

Paget's Disease of Bone and the Spine

A patient guide

In brief: Paget's disease of bone is a chronic disorder of bone remodelling, the lifelong process by which old bone is removed and new bone laid down in its place. In affected areas this orderly cycle becomes disordered and runs too fast: bone is broken down by overactive, oversized cells and then rebuilt in a hurried, structurally chaotic fashion. The result is bone that is larger and denser to look at but mechanically weaker, prone to bending, fracturing and overgrowing the spaces around it. The condition has a strong preference for certain parts of the skeleton, and after the pelvis the spine is the commonest site of all, with the lumbar region most often affected. In the spine the disordered remodelling enlarges and deforms the vertebrae, and it is this enlargement, in a confined bony canal that houses the spinal cord and nerve roots, that gives Paget's disease its particular relevance to the spinal surgeon. Much pagetic disease is silent and discovered by chance; where it does cause trouble in the spine, it does so chiefly through back pain, narrowing of the spinal canal, fracture and deformity, and, rarely, malignant change. The single most important idea is that this is a disease of bone that is being remodelled wrongly, producing bone that is bigger but weaker, and the spinal consequences flow from that one fact.

What Paget's disease of bone is, and why it matters in the spine

Healthy bone is not a static scaffold but a living tissue that is continually renewed. Specialised cells called osteoclasts resorb small packets of old bone, and osteoblasts then refill the cavity with fresh bone, the two processes kept in careful balance so that the skeleton maintains its strength and shape across a lifetime. Paget's disease is, at heart, a breakdown of this balance in one or several discrete regions of the skeleton. The osteoclasts in a pagetic focus are abnormal: they are larger than normal, contain many more nuclei, and resorb bone far too vigorously. The body responds with a frantic burst of new bone formation, but the bone laid down in this hurried repair is poorly organised, with a coarse, disordered internal architecture rather than the neat, load-bearing arrangement of normal bone.

The consequence is a paradox that runs through the whole subject. Pagetic bone is often thicker, denser and more prominent than the bone around it, yet it is mechanically inferior. It is structurally weak despite its bulk, which is why it bends, fractures and deforms more readily than its appearance would suggest. The disease tends to be focal, affecting one bone or a handful of bones while leaving the rest of the skeleton entirely normal, and it can be confined to a single site or scattered across several.

When this process settles in a vertebra, it produces the very combination that matters to a spinal surgeon: a bone that is enlarging within a rigid bony canal, and that is simultaneously too weak to be trusted mechanically. The spine, after the pelvis, is the second commonest site of involvement, and the lumbar vertebrae are affected more often than those higher up. It is the meeting of these two features, expansion and weakness, in the one place where there is no room to spare, that explains why pagetic involvement of the spine can produce nerve compression, fracture and deformity.

How disordered remodelling enlarges and weakens the vertebra

In a vertebra affected by Paget's disease, the disordered cycle of resorption and over-hasty rebuilding gradually transforms the bone. The vertebral body tends to enlarge, increasing in its front-to-back and side-to-side dimensions, while the cortex, the dense outer shell of the bone, becomes thickened. The internal trabeculae, the strut-like network that gives bone its strength, become coarse and thickened too, but in a disorganised pattern that does not align with the lines of load the way healthy trabeculae do.

This is the origin of the characteristic radiographic appearances. As the cortex thickens around the rim of an enlarged vertebral body while the centre remains comparatively less dense, the bone takes on a squared, outlined look that has long been described as the "picture-frame" vertebra. In other vertebrae the disease enters a more sclerotic, densely white phase in which the whole body becomes uniformly dense and enlarged, the "ivory" vertebra. These appearances are useful because they are fairly distinctive, but the ivory vertebra in particular overlaps with other causes of a uniformly dense vertebra, including certain cancers and lymphoma, which is one reason imaging in pagetic disease is interpreted with care.

Underlying all of this is the central mechanical truth already described. The enlarged, thick-cortexed, coarsely trabeculated vertebra looks robust on a scan, but the bone is laid down too quickly and too chaotically to be strong. It is this combination, a vertebra that is growing larger and yet is mechanically unreliable, that sets up the spinal problems of stenosis, fracture and deformity.

Spinal stenosis and nerve or cord compression

The most distinctive spinal consequence of Paget's disease follows directly from vertebral enlargement. The spinal canal is a fixed bony tunnel running down through the vertebrae, and within it lie the spinal cord, in the neck and upper back, and the cauda equina, the bundle of nerve roots, in the lower back. When a pagetic vertebra enlarges, its expanding bone encroaches on this canal and on the smaller channels through which the nerve roots leave the spine. There is simply less room for the neural structures than there was, and the result is spinal stenosis.

A substantial proportion of people with spinal Paget's disease have evidence of this narrowing on imaging, and a meaningful minority develop symptoms from it. Where the lumbar canal is involved, the picture can resemble the more familiar degenerative spinal stenosis: aching or heaviness in the legs that comes on with walking and standing and eases with sitting or bending forward, a pattern known as neurogenic claudication. Where the involvement is higher, in the thoracic or cervical spine, compression of the spinal cord itself can produce more serious problems, including weakness and altered sensation in the limbs, unsteadiness, and disturbance of bladder and bowel control.

The literature describes an additional and unusual mechanism by which pagetic bone can impair the spinal cord even without obvious mechanical compression. Pagetic bone is intensely vascular, carrying a far greater blood supply than normal bone, and it has been proposed that this hungry tissue can effectively divert blood away from the spinal cord, a so-called vascular "steal" phenomenon, contributing to neurological dysfunction. This mechanism is of more than academic interest, because it helps explain why some patients with pagetic spinal cord problems improve markedly with drug treatment alone, as the metabolic activity and blood demand of the bone are brought down, even when the bone has not been physically removed.

Back pain, and distinguishing pagetic pain from coexisting arthritis

Back pain is the commonest spinal symptom attributed to Paget's disease, but it is also one of the most difficult to interpret, because back pain has so many possible sources and because pagetic and degenerative changes so often coexist in the same older spine.

Pain arising directly from pagetic bone is typically described as a deep, dull, aching discomfort that is present at rest and may be worse at night, reflecting the heightened metabolic activity and increased blood flow within the affected bone. This is sometimes called the pain of "active" disease, and it is the component most likely to respond to treatment that quiets the bone.

Distinguishing this from other sources of pain is a recurring theme in the literature, because much of the back pain in a person with spinal Paget's disease does not come from the pagetic bone at all. A pagetic vertebra alters the mechanics of the segment and the way the small facet joints behind it are loaded, and secondary osteoarthritis of these joints, as well as ordinary age-related degeneration of the discs and joints elsewhere in the spine, is extremely common. Pain from arthritis tends to be mechanical, brought on by movement and relieved by rest, in

contrast to the resting, aching quality of pagetic pain. There may also be pain from nerve compression where stenosis has developed, which has its own radiating, activity-related character. Untangling which of these is responsible for a given person's pain is central to understanding their problem, because pain from active pagetic bone may settle with drug treatment whereas pain from established arthritis or mechanical degeneration generally will not.

Pathological vertebral fractures and kyphosis

Because pagetic bone is weak despite its bulk, the vertebrae it affects are vulnerable to fracture. These pathological fractures can occur with little or no injury, the weakened bone giving way under loads it should comfortably tolerate. In the spine a fracture may take the form of a compression fracture, in which the front of the vertebral body collapses, or fissure-like cracks within the abnormal bone.

The collapse of one or more vertebral bodies at the front has a predictable effect on the shape of the spine. As the anterior height is lost while the back of the column is relatively preserved, the affected segment tips forward, and the cumulative result is an increase in the forward curvature of the spine, a kyphosis. Pagetic involvement can therefore contribute to a stooped, rounded posture, particularly where the disease affects the thoracic vertebrae, and the deformity may progress as bone continues to remodel and weaken or as further fractures occur. Loss of height and a forward-bent posture are among the recognised structural consequences of the disease in the spine.

It is worth noting that softened pagetic bone can also slowly deform under load without an abrupt fracture, bending over time, and that the deformity of the spine in Paget's disease usually reflects a mixture of this gradual plastic deformation, frank compression fractures, and the altered mechanics of an enlarged, abnormally shaped vertebra.

The rare but serious risk of pagetic sarcoma

By far the most feared complication of Paget's disease, though a genuinely rare one, is the development of a bone cancer within the pagetic bone, known as pagetic or secondary sarcoma. The disordered, rapidly turning-over bone of a long-standing pagetic focus occasionally undergoes malignant transformation, most commonly into an osteosarcoma, a high-grade cancer of bone-forming cells.

The risk is small. The transformation is generally estimated to occur in well under one per cent of people with Paget's disease, with most figures placing it around or below this level, although it appears somewhat commoner in those with extensive, long-standing, multi-bone disease. It tends to arise in older patients and is more frequent in men. The features that raise concern in the literature are a change in the character of the disease at a previously stable site: new or escalating, unremitting pain, a soft-tissue swelling, a fresh fracture through pagetic bone, rapid change on imaging with breakthrough of the cortex, or a sharp rise in the blood marker of bone activity that had previously been stable.

The reason pagetic sarcoma commands such respect, despite its rarity, is its prognosis. Sarcoma arising in pagetic bone carries a markedly worse outlook than ordinary osteosarcoma, with the published literature reporting short median survival and low long-term survival even with surgery, radiotherapy and chemotherapy. Within the spine specifically it is rarer still, and only isolated cases are described, but the same principles of vigilance apply. This is information about a recognised, infrequent complication and the features clinicians watch for, not a description of what any individual's symptoms signify.

How Paget's disease of the spine is investigated

The investigation of Paget's disease rests on a combination of imaging and simple blood tests, which together establish where the disease is, how active it is, and whether it is producing complications.

****Plain X-rays**** remain the foundation of diagnosis, because the appearances of pagetic bone, the enlargement, cortical thickening, coarse trabeculae and the picture-frame or ivory vertebra, are often characteristic enough to

suggest the diagnosis directly.

****The radionuclide bone scan**** is used to map the full extent of the disease across the skeleton, because pagetic foci take up the tracer avidly and light up clearly, revealing how many bones are involved and which ones.

****Computed tomography and magnetic resonance imaging**** come into their own when the spine is involved and complications are in question. CT shows the bony anatomy, the degree of canal narrowing and the structure of the abnormal vertebra in detail, while MRI is the means of assessing the spinal cord and nerve roots themselves, demonstrating whether and where they are being compressed, and helping to distinguish pagetic change from other causes of an abnormal-looking vertebra such as infection or tumour.

****Blood tests**** measure the activity of the disease rather than its location. The serum total alkaline phosphatase, an enzyme released by the busy bone-forming cells, is the standard marker: it is typically raised in active Paget's disease, reflects the overall metabolic activity of the bone, and is used both to support the diagnosis and to follow the response to treatment over time. A more specific marker of bone formation or resorption may be used where the total alkaline phosphatase is unhelpful. Taken together, these tests describe both the anatomy of the disease and the briskness of the underlying remodelling.

What the evidence shows about treatment

The treatment of Paget's disease has been transformed by a single class of drugs, the bisphosphonates, and any account of management has them at its centre. The descriptions that follow report what the literature and guidelines observe about the condition in general; they are not guidance for any individual, whose care is a matter for assessment by the treating team.

****Bisphosphonates**** are drugs that act directly on the overactive osteoclasts, switching off the excessive bone resorption that drives the whole disordered cycle. By quietening the osteoclasts they allow more orderly remodelling to resume, bring the raised markers of bone activity back towards normal, and reduce the heightened blood flow through the bone. Within this class, a single intravenous infusion of zoledronic acid (zoledronate) has been shown in randomised comparison to produce far higher and more durable rates of biochemical remission than the older oral agent risedronate, normalising the alkaline phosphatase in a large majority of patients and maintaining that response for years after a single dose. For this reason the Endocrine Society's clinical practice guideline identifies a single 5 mg infusion of zoledronic acid as the treatment of choice for most patients with active disease who are at risk of complications and have no contraindication.

****The role of treatment in spinal disease**** is particularly relevant here. Bisphosphonate therapy is principally aimed at controlling active, painful disease and is described as effective for the deep, aching pain of metabolically active pagetic bone. Strikingly, the guideline notes that bisphosphonate treatment may reverse the paraplegia associated with spinal Paget's disease in some cases, an observation that fits the vascular "steal" mechanism described earlier, in which calming the metabolic demand of the bone restores blood flow to the cord. Older reports describe similar neurological recovery with calcitonin, an alternative antiresorptive agent now used far less often than bisphosphonates.

****Surgical considerations**** arise when the structural consequences of the disease, severe stenosis with cord or nerve compression, instability, fracture or deformity, cannot be managed by medical means alone, or when malignant change is suspected. The dominant surgical theme in the literature is the intense vascularity of pagetic bone. Because the bone carries such a rich blood supply, operating on it is associated with the risk of considerable bleeding, and this hypervascularity is a well-recognised practical concern. For this reason a period of treatment with a bisphosphonate before planned surgery on pagetic bone is suggested in the guideline, with the aim of reducing the metabolic activity and the blood flow of the bone and so reducing operative bleeding. Where surgery is required for cord or nerve compression, decompression of the neural structures is the principle, often combined with stabilisation of an abnormal or fractured segment.

In summary, the evidence places potent bisphosphonates, and zoledronic acid in particular, at the centre of controlling active pagetic disease and its pain, recognises that medical treatment can sometimes reverse even neurological compromise of the spinal cord, and reserves surgery for structural and neurological problems that medical treatment cannot resolve, with careful attention to the vascular nature of the bone, all within a framework of individualised decisions made with the treating team.

Outlook

The outlook in Paget's disease of bone is, for most people, good, and it has improved considerably in the era of effective drug treatment. A great deal of pagetic disease never causes symptoms at all and is discovered incidentally on an X-ray or blood test taken for another reason. Where the disease is active and causing pain, modern bisphosphonates can quieten it durably, often with a single infusion, and bring the markers of bone activity back to normal for years.

In the spine, the picture depends heavily on which complication, if any, has developed. Pain from active pagetic bone tends to respond well to treatment, whereas pain from the secondary arthritis and degenerative change that so often accompany it follows its own course. Spinal stenosis and cord compression can, in some cases, improve with drug treatment alone, while in others they require surgery; and even the neurological problems of the cord may recover to a degree that surprised earlier generations of clinicians. The structural legacies of the disease, established deformity, healed fractures and a kyphotic posture, are less reversible, which is part of why controlling active disease matters.

The one genuinely serious shadow over the condition is the rare possibility of sarcomatous change, which is why a clear, sustained change in a previously stable site is taken seriously. Set against the rarity of that event, the overall message of the modern literature is reassuring: most pagetic disease is silent or controllable, the spinal complications are often treatable, and any individual outlook is a matter for assessment by the treating team rather than something that can be read from a label or an X-ray alone.