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Transforaminal Full-Endoscopic Lumbar Discectomy for Lumbar Pyogenic Discitis: A Review

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Pyogenic discitis can cause significant back pain, neurological complications, and spinal deformities. An early and accurate diagnosis of pyogenic discitis is crucial for its effective management. Magnetic resonance imaging is the gold standard for the diagnosis of pyogenic discitis. Hematologic markers such as white blood cell count, erythrocyte sedimentation rate, and C-reactive protein level are also helpful in monitoring disease progression. Furthermore, blood culture is essential for identifying the causative bacteria and selecting the antibiotic to be used. Biopsies are useful for identifying the causative bacteria when blood cultures are negative or when antibiotics are not sufficiently effective. While open biopsy or computed tomography-guided biopsy has conventionally been used for this purpose, recently, transforaminal full-endoscopic biopsies have been used to detect the causative bacteria in pyogenic discitis. Endoscopy can be used to obtain sufficient intervertebral disc samples with direct visualization, which increases the detection rate of causative bacteria and has been reported to be effective in relieving back pain through decompression for pyogenic disc space. However, the effectiveness of endoscopic surgery might be limited in cases of advanced infection or extensive bone destruction. In such situations, open surgery with anterior reconstruction using minimally invasive techniques may be preferred. Although it has its limits, transforaminal full-endoscopic discectomy has emerged as a standard method for identifying the causative bacteria in pyogenic discitis. It also has a high therapeutic effect.

Key Words: Spondylodiscitis, Diskectomy, Percutaneous, Endoscopy, Biopsy, Debridement

INTRODUCTION

The diagnosis and treatment of pyogenic discitis involve symptom assessment, magnetic resonance imaging (MRI), hematological tests, and bacteriological examinations [1-5]. The principle of treatment for pyogenic discitis is appropriate antibiotic treatment. Failure of antibiotic treatment may cause difficult-to-treat conditions, including persistent back pain, vertebral compression, kyphotic deformity, formation of epidural abscesses, and spinal instability, which necessitate surgical intervention [6,7]. Prompt diagnosis and early intervention with the appropriate antibiotics help resolve pyogenic discitis without the need for surgical intervention. Effective treatment for bacterial discitis involves a sequential process: first, discitis is diagnosed based on symptoms, MRI, and hematological tests. The subsequent empiric antibiotic therapy is then commenced,

preferably immediately after diagnosis, followed by tailoring the antibiotic therapy to ensure that it is effective against the causative bacteria identified. While blood cultures are useful for identifying the causative pathogen, the detection rate using this method is approximately 50%. Reportedly, biopsies help effectively identify the causative bacteria, with a higher detection rate of 70%–100%. Recently, an increasing number of reports on biopsy methods have been published, with computed tomography (CT)-guided percutaneous biopsy becoming the preferred option as it is less invasive and safer than open biopsy [5]. The body of evidence on the effectiveness of full-endoscopic biopsies in discitis is also growing [8,9]. In full-endoscopic biopsy, a sufficient amount of samples are obtained from the intervertebral discs, leading to a higher detection rate of the causative microorganisms. Endoscopic decompression and lavage of the intervertebral space contribute to ameliorating postoperative back pain and facilitate antibiotic treatment success, ultimately reducing the need for surgical intervention.

With the widespread use of full-endoscopic lumbar surgery, the number of reports on its effectiveness as a minimally invasive initial treatment for intervertebral discitis is increasing, creating a need to summarize the existing literature on the topic [10,11]. This review aims to provide a comprehensive overview of transforaminal full-endoscopic lumbar discectomy (FELD) for pyogenic discitis.

DIAGNOSIS OF PYOGENIC DISCITIS

1. Symptoms

Sapico and Montgomerie found that 50% of patients with pyogenic discitis experienced symptoms persisting for over 3 months before diagnosis [1]. Pain is the dominant symptom and presents in 90% of the patients, whereas fever is observed in only 52%, with chills or fever spikes being rare [12]. The pain is primarily localized to the spine but may radiate to other areas, such as the abdomen, hip, leg, scrotum, groin, or perineum. Radicular symptoms were found in 50%–93% of cases [13].

The primary signs of spondylodiscitis include tender paravertebral muscles, muscle spasms, and limited spinal movement. Neurological complications, such as spinal cord or nerve root compression and meningitis, occur in approximately 12% of patients [14].

Progression of spinal pain to radicular symptoms, weakness, and paralysis may indicate the formation of an epidural abscess or kyphotic collapse at the infection level. Sensory involvement is rare, whereas motor and long-tract signs are more common because of anterior cord compression [15,16].

2. Radiology

As MRI is more sensitive than bone scans, it has become the gold standard for evaluating pyogenic spondylodiscitis. It shows characteristic findings early in the disease course, with a sensitivity of 96%, specificity of 92%, and accuracy of 94% in diagnosing spondylodiscitis [2]. The postinflammatory phase of the disease is marked by characteristic histological changes, including vascularized fibrous tissue, fatty bone marrow transformation, subchondral fibrosis, and osteosclerosis, which can be clearly visualized using MRI. In addition, MRI can be used to monitor therapeutic responses during treatment [17].

In patients with symptoms for less than 2 weeks, MRI findings help diagnose or are suggestive of pyogenic spondylodiscitis in 55% and 36% of the cases, respectively [18]. After 2 weeks, the rates of correct and possible diagnoses are 76% and 20%, respectively. Early MRI abnormalities occur because of edema and inflammatory cells infiltrating the vertebral body and disc spaces. This causes the marrow to have lower intensity on T1-weighted images and higher intensity on T2-weighted sequences. The intervertebral disc is also visualized as high-intensity on T2-weighted images owing to increased water content. Gadolinium-based contrast agents may show enhancement at the endplate–disc interface early in the infection stage; the enhancement area widens as the disease progresses. Follow-up MRI findings of pyogenic spondylodiscitis may show variable tissue responses. It has been reported that changes in C-reactive protein (CRP) are correlated with changes in soft tissue, and changes in erythrocyte sedimentation rate (ESR) are correlated with changes in bone on MRI. Similar to the ESR, which normalizes more slowly than CRP, bone abnormalities on MRI take more time to be normalized than soft tissue abnormalities. If ESR or CRP increases over the course of treatment for discitis, a follow-up MRI may be required to determine whether this is due to treatment failure or inflammation elsewhere [19].

3. Hematology

In patients with spondylodiscitis, the white blood cell count is usually normal; however, it may be elevated in 35% of cases, typically not exceeding 12,000 cells/mm^3. The ESR is often elevated, with a mean value of 85 mm/hr (normal value, 0–20 mm/hr), and tends to decline with appropriate medical treatment. The CRP rises within 6 hours of bacterial infection and

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is elevated in more than 90% of patients with discitis. Although CRP and ESR are elevated after infections, CRP normalizes after appropriate treatment of an infectious process faster than ESR. CRP level is another clinically useful marker for monitoring disease progression [3,4].

4. Bacteriology

Blood, urine, and focal suppurative processes should be cultured to identify the causative organism of discitis. Blood cultures are positive in approximately 50% of cases and can aid in guiding antimicrobial therapy. If the organism cannot be identified using minimally invasive methods, direct culture from the affected vertebral body and/or disc space should be attempted. CT-guided percutaneous needle biopsy is a safe and precise diagnostic option, with accuracy rates ranging from 70%–100%. Open biopsies have a diagnostic accuracy of over 80% but are associated with higher morbidity [5].

Nonculture amplification-based DNA analysis is highly sensitive and specific, particularly in cases where standard culture methods fail to identify the infectious agent. This method can be useful in identifying the cause of infectious spondylodiscitis and guiding species-specific treatment when blood and disc aspirate cultures are negative [20].

In cases where fungal or mycobacterial infections are suspected based on subacute presentation, along with negative Gram staining and bacterial culture, cultures specific for fungi and mycobacteria should be obtained. Whenever possible, antibiotics should be withheld until cultures are obtained to ensure accurate identification of the causative organism and appropriate treatment.

BIOPSY METHODS

Empirical antibiotic therapy before biopsy can lead to challenges in isolating organisms from bacteriological cultures because the microbial growth rate significantly decreases when patients are already on antibiotics (from 40% to 25%). However, despite this difficulty, spinal biopsy results in a direct change in management for 35% of patients with discitis, and it remains valuable even if the patient has already started antibiotic treatment. Spinal biopsy should be performed before initiating antibiotics, with samples sent to both the pathology and bacteriology departments for accurate diagnosis and appropriate management [21].

Biopsy is primarily indicated in patients with suspected spondylodiscitis and negative blood cultures. Percutaneous biopsy is a safe procedure that can be performed using guided CT-scanning or endoscopy [22]. Endoscopy facilitates both the biopsy procedure and discectomy and drainage, leading to better bacterial recovery compared with that after CT-guided spinal biopsy. Endoscopy is currently considered the standard method for obtaining samples, as it enables further surgical treatment if necessary [8]. If the initial biopsy result is negative, a second biopsy should be performed; in any case, more than 6 samples from different areas of the surgical field should be collected to improve diagnostic accuracy [9].

Currently, surgical biopsy is more commonly used than minimally invasive techniques [23,24]. However, with advancements in endoscopy, open surgery is becoming less favored as a biopsy method. Biopsy after antibiotic treatment may result in a negative culture [22,25]; therefore, antibiotic suppression before biopsy is recommended. However, this approach is controversial, as negative culture results may be yielded in approximately 40% of spondylodiscitis cases without prior antibiotic treatment [26,27].

1. Usefulness of Endoscopic Discectomy

One study reported on 15 consecutive patients with pyogenic spondylodiscitis of the thoracic or lumbar spine [10]. All patients had previously failed preoperative antibiotic treatment. Transforaminal full-endoscopic debridement and irrigation were performed under local and intravenous anesthesia. All patients experienced immediate postoperative pain reduction. After an average of 3.7 weeks of antibiotic administration, inflammation in patients was ameliorated, and a high spinal fusion rate was achieved. The authors also reported that they were able to reduce epidural abscesses based on imaging, improve clinical symptoms caused by the abscess, and eliminate the psoas abscess [10].

Another study retrospectively reviewed the medical records of 21 patients who had undergone FELD for advanced lumbar infectious spondylitis [11]. Causative bacteria were identified in 90.5% of the biopsy specimens, and appropriate antibiotics were prescribed based on the predominant pathogen. The overall infection control rate was 86%. Most patients reported satisfactory recovery and relief from back pain, except for those with multilevel infections who required additional anterior debridement and fusion. FELD successfully provided a bacteriological diagnosis, relieved symptoms, and contributed to the eradication of lumbar infectious spondylitis. The indications for FELD can be extended to patients with spinal infections, paraspinal abscesses, or postoperative recurrent infections.

However, patients with multilevel infections may experience limited benefits from FELD because of poor infection control and mechanical instability of the affected segments [11].

OPERATIVE PROCEDURE

In the aforementioned study, FELD was performed in patients with infectious spondylitis of the lumbar region. Patients were placed in the prone position on a radiolucent frame suitable for fluoroscopy, and all procedures were performed under local anesthesia with conscious sedation, similar to the standard lumbar discography procedure.

Under fluoroscopic guidance, the target site within the infected disc was located, and the entry site on the skin was marked 8–12 cm from the midline. After sterile preparation, draping, and local anesthesia administration, a spinal needle was inserted directly into the center of the targeted disc. A guidewire was then introduced through the needle into the central disc space, and the needle was removed. A small incision (approximately 1 cm) was made, and a dilator and cannulated sleeve were sequentially guided over the wire and into the center of the disc. Fluoroscopy was repeated in 2 orthogonal planes to ensure the correct positioning of the endoscope tip [11].

The tissue dilator was removed, and a cutting tool, a cylindrical sleeve with a serrated edge at its distal end, was inserted to harvest a core biopsy specimen of the infected tissue. Discectomy forceps were then inserted through the cannulated sleeve to extract additional infected tissue from the disc. Percutaneous debridement was performed in a piecemeal manner by manipulating the biopsy forceps, flexible rongeurs, and shaver into different positions to remove as much infected tissue as possible. Fluoroscopy was used for monitoring. The same procedure was repeated on the opposite sides of the disc. Working sheaths were retained on both sides to allow sufficient extirpation and extensive debridement of the infected intervertebral disc, and even parts of the endplate were removed from different endoscopic directions.

Approximately 35 mL of povidone-iodine was diluted with 1,000 mL of normal saline to obtain a 3.5% betadine solution, which was used for irrigation after biopsy and debridement. At least 10,000 mL of the diluted betadine solution was used for irrigation [11].

1. Limitations of Full-Endoscopic Discectomy and Lavage

The effectiveness of transforaminal full-endoscopic surgery for pyogenic spondylodiscitis has been demonstrated in previous studies [10,28,29]; however, most of these studies focused on early-stage infections. In one study wherein the posterolateral endoscopic technique was used in 4 patients with pyogenic spondylodiscitis, all patients experienced immediate back pain reduction after surgery and were subsequently treated with parenteral antibiotics, but not all had successful outcomes. Two possible causes for these adverse effects have been identified. First, all patients were compromised hosts with comorbidities, such as diabetes. Second, vertebral destruction had progressed in the patients after they underwent conservative therapy for some time before surgery. Aggressive debridement with the endoscopic procedure may have increased instability and exacerbated pain in certain cases, leading to neurological disorders, such as foraminal stenosis. Severe cases require open surgery with anterior reconstruction using an iliac strut bone graft and posterior instrumentation [30].

The progression of vertebral destruction, along with preoperative destructive changes at the vertebral level, can lead to local kyphosis progression during follow-up after aggressive debridement with full-endoscopic surgery [10,11]. To ensure successful outcomes, it is essential to quantify and evaluate the degree of preoperative bone destruction and to determine clear indications for endoscopic surgery. In cases of extensive bone destruction, open debridement and bone grafting can provide better stability and symptom relief and prevent kyphosis. Recently, a minimally invasive direct lateral retroperitoneal approach that offers thorough debridement and spinal reconstruction has been reported as an alternative surgical treatment for lumbar discitis and osteomyelitis [31,32]. Therefore, in cases of significant vertebral destruction, it is advisable to consider open surgery using minimally invasive techniques as the primary treatment rather than endoscopic procedures.

CONCLUSION

In the treatment of pyogenic discitis, transforaminal full-endoscopic discectomy increases the identification rate of causative bacteria by facilitating direct visualization and helping obtain a sufficient amount of disc sample, enabling the selection of appropriate antibiotics. It is less invasive and safer than open biopsy or CT-guided biopsy. In addition, as a large amount of intervertebral discs can be removed, transforaminal full-endoscopic discectomy decreases intervertebral compression and is also highly effective in relieving back pain caused by discitis. Furthermore, lavage can be performed at the same time as the biopsy, aiding in diagnosis with a high therapeutic effect.

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Thus, although it has its limitations, transforaminal full endoscopy can be considered the procedure of choice for the diagnosis and treatment of discitis in the future.

NOTES

Conflicts of Interest

The authors have nothing to disclose.

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