Testicular MRI: Beyond malignancy

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Learning objectives

- To review the current role of magnetic resonance imaging (MRI) in testicular lesions and its indications.

- To show the characteristic MRI findings for benign and malignant conditions involving the testes.
**Background**

In recent years, MRI has proven useful in the diagnosis of testicular lesions.

In the classical approach to testicular lesions, ultrasound is the imaging modality of choice because of its accessibility and ability to establish a diagnosis in most cases. Computed tomography (CT) has a role in the study of the extent of testicular cancer. Given the widespread use of plain-film chest X-rays, they are occasionally the first imaging test in patients with testicular cancer detected after the discovery of lung metastases.

MRI has a complementary role in patients with suspected testicular lesions; it is useful in cases in which the ultrasound findings are inconclusive.

The advantages of MRI over other imaging techniques are:

- It makes it possible to differentiate between intra- and extra-testicular lesions.
- It has a larger field-of-view, showing the inguinal region and lesser pelvis (useful in cryptorchidism).
- It provides better characterization of lesion contents (fat, blood, fibrosis…) and makes it possible to differentiate between solid and cystic lesions.
- It makes it possible to evaluate lesion enhancement.
- It is useful for local staging in testicular cancer.
Findings and procedure details

The MRI protocol for testicular lesions usually includes T1-weighted sequences (with or without fat-sat), T2-weighted sequences, and gadolinium-enhanced T1 fat-sat sequences (all in different spatial planes).

Compared to striated muscle, normal testes are isointense (homogeneous intermediate) at T1 and hyperintense at T2; normal testes show homogeneous uptake of contrast material.

Intratesticular lesions can be classified as benign, malignant, or pseudolesions.

Most solid intratesticular lesions are malignant (Table 1).

1. **Benign lesions**

   **Testicular cyst**

   MRI findings: circumscribed lesions located within the testis itself or in the tunica albuginea that are hypointense at T1-weighted sequences and hyperintense at T2-weighted sequences. They sometimes contain proteinaceous fluid and spermatozoa (when they can be called spermatoceles) and have a fluid-fluid level (fig 1).

   **Epidermoid cyst**

   This solid benign lesion consists of a cavity filled with keratin and products of desquamation, delimited by a single layer of squamous epithelium.

   MRI findings: round, well-delimited (with or without a capsule), non-enhancing lesion that can be hyperintense at T1-weighted images (due to high protein contents). At T2-weighted images, it may have a low-intensity rim or may also show alternating rings of high and low signal ("onion ring" appearance). Fig quiste epiderm

   Imaging diagnosis of these lesions enables conservative management (enucleation), thus avoiding unnecessary orchiectomy (fig 2)

2. **Malignant testicular lesions**
Testicular cancer is the most common tumor in young and middle-aged men (usually between 15-35 years). Risk factors include cryptorchidism, chromosomal abnormalities (e.g., Klinefelter), previous or family history of testicular cancer, and infertility.

Intratesticular cancer is divided into germ-cell tumors and non-germ-cell tumors; germ-cell tumors account for 90% to 95% of all malignant testicular tumors.

**Germ-cell tumors** are subdivided into seminomas and non-seminomas:

- **Seminomas** are more common and comprise various histologic subtypes; they are usually seen as well-defined, homogeneous, solid lesions. MRI findings: homogeneous lesions, hypointense at T2-weighted sequences, isointense at T1-weighted sequences; they may contain fibrovascular septa and may enhance after contrast administration (fig 3). Some histological variants with aggressive component may have an heterogeneous enhancement and cystic/necrotic areas. (fig 4)

- **Non-seminomas** comprise a broad group with diverse histologic types, including embryonal carcinomas, yolk-sac carcinomas, choriocarcinomas, teratomas, etc. At histology, these tumors can present a single histologic type, but more often they are a mix of different types, sometimes with a seminoma component as well. MRI findings: non-seminomas are usually larger than seminomas; they are heterogeneous, with areas of necrosis/hemorrhage, and show patchy uptake of contrast material. (fig 5)

  The imaging findings for seminomas and non-seminomas overlap, making it impossible in some cases to differentiate between the two main types.

**Non-germ-cell tumors** are uncommon; this group comprises different types of lesions:

- **Sex cord-stromal tumors** (a group that includes Leydig cell tumor, Sertoli cell tumor, and granulosa cell tumor). The most common type in this subgroup is Leydig cell tumors (1%-3% of all testicular tumors); these lesions may be classified as potentially malignant (Leydig cell hyperplasia) or as malignant (Leydig cell tumor). It is practically impossible to differentiate between benign and malignant lesions on imaging studies. MRI findings: isointense at T1, hypointense at T2, with characteristic intense, homogeneous enhancement. Because patients with these types of tumors are potential candidates for minimally invasive surgery (enucleation), radiologic suspicion is important to avoid unnecessary orchiectomies (fig 6).

- **Lymphomas** account for 1% to 9% of testicular tumors; they are the most common testicular tumors in adults ≥60 years old. They are typically non-Hodgkin lymphomas (most often diffuse large B-cell type). MRI findings:
infiltrative lesions with ill-defined margins; hypointense at T2-weighted sequences and isointense at T1-weighted sequences, with variable enhancement (usually homogeneous or patchy in large lesions) (fig 7).

- Metastases: metastases to the testes are rare, usually occurring in the context of disseminated disease from primary prostate, lung, or colorectal cancer; testicular involvement tends to be multifocal and bilateral.
- Leukemia, sarcoma, leiomyoma, vascular tumors...

3. Pseudolesions

Some non-neoplastic conditions can simulate solid masses. These are often abnormalities of vessels or of the perfusion of the testicular parenchyma: infarction, hematoma, orchitis, fibrosis, and tubular ectasia.

Tubular ectasia of the rete testis

Dilation of the seminiferous ducts located in the mediastinum testis due to partial or total obstruction of the efferent ducts. It is seen as a multicystic elongated tubular lesion that is characteristically hypointense at T1-weighted sequences and hyperintense at T2-weighted sequences and does not enhance after the administration of contrast material. (fig 8).

Testicular atrophy

Unilateral or bilateral decrease in testicular size (both in diameters and volume), testicular atrophy can be due to congenital causes (cryptorchidism is a common cause) or due to processes occurring in the past (e.g., ischemia, infections, trauma).

MRI findings: smaller than normal testis or testes; the parenchyma is hypointense on both T1- and T2-weighted sequences, with overall hypoenhancement after the administration of contrast material. (fig 9)

Orchitis

An infectious process involving the testes, orchitis can be viral (in children) or bacterial (most cases of bacterial orchitis occur in sexually active men or in men older than 50 years of age with benign prostatic hypertrophy).

MRI findings: enlarged testis with a heterogeneous signal that is diffusely hypointense on T2-weighted sequences and slightly hyperintense on T1-weighted sequences; the involved testis has increased uptake of contrast material compared to the contralateral testis. These findings can be associated with radiologic signs of epididymitis, thickening of scrotal linings, and hydrocele or pyocele, especially in pyogenic infections, and this is
useful for the diagnosis. This clinical syndrome can be complicated by the development of an intratesticular abscess, which is seen as a collection within the parenchyma with moderate peripheral enhancement. (fig 10 and 11)

**Segmental infarction**

Segmental infarction corresponds to an area of ischemic parenchyma in the testis; it can occur secondary to multiple causes that are not always recorded in the clinical history: infection, trauma, or hematologic abnormalities (e.g., sick-cell anemia or polycythemia).

MRI findings: an isointense area in T1-weighted sequences that has a variable signal in T2-weighted sequences; characteristically, the lesion itself does not enhance, although a thin peripheral ring of enhancement is sometimes present. (fig 12)

**Testicular hematoma**

A hematic intratesticular collection can be due to multiple causes (e.g., trauma or ischemic infarction) or can arise spontaneously. MRI is very sensitive in differentiating among the different stages in the evolution of the hematoma itself.

MRI findings: a hyperintense area on T1-weighted sequences that has variable signal intensity on T2-weighted sequences. In older hematomas, a hypointense halo can be appreciated in the periphery. Hematomas do not enhance after the administration of contrast material. (fig 13)
### Table 1

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**Sex Cord-Stromal tumors**

- Leydig cell tumor
- Sertoli cell tumor
- Granulosa cell tumor
- Thecoma-fibroma

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Fig. 1: Testicular pain in a 20-year-old man. A) US image shows a well-defined and anechoic lesion with a thin septation B) Coronal T2-weighted image shows that the lesion (arrow) has the characteristic high signal intensity of fluid C) Axial T1-weighted and D) Axial gadolinium-enhanced T1-weighted images shows homogeneous low-signal-intensity lesion without enhancement.

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Fig. 2: Painless left testicular mass in a 31 year-old man. A ) US image shows a solid mass with concentric rings of hypoechochogenicity and hyperechogenicity ("onion ring" appearance). The center of the mass was slightly echogenic. B ) Axial and C) Coronal T2-weighted images shows a high-signal-intensity lesion with central intermediate-signal-intensity focus. The lesion is surrounded by a low-signal-intensity rim. D ) Sagittal T1-weighted and E ) Axial gadolinium-enhanced T1-weighted images shows sharply marginated homogeneous low-signal-intensity mass without enhancement.

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**Fig. 3:** Painless testicular left mass in 40 year-old man. A) Axial and B) Coronal T2-weighted images show an hypointense polilobulated mass in left testis. C) Axial T1-weighted image and D) Sagital gadolinium-enhanced fat-sat T1-weighted images shows that the mass enhances more than the normal testis

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Fig. 5: Right testicular trauma in a 39 year-old man. In 2000, he underwent left orchiectomy for testicular cancer. A,B) Sonogram images show multiple microlitiasi in a marked heterogeneous testicle which has increased Doppler signal except in some ill-defined areas (diminished Doppler signal) (arrowhead) C ) Coronal T2-weighted MR image demonstrates a very heterogenous intratesticular containing cystic and solid components that almost replaces the testis. D) At Axial T1-weighted image we can observe a hyperintense small area that corresponds to hemorrhage focus. E) Axial and F) sagittal contrast-enhanced T1-weighted images show heterogeneous enhancement of the mass (arrow) after contrast material administration

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**Fig. 4:** Painless testicular growth in a 56 year-old man. A) US image shows the right testis that is increased in size, unstructured, heterogeneous with a partially cystic and partially solid intratesticular mass. Right hydrocele B) Axial T2-weighted image shows a large intratesticular mass (arrow) containing cystic and solid components that replaces the testis. Right hydrocele (arrowhead) C) Axial T1-weighted image. D) Axial and E) Sagittal contrast-enhanced T1-weighted images show a large bilobulated mass show enhancement of the solid-tumor components after contrast. F) Sagittal contrast-enhanced T1-weighted image shows the normal left testis. Pathology report confirmed that the mass was Testicular Seminoma with High Mitotic Index.

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**Fig. 6:** Azoospermia in a 41 year-old man

A) US image shows a small, hypoechoic, ovoid intratesticular mass

B) Axial and C) Coronal T2-weighted images show an intratesticular nodule (arrowhead) that is hypointense.

D) Axial T1-weighted and E) contrast-enhanced T1-weighted images demonstrate hyperenhancement relative to the testis.

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**Fig. 7:** Painless testicular right mass in 62 year-old man. Axial sonogram (not shown) demonstrated a very heterogeneous right testicle. A ) Coronal and B ) Axial T2-weighted MR images demonstrates an infiltrative intratesticular mass which is uniformly hypointense and has ill-defined margins. C) On T1-weighted images it is slightly hypointense to the normal testis D ) In our case, Sagittal contrast-enhanced T1-weighted image shows that the mass enhances more than the normal testis. Sometimes, the mass presents low-level enhancement (less than the normal testis) In this case, pathology report confirmed that the mass was lymphoma.

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**Fig. 8:** Testicular pain in a 80-year-old man. A) US image shows multiple small tubular anechoic structures that replace and enlarge the testicular mediastinum with geographic shape (arrow). B) Axial and C) Coronal T2-weighted images: the ectasia of multiple small tubules of the rete testis appears hyperintense (arrowhead). D) Axial T1-weighted and E) Coronal contrast-enhanced T1-weighted images. After administration of gadolinium contrast material, no internal enhancement is seen.

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**Fig. 9:** Azoospermia in a 38-year-old man. A) Coronal T2-weighted and (C) Axial T2-weighted show a diminsh of size right testis with a heterogeneous low-signal-intensity (B) Axial T1-weighted fat-suppressed (D) gadolinium-enhanced fat-suppressed T1-weighted images shows the mild and heterogeneous contrast enhancement of right testis.

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Fig. 10: 32-year-old man with left-sided orchitis. A, B) Axial T2-weighted, C) Coronal T2-weighted, show an subtle heterogeneous and hypointense testicular parenchyma (arrowhead) and an enlarged epididymis (circle). D) Axial T1-weighted. E) Sagittal T1-weighted fat-suppressed contrast-enhanced shows marked increased enhancement of the left testis with the typical tiger skin-like pattern (arrow), epididymis(circle), and overlying subcutaneous tissues.

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**Fig. 11:** Testicular pain and fever in a 40 year-old man. A) US shows an intratesticular hypoechoic lesion (arrow) with defined walls and low-level internal echogenicity. The surrounding testicular parenchyma is hypervascular B) Axial T2-weighted demonstrate an intratesticular mass (arrowhead), which has mild signal intensity with a thin hypointense rim C) Axial T1-weighted image.D) Axial gadolinium-enhanced T1-weighted images shows that the lesion does not enhance, but has a thin hyperintense rim. Follow-up US image obtained 8 weeks later showed that the area seen in was significantly smaller.

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**Fig. 12:** Testicular pain in a 71-year-old man A,B) US images shows a hyperechoic irregularly shaped area which exhibit Doppler signal. (C) Coronal T2-weighted image show an heterogeneous low-signal-intensity area in right testis. (D) Axial Fat saturated T1-weighted image. E) Coronal and F) Axial Contrast-enhanced Fat saturated T1-weighted images show avascular areas at post-contrast MRI sequences. So, the US image correlates with an area of preserved testicular parenchyma.

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**Fig. 13:** 42-year-old man with acute scrotal pain in left testicle. A ) Gray-scale sonogram with linear transducer shows an ovoid hyperchoic lesion in left testicle (arrowhead). B ) Color Doppler sonogram shows hypovascular area with no flow in lesion (arrowhead). C ) Axial T2-weighted shows a lesion with isointense signal and hypointense welldefined borders (arrowhead) D ) Axial T1-weighted shows a lesion with hyperintense signal E ) Sagital and F ) Axial Fat-sat T1-weighted image after contrast use show findings similar in morphology but with borders better defined than on sonography. Enhanced image also defines avascular lesion with marked rim enhancement of borders

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Conclusion

MRI is a useful complementary test in the diagnosis of testicular lesions in cases where ultrasound is inconclusive. The advantages of MRI are especially evident in benign lesions and pseudolesions. The behavior of malignant lesions varies; nevertheless, there are differences in the radiologic appearance of the different types of tumors.
References

