The prostate after ablative treatments for prostate carcinoma: Magnetic resonance (MR) patterns

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Authors: G. Cardone, C. Iabichino, A. Losa, L. Nava, M. Lazzeri, P. Mangili, G. Guazzoni, G. Balconi; Milan/IT
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Learning objectives

To illustrate the most frequent MR imaging appearance of the prostate treated for prostate cancer, using ablative treatments.
To review the most frequent recurrence patterns after prostate ablative treatments.
To evaluate the most effective MR imaging examination techniques.

Background

The standard treatment options for localized prostate cancer are radical prostatectomy, external-beam conformal radiotherapy, brachytherapy and watchful waiting. Ablative techniques (cryoablation and HIFU ablation) are alternative treatments that provide some advantages over the conventional treatments (low morbidity rate, shorter hospital stay, negligible blood loss, less expensive than competing therapies).

The soft-tissue contrast resolution and multiplanar imaging capability of MR provide an effective tool for imaging follow-up of neoplastic lesions treated with ablative techniques. We reviewed 49 cases of MR examinations of patients with prostate cancer, treated with cryoablation and HIFU ablation, to illustrate MR imaging patterns of the treated prostate, most common postoperative complications and most frequent recurrence patterns.

Imaging findings OR Procedure details

MATERIALS AND METHODS
49 patients treated with cryoablation and HIFU ablation performed MR follow-up between July 2005 and February 2009.
All MR examinations were performed with a 1.5T MR system (Philips Gyroscan Intera Power), using a dedicated endorectal coil. Pts treated with cryotheraphy were examinated using the body phased-array coil.
All the patients underwent MR conventional multiplanar Turbo Spin-Echo (TSE) T2w sequences, followed from dynamic axial contrast enhanced (ce) Gradient-Echo (GRE) T1w sequence.

IMAGING FINDINGS
A) CRYOTHERAPY

Background

Cryosurgery is the term used to describe tissue destruction using extreme cold temperature (Fig. 1 on page 4). The histologic sequelae of this process are inflammatory reaction, coagulative necrosis and finally fibrosis and scarring.
Cryosurgical ablation is a safe, well tolerated and minimally invasive alternative therapy for localized prostatic carcinoma. Cryoablation procedure is performed using 10-15
cryoprobes (SeedNet, Galil Medical). The freezing zone encloses the prostate with a margin of about 1 cm, taking care of the periurethral zone in order to spare the urethra. As it is not possible to document hystopatologically the complete tissue necrosis after cryoablation and PSA level results variable during the follow-up, a radiological follow-up can be useful (1,2).

**Post treatment anatomy**

Cryolesions typically appeared to be isointense on T1w images and hypo- or hyperintense on T2w images due to the coagulative or colliquative necrosis induced by cryotherapy (Fig. 2 on page 4). All cryolesions showed an increase in size 24 hours after treatment, due to postcryosurgery prostate edema, and a progressive decrease in size (more than 80% at 36 months) due to fibrotic evolution of cryolesions (Fig. 3 on page 5). Treated prostate showed no significant vascularization of the peripheral zone, with periurethral zone sparing, on ce-MR images, due to vasocostriction and thrombosis of distal arterioles and venules induced by cryotherapy (1,2,5,7,8) (Fig. 3 on page 5, Fig. 4 on page 5).

The most significant MR patterns in the follow up of prostatic carcinoma treated with cryosurgical ablation were the decrease in size of the gland with the passing of time and the complete ischemia of the prostate, with periurethral zone sparing.

The most effective MR techniques for lesions size and enhancement evaluation were TSE T2w and subtracted ce-TSE-FS T1w sequences (1).

**Patterns of recurrence**

On MR images local recurrences after prostate cryoablation showed focal nodular areas with intermediate signal intensity on T2w images and contrast enhancement on ce TSE T1w images (Fig. 5 on page 6). MR can be an effective imaging technique in the follow-up of prostate tumors treated with cryosurgical ablation, in particular in the early evaluation of the efficacy of the treatment (immediate feedback about size and geometry of the cryoinsult) and in the evaluation of patients with clinical or laboratory suspect of recurrence (1).

**B) HIFU ABLATION**

**Background**

HIFU ablation is an alternative treatment for localized prostate carcinoma, that has the potential to treat the tumor minimizing the sexual and urinary morbidity that accompany radical therapies. The treatment is performed using an endorectal probe capable of providing real-time diagnostic imaging or high energy for therapeutic ablation. The treatment induces a coagulative necrosis of the gland (3) (Fig. 6 on page 6).

**Post treatment anatomy**

After the treatment, the prostate showed predominantly low signal intensity on both T1w and T2w MR images, with poor definition to the capsule and with heterogeneous signal intensity of the surrounding fat. Treated glands showed an increase in size 24 hours after treatment and a progressive decrease in size (more than 45%), due to fibrotic evolution. On ce-dynamic MR images the treated gland showed nonenhancing, low signal intensity within the prostate, extended outside the gland and involved the periprostatic fat and the levator ani muscle (Fig. 7 on page 7).
The most significant MR patterns in the follow up of prostatic carcinoma treated with HIFU ablation were the decrease in size of the gland with the passing of time and the complete ischemia of the prostate, with periurethral zone sparing. The most effective MR techniques for lesions size and enhancement evaluation were TSE T2w and subtracted ce-TSE-FS T1w sequences (3).

Patterns of recurrence
On MR images local recurrences after prostate HIFU ablation showed focal nodular areas with intermediate signal on T2w images and contrast enhancement on ce TSE T1w images (Fig. 8 on page 8). MR can be an effective imaging technique in the follow-up of prostate tumors treated with HIFU ablation, in particular in the early evaluation of the efficacy of the treatment and in the evaluation of patients with clinical or laboratory suspect of recurrence (3).

Images for this section:

Fig. 1: FIG. 1 CRYOTHERAPY TREATMENT TECHNIQUE (A) 17G cryoneedle. (B) scheme of cryoprobes placement into the prostate gland (C) 17G cryoneedles inserted through the perineum to outline the shape of the prostate

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Fig. 2: FIG. 2 CRYOTHERAPY NORMAL ANATOMY: SIGNAL INTENSITY On T1w images, treated prostate was iso-hyperintense 24 hrs after treatment and isointense at 3, 12 and 36 months. On T2w images, treated prostate was heterogeneously iso-
hyperintense 24 hrs after treatment. Cryolesion was hypointense, with hyperintensity of
the spared periurethral zone at 3, 12 and 36 months. 24 hrs after treatment, cryolesion
was about 1 cm larger than the original gland; progressive decrease in size at 3, 12 and
36 months after surgery.

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**Fig. 3:** FIG. 3 CRYOTHERAPY NORMAL ANATOMY: SIZE 24 hrs after treatment, cryolesion was more than 6 mm larger than the original gland; progressive decrease in size at 12 and 36 months after surgery. Subtracted ce-T1w MR images showed ischemia of the peripheral gland and enhancement of the central portion of the prostate, due to the sparing of the periurethral zone.

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**Fig. 4:** FIG. 4 CRYOTHERAPY NORMAL ANATOMY: VASCULARIZATION MR images showed ischemia of the peripheral gland and relative enhancement of the central portion
of the prostate, due to the sparing of the periurethral zone, 24 hrs after treatment and at 12 months. The lack of enhancement of the peripheral zone was better evaluated 12 months after treatment (red arrow).

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**Fig. 5:** FIG. 5 CRYOTHERAPY RECURRENCE 3 YEARS AFTER TREATMENT
Increase in size of the periurethral spared zone (red arrows) on MR images at 36 months from treatment, in patient with increase of PSA level. Biopsy findings suggested a local recurrence.
Fig. 6: FIG. 6 HIFU ABLATION TREATMENT TECHNIQUE Scheme of position of the HIFU endorectal probe, capable of provide real-time diagnostic imaging or high energy for therapeutic ablation.
**Fig. 7:** FIG. 7 HIFU ABLATION NORMAL ANATOMY After the treatment, the prostate shows predominantly low signal intensity on both T2w (A) and T1w (B) MR images. Subtracted ce-dynamic MR image (C) shows lack of enhancement of the treated gland.

**Fig. 8:** FIG. 8 HIFU ABLATION RECURRENCE 2 YEARS AFTER TREATMENT Transverse (A) and sagittal (B) TSE T2w MR images show low signal intensity of the peripheral gland, with an area of intermediate signal intensity in central zone (arrow). After
injection of contrast material, conventional (C) and subtracted (D) ce GRE T1w images show fast enhancement of the lesion (arrow)
Conclusion

MR is an effective imaging technique in the follow-up of prostate carcinoma after ablative treatments. The most effective techniques were multiplanar TSE T2w and dynamic GRE T1w sequences. The most important parameter in the evaluation of the ablated prostate was the absence of nodular patterns of enhancement on dynamic MR study on the treated areas.

Personal Information

Dr. Gianpiero Cardone
Chief MR and CT division
Radiology department
San Raffaele Turro Hospital
Milan, Italy
Via Stamira d'Ancona 20 20127
ph. +39 10 26433285
email cardone.gianpiero@hsr.it

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