MRI in the characterization scrotal lesions and local staging of malignancy

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Aims and objectives

Although ultrasound was the first examination performed for scrotal disease, with a sensitivity close to 100% for detecting intrascrotal lesions, sometimes the findings are insufficient in specificity to allow a definitive diagnosis (1). When ultrasound is inconclusive, the ultrasound must be completed with MRI. Several recent studies have been reported of using MRI in identifying scrotal masses and it helps provide accurate diagnosis in the majority of the cases (1-3). MRI can clearly show the location, size, its signal characteristics and structural relation with adjacent tissues of scrotal masses. It is suggested that MRI imaging characterization of testicular neoplasms reflect the tissue histologic nature, providing a preoperative characterization of the histologic type of testicular tumors in many cases (4). MR imaging also has highly diagnostic accuracy for differentiating intratesticular and extratesticular disorders (5,6). With the use of a gadolinium-based contrast-enhanced technique, MRI can provide useful information about testicular blood flow than provided by ultrasound and unenhanced MR imaging (7-10). The pattern and degree of enhancement of scrotal lesions can also be evaluated. These findings can improve the differential diagnosis. Furthermore, in certain patients with benign tumors, MRI show the location and precise number of the lesions, providing preoperative guidance for surgical management (6).

The purpose of this study was to describe the MRI features of extratesticular and intratesticular lesions and correlate MRI findings with histopathologic features, more specifically, to determine the diagnostic value of MRI in the preoperative local staging of malignant intratesticular tumor.
Methods and materials

Materials and Methods Study population

From August 2009 to September 2013, 63 cases of testicular MRI were performed during the study period. The exclusion criteria included: negative result of MRI, patients without subsequent surgery. Thus, 9 cases of normal MRI findings, 24 cases of suspicious finding without subsequent surgery were excluded from the study. The preoperative MRI examinations of remaining 30 patients were retrospectively analyzed.

Due to the retrospective nature of the study, our institutional review board did not require formal approval or informed consent from patients whose records were included in the study.

MRI technique

The MRI studies were obtained using a 3.0 -T system (Trio; Siemens Medical Systems, Erlangen, Germany) with a pelvic phased-array coil. All patients were supine position and headfirst for the examination. Pulse sequences included axial, sagittal, and coronal planes T1-weighted spin-echo sequences (TR/TE, 530-700/11ms; slice thickness, 5mm; gap, 0.5 mm; field of view, 240 ×270mm; and matrix, 256 × 256 mm) and fat-suppressed fast spin-echo T2-weighted images (TR/TE, 3700-5000/86-134; slice thickness, 5 mm; gap, 0.5 mm; field of view, 240 × 270 mm; and matrix, 256 × 256 mm). When a lesion with high T1 signal intensity was seen, fat-suppressed T1-weighted sequences were added. After manual intravenous bolus injection of gadopentetate dimeglumine (0.1 mmol/kg) (Magnevist; Bayer Schering Pharma, Leverkusen, Germany) into an antecubital vein, fat-suppressed T1-weighted spin-echo sequence was repeated with axial, sagittal, and coronal images for all patients.

MR imaging interpretation and data analysis

Two radiologists experienced in either uroradiology or MRI reviewed the MR images, and discrepancies were resolved by consensus. These radiologists did not know the surgical and histopathologic findings. The MRI characterization for scrotal neoplasms was referred as previously described diagnostic criteria in the literature (4, 11, 12). The tumor location (extratesticular or intratesticular), size, shape, border definition (well defined or ill-defined), intrinsic characteristics (signal intensity, signal homogeneity or heterogeneity, and septation), and enhancement patterns of the lesions were observed and analyzed. Signal intensity of lesions was qualitatively compared with the normal contralateral testis as having hyperintense, hypointense, isointense, or mixed signal.
intensities. The presence or absence of hemorrhage and necrosis was noted. The presence of laminated appearance was diagnosed as alternating low- and high-signal-intensity areas ("onion skin" sign) on T2-weighted MR imaging. Lesions with low signal-based, center with spotty high signal was diagnosed as "target sign". The patterns of enhancement of both the normal testes and the testicular lesions were evaluated on MR image were classified as heterogeneous, homogeneous, or absent.

In patients with malignant intratesticular tumors, whether the tunica albuginea, tunica vaginalis, epididymis or spermatic cord involved were evaluated. In imaging, an intratesticular tumor surrounded by a rim of normal testicular parenchyma or intact testicular tunicae detected as a continuous hypointense halo in the periphery of the testicle was classified category T1 disease. In cases in which the neoplasm interrupted the testicular tunicae with or without a mass in the paratesticular space, the local category of disease was categorized T2. Enlargement and contrast enhancement of the spermatic cord due to neoplastic involvement were categorized T3. Tumoral invasion of the scrotal wall was considered category T4 (13). Then the accuracy of MRI in the assessment of local T stage of disease was analysed.

A surgery was performed after MRI examination during the study period. The time interval between MRI and surgery was less than 2 weeks. The histologic diagnosis, which were the standard of reference, was recorded for each case and correlated with MRI findings.

Statistical analysis

We calculated the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for accuracy of MRI in the diagnosis of scrotal lesions compared with histopathology. The diagnostic value of MRI in the local stage was evaluated in terms of sensitivity, specificity. The kappa statistics (#) were determined between MRI imaging and histologic staging. Statistical analysis was performed with SPSS 11.5 software (SPSS Inc, Chicago, IL, USA).
Results

Of the 30 patients, the age ranged from 19 to 76 years old, at the time of diagnosis with mean age 44.52±17.56 years old. MRI revealed 31 scrotal lesions of 30 patients. 29 patients have only one lesion, the other one had both intratesticular (dilated rete testis) and extratesticular (cyst) lesions. With MRI, all lesions in the scrotum were identified and localized correctly either as intratesticular (22 lesions, 22/31, 71%) or extratesticular (9 lesions, 9/31, 29%) compared with the reference. In 22 intratesticular lesions, 13 (59.1%) were malignant, including 4 cases of diffuse large B cell lymphoma, 7 cases of seminoma, 2 cases of embryonal carcinoma. And 9 (40.9%) were benign, including 7 cases of epidermoid cyst, 1 cases of tuberculosis and 1 cases of dilated rete testis. In 9 extratesticular lesions, only 1 (11.1%) was malignant of myxoid liposarcoma. And the other 8 (88.9%) were all benign, including 3 cases of cyst, 2 cases of tuberculosis, one case of leiomyoma, one case of testicular adenomatoid tumor, and one case of hematoma.

The mean size of 22 intratesticular lesions was 39.15 mm with a range of 18-83 mm. 3 cases of epidermoid cyst had typical laminated appearance ("onion skin" sign) and one of which also have "target sign" (Fig. 1-4). The other 4 cases of epidermoid cyst revealed homogeneous isointense or heterogeneous intense with T1-weighted images and heterogeneously mixed signal intensities with linear low-signal-intensity rings of the edges with T2-weighted images. Gadolinium enhancement MRI revealed no enhancement in all cases. 1 case of tuberculosis revealed heterogeneously hypointense on T1-weighted images and hyperintense with a hypointense rim on the T2-weighted image. The sinus tract was seen and the scrotal wall was invaded. On enhanced MRI scan, there was ring enhancement of lesion, which be strongly suggestive of abscess.

1 cases of dilated rete testis showed geographic shape hypointense with T1-weighted images and hyperintense with T2-weighted image. On enhanced MRI scan, no internal enhancement is seen. A large epididymal cysts was found to coexist in the paratesticular space (Fig. 5-7). 2 cases of diffuse large B cell lymphoma with the testis being replaced by tissue, showed isointense to the testis on T1-weighted images, low-signal-intensity on T2-weighted images. One case also exhibited signal heterogeneity with small areas of necrosis. All 2 cases of the mass has a degree of enhancement less than the normal testis. The other one manifested as multinodular homogeneous low-signal-intensity masses on T2-weighted images. The mass has a degree of enhancement slightly less than the normal testis with enhancement of fibrovascular septa. Seven seminomas were recognized as relatively homogeneous isointense compared with the contralateral testis on T1-weighted images, multinodular, sharply defined, homogeneous tumors of low-signal-intensity on T2-weighted images. Areas of necrosis were detected in two cases. In all cases of seminomas, fibrovascular septa were detected within the tumors as bandlike areas of low signal intensity on T1- and T2-weighted images, showing
greater enhancement than tumor tissue after gadolinium administration. Mean age of all seminomas were 38.57±9.13 years old. 2 cases of embryonal carcinoma all involved of the testis, the ipsilateral epididymis, spermatic cord and tunica vaginalis. Mean age were 24±7.07 years old. The masses exhibited signal heterogeneity on T1- and T2-weighted images. More focal areas of hemorrhage(Fig. 4) was seen in one case and areas of necrosis was seen in all two cases. Significantly heterogeneous enhancement were seen in all 2 cases, the areas of unenhancement histologically indicated of necrosis and hemorrhage.

In this study, the mean size of 9 extratesticular lesions was 39.38 mm with a range of 6-82mm. Three cases of cyst with typical fluid signal showed hypointense with T1-weighted images and hyperintense with T2-weighted image. On enhanced MRI scan, no enhancement of lesion was detected. Two cases of tuberculosis of epididymis with enlarged heterogeneous epididymis, had T2 heterogeneous hypointense with significantly heterogeneous enhancement (Fig. 8-10). The study included one case of leiomyoma, which presented as isointense signal well circumscribed lesion with T1-weighted images and hypointense with T2-weighted images. On enhanced MRI scan, compared with the normal testis, the degree of enhancement of lesion is less (Fig. 11-13). One case of testicular adenomatoid tumor of tunica vaginalis showed isointense lesion with T1-weighted images and hypointense with T2-weighted image. On enhanced MRI scan, compared with the normal testis, the degree of enhancement of lesion is slightly higher (Fig. 14-16). The diagnosis of paratesticular hematoma was in one patient, with hypointense intensity with T1-weighted images, low and high mixed signal intensities combined with liquid - liquid surface on T2-weighted images. On enhanced MRI scan, no contrast enhancement was observed (Fig. 17-19). The study included one case of liposarcoma. T1-weighted images showed a isointense intensity mass with a large amount of hyperintense signal in periphery. Fat-suppressed images showed loss of signal corresponded to high intensity signals on T1-weighted images. Contrast-enhanced T1-weighted images showed enhancement of the soft-tissue component of the mass (Fig. 20-22). Histology later confirmed that 2 misdiagnosis cases, one initially misdiagnosed as a possible seminomas on MRI, was a lymphoma. The other one misdiagnosed as a possible adenomatoid tumors on MRI, was a leiomyoma. The sensitivity, specificity of the technique of MRI in differentiating benign from malignant scrotal lesions were 100%. MRI results matched the histopathology in 28 of the 30 patients. The consistency between MRI and histopathology was 93.3%. With MRI, 3 malignant intratesticular tumors were confined within the testis (T1 stage), 4 invaded the testicular tunicae or epididymis (T2 stage), 4 invaded the spermatic cord (T3 stage), and 2 invaded the scrotal wall (T4 stage). Histology confirmed that 2 misdiagnosis cases, one case of T2 stage seminomas was incorrectly categorized as T1 stage at MRI. The other one of T1 stage lymphoma misdiagnosed as T2 stage on MRI. The accuracy of MRI diagnosis in the local staging of testicular tumors was 84.6% (11/13). Stage-specific sensitivities and specificities were calculated: T1 (66.7%; 90%), T2 (75%; 88.9%), T3(100%; 100%) and T4(100%; 100%). The kappa value of a correlation between radiologic and histologic staging were 0.567 (T1), 0.639(T2), 1(T3) and1(T4), (p<0.05), respectively.
Fig. 1: Figure 1-4. Epidermoid cyst of right testicle in a 21-year-old man. (Fig 1) Coronal T1-weighted MR image shows a target sign, with high signal foci on T1-weighted images (arrow).

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**Fig. 2:** Figure 1-4. Epidermoid cyst of right testicle in a 21-year-old man. (Fig 2) Coronal T2-weighted MR image shows lesion of a laminated appearance, with alternating hypo and hyperintensity layers (arrow).

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**Fig. 3:** Figure 1-4. Epidermoid cyst of right testicle in a 21-year-old man. (Fig 3) Coronal T2-weighted MR image shows lesion with high signal foci (arrow).

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Fig. 4: Figure 1-4. Epidermoid cyst of right testicle in a 21-year-old man. (Fig 4) Coronal T1-weighted fat-suppressed enhanced MR image shows no enhancement of the lesion and with high signal foci (arrow).

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**Fig. 5:** Figure 5-7. Dilated rete testis and epididymis cyst of right testicle in a 60-year-old man. (Fig 5) Sagittal T1-weighted MR image show extratesticular mass (arrow), which was hypointense to the normal testis. A hypointense intratesticular lesion also can be seen (arrowhead).

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Fig. 7: Figure 5-7. Dilated rete testis and epididymis cyst of right testicle in a 60-year-old man. (Fig 7) Sagittal T1-weighted enhanced fat-suppressed image shows no enhancement of extra- (arrow) and intratesticular (arrowhead) lesions.

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**Fig. 6:** Figure 5-7. Dilated rete testis and epididymis cyst of right testicle in a 60-year-old man. (Fig 6) Sagittal T2-weighted fat-suppressed MR images shows that a hyperintense extratesticular mass (arrow). The tubular appearance intratesticular lesion show typically hyperintense (arrowhead).

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Fig. 8: Figure 8-10. Tuberculous infections of left epididymis in a 53-year-old man. (Fig 8) Coronal T1-weighted MR image demonstrates swelling of epididymis and internal signal intensity (arrow).

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**Fig. 9:** Figure 8-10. Tuberculous infections of left epididymis in a 53-year-old man. (Fig 9) Coronal T2-weighted fat-suppressed images showed the heterogeneous abnormal low signal intensity (arrow).

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Fig. 10: Figure 8-10. Tuberculous infections of left epididymis in a 53-year-old man. (Fig 10) Coronal T1-weighted enhanced fat-suppressed image shows the heterogeneously significantly enhancement of the lesion.

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**Fig. 11:** Figure 11-13. Leiomyoma of the left side of the scrotum in a 41-year-old man. (Fig 11) Sagittal T1-weighted MR image show extratesticular mass (arrow), which was isointense compared with the normal testis (star).

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Fig. 12: Figure 11-13. Leiomyoma of the left side of the scrotum in a 41-year-old man. (Fig 12) Sagittal T2-weighted fat-suppressed MR images shows the extratesticular lesion (arrow) has hypointense compared with the normal testis (star).

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Fig. 13: Figure 11-13. Leiomyoma of the left side of the scrotum in a 41-year-old man.
(Fig 13) Sagittal T1-weighted enhanced fat-suppressed image shows the mass (arrow) has a degree of enhancement less than the normal testis (star).

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**Fig. 14**: Figure 14-16. Adenomatoid tumor of the right side of the scrotum in a 68-year-old man. (Fig 14) Axial T1-weighted MR image show extratesticular mass (arrow), which was isointense to the normal testis (star).

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**Fig. 15:** Figure 14-16. Adenomatoid tumor of the right side of the scrotum in a 68-year-old man. (Fig 15) Coronal T2-weighted fat-suppressed MR images shows the extratesticular lesion (arrow) has hypointense, which be proved to originate from tunica vaginalis at pathologic examination.

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Fig. 16: Figure 14-16. Adenomatoid tumor of the right side of the scrotum in a 68-year-old man. (Fig 16) Axial T1-weighted enhanced fat-suppressed image shows the mass (arrow) has a degree of enhancement slightly higher than that of the normal testis (star).

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Fig. 17: Figure 17-19. Hematoma of the right side of the scrotum in a 68-year-old man. Axial T1-weighted MR image show a hypointense intensity extratesticular lesion (arrow) compared with the normal testis (star).

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**Fig. 18:** Figure 17-19. Hematoma of the right side of the scrotum in a 68-year-old man.

(Fig 18) Axial T2-weighted fat-suppressed MR image shows heterogeneous mix signal intensity lesion. Liquid-liquid surface (arrows) were clearly displayed. High signal located at the top, low signal located in the below, which represented different periods of the hematoma.

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**Fig. 19:** Figure 17-19. Hematoma of the right side of the scrotum in a 68-year-old man. (Fig 19) Axial T1-weighted enhanced image shows no enhancement of lesion (arrow).

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**Fig. 20:** Figure 20-22. Left paratesticular myxoid liposarcoma in a 76-year-old man. (Fig 20) Axial T1-weighted MR image shows a large isointense intensity mass with a large amount of hyperintense signal in periphery (arrow).

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**Fig. 21:** Figure 20-22. Left paratesticular myxoid liposarcoma in a 76-year-old man. (Fig 21) Axial T1-weighted fat-suppressed image shows enhancement of the soft-tissue component (arrowhead) and no enhancement of fatty component in periphery (arrow).

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**Fig. 22:** Figure 20-22. Left paratesticular myxoid liposarcoma in a 76-year-old man.

(Fig 22) Axial T1-weighted fat-suppressed image shows enhancement of the soft-tissue component (arrowhead) and no enhancement of fatty component in periphery (arrow).

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Conclusion

In conclusion, our study shows that MRI is reliable in the detection of scrotal lesions. Furthermore, it can be precisely differentiate paratesticular lesions from intratesticular lesions, and be reliable in the distinction between benign from malignant testicular lesions, in the evaluation of the preoperative local staging of malignant intratesticular tumor. In this study, the differential diagnosis was narrowed on the basis of the MRI features, and certain lesions can be accurately preoperative predicted basing on MRI images.
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