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REVIEW ARTICLE

Sexual Dysfunction Following Spinal Cord Injury: Insights into Pathophysiology and Management Approaches

Amirmohammad Soleimanian[1], Maryam Salehi[2], Saeed Kooshafar[2], Farsad Nemati Karimooy[3], Alireza Davoodi[1], Farhang Mir Akhorli[4], Seyed Ali Shariat Razavi[4], Neda Kamandi[1], Hamideh Feiz[5] ✉, Mohsen Khamoushi Kahdouee[4]

[1] *Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*

[2] *Department of Urology, Faculty of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran*

[3] *Department of Radiology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*

[4] *Department of Neurosurgery, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*

[5] *Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*

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Abstract

Spinal cord injury (SCI) significantly affects sexual function in both men and women. This review explores the impact of SCI on sexual dysfunction and discusses current management and treatment options. Addressing sexual dysfunction is crucial for improving the quality of life for individuals with SCI. Advances in pharmaceuticals and technology have provided new ways for patients to adapt to their changed circumstances. Encouraging open conversations about sexuality after an injury is vital, as maintaining a fulfilling sexual relationship following SCI is entirely achievable. Although significant strides have been made in addressing male sexual dysfunction related to SCI, advancements in managing female sexual dysfunction remain comparatively limited. More research is needed in this area, particularly for women with SCI, as sexual health is a key component of overall well-being.

Key words: Disease Management, Pathophysiology, Sexual Dysfunction, Spinal Cord Injuries

Introduction

The National Spinal Cord Injury Statistical Center reports that each year in the United States, around 17,810 individuals experience a spinal cord injury(1). Of these cases, 78% affect young males with an average age of 43 years. Spinal cord injuries (SCIs) significantly impact both male and female sexuality after this life-altering event (2). Advances in pharmaceuticals and technology have made overcoming these challenges easier, although there remains a discrepancy in how male versus female sexual dysfunctions are perceived, discussed, and managed (3).

Tel: +985632381214
Fax: +985632440488
Po Box 97175-379
Email: jsurgery@bums.ac.ir

✉**Correspondence to:**
Hamideh Feiz, Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran
Telephone Number: +989156008456
Email: feyzh@mums.ac.ir r

While significant progress has been made in addressing male sexual dysfunction, female sexual dysfunction remains a mysterious and underexplored topic, particularly within the context of SCIs (4, 5). In this comprehensive review, we delve into the pathophysiology of sexual dysfunctions in both men and women, exploring the existing management options for each population.

Methods

A comprehensive review of databases (PubMed, Scopus, search engine of Google Scholar) was conducted using the key terms "Spinal Cord Injury," "Sexual Dysfunction," and "Erectile Dysfunction" for literature spanning from 1900 to 2024. The review focused on studies exploring the applications of endoscopic surgeries, their associated results, limitations, and potential future developments. Research not published in English was omitted.

Results

Male Sexual Function

Pathophysiology

To unravel the impact of spinal cord injury (SCI) on erectile dysfunction (ED), one must delve into the intricate neural regulation of erections and the fundamental physiology at the penile level.

The sacral reflex arc, located at levels S2-4, plays a crucial role in regulating erections. Parasympathetic autonomic fibers, originating from neurons at this site—later recognized as lower motor neurons—extend via pre-ganglionic fibers to the pelvic nerve, which connects to the pelvic plexus. Meanwhile, post-ganglionic sympathetic fibers from the thoracolumbar region (T10-L2) also contribute to the pelvic plexus through the hypogastric nerve. From there, cavernous nerves branch out of the pelvic plexus to autonomously innervate the corpora cavernosa, facilitating the process of erection.

Sensory input plays an essential role as the dorsal nerve of the penis, through the pudendal nerve (S2-4), supplies somatic sensory signals to the reflex arc. Additionally, supraspinal stimuli—such as visual, auditory, and olfactory cues, as well as imaginative thoughts—are processed via hypothalamic input into the thoracolumbar sympathetic pathway. Notably, this mechanism enables neural signals to reach the penis without relying on an intact S2-4 reflex arc and is thought to be responsible for psychogenic erections (6-8).

Erectile Dysfunction after SCI

In the United States, young men represent the majority of new spinal cord injury (SCI) cases. For paraplegics, improving sexual function is considered the most significant factor in enhancing quality of life, while for tetraplegics, it ranks second only to regaining arm and hand function. It is essential to acknowledge that SCIs are not always isolated injuries, and exceptions are common.

Regarding penile innervation, injuries above the thoracolumbar region (upper motor neuron lesions) generally maintain reflexogenic erections but limit the potential for psychogenic erections. Conversely, lower motor neuron lesions affecting the S2-4 spinal cord segments or the conus or cauda equina lead to reduced reflexogenic erections and minimal psychogenic capacity. In both scenarios, erections—particularly reflexogenic ones—are often inconsistent, brief, and may lack sufficient rigidity for successful intercourse (10-13).

Approximately 91% of men with SCIs experience ejaculatory dysfunction alongside ED, necessitating medical assistance for ejaculation (14, 15). Men with SCI are often presented with options such as penile vibratory stimulation and electroejaculation. If these methods prove ineffective, more invasive surgical approaches can be explored (13, 16, 17).

Diagnostic modalities

Assessing sexual dysfunction in males involves a comprehensive approach, including detailed medical, sexual, and psychological histories. Alongside this, a thorough physical examination is essential, complemented by validated questionnaires, selective laboratory tests, and, in certain cases, penile ultrasound to evaluate penile vascular flow (18, 19).

The widely used International Index of Erectile Function serves as a reliable measure for assessing ED (20, 21). Version 2.0 of the basic data sets, developed by the International Spinal Cord Injury Male Sexual Function and Female Sexual and Reproductive Function Expert Panel, recommends its inclusion in patients' medical records for both clinical and research purposes.

Following an injury, individuals brought to a hospital undergo a comprehensive neurological examination, which includes sensory and motor testing of each limb and rectum. Additionally, spine imaging via X-ray or computed tomography is performed. If SCI is suspected, more detailed and advanced imaging, such as magnetic resonance imaging, helps localize spinal cord transection, edema, and hemorrhaging. Electrophysiology, which does not require conscious patient participation, provides insights into recovery mechanisms, including plasticity, adaptation, and regeneration (18, 19).

The International Standards for Neurological

Classification of Spinal Cord Injury is widely regarded as the standard method for diagnosing and categorizing SCI. In clinical trials, it is the key metric used to evaluate neurological outcomes. Importantly, both the severity and the level of spinal cord injury play a crucial role in influencing the extent of sexual dysfunction experienced by affected individuals (22).

Treatment of ED in men with SCI

The Massachusetts Male Aging Study indicates that around 52% of able-bodied men aged 40 to 70 experience sexual dysfunction. Standard treatment typically includes FDA-approved oral phosphodiesterase type 5 inhibitors (PDE5i), such as sildenafil, tadalafil, vardenafil, and avanafil, along with addressing modifiable risk factors contributing to sexual dysfunction (23, 24). Traditional approaches, such as vacuum erection devices, intraurethral alprostadil, and intra-cavernosal injections, have also demonstrated effectiveness in managing sexual dysfunction among men with spinal cord injuries.

Most SCI patients are young males, and their sexual lives undergo significant disruption due to the catastrophic injury. After intensive rehabilitation, approximately 80% of these patients experience improved erectile function with PDE5i, reassuring them that they can still perform sexually. The journey to managing sexual dysfunction in male SCI patients has evolved over time. In their seminal 1960 article, Bors and Comarr detailed various forms of sexual dysfunction linked to neurogenic disturbances, particularly SCI. Two decades later, the introduction of penile prostheses offered caregivers a practical solution for addressing erectile dysfunction in patients with SCI.

During the late 1980s, pharmacoactive penile injections provided both men and women with the possibility of engaging in regular sexual activities. Agents such as phentolamine, papaverine, and alprostadil demonstrated an 80% success rate (25, 26). However, intraurethral alprostadil was less commonly preferred among men with SCI. Positive results were observed with PDE5 inhibitors, particularly in patients with upper motor neuron lesions (27-31). Vacuum erection devices represent another viable option; however, it is crucial for men with SCI to remove the constriction band immediately after intercourse to avoid vascular injury to the penis (32, 33). When other methods prove ineffective, surgical placement of penile prostheses becomes the final option (3-5, 15), with the choice between malleable and inflatable prostheses depending on personal preference and the level of hand dexterity in tetraplegic patients.

Sexual function and rehabilitation following spinal cord injury encompass two main aspects. The first involves maximizing and enhancing the residual erectile function after the injury. The second focuses on adapting to a new self, which includes comprehending the pathophysiology of SCI sequelae (34). For individuals with partners, developing a new physical, emotional, and logistical dynamic within the relationship is vital. For those without partners, mastering these dynamics becomes equally important as new relationships are established and navigated (35).

Over the last two decades, societal advancements and developments across various domains have contributed to more seamless adjustments. For example, the Americans with Disabilities Act of 1990 broadened anti-discrimination protections for individuals with disabilities, integrating accommodations into everyday life (36). Increasing societal acceptance of adaptation has further simplified personal transitions.

When addressing ED in neurogenic patients through a holistic therapeutic lens, it is essential to recognize that ED represents only a fragment of their broader challenges. Traditional management of neurogenic ED often emphasizes the facilitation of erections. However, holistic medicine endeavors to tackle the root cause of the underlying neurological condition affecting the patient, aiming for a more comprehensive resolution (37).

In recent years, there has been a surge in research dedicated to stem cells and platelet-derived biomaterials found in platelet-rich plasma, which are hailed as potential game-changers in the medical field. These innovative agents have captivated the interest of researchers investigating ED, particularly of neurogenic origin. Stem cells are celebrated for their regenerative capabilities and potential to restore normal cellular functions. Their remarkable ability to differentiate into various cell types and secrete numerous trophic factors positions them as promising therapeutic agents for a variety of diseases (37, 38).

Various types of stem cells have been proposed, including embryonic stem cells, mesenchymal stem cells, neural crest stem cells, and endothelial cells. Totipotent embryonic stem cells have the ability to differentiate into any cell type; however, their use in cavernosal nerve injury remains constrained by ethical considerations. Mesenchymal stem cells, in contrast, can transform into a variety of cell types, such as adipocytes and neurons. Among these, adipose-derived stem cells have drawn significant attention due to the simplicity of their extraction through liposuction (37, 38).

The surgical implantation of a penile prosthesis

(PPI) represents the ultimate intervention for addressing erectile dysfunction (ED), reserved for instances where all other treatment options have either failed or been deemed unsatisfactory by the patient. Two main types of implants are used: semi-rigid (malleable) and inflatable (available in two or three-piece models). However, both options come with potential complications, predominantly mechanical failures and infections. Even in specialized centers, where procedures are conducted by highly skilled surgeons and appropriate antibiotic prophylaxis is applied to target both Gram-positive and Gram-negative bacteria, or when specially designed devices such as antibiotic-impregnated prostheses (AMS Inhibizone™) or hydrophilic-coated prostheses (Coloplast Titan™) are utilized, infection rates can still range up to 2-3% in low-risk patients (37, 38).

For neurogenic patients, excluding those recovering from radical prostatectomy, the majority are individuals with spinal cord injuries (SCI) or diabetes mellitus. However, the existing literature provides limited data on the clinical outcomes of penile prosthesis implantation (PPI) surgery in cases of neurogenic erectile dysfunction (37, 38).

Generally, diabetics present a higher risk of post-implantation infection due to their hyperglycemic environment, which impairs immune function and hinders wound healing. Diabetic patients with ED constitute a unique group that requires meticulous care when considering penile prosthesis implantation. In addition to perioperative antibiotic prophylaxis and the use of specially coated devices, stringent monitoring, and glycemic control are imperative both pre- and post-implantation (37, 38).

Special considerations are essential for strictly neurogenic patients, such as those with SCI. These patients exhibit higher complication rates compared to non-neurogenic men, making them less suitable candidates for penile prosthesis implantation. As reported by Kim et al., the total complication rate in these patients is 16.7%. Several factors contribute to this elevated risk. Many SCI patients lack dexterity, which makes the malleable prosthesis a more appropriate choice for them; they often suffer from reduced sensitivity, use of suprapubic or condom catheters, or intermittent catheterizations leading to bacteriuria, decubitus ulcers, recurrent urinary tract infections frequently associated with neurogenic bladder, and a progressive nature of their condition that complicates outcome prediction (37). Nevertheless, successful PPI implantation can simultaneously address other significant issues faced by these patients, such as urinary incontinence, facilitating the use of urinal condoms (38).

In summary, although contemporary advancements and innovations in penile prosthesis implantation (PPI) technology have improved treatment options, careful consideration is required when selecting and managing these patients. It is essential to provide thorough counseling regarding the elevated risk of complications and the possibility of requiring revisions (37, 38).

Female sexual function

Pathophysiology

While significant progress has been made in addressing male fertility and sexual dysfunction in both able-bodied individuals and those with SCIs, there remains considerable work to be done in understanding and managing female sexual dysfunction (FSD) (39). To comprehend FSD after spinal cord injury, we must delve into the etiology and physiology of sexual dysfunction in able-bodied females, as well as its broader implications in the general population. Female sexual dysfunction is multifaceted, involving biological, psychological, relational, and sociocultural factors. Hormonal changes due to various life stages, including aging, can impact sexual function. Importantly, any sexual health concerns causing distress should be considered dysfunction, even if they fail to meet specific criteria. In such cases, intervention is warranted (40).

Female sexual dysfunctions are classified into four primary categories: desire, arousal, orgasm, and pain (41). For example, conditions like diabetes mellitus can influence desire, while coronary artery disease may affect arousal. Some medical conditions, such as neuromuscular disorders and SCI, can impact all four categories. Psychological factors, including depression, anxiety, negative body image, and histories of sexual or emotional abuse, also play a significant role in female sexual dysfunction. Furthermore, certain medications—such as psychotropics, narcotics, and cardiovascular drugs—can contribute to issues related to desire, arousal, and orgasm (40).

Female Sexual Dysfunction after SCI

In women with SCI, both physiological and psychological changes can have a substantial effect on sexual function. The degree to which orgasm and psychogenic arousal are impacted is closely tied to the level and severity of the spinal cord injury (8, 42). Considering the intricate and dynamic nature of the female sexual cycle, the psychological consequences of the injury, along with the necessary lifestyle adjustments, play a pivotal role in shaping a woman's perception of her own [illegible]lity.

Hajiaghababaei et al. (43) conducted a study on FSD among SCI patients in Iran. Their findings suggested that the increased prevalence of depression following injury, along with physiological changes such as prolonged time to orgasm and reduced lubrication, could contribute to pain during intercourse. Notably, 87% of women with SCI reported higher levels of sexual dysfunction compared to 37% in the able-bodied control group, with lack of lubrication being the most common issue (44). Anxiety and depression were strongly linked to more severe sexual dysfunction (43). Given the significant psychological component, healthcare teams should take early action to address these concerns during treatment.

A study conducted by Celik et al. (45) in Turkey investigated sexual issues among women with SCI, emphasizing their perceptions of sexuality and physical changes. Among the 26 participants, 24 reported receiving no information or guidance about sexual health or pregnancy following their injury. When surveyed, all participants expressed a strong desire for information on sexuality and fertility, with 42% preferring to receive it during their inpatient acute rehabilitation phase. Interestingly, 92% indicated a preference for obtaining this information directly from their physicians (46). This study highlights the critical need for open communication between physicians and female patients about sexual identity during the treatment of physical injuries. Such dialogue is a fundamental component of recovery during rehabilitation and aids in establishing a new lifestyle for women with SCI (45).

Urinary incontinence and the risk of urinary tract infections can significantly contribute to sexual dysfunction in women with SCI. Deterrents may include factors such as catheter use, urine odor, and reduced spontaneity during sexual activity. Additionally, the neurological effects on bladder function can physiologically impact sexual dysfunction (42). Addressing these factors is crucial when developing tailored management strategies to support the sexual experiences of SCI patients.

Diagnostic modalities

In both men and women, the diagnosis and classification of spinal cord injuries adhere to similar guidelines. For female patients, it is essential for healthcare providers to distinguish between sexual dysfunction and natural variations in sexual response. For example, reduced arousal caused by menopausal hormonal changes—leading to decreased vaginal blood flow and lubrication—is considered a normal variation. During routine c

is important to include a comprehensive sexual history, physical examination, and a well-structured questionnaire addressing key aspects of FSD. The Female Sexual Function Index is a widely recommended tool for evaluating sexual dysfunction in women with spinal cord injuries (47).

Treatment of sexual in females with SCI

The management FSD involves a variety of approaches tailored to its underlying causes. For issues related to sexual desire or arousal, treatment options include both hormonal and non-hormonal therapies. Hormonal treatments consist of estrogen replacement, androgen supplementation, and selective estrogen receptor modulators. Non-hormonal approaches include flibanserin (48), sildenafil, herbal therapies, Eros-clitoral devices (49), clitoral vacuum suction, vibratory stimulation (50), psychotherapy, and bupropion (41).

In contrast, options for addressing orgasmic disorders are more limited. Cognitive behavioral therapy can help reduce anxiety, while guidance on direct clitoral stimulation offers another potential solution. Effective treatment of FSD requires acknowledging the multifaceted origins of the condition, although significant progress remains to be made in this field (39, 41).

Clinicians have a crucial role in discussing sexuality with female SCI patients. Beyond initial sexual health information during rehabilitation, ongoing conversations during follow-up appointments help evaluate what works best for each unique individual. Alexander et al. (51) provide recommendations for addressing these concerns during history and physical examinations. Their discussion highlights the off-label use of sildenafil to enhance sexual dysfunction and testosterone to boost sexual interest and orgasmic capacity (50). Gradual sexual improvement can be achieved through self-exploration and vibratory stimulation, while clitoral vacuum suction devices provide advanced solutions for addressing specific concerns (51).

Conclusions

Spinal cord injuries (SCI) have a profound impact on sexual function in both male and female patients. For men with SCI, treatment options include pharmaceuticals such as PDE5 inhibitors, penile injections, and vacuum erection devices. Surgical solutions, like penile prostheses, are also available. Promising investigational therapies, including low-intensity extracorporeal shock wave therapy, intra-cavernosal stem cell therapy, and platelet-rich plasma therapy, offer potential advancements in SCI management. In comparison, FSD

following SCI remains under-researched. Current approaches include off-label use of sildenafil and testosterone, self-exploration, and vibratory stimulation. Early sexual education, counseling, and personalized therapies during rehabilitation are essential, as sexuality plays a critical role in the quality of life for both male and female SCI patients.

Conflict of Interest

The authors declare no conflict of interest.

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