Spondylodiscitis: Surgical Treatment And Indications

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ABSTRACT

Spondylodiscitis is a serious infectious disease affecting the spine, causing inflammation of the vertebral bodies and intervertebral discs. It is caused by a bacterial infection and can lead to significant disability if left untreated. Initial management of the disease is conservative. Aiming to evaluate the indications and the methods of surgical management in patients with spondylodiscitis, a literature review was conducted searching the keywords: "spondylodiscitis" AND ("surgical treatment" OR '"surgical management" OR "indications") on Pubmed database. The search included only prospective studies. Initially, 308 studies were identified after primary search. At last, 26 studies remained for analysis. The study concluded that indications for surgical treatment include neurological deficits, spinal instability, abscess formation and failure of conservative treatment. Surgical management includes debridement of the infected tissues and spinal fusion with instrumentation, through an anterior, a posterior or a combined approach. The choice of material for spinal support and enhancement of spinal fusion does not influence the clinical result.

Keywords: Spondylodiskitis, treatment.

Introduction

Spondylodiscitis is defined as an infection of the intervertebral disc and adjacent vertebral body. It is a relatively uncommon condition, but it can lead to significant morbidity and mortality if left untreated. The epidemiology of spondylodiscitis varies depending on a variety of factors, including age, sex, underlying medical conditions, and geographic location. In general, spondylodiscitis is more common in older adults, with a peak incidence in the sixth and seventh decades of life. It is also more common in men than in women, with a male-to-female ratio of approximately 2:1. This may be due in part to a higher incidence of risk factors for spondylodiscitis, such as intravenous drug use and alcohol abuse, in men. The incidence of spondylodiscitis has been found to be increasing in recent years. This may be due in part to an aging population, as older adults are at increased risk for developing spondylodiscitis. Patients with conditions that weaken the immune system, such as HIV/AIDS, cancer, or chronic steroid use, are at increased risk for developing spondylodiscitis. Additionally, patients with diabetes mellitus are also at increased risk for spondylodiscitis, as high blood sugar levels can impair immune function and increase the risk of infection [1-3].

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The pathophysiology of spondylodiscitis involves a complex interplay between host defenses and microbial virulence factors. The most common bacteria associated with spondylodiscitis are *Staphylococcus aureus* and *coagulase-negative staphylococci*, accounting for the majority of cases of spondylodiscitis, particularly in developed countries. Other bacterial species that have been implicated in spondylodiscitis include *Streptococcus species, Enterococcus spp, Escherichia coli, Pseudomonas aeruginosa, Brucella spp and Mycobacterium tuberculosis* [4]. According to the responsible pathogen, spondylodiscitis may be classified as pyogenic, tuberculous and brucellar [5].

The etiology of spondylodiscitis can be divided into two main categories: (a) hematogenous and (b) direct inoculation. Hematogenous spondylodiscitis occurs when microorganisms gain access to the vertebral body and disc space via the bloodstream, deriving from a primary infection elsewhere in the body. Direct inoculation spondylodiscitis, on the other hand, occurs when microorganisms are introduced directly into the vertebral body and disc space via invasive procedures, such as spinal surgery or injections [6-7].

Regardless of the route of infection, once microorganisms gain access to the vertebral body and disc space, they can cause a cascade of inflammatory events that ultimately lead to the characteristic clinical features of spondylodiscitis. The first step in this process is adhesion of microorganisms to the endothelium of the vertebral body and disc space. This is followed by invasion of the surrounding tissues and establishment of a biofilm, which serves as a protective barrier against host defenses and antimicrobial agents. The presence of the biofilm triggers an inflammatory response that is characterized by the release of pro-inflammatory cytokines and chemokines, which attract neutrophils and monocytes to the site of infection, where they phagocytose and attempt to kill the invading microorganisms. However, the virulence factors produced by the invading microorganisms can interfere with this process. For example, many bacteria produce enzymes that can degrade the extracellular matrix of the vertebral body and disc space, allowing the microorganisms to invade further into the surrounding tissues. Additionally, some bacteria produce toxins that can directly damage host cells and tissues, leading to further inflammation and tissue destruction. As the infection progresses, the inflammatory response becomes more intense, leading to the formation of an abscess. The abscess can compress adjacent neural structures, leading to neurological deficits and severe pain. In addition, the abscess can cause destruction of the surrounding bone, leading to vertebral collapse and spinal instability [8].

Clinical presentation of spondylodiscitis may vary, depending on the location and severity of the infection. In general, patients present with back pain that is typically localized to the affected vertebral level. The pain is often severe and unrelenting, and it may be exacerbated by movement or palpation. Additional findings may include muscle spasm, weight loss, lower back, groin, or buttock pain, as well as symptoms of rhizopathy and myelopathy (advanced stage). In addition, patients may present with fever, chills, and other systemic symptoms of infection [9].

Diagnosis of spondylodiscitis is typically made based on a combination of clinical findings, radiographic imaging, and laboratory tests. Radiographic imaging, such as magnetic resonance imaging (MRI) and computed tomography (CT) can identify the characteristic changes in the vertebral body and disc space that are associated with spondylodiscitis [10]. Blood cultures and inflammatory markers, such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) can help to identify the causative microorganism and monitor the inflammatory response. Isolation of the pathogen is of vital importance and should be attempted in any case. CT-guided biopsy is the method of choice because it allows a sample to be taken from inside the lesion [11-14].

Antimicrobial therapy is a crucial component of the treatment of spondylodiscitis. The choice of antimicrobial agent(s) depends on the suspected or identified pathogen(s), as well as the patient's clinical status and underlying medical conditions. In general,

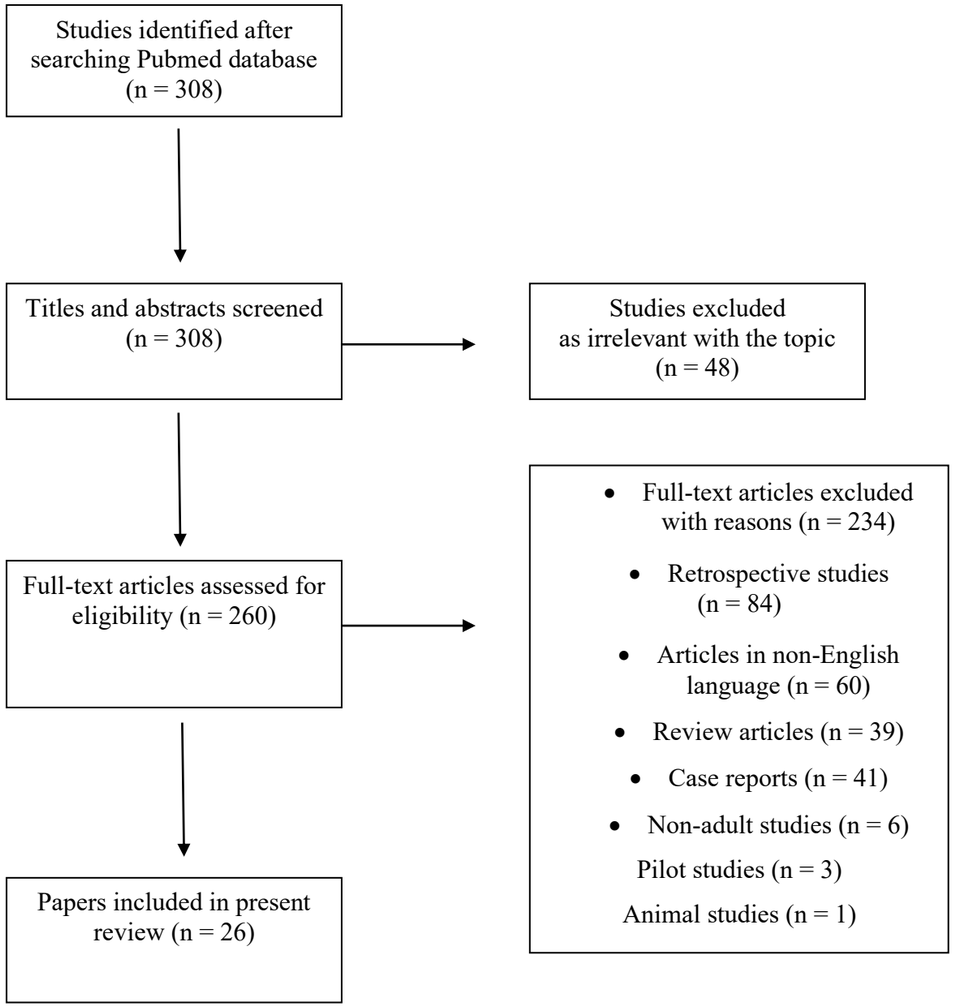

Figure 1. Study flowchart

broad-spectrum antimicrobial therapy should be initiated empirically in patients with suspected spondylodiscitis, pending the results of culture and sensitivity testing. Empiric therapy should cover the most common pathogens associated with the condition, such as *Staphylococcus aureus* and *coagulase-negative staphylococci*. Once the causative pathogen has been identified through culture and sensitivity testing, antimicrobial therapy can be tailored to the specific organism and its susceptibility to antibiotics. The duration of antimicrobial therapy typically ranges from 6 weeks to 12 weeks, depending on the severity and extent of the infection, as well as the patient's response to treatment. Antibiotic treatment should not be ceased until the normalization of inflammatory markers return to normal. Although rest is indicated for the early stages of treatment, early mobilization of the patient with the help of a brace is recommended [15-17].

The aim of the present review is to summarize the surgical treatment and its indications in the management of spondylodiscitis in adults. A literature review was conducted based on the Pubmed internet database, following the PRISMA Guidelines. Article titles were searched with the use of the keywords: "spondylodiscitis" AND ("surgical treatment" OR '"surgical management" OR "indications"). The search included only prospective studies, evaluating the indications and the methods of the surgical treatment in patients with spondylodiscitis. Studies published in non-English language, retrospective studies, reviews, case reports, animal studies and pilot studies were excluded. Studies in children and adolescents were also excluded.

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Discussion

Initially, 308 studies were identified after initial search on Pubmed internet database. After screening of titles and abstracts, 48 articles were excluded as irrelevant with the searched topic. Among the remaining 260 studies, 234 were rejected for various reasons (figure 1), leaving 26 studies for final analysis to be included in the present review.

Indications of surgical treatment

Surgical treatment is one option for patients with spondylodiscitis, and it is typically reserved for cases where non-surgical treatments have failed, or where there is a high risk of complications. Indications of surgical treatment include:

Failure of conservative treatment: In some cases, the infection may not respond to antibiotics or the patient may experience severe pain while inflammation markers are still high after 4 - 6 weeks. The thresholds of 50 mm/hr for ESR and 2.7 gr/dl for CRP have been proposed for consideration of surgical treatment [18]. Moreover, prolonged antimicrobial therapy may cause antibiotic resistance and pharmacological side effects, as renal or hepatic impairment. In these situations, surgical intervention may be necessary to remove the infected tissue and alleviate the pain [19-21].

Neurological deficits: When the infection spreads to the spinal cord or nerve roots, it can cause compression and damage to these structures, leading to neurological symptoms. Surgery may be necessary to decompress the affected nerves and prevent further damage [19, 22-23].

Spinal instability: As spondylodiscitis can cause significant damage to the spine, including the destruction of the vertebral bodies and intervertebral discs and leading to spinal instability, surgical fixation may be necessary to stabilize the spine and prevent further damage [22, 24].

Spinal abscess: In case a spinal abscess is formed, it can put pressure on the spinal cord and nerve roots, leading to neurological deficits. Emergency surgical treatment may be necessary to drain the abscess and allow neural decompression, correction of deformity and segmental stabilization, preventing further complications [19, 25].

Responsible pathogen: Tuberculous spondylodiscitis in adults are usually easily controlled by proper antimicrobial therapy and the indications for surgery are few [26]. Mycotic spondylodiscitis may cause rapid destruction of the spinal tissues and often need surgical eradication and fusion [27].

Multi-level infection may be difficult to treat with antibiotics alone. Surgery may be necessary to remove the infected tissue and prevent the spread of the infection to other parts of the spine [19].

Suspected malignancy: As spondylodiscitis can sometimes mimic the symptoms of cancer, and it may be necessary to perform a biopsy or other diagnostic tests to confirm the diagnosis [19].

The Brighton Spondylodiscitis Score is a clinical tool that has been introduced to aid in the diagnosis and management of spondylodiscitis. According to this score, the need for surgical management of spondylodiscitis depends on the presence of distant site infection, comorbidities, immunosufficiency, MRI findings, anatomical location and neurological signs [28].

Methods of surgical treatment

The primary goal of surgical intervention for spondylodiscitis is the eradication of the infection and the stabilization of the spine. There are several methods of surgical treatment for spondylodiscitis, and the choice of method will depend on various factors, such as the location and severity of the infection, the presence of neurological deficits, and the patient's overall health. Surgical options include debridement of infected tissues and spinal fusion with instrumentation. In general terms, posterior pedicle screw-and-rod instrumentation, along with decompression of the spinal canal, radical debridement of the infected disc and interver-

tebral fusion using either titanium cages or autologous bone graft are considered today's gold standard [21].

Debridement and drainage: Debridement and drainage are the most common surgical procedures used to treat spondylodiscitis. These procedures involve the removal of infected tissue and drainage of any abscesses or collections of pus. Debridement and drainage may be performed through an open surgical approach or minimally invasive techniques, such as percutaneous or endoscopic procedures. In the open approach, the infected area is approached through a skin incision and a muscle dissection, either with a ventral or a dorsal approach. The infected tissue is then removed, and any abscesses are drained. [25]. Transpedicular curettage and drainage is also a useful option for patients with poor health and multiple comorbidities [29]. In case of brucella-related spondylodiscitis, simple laminectomy and debridement is an effective method for treatment [30]. In percutaneous or endoscopic procedures, the infected area is accessed through small skin incisions with the use of a camera and specialized instruments. Percutaneous irrigation and suction of pyogenic spondylodiscitis is a minimally invasive option for the management of recalcitrant spondylodiscitis. It is most effective in cases where the infection is localized and has not spread to adjacent vertebrae. During this method, one or two needles are inserted percutaneously into the intervertebral disk space. The procedure can be performed under local anesthesia and is typically done on an outpatient basis. Percutaneous procedures are less invasive than open surgery, and they often result in less pain and a quicker recovery time [31].

Instrumentation and fusion: Instrumentation and fusion are surgical procedures that are used to stabilize the spine after debridement and drainage. The affected vertebrae are fused together with the use of hardware. These procedures are typically performed in cases where there is significant damage to the vertebral bodies and intervertebral discs, or where there is spinal instability.

In instrumentation, hardware such as metal rods, screws, or other devices are inserted into the spine to provide stability and support. In fusion, bone grafts or other materials are placed between the affected vertebrae to encourage bone growth and fusion, which further stabilizes the spine. Tricortical autologous bone grafts for intervertebral fusion are widely accepted but they are associated with donor-site morbidity and increased risk of subsidence and non-union. Titanium cages may enhance fusion and restore kyphotic deformity [19]. Polyethyl-ether-ether-ketone (PEEK) is a biocompatible alternative to metal implants. PEEK cages are used in single-stage debridement and fusion [21]. Radiolucent carbon-fiber-reinforced (CFR) PEEK hardware has shown inferior results compared to titanium screws, due to higher loosening rare and potential stronger adhesion to bacteria [32].

Instrumentation and fusion may be performed through an open surgical approach or minimally invasive techniques, such as percutaneous or endoscopic procedures. The choice of approach will depend on the location and severity of the infection, as well as the patient's overall health [23].

Anterior transthoracic or retroperitoneal approach with radical surgical debridement and reconstruction of the anterior column using bone graft, titanium cages and plates is indicated in patients with intravertebral abscesses and without major bone destruction, deformity and instability. Anterior approach is also effective in spinal canal decompression if the anterior column is involved. In general, isolated anterior internal fixation is not recommended in the thoracolumbar region due to high invasiveness [33]. The use of antibiotic-loaded bone cement as an efficient gap filler in anterior approaches has been described, in combination with additional stabilization and oral antibiotics. Antibiotic-loaded bone cement is typically used in cases where the infection is localized and has not spread to adjacent vertebrae. The procedure is less invasive than debridement and fusion and can be performed using minimally invasive techniques. It may contribute to the reconstruction of anterior column and the local infection control [34].

The combination of anterior decompression and debridement with posterior instrumentation has been reported with success. Posterior spinal fusion after anterior decompression is indicated in cases with severe kyphotic deformity, loss of alignment or after radical surgical debridement and multiple-level corpectomy. Spinal fusion hardware and grafts can be used at the site of infection, provided that radical surgical debridement is fully achieved [20,35]. Combined posterior approach for circumferential debridement and anterior reconstruction with fibular allograft has been applied in patients with skipped multifocal pyogenic spondylodiscitis with good clinical outcomes [36].

Recent evolution in the development and design of titanium implants has offered the potential to complete both the requisite debridement of the infected disc and correction of deformity from a single posterior approach. Isolated posterior stabilization is indicated in case of spondylodiscitis without bone destruction or local kyphosis caused by disc loss and distraction of the vertebral bodies. In case of formation of segmental kyphosis and loss of alignment, posterior stabilization should be combined with additional anterior fixation [33]. Posterior stabilization and fusion is an effective method of treatment of brucella-related spondylodiscitis, in case surgical intervention is required [30]. In case of a single-level spondylodiscitis, continuous epidural irrigation combined with posterior debridement and posterior lumbar interbofy fusion is an effective method facilitating the eradication of residual infection [37]. Percutaneous posterior instrumentation with 4 - 8 screws bridging the level of infection and contoured rods is associated with high overall satisfaction and low complication rate, in a 10-years follow-up [38]. Single-stage posterior transforaminal lumbar interbody fusion (TLIF) with PEEK cages is a reliable and feasible surgical option [21].

Extreme lateral interbody fusion (XLIF) with percutaneous posterior instrumentation is a minimally invasive interbody fusion technique which spares the anterior longitudinal ligament and allows adequate visualization of the intervertebral discs and vertebral bodies in order to debride necrotic and infected tissue and place a large, lordotic cage. Studies have suggested that XLIF is a safe and effective alternative to ALIF for the treatment of spondylodiscitis [39].

In case of tuberculous thoracic and lumbar spondylodiscitis, both anterior and posterior approaches are effective. Posterior approaches are associated with better kyphotic angle correction, less angle loss, better improvement of pain, greater duration of surgery and greater blood loss [40]. In these patients, video-assisted thoracoscopic surgery (VATS) involving anterior debridement and fusion along with minimally invasive posterior pedicle screw instrumentation and mini open posterolateral debridement and fusion have produced encouraging functional results [22]. For elderly patients with pyogenic spondylodiscitis and intraspinal abscess, microsurgical decompression and debridement of the infective tissue, followed by posterior stabilization and interbody fusion with iliac crest bone graft in one or two lumbar segments has good results [41]. Chronic kidney disease and hemodialysis is not a factor that increases complications after spinal instrumentation for pyogenic spondylodiscitis [42]. In these patients, surgical debridement with posterior instrumentation is a sufficient surgical option with good clinical outcome [43].

Conclusion

In conclusion, spondylodiscitis is a relatively uncommon condition that can lead to significant morbidity and mortality if left untreated. Initial management is conservative, including antibiotics, rest and braces. Indications for surgical treatment include neurological deficits, spinal instability, abscess formation and failure of conservative treatment. Surgical management includes debridement of the infected tissues and spinal fusion with instrumentation, through an anterior, a posterior or a combined approach. The choice of material for spinal support and enhancement of spinal fusion does not influence the clinical result.

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