CONTINUING EDUCATION PROGRAM: FOCUS...

Imaging tumours of the penis

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Tumour;
MRI;
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Abstract  Malignant primary epithelial tumours of the penis are rare and mainly affect uncircumcised men in their fifties to seventies. They are most frequently located in the glans and foreskin. Imaging is performed if the clinician has doubts about deep extension, after a diagnostic biopsy. High-resolution ultrasound and above all MRI are used to detect invasion of the corpora cavernosa and spongiosum. The lesion is often seen as a moderate T2 hyposignal, making it possible to distinguish it from the relative hypersignal of the corpora cavernosa. The sentinel lymph nodes are inguinal. Adenopathy is frequently present, but does not, however, necessarily reflect tumour invasion, as secondary infection of the lesion, which is often ulcerated, is common. The prognosis for T1 N0 tumours is good, at the cost of mutilating ablation. Extension to the lymph nodes is detrimental. Non-epithelial tumours and metastases are even rarer.

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Few teams have regular experience of penis imaging, due to the rarity of indications for it: these are mainly suspected Peyronie’s disease, erectile dysfunction, tumours and trauma, certain sub-acute sepsis, prosthesis complications etc. Two techniques are used: Doppler sonography and MRI. Ultrasound is used relatively often to look for calcified plaques, or arteriocavernous fistulae in high flow priapism; Doppler with intracavernous injection of prostaglandins is of recognised value for investigating erectile dysfunction. MRI of the penis has been the subject of several general didactic articles [1–3], a few, generally retrospective, cohort studies with a small number of patients, on certain named diseases, and of quite a few case reports on rarer diseases.

We will first present some epidemiological, anatomical and radio-anatomical reminders and then develop imaging results.

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Epidemiology

Primary tumours of the penis are rare lesions, affecting men of about 60 years of age. They are usually squamous cell carcinomas. These are serious tumours, resulting in death within 2 years if not treated. Diagnosis is frequently late because there is often a delay between the first symptoms and consultation, caused by patients’ embarrassment.

There is a wide variability in prevalence between different countries: 4 per 100,000 in Africa, Asia and South America as against 0.3—1 per 100,000 in North America. In France, incidence is estimated at 270 new cases per year, and these tumours account for 0.5% of cancers in men [4]. This tumour affects the glans and/or the foreskin in 98% of cases, which is why a lesion of the corpora cavernosa of the body of the penis should initially suggest another diagnosis (e.g. metastasis).

Factors helping prevent these tumours are circumcision, the use of condoms and good hygiene. The risk factors, on the other hand, are the absence of circumcision, poor hygiene and sexually transmitted human papilloma virus (HPV) infections. Tobacco, UVA and phimosis have been implicated. Some skin lesions, such as Bowen’s disease, lichen sclerosus and erythroplasia of Queyrat, are considered pre-cancerous.

Invasive lesions require surgery, which is extremely mutilating. The current difficulties of management are in assessing the depth of extension, for which radiologists try to provide an answer with MRI, and especially in assessing lymph node invasion: bilateral deep curage is indeed associated with severe morbidity. In some cases, concomitant iliac lymphadenectomy is recommended. The role and type of chemotherapy remain to be defined.

The TNM classification is shown in Box 1.

<table>
<thead>
<tr>
<th>Box 1: TNM classification of tumours of the penis (primary carcinomas)</th>
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<tbody>
<tr>
<td><strong>T - Primary tumour</strong></td>
</tr>
<tr>
<td>Tx Tumour cannot be assessed</td>
</tr>
<tr>
<td>T0 Absence of tumour</td>
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<tr>
<td>Tis Carcinoma in situ</td>
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<tr>
<td>Ta Superficial verrucous cancer</td>
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<tr>
<td>T1 Tumour invades subepithelial connective tissue</td>
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<tr>
<td>T2 Invasion of the corpus spongiosum or cavernosum</td>
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<tr>
<td>T3 Invasion of the urethra or prostate</td>
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<tr>
<td>T4 Invasion of other adjacent structures</td>
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<tr>
<td><strong>N - Regional lymph nodes</strong></td>
</tr>
<tr>
<td>Nx Cannot be assessed</td>
</tr>
<tr>
<td>N0 Absence of regional lymph node metastases</td>
</tr>
<tr>
<td>N1 Single superficial inguinal lymph node metastasis</td>
</tr>
<tr>
<td>N2 Bilateral or multiple superficial inguinal lymph node metastases</td>
</tr>
<tr>
<td>N3 Unilateral or bilateral deep inguinal or pelvic metastasis or metastases</td>
</tr>
<tr>
<td><strong>M - Distant metastases</strong></td>
</tr>
<tr>
<td>Mx Cannot be assessed</td>
</tr>
<tr>
<td>M0 Absence of metastases</td>
</tr>
<tr>
<td>M1 Distant metastasis or metastases</td>
</tr>
</tbody>
</table>

Treatment is the most conservative possible, either by surgery or brachytherapy.

Basal cell carcinomas, melanomas, mesenchymal tumours such as sarcomas or angiomatis, which have no specific imaging features, are also infrequently observed in the primary tumour group.

Metastases (mainly primary tumours of the urogenital region) and lymphomas have also been described.

Anatomical overview and radio-anatomy

Anatomy

The penis is formed from three erectile organs, the corpus spongiosum and two corpora cavernosa. The corpora cavernosa have their origins on the ischiopubic rami and terminate at the base of the glans (dorsal surface of the penis) (Figs. 1—3). They consist of sinusoids separated by a fibrous framework, and they are crossed by the cavernous arteries, which give rise to the helicine arteries. The corpora cavernosa are surrounded by the tunica albuginea. The corpus spongiosum contains the urethra, has its origin on the central fibrous nucleus of the perineum (median) and ends with the glans. The tunica albuginea surrounding the corpus spongiosum is thinner than that of the corpora cavernosa. The peripheral tissues surrounding these structures are Buck’s fascia, Colles fascia, dartos fascia, and finally the skin.

Doppler sonography

The use of high frequency probes has significantly changed diagnostic accuracy for abnormalities, especially tumours. Most of the studies pointing out the lack of a significant contribution of ultrasound were published before the progress contributed by these new probes. Colour Doppler...
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Figure 2. Transverse section of the penis. 1: skin; 2: Dartos fascia; 3: coles’ fascia; 4: dorsal superficial vein of the penis; 5: Buck’s deep fascia; 6: deep dorsal vein of the penis; 7: dorsal artery; 8: dorsal nerve; 9: Tunica albuginea; 10: Corpora cavernosa; 11: cavernous artery; 12: Corpus spongiosum; 13: Urethra.

must be adapted to slow flows (Power Doppler) (Fig. 4). The penis can be scanned placed on the abdomen, then resting on a support, and finally with a percutaneous approach for the deep fixed portion.

The inguinal lymph nodes should also be explored.

MRI

The technique is adapted to the patient’s anatomy (short, buried penis, etc.). Whether the penis is resting on the abdomen, or is downwards, resting on a support, it is important for it to be median, and to remain so throughout the examination (held in place). A small circular coil should be used, and T2-weighted sequences programmed in all three planes, because this weighting is the most sensitive for almost all pathological conditions. We identify the most demonstrative plane for the condition (in the case of a tumour, this is often a sagittal slice), in order to repeat it in T1 weighting before and after gadolinium injection, with or without fat saturation. Some authors have used intracavernous injections of prostaglandin E1 (PGE1) to maintain the penis erect and optimise the examination [5]. The field of view must be such that the inguinal lymph nodes can be explored.

Figure 3. Sagittal section of the distal end: glans and coronal sulcus. The glans is continuous with the corpus spongiosum; it is covered by a non-keratinised epithelium covering the sub-epithelial connective tissue.

Chest/abdomen/pelvis CT scan

This is the part of staging, which must particularly look for lymph node, lung and bone metastases.

Normal results of MRI

The corpora cavernosa are theoretically in T2 hypersignal (Fig. 5). However, in our experience this is not constant, without that being pathological: areas of T2 hyposignal are very common and should not be misinterpreted for areas of fibrosis. The tunica albuginea surrounding the corpora cavernosa is in sharp T1 and T2 hyposignal. Its thickness is variable. The corpus spongiosum is less developed, contains the urethra and is clearly enhanced early after injection of gadolinium. The corpus spongiosum remains median, starting with the bulb and ending with the glans.

Primary epithelial tumours of the penis

Ultrasonography

Ultrasound shows a discrete hypoechoic, non-absorbent lesion with lobulated contours, which is poorly vascularised in colour Doppler (Fig. 6a). Extension of the tumour (usually affecting the glans) to the corpora cavernosa is directly visible, with interruption of the tunica albuginea. Nodules at a distance on the venous drainage routes can be identified. Ultrasound is not the reference method for local staging.

Adenopathies are often hypoechoic, with a necrotic centre (thick liquid content). Abscesses adjacent to the tumour have been described.

MRI

MRI helps evaluate primary tumours of the penis, particularly the assessment of local invasion (Figs. 6–9) [6–9]. The tumour appears as a T2 relative hyposignal, in T1 it is in

Figure 5.  Normal MRI of the penis: a: axial T2-weighted slice. Corpora cavernosa inserted on the ischiopubic rami. In the centre, start of the corpus spongiosum known as the bulb (thin arrow). Superficial transverse muscle (thick arrows); b: perineal axial slice. The hyposignal 'U' is the bulbocavernous muscle; c: axial section of the penis (flat on the abdomen) in a T2-weighted sequence. The corpora cavernosa (star) are in normal hypersignal, surrounded by the tunica albuginea in hyposignal (arrow). The urethra can be seen (thick arrow) within the corpus spongiosum; d: axial T1-weighted image of the penis: the tunica albuginea appear in hyposignal (arrow).
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Figure 6. Tumour of the glans (squamous cell carcinoma): a: Doppler ultrasound: the tumour is vascularised, with lobulated contours. It is deeply invading the corpus spongiosum; b: T2 sagittal slice: the lesion in relative hyposignal occupies the whole glans (corpus spongiosum) and is invading the distal end of the corpora cavernosa; c: axial T1 slice after injection: contrast enhancement of the invaded left corpus cavernosum.

Figure 7. Tumour of the glans on a 3 T MRI. Imaging of the penis benefits from the improved spatial resolution. The invasion of the corpus cavernosum is clearly visible. Grateful thanks to Prof. Roy, Strasbourg.

isosignal and enhances moderately after injection. Carrying out the examination on an erect penis after intracavernous injection of prostaglandin is recommended in theory, but rarely applied in practice. Investigating the depth of extension will help the surgeon to prepare the penectomy, which in some cases will be wider than it would appear from the initial extension, for anatomical and functional reasons (comfort during urination).

Adenopathies may be the result of secondary infection, which is frequent, and conventional imaging (ultrasound, CT, MRI) cannot distinguish with certainty between tumour invasion and secondary infection. Some authors have found that a necrotic centre and lobulated contours were arguments for tumour invasion rather than secondary infection [10]. The most recent reviews recommend needle aspiration biopsy of adenopathies, whether they are palpable or not, and the use of the sentinel node procedure if needle aspiration biopsy is negative [11]. This technique is still underdeveloped compared with its use in the management of breast cancer that has served as a model. A recent series has shown the potential value of 18-fluorodeoxyglucose PET in improving the sensitivity and specificity of imaging [12].
Figure 8. Squamous cell carcinoma of the foreskin in a 25-year-old man: a: preoperative view; b: T1 MRI after gadolinium: the tumour (arrow) surrounds the glans and the corpora cavernosa, without clearly visible invasion. Histopathology revealed a small nodule in a corpus cavernosum, which was not found on the MRI, even retrospectively.

Figure 9. Inguinal adenopathies: a: CT scan; b: MRI. The necrotic character of the adenopathy does not allow prejudgment of their invasion.

MRI is useful for post-treatment surveillance (partial or rarely total penectomy, brachytherapy) in addition to clinical examination (Fig. 10).

Other malignant tumours of the penis

Urethral tumour

This is usually a transitional cell carcinoma, which can invade the corpora cavernosa. MRI is a method of choice for assessing its extension (Fig. 11).

Metastases

The primary tumours concerned are usually of urogenital (prostate, bladder, urethra, testes) or rectal origin [13,14]. They can involve several levels of the corpora cavernosa or spongiosum, which is an argument for diagnosing metastases (Figs. 12–13). They can be revealed by priapism. The lesions are right in the middle of the corpora cavernosa or spongiosum, which distinguishes them from primary lesions; they appear in T2 hyposignal, and show non-specific enhancement after injection. Percutaneous biopsies are possible (penile block as anaesthesia).
Lymphoma

A few cases of primary lymphoma of the penis have been described [15–17], and should be distinguished from secondary invasion of the pelvic or genital organs by diffuse lymphomas.

Sarcoma

A few cases have been reported of Kaposi’s sarcoma of the penis in HIV patients. These same sarcomas have been reported in HIV-negative patients [18,19]. Other rare cases of angiosarcoma, leiomyosarcoma and carcinosarcoma have been described [20–22].

Benign conditions simulating a tumour

Epidermoid cyst

The most common lesion is an epidermoid cyst; with ultrasound it can simulate a solid tumour because of its echogenic character (thick contents), but it is avascular with Doppler.
In MRI, it often has a T1 hypesignal (protein rich content) and is not enhanced after injection.

Post-traumatic fibrosis

The classic circumstance is a penile fracture (which may not have been related to the doctor). The patient has a focal induration and a diversion on erection [23]. Ultrasound shows an attenuated, rather hyperechoic zone, and the MRI a clear focal area in T2 hyposignal. Enhancement varies depending on the age of the injury (Fig. 14).

Spontaneous thrombosis of one or both corpora cavernosa

This is rare, the subject of just a few cases reported [24,25], and some considerable time after the acute episode of thrombosis, a differential diagnosis may have to be made between this condition and a deep tumour. The thrombosis, which is usually unilateral, is characterised by severe, mostly perineal pain, because it usually concerns the proximal part of one of the corpora cavernosa. Clinical examination shows a very firm corpus cavernosum; the pain subsides within a few days while the swelling remains. In an MRI, the corpus cavernosum is swollen, in hypersignal in T1 and T2, without enhancement after injection (subtraction being useful). Treatment is medical (an anticoagulant, analgesic and/or anti-inflammatory). Haemostasis abnormalities should be sought or a hyperviscosity syndrome.

Peyronie’s disease

There is no real diagnostic problem in most patients. However, some areas may be decidedly nodular and can be confused with an intracavernous tumour mass. The aetiology is unknown, although a genetic predisposition is probable (HLA-B27). The patient consults for pain (permanent or on erection) and kinking of the penis [26–28]. Ultrasonography and MRI are complementary. Old plaques are often calcified (Fig. 15). Treatment is difficult and can be medical (vitamin E, Potoba, pentoxifylline, verapamil etc.) or surgical (grafting, plication, prosthesis etc.). Lithotripsy does not appear to improve the kinking.

Figure 13. Metastasis of a prostate carcinoma. Sagittal T1-weighted slice after gadolinium injection. The lesion was most visible in this sequence, and hardly visible in spontaneous contrast. Grateful thanks to Prof. Rouvière (Lyon).

Figure 14. Post-traumatic fibrosis. Kinking of the penis on erection and palpable nodule. On questioning, there was a trauma several months ago: a: ultrasonography. Absorbent localised echogenic area, suggesting a fibrous scar; b: T2 MRI. Fibrous nucleus, in T2 hyposignal, in the left corpus cavernosum.
**TAKE-HOME MESSAGES**

- The glans and the foreskin are the virtually exclusive locations for primary carcinomas of the penis, encouraged by non-circumcision and often developing on a precancerous lesion.
- MRI gives the best preoperative appreciation of the depth of local extension of the tumour within the corpus spongiosum or corpora cavernosa (essentially in T2-weighted sequences).
- The sentinel lymph nodes are inguinal.
- A chest/abdomen/pelvis CT scan including the inguinal area assists staging.
- Lymph node invasion is a real problem for diagnosis and treatment (morbidty of deep bilateral curage).
- 18FDG PET gives apparently promising results for lymph node and metastatic staging. Lymph node needle aspiration biopsies (ultrasound-guided if they are not easily palpable) are currently recommended to determine the type of curage.
- Benign tumours, non-epithelial malignant tumours and metastases (urogenital cancers) are even rarer than primary malignant tumours.

**Disclosure of interest**

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

**References**


