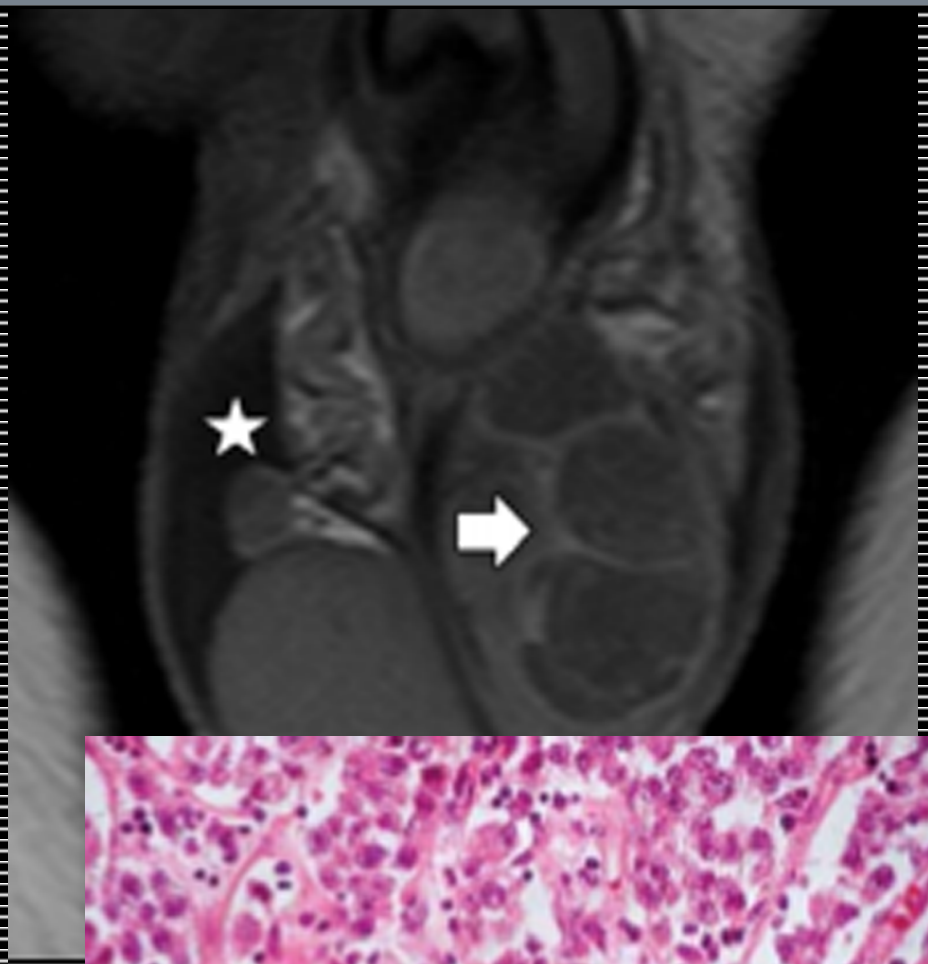
Johnson et al. 1990, Cramer et al. 1991, Tsili et al. 2007, Kim et al. 2007, Cassidy et al. 2014, Tsili et al. 2015

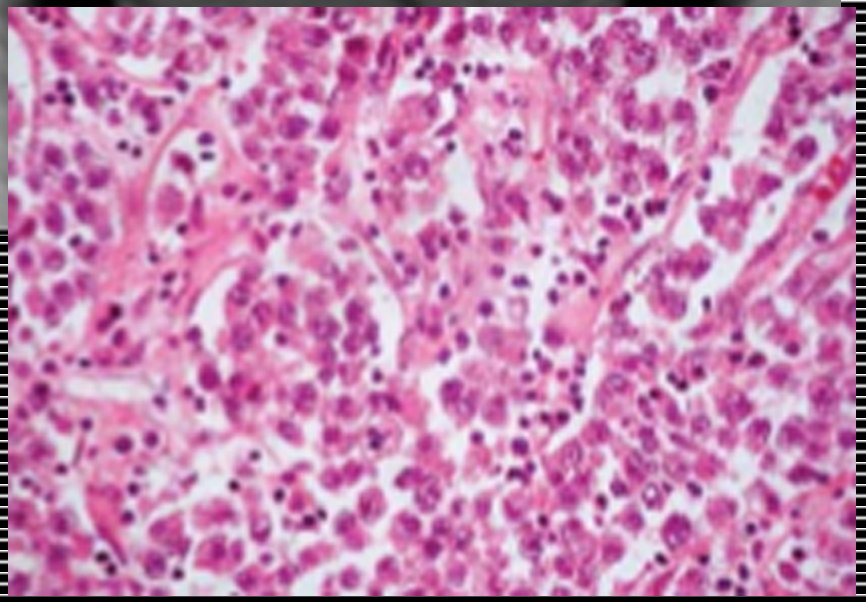
MRI features suggestive of seminoma

- ✓ multinodular
- ✓ mainly isointense on T1WI
- ✓ relatively homogenous and hypointense on T2WI
- ✓ bandlike structures of low T2 signal (fibrovascular septa)
- ✓ septa enhancing more than the remaining tumor
- ✓ lower ADC, compared to nonseminomas

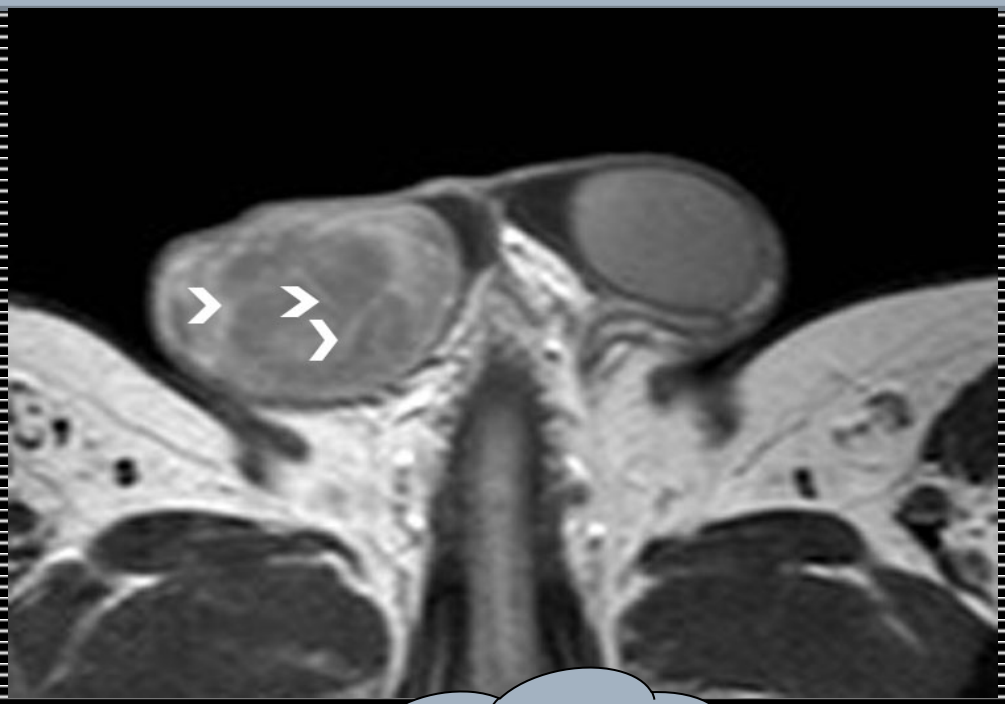
Testicular seminoma







Testicular seminoma

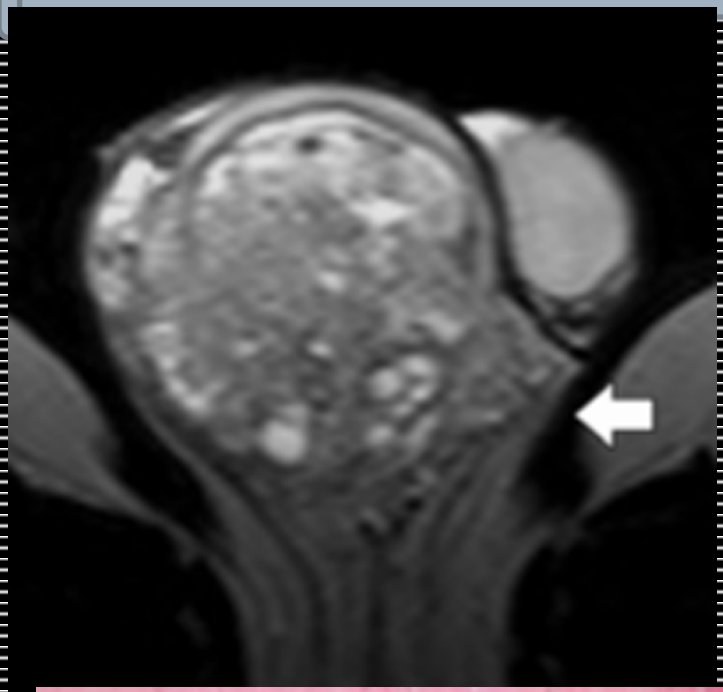


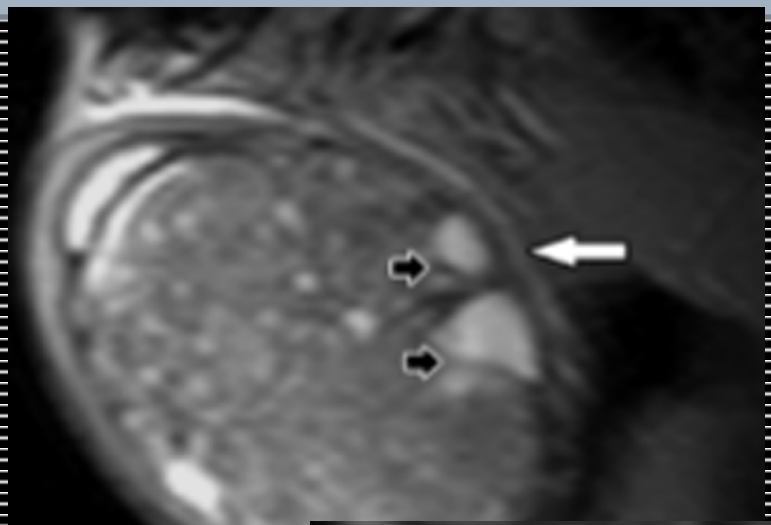
ADC (tumor):
0.52×10^{-3} mm^2/s^{-1}

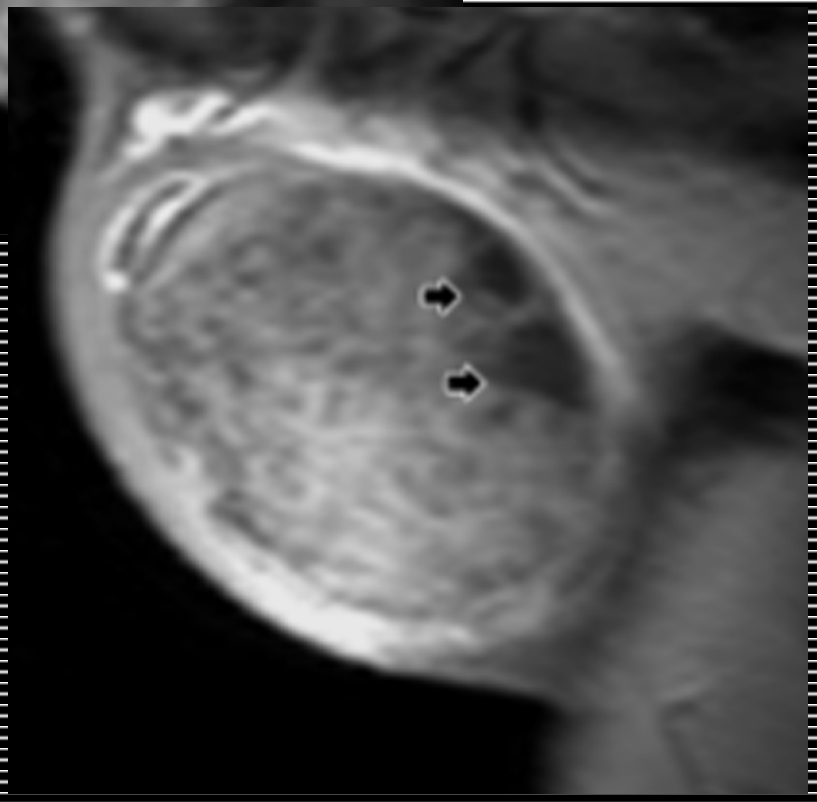
MRI features suggestive of nonseminoma

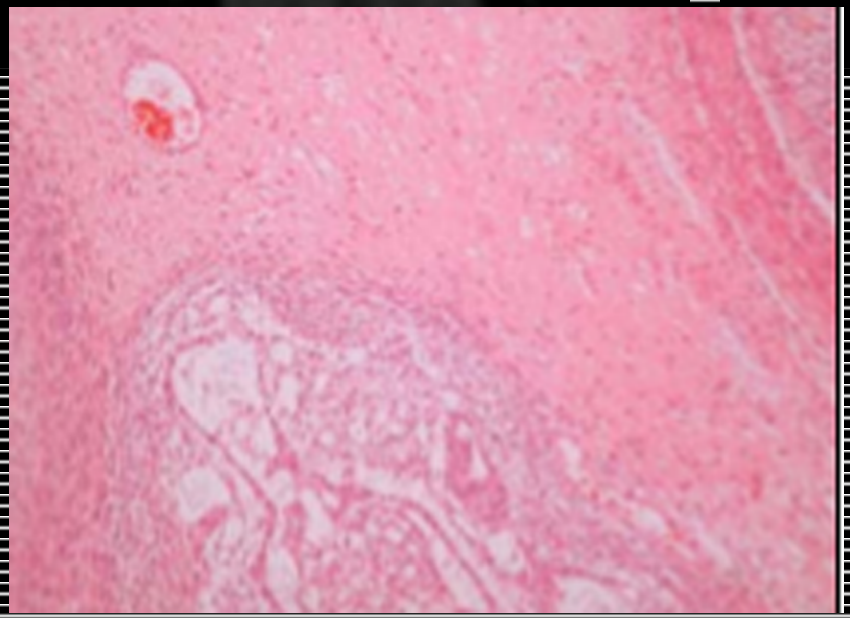
- often surrounded by a low signal intensity halo (fibrous capsule)
- heterogeneous on T1WI
- markedly heterogeneous on T2WI
- heterogeneous enhancement
- (areas of necrosis and/or haemorrhage)

Teratocarcinoma









Differentiating between TGCTs and non-germ cell neoplasms

- Increase of incidentally discovered nonpalpable small testicular tumors
- up up to **80% are benign**
- **Leydig cell tumors (LCTs)**: most frequent
- organ-sparing surgery may be recommended

Differentiating between TGCTs and non-germ cell neoplasms

- MRI may help in the characterization of LCTs (Grade B)

Differentiating between TGCTs and non-germ cell neoplasms

- **MRI features suggestive of LCT**
  - ✓ well-defined margins
  - ✓ markedly hypointense on T2WI
  - ✓ homogeneous contrast enhancement
  - ✓ rapid, marked wash-in
  - ✓ prolonged wash-out
- **MRI features suggestive of seminoma**
  - ✓ blurred margins
  - ✓ weak hypointense T2 signal
  - ✓ weak hyperintense T1 signal
  - ✓ weak, progressive wash-in
  - ✓ absent wash-out
- overall diagnostic accuracy: 93 %

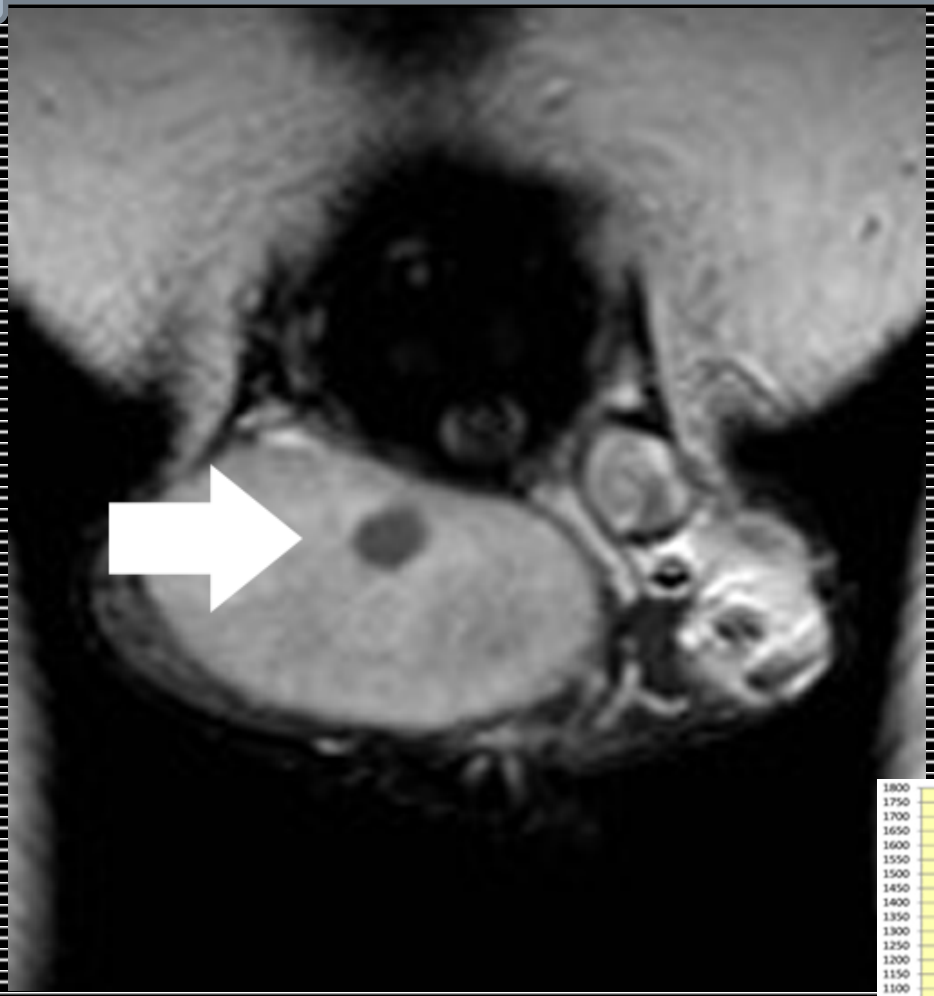
Mangarano et al, Eur Radiol 2015

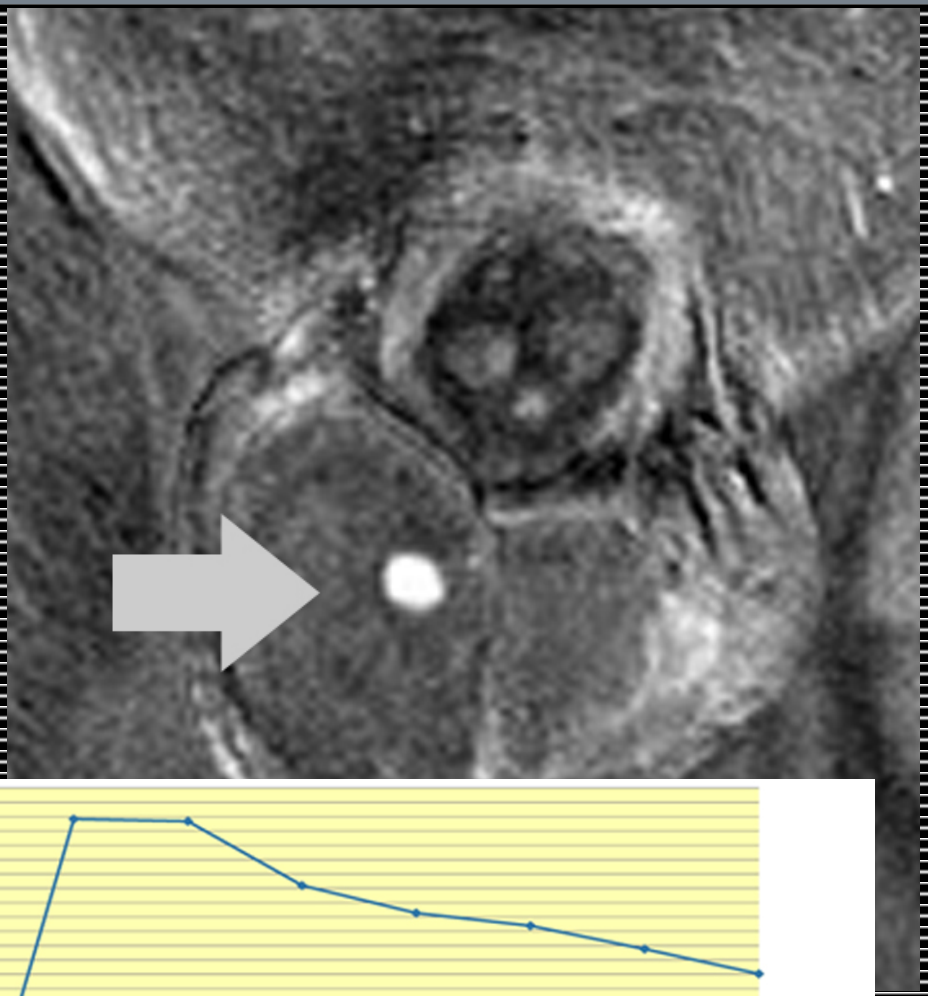
Differentiating between TGCTs and non-germ cell neoplasms

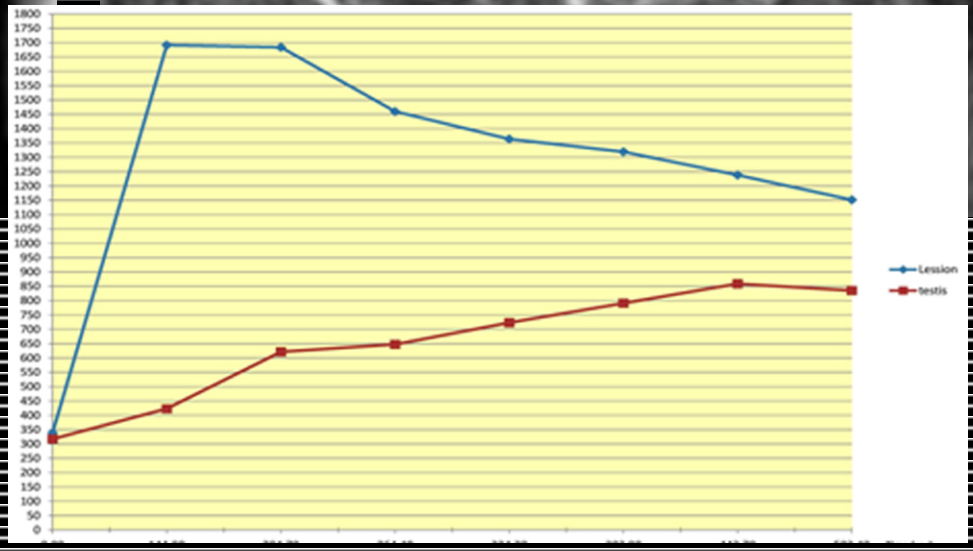
- **DCE-MRI features**
  - ✓ percentage of peak enhancement (Epeak), wash in rate (WIR), volume transfer constant (Ktrans), rate constant (Kep), initial area under the curve (IAUC): higher, and
  - ✓ time to peak (TTP) shorter in TGCTs compared to seminomas
  - ✓ cutoff values for identification of seminomas: Ktrans ≤0.135 min^{-1}, Kep ≤0.45 min^{-1}, IAUC ≤10.96, WIR ≤1.11, Epeak ≤96.72, TTP >99 s

Mangarano et al, Eur Radiol 2018

Leydig cell tumor







Diffusion-weighted imaging (DWI)

- **included in routine MRI protocol (Grade B)**

- axial images, echo planar diffusion pulse sequence, at least three different *b* values: 0, 400–500 and 800–1,000 s/mm²

- **normal adult testis**

✓ restricted diffusion (histologic complexity of normal testicular parenchyma)

✓ **ADC:** $1.08–1.31 \times 10^{-3}$ mm^2/s, increasing with age

DWI

- **improvement in the characterization of intratesticular lesions with the addition of DWI (LE2)**
  - ✓ conventional MRI: 91%
  - ✓ DWI: 87%
  - ✓ conventional + DWI: **100%**

- ADC of TGCTs <normal testis and various benign testicular lesions

Tsili et al, Asian J Androl 2012

- cut-off ADC <0.99
  - ✓ sensitivity: 93.3%
  - ✓ specificity: 98%

Algebally et al, Pol J Radiol 2015

DWI

- lower ADC for seminomas compared to nonseminomas

- cut-off ADC <0.68
  - ✓ sensitivity: 63.6%
  - ✓ specificity: 80%

Tsili et al, Eur J Radiol 2015

Dynamic Contrast-Enhanced (DCE) MRI

- **Subtracted DCE-MRI is recommended in the evaluation of scrotal diseases (Grade B)**

  - ✓ when further tissue of intratesticular lesions is needed **(LE2)**

- series of coronal 3D FTE sequences, obtained after gadolinium administration, 5–7 consecutive imaging sets, up to 8 min

- **normal adult testis**
  - ✓ moderate, homogeneous enhancement, type I curve

DCE-MRI

- ✓ types of contrast enhancement patterns: **differentiation of testicular lesions**
  - **type I:** gradual linear increase of enhancement throughout the examination → normal testis
  - **type II:** brisk upstroke enhancement, followed by either a plateau or a slight further increase in enhancement → benign lesions
  - **type III:** brisk enhancement, followed by gradual washout of the contrast medium → malignancies
  - **type C**
  - relativ
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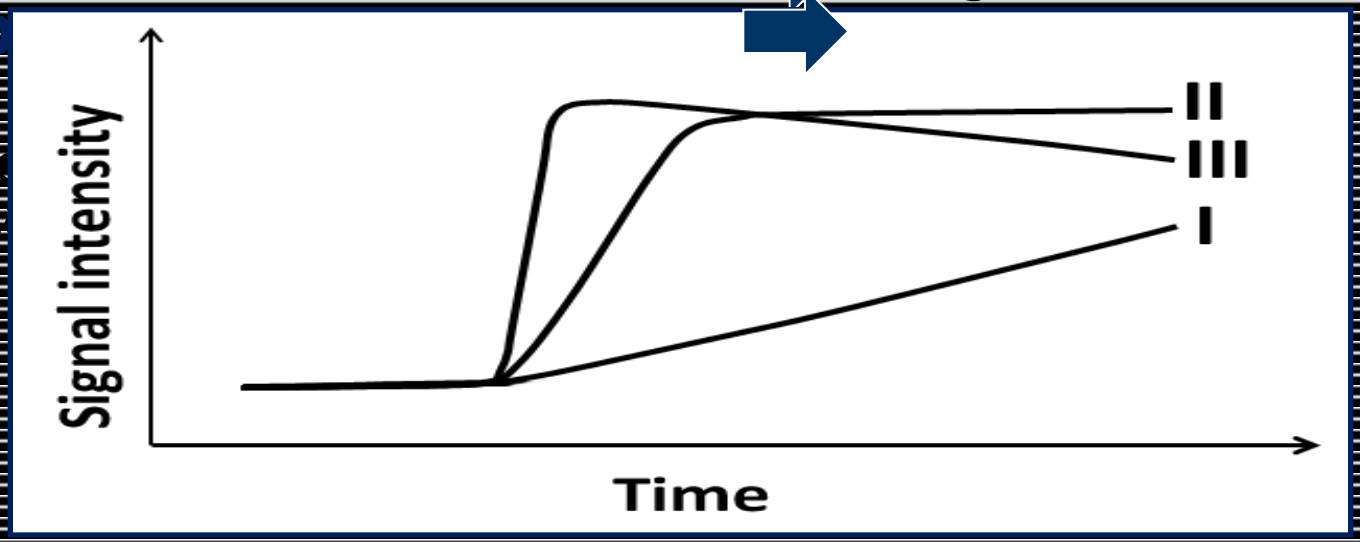


Diffusion tensor imaging (DTI)

- DTI was developed on the basis of DWI to demonstrate the direction and speed of water molecule diffusion
- structural integrity and microstructural changes
- **ADC, FA (fractional anisotropy)**

DTI

- **normal adult testis**
  - ✓ structured organ, with seminiferous tubules, septa and vessels radiating towards the mediastinum
- isotropic diffusion pattern (1.5 T, *b*= 0 and 400 s/mm²)
- **ADC:** 1.15 +- 0.16 x 10-3 mm/s
- **FA:** 0.11

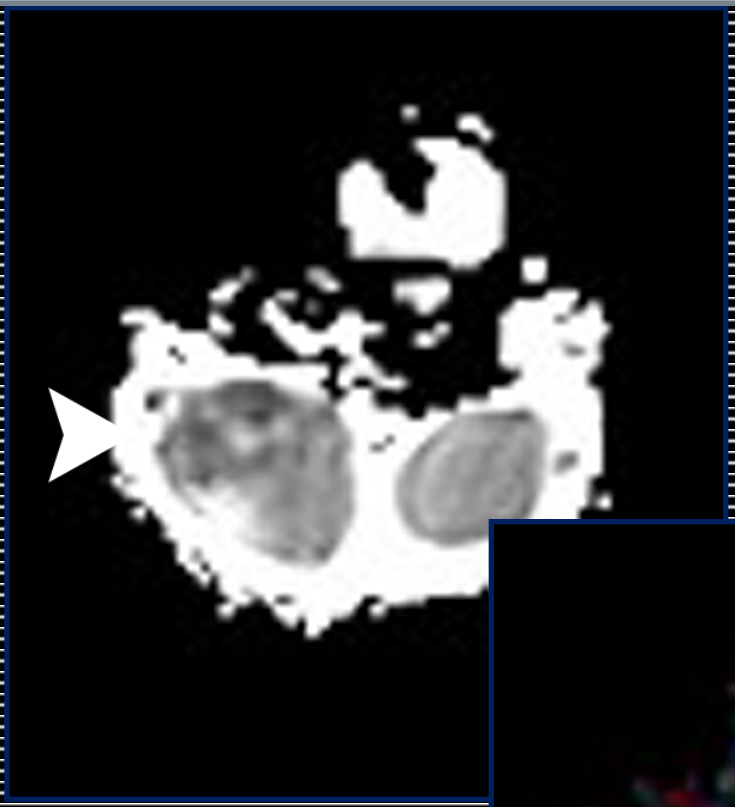
Tsili et al, Eur J Radiol 2017

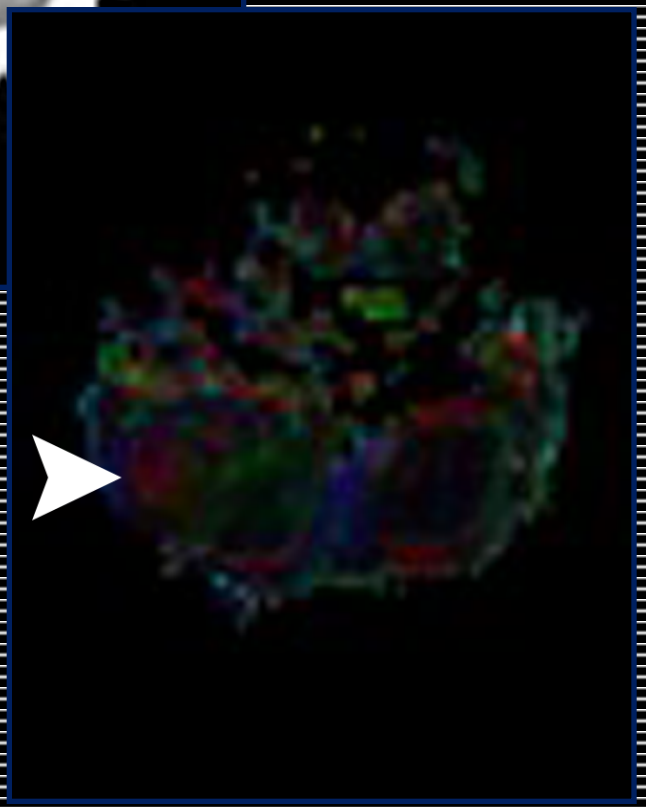
DTI

- both ADC and FA significantly differ between testicular lesions and normal testis
- **testicular malignancies have low ADC and high FA values**
- although FA did not show an incremental diagnostic value compared to ADC in differentiating malignant from benign testicular lesions

Tsili et al, Eur J Radiol 2017

Testicular seminoma





Tumor
ADC O.70/ FA O.20

Magnetization transfer imaging (MTI)

- MT phenomenon is determined by the restricted macromolecular protons and is quantified by the MT ratio (MTR)

- **normal adult testis: 46.2 %**
  - ✓ many macromolecular structures implicated in the secretory activity of the testis
  - ✓ rough endoplasmic reticulum (RER), consisting of macromolecules, important role in the synthesis of testosterone
  - ✓ collagen: tunica albuginea, peritubular tissue, lamina propria of the peritubular complex of the seminiferous tubules, basement membrane

Tsili et al, Eur Radiol 2016

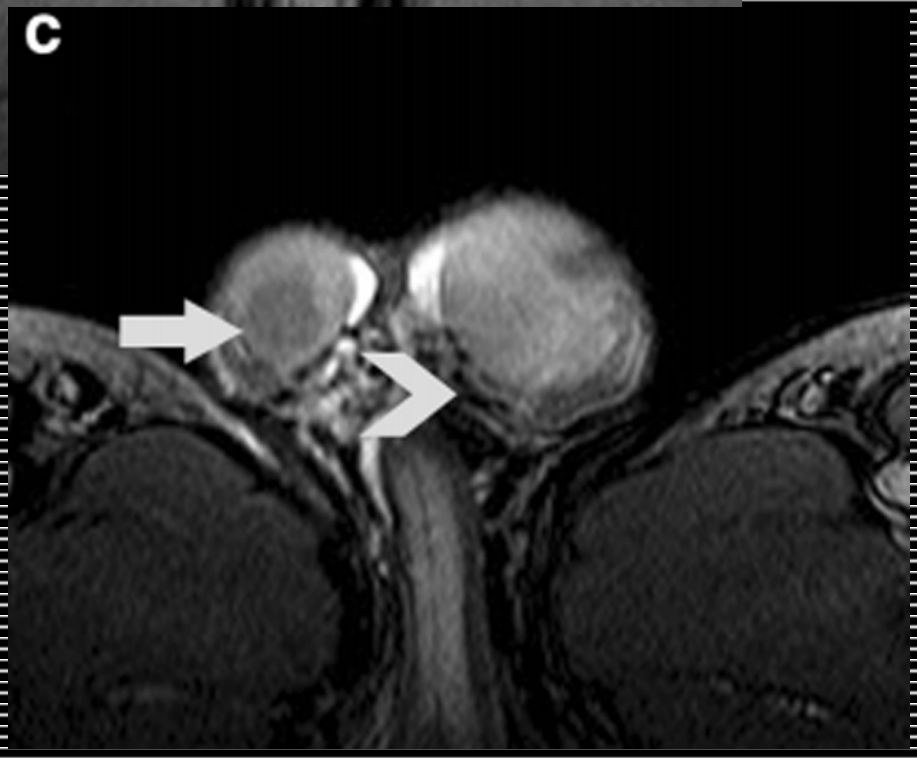
Magnetization transfer imaging (MTI)

- MTI may be useful in the diagnostic work up of testicular lesions

- **TGCTs have high MTR** compared to benign testicular lesions and normal testicular parenchyma

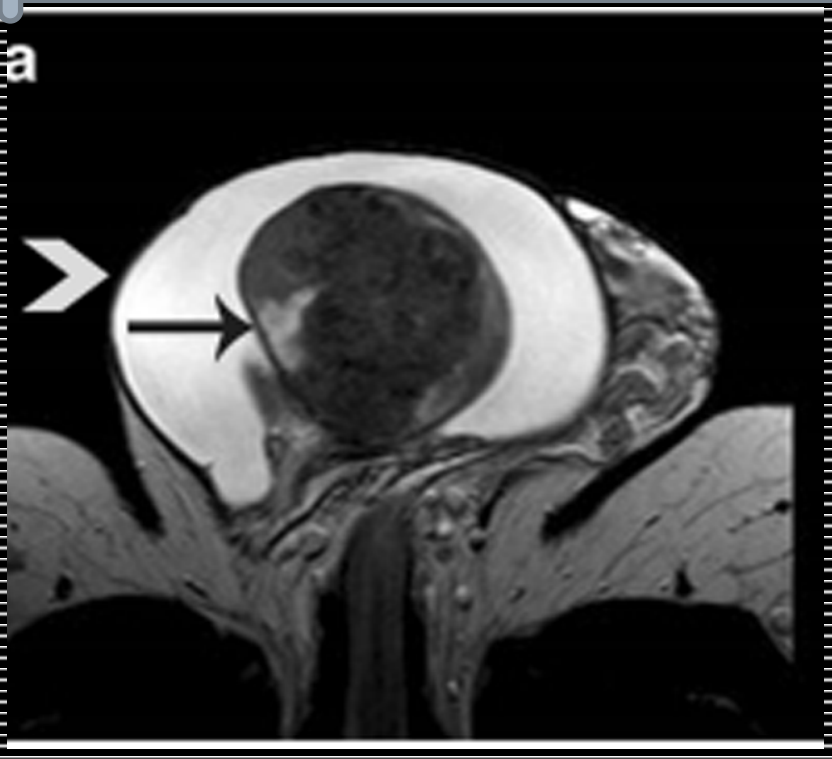
Tsili et al, Eur Radiol 2016

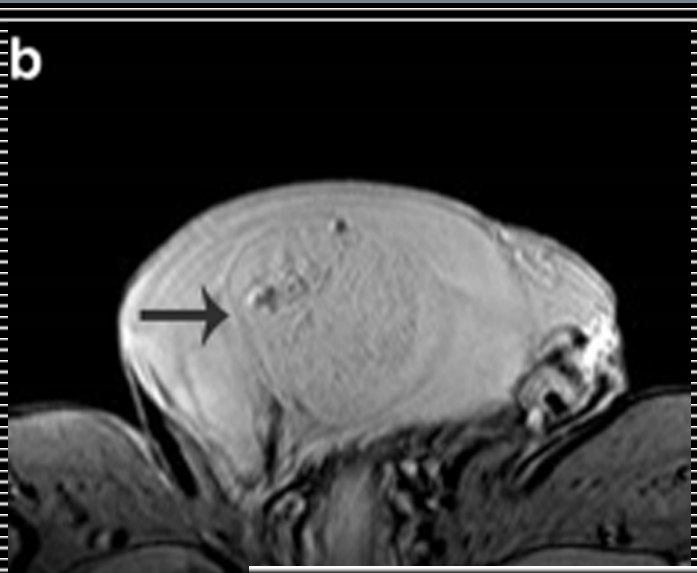
Seminoma



MTR (tumor): 59.2%
LT testis: 47.6%

Embryonal carcinoma





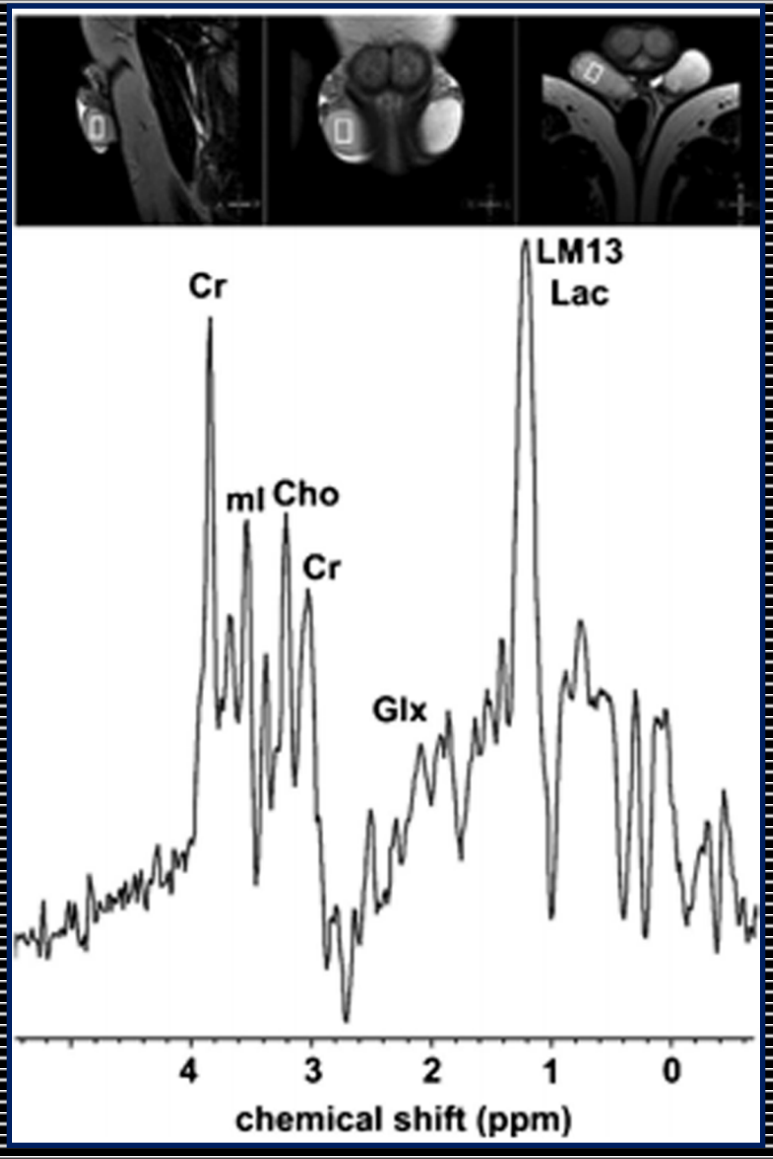
MTR (tumor): 57.9%
LT testis: 46%

1H-MR spectroscopy

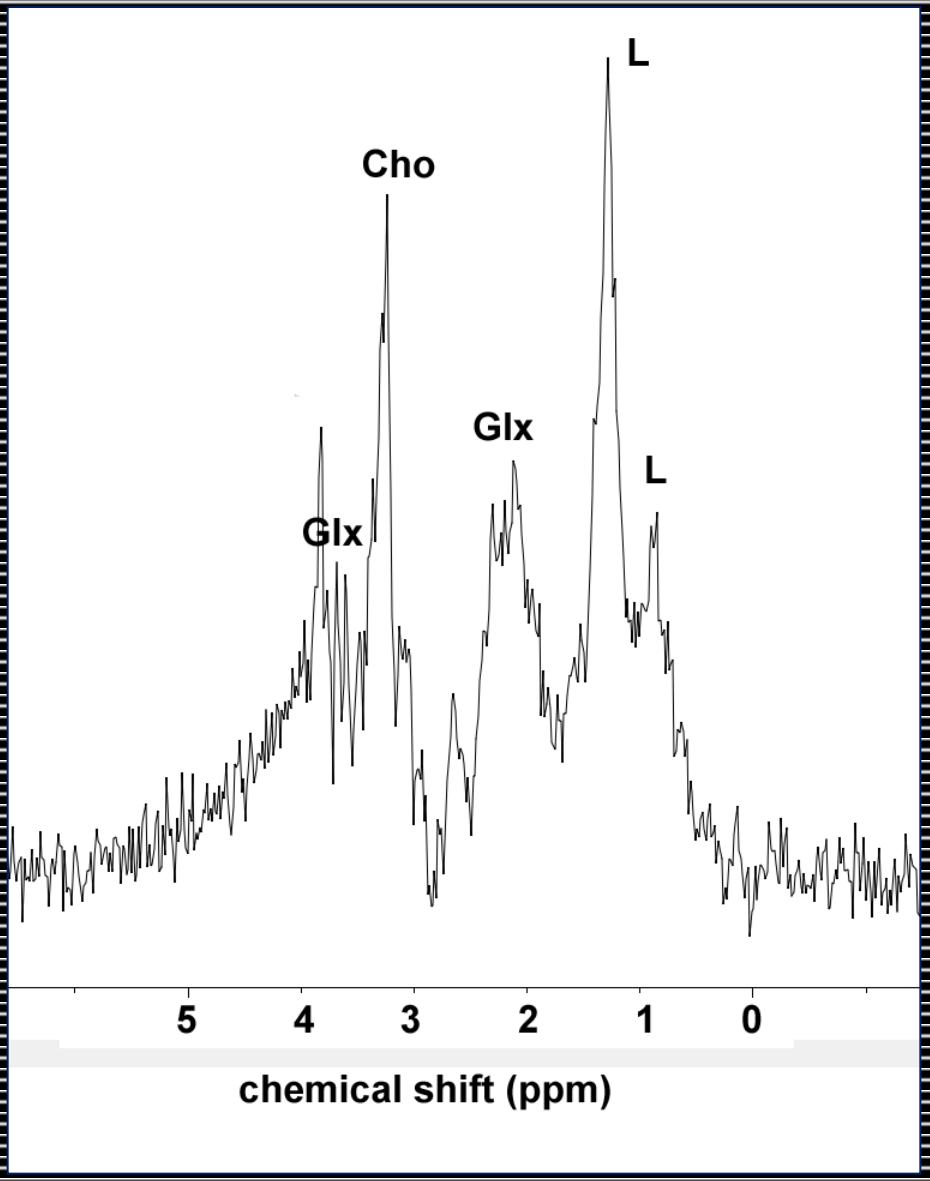
- **normal adult testes:** several metabolite peaks
  - ✓ most prominent peaks: Cho, Cr, mI, and lipids
- abnormal testes **??**

Tsili et al, Eur Radiol 2016

Baleato-Gonzalez et al, Clin Radiol 2015



normal spectrum in a 26-year-old man



Seminoma

ESUR course 2018

ESUR Scrotal and Penile Imaging Working Group

Multimodality Imaging Approach to Scrotal and Penile Pathologies

2nd ESUR teaching course

4-6 October 2018
Aegli Zappion, Athens, Greece

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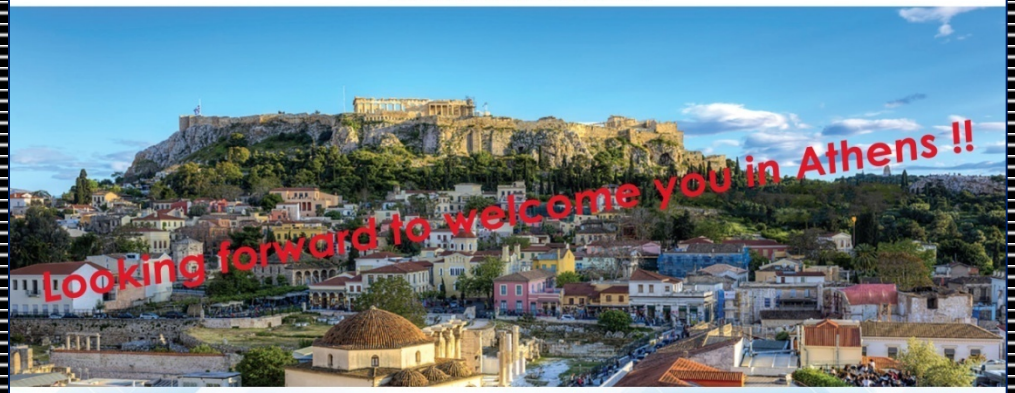

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