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Review article

eISSN 2799-8010
J Yeungnam Med Sci 2024;41(3):166-178
https://doi.org/10.12701/jyms.2024.00339

JYMS
JOURNAL OF YEUNGNAM MEDICAL SCIENCE

Failed back surgery syndrome—terminology, etiology, prevention, evaluation, and management: a narrative review

Jinseok Yeo

Department of Anesthesiology and Pain Medicine, School of Medicine, Kyungpook National University, Kyungpook National University Chilgok Hospital, Daegu, Korea

Amid the worldwide increase in spinal surgery rates, a significant proportion of patients continue to experience refractory chronic pain, resulting in reduced quality of life and escalated healthcare demands. Failed back surgery syndrome (FBSS) is a clinical condition characterized by persistent or recurrent pain after one or more spinal surgeries. The diverse characteristics and stigmatizing descriptions of FBSS necessitate a reevaluation of its nomenclature to reflect its complexity more accurately. Accurate identification of the cause of FBSS is hampered by the complex nature of the syndrome and limitations of current diagnostic labels. Management requires a multidisciplinary approach that may include pharmacological treatment, physical therapy, psychological support, and interventional procedures, emphasizing realistic goal-setting and patient education. Further research is needed to increase our understanding, improve diagnostic accuracy, and develop more effective management strategies.

Keywords: Back pain; Chronic pain; Failed back surgery syndrome

Introduction

Low back pain (LBP) is the leading cause of years lived with disability. In 2020, an estimated 619 million individuals worldwide experienced LBP, a substantial increase of 60.4% from 1990 [1]. A significant increase in the rate of spinal surgeries across various regions mirrored this escalation in the incidence of LBP. In the United States, there has been a marked increase in lumbar fusions and laminectomies, with increases of 170% and 11.3%, respectively, between 1998 and 2008 [2]. South Korea also reported a steady increase in spinal surgery cases from 168,836 in 2016 to 188,394 in 2020 [3]. In Japan, the annual number of spinal surgeries increased 140% between 2003 and 2017 [4]. Norway saw a 54% increase in lumbar spine surgery rates from 1999 to 2013 [5]. Despite geographical variations in the growth rate, the global trend indicates a clear and undeniable increase in the occurrence of spinal surgeries, paralleling the increased prevalence of LBP.

Despite advances in diagnostic and surgical techniques, the escalation in spinal surgeries has not resulted in commensurate pain relief. Recent studies have reported a prevalence of chronic pain after spinal surgery ranging from 5% to 27.6%, with a pooled prevalence of 14.97% [6]. Individuals experiencing persistent or recurrent pain after spinal surgery are diagnosed with failed back surgery syndrome (FBSS). Patients with FBSS have lower quality of life

Received: April 3, 2024 • **Revised:** May 8, 2024 • **Accepted:** May 16, 2024 • **Published online:** June 10, 2024
Corresponding author: Jinseok Yeo, MD, PhD
Department of Anesthesiology and Pain Medicine, School of Medicine, Kyungpook National University, Kyungpook National University Chilgok Hospital, 807 Hoguk-ro, Buk-gu, Daegu 41404, Korea
Tel: +82-53-200-2644 • Fax: 82-53-200-3870 • E-mail: painfree@gmail.com

(QOL) scores, higher levels of pain and disability, higher psychological morbidity, and higher rates of unemployment [7].

Therefore, an improved understanding of FBSS and its management is essential for physicians and surgeons caring for this patient population. This review aims to provide a comprehensive overview of the terminology, etiology, prevention, appropriate diagnostic imaging modalities, and treatment strategies for FBSS.

Terminology

An accurate definition of the disease is essential for optimal treatment of FBSS. FBSS is a term used to describe chronic back pain following one or more spinal surgeries. It is defined by the International Association for the Study of Pain as "lumbar pain of unknown origin either persisting despite surgical intervention or appearing after surgical intervention for spinal pain originally in the same topographical location" [8]. Waguespack et al. [9] propose a functional definition—that FBSS be diagnosed when "the outcome of a lumbar spinal surgery did not meet the expectations established by the patient and the surgeon before surgery".

However, this term lacks specificity regarding the underlying cause and provides limited treatment guidance. It does not describe the consequences of unsuccessful surgery, nor does it distinguish between symptoms resulting from correctly or incorrectly indicated surgery, or between pain not relieved by surgery and new pain unrelated to surgery. It also does not specify the type of surgery previously performed. Additionally, it suggests the failure of, or places blame on, treatment.

Healthcare professionals advocate reconsidering this terminology, suggesting that it should be renamed to reflect a more accurate and less stigmatizing description of the condition [10]. In the International Classification of Diseases 10th revision (ICD-10), FBSS is designated as a "postlaminectomy syndrome," although this terminology fails to encompass the full spectrum of what is known about FBSS. In ICD-11, the categorization evolves to "chronic pain after spine surgery," placing it within the broader context of chronic postsurgical or posttraumatic pain, thereby offering a more inclusive and descriptive classification [11]. The term "chronic pain after spine surgery" is preferred because it eliminates the notion of surgical failure. However, this term does not include pain unrelated to surgery and may inadvertently suggest that pain is solely a result of spinal surgery.

The term "persistent spinal pain syndrome" (PSPS) has been proposed as a replacement for FBSS [12]. This term encompasses a clinical presentation characterized by persistent axial and/or radicular pain originating from the spine despite comprehensive therapeutic interventions involving surgical and nonsurgical treatments. PSPS is classified into two subtypes based on the relevance of prior surgical intervention: type I, in which no relevant surgery has been performed, and type II, which involves cases in which the patient has undergone relevant surgical procedures. PSPS is further divided into subdivisions that address variations in pain location and underlying pathophysiology. This structured classification facilitates a greater understanding beyond the simple substitution of the term "FBSS," increases diagnostic accuracy, optimizes treatment strategies, and improves overall patient care [12].

Etiology

Individuals diagnosed with FBSS are a diverse and heterogeneous population with a wide range of underlying causes. This condition represents treatment failure and functional impairment of the spinal structures (Table 1).

1. Patient-related factors

Psychological factors have a considerably more significant impact than structural abnormalities in forecasting the onset of LBP [13]. Depression, anxiety, inadequate coping mechanisms, somatization,

Table 1. Etiology of failed back surgery syndrome

Factor	Details
Patient-related factors	
Psychological factors	Anxiety, depression, inadequate coping mechanisms, somatization, hypochondriasis
Social factors	Litigation, worker's compensation
Behavioral factors	Smoking, obesity
Surgery-related (intraoperative) factors	Revision surgery, unsuitable surgical procedure, mistakes during surgery
Postoperative factors	
Surgical complications	Infection, hematoma, pseudomeningocele, nerve injury
Progression of disease	Recurrent disc herniation, restenosis
Altered biomechanical dynamics	Adjacent segment degeneration, muscle spasm, fatigue
Epidural adhesion	
Denervation-related muscle atrophy	

and hypochondriasis have been identified as the primary psychological factors contributing to poor outcomes [14]. Considering these findings, preoperative psychological screening is recommended; however, its implementation remains limited [15].

Social factors can interfere with successful surgical outcomes and create the confounding variable of secondary gain, detracting from the patient's motivation to improve. Patients receiving workers' compensation often experience less favorable results after spinal surgery, characterized by increased pain, increased opioid use, decreased functional capacity, and reduced overall emotional well-being [16]. The influence of litigation must be considered as a significant variable that can intensify claims related to the severity and duration of symptoms, regardless of the medical or surgical treatment administered, underscoring the critical need to understand how legal processes affect symptom perception and reporting [17].

Behavioral factors can also influence postoperative outcomes. Smoking and obesity may contribute to recurrent disc herniation, requiring reoperation [18]. Smoking is associated with impaired wound healing, increased infection rates, and increased incidence of nonunion following surgical fusion. In addition, smokers require higher doses of analgesics, have decreased ambulation, and experience reduced QOL postoperatively [19]. Patients who are obese report less improvement in leg pain after surgery [20].

2. Surgery-related factors

Incorrect selection of the surgical procedure is a significant risk factor for FBSS. Performing decompression at the wrong level or single-level decompression without recognizing multilevel spinal involvement is unlikely to yield satisfactory outcomes. Inadequate lateral recess and neural foraminal decompression are significant causes of FBSS [21].

Errors during spinal surgery can exacerbate preoperative pain and create new sources of pain. Poor surgical techniques can lead to segmental instability and increased pain resulting from direct nerve damage and intraoperative spinal cord ischemia. Furthermore, inadequate techniques that fail to meet surgical objectives may result in persistent pain or emergence of new pain symptoms [22].

3. Postoperative factors

Immediate postoperative pain mainly results from surgical complications such as infection, epidural or subdural hematoma, pseudomeningocele, and nerve injury. Disease progression can also lead to postoperative pain. One study found that, among patients who underwent surgery for disc herniation, the overall reoperation rate was 15%, and 62% of these reoperations were performed for recurrent disc herniation [23]. Additionally, among patients who underwent surgery for spinal stenosis, 13% underwent subsequent surgery, with 80% of these reoperations involving the same spinal level as the initial surgery [24]. Preexisting degenerative changes within the spine, such as spondylolisthesis and facet arthropathy, may also cause spinal stenosis and nerve root compression after surgery [12].

Spinal surgery often alters biomechanical dynamics, resulting in decreased lordosis due to fusion [25]. These alterations can result in adjacent segment degeneration above and below the surgical site, affecting the intervertebral discs, facet joints, sacroiliac joint (SIJ), and posterior sacroiliac ligament complex [26] (Fig. 1). The 10-year prevalence of adjacent segment disease ranges from 22% to 36%, with more than 20% of patients requiring revision surgery [26]. Altered biomechanical dynamics may also elevate tension within the paravertebral muscles. This heightened tension can lead to stiffness, inflammation, muscle spasms, and fatigue, thereby contributing to the development of back pain [27].

Dissection and prolonged retraction of the paravertebral muscles during surgery can result in denervation-related muscle atrophy [28]. Reduced muscular support after surgery results in disability and increased biomechanical stress, which may contribute to the development of back pain.

Fig. 1. Adjacent segment degeneration. (A) Plain radiograph and (B) magnetic resonance image of a patient who had undergone a two-level lumbar spinal fusion from L3 to L5 2 years earlier. The magnetic resonance image reveals a herniated disc at the L3–L4 level.

Spinal surgery often results in the development of fibrotic adhesions within the epidural space, known as epidural fibrosis [29]. These fibrotic adhesions in the epidural space can lead to adhesions with the dura mater and entrapment of nerve roots, compressing the nerve roots, contributing to back and leg pain, limiting back motion, and causing pain during movement. In a prospective cohort observational study, 83.3% of patients with FBSS had severe epidural fibrosis, as determined by epiduroscopy [29]. Nerve compression and the accumulation of inflammatory mediators around the scar tissue can disrupt nerve nutrition, increase sensitivity, and lead to chronic pain [30].

Prevention

Once established, FBSS is a major treatment challenge. Preventing FBSS through strategic management and decision-making is crucial for enhancing pain relief and QOL. Furthermore, aligning the preoperative expectations of patients and surgeons requires effective communication and comprehensive patient education regarding surgical goals and expectations based on documented success rates [10].

Patients with substantial motor deficits or major spinal fractures require surgical intervention. However, the need for spinal surgery in patients with radicular pain or back pain remains controversial. Surgical intervention for radicular pain has been shown to reduce the pain and improve functional outcomes short- to medium-term, although this is based on low-quality evidence [31]. For non-radicular back pain associated with degenerative spinal conditions, the benefits of spinal fusion were not superior to those of nonoperative treatment [32]. Previous evidence suggests that patients with radicular pain may have better outcomes after spinal surgery and that preoperative working status may be a reliable indicator of surgical success [33].

Epidural fibrosis may be a prevalent cause of chronic pain following spinal surgery. The removal of established epidural fibrosis and associated scarring is challenging, and the risk of dural tears increases during subsequent interventions or surgeries. Prevention of fibrosis, inflammation, and adhesion may be possible through local and immediate application of drugs such as mitomycin C, dexamethasone, nonsteroidal anti-inflammatory drugs (NSAIDs), and rosuvastatin, and biomaterials such as animal collagen membranes, human amniotic membranes, and autologous lipid grafts [34]. In addition, the intraoperative use of an adhesion barrier gel attenuates fibrosis and reduces inflammation and adhesion. A recent meta-analysis demonstrated that the application of an adhesion barrier gel in single-level lumbar disc surgery significantly decreased postoperative leg pain [35].

Psychological factors and social stressors increase the incidence of spinal pain and complications, and diminish functional outcomes after surgery. Preoperative psychosocial assessment may help prevent FBSS [36].

Patient evaluation

A thorough evaluation of patients with FBSS is essential to accurately identify the sources of pain. This begins with obtaining a history and performing a physical examination. Identifying red flags, such as recent cancer history, unexplained weight loss, fever, history of trauma, and difficulties in voiding, is essential. These symptoms may indicate life-threatening conditions or the need for emergency surgical intervention [37].

It is essential to comprehensively evaluate postoperative pain, including its onset, severity, distinct characteristics, location, and comparison with preoperative pain. New-onset pain immediately following surgery may be attributable to surgical complications such as pedicle screw misplacement or iatrogenic injury. If postoperative pain mirrors preoperative pain, it indicates that the surgery has not successfully resolved the cause of discomfort, which may be due to inadequate decompression, residual disc tissue or fragments, or foraminal stenosis [38].

Pain types, such as neuropathic or nociceptive, should be classified on the basis of their characteristics. Neuropathic pain is a spontaneous paroxysmal pain characterized by shooting or electric shock-like pain, which may be described as burning, tingling, or crawling sensations with allodynia and pain in an area entirely numb to touch. Screening tools such as PainDETECT (Pfizer, New York, NY, USA), LANSS (University of Leeds, Leeds, UK), and DN4 (Groupe d'Étude sur la Douleur Neuropathique, Marseille, France) can help identify neuropathic pain [39].

A comprehensive evaluation that includes assessment of posture, gait, and physical function is essential. Physical examination can provide valuable insights into the origin of pain. For example, paraspinal tenderness may indicate facetogenic pain, myofascial pain, or cluneal neuralgia [40,41]. Three or more positive SIJ-specific provocation tests significantly increase the likelihood of identifying the SIJ as the primary source of pain [42]. Therefore, it is recommended that various diagnostic tests, such as distraction, compression, sacral thrust, femoral thrust, and the Gaenslen test, be performed to thoroughly evaluate the SIJ. Pain that does not conform to an anatomical distribution is often considered nonorganic and indicative of underlying psychological distress. In such cases, Waddell's sign is a useful diagnostic tool [43]. Nonorganic signs have been significantly associated with treatment failure [44].

Behavioral assessments are essential for FBSS treatment because they help identify and manage psychosocial barriers. These barriers include fear-avoidance behaviors, low mood, social withdrawal, and a passive approach to pain management. Potential secondary gains such as those resulting from ongoing litigation and the ingrained belief that pain is inherently harmful further complicate the recovery process. Additionally, substance use is a significant challenge and major barrier to the successful treatment of FBSS [10].

Harmonized guidelines for diagnostic imaging have not been proposed [45]. The lack of standardized imaging strategies has made it challenging to accurately identify the sources of pain. Plain radiography, which is often the initial imaging modality, encompasses flexion-extension films and whole-spine anteroposterior and lateral views. It identifies degenerative changes within the spine, evaluates spinal alignment, and diagnoses functional spondylolisthesis, particularly in cases in which magnetic resonance imaging (MRI) results appear normal [46]. Despite their utility, plain radiographs are not optimal for visualizing soft tissues and discs and offer only two-dimensional perspectives [47].

Computed tomography (CT) helps evaluate bony changes in the spinal canal, including facet arthropathy and the condition or position of implants [48]. Weight-bearing CT can help visualize the postoperative spine and detect minimal instability [49]. CT myelography with iterative metal artifact reduction can be useful for evaluating soft tissue and disc changes in patients with instrumented spinal fusion [50]. CT can help patients with limited MRI options, such as those with implanted spinal cord stimulators (SCSs). Single-photon emission CT has demonstrated accuracy in localizing bone turnover at the disc and pars interarticularis, aiding in assessing functional pain sources originating from the facet joints and discs [51]. MRI provides soft tissue contrast that is superior to that of X-ray and CT scans, facilitating detailed imaging of neural tissue, inflammation, or lipomatous changes. Gadolinium-enhanced MRI is the preferred imaging modality for evaluating the postoperative spine because it effectively differentiates between epidural fibrosis, disc herniation, arachnoiditis, and postoperative discitis [47]. Magnetic resonance neurography provides a detailed assessment of nerve structures, hip muscles, and the lumbosacral plexus, and has identified a more comprehensive range of abnormalities, such as neuropathy, foraminal stenosis, and hamstring tendinopathy, significantly influencing diagnostic and management strategies [52].

Management

A multidisciplinary approach is crucial for the effective management of FBSS. Setting realistic treatment objectives, exploring various treatment modalities, and engaging in comprehensive discussions with the treatment team are imperative. The expectation of total pain relief with a single treatment modality is likely to lead to disappointment. Management goals should focus on restoring functional capabilities, enhancing QOL, developing coping strategies, and fostering skills for pain self-management.

1. Pharmacological management

NSAIDs can reduce pain and improve disability management [53]. However, NSAIDs have not demonstrated superiority over other conservative treatments for LBP and have failed to show an analgesic benefit for radiating pain. Evidence supporting their effectiveness is moderate, and concerns persist regarding their side effects, including gastrointestinal bleeding, renal dysfunction, and long-term safety [54]. Acetaminophen is frequently prescribed for the treatment of LBP owing to its low risk of side effects. However, its analgesic effectiveness for acute back pain did not significantly differ from that of a placebo, and there is a lack of evidence supporting its efficacy in chronic LBP [53].

Antidepressants, such as tricyclic antidepressants and serotonin-norepinephrine reuptake inhibitors, have the potential to mitigate pain and improve functional outcomes, especially in individuals with sciatica [55]. However, their use is associated with a significantly increased incidence of adverse events such as xerostomia, vertigo, and constipation. Duloxetine is often recommended as a first- or second-line treatment because of its favorable side-effect profile [56].

Antiepileptic drugs, including gabapentin and pregabalin, are increasingly being used and evaluated in clinical trials for the treatment of FBSS. These agents have shown efficacy in relieving neuropathic pain in patients with FBSS [57]. However, systematic reviews indicate that these drugs only provide short-term improvements in sciatica symptoms, and there is no substantial evidence to support their efficacy in treating LBP [58,59]. In addition, these medications are often associated with adverse events including vertigo and xerostomia. Therefore, cautious use of these medications is recommended.

Benzodiazepines and muscle relaxants are commonly prescribed to treat muscle spasms and spasticity. These medications effectively relieve acute LBP, as supported by moderate-quality evidence. However, the effectiveness of muscle relaxants for chronic LBP remains unclear due to conflicting data [53]. Benzodiazepines are more likely to provide pain relief than placebo, although this is based on low-quality evidence [53]. Benzodiazepines are associated with sedative effects and risks of dependency, overdose, and withdrawal. Therefore, they should be used with caution.

Tramadol is a synthetic opioid analgesic characterized by a dual mechanism of action involving μ-opioid receptor agonism and inhibition of norepinephrine and serotonin reuptake. It offers modest reductions in pain and slight improvements in disability when tolerated and not contraindicated [60].

Opioids are frequently prescribed for patients who do not respond adequately to other pain medications. However, the effectiveness of opioid therapy for the treatment of LBP is limited. Although short-term opioid therapy can relieve pain, its long-term effectiveness in reducing pain intensity or improving pain-related functions has not been demonstrated [61]. Moreover, prolonged opioid use has numerous adverse effects such as immunosuppression, androgen deficiency, constipation, and depression [61]. Despite these drawbacks, opioid prescriptions for back pain have escalated, leading to an increase in opioid diversion, misuse, abuse, and opioid-related mortality [62]. The concomitant use of gabapentin or pregabalin with opioids significantly increases the risk of opioid-related mortality [63]. This increased risk has led to increased efforts to reduce or discontinue chronic opioid use, highlighting the urgent need for safer and more effective pain management alternatives.

2. Physical therapy and exercise

Patients with FBSS may experience deconditioning, resulting in weakened muscles, including the transversus abdominis and paraspinal muscles, which are critical for spinal stability. The primary goals of exercise therapy are to relieve pain, improve gait and posture, stabilize hypermobile segments, increase muscle strength and overall physical function, and reduce mechanical stress on spinal structures. Exercise effectively manages pain and is likely to minimize disability [64]. Individuals experiencing chronic LBP are recommended to participate in enjoyable exercise activities that promote adherence to regular exercise regimens. Commonly recommended exercises include walking, stationary cycling, aquatic exercises, yoga, and tai chi. Exercise programs that include supervision, stretching, and strengthening components tailored to the individual are associated with better outcomes [64]. A recent network meta-analysis showed that the McKenzie method, Pilates, and functional restoration exercises are superior to other forms of exercise in reducing pain intensity and functional limitations [65]. Multidisciplinary biopsychosocial rehabilitation (MBR) programs include physical, psychological, educational, or work-related components and are often delivered by a team of healthcare providers with expertise in different areas. MBR interventions are more effective than usual care and physical treatments based on moderate- and low-quality evidence, respectively, in reducing pain and disability among individuals with chronic LBP [66].

3. Psychological therapy

Considering the considerable influence of psychological factors on FBSS, the inclusion of psychological therapy in the treatment plan is a logical approach. Cognitive behavioral therapy (CBT) is a comprehensive approach with four primary components: enhancing patients' knowledge and understanding of their pain and perceptions, teaching active coping strategies, ensuring the maintenance of these coping strategies, and developing problem-solving plans to address pain and effectively navigate challenging situations [67]. CBT has demonstrated efficacy in reducing pain, disability, and distress in patients with chronic pain, as supported by moderate-quality evidence [68]. Meditation-based therapies may offer substantial benefits in reducing pain and improving QOL in individuals experiencing chronic back pain [69].

4. Interventional pain procedures

Owing to the significant failure rates associated with revision surgery, it is recommended that minimally invasive procedures be prioritized for pain management. Interventional pain procedures can be used to effectively diagnose and alleviate pain by targeting specific spinal levels. Determining the most suitable procedure requires a thorough evaluation, encompassing the patient's medical history to differentiate between radicular and axial symptoms, along with findings from physical examinations and diagnostic testing.

1) Epidural injections

One proposed cause of radicular pain is inflammation initiated by phospholipase A2 in the herniated disc. Epidural steroid injections (ESIs) attenuate this process by inhibiting prostaglandin synthesis and reducing the local levels of inflammatory mediators, directly targeting the inflammatory pathways involved in the pathogenesis of radicular pain [70]. ESIs for radicular pain demonstrate short-term benefits and provide modest improvements in pain and disability levels [71].

Three ESI approaches are commonly used in clinical practice: caudal, interlaminar, and transforaminal. Each technique targets different areas of the spine for therapeutic intervention, to address specific conditions and anatomical considerations. The transforaminal approach to ESI is particularly effective in diagnosing and treating radicular pain by targeting specific spinal levels. This approach has been shown to provide significant short-term relief from radicular pain and offer superior long-term pain reduction and functional improvements compared to other injection techniques [72].

2) Facet joint procedures

When the complaint of pain is primarily axial, the likelihood of facet joint pathology increases. Facet joints have been implicated as a source of pain in 16% of patients with recurrent pain after lumbar spine surgery [73]. Pain not predominantly situated along the midline, accompanied by potential tenderness over the facet joints, suggests facet joint pain. The selection of block levels should be based on clinical presentation, including radiographic findings (if available), tenderness identified by palpation under fluoroscopic guidance, and pain referral patterns [74]. Facet joint pain can be diagnosed using intra-articular injections or medial branch blocks, with the latter considered more effective. The superior diagnostic accuracy of medial branch blocks for facet joint pain has been attributed to the possible aberrant innervation of the facet joints [74]. Furthermore, it has been demonstrated that medial branch blocks are more predictive of successful outcomes following radiofrequency ablation (RFA) therapy [75].

After diagnosing the specific level of the spine responsible for the pain, a physician may choose to perform RFA of the nerve. RFA procedures on patients with preexisting hardware have similar efficacy to those performed on individuals without hardware [76]. In patients with an optimal response to diagnostic nerve blocks, RFA significantly reduces facet joint pain during the first 12 months after the procedure [77].

3) Sacroiliac joint procedures

The SIJ may be implicated as a source of persistent LBP owing to its susceptibility to biomechanical alterations following lumbar spine surgery. The incidence of SIJ dysfunction is estimated to be 7.0% following lumbar fusion surgery and increases with the number of fused segments, peaking in patients with three or more levels of fusion [78]. Diagnostic injection into the SIJ combined with positive outcomes from SIJ pain provocation tests enhances the probability of the SIJ being identified as a source of pain [79]. Both intra-articular and extra-articular injections may provide moderate relief from SIJ pain [80]. Cooled RFA of the SIJ relieves pain intensity and improves QOL [81].

4) Percutaneous and epiduroscopic adhesiolysis

Epidural fibrosis occurs frequently after spinal surgery. The formation of dense fibrous scar tissue in the epidural space results in adhesions to the dura mater and tethering of the nerve roots, causing back and radicular pain [30]. Theoretically, the lysis of adhesions relieves pain, and percutaneous adhesiolysis has been developed to relieve back and radicular pain caused by epidural adhesions due to fibrous scarring. Lysis of adhesions can also be performed using epiduroscopy, which may allow physicians to directly visualize adhesions in the epidural space (Fig. 2). Percutaneous adhesiolysis effectively reduces pain in patients with FBSS, as supported by significant evidence [82]. Epiduroscopic adhesiolysis has been shown to cause clinically meaningful reductions in pain and disability scores within 6 to 12 months in patients with FBSS, which is supported by moderate-quality evidence [83].

5) Neuromodulation

Neuromodulation involves implantation of an electrode in the epidural space (Fig. 3). This technique relies on the implantation of a device (an SCS) that delivers electrical impulses to the spinal cord to interrupt the nerve signals before they are transmitted to the brain. The advantages of this technique include safety, reversibility, and a trial period to determine its efficacy using temporary electrodes before permanent implantation.

The outcomes of SCS implantation are promising, showing significant enhancements in pain relief, QOL, and functional capacity [84,85]. SCS implantation is more effective than reoperation or conventional treatments for persistent radicular and axial pain after lumbosacral spine surgery [86-88]. High-frequency stimulation can reduce pain more than low-frequency stimulation [89]. SCS implantation is also considered cost-effective compared to conventional medical management and reoperation [90]. However, a recent study showed that the use of an SCS was not associated with a reduction in opioid use at 2 years, and previous findings were criti-

Fig. 2. Mechanical adhesiolysis is performed with an epiduroscope. The fluoroscopic image shows the tip of the epiduroscope at the left L5/S1 intervertebral foramen.

 https://doi.org/10.12701/jyms.2024.00339

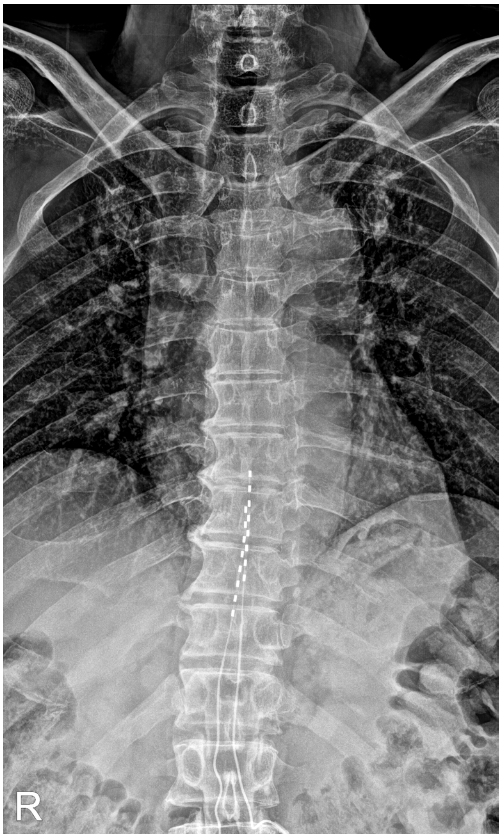

Fig. 3. Spinal cord stimulator implantation. The image shows that the electrodes are implanted at the T8–T11 vertebral levels.

cized for inadequate blinding, selective reporting bias, and lack of long-term results (> 12 months) [91,92].

6) Intrathecal drug delivery systems

Intrathecal drug delivery systems (IDDSs) using opioids and local anesthetics have been used to relieve pain in patients diagnosed with FBSS [93-95]. IDDS implantation is typically preceded by a trial period and a thorough analysis of the results. A patient implanted with an IDDS requires regular long-term follow-up for pump refills. The common adverse effects of IDDSs include infection, catheter granuloma, catheter dislodgement or twisting, pump failure, cerebrospinal fluid leakage, and hypersensitivity or allergy to intrathecal drugs. Prolonged use of intrathecal opioids is associated with alterations in the hypothalamic–pituitary-gonadal and hypothalamic–pituitary-adrenal axes, resulting in impaired sexual function, decreased libido, infertility, and osteoporosis.

IDDSs have demonstrated long-term benefits, including reduced pain levels, reduced daily oral opioid use, and improved QOL. Intrathecal opioid doses tend to stabilize within the first 2 years after implantation. However, these observations were based only on retrospective analyses [93-95].

5. Surgical revision

Revision surgery is often recommended for patients with pain that is refractory to other treatments and has an anatomical or pathological source identified by imaging [22]. For example, chronic pain caused by recurrent disc herniation and adjacent segment degeneration usually requires surgical intervention. However, surgical revision is associated with significant morbidity, a higher risk of developing new neurological deficits, and low success rates, with insufficient evidence supporting its efficacy [96]. Given the unsatisfactory outcomes of revision surgery, surgical treatment should be considered a limited therapeutic option.

6. Multidisciplinary treatment

A care pathway involving a multidisciplinary team from evaluation to treatment has been proposed to optimize the management of FBSS [97]. This comprehensive FBSS care pathway can help improve decision-making, minimize practice variation, and optimize outcomes. However, the implementation of multidisciplinary care is frequently hindered by limited access to specialized centers and higher costs owing to the involvement of multiple professionals [98].

MBR is a commonly used combination of treatments that includes physical, psychological, educational, and vocational components. This strategy has effectively reduced pain, improved functional status compared to usual care, and increased self-efficacy in treating FBSS [99]. However, a network meta-analysis indicated that MBR demonstrates only minimal differences in effectiveness when compared to minimal intervention and usual care in the treatment of chronic LBP, with no single treatment approach exhibiting clear superiority. Therefore, a thorough cost-benefit analysis is warranted to determine the most economically viable and clinically effective treatment modality among multidisciplinary approaches [98].

Conclusion

FBSS is a complex clinical condition owing to its diverse pathophysiology and multifaceted clinical manifestations. Current diagnostic labels fail to capture the complexity of FBSS. The proposed term PSPS describes this complex clinical condition and promotes the development of more effective and personalized management strategies to improve patient outcomes.

The effective management of FBSS requires a thorough understanding of patient-specific etiologies and a coordinated multidisciplinary approach. Although medications and reoperations are commonly used, their effectiveness is supported by limited evidence. Exercise, adhesiolysis for epidural fibrosis, and SCS implantation have shown efficacy. These treatment results suggest that a broader range of therapeutic options is needed to effectively treat FBSS.

FBSS presents significant challenges in accurately defining the syndrome, identifying specific causes of pain, and overcoming the limitations of current treatments. Addressing these challenges requires enhanced efforts to deepen our understanding of this complex condition and develop more effective treatment strategies.

Article information

Conflicts of interest

No potential conflict of interest relevant to this article was reported.

Funding

None.

ORCID

Jinseok Yeo, https://orcid.org/0000-0001-9686-9955

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