The Need for Comprehensive Medical Management in Pyogenic Spondylodiscitis: A Review Article

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Abstract:

The incidence of spontaneous or primary spondylodiscitis has been increasing over the years, affecting the aging population with multiple comorbidities. Several conditions influencing treatment outcomes stand out, such as diabetes mellitus, renal insufficiency, cardiovascular and respiratory dysfunction, and malnutrition. Due to these, the question arises regarding properly managing their current conditions and pre-existing disease states. Treatment plans must consider all concomitant comorbidities rather than just the infectious process. This can be done with the help of multidisciplinary teams to provide comprehensive care for patients with pyogenic spondylodiscitis. To date, there is no article regarding comprehensive medicine for spontaneous pyogenic spondylodiscitis; hence, this paper reviews the evidence available in current literature, recognizes knowledge gaps, and suggests comprehensive care for treating patients with spinal infections.

Pre-requisites for implementing multidisciplinary teams include leadership, administrative support, and team dynamics. This group comprises an appointed leader, coordinator, and different subspecialists, such as orthopedic surgeons, infectious disease specialists, internists, rehabilitation doctors, psychiatrists, microbiologists, radiologists, nutritionists, pharmacologists, nurses, and orthotists working together with mutual trust and respect.

Employing collaborative teams allows faster time for diagnosis and improves clinical outcomes, better quality of life, and patient satisfaction. Forefront communication is clear and open between all team members to provide holistic patient care. With these in mind, the need for employing multidisciplinary teams and the feasibility of its implementation emerges, showing a promising and logical path toward providing comprehensive care in managing multimorbid patients with pyogenic spondylodiscitis.

Keywords:

Comprehensive management, Collaborative care, Multidisciplinary teams, Pyogenic spondylodiscitis, Spine infections

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Introduction

The incidence of spontaneous or primary pyogenic spondylodiscitis has been increasing over the years and is estimated at 4-24 cases per million inhabitants per year[1)]. From 2010 to 2019, its incidence almost doubled in developed countries[2)], comprising 2%-7% of all musculoskeletal infections[3)].

Compared to postoperative spondylodiscitis, recent studies show that spontaneous spondylodiscitis has a higher predisposition for epidural abscess, paraspinal abscess, and bone destruction, leading to a complicated clinical course with high mortality[4)]. As the aging population is progressively increasing, patients with spondylodiscitis are immunocompromised with multiple comorbidities, placing them at a high risk for serious adverse events[5)]. Due to this, healthcare providers must be wary of the risks and benefits of different treatment options to ensure safety. The conservative route is the mainstay of treatment and has satisfactory outcomes, but surgical intervention may be warranted based on response to antibiotics and spinal stability[2)]. Although conventional management has been established, treatment plans are tailored for each patient and are made on a case-to-case basis involving multiple subspecialties.

To date, there is no article regarding comprehensive medicine aside from conventional orthopedic management for

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spontaneous pyogenic spondylodiscitis; hence, this paper reviews the evidence available in current literature, recognizes knowledge gaps, and suggests comprehensive treatment for multimorbid patients with spinal infections.

Current Trends in Pyogenic Spinal Infections

Pathophysiology

The mechanisms of infection of pyogenic spondylodiscitis comprise three pathways: hematogenous seeding, contiguous spread, and direct inoculation. Hematogenous spread is commonly through the arterial circulation but can also disseminate via the Batson's plexus, which acts as a route for spreading pelvic and genitourinary infections[6,7]. Contiguous spread may be from the respiratory tract, oral cavity, urinary or gastrointestinal tract, or infected cardiac devices. Direct inoculation may occur through procedures, such as epidural blocks or lumbar punctures, and intravenous drug use[6].

Location

Pyogenic spinal infections were present in different locations. They may be classified as vertebral osteomyelitis; discitis or spondylodiscitis; spinal canal infections, such as epidural, subdural, and intramedullary abscess; and paraspinal infections[6]. Hadjipavlou et al. reported that the lumbar spine (56%) is the most commonly affected, followed by the thoracic (34%) and cervical (10%) areas[8]. Neurologic deficits are seen more in thoracic infections (19%) than in the cervical (15%) and lumbar spine (9%) due to small medullary canal diameter and limited arterial supply[9,10].

Etiology

Identifying the offending organism is one of the most important steps in treating spine infections. In 84% of cases, the organism identified is *Staphylococcus aureus*[1], where 6.8%-30% are methicillin-resistant[6]. Gram-negative organisms are seen in 7%-33%, commonly *Escherichia coli,* together with *Proteus mirabilis*, *Klebsiella spp.*, and *Enterococcus spp.* These usually occur in those with advanced age, diabetics, patients with gastrointestinal tract infections, and those who previously underwent surgery. The growth of *Pseudomonas aeruginosa* is seen in intravenous drug users, although *S. aureus* is still the predominant organism in this population[1,7]. *Staphylococcus epidermidis* is usually attributed to implant-related infections. Brucellosis is prevalent in the Mediterranean and Middle Eastern countries, affecting 6%-12% of patients, and *Echinococcal* infections may be seen in South America, southern and central Russia, China, and some parts of Africa[1].

Gender and age distribution

Patients with pyogenic spondylodiscitis are usually males in the 8th decade of life with multiple comorbidities, most commonly diabetes mellitus (DM)[11]. Those over 65 years old are at a high risk of having neurological complications[12], including those with DM and rheumatoid arthritis[13]. Other risk factors that increase mortality include end-stage renal disease that needs hemodialysis, liver cirrhosis, malignancy, infective endocarditis[11], and chronic steroid use[3].

Diagnosis

The most common presenting symptom is back or neck pain that usually worsens at night[6]. Pain onset is insidious and severe, lasting for several weeks, with 80% of patients experiencing no relief with analgesics. Fever is present in 35%-60% of cases[14], and neurologic deficits are seen in 30% of patients[6]. Tenderness on direct palpation or paraspinal muscle spasm may also be appreciated[1,14].

Standard laboratory examinations include C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and white blood cell count. Procalcitonin (PCT) may be taken, although its sensitivity is lower than that of CRP[15], and that is better used as a predictor of the persistence of bacterial infection rather than for diagnosis[16]. Since patients with pyogenic spondylodiscitis are multimorbid, hemoglobin A1c (HbA1c), glomerular filtration rate (GFR), and albumin should also be part of the workup. At least two pairs of aerobic and anaerobic blood cultures should be obtained[17,18], which can be used as a diagnostic material in 40% of patients even without fever[17,19]. When cultures yield gram-positive organisms, an echocardiogram screen for infective endocarditis[6]. Image-guided aspiration biopsy is recommended for patients whose microbiologic diagnosis has not been established after serologic cultures[18]. Open biopsy is only indicated for negative image-guided aspiration results[6].

Plain radiographs are the initial imaging examination as they show the extent of bone destruction and provide information regarding deformity and instability. The narrowing of disk spaces is the early radiographic findings, followed by the scalloping of adjacent endplates[1]. Computed tomography shows bony sequestra formation and vertebral body destruction, which is essential in surgical reconstruction[1,20]. Magnetic resonance imaging (MRI) is the gold standard in the radiographic diagnosis of spondylodiscitis, allowing visualization of soft tissues and neurologic structures with 96% sensitivity, 92% specificity, and 94% accuracy[1,6]. Early findings include edema, hypointense T1 and hyperintense T2 vertebra, and disk signals. Contrast administration shows enhancement of the disk, adjacent vertebral bodies, posterior elements, and paraspinal areas[6].

Several mimickers of disease should be differentiated from bacterial infection (Table 1). Tuberculous spondylitis typically spares the disk, which may be seen with Gibbus deformity and present with a calcified paraspinal mass with rim enhancement[21]. Osteoporotic vertebral fractures usually have a linear or triangular area of hyperintensity in fat-suppressed T2-weighted images corresponding to vertebral body edema called the fluid sign[22]. Metastatic lesions have a halo sign with a bright rim around the area of metastasis and expansile lesions with a predilection for the posterior column[23].

Table 1. Imaging Findings of Pyogenic Spondylodiscitis as Compared to Differential Diagnoses[1, 6, 14, 19-21, 73-75].

Pathology	Classic Findings	Radiographic Features	CT scan Features	MRI Features
Pyogenic spondylodiscitis	Homogenous enhancement of disk space, bone marrow, posterior elements, and paraspinal areas after contrast administration	Disk space narrowing Endplate irregularity	Endplate destruction Sequestra formation	T1WI hypointense T2WI hyperintense Post-gadolinium hyperintense (homogenous enhancement)
Tuberculous spondylitis	Spares intervertebral disk Intraosseous abscess Subligamentous spread	Gibbus deformity: vertebral body collapse and anterior wedging with local kyphosis	Bone necrosis Pathological calcifications	T1WI hypointense T2WI hyperintense Post-gadolinium hyperintense (intraosseous abscess with rim enhancement)
Osteoporotic vertebral fractures	Fluid sign: linear or triangular area of hyperintensity in fat-suppressed T2WI corresponding to vertebral body edema	Anterior vertebral height loss of 20% Endplate deformity	Puzzle sign: sharp fracture lines without cortical destruction Vacuum phenomenon/ air-filled cleft	T1WI hypointense T2WI hyperintense Post-gadolinium isointense ("return-to-normal" signal intensity)
Metastatic lesions	Halo sign: bright rim around the area of metastasis Expansile lesions with predilection for posterior column	Erosion along pedicles or posterior vertebral body	Posterior cortical destruction Epidural mass displacing thecal sac or encroaching neural foramen	T1WI iso- to hypointense T2WI hyperintense (osteolytic) or iso- to hypointense (osteoblastic) Post-gadolinium hyperintense (heterogenous enhancement)

CT, Computed tomography; MRI, Magnetic resonance imaging; WI, weighted image

Historically, classification systems have been used to describe disease severity. Kulowski classified the condition chronologically: acute (<3 weeks), subacute (3 weeks to 3 months), and chronic (>3 months)[24]. Griffiths and Jones categorized pyogenic spondylodiscitis based on bone destruction on plain radiographs: early (narrowing of disk space), destructive (vertebral collapse and bone proliferation), and sclerotic (healing and new bone formation)[25]. However, since these categories provide no recommendation concerning treatment, new classification systems have been developed based on clinical and radiographic characteristics. Pleumer et al. designed the Spinal Infection Treatment Evaluation (SITE) Score (Table 2). This considers neurologic symptoms, location of the infection, radiographic findings, pain, and comorbidities. Treatment options are based on the overall score where 0-8 suggest surgical intervention, 9-12 recommend medical treatment and optional surgical management, and 13-15 advocate for medical intervention[26]. The Pola classification (Table 3) further describes specific treatment schemes by categorizing the disease based on the absence of bone destruction or segmental instability (Type A), the presence of spinal instability without epidural abscess and neurological impairment (Type B), and the presence of epidural abscess and/or neurological impairment (Type C). A secondary criterion depends on paravertebral soft tissues and intramuscular abscess involvement. Rigid orthosis immobilization may be done for Type A, rigid orthosis immobilization or percutaneous stabilization for Type B, and open debridement and stabilization and/or debridement for Type C[27].

Selection of antibiotics

For effective antibiotic management, treatment should always be culture-guided. Empiric antibiotics should only be administered in patients who are septic, hemodynamically unstable, or with progressive neurologic deficits[6]. Due to poor vascularity and low oxygen tension at areas of infection, penetrating the intervertebral disk and the bone is difficult. Studies show that positively charged antibiotics, such as gentamicin, vancomycin, clindamycin, and aminoglycosides, can penetrate the disk better compared to negatively charged ones, such as linezolid, penicillin, and cephalosporins, as the extracellular matrix of the disk is also negatively charged[28-30].

Beta-lactams have moderate penetration and are the initial choice when starting treatment due to good tolerance and high dosages that can be given parenterally. Clindamycin has higher penetration than beta-lactams and has good bioavailability; hence, it is a good choice for oral stepdown. Fluoroquinolones are broad-spectrum antibiotics, have good bone penetration, and can be used for prolonged periods due to their good safety profile. Rifampicin is particularly effective for biofilm and has good bone penetration but should always be used with another antibiotic due to rapid resistance development. Glycopeptides, such as vancomycin and teicoplanin, are first-line antibiotics for methicillin-resistant *S. aureus* (MRSA). Compared to teicoplanin, vancomycin has better efficacy but with lower activity in anaerobes. Lipopeptides, such as daptomycin, may also be used for MRSA; it also works on biofilm. Linezolid is an oxazolidinone working against gram-positive organisms and MRSA. However, prolonged use may result in hematotoxicity, such as anemia and thrombocytopenia[19]. The treatment of *Pseudomonas* and *Enterococcus* species includes a combination of two drugs, but the role of combined antibiotic therapy is currently unclear for *S. aureus*[31].

Table 2. Spinal Infection Treatment Evaluation Score[26].

Variable	Score
1. Neurology	
Acute plegia or bladder/bowel dysfunction	Surgery
Motor dysfunction	1
Sensory dysfunction	2
Neurologically intact	3
2. Location	
Junctional (occiput–C2, C7–T2, T11–L1, L5–S1)	1
Mobile (C3–6, L2–4)	2
Semirigid (T3–10)	3
Rigid (S2–5)	4
3. Radiology	
Spinal canal stenosis with central neural element impingement with or without de novo deformity	1
Segmental angulation or translation with de novo deformity or foraminal stenosis OR erosion of vertebral body on CT >50% OR posterolateral involvement on both sides	2
Visible endplate erosion on CT OR edema of vertebral body >50% on MRI OR intervertebral disk involvement on MRI OR posterolateral involvement on one side	3
None of these radiographic findings	5
4. Pain	
Standing axial pain OR inability to ambulate	0
Other pain with inability to ambulate	1
No pain	2
5. Host comorbidities	
Intravenous drug use or diabetes mellitus	0
Other comorbidities or no comorbidities	1
SITE Score Treatment Group	**Overall Score**
Severe spinal infection with high instability probability or neural element impingement Surgery recommended	0–8
Moderate spinal infection, moderate risk of instability or neural element impingement Medical treatment recommended; surgical treatment optional	9–12
Mild spinal infection, mild to no instability risk or neural element impingement Medical treatment recommended	13–45

CT, computed tomography; MRI, magnetic resonance imaging

Conditions Influencing Treatment Outcomes

Nutrition

Patients with spondylodiscitis are chronically ill and under severe stress due to the catabolic nature of the condition. Malnutrition is a modifiable preoperative risk factor[32]; yet nutritional evaluation is often understated in patients with spine problems[33]. Common measures used to look at nutritional status are serum albumin and total lymphocyte count, which quantify protein mass and depict the integrity of immune response, respectively. Serum albumin of <3.5 mg/dL and total lymphocyte count of <1,500-2,000 cells/mm^3 are the objective limits determining malnutrition[19]. Low levels are associated with immunosuppression, postoperative infections, poor cardiac function, muscle wasting, and increased mortality[32,33]. Kugimiya et al. reported that among patients treated for pyogenic spondylodiscitis, those who achieve cure through conservative management depicted by CRP normalization are those with albumin ≥3.12 g/dL. Those with albumin ≤2.85 g/dL are likely to fail in conservative management[34].

To address malnutrition, voluntary oral feeding and immunonutrition (IMN) have been introduced. IMN, either enteral or parenteral, comprises formulas to support stress states and improve immune response. Enteral feeding is advocated as it is more physiologic and provides better outcomes[35]. The North American Surgical Nutrition Summit outlined the IMN protocol comprising preoperative administration of 500-1,000 mL/day of arginine, omega-3 fatty acids, and nucleotide formula 5-7 days before any surgical intervention and 1,000 mL/day of the same formula 5 days after surgery[36]. With nutritionists and the nutrition management team of the hospital, nutritional buildup should be done in at-risk patients to avoid severe adverse events[32,33,37].

Medical comorbidities

Diabetics have a higher predisposition to spinal infections than healthy cohorts[5,38]. Bacteria thrive in high glucose environments, and the hyperglycemic state impairs the body's ability to respond to antimicrobial therapy[39]. In a prospective study on spondylodiscitis profiling by Kapsalaki et al., they

Table 3. Pola Classification[27,76].

Type	Description	Treatment of Choice
Type A	*All cases without biomechanical instability, epidural abscesses or neurological involvement*	
A1	Simple discitis without vertebral body involvement	Rigid orthosis immobilization
A2	Spondylodiscitis involving the intervertebral disk and adjacent vertebral bodies	Rigid orthosis immobilization or percutaneous stabilization
A3	Spondylodiscitis with limited paravertebral soft tissue involvement	
A4	Spondylodiscitis with unilateral (A.4.1) or bilateral (A.4.2) intramuscular abscesses	
Type B	*Cases with radiological instability of significant bone destruction without epidural abscesses or neurological involvement*	
B1	Destructive spondylodiscitis without segmental instability	Rigid orthosis immobilization or percutaneous stabilization
B2	Destructive spondylodiscitis extending to paravertebral soft tissues without segmental instability	
B3	Destructive spondylodiscitis with biomechanical instability and segmental kyphosis	Percutaneous or open stabilization
Type C	*All cases with neurological compromise or epidural abscesses*	
C1	Epidural abscess without neurological impairment and segmental instability	Rigid orthosis immobilization or percutaneous stabilization with closer clinical-radiological monitoring
C2	Epidural abscess and segmental instability without neurological impairment	Open debridement and stabilization
C3	Epidural abscess and acute neurological impairment without segmental instability	Open debridement and decompression
C4	Epidural abscess and acute neurological impairment with segmental instability	Open debridement, decompression and stabilization

saw that 75% of patients in the cohort had uncontrolled DM indicated by deranged HbA1c levels[40]. The recommended random blood sugar level is 140-180 mg/dL[41], and the HbA 1c cutoff is 6.9%, especially in those needing operative intervention. High levels are remarkably correlated with surgical site infection[42]. Despite the type of management, whether conservative or surgical, DM increases the risk for mortality and leads to poor prognostic outcomes; hence, a collaborative effort with endocrinologists is essential[5].

Kidney function, measured by the GFR, also influences the outcomes of patients with spondylodiscitis. Bacteremia resulting in inflammation and ischemia is thought to cause acute kidney injury, leading to GFR derangement. As GFR decreases, complication rates increase. Notable outcomes include delayed wound healing, pneumonia, implant failure, longer hospital stays, and higher mortality rates. In patients with GFR of >60 mL/min/1.73 m^2, a remarkable decrease in the need for monitoring at the intensive care unit was observed. Hence, this parameter can be used to predict complication risks. Electrolyte management, maintenance of an adequate volume status, and avoidance of nephrotoxic drugs with the help of nephrologists may be done to improve kidney function[43].

Another important yet underrepresented assessment in most orthopedic sections is psychiatric status. As the population of patients with spondylodiscitis is growing older, many have problems in using opioids and narcotics[44]. Due to delayed diagnosis owing to non-specific symptoms and possible spinal instability stemming from the condition, many experience chronic pain treated by a myriad and overdosage of analgesics. Chronic pain commonly occurs with mental and substance use disorders, where patients are at risk for suicidal ideation[45], depression, and delirium. On taking follow-up quality of life scores of patients treated for spondylodiscitis, the mental health component of the EuroQol five-dimension questionnaire (EQ-5D) was significantly lower than that of the age-matched healthy cohort. This implies that psychological assessment should be done routinely upon admission, followed up throughout the entire hospital stay, and continue even after discharge with the help of psychiatrists[46]. Working with pharmacists and geriatricians would also be essential to avoid polypharmacy and ensure that only essential medications are taken.

Treatment Options

Conservative treatment

Success with conservative treatment is best seen in patients in the early phase of the condition where the duration of disease is <3 months. Non-surgical management is the treatment of choice and provides satisfactory results up to 85.7%[6], even in those with extremely elevated CRP levels as long as there is no paralysis or worsening kyphosis[47]. Most guidelines recommend antibiotic treatment for 6-12 weeks with varying rationale[18]. McHenry et al. saw that parenteral therapy for 4-6 weeks is the minimum duration of treatment where oral antibiotics are given indefinitely until pain, CRP and ESR levels, and mobility improve[48]. Bernard reported that 6-week and 12-week antibiotic treatment have the same effect, where patients are cured without needing further antibiotic treatment at the 1-year follow-up. However, there was no standardized parenteral and oral antibiotic administration duration in this study[49]. This was addressed by Rutges et al., wherein they reported that antibiotic therapy, as long as it targets a specific pathogen, can be shortened from 6 weeks to 2 weeks (intravenous) and 4 weeks (oral)—without risk of relapse or infection-related mortality[50].

In addition to antibiotics, bracing with a rigid orthosis is advocated to control pain by redistributing loads to adjacent spinal segments, preventing deformity and encouraging ambulation. The duration varies, but it is recommended until the infection or bony fusion is resolved, which is expected for up to 6-10 weeks[6].

Rehabilitation is also essential to non-surgical treatment and should be done as early as possible. In patients without neurologic deficits and with manageable pain, bed rest should be kept to a maximum of 72 h. Prolonged immobilization can lead to trunk and lower extremity muscle weakness, resulting in immobilization-related morbidity, such as urinary tract infection and decubitus ulcers. In the acute stage of illness, where pain scales are high and movement might be difficult, isometric, passive, and active-assisted exercises should involve all joints and muscles to avoid contractures and atrophy. Respiratory exercises should be included, especially for those with thoracic spine infections. Proper bed positioning and turning every 2 h is advocated to avoid pressure sores. Once patients are comfortable with pain and have the appropriate brace, out-of-bed mobilization is done, including active and active-assisted exercises, sitting on the edge of the bed, balance exercises, and ambulation with assistive devices[51].

Surgical management

Surgical management for primary spinal infections is reserved for patients with progressive neurologic deficits, secondary spinal deformity, and poor response to conservative treatment[2]. The main contraindications are if the patient is severely ill, in poor general condition, and cannot withstand the stresses of surgery, leading to more risks[52,53].

Early surgical intervention is recommended for patients who develop complete paraplegia due to thoracic or cervical epidural abscess and those with cauda equina syndrome due to lumbar epidural abscess. Traditionally, procedures of choice for surgical treatment include anterior decompression and fusion with titanium cages or strut grafts and one- or two-stage posterior stabilization[19]. Metallic implants were initially believed to act as targets of bacteria and biofilm formation, reducing antibiotic penetration in areas of infection. Pluemer et al. reported that this is safe and effective without difference in recurrence of infection and failure of treatment between instrumented and non-instrumented surgery[54]. However, Carragee reported a 47% risk for postoperative complications in his series, which were most commonly instrumentation failure and wound dehiscence[55]. Wang et al. saw that open surgery entails high blood loss, leads to frequent blood transfusion, and has a 10% mortality rate[56]. Also, surgically treated patients are predisposed to high odds of having medical complications (odds ratio [OR]: 2.62) and surgical site infection (odds ratio [OR]: 6.04) leading to prolonged hospital stay[57]. Due to these numbers and since patients are at high risk, techniques have been advocated to lessen the invasiveness of surgical management.

Percutaneous aspiration and drainage is one method done under local anesthesia where saline infusion and suction aspiration are performed through a tube placed on the intervertebral disk. In 2010, Ando et al. reported good results in 73% of patients treated using this technique within a 10-year period[58]. Similarly, in 2018, Griffith-Jones et al. reported that this is a truly minimally invasive option offering promising outcomes for patients in the early stages of the disease[59]. Ito et al. looked into posterolateral endoscopic debridement and irrigation and achieved short operative times and low blood loss, including statistically significant improvement in pain and laboratory parameters. Neurologic function recovered progressively, and radiographic evaluation showed the resolution of abscesses and bony fusion[60]. Key points are curettage of intervertebral disk and vertebral body to remove infected disk material and stimulate bone bleeding to facilitate healing[61,62].

Posterior fusion helps alleviate pain, correct or preserve spinal alignment and stability of the segment[1]. One method is percutaneous pedicle screw fixation alone, which Fukutake et al. saw as an effective technique to alleviate pain, leading to a short ambulation period and hospital stay[63]. Lai et al. compared percutaneous endoscopic drainage and debridement (PEDD) with percutaneous endoscopic interbody debridement and fusion (PEIDF) using percutaneous pedicle screws in patients with severe comorbidities and poor health status. Both procedures had blood loss of less than 50 mL, with PEIDF being longer than PEDD by an average of 42 min. Within 1 year postoperatively, seven PEDD patients underwent reoperation due to back pain and residual infection, while only one PEIDF patient did. They concluded that a one-stage PEIDF surgery could be done for spondylodiscitis patients with unstable vertebral segments and severe medical comorbidities[64]. Yang et al. retrospectively studied endoscopic debridement on the first surgery and assessed 7-14 days postoperatively using the Pola classification on MRI scans to consider whether a second-stage minimally invasive fusion should be done. All patients showed great improvement with only two having minor complications of fever; thus, they reported that using staged treatment guided by the Pola classification in deciding subsequent fusion is feasible in treating patients with spondylodiscitis[65].

These studies show that endoscopic debridement and minimally invasive spinal fusion are effective and provide lesser risks than open surgery in the surgical treatment of high-risk patients with pyogenic spondylodiscitis. However, due to various employable techniques, there is no consensus concerning the indications of single versus staged surgery. Hence, this should be verified using high-level studies.

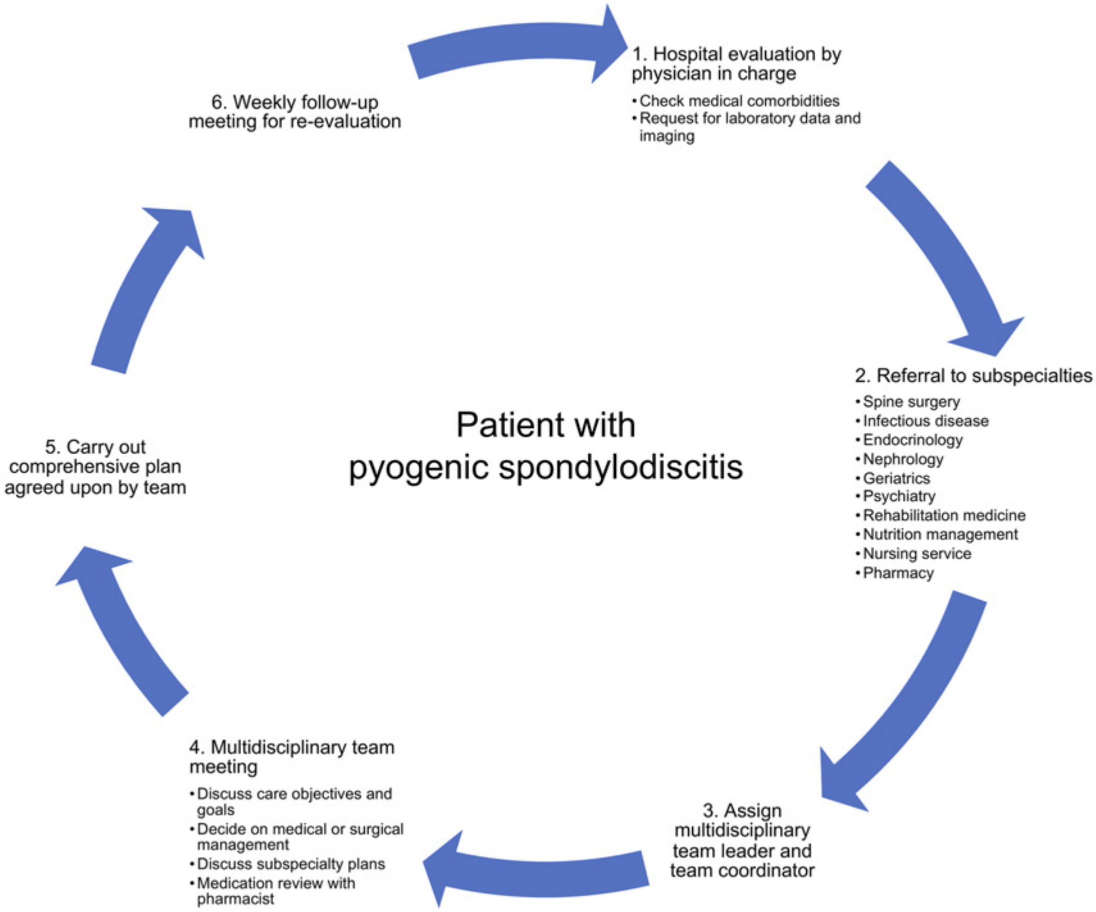

Figure 1. Flowchart of comprehensive care for patients with pyogenic spondylodiscitis.

Collaborative Care

Knowing that patients afflicted with pyogenic spondylodiscitis are commonly the elderly with multiple comorbidities, the question arises regarding properly managing their current condition and pre-existing disease states. The authors believe that establishing a model in a multidisciplinary team (MDT), looping together different medical fields, allows ultra-specialized skills and evidence-based practices to address medical and non-medical needs[66].

MDTs first emerged in oncology in the mid-1980s and are the "cooperation between different specialized professionals involved in care with the overarching goal of improving treatment efficiency and patient care"[67]. In Orthopedics and orthopedic oncology, this is usually seen when managing polytrauma patients; however, this is not widely employed in spine surgery. Musculoskeletal infections, including those affecting the spine, were historically treated by orthopedic surgeons alone, but due to the challenging diagnosis and management coupled with its increasing incidence, the need for a collaborative approach arises[66].

For an effective MDT, the following elements are required: leadership, administrative support, and team dynamics. An MDT leader should be appointed and ensure that the members are treated equally and given chances for their voices to be heard. An MDT coordinator, different from the MDT leader, is essential in ensuring that all members are informed, complete patient data is available, and records are kept during meetings. The team should also have mutual respect and trust toward all members[68].

In treating pyogenic spondylodiscitis, key members include orthopedic surgeons, infectious disease specialists, internists, rehabilitation doctors, psychiatrists, microbiologists, radiologists, nutritionists, pharmacologists, nurses, and orthotists[66]. Fig. 1 suggests the process to be undertaken and guides the collaborative team for patients with pyogenic spondylodiscitis. The physician-in-charge does initial management upon receiving the patient at the emergency room, at the clinic, or from referrals from other institutions. The primary physician may be a general practitioner, an intensivist, or an internist; it does not necessarily need to be a spine surgeon. After baseline diagnostics, subspecialties should be looped in based on patient needs and are not limited to those listed. Once individual evaluations have been made, the team, the MDT leader, and the coordinator should discuss and create a treatment plan, emphasizing care objectives and goals for the patient. This is when each subspecialty provides their plan and when a medical or surgical approach is decided. Upon reaching a consensus with regard to management, this can now be implemented. Frequent reevaluation is needed as the patient's condition changes, and new concerns might need additional intervention.

Although an emerging practice, evidence regarding the advantages of multidisciplinary teams in spine infections has been reported. Vanino et al. proposed a spinal infection multidisciplinary management flowchart for Pott's disease outlining important steps in diagnosis and management, which includes a joint monthly evaluation by spine surgeons and infectious disease specialists. They saw in this retrospective study that this collaboration is effective in the timely and efficient treatment of patients[69]. Ntalos et al. reported in another retrospective study that establishing a multidisciplinary approach for spondylodiscitis patients comprising a spine surgeon, medical microbiologist, infectious disease specialist, and pathologist who discuss and review patient records leads to more appropriate duration of antibiotics and sound surgical indications as compared to that of single discipline approach[70]. Yoshizaki et al. also retrospectively compared elderly patients with pyogenic spondylodiscitis treated with comprehensive medicine with those who received treatment from orthopedic spine surgeons alone and found similar results. The team focused on controlling all comorbidities, building up and managing nutrition, and optimizing drug use, resulting in overall improvement of clinical outcomes and quality of life of patients[71].

Although it has been seen that an MDT provides major advantages, one limitation is that there are few reports with high levels of evidence. Lamb et al. also outlined some challenges that this team may face. There may be incomplete attendance in meetings due to differing schedules. The environment for discussion may also not be one of equality, such that nurses feel that their contributions are inferior to that of physicians. Due to these, effective leadership is essential to provide an inclusive environment fostering trust and accountability[72]. Communication between all members is at the forefront of creating a collaborative team to provide effective holistic management. With these in mind, the need for employing multidisciplinary teams and its feasibility emerges, showing a promising and logical path toward comprehensive care in managing patients with pyogenic spondylodiscitis.

Conclusion

The incidence of pyogenic spondylodiscitis is increasing and is affecting the elderly with multimorbid conditions. Due to this, spinal infections should be treated as systemic diseases rather than local conditions. Implementing comprehensive care involving multidisciplinary teams effectively improves clinical outcomes and the quality of life of patients with pyogenic spondylodiscitis.

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