www.rcr.ac.uk

Clinical Radiology
The Royal College of Radiologists

Recommendations for cross-sectional imaging in cancer management, Second edition

Prostate tumours

Faculty of Clinical Radiology

Contents

Prostate tumours **3**
Clinical background 3
Who should be imaged? 4
Staging objectives 4
Staging 4
Follow-up 6
Tips 6

References **8**

Prostate tumours

Clinical background

Prostate cancer is the most common cancer in men and makes up 26% of all male cancer diagnoses in the UK. In 2008, 34,335 men were diagnosed with prostate cancer and in 2010 there were 9,632 deaths from prostate cancer in England, Wales and Northern Ireland.[1–4]

An increasing incidence and patient awareness, together with technical developments in treatment, have generated an increased need to improve imaging to detect and stage the tumour initially, to help determine the most appropriate treatment for diagnosed patients and to detect relapsed disease after definitive therapy. Monitoring local disease response is not generally in the realm of imaging. Pathologic diagnosis is usually established on transrectal ultrasound-guided biopsy (TRUS)[5] or as an incidental finding on histological reviews of chippings from transurethral resection of the prostate done for benign prostatic hyperplasia (BPH).

Increasingly MRI is being recommended in patients without a cancer diagnosis when serum PSA levels are markedly elevated, in a large prostate gland or after an abnormal digital rectal examination. The National Institute of Health and Care Excellence (NICE) has also recommended that multiparametric MRI be undertaken in patients with persistent suspicion of prostate cancer.[4] In these patients groups, MRI can help to guide the most appropriate method for obtaining biopsy material when an abnormality is found. Discussions of these prediagnosis indications for MRI are, however, beyond the scope of these guidelines.

Appropriate treatment selection for prostate cancer patients requires high-quality and clinically relevant imaging that is best managed through urology multidisciplinary team (MDT) working, where diagnostic radiologists can understand underlying clinical issues and where clinicians can appreciate the indications for, limitations of and developments in, imaging that are available to them. Prostate MR imaging now incorporates sophisticated and highly accurate anatomical imaging and physiological and biological imaging yielding an expanding volume of data about tumour location and extent.

The interpretation of combined imaging findings and clinical information informs the choice of treatments including surveillance, radical treatments including surgery and radiotherapy, or palliative strategies including watchful waiting and androgen blockage.

- If disease is organ-confined, depending on the risk category, active surveillance or radical treatment may be offered. Lower risk patients may undergo nerve-sparing surgery but for those at higher risk, the surgical priority changes to achieving negative surgical margins and nerve sparing if possible. The role and duration of adjuvant therapies is determined by the risk category and the postoperative pathologic status (if undertaken).
- If disease is largely organ-confined with small volume periprostatic or seminal vesicle spread, radical radiotherapy and/or radical surgery can still be offered with/without pelvic nodal irradiation and adjuvant hormonal therapy, determined by the risk category and the postoperative pathologic status (if undertaken).
- The presence of suspected apical tumour will affect radiotherapy margins and may alter the surgical approach with regard to the prostatic apex.
- Patients presenting with locally advanced or metastatic disease do not always need detailed local tumour staging. The emphasis for these patients is on metastatic staging most often done with CT scanning and isotope scintigraphy.

Therefore, the choice of which imaging technique to use and how imaging should be interpreted depends on the clinical presentation and the intent to treat actively or otherwise; the choice of radical therapy will also influence the imaging approach. Elderly men and those with significant co-morbidities may well not require any imaging at all, in the absence of any intention to offer

radical therapy. Such patients can be monitored (watchful waiting) with serum prostate-specific antigen (PSA) as necessary and medical intervention can usually be done without the need for highly sophisticated cross-sectional imaging.

Who should be imaged?

MRI has become established at various points in the prostate cancer patient pathway. There is an evolving view among urologists, uro-oncologists and urological radiologists concerning appropriate patient categories that should be imaged using MRI. Most agree that the following cancer patient categories require MRI of the prostate gland:

- Symptomatic patients, as MRI has an important contributing role in determining tumour extent, detecting tumour-associated complications and planning treatment
- Patients at high risk of local/metastatic spread with PSA greater than 20 ng/ml, Gleason score 8–10 and clinical stage T3 or T4 (these patients should also be assessed for metastatic disease, usually with isotope scintigraphy and CT scanning)
- Potential surgical candidates when their risk category suggests that the risk of extra-prostatic disease is significantly elevated
- Patients with palpable apical tumours
- Patients about to embark on a period of active surveillance for apparently low-risk disease because about a third of such patients are misclassified.[4]

Staging objectives

- To delineate the intra- and extra-prostatic location and extent of the local disease. Here, the key distinction continues to be organ confinement versus presence and extent of extra-prostatic disease. Although prostatic cancer is often multifocal, the detection of the dominant prostatic cancer nodule (index lesion) is becoming important for therapy planning because it can determine the patient's therapy plan and prognosis. To detect the presence of cancer at the prostatic apex; this is an important consideration for a patient being considered for surgical therapy.
- To detect the presence and location (intra- versus extra-pelvic) of nodal enlargement.
- To detect the presence of bone metastases.
- To detect the presence of complications of urinary tract obstruction.

Staging

Currently, imaging on a 1.5 Tesla scanner is recommended with high density surface pelvic-phased array coil. 3T imaging improves image quality considerably and should be used when available. An endorectal coil may yield additional benefits due to increased signal-to-noise ratio and the ability to perform higher resolution imaging, but it cannot be routinely recommended. The routine use of diffusion-weighted MRI (DW-MRI) is highly recommended but it does require a highly specified MRI scanner with appropriate software. Dynamic contrast enhancement (DCE-MRI) and spectroscopic imaging (MRSI) cannot be recommended for routine use when staging disease, but DCE-MRI can be useful for lesion detection particularly after previous negative TRUS biopsies, for the triage of patients being considered for active surveillance and for detecting recurrent disease after definitive therapy.[4]

MRI

MRI is the imaging technique of choice for staging clinically localised prostate cancer when radical treatment is under consideration. Radical surgery, radiotherapy or other forms of locally ablative therapy require accurate delineation of disease extent and the likely nodal status. A bowel relaxant may be used to improve quality of images.

Protocol for imaging of prostate tumours (at 1.5T)

Sequence	Plane	Slice thickness	Field of view	Reason
TIW	Axial prostate	3 mm (max)	Small (eg, 20 cm)	To detect the presence of intraprostatic blood and to delineate the outline of the gland
T2W	Axial prostate	3 mm	Small	Local staging, detection of dominant intraprostatic nodule and apical tumour
T2W	Coronal prostate	3 mm	Small	Local staging particularly involvement of prostatic base and adjacent seminal vesicle invasion. Nodal involvement also well shown
T2W fast spin echo (FSE)	Axial abdomen (breath-hold) & pelvis (non-breath-hold)	5–6 mm	Large	Nodal involvement
T1W spin echo (SE)	Axial pelvis	5–6 mm	Large	Nodal involvement and bone metastatic disease
DW-MRI echo planar (EPI)	Axial prostate	4–5 mm	Intermediate	To detect the intra-prostatic location of tumours

T2W fast spin echo (FSE) sequences give the optimum contrast between tumour and normal prostate in the peripheral zone while T1W images give sharp demarcation of the outer contour of the prostate against periprostatic fat. The echo train length of FSE sequences should not be excessive (greater than 30) because image blurring will occur. Sagittal plane imaging does not always contribute and is not recommended for routine use. Differentiation of tumour from nodular BPH in the transition zone gland is difficult on all sequences and is best undertaken on T2W FSE sequences.

DW-MRI should use at least three b-values (highest ≥1000 s/mm^2) for accurate apparent diffusion coefficient (ADC) map calculations. Ultra long b-values can be a useful aid in lesion localization.[6] ADC values correlate inversely with tumour grade. DW-MRI is useful for detecting the intraprostatic location of tumours, particularly in the peripheral zone and recurrent tumours after radiotherapy but are less effective when low-dose-rate brachytherapy seeds are in situ. DW-MRI can be helpful for detecting anterior fibromuscular stromal tumours.

Dynamic contrast-enhanced (DCE-MRI) T1W sequences (with temporal resolution <15 sec) may help to improve the localisation of the tumour within the gland; they have been shown to better demonstrate small volume extraprostatic disease extension (both T3A/T3B disease) and have roles in detecting recurrent tumour in the treated gland or after radical surgery.

CT

CT of the pelvis does not have a role in T-staging prostate cancer and is not recommended. The contribution of CT is in the assessment of nodal status and in detecting metastatic bone disease in high-risk prostate cancer patients at baseline staging and for those with suspected relapse when PSA levels are high or when PSA doubling time is short.

CT of the abdomen and pelvis should be performed.

- Oral administration of 1 litre of water or iodinated contrast medium.
- 100 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec.
- MDCT is commenced at 70–80 seconds post-injection to assess the abdomen and pelvis.
- Using MDCT, slice thickness will depend on scanner capability. In general, sections are acquired at 1.25–2.5 mm and reformatted at 5 mm for viewing.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and section on Radiation protection for the patient in CT in Section 2).

Note: 99mTc-labelled bone scan is superior to CT for detecting metastatic bone disease.

PET-CT

^{18}FDG PET-CT does not have a primary role in the staging of primary prostate cancer. Newer tracers such as ^{18}F-Choline has become commercially available, but its roles is incompletely defined. Choline PET-CT may be useful when conventional imaging suggests but is not diagnostic of nodal or metastatic disease when confirmation or exclusion of distant disease would directly affect management.[7] Choline PET-CT does not have the test performance to adequately exclude nodal metastases in apparently node-negative disease patients due to undergo radical treatments. Sodium fluoride PET-CT produces very high-quality images of the skeleton and is more sensitive than conventional planar bone scintigraphy for detection of bone metastases. The CT component increases specificity and localisation of the sodium fluoride uptake. Whole-body MRI is an upcoming modality for detecting distant metastases whose role requires further investigation.

Follow-up

Follow-up for prostate cancer will depend on the type of treatment used. Routine imaging follow-up is not indicated following radical treatment (either surgery or radiotherapy).

- Biochemical failure (serial rising serum PSA levels) may require imaging to try to determine whether the recurrence is confined to the pelvis (local) and/or systemic. Local salvage treatment requires the exclusion, as far as possible, of distant metastases.
- MRI is more helpful than CT for assessing the prostate bed following radical prostatectomy. Dynamic contrast enhancement may be useful for differentiating scar tissue from active disease. Surgical clips may render DW-MRI less effective in prostatectomy patients.
- DCE-MRI and DW-MRI are both useful techniques to detect the intraprostatic extent of recurrent disease following radical external beam prostate radiotherapy – thus allowing salvage therapies to be undertaken. Both MRI and CT can be used to detect lymph node metastases.
- Choline PET-CT may be of value in suspected recurrence in patients with a rapidly rising PSA and indeterminate or equivocal conventional imaging where the results would directly influence patient management but, at present, this is only available in a few centres in the UK.

Tips

- When reporting prostate MRI, it is useful to refer to nomograms such as Partin tables, which provide the pre-test probability of organ confinement, seminal vesicle invasion and nodal involvement. These tables are particularly helpful when imaging findings are equivocal and staging will affect treatment. It has been shown that this approach improves accuracy of staging overall.
- Prostatic haemorrhage is almost universally seen after transrectal biopsy of the prostate and can take many weeks to clear. The presence of haemorrhage has detrimental effects on localising the extent of intra-prostatic disease. Occasionally, blood can lead to blurring of the prostatic capsule making the evaluation of small volume extra-prostatic disease problematic. Caution should be exercised in interpreting minimal extra-prostatic spread in the presence of haemorrhage. Recommendations on the delay of performing MRI after TRUS biopsy are not universally accepted and vary between four to six weeks.[6] Many UK centres now perform MRI scans before prostate

biopsy to avoid the detrimental effects of biopsy related intraprostatic blood, so as to minimise delays in arriving at a diagnosis in patients with suspected cancer.

Approved by the Clinical Radiology Faculty Board: 31 October 2013

References

1. Data were provided by the Office for National Statistics on request, March 2013. Similar data can be found here: http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm%3A77-27475

2. Data were provided by ISD Scotland on request, November 2012. Similar data can be found here: http://gro-scotland.gov.uk/statistics/theme/vital-events/general/ref-tables/index.html.

3. Data were provided by the Northern Ireland Cancer Registry on request, May 2013. Similar data can be found here: http://www.nisra.gov.uk/demography/default.asp22.htm

4. The Royal College of Radiologists. *iRefer: Making the best use of clinical radiology,* 7th edn. London: The Royal College of Radiologists, 2012. (www.irefer.org.uk)

5. NICE 2014: Prostate cancer (CG175). Here is the website http://www.nice.org.uk/guidance/index.jsp?action=byID&o=14348

6. Kirkham AP, Haslam P, Keanie JY *et al.* Prostate MRI: who, when, and how? Report from a UK consensus meeting. *Clin Radiol* 2013; **68**(10): 1016–1023.

7. The Royal College of Physicians and The Royal College of Radiologists. *Evidence-based indications for the use of PET-CT in the United Kingdom 2013.* London: Royal College of Physicians, 2013.

Authors:

Professor Anwar R Padhani, Consultant Radiologist and Professor of Cancer Imaging, Paul Strickland Scanner Centre, Mount Vernon Cancer Centre and The Institute of Cancer Research, London

Dr Brendan Carey, St James' University Hospital, Leeds

Dr Clare Allen, University College Hospital, London

Citation details

Padhani AR, Carey B, Allen C. Prostate tumours. In: Nicholson T (ed). *Recommendations for cross-sectional imaging in cancer management*, Second edition. London: The Royal College of Radiologists, 2014.

Ref No. BFCR(14)2

The Royal College of Radiologists
63 Lincoln's Inn Fields, London WC2A 3JW
Tel: +44 (0)20 7405 1282
Email: enquiries@rcr.ac.uk **www.rcr.ac.uk**

A Charity registered with the Charity Commission No. 211540