Imaging of testicular tumours

EJ Owens, J Kabala, P Goddard

This article reviews the diagnosis, pathology and imaging of testicular tumours, predominantly germ cell tumours. It will discuss the imaging techniques used in their diagnosis, staging and surveillance.

Dr EJ Owens is Specialist Registrar in Radiology, **Dr J Kabala** is Consultant in Radiology and **Professor P Goddard** is Consultant in Radiology, Bristol Royal Infirmary, United Bristol Health Care Trust, Bristol BS2 8HW

Correspondence to: Dr J Kabala

Testicular tumours are relatively uncommon, accounting for about 1% of all cancers in males. However, they are the most common malignancy in males between the ages of 20–40 years. The current cure rate approaches 97% when detected and treated in the early stages. Imaging is important for the initial diagnosis, staging and surveillance.

RISK FACTORS

Testicular maldescent or atrophy is the most important risk factor with a ten-fold increase in risk. Testicular microlithiasis (*Figure 1*) is now a recognized risk factor and if found incidentally, is usually followed up with repeated ultrasound (USS) scanning. Other risk factors include previous testicular malignancy (incidence 2.5–5%), a family history (in 2%), Caucasian race, infantile hernia, low birth weight and maternal exposure to diethylstilboestrol.

PRESENTATION

The most common presentation of a testicular tumour is a painless scrotal lump, which is inseparable from the testis, although patients may describe an associated dull ache or dragging sensation.

Approximately 10% of patients present with an acutely painful testicle and the diagnosis of malignancy must be considered when there is a suspected torsion. Similarly, this diagnosis should be considered when the discovery of a lump coincides with a history of trauma.

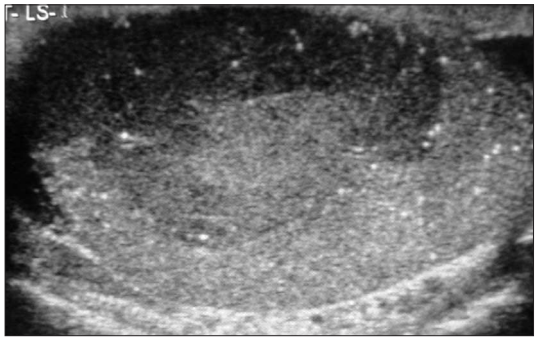

Figure 1. Testicular tumour associated with microlithiasis.

Occasionally the presentation may be of widespread pulmonary or abdominal metastases, rarely with the primary no longer palpable (Azzopardi tumour). The presentation may then be with back pain, particularly if there is significant para-aortic lymphadenopathy.

Rarely premature virilization or gynaecomastia can result from tumours such as the Sertoli or Leydig cell tumours, which may produce sex hormones.

PATHOLOGY

Ninety-five per cent of testicular tumours are germ cell tumours and 4% are lymphomas. The remaining 1% are miscellaneous rare tumours such as metastases or Leydig or Sertoli cell tumours.

Approximately half of germ cell tumours are seminomas. These are less aggressive and occur in an older age group with a peak incidence at 30–40 years of age. The remainder are classified as non-seminomatous germ cell tumours (NSGCT) of varying histology by one of two classification systems, although up to 20% may contain some seminomatous element. These occur in a younger age group, with a peak age of 20–30 years, and at least one biochemical marker (α-fetoprotein or β-human chorionic gonadotrophin) is produced in 80%.

Lymphomas are rare but are the most common testicular malignancy in patients over 60 years old resulting in a further peak in testicular tumours in this age group.

DIAGNOSIS AND PREOPERATIVE INVESTIGATIONS

Diagnosis is usually made by clinical examination and scrotal USS, which has a sensitivity approaching 100%. USS can determine initially if the lesion is within the testicle and can exclude a number of benign lesions such as cysts (*Figure 2*).

A tumour on USS is usually seen as a low echogenic lesion within the testis resulting in architectural distortion, although smaller tumours may show no mass effect. Tumours

measuring <1.5 cm are usually hypovascular on colour Doppler and those measuring >1.6 cm are invariably hypervascular. There may be an associated hydrocoele (*Figure 3*).

Histology cannot be accurately predicted from USS, but classically seminomas are well defined and modestly echo-poor, whereas NSGCTs tend to contain echogenic areas of fibrosis or calcification or hypoechoic cystic areas.

The differential diagnosis includes focal or diffuse orchitis, abscess, haemorrhage and infarct; however, any echo-poor area should always be regarded as highly suspicious for malignancy (*Figure 4*).

Blood for tumour markers should be taken before any operation and a chest X-ray performed. Further staging investigations can wait until the postoperative period and should not be performed until histological diagnosis is confirmed, as occasionally the mass can be benign.

STAGING AND SURVEILLANCE OF GERM CELL TUMOURS

The management and prognosis relies on the presence or absence of spread of disease. In patients with early stage disease, the cure rate is approximately 90%, and even with advanced disease, it is 50%.

The most common sites for metastases are via the lymphatic system to nodes within the pelvis, abdomen and thorax and via the haematogenous route to the lungs. Less common sites of haematogenous metastases are liver, brain and bone.

Lymph node metastases follow the pattern of the arterial supply and are usually localized to the side of the primary tumour. The lymphatic drainage of the testicle is via several lymphatic vessels that accompany the spermatic cord through the inguinal canal and into the pelvis. On the right, drainage is to pre-caval, para-caval and aorto-caval nodes, and on the left it is to the renal hilar, para-aortic and pre-aortic nodes. Crossover from right to left is common but from left to right is rare.

Retrograde lymphatic spread may occur into the mesenteric lymph nodes and antegrade spread into the retrocrural, mediastinal and supraclavicular lymph nodes. It is rare for haematogenous metastases to occur before lymphatic metastases except with choriocarcinoma.

Although there is a TNM classification (Husband and Reznek, 1998), the Royal Marsden classification (Husband and Reznek, 1998) is

Figure 2. Cysts can be readily differentiated on ultrasound.

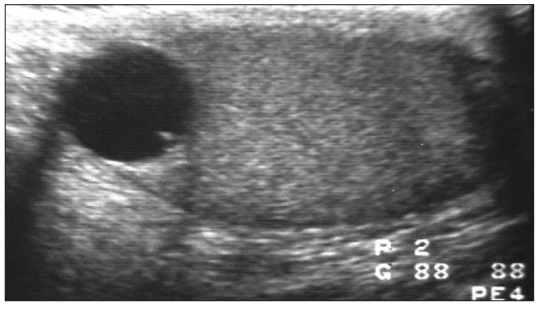

Figure 3. Appearances of a testicular teratoma as a well-defined area of mixed echogenicity with an associated hydrocoele.

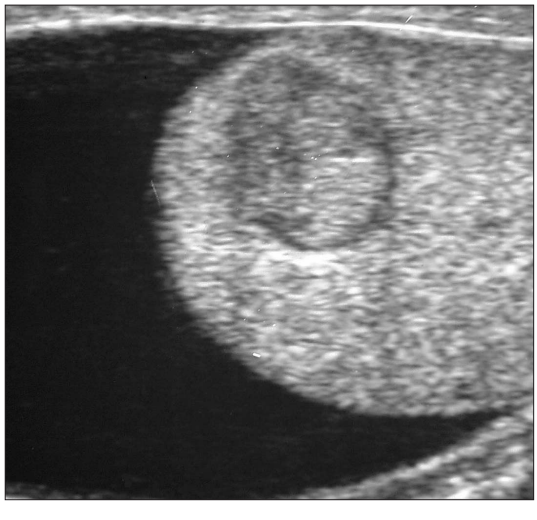

Figure 4. The differential diagnosis of an echopoor area includes (a) epididymo-orchitis and (b) testicular infarct.

most often used in clinical practice (*Table 1*). This is based on both the geographical extent of disease and also the volume of disease, which is likely to be at least as important. Classification of stages III and IV has now been largely superseded by the International Germ Cell Consensus Classification, (Sutton, 2002) which is also based on the level of tumour markers.

Computed tomography (CT) is the conventional staging investigation and CT of the thorax, abdomen and pelvis should be performed at the initial presentation. Intravenous contrast is not routinely necessary, but should be given if there is a question about any specific areas. Difficulties can arise for example in differentiating unopacified bowel or blood vessels from lymph nodes, where intravenous contrast may be invaluable.

Imaging of the brain (CT or magnetic resonance imaging; MRI) is not routine but should be performed if there are any neurological symptoms, >10 lung metastases or elevated tumour markers.

CT detection of lymph nodes depends on their size. A lymph node measuring >1 cm is usually involved and >1.5 cm almost always involved. Micrometastases cannot be detected and any visible lymph nodes <1 cm should be regarded as equivocal and rescanned in 3 months time. Lymph node metastases are usually of soft tissue density and can become very large. Those from seminomas are usually homogenous although can occasionally contain central areas of necrosis, whereas those from NSGCTs can become heterogenous with enlargement with low density or cystic elements (*Figure 5*).

TABLE 1.
The Royal Marsden stain classification

Stage	Definition		
I	No evidence of extratesticular spread		
IM	Rising serum tumour markers with no other evidence of metastases		
II	Infradiaphragmatic node metastases	A	<2 cm in diameter
		B	2–5 cm in diameter
		C	5–10 cm in diameter
		D	10 cm in diameter
III	Supradiaphragmatic node metastases	M	Mediastinal
		N	Supraclavicular/cervical/axillary
		O	No abdominal node metastases
		ABC	Node size as stage II
IV	Extralymphatic metastases		
	Lungs	L1	<3 metastases
		L2	>3 metastases, all <2 cm
		L3	>3 metastases, one or more >2 cm
		H+, Bo+ and Br+	Liver, bone and brain involvement

Within the lungs, multiple soft tissue nodules are usually metastatic. A single nodule, particularly if subcentimetre in size, can present a diagnostic problem. If equivocal, the scan should be repeated in 4–8 weeks to check for interval growth.

The role of MRI is currently uncertain, but it can be used in much the same way as CT. Its advantages are better soft tissue resolution for the detection of lymph node metastases and no ionizing radiation (*Figure 6*). Problems include limited access to an MRI scanner, poorer detection of lung metastases, and significantly increased scan time and the problems with movement artefact related to this.

All staging should be completed within 3 weeks of a histological diagnosis.

TREATMENT

An inguinal orchidectomy is performed for diagnosis and treatment. Adjuvant treatments include chemotherapy and radiotherapy depending on the staging of the tumour.

If the patient presents with widespread disease, the systemic disease should be treated initially with chemotherapy or radiotherapy and the orchidectomy postponed.

Figure 5. Unenhanced axial computed tomography of heterogenous para-aortic lymph node metastases.

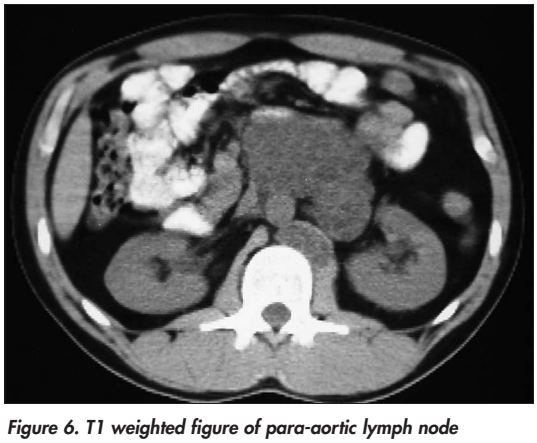

***Figure 6. T1 weighted figure of para-aortic lymph node metastases of the patient in* Figure 5.**

SURVEILLANCE

The regularity of follow up and the radiological investigations performed is currently under debate, but is dependent on the initial pathology, stage and any adjuvant treatment.

Seventy-five per cent of seminomas have stage I disease, and 80% of these are curable by orchidectomy alone. The remainder are at risk of developing nodal metastases. Surveillance is difficult and relapses are often difficult to detect, as the metastases are almost exclusively nodal and there is a lack of tumour markers. The course is often quite prolonged requiring regular abdominal CT scans over a long period of time. For these reasons, para-aortic radiotherapy is usually performed as this raises the cure rate to 97%.

The relapse rate in stage I NSGCTs is between 20 and 30%, and 80% of relapses occur within the first year. These are usually detectable by either clinical examination or elevation of tumour markers and so are easier to monitor with surveillance. Most centres would perform a CT of the chest and abdomen twice within the first 2 years. Although a CT of the pelvis is performed as part of the initial staging, this may be omitted during follow up in the absence of any risk factors (previous inguinoscrotal surgery, previous retroperitoneal surgery or irradiation, para-aortic nodal disease and tumour invasion through the tunica vaginalis). There is some debate as to whether the plain chest radiograph is sufficient follow-up for the thorax rather than CT.

Approximately 25% of patients with NSGCT have extratesticular spread at presentation. Three quarters of these will be associated with a complete response following chemotherapy. The remainder will demonstrate a persistent lymph node mass, the majority of which will contain areas of fibrosis, haemorrhage, cystic degeneration or calcification. A small proportion will contain areas of active malignancy and so these are often treated with surgical excision. Positron emisson tomography (PET) scanning is highly sensitive and specific for differentiating tumour activity from benign disease and may in the future determine which of these persistent tumour masses need to be excised. At present, the lack of funding and availability means that surgical excision is often the only option.

CONCLUSIONS

Ultrasound is the initial investigation of choice to establish if the abnormality is within the testis, and to give an initial diagnosis. Diagnostic uncertainties arise with other conditions, such as infection, haemorrhage and infarction, and any echo-poor lesion should be considered suspicious.

Patients should have a CT scan of the chest, abdomen and pelvis as an initial staging investigation, although this should only be performed when the histological diagnosis of a tumour is known.

Surveillance imaging is currently under debate and depends on the underlying pathology, stage and adjuvant treatments given at the time of diagnosis.

There are current diagnostic difficulties in establishing which patients with a persistent mass on CT following chemotherapy for para-aortic lymphadenopathy still have areas of active disease. Currently, patients usually undergo surgical excision of any remaining mass, but with increasing use of PET scanning, which is extremely sensitive in identifying these areas, the number of patients undergoing surgery may decrease. **HM**

Conflict of interest: none.

Husband JES, Reznek RH (1998) *Imaging in Oncology.* Isis Medical Media Ltd, Oxford

Sutton D (2002) *Textbook of Radiology and Imaging*. 7th edn. Churchill Livingstone, New York

Further reading

Dahnert W (1999) *Radiology Review Manual*. 4th edn. Lippincott Williams and Wilkins, Baltimore

Dearnaley DP, Huddart RA, Horvich A (2001) Managing testicular cancer. *Br Med J* **322:** 1583–8

Hain SF, Maisey MN (2003) Positron emission tomography for urological tumours. *BJU Int* **92**(2): 159–64

Mead GM, Stenning SP, Parkinson MC et al (1992) The Second Medical Research Council Study of Prognostic Factors in Non-Seminomatous Germ Cell Tumours. *J Clin Oncol* **10**: 85–94

Royal College of Radiologists' Clinical Oncology Information Network in partnership with the Scottish intercollegiate guidelines network (2002) *Guidelines on the Management of Adult Testicular Germ Cell Tumours.* Royal College of Radiologists, London (http://www.rcr.ac.uk/testicular.htm)

KEY POINTS

- Although testicular cancer is uncommon, it is the most common malignancy in young men and is potentially curable.
- About 95% of testicular tumours are germ cell tumours, 4% lymphoma and the remaining 1% are rarities such as metastases or Leydig or Sertoli cell tumours.
- Peak age for seminomas is 25 years and for non-seminomatous germ cell tumours is 35 years. A later peak is seen in cases of lymphoma.
- Initial diagnosis consists of clinical examination and scrotal ultrasound.
- Initial staging consists of computed tomography (CT) of the thorax, abdomen and pelvis.
- Inguinal orchidectomy if often curative but radiotherapy and chemotherapy are often used depending on tumour staging and histological subtype.
- Surveillance is variable but consists of tumour markers, regular clinical examination and often annual CT.
- Positron emission tomography is currently not widely available, but is sensitive and specific for tumour presence and may prevent those patients with post chemotherapy lymph node masses from further surgery.