Management of vertebral osteomyelitis in adults

Abstract

Vertebral osteomyelitis is a condition that predominantly affects older men with chronic comorbidities, such as diabetes, renal and hepatic failure, or immunosuppression. Symptoms develop insidiously and a high index of suspicion is required to diagnose the condition; this is achieved through serological testing and imaging. The mainstay of treatment is long-term antibiotic therapy, lasting a minimum of 6 weeks; however, surgical debridement with stabilisation is required when conservative treatment is proving ineffective and infection progresses. It is critically important that sufficient treatment is provided for those experiencing vertebral osteomyelitis, as not doing so could lead to severe neurological compromise and death.

Key words: Discitis; Spondylodiscitis; Vertebral osteomyelitis

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Introduction

Vertebral osteomyelitis is an infection that occurs in the vertebral body and its surrounding structures, which can lead to localised bony destruction, abscess formation and permanent neurological deficits. It primarily affects older men, and risk factors include diabetes, immunosuppression, malignancy, renal and hepatic failure, and intravenous drug use (Mylona et al, 2009; Cheung and Luk, 2012). The most common causative organism is *Staphylococcus aureus*, which accounts for 44–59% cases of vertebral osteomyelitis (Jung et al, 2021), with less common organisms being *Streptococcus* spp., *Mycobacterium tuberculosis*, Gram-negative organisms such as *Escherichia coli*, *Proteus* and *Brucella*, and fungal infections (Govender, 2005; Cheung and Luk, 2012). The incidence of vertebral osteomyelitis is increasing globally, affecting between 4 and 10 patients per 100 000 per year (Bernard et al, 2015). This is likely a result of increased life expectancy and a rise in patient populations who are at an epidemiological risk (Mehkri et al, 2022). A multidisciplinary team approach is required to effectively treat patients with vertebral osteomyelitis, involving orthopaedic surgeons, radiologists and microbiologists.

Pathophysiology

Vertebral osteomyelitis is also known as spondylodiscitis, and encompasses various forms of infection involving the osseous and soft tissue elements of the spine (Zimmerli, 2010). It is usually secondary to a haematogenous spread of bacteria from a distant focus of infection and is rarely caused by direct inoculation of the spine (Cheung and Luk, 2012). The vertebrae are particularly susceptible to seeding of bacteria from both arterial and venous dissemination (Cheung and Luk, 2012; Guerado and Cerván, 2012). In adults, there is a rich blood supply to the vertebrae, and the organisms invade the end-arterial arcades in the vertebral endplates and can spread to the adjacent avascular discs and epidural space (Tay et al, 2002). However, in children, there are persistent vascular channels within the discs that can lead to discitis following a bacteraemia, which can then spread contiguously to the vertebrae (Govender, 2005). The lumbar vertebrae are most commonly affected, followed by thoracic and cervical vertebrae respectively, with some infections involving multiple levels, most notably in intravenous drug users (Mylona et al, 2009)

Postoperative vertebral osteomyelitis is an uncommon complication following spinal surgery, and is a result of direct inoculation during surgery; the rate of infection following spine surgery ranges from 0.2–0.9% in the literature (Kim et al, 2019). This complication appears to differ from native vertebral osteomyelitis, presenting more commonly with

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neurological dysfunction, and may require removal and exchange of metalwork along with 6–12 weeks of targeted antibiotic therapy to treat (Breuninger et al, 2020). An increased proportion of cases of postoperative vertebral osteomyelitis is caused by coagulase-negative staphylococcal species than cases of native vertebral osteomyelitis (Kim et al, 2019; Ahsan et al, 2021). Outcomes of treatment postoperative vertebral osteomyelitis remain positive, as shown by a prospective study by Breuninger et al (2020), with patients demonstrating a decreased mortality risk compared to those who experience native vertebral osteomyelitis, albeit those with postoperative vertebral osteomyelitis had fewer comorbidities. However, a retrospective comparison study reported an increased incidence of treatment failure and recurrence at 12 months if methicillin-resistant *Staph. aureus* was the causative organism (Kim et al, 2019).

Diagnosis

The diagnosis of vertebral osteomyelitis can be challenging unless there is a high index of suspicion, which can result in a diagnostic delay of several months or more from onset of symptoms, resulting in bony destruction and permanent neurological complications (Russo et al, 2019; Maamari et al, 2022). A combination of history-taking and examination, laboratory tests and imaging helps with the diagnosis.

Symptoms often develop insidiously and are indolent in nature, with back pain being the most commonly presenting complaint; some individuals experience febrile episodes. Neurological deficits, including weakness, paraesthesia, radiculopathy and urinary retention, are less common (Maamari et al, 2022). Specific blood tests include white cell count, C-reactive protein or erythrocyte sedimentation rate, levels of which are raised in an acute infection, but may be normal during a chronic infection (Herren et al, 2017). However, leucocytosis is the least sensitive or specific marker of infection, as it may be mildly elevated or normal in patients with chronic vertebral osteomyelitis; the combination of both elevated C-reactive protein level and erythrocyte sedimentation rate helps with diagnosis and monitoring of treatment (Herren et al, 2017; Maamari et al, 2022).

To confirm diagnosis and guide the treatment of vertebral osteomyelitis, the causative organism should be isolated and correctly targeted, with antimicrobials held if there is an indolent presentation. Following laboratory tests, blood cultures should be taken, as the source of infection is variable and spreads haematogenously; the pathogen can be found in 25–59% of positive blood cultures (Cheung and Luk, 2012).

Once clinical suspicion of vertebral osteomyelitis is established, it should be confirmed on magnetic resonance imaging, which is the gold standard because of its high sensitivity and specificity in all stages of the condition. During the early stages of the condition, osseous oedema will be visible as low signal on T1-weighted images and high signal on T2-weighted images, with distortion of the normal disc anatomy. The signs of oedema eventually settle, leaving sclerotic changes seen in both T1- and T2-weighted images, alongside permanent vertebral body height changes during the resolution and healing phase (Prodi et al, 2016). Magnetic resonance imaging is an excellent modality to assess the epidural space and the spinal cord (Cheung and Luk, 2012).

For those who cannot undergo magnetic resonance imaging, computed tomography can be used to evaluate osseous anatomy; when enhanced with contrast, this can establish paraspinal and epidural soft tissue involvement. However, it is not good for imaging disc spaces and neural elements (Prodi et al, 2016). Nuclear imaging techniques are another alternative for those unable to undergo magnetic resonance imaging. Gallium-67 scintigraphy single photon emission computed tomography has similar sensitivity to magnetic resonance imaging for detection of vertebral osteomyelitis, but is not very accurate in detecting epidural abscesses. Bone scintigraphy scans with technetium-99 and indium-111 are less sensitive and are rarely used for diagnosing vertebral osteomyelitis and its complications (Zimmerli, 2010; Prodi et al, 2016; Mehkri et al, 2022).

Tissue specimens can be obtained percutaneously through a computed tomography or fluoroscopic-guided biopsy, which yield 44% and 55% respectively (McNamara et al, 2017). Open surgical biopsy is the most reliable tool, with a 76% yield in a more recent systematic review (Maamari et al, 2022); however, the effect of prior antibiotic use is unclear. When cultures fail to isolate a pathogen, a 16S ribosomal RNA gene polymerase chain reaction assay can be used to ascertain the causative organism. A prospective study by Choi et al (2014) showed that this was more sensitive than the conventional methods of pathogen cultures. If all attempts to isolate the pathogen are futile, empirical treatment of vertebral osteomyelitis continues until the patient's symptoms settle and their biochemical markers return to normal levels.

Treatment

Treatment of vertebral osteomyelitis involves a combination of medical and surgical management, using long-term antibiotics as the mainstay of treatment and with surgical intervention when medical management fails. There are no definitive guidelines on the management of vertebral osteomyelitis, which is based on the preferences of each institution. The goal of treatment is to eradicate the source of infection and the infection within the vertebral body, to restore function and alleviate symptoms (Mehkri et al, 2022).

Initially, patients are started on empirical antibiotics that cover the common causative organisms, which are then tailored depending on culture sensitivities (Cheung and Luk, 2012). There is no consensus on the optimal duration of antibiotic treatment, as evidenced by a systematic review by Huang et al (2019), with some advocating for between 4–12 weeks of antibiotic therapy (Zimmerli, 2010). A randomised controlled trial by Bernard et al (2015) showed that 6 weeks of antibiotic treatment is not inferior to 12 weeks in regards to the number of patients deemed cured at 1 year; it has suggested that 6 weeks of treatment should be the standard treatment duration. However, a retrospective review by Park et al (2016) stated that those at a high risk of recurrence should receive a prolonged course of antibiotics (>8 weeks), while those at low risk should receive 6–8 weeks of treatment. Current practice advocates for 6 weeks of antimicrobial therapy, with treatment extended to 12 weeks if the patient has metalwork in their spine from previous surgery. Patients who have had previous instrumentation of their spine may require a revision procedure, with debridement and potential replacement of the metalwork; extended treatment with antibiotics will aim to prevent formation of biofilm. External immobilisation of the spine helps to reduce pain by stabilising the spine and preventing deformity (Cheung and Luk, 2012).

Surgical intervention is indicated when conservative management is failing and infection progresses, causing compression of neural matter or spinal instability owing to bony destruction, leading to severe kyphosis and intractable pain. The primary goal of surgical treatment is to clear infective material and decompress the neural matter, debride the infected tissues and establish stability within the spine (Guerado and Cerván, 2012). Timing of surgery has been a contentious matter for treatment of vertebral osteomyelitis, as there are not clear guidelines regarding when it is most appropriate. A large retrospective cohort study showed that those who required surgical intervention had a better outcome when surgery was undertaken within 24 hours of admission; delays lead to increased rates of complications and neurological deficits (Segreto et al, 2018).

Surgical principles of treatment remain the same throughout the whole axial skeleton, and there are several approaches depending on the specific goal of treatment. The majority of cases of vertebral osteomyelitis affect the anterior aspect of the vertebral body; therefore, an anterior surgical approach allows easy access to the infected tissue. Corpectomies and discectomies are performed to debride infected bone and discs until there is bleeding cancellous bone (Dai et al, 2008). Drainage of epidural and paravertebral abscesses and posterior instrumentation, such as pedicle screws and rod fixation, advocate for a posterior approach to the spine. Posterior stabilisation with pedicle screws and rod fixation is necessary with radical corpectomies, as this leads to structural instability; therefore, further stabilisation is required to allow the fusion to establish itself (Gorensek et al, 2013).

Following debridement, an interbody fusion is performed for stability within the spine; however, it is unclear whether a single- or two-stage procedure is best for the patient, because of the perceived increased risk of infection of hardware (Chen et al, 2007). A single-stage procedure involves debridement and fusion with instrumentation within the same session, whereas a two-staged procedure involves initial debridement, with a delayed second operation for surgical fusion. A systematic review and meta-analysis of nine articles, with

Key points

- This article gives an overview of the diagnosis and management of vertebral osteomyelitis.
- The mainstay of treatment is targeted long-term antibiotic therapy and it is imperative to isolate the causative organism.
- Surgical management is primarily necessary when there is neurology secondary to abscess formation or instability despite antibiotic therapy.

a total of 299 participants, concluded that there was no significant difference in reinfection rates in patients who underwent a single-stage instrumentation compared to those with delayed instrumentation (Sanda et al, 2021). Fusion is achieved through various methods, with a common method being cortical strut autografts, using the rib, iliac crest or fibula grafts (Guerado and Cerván, 2012). A retrospective study of 20 patients showed favourable outcomes for those undergoing anterior debridement and fusion with strut autografts and posterior instrumentation with pedicle screws (Shin et al, 2007). Titanium mesh cages are another method of achieving fusion following radical debridement of the vertebral body, and are an effective alternate method of maintaining sagittal alignment and height of the vertebral body (Guerado and Cerván, 2012). A retrospective study by Kim et al (2011) showed that use of titanium mesh cages with autologous allograft is a safe and effective method to maintain alignment, without an increased incidence of recurrence of infection and a high rate of successful fusion, with 83.3% of patients achieving this outcome.

Conclusions

The incidence of vertebral osteomyelitis is increasing globally, and it is a condition with an insidious course, potentially resulting in severe neurological complications and death if not treated appropriately. There are no guidelines to help clinicians treat vertebral osteomyelitis, but a multidisciplinary approach is necessary to adequately treat these patients.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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