Seminomas and non-seminomatous testicular neoplasms: MR imaging features with histologic correlation

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Learning objectives

The present study aims to illustrate the spectrum of MR imaging features of testicular germ cell tumors and correlate them with the histologic findings, emphasizing on the distinction between seminoma and non-seminomatous tumors, two broad categories with different treatment algorithms.
Background

Testicular germ cell tumors (GCTs) account for 95% of all testicular carcinomas and arise from the germinal epithelium of the seminiferous tubules. The GCT line is fairly evenly split between seminomas and non-seminomatous germ cell tumors (NSGCTs). The latter have various histologic subtypes including teratoma, choriocarcinoma, embryonal and yolk sac tumor. The distinction between seminoma and non-seminoma is of significant importance, as based on that the therapeutic approach should be modified. Seminomas are radio-sensitive, while NSGCTs are radio-resistant. The therapeutic plan in stage I and II seminoma is radical orchectomy followed by radiotherapy to ipsilateral lymph nodes, while in stage I and II NSGCTs a radical orchectomy followed by lymph nodes dissection is usually performed.

Ultrasonography is the primary imaging technique in the assessment of scrotal disease. However, MRI currently consists an efficient supplemental scrotal imaging modality. Its wide field of view, multiplanar capability and high soft tissue resolution render it a diagnostic tool of high performance.

Germ cell tumors have some typical characteristics in MR imaging. Seminomas appear as sharply defined homogenous tumors of low signal intensity on T2-weighted images with fibrovascular septa of lower signal intensity compared to the tumor. After paramagnetic substance administration tumors show homogeneous enhancement with characteristic intenser enhancement of the fibrous septa. Seminomas may exhibit heterogeneous signal of predominantly low intensity on T2-weighted image with small and well demarcated areas of necrosis.

Non-seminomatous germ cell tumors appear with heterogeneity in all MR sequences. In these tumors coexistence of hemorrhagic and necrotic areas is not rare.

Histologically, seminomas consist of a uniform population of large cells, arranged in sheets and nests separated by delicate connective tissue. The tumor cells are uniform, have abundant clear cytoplasm and large centrally located nucleus. The fibrous septa are slender and usually demonstrate lymphocytic infiltration.

Non-seminomatous germ cell tumors refer to the germ cell tumors that contain embryonal stem cells. The 4 histologic classifications of NSGCTs include 1) embryonal tumor, 2) teratoma, 3) choriocarcinoma and 4) yolk sac tumor. Mixed tumors are those with a mixture of all type histologies. Tumors with both seminomatous and non-seminomatous elements are considered NSGCTs because the NSGCT component most accurately reflects the response to treatment and overall prognosis.
Imaging findings OR Procedure details

The distinction between seminoma and non-seminoma is clinically important, since the therapeutic approach between these two entities is different. Although, there is a wide overlap of the MR imaging findings between seminomas and non-seminomatous germ cell tumors, an obvious difference between their signal characteristics still exists.

The first case represents a 38-year-old man with testicular swelling deteriorating over the last months, that was operated and histologically proven classic seminoma with associated hydrocele (Fig. 1-5). The tumor demonstrates predominantly low signal intensity with small and larger foci of high signal intensity on T2-weighted images corresponding to necrotic areas. The characteristic septa have a bandlike appearance and demonstrate a low signal intensity on T2WI due to their connective tissue content. After gadolinium administration these septa exhibit intenser enhancement compared to the tumor tissue.

Similar findings are apparent in our second case of seminoma in a 35-year-old male (Fig. 6-8). In this case, notice the homogeneity of the tumoral tissue exhibiting a low signal intensity on T2-weighted images due to their cellularity and cellular uniformity. The necrotic areas demonstrate characteristic for seminoma well-delineated margins.

The last two cases represent non-seminomatous germ cell tumors. A 22-year-old male with embryonal carcinoma coexisting with testicular microlithiasis (Fig. 9-12). MRI demonstrates a very small lesion with relatively low signal intensity without septation. The tumor exhibits an atypical, mainly peripheral enhancement after contrast medium administration.

The last case refers to a mixed germ cell tumor in a 26-year-old male (Fig. 13-19). This tumor appears with a high signal intensity on STIR sequences, low signal intensity on T1-weighted images and remarkably heterogenous enhancement after contrast administration. The heterogenous enhancement is indicative for NSGCT. Furthermore, the high signal intensity on T2-weighted images aids in the distinction from seminoma.

In our experience, although there is a wide overlap of the MR imaging findings between seminomas and non-seminomas, there are MR features that, to a certain extent, can characterize a seminoma and distinguish it from a non-seminomatous lesion.
Fig. 0: Classic seminoma in a 35-year-old male. Coronal T2-weighted image demonstrates a large tumor with predominantly low signal intensity, areas of necrosis and septa. There is an associated large hydrocele.

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Fig. 0: Classic seminoma in a 35-year-old male. Axial STIR image shows low signal intensity of the tumor, necrotic areas of high signal intensity and bandlike septa with lower signal intensity compared to the tumor due to their fibrous component.

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**Fig. 0:** Classic seminoma in a 35-year-old male. Axial T1-weighted image demonstrates the necrotic areas with low signal intensity and the rather homogeneity of the tumor tissue.

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**Fig. 0**: Classic seminoma in a 35-year-old male. Axial gadolinium-enhanced T1-weighted image demonstrates the enhancement of the tumor and septa. Note the intenser enhancement of the septa compared to the tumor.

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**Fig. 0:** Classic seminoma in a 35-year-old male. H&E staining shows sheets of dense arranged uniform germ cells separated by fibrous septa with lymphoid infiltration.

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**Fig. 0:** A 38-year-old male with seminoma. Coronal T2-weighted image shows a low signal intensity tumor with large necrotic areas and bandlike septa. Note the characteristic sharply demarcated necrotic areas typical for seminoma.

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**Fig. 0:** A 38-year-old male with seminoma. Coronal gadolinium-enhanced T1-weighted image shows the enhancement of the tumor and septa. Lack of enhancement centrally due to necrosis.

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**Fig. 0:** A 38-year-old male with seminoma. H&E staining shows sheets of uniform germ cells separated by fibrous septa with lymphoid infiltration.

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**Fig. 0:** 22 years old male with embryonal carcinoma. Coronal T2-weighted image shows a small, round lesion of low signal intensity compared to the adjacent parenchyma and relative homogeneity, located in the upper testicular pole.

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**Fig. 0:** 22 years old male with embryonal carcinoma. Axial T1-weighted image after contrast medium administration demonstrates mainly peripheral enhancement.

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Fig. 0: 22 years old male. Papillary type embryonal carcinoma of testis in hematoxylin and eosin (H&E) staining.

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Fig. 0: 22 years old male with embryonal carcinoma. The H&E staining exhibits microcalcifications (arrows) within adjacent seminiferous tubules.

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**Fig. 0:** 26-year-old male with mixed germ cell tumor. Axial STIR image shows a heterogenous testicular mass of high signal intensity.

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**Fig. 0:** 26-year-old male with mixed germ cell tumor. Axial T1-weighted image shows the mildly heterogenous texture of the tumor.

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**Fig. 0:** 26-year-old male with mixed germ cell tumor. Axial gadolinium-enhanced T1-weighted image shows heterogeneous enhancement of the tumor.

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Fig. 0: 26-year-old male with mixed germ cell tumor. H&E staining shows area of seminoma with sheets of uniform germ cells separated by slender fibrous septa.

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**Fig. 0**: 26-year-old male with mixed germ cell tumor. H&E staining shows area of tubular type embryonal carcinoma.

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Fig. 0: 26-year-old male with mixed germ cell tumor. H&E staining shows area of yolk sac tumor.

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**Fig. 0:** 26-year-old male with mixed germ cell tumor. H&E staining shows area of teratoma with presence of immature cartilage (arrow) and epithelium.

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Conclusion

The distinction of GCTs in seminomatous and non-seminomatous neoplasms is important for determining treatment and prognosis.

MRI has been proven highly accurate in the distinction of extratesticular from intratesticular disease and the differentiation between benign and malignant masses. Currently, MRI plays significant role in the distinction between seminomatous and non-seminomatous germ cell tumors.

The presence of an intratesticular lesion of predominantly low signal intensity on T2-weighted images with septa enhancing more than tumor tissue after paramagnetic substance administration is indicative for seminoma. On the other hand, tumors with heterogenous appearance that show heterogenous enhancement are suggestive of non-seminomatous germ cell tumors.
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