Documentation of the Impact of Spinal Cord Injury on Female Sexual Function: The Female Spinal Sexual Function Classification

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Significant new research has examined the impact of specific levels and degrees of spinal cord injury (SCI) on female sexual response. Research has also recently examined two methods of improving sexual responsiveness in women with SCI. The use of false-positive feedback and sildenafil were both noted as potential treatment methods that deserve further study. Concomitant with these observations, there has been a significant increase in overall interest in female sexual dysfunction. This interest has resulted in a new classification system for female sexual dysfunction, which takes into account both physiological and psychological aspects of sexual dysfunction. We propose a new classification system to predict female sexual function and dysfunction after SCI. This nomenclature, the Female Spinal Sexual Function Classification, is recommended for use as an adjunct to the International Standards for Neurological Classification of Spinal Cord Injury. Key words: *female sexual response, sexual dysfunction, spinal cord injury/disorders*

In the past 10 years, significant new information has been made available about the impact of spinal cord injury (SCI) on female sexual functioning. The information has included laboratory-based information about the effects of various levels and degrees of SCI on female sexual response and potential new treatment methods. The goal of this article is to review recent information pertaining to both human and animal models of SCI and female sexual function and potential methods for improving sexual responsiveness. Moreover, in light of recent normative data, a new classification system to describe the neurologic impact of spinal cord disorders on women's sexual response and the presence or absence of concomitant sexual dysfunction is described.

Studies of Female Sexual Arousal After SCI

Laboratory-based analyses have surpassed questionnaire studies as a means to study human female sexual function. Photoplethysmography[1] has been utilized to assess vaginal blood flow, specifically through the monitoring of vaginal pulse amplitude (VPA). This method has been utilized in many studies of the able-bodied popula-

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tion and currently remains the preferred method for monitoring changes in vaginal engorgement.[2] A number of studies have recently utilized VPA to assess genital blood flow in the SCI population.[3–6] These laboratory-based studies have documented how women with various patterns of SCI respond subjectively, autonomically, and genitally during sexual arousal.

Increased vaginal blood flow is one of the main physiologic occurrences during the arousal phase of sexual response in women. Sexual arousal can occur psychogenically when the brain perceives an erotic stimulus or manually when the genitals are stimulated. Women with complete SCI at the level of T6 and above were noted to have the capacity for increased subjective sexual arousal without a concomitant increase in genital blood flow.[3] These same women (with upper motor neuron dysfunction affecting their sacral spinal segments) were also noted to develop increased genital vasocongestion through manual stimulation without further increases in subjective sexual arousal.[3] This was thought to be a demonstration of reflex genital vasocongestion. Women with incomplete SCI at the level of T6 and above[4] were also noted to have a similar capacity for reflex genital vasocongestion. Furthermore, preliminary findings in these same participants supported the hypothesis that control of psychogenic genital vasocongestion is based in the sympathetic nervous system.

More recent work has expanded the study of sexual arousal in women with SCI to all levels of injury. A total of 68 women with SCI (41 incomplete injuries, 27 complete injuries at C2 to L4) and 21 able-bodied controls underwent a 78-minute experimental protocol designed to assess psychogenic and reflex sexual responses.[6] Results revealed a difference in the ability to achieve psychogenic genital vasocongestion based upon the degree of preservation of the ability to perceive sensation in the T11-L2 dermatomes, as recorded by the combined International Standards Sensory Scores.[7] With these sensory scores, each side of the dermatome is assigned a score of 0–2 to represent the degree of sensation present in that particular dermatome. A score of 0 indicates the inability to perceive light touch or pinprick sensation, a score of 1 indicates that the ability is present but is altered or impaired, and a score of 2 indicates that the sensation is normal. Sensation is tested for both pinprick and light touch. Thus, for the dermatomes from T11-L2, scores can range from 0–32. Those participants with scores of 0–8 did not demonstrate a significant increase in VPA with psychogenic stimulation (M_{stim} = 11.6) compared to baseline (M_b = 11.3), whereas those with scores of 9–23 did (M_{stim} = 14.3; M_b = 12.9; p = .006). Participants with scores of 24–32 demonstrated still further significant increases (M_{stim} = 26.3; M_b = 23.9; $p < .001$). Analysis of between-group differences also revealed highly significant differences in VPA change scores, $F(3, 38) = 9.40$, $p < .0001$. Significant differences occurred between participants with sensory scores of 0–8 (M = .03) and the remaining three groups with scores of 9–23 (M = 0.22, p = .01), scores of 24–32 (M = .27, $p < .001$), and controls (M = 0.26, p = .001). These between-group differences in genital responses were not noted when participants were divided based upon their total sensory scores in the T6-9 or the S2-S5 dermatomes.

Overall, these results were interpreted as evidence for the hypothesis that the neuro-

logical basis for the psychogenic control of female genital vasocongestion lies in the sympathetic nervous system. The sympathetic cell bodies pertaining to sexual function lie in the intermediolateral cell columns at the T11-L2 levels of the spinal cord. Cell bodies of spinothalamic neurons are primarily situated in lamina V in close proximity to the intermediolateral cell column in lamina VII. Furthermore, the axons of neurons going to the spinothalamic tracts cross through lamina VI, VII, and X to ascend the contralateral side of the spinal cord.[8] This hypothesis is also supported by recent studies of able-bodied sexually functional and dysfunctional women in which sexual arousal was enhanced through sympathetic stimulation.[9–11] Moreover, if parasympathetic stimulation was responsible for psychogenic genital vasocongestion, one would expect a similar differential in SCI participants' VPA responses when participants were grouped based on their sensory responses at the S2-5 dermatomes. The absence of this differential strongly supports the hypothesis that the control of psychogenic genital vasocongestion lies in the sympathetic nervous system.

Animal Studies

Animal studies have recently shed light on the neurologic control of female sexual response. The cavernous nerve provides vasodilatation to the clitoris of rats.[12] Stimulation of the parasympathetic nervous system in rats has also been shown to produce increased genital vasocongestion along with clitoral engorgement, vaginal vaso-congestion, and lubrication. In contrast, stimulation of the sympathetic nervous system of rats was thought to be mainly inhibitory to genital vasocongestion. These results, which at first glance appear different than those in humans, may not be. Rather, parasympathetic stimulation could be producing the equivalent of a reflex lubrication in rats, and the inhibitory nature of sympathetic stimulation in rats may be documenting the presence of a psychogenic pathway. These results underscore the strength of the performance of animal-based research in unequivocally documenting distinct neurologic pathways. The major weakness, however, is our inability to communicate accurately with rats regarding sexual function.

Although they were not interested in the specific effects of SCI on sexual arousal per se, another group of investigators reported that cervical stimulation resulted in increased tolerance to pain and pupil dilatation in both able-bodied and spinal-injured rats.[13] They also performed bilateral vagotomy in rats and found that this abolished vaginal stimulation-induced analgesia and papillary dilatation.[14] These and other findings led these authors to hypothesize that the vagus nerve provides a sensory pathway from the reproductive organs directly to the medulla in the rat, bypassing the spinal cord. These results have yet to be reproduced in another laboratory, and there is no anatomical evidence of this in human cadaveric specimens. Critical review of the investigators' methodology raises several questions. How could the cervical stimulation have been performed in an able-bodied rat? Moreover, could the psychological stress caused by vaginal penetration by an external device in both able-bodied and spinal-injured rats have resulted in sympathetic stimulation with resultant pupillary dilatation and increased pain thresholds? These issues must be addressed

before any reasonable conclusions can be drawn from this research.

Studies of Female Orgasm After SCI

A number of studies have assessed the ability of women with SCI to achieve orgasm. These studies have documented that women with SCI have the ability to achieve orgasm and that their subjective descriptions are similar to those of able-bodied women. Information has also been obtained on the orgasmic potential of women with different levels and degrees of SCI; however, the specific neurologic foundation for the sensations associated with the orgasmic experience in women with SCI has yet to be identified.

We studied 62 women with SCI and 21 able-bodied control participants in the laboratory and via questionnaire to assess their orgasmic capacity and the qualities of their orgasms.[6] After informed consent was obtained, monitors were placed to measure heart rate, blood pressure, and respiratory rate every 3 minutes. Participants were given a vibrator and were instructed to stimulate themselves to orgasm in any way they preferred. Participants had up to 75 minutes to achieve orgasm and could stop the study at any time.

Ability to achieve orgasm was significantly lower in spinal cord-injured participants than in able-bodied controls (AB) both historically (SCI, 55% vs. AB, 100%; $p = .001$) and in the laboratory (SCI, 44% vs. AB, 100%; $p = .001$). Grouping of participants based upon whether there was complete lower motor neuron injury affecting the S2-S5 spinal segments revealed that these participants were significantly less likely to report the ability to achieve orgasm.

The characteristics of SCI participants' orgasms versus able-bodied women's orgasms were assessed. Responses of able-bodied and SCI participants were similar. Both groups had significant increases in heart rate and respiratory rate from baseline to orgasm in addition to significant increases in systolic blood pressure. There was not, however, a significant increase in diastolic blood pressure in either group with orgasm. It should be noted that none of the women with SCI exhibited any tendency toward autonomic dysreflexia during the study. Average latency to orgasm was significantly greater in SCI participants (26 minutes) compared to able-bodied participants (16 minutes).

Subjective descriptions of orgasm were also compared between able-bodied and SCI participants. In contrast to traditional thinking that SCI participants prefer sexual stimulation around their level of injury, all but one SCI participant chose genital stimulation to achieve orgasm. Additionally, two psychologists with expertise in sexuality were masked and tried to determine whether individual participant's descriptions of their orgasms came from able-bodied or SCI participants. Neither was able to accurately assess whether the responses came from able-bodied or SCI participants. Moreover, responses were similar between participants with complete and incomplete SCI.

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We interpreted these findings to mean that the neurologic ability to achieve orgasm requires the presence of at least a partially intact sacral reflex arc and that orgasm is a reflex response of the autonomic nervous system. In addition, we hypothesized that the neurologic basis for the sensory experience of orgasm after SCI lies in the autonomic nervous system and does not require the cerebral transmission of impulses. The former hypothesis appears to be supported by studies of acutely spinal-injured female rats that have been shown to have a climax-like response to genital stimulation including rhythmic perineal, vaginal, and uterine muscle contractions.[15]

Orgasm has also been studied in women with complete SCI below T6. Directed cervical stimulation in a laboratory setting resulted in 3 of 16 women with SCI reporting orgasms through self-applied cervical stimulation with a diaphragm.[16] It is not known whether these participants had injuries affecting the upper motor neuron (UMN) or lower motor neuron (LMN). This finding in women with SCI along with previous rat findings[12,13] from various combinations of cervical stimulation and interruption of neurologic input were offered by the authors as the basis for a hypothesis that the vagus nerve is responsible for the cerebral transmission of sexual sensations that accompany the orgasms of women with SCI.

This report of orgasms does not preclude the hypothesis that orgasm is a reflex response of the autonomic nervous system requiring an intact sacral reflex arc. In fact, it may be a further demonstration of the hypothesis. Whipple et al.[16] divided women into those with "upper" spinal injury with level of injury at T10 and/or above and "lower" spinal injury with level of injury below T10. Two of six participants with upper injury and only 1 of 10 participants with lower injuries were orgasmic in the laboratory. Whereas, all of the participants with injuries above T10 probably had UMN lesions affecting their sacral segments, some of the participants with injuries below this level probably had LMN sacral dysfunction. These participants were probably incapable of achieving orgasms, and this contributed to the discrepancy regarding incidence of orgasm in these two groups. Women in the Whipple[16] study who were orgasmic probably had an intact sacral reflex arc. The low percentage of participants that were orgasmic in both groups possibly can be explained by the fact that the setting was artificial and inhibited them from achieving orgasm. For example, participants were instructed on how to stimulate themselves to orgasm, and an investigator was in the room during the study.

The reflex response theory is superior to the vagus nerve theory, because the latter does not explain the relative inability of women with complete LMN damage affecting the sacral spinal segments to achieve orgasm.

In sum, the ability of many women with SCI to achieve orgasm has been documented, with the exception of women with complete LMN injuries affecting the S2-S5 spinal segments. Based upon these findings, if some women with SCI are able to achieve orgasm, then the neurologic potential should exist for all women with SCI (exclusive of those with complete LMN injuries) to achieve orgasm. Diagnosis and treatment of orgasmic dysfunction should therefore be considered in women with SCI who do not have complete LMN sacral damage. Other contributing factors to orgasmic dysfunction, such as partner

issues, lack of education, depression, premorbid orgasmic dysfunction, and medication side effects, should be considered and addressed. Moreover, new methods of treating sexual dysfunction in women with SCI should be considered.

Studies of Means to Improve Sexual Functioning in Women with SCI

A limited number of published studies have evaluated methods to improve the sexual responsiveness of women with SCI. One study looked at the use of sildenafil, while another looked at the use of a cognitive intervention. Both studies advocated that uniform testing measures be developed in the future to optimize usefulness in women with SCI.

In a double-blind, placebo-controlled laboratory study, the impact of 50 mg of sildenafil taken 1 hour before a structured sexual stimulation protocol as compared to placebo on subjective sexual arousal and genital blood flow was assessed.[17] A total of 19 premenopausal women participated in the study. Results indicated that significant increases in subjective arousal occurred with both drug ($p < .01$) and stimulation conditions ($p < .001$). Although VPA was generally greater on the day participants took sildenafil than placebo, results failed to reach statistical significance ($p = .07$). Sildenafil was noted to result in mild increases in heart rate (+/– 5 bpm) and blood pressure (+/– 4 mm Hg) and was generally well tolerated in these women. Overall, these results led authors to advocate for a larger scale clinical trial to evaluate the efficacy of sildenafil in women with SCI and other neurogenic sexual dysfunctions.

In another laboratory-based study, a controlled trial of positive feedback was performed to see whether this feedback would result in increased subjective and/or genital sexual arousal. Thirty-seven participants with SCI at the level T6 and below and 10 able-bodied participants were studied. SCI participants were grouped based upon their ability to perceive sensation at the T11-L2 dermatomes, similar to conditions in other reports.[6] Results revealed that false-positive feedback increased participants' sexual arousal, regardless of the degree of their SCI or whether they were able-bodied. Furthermore, results revealed that those SCI participants most likely to have the capacity for genital sexual arousal (combined sensory scores of 24–32 in the T11-L2 dermatomes) and able-bodied participants both had a significant increase of genital responsiveness with false-positive feedback. Participants with a lower capacity for genital sexual arousal (combined sensory scores of 0–23 in the T11-L2 dermatomes) did not. This further supports the belief that the sympathetic nervous system controls psychogenic sexual arousal and that false-positive feedback may be a viable means to improve female sexual functioning after SCI.

No other published studies have looked at a means of improving sexual responsiveness in women with SCI. Two unpublished studies have been completed; data are currently undergoing analysis. These results will be published at a later date. In the past 5 years, there has been an increased interest in the sexual needs of women. A new professional society has been dedicated to issues pertaining to female sexual function. In addition, at least one new product has been developed and has obtained FDA approval as a means to remediate female sexual dysfunction (Eros

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Therapy; UroMetrics, Inc., 445 Etna Street, Suite 56, St. Paul, MN 55106; (651) 774-1552; www.urometrics.com). This therapy is comprised of a clitoral vacuum device that is intermittently applied to the clitoris to improve blood flow to the clitoris. In light of the relative success of the device in the able-bodied population, a clinical trial assessing the efficacy in women with SCI and other types of neurogenic sexual dysfunction is currently being planned.

New Classification of Female Sexual Dysfunction

There are limitations to the use of *DSM–IV: Diagnostic and Statistical Manual of Mental Disorders*[18] to assess sexual disorders. The main limitation with the system is that it was not designed to be used to classify organic female sexual dysfunction. In light of these limitations, an international multidisciplinary consensus development conference, including representation from the field of rehabilitation medicine, was convened to begin to address the needs associated with classification of female sexual dysfunction. The outcome of this conference, sponsored by the American Foundation for Urologic Disease, was the development of the 1999 Consensus Classification.[19] For a detailed review of the classification system, the reader is referred to the original article; however, a synopsis of definitions and diagnostic categories will be described in the following discussion.

Four main categories of sexual dysfunction are described by the classification system: (a) sexual desire disorders, (b) sexual arousal disorder, (c) orgasmic disorder, and (d) sexual pain disorders. Although it has been noted as a limitation of the system, especially with regard to women with neurogenic sexual dysfunction,[20] an important point to realize is that for a diagnosis to be present all of the disorders must cause personal distress.

Sexual desire disorders include *hypoactive sexual desire disorder*, which is the persistent or recurrent deficiency (or absence) of sexual fantasies/thoughts and/or desire for or receptivity to sexual activity. *Sexual aversion disorder* is the persistent or recurrent phobic aversion to and avoidance of sexual contact with a sexual partner. *Sexual arousal disorder* is the persistent or recurrent inability to attain or maintain sufficient sexual excitement that may be expressed as a lack of subjective excitement or genital (lubrication/swelling) or other somatic responses. *Orgasmic disorder* is the delay in or absence of attaining orgasm after sufficient sexual stimulation and arousal. Sexual pain disorders include *dyspareunia*, the recurrent or persistent genital pain associated with sexual intercourse; *vaginismus*, the recurrent or persistent involuntary spasm of the musculature of the outer third of the vagina that interferes with vaginal penetration; and *noncoital sexual pain disorder*, recurrent or persistent genital pain induced by noncoital sexual stimulation. Each of the

diagnoses should also be subtyped as (A) lifelong versus acquired, (B) generalized versus situational, and (C) etiologic origin (organic, psychogenic, mixed, or unknown) based upon the best available evidence from the history, physical exam, and laboratory studies.[19]

Although decreased sexual desire, sexual satisfaction, and frequency of sexual activity have been noted in women with SCI,[21,22] studies of SCI typically do not document sexual dysfunction according to any classification system. However, with the development of the new system for describing female sexual dysfunction and the desire to improve sexual function in women with SCI, it is time that clinicians and researchers begin documenting the sexual abilities and disabilities of women with SCI. This is one of the goals of the Female Spinal Sexual Function Classification system.

Female Spinal Sexual Function Classification

Based upon recent research findings with associated normative data and recent changes in the description of overall female sexual dysfunction, we propose the Female Spinal Sexual Function Classification for documenting the degree of sexual potential for women with SCI (see Table 1).

Category A: Presence of sexual dysfunction

The presence or absence of sexual dysfunction is first determined based upon the criteria of the 1999 Consensus Classification system.[19] Once this is determined, the presence or absence of sexual dysfunction is documented and, if present, the diagnosis should be listed as sexual desire disorder, sexual arousal disorder, orgasmic disorder, or sexual pain disorder.

Category B: Ability to achieve psychogenic genital arousal

The ability to achieve psychogenic genital arousal is next documented, based upon the degree of preservation of sensory function in the T11-L2 dermatomes. This is measured based on the sum of International Sensory Scores, which are on a continuum from 0 to 32. For our purposes, four distinct groups are identified. Those women with a total score of 32 should be listed as intact or normal psychogenic genital arousal expected. Those women with scores of 16–31 should be listed as likely to achieve psychogenic genital arousal; those with scores of 1–15 should be listed as unlikely to achieve genital arousal; and those with the score of 0 in these dermatomes should be listed as psychogenic genital arousal not possible. The rational for dividing the sensory scores at 16, although it may appear arbitrary, is akin to the rationale for determining the intactness of motor function at specific spinal levels as described in the International Standards (e.g., joint movements such as the elbow flexion that are innervated by two levels of the spinal cord must have a score of 3 to be considered intact at the most caudal level).[23] Thus, we consider the cutoff point for psychogenic arousal to be between the scores of 16 and 15, with scores at and above 16 as likely intact and at and below 15 as unlikely intact.

Category C: Ability to achieve reflex genital arousal

The ability to achieve reflex genital arousal is documented next, based upon the presence of an intact or hyperactive bulbocavernosus (BC) and anal wink reflexes. The presence of hyperactive or normoactive anal wink and BC reflexes indicates that reflex

Table 1. Female spinal sexual function classification

Function	Response	Criteria
A: Sexual dysfunction	Present	Desire disorders Arousal disorders Orgasm disorders Pain disorders
	Absent	
B: Psychogenic genital arousal	Intact/normal	SS = 32 T11-L2
	Likely	SS = 16–31 T11-L2
	Unlikely	SS = 1–15 T11-L2
	Not possible	SS = 0 T11-L2
C: Reflex genital arousal	Intact	Normal or hyperactive BC and anal wink reflexes
	Possible	Hypoactive or partially intact BC and/or anal wink reflexes
	Not possible	Absent BC and anal wink reflexes
D: Orgasm	Not possible	No S2-S5 sensation; absent BC and anal wink reflexes
	Possible	All other neurologic lesions

Note: SS = sum of International Sensory Scores; BC = bulbocavernosus.

function should be intact. The presence of intact though hypoactive BC and/or anal wink reflexes indicates that reflex function is possible, and the absence of both BC and anal wink reflexes indicates that reflex function is not possible.

Category D: Potential to achieve orgasm

The last category describes the woman's neurologic potential to achieve orgasm. Women with complete LMN injuries affecting their S2-S5 spinal segments along with absent BC and anal wink reflexes are listed with no possible potential for orgasm, whereas women with all other patterns and degrees of neurologic injury are listed as possible for orgasmic potential.

It is the goal of the Female Spinal Sexual Function Classification to begin a process of better documentation of the potential for sexual response in women with spinal cord dysfunction. It is not represented as a fully developed system, and revisions are anticipated. However, with the recent developments and availability of therapies to remediate sexual dysfunction, the develop-

ment of such a classification system seems warranted. The system is by no means recommended as an alternate to the International Standards for Neurologic Classification of Spinal Cord Injury[23] but rather as an adjunct. It may potentially be useful for both clinical and research purposes by allowing for an exact description of the potential for sexual responses in women with SCI and the presence or absence of sexual dysfunction.

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