

Primary Bone Tumours of the Spine

A patient guide

In brief: Primary bone tumours of the spine are growths that begin within the bone of the spinal column itself, as distinct from secondary tumours that have spread to the spine from a cancer elsewhere in the body. They are uncommon, accounting for a small fraction of all bone tumours, and they range very widely in their behaviour. At one end sit benign lesions such as osteoid osteoma, osteoblastoma, aneurysmal bone cyst, giant cell tumour and osteochondroma, many of which are discovered by chance and behave in a settled, local manner. At the other end sit the primary bone cancers, chiefly chordoma, chondrosarcoma, osteosarcoma and Ewing sarcoma, which are rare but require careful, coordinated treatment. A separate group, the plasma-cell tumours of plasmacytoma and myeloma, are the commonest tumours to arise in the vertebral bone but belong to the blood-and-marrow category rather than to true bone tumours. The single most important theme that runs through this whole subject is that recognising the possibility of a primary bone tumour and arranging onward referral to a specialist bone-tumour and spinal-oncology team, before any biopsy is taken, shapes everything that follows.

What "primary" means, and why the distinction matters

A primary bone tumour is one that originates in the cells of the bone, cartilage or marrow of the spine itself. This sets it apart from a metastasis, which is a deposit that has travelled to the spine from a cancer that started elsewhere, such as the breast, prostate, lung, kidney or thyroid. Metastases are far more common than primary bone tumours in the adult spine, and the two groups are approached quite differently, so distinguishing them is one of the first tasks in assessment.

Within the primary group there is a second, equally important division: between benign tumours and malignant ones. Primary tumours of the spinal column make up only around five in every hundred of all primary skeletal tumours, and within the spine the majority of primary lesions are benign, with the malignant forms comprising roughly a fifth. The benign tumours are, broadly, growths that stay local and do not spread to other organs, although some of them can still be locally troublesome by pressing on nerves or weakening bone. The malignant tumours are true cancers with the capacity, if untreated, to grow destructively and in some cases to spread.

The reason this benign-versus-malignant distinction is laboured so early is that it governs the entire pathway. A small, settled, incidentally found benign lesion and a rare primary bone cancer may both first appear as a shadow on a scan, yet the investigations, the people involved and the eventual management differ profoundly. The purpose of careful assessment is to place a lesion correctly within this spectrum.

How they are often found: incidental discovery and the patterns of pain

Many benign bone lesions of the spine cause no symptoms at all and are discovered incidentally, when a scan is performed for an unrelated reason such as back pain, an injury or another investigation entirely. Vertebral haemangiomas, the commonest benign vertebral lesions of all, are present in something like one in ten spines and are usually silent, found by chance and recognised by their characteristic appearance. The notion that a lesion seen on a scan must be sinister is, for this large group, simply not the case.

Other tumours announce themselves through pain, and the character of that pain can itself be informative. The classic example is the osteoid osteoma, a small benign tumour whose hallmark is pain that is often worse at night and that is characteristically eased by anti-inflammatory medication. This distinctive pattern, well described across the literature, is one of the recognised clues that points towards a particular diagnosis. More aggressive or malignant lesions tend to produce pain that is more persistent, less predictable, and not relieved in this neat way, sometimes accompanied by other features. The point, described here neutrally, is that the story a lesion tells through its symptoms forms part of how it is recognised and placed within the spectrum.

Where they tend to grow: vertebral body versus posterior elements

The spine is built of a block-like vertebral body at the front and an arch of bone behind it, the posterior elements, which include the pedicles, laminae, facets and the spinous and transverse processes. One of the more useful patterns in this field is that different tumours show a preference for different parts of this structure, and that preference carries information.

As a broad tendency described in the radiology literature, tumours arising in the vertebral body are more often malignant, while tumours arising in the posterior elements are more often benign. Figures frequently quoted suggest that around three-quarters of vertebral-body tumours prove malignant, whereas only about a third of posterior-element tumours do. This is why a lesion in the posterior arch of a young person is often regarded with less alarm than one destroying a vertebral body in an older adult.

The individual tumours follow these tendencies. Osteoid osteoma and osteoblastoma have a strong predilection for the posterior elements. Aneurysmal bone cysts also favour the posterior elements, often expanding outward. By contrast, chordoma, chondrosarcoma and the plasma-cell tumours tend to involve the vertebral body. These are tendencies rather than rules, and exceptions are well recognised, but they form part of the pattern-recognition that guides assessment.

The benign tumours in brief

Osteoid osteoma is a small benign bone-forming tumour, typically less than two centimetres across, consisting of a central core, the nidus, surrounded by a rim of reactive bone. In the spine it favours the posterior elements and characteristically causes night pain eased by anti-inflammatory medication. It can be associated with a painful, stiff curvature of the spine. Around a fifth of all osteoid osteomas arise in the spine.

Osteoblastoma is closely related to osteoid osteoma but larger, generally more than two centimetres, and tends to behave more actively. It too has a strong predilection for the posterior elements, although it can extend forward through the pedicle into the vertebral body. Its more aggressive forms can be expansile and can, on imaging, resemble other lesions. A proportion of osteoblastomas contain an aneurysmal-bone-cyst component.

Aneurysmal bone cyst is a benign but expansile, blood-filled lesion that can balloon the bone outward. In the spine it shows a particular tendency for the posterior elements, more often in younger people, and although benign it can be locally aggressive and may arise alongside another tumour such as an osteoblastoma or giant cell tumour.

Giant cell tumour of bone is classed as benign but is genuinely locally aggressive, with a capacity for extensive bone destruction and soft-tissue extension, and a recognised tendency to recur locally. In the spine above the sacrum it is uncommon, tends to involve the vertebral body, and is seen most often in young and middle

adulthood, somewhat more in women. A targeted medication, denosumab, has become part of the modern picture for some of these tumours, used in specialist settings.

Osteochondroma is a cartilage-capped bony outgrowth and one of the commonest benign bone tumours overall, although it is rare in the spine, where it most often involves the posterior elements. It may occur as a single lesion or as part of an inherited condition, hereditary multiple exostoses, in which multiple lesions are present. The risk of a benign osteochondroma turning malignant, into a chondrosarcoma, is small for solitary lesions and higher, though still a minority, in the inherited multiple form, with warning features described in the literature such as growth after skeletal maturity and a thickened cartilage cap.

The primary bone cancers in brief

Chordoma is a rare, slow-growing but locally destructive cancer that arises from remnants of the notochord, the embryonic structure around which the spine forms. For this reason it has a strong predilection for the two ends of the axial skeleton: the sacrum and tailbone at the bottom, and the clivus at the skull base. It tends to involve the midline vertebral body, grows insidiously, and has a well-documented tendency to recur locally if not completely removed. It is one of the tumours for which complete, en-bloc removal at the first attempt is considered the most important factor in the long-term outcome.

Chondrosarcoma is a cancer of cartilage-forming cells. In the spine it more often involves the vertebral body when arising primarily, and may also develop from a pre-existing cartilage lesion such as an osteochondroma. It is characteristically resistant to both chemotherapy and radiotherapy, which is precisely why complete surgical removal is so central to its management, and why the literature emphasises en-bloc resection.

Osteosarcoma is an aggressive bone-forming cancer, far commoner in the limbs than the spine; in the spine it frequently involves the posterior elements with some vertebral-body extension. Its management is multimodal, combining chemotherapy with surgical removal.

Ewing sarcoma, a small-round-cell cancer related to the primitive neuroectodermal tumours, occurs chiefly in children and young adults and only rarely in the spine. Unlike chondrosarcoma it is sensitive to chemotherapy and radiotherapy, and its management is firmly multimodal, combining systemic chemotherapy, radiotherapy and surgery as appropriate.

A note on plasmacytoma and myeloma

Plasma-cell tumours deserve a separate mention because, taken together, they are the commonest tumours to arise within the bone of the adult vertebra, yet they belong to a different family. A solitary plasmacytoma is a single focus of abnormal plasma cells in bone, most often in a vertebral body, while multiple myeloma is the same cell type present diffusely throughout the marrow. The two are linked, and a solitary spinal plasmacytoma is widely regarded as a lesion that may precede or evolve into myeloma. Because these are tumours of the blood and marrow rather than true bone tumours, their assessment and management are led by haematology, in coordination with the spinal team where the bone is structurally affected.

How a lesion is characterised and staged

Once a bone lesion of the spine is identified, the work of characterising it draws on imaging, on the pattern of where and how it grows, and ultimately on tissue examination. Plain X-rays, computed tomography and magnetic resonance imaging each contribute: CT defines the bony architecture and any matrix the tumour produces, while MRI shows the soft-tissue extent and the relationship to the spinal cord and nerves. The location within the vertebra, the age of the person, and the imaging characteristics together generate a list of likely possibilities.

For tumours that may be malignant, the literature describes two staging frameworks that are often mentioned together. The Enneking system, developed for tumours of the limbs, grades a tumour by whether it is benign or malignant, how aggressive it appears, and whether it has spread, and it informs the goal of surgery. The Weinstein-Boriani-Biagini, or WBB, system is specific to the spine: it maps the tumour onto a clock-face of twelve radiating zones around the vertebra and into concentric layers from the surface inward, in order to plan how, and whether, the tumour can be removed in one piece. Described simply, Enneking asks what kind of tumour this is and how it behaves, while WBB asks how it sits within the architecture of the vertebra and what a complete removal would require. Both are tools used by specialist teams to plan, not measures the reader is expected to apply.

Why the biopsy is best taken at the treating centre

A recurring and important principle in the management of bone tumours, described here neutrally, is that when a primary bone tumour is suspected, the biopsy is best planned and performed at the specialist centre that would go on to treat the tumour, rather than at the first hospital the person attends.

The reasoning is technical. A biopsy passes a needle or makes an incision through tissue to obtain a sample, and for an aggressive or malignant tumour that needle track is regarded as potentially seeded with tumour cells. At the time of definitive surgery, that track must be removed along with the tumour. If the biopsy has been placed without knowledge of the eventual surgical plan, it can compromise the chance of a clean, complete removal and has been associated with a higher rate of complications and local recurrence. The literature is consistent that biopsies performed outside experienced tumour centres carry more problems, and that the placement, marking and route of the biopsy are decisions for the team that will operate. For this reason, expert pathological review at a reference centre is also part of the standard pathway. None of this is advice to any individual; it is a description of why the sequence of referral, then biopsy, then treatment, in that order and in the same expert hands, is so strongly emphasised.

How management is organised: the specialist multidisciplinary team

Across this entire field, the consistent message is that the management of primary bone tumours of the spine is led by a specialist multidisciplinary team, often called an MDT. Such a team brings together spinal and orthopaedic oncology surgeons, musculoskeletal radiologists, specialist bone pathologists, oncologists who deliver chemotherapy and radiotherapy, and supporting specialists, who together review each case and agree a plan.

The shape of that plan depends on the diagnosis. For many benign lesions, the appropriate course described in the literature ranges from simple observation of a settled, symptomless lesion through to targeted treatment of a painful one. Osteoid osteoma, for instance, may be managed with anti-inflammatory medication or with image-guided radiofrequency ablation, a technique that destroys the small nidus through heat, used where it can be done safely away from neural structures, while surgical removal remains an option. Aggressive benign tumours such as giant cell tumour may involve surgery, embolisation, or the targeted medication denosumab in specialist hands.

For the primary bone cancers, the governing principle for chordoma and chondrosarcoma is complete, en-bloc removal of the tumour with a margin of healthy tissue, since both respond poorly to chemotherapy and radiotherapy and local control depends on the completeness of that first operation. Techniques such as total

en-bloc spondylectomy, the removal of an entire vertebra in one piece, are described for this purpose; they are demanding operations with recognised risks, reserved for selected cases in specialist centres. For chemo-sensitive and radio-sensitive cancers such as Ewing sarcoma, and for osteosarcoma, management is multimodal, combining systemic treatment with surgery and, where appropriate, radiotherapy. Plasma-cell tumours are managed primarily by haematology. In every case, the literature frames these as team decisions, individualised to the person and the tumour.

What the evidence shows about outcomes

The outlook across primary bone tumours of the spine is as varied as the tumours themselves, and any general statement has to be read with that variety in mind. For the benign lesions, the outlook is generally good: many are settled and symptomless, and even the locally aggressive ones are usually controllable, although some, such as giant cell tumour and aneurysmal bone cyst, have a recognised tendency to recur and so require follow-up.

For the primary cancers, the evidence repeatedly links outcome to the completeness of that first treatment. In chordoma, en-bloc resection offers the best chance of preventing local recurrence, and incomplete first surgery is the factor most consistently associated with poorer results; reported survival across large series is measured over years rather than being uniformly high, reflecting the tumour's tendency to recur. In chondrosarcoma, where surgery is the mainstay because the tumour resists other treatments, completeness of removal again dominates. In Ewing sarcoma, the responsiveness to chemotherapy and radiotherapy means that multimodal treatment achieves meaningful long-term survival in localised disease, though spinal sites are challenging. These are descriptions of what has been observed in groups of patients, drawn from retrospective series and registries rather than from large randomised trials, and they are not predictions for any individual. The recurring theme is that outcome is tied to accurate diagnosis, correct staging, and complete first treatment delivered by an experienced team.

Outlook

Taken as a whole, primary bone tumours of the spine are uncommon, diverse, and best understood through a few organising ideas. The first is the distinction between primary tumours and the far commoner metastases, and within the primary group between the benign majority and the malignant minority. The second is that location matters: posterior-element lesions tend towards the benign, vertebral-body lesions towards the malignant, and certain tumours, most notably chordoma at the sacrum and skull base, betray their origin through where they grow. The third, and perhaps the most consequential, is that the pathway itself, recognition, referral to a specialist bone-tumour and spinal-oncology team, biopsy planned and performed within that team, and treatment built around complete first removal for the primary cancers, shapes the outcome more than almost anything else. Much of what determines any individual situation, including the precise diagnosis and the plan that follows from it, is a matter for assessment by that specialist team rather than something that can be read from a category or an image alone.