Failed Back Surgery Syndrome

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Abstract

Failed back surgery syndrome (FBSS) is a chronic pain condition that has considerable impact on the patient and health care system. Despite advances in surgical technology, the rates of failed back surgery have not declined. The factors contributing to the development of this entity may occur in the preoperative, intraoperative, and postoperative periods. Due to the severe pain and disability this syndrome may cause, more radical treatments have been utilized. Recent trials have been published that evaluate the efficacy and cost-effectiveness of therapeutic modalities such as spinal cord stimulation for the management of patients with failed back surgery. FBSS is a challenging clinical entity with significant impact on the individual and society. To better prevent and manage this condition, knowledge of the factors contributing to its development is necessary. While research on FBSS has increased in recent years, perhaps the best strategy to reduce incidence and morbidity is to focus on prevention. Patients diagnosed with FBSS should be managed in an interdisciplinary environment. More radical treatments for FBSS have now been extensively studied providing clinicians with much needed evidence on their efficacy. Incorporating these results into our current knowledge provides a basis on which to construct an evidence-based guide on how best to manage patients who suffer from FBSS.

Keywords: Failed Back Surgery Syndrome, Chronic Pain, Spinal Surgery, Spinal Cord Stimulation.

1. Introduction

Failed back surgery syndrome (FBSS) is defined by the International Association for the Study of Pain as "lumbar spinal pain of unknown origin either persisting despite surgical intervention or appearing after surgical intervention for spinal pain originally in the same topographical location." The pain may originate after surgery, or the surgery may exacerbate or insufficiently ameliorate existing pain. Thus, failed back surgery syndrome is a syndrome with many causative etiologies and marked heterogeneity among patients. Despite its debilitating effect on patients and relative prevalence among the population receiving back surgery, few high-quality randomized trials exist investigating treatment for FBSS [1].

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" [2]. Waguespack et al. [3] 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 [4]. 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. 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 [5]. The term "persistent spinal pain syndrome" (PSPS) has been proposed as a replacement for FBSS [6]. 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 [6].

Epidemiology

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. 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 [7]. South Korea also reported a steady increase in spinal surgery cases from 168,836 in 2016 to 188,394 in 2020. In Japan, the annual number of spinal surgeries increased 140% between 2003 and 2017. Norway saw a 54% increase in lumbar spine surgery rates from 1999 to 2013. 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 [8]. 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% [9]. Estimates of the percentage of adults who experience chronic lower back pain during their lifetime range from 51% to 84%. The incidence of lower back pain increases with age and in females. As the population ages, the incidence of surgery for lower back pain increases dramatically; the number of primary lumbar fusions, for instance, increased by upwards of 170% from 1998 to 2008 [10]. Failed back surgery syndrome is reported to affect between 10 to 40% of patients following back surgery, but estimating the incidence of FBSS is difficult due to the wide scope of its definition and its heterogeneous etiology. Increased complexity of back surgery increases the rate of FBSS; failure rates range from 30% to 46% for lumbar fusion and 19% to 25% for microdiscectomy [11].

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 [2].

1. Patient-related factors

Psychological factors have a considerably more significant impact than structural abnormalities in forecasting the onset of LBP. Depression, anxiety, inadequate coping mechanisms, somatization, and hypochondriasis have been identified as the primary psychological factors contributing to poor outcomes. Considering these findings, preoperative psychological screening is recommended; however, its implementation remains limited [12]. 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. 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 [13]. Behavioral factors can also influence postoperative outcomes. Smoking and obesity may contribute to recurrent disc herniation, requiring reoperation. 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. Patients who are obese report less improvement in leg pain after surgery [14].

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 [15]. 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 [16].

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 [17]. 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. Preexisting degenerative changes within the spine, such as spondylolisthesis and facet arthropathy, may also cause spinal stenosis and nerve root compression after surgery [6]. Spinal surgery often alters biomechanical dynamics, resulting in decreased lordosis due to fusion. 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. The 10-year prevalence of adjacent segment disease ranges from 22% to 36%, with more than 20% of patients requiring revision surgery. 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 [18]. Dissection and prolonged retraction of the paravertebral muscles during surgery can result in denervation-related muscle atrophy. Reduced muscular support after surgery results in disability and increased biomechanical stress, which may contribute to the development of back pain [2]. Spinal surgery often results in the development of fibrotic adhesions within the epidural space, known as epidural fibrosis. 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. Nerve compression and the accumulation of inflammatory mediators around the scar tissue can disrupt nerve nutrition, increase sensitivity, and lead to chronic pain [19]. Dissection and prolonged retraction of the paravertebral muscles during surgery can result in denervation-related muscle atrophy. Reduced muscular support after surgery results in disability and increased biomechanical stress, which may contribute to the development of back pain [2]. Spinal surgery often results in the development of fibrotic adhesions within the epidural space, known as epidural fibrosis. 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. Nerve compression and the accumulation of inflammatory mediators around the scar tissue can disrupt nerve nutrition, increase sensitivity, and lead to chronic pain [19].

Diagnosis

The assessment and diagnosis of FBSS always begins with eliciting a thorough history and physical examination. The first step involves determining the severity and location of the pain. A temporal relationship between the pain and the surgery should be established. This information, compared to the patient's presurgical pain, can help elucidate a differential diagnosis. For example, presurgical radicular pain that persists in the immediate postoperative period may be indicative of a wrong site or incomplete surgery, whereas new onset radicular symptoms immediately after surgery may result from a misplaced screw that could warrant an immediate return to the operating room. New onset radicular symptoms in the acute postoperative period (1–5 days) may also result from a hematoma or abscess [16].

History and Physical examination

An accurate and thorough history and physical examination of patients with persistent pain after lower back surgery are crucial for correct diagnosis. The character and location of the patient's pain should be identified and

compared to presurgical pain; lack of immediate pain relief may indicate operation at the wrong level whereas new-onset pain may indicate surgically-induced nerve damage [1]. Pain in the leg likely indicates nerve compression from stenosis, epidural fibrosis, or disc herniation, while low back pain is more common in facet joint arthropathy, sacroiliac joint issues, or myofascial etiologies. Patients should be asked about "red flag" symptoms that may indicate life-threatening conditions; these include, but are not limited to: saddle anesthesia or bowel/bladder incontinence, indicative of cauda equina syndrome; fever, chills, or weight loss indicating infection; and signs of malignancy. Patients should also have an evaluation for anxiety, depression, and other psychiatric conditions due to their high comorbidity with FBSS [20]. Physical exam for the failed back surgery syndrome patient is generally not useful for identifying a specific etiology of pain, although the practitioner may be able to elicit several suggestive findings. Symptoms due to spinal stenosis are usually exacerbated upon spinal extension and relieved by flexion. On the other hand, pain from a disc herniation may present with a positive sign on straight leg rais. Focal neurological deficits in FBSS patients warrant further testing [16]. Deficits in strength or sensation in the lower extremities may help narrow down which nerve roots are affected. Waddell signs can be used to evaluate for psychogenic etiology of lower back pain; while the interpretation of these tests is controversial, they may be useful especially if there is a suspicion of secondary gain [21]. Longstanding pain after surgery may not be as emergent as in the acute phase but is often more difficult to assess. Physical examination findings may help create a differential diagnosis, but they are often not reliable in establishing a clear diagnosis. The only clinical examination finding that correlates with facet arthropathy is paraspinal tenderness. Unfortunately, paraspinal tenderness is also a major clinical examination finding for myofascial pain. In addition, myofascial referred pain can be mistaken for radicular pain on physical examination. Discogenic pain may also present as either radicular or nonradicular pain. Because of the limitations of the physical examination, the practitioner must rely on other diagnostic modalities like imaging and diagnostic procedures [22].

Imaging

In terms of imaging, X-rays are a simple first step in the evaluation of chronic postoperative back pain. Full spine standing flexion and extension X-rays can be used to assess spinal deformities, changes in lordosis, and sagittal balance and can demonstrate spondylolisthesis even with normal magnetic resonance imaging (MRI) findings. Limitations of plain film X-rays include its inability to show the spine in three dimensions as well as its inability to display soft tissue, rendering plain films inadequate in visualizing postoperative adhesions, spinal stenosis, disc deformities, and nerve root impingement. These limitations may necessitate more advanced imaging [23]. The gold standard for visualization of the spine is Gadolinium-enhanced MRI. Gadolinium-enhanced T1-weighted images allow the practitioner to differentiate disc herniation from postsurgical fibrosis as a cause of back pain. Although MRI is the preferred imaging modality for soft tissue visualization, computed tomography (CT) is helpful in visualizing osseous changes within the spine including facet changes and assessing the osseous dimensions of the canals [24].

Often times, both CT and MRI are needed for optimum evaluation of the spine, but in cases where MRI is contraindicated (implanted medical device or metal) or where implanted hardware creates artifact on MRI, CT myelography or discography may be needed [25].

Diagnostic procedures

Diagnostic nerve blocks

Nerve blocks can be used for both diagnostic and therapeutic purposes. Selective nerve root blocks with only local anesthetic have been done historically as a mode of diagnosis and as a predictive guideline for patients considering lumbar decompression surgery despite its accuracy having been questioned. Adding steroid to local anesthetic can improve the duration of pain relief of injections, thus many injections can be both diagnostic and therapeutic. In some patients, both intra-articular (IA) and extra-articular (EA) injections may provide relief for those suffering from SIJ pain (2). Consequently, the efficacy of IA versus EA injection is controversial [26]. Diagnostic blocks of the facet joints have been done historically by two approaches; either by blocking the medial branches (MBs) innervating the joint or by directly injecting local anesthetic into the joint. It is widely considered that medial branch block (MBB) is a superior approach since in some patients the facet can be aberrantly innervated by other nerves. This may be a reason why MBBs are considered to be more predictive of successful radiofrequency ablation (RFA), although there have been no head to head studies directly comparing the two [26].

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 [2].

1. Pharmacological management

NSAIDs can reduce pain and improve disability management. 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. 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 [27].

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. 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 [28]. 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. 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. In addition, these medications are often associated with adverse events including vertigo and xerostomia. Therefore, cautious use of these medications is recommended [29]. 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. Benzodiazepines are more likely to provide pain relief than placebo, although this is based on low-quality evidence. Benzodiazepines are associated with sedative effects and risks of dependency, overdose, and withdrawal. Therefore, they should be used with caution [27]. 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 [30]. 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. Moreover, prolonged opioid use has numerous adverse effects such as immunosuppression, androgen deficiency, constipation, and depression [31]. Despite these drawbacks, opioid prescriptions for back pain have escalated, leading to an increase in opioid diversion, misuse, abuse, and opioid-related mortality. The concomitant use of gabapentin or pregabalin with opioids significantly increases the risk of opioid-related mortality. 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 [32].

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 [33]. 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 [33].

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. 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 [34].

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 [35]. CBT has demonstrated efficacy in reducing pain, disability, and distress in patients with chronic pain, as supported by moderate-quality evidence. Meditation-based therapies may offer substantial benefits in reducing pain and improving QOL in individuals experiencing chronic back pain [36].

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 [2].

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. ESIs for radicular pain demonstrate short-term benefits and provide modest improvements in pain and disability levels [37]. 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 [38].

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. 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 [39]. 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. Furthermore, it has been demonstrated that medial branch blocks are more predictive of successful outcomes following radiofrequency ablation (RFA) therapy [40]. 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. In patients with an optimal response to diagnostic nerve blocks, RFA significantly reduces facet joint pain during the first 12 months after the procedure [41].

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. 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. Both intra-articular and extra-articular injections may provide moderate relief from SIJ pain. Cooled RFA of the SIJ relieves pain intensity and improves QOL [42].

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. 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 [2].

Percutaneous adhesiolysis effectively reduces pain in patients with FBSS, as supported by significant evidence. 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 [43].

5) Neuromodulation

Neuromodulation involves implantation of an electrode in the epidural space (4). 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 [2]. The outcomes of SCS implantation are promising, showing significant enhancements in pain relief, QOL, and functional capacity. SCS implantation is more effective than reoperation or conventional treatments for persistent radicular and axial pain after lumbosacral spine surgery. High-frequency stimulation can reduce pain more than low-frequency stimulation. SCS implantation is also considered cost-effective compared to conventional medical management and reoperation. 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 criticized for inadequate blinding, selective reporting bias, and lack of long-term results (>12 months) [44].

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. 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 [45]. 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 [46].

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. 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. Given the unsatisfactory outcomes of revision surgery, surgical treatment should be considered a limited therapeutic option [47].

6. Multidisciplinary treatment

A care pathway involving a multidisciplinary team from evaluation to treatment has been proposed to optimize the management of FBSS. 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 [48].

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 [49]. 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 [48].

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 [4]. 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. For non-radicular back pain associated with degenerative spinal conditions, the benefits of spinal fusion were not superior to those of nonoperative treatment. 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 [50]. 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 [51]. 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 [52]. 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 [53].

Complications of FBSS

In addition to intractable low back pain, patients with failed back surgery syndrome often suffer from associated disorders. Psychiatric comorbidities are common in FBSS patients and correlate with worse pain outcomes. A survey of failed back surgery syndrome patients by Long and colleagues found that 67 of 78 patients with FBSS suffered from depression, with the vast majority experiencing an onset of depressive symptoms following the initial onset of pain [54]. Patients with failed back surgery syndrome may also

experience complications from attempted treatment of their pain. Prolonged NSAID use has significant adverse effects on gastrointestinal and renal health. Opioids also have significant addictive potential; one study found that opioid overdose was the most common cause of death following lumbar fusion surgery. Back surgery itself also has several significant complications, including anesthesia-related complications and infection [55].

7. Conclusions

FBSS is a challenging clinical entity with significant impact on the individual and society. To better prevent and manage this condition, knowledge of the factors contributing to its development is necessary. While research on FBSS has increased in recent years, perhaps the best strategy to reduce incidence and morbidity is to focus on prevention. Patients diagnosed with FBSS should be managed in an interdisciplinary environment. More radical treatments for FBSS have now been extensively studied providing clinicians with much needed evidence on their efficacy. Incorporating these results into our current knowledge provides a basis on which to construct an evidence-based guide on how best to manage patients who suffer from FBSS [55].

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