Multimodal MRI features of granulomatous prostatitis and tubercular prostate abscess

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Abstract The authors report the diffusion and contrast-enhanced MRI appearance of five cases of granulomatous prostatitis (GP), non-specific (two cases) and infectious post-Bacillus Calmette-Guerin (BCG) therapy (three cases, with a tubercular abscess in two of them). All patients had raising PSA levels and abnormal DRE. History of BCG therapy or acute prostatitis was present in four patients. Multiparametric MRI (T2W-MRI, DW-MRI and DCE-MRI) was performed before biopsies. Diagnosis was confirmed by TRUS-guided biopsies in four cases and by transurethral resection in one case. MRI showed a tumor-like appearance in three cases, an abscess-like appearance in one case and a combined tumor/abscess-like appearance in one case. Extraprostatic fat was infiltrated in three patients, simulating T3a disease. Histologically, caseous necrosis was found when MRI showed abcedation. Demonstration of occult tubercular abscesses in post-BCG GP may have therapeutic implications and MRI is useful prior to surgical or interventional drainage of large caseous abscesses.

The impact of multiparametric MRI before biopsy in patients with clinical and/or biological suspicion of prostate cancer is gaining increasing clinical acceptance [1]. The clinical role of pre-biopsy MRI is under evaluation for its value to not only avoid over-staging errors caused by biopsy artifacts [1], but also to allow for targeted TRUS-guided biopsies of suspicious areas [1]. This workflow substantially increases cancer detection rate of significant tumors [2], providing a better evaluation of the tumor burden (tumor volume and Gleason score) and may help avoid immediate biopsy in men with no target on MRI [1]. As a result, suspicion of prostate cancer can be observed in patients who develop benign prostatic tumor-like conditions. MRI appearance of chronic prostatitis

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http://dx.doi.org/10.1016/j.diii.2012.09.001
in the peripheral zone and stromal hyperplastic nodules of the transition zone can simulate prostate cancer and multiparametric MRI has been found to be a valuable tool to differentiate these two conditions from prostate cancer [3].

Granulomatous prostatitis is a much less frequent condition with a TRUS appearance found many years ago to be indistinguishable from that of prostate cancer [4]. The hypointense appearance of the disease on T2-weighted MRI has been mentioned in few isolated cases [5], but diffusion weighted MRI and dynamic contrast-enhanced MRI features of the disease have, to our knowledge, not been reported. We present multiparametric MRI appearance of five cases of granulomatous prostatitis, two of which were complicated by a tuberculous abscess occurring after intravesical instillations of Bacillus Calmette-Guérin for superficial bladder tumor.

### Cases

The five patients were 50 to 66 years old. All of them presented with rising PSA (3.9–9.5 ng/ml) and suspicious digital rectal examination. Three patients had received intravesical instillations of Bacillus Calmette-Guérin (BCG) for superficial bladder tumor, one patient had developed, eight months earlier, an acute prostatitis and clinical history was unremarkable in the fifth patient.

MR images were obtained at 1.5 Tesla with an integrated endorectal (MR Innova; Medrad, Pittsburgh, Pa) — pelvic phased-array coil (eight channels) in four cases and with a 32 channel pelvic phased-array coil alone in the fifth case. T2-weighted images were acquired with a three plane 2D sequence with the 32 channels pelvic coil (voxel size: 0.7 × 0.7 × 3.5 = 1.2 mm³) and with a 3D sequence (SPACE) with the integrated endorectal-pelvic phased-array coil (voxel size: 0.8 × 0.8 × 1 = 0.64 mm³). DWI and DCE parameters were the same for both coils. Four b values were used (100-200-400-800) for DW-MRI and a 8.5 s temporal resolution was used for DCE (T1W-gradient echo sequence). All the acquisitions (T2W, DWI and DCE) were displayed on the screen of a workstation (iCAD Inc., Nashua, NH, USA) with automatic synchronization of the magnification and slice position.

In three cases, MRI showed focal or multifocal hypointense areas with the peripheral zone and/or the transition zone, with a marked decrease of the ADC value (760 ± 82 mm²/s) and a moderate enhancement on DCE-MRI. Despite this moderate vascularization, lower than that expected in most prostate cancers, MRI appearance could not be differentiated from that of prostate cancer (Fig. 1).

In one case MRI showed DW features of a prostatic abscess involving the whole gland (Fig. 2), related to a massive caseous necrosis induced by a post-BCG PG. In the fifth case (post-BCG PG), MRI showed an occult caseating abscess associated with a tumor-like multifocal appearance of the rest of the gland (Fig. 3). In four cases, both the PZ and the TZ were both involved. In the fifth case, only (or solely) the PZ was involved. Evaluation of the capsular signal and the periprostatic spaces showed obliteration of the capsular signal and infiltration of the periprostatic fat in three cases (Figs. 1 and 4). Seminal wall thickening was observed in one case (Fig. 5) with no capsular abnormality.

Diagnosis was confirmed by TRUS-guided biopsies in four cases and by transurethral resection in one case. All positive cores showed typical features of granulomatous prostatitis with epithelioid cells and more or less dense multinucleated giant cells infiltration. Histology of two of the three BCG-PG cases demonstrated a typical tubercular appearance with central foci of caseous necrosis (Fig. 3). Search of acid-alcohol fast bacilli was not performed. Histological analysis did not show evidence of prostate cancer in any of the patients.

During follow-up, PSA level returned to baseline value in all cases one year after the initial MRI examination and CT scan, performed one year after TURP and initiation of antituberculous therapy in the patient presenting with a large volume tuberculous abscess, showed complete resolution of the cavity (Fig. 2).

### Discussion

Based on clinical and histological data obtained from prostate biopsies [6], granulomatous prostatitis (GP) can be classified as non-specific, infectious and indeterminate, representing 78, 18 and 4% of cases, respectively. History of prior BCG therapy is present in every case of infectious GP [6]. The clinical presentation of GP may be indistinguishable from that of prostate cancer [7]. In the absence of tuberculous abscess, urinary symptoms are absent or moderate, observed in 0.9 to 1.3% of cases [7] and prostate cancer is suspected in the presence of elevated PSA level and/or abnormal digital rectal examination [6]. Histologically, non-specific GP demonstrates peril glandular distribution of epithelioid histiocytes admixed with variable numbers of multinucleated giant cells, lymphocytes, plasma cells, neutrophils or histiocytes. Infectious GP consists of two patterns, namely, well-formed granuloma with central caseous necrosis and nodular aggregates with sheets of epithelioid cells lacking necrosis. Caseating necrosis is identified in 76% of cases of infectious GP. The extent of core involvement is not correlated with PSA level [6].

MRI features of granulomatous prostatitis can be separated into two types. The first type, by far the most frequently reported, has tumor-like appearance and cannot be distinguished from prostate cancer (PCa). MRI shows hypointensity on T2W-MRI, similar to that of PCa, at least if the granulomatous foci involve the peripheral zone [5]. To our knowledge, DW-MRI and DCE-MRI features of the disease have not been reported. Cellular density, which causes restriction of diffusion [8], is very high in granulomatous prostatitis [7] and low ADC values within granulomatous foci could thus be expected. In our study, the mean ADC value of non-necrotic granulomatous foci (760 ± 82 mm²/s) was lower than that reported in case of prostate cancer [9] (1020 ± 250 mm²/s) with MRI protocol settings comparable to ours (study at 1.5 T, using a b value of 800). DCE-MRI showed only a moderate enhancement in all cases of non-necrotic granulomatous foci located in the peripheral zone, contrarily to what is usually observed in prostate cancer [3]. In a specific clinical setting such as history of superficial bladder tumor treated with intravesical BCG instillations, a low ADC value together with a low DCE score may suggest granulomatous prostatitis rather than cancer. These findings...
Figure 1. Non-specific granulomatous prostatitis. Fifty-seven year-old man with a history of acute bacterial prostatitis eight months earlier. PSA level: 3.9 ng/mL. Right firmness at DRE: a, b: T2-weighted transverse and sagittal views. Large volume hypointense nodule involving both PZ and TZ (asterisk). Infiltration of the retroprostatic fat (arrows), simulating pT3a stage PCa. Contralateral granulomatous focus in the left TZ (arrowhead); c: DW-MRI shows low ADC values (986) in both granulomatous foci; d–f: DCE-MRI. Focal center-limited high intensity of color-coded $K_{\text{trans}}$ and $K_{\text{ep}}$ values. Remarkable low color-coded iAUGC value can be noticed; g: biopsy results: a typical non-specific epithelioid granuloma (arrow) is visible together with normal prostatic glands (asterisk); h: higher magnification field. Giant cells are visible (arrows) intermixed with lymphocytic and plasmocytic cells.

may allow to defer biopsies because elevated PSA, observed in approximately 40% of patients after intravesical BCG therapy, returns to baseline in 3 to 12 months [10]. However, it has been recommended that patients with BCG-related granulomatous prostatitis should be treated with isoniazid and rifampicin for 3 months [10], thus requiring histologic confirmation. Moreover, four cases in our study showed signs of periprostatic or seminal vesicles wall infiltration mimick-
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Figure 2. Tubercular abscess post intravesical BCG therapy. Sixty-six year-old man. Raising PSA (7 ng/ml) 8 months after the last of a series of six instillations. DRE revealed a swollen prostate suggesting abcedation: a, b: T2W-MRI, axial (prostate base) and sagittal views. Slight homogenous hypersignal of the entire prostate (asterisk) suggesting cavitation. The apex is equally involved (arrow, sagittal view); c,d: DW-MRI showing an ADC value of 730 (asterisk) and high signal intensity of the cavity on b800 images (asterisk); e: DCE-MRI. The color-coded $K_{\text{trans}}$ value (asterisk) within the avascular cavity has a score 0; f: Pelvic contrast-enhanced CT 12 months after TURP and antituberculous treatment. Complete recovery is demonstrated.

Figure 3. Infectious granulomatous prostatitis with a tubercular abscess within the transition zone. Fifty-eight year-old man presenting with raising PSA level and left firmness at DRE, 8 months after the end of an intravesical BCG therapy. The abscess (asterisk) is hyperintense on T2W-MRI (a), has a low ADC value (b) and hyperintense signal on b800 images (c). It is avascular on DCE parameters (d–f). Arrowhead indicates the presence of a contralateral granulomatous focus. Biopsy (h) shows several areas of caseous necrosis (grey arrow) with a massive granulomatous infiltration of the prostatic tissue (asterisk). Giant cells (white arrow) are visible, embedded within the granulomatous process.
Figure 3. (Continued)
Figure 4. 68 y/o man with raising PSA level and left palpable nodule 8 months after the end of an intravesical BCG treatment. Transverse and sagittal views of T2W-MRI of the prostate base. The left hyposignal corresponds to a granulomatous nodule on guided biopsies. Capsular signal is obscured and a discrete infiltration of the prostate-rectal fat can be seen (arrow).

Figure 5. Same patient as in Fig. 3. The left seminal vesicle wall is thickened on T2W-MRI (arrow, a, b). The tubercular abscess is visible on the coronal view (asterisk, b). The ADC value is low in the root of the left seminal vesicle (arrow, c) which shows high color-coded values of dynamic parameters (kep), simulating malignant seminal vesicle invasion.
The second MRI pattern of granulomatous prostatitis is far more uncommon, because it corresponds to a caseous abscess induced by a severe caseating necrotic process. Clinical expression of this complication is probably an exceedingly rare event, as only three cases of tubercular abscesses following intravesical BCG therapy have been reported so far [11–13]. MRI features of the two cases of our study showed, in all involved octants, a necrotic area which demonstrated characteristic features of soft-organ abscesses, whatever the location and causative agent [14]. Abnormal findings included a discrete hyperintense signal on T2W-MRI, with a total lack of vascularity, associated with characteristic DW-MRI findings combining a low ADC value and a focal hyperintensity on high b value images [14]. Similar findings have been described in two cases of pyogenic prostate abscesses [15] with emphasis on the very low ADC values in the two cases (610–630 mm²/s) reaching those of the highest Gleason score carcinomas [16]. In our study, the mean ADC value of the caseous foci (749 ± 135 mm²/s) was comparable. Owing to cavitation, it may be useful to evaluate the prevalence of occult caseous formation in infectious GP to ascertain if inclusion of multiparametric MRI in the work-up of a granulomatous prostatitis would have a clinical impact on treatment. Our cases suggest that occult tubercular abscesses could not be seen infrequently and that a repeat MRI exam may be performed after 3 months of antituberculous treatment to ensure that the abscess cavity has resolved. Large prostate tubercular abscesses require surgical or interventional drainage and antituberculosis treatment for one year [11,13]. Repeat imaging in our case after one year of antituberculous treatment showed return to a normal appearance of the prostate gland with no detectable residual cavity on CT scan.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References