Women's Sexual Health and Reproductive Function After SCI

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Sexual function and to a lesser extent reproduction are often disrupted in women with spinal cord injuries (SCI), who must be educated to better understand their sexual and reproductive health. Women with SCI are sexually active; they can use psychogenic or reflexogenic stimulation to obtain sexual pleasure and orgasm. Treatment should consider a holistic approach using autonomic standards to describe remaining sexual function and to assess both genital function and psychosocial factors. Assessment of genital function should include thoracolumbar dermatomes, vulvar sensitivity (touch, pressure, vibration), and sacral reflexes. Self-exploration should include not only clitoral stimulation, but also stimulation of the vagina (G spot), cervix, and nipples conveyed by different innervation sources. Treatments may consider PDE5 inhibitors and flibanserin on an individual basis, and secondary consequences of SCI should address concerns with spasticity, pain, incontinence, and side effects of medications. Psychosocial issues must be addressed as possible contributors to sexual dysfunctions (eg, lower self-esteem, past sexual history, depression, dating habits). Pregnancy is possible for women with SCI; younger age at the time of injury and at the time of pregnancy being significant predictors of successful pregnancy, along with marital status, motor score, mobility, and occupational scores. Pregnancy may decrease the level of functioning (eg, self-care, ambulation, upper-extremity tasks), may involve complications (eg, decubitus ulcers, weight gain, urological complications), and must be monitored for postural hypotension and autonomic dysreflexia. Taking into consideration the physical and psychosocial determinants of sexuality and childbearing allows women with SCI to achieve positive sexual and reproductive health. **Key words:** *pregnancy, reproductive health, sexual function, spinal cord injury, women*

Sexual function and to a lesser extent reproduction are often disrupted following a lesion to the spinal cord.[1-3] For women, this can result in changes in vaginal lubrication, genital congestion, and orgasm, although women still report sexual pleasure, adaptations, and sexual satisfaction. Fertility is usually maintained, but pregnancy requires close monitoring and follow-up. It is thus beneficial to educate women about these issues to help them adapt to their new lives and to maintain a positive attitude toward sexual health and motherhood.

Remaining Sexual Potential in Women with Spinal Cord Injury

The literature on women with spinal cord injuries (SCIs) repeatedly shows that sexual function is possible despite the level or degree of injury. These women remain sexually active and consider sexuality as essential part of their quality of life.[1,3,4-10]

Studies of women with SCIs indicate that their sexual responses can be differentially preserved with psychogenic or reflexogenic (genital) stimulation depending on the lesion level and extent.[11-14] Findings from women with spinal cord lesions, along with those from men with SCI[15-18] and experimental evidence from animal studies,[19-22] demonstrate that differential pathways mediate psychogenic responses through thoracolumbar (TL) nerves and reflexogenic responses through sacral nerves.

Bérard[10] was the first to highlight this distinction between psychogenic and reflexogenic responses in women through interviews. Vaginal lubrication was possible for women with lower spinal cord lesions using psychogenic stimulation, whereas

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vaginal lubrication was reported in women with higher spinal cord lesions using reflexogenic (genital) stimulation.

Sipski et al[12] performed a laboratory-based controlled analysis of components of sexual arousal in women after SCI using vaginal pulse amplitude to measure genital vasocongestion. Analysis of the vaginal responses of 67 women with varying degrees and levels of SCI revealed that the occurrence of psychogenic genital responsiveness was significantly associated with the degree of combined pinprick plus light touch American Spinal Injury Association Impairment Scale (AIS) sensory score in the T11-L2 dermatomes.[14] This was perceived as evidence for the role of TL sympathetic fibers in the occurrence of psychogenic genital vasocongestion in women with SCI. In later laboratory-based controlled studies, these results were confirmed by documenting a greater impact of anxiety-provoking stimulation[23] and false feedback,[24] both treatments that rely on psychogenic stimulation to promote increased genital blood flow, in women with SCI and varying degrees of combined pinprick and light touch scores from T11-L2.

The same group of subjects[11,14] participated in a separate controlled study where they were provided a vibrator and asked to stimulate themselves any way they desired to achieve orgasm. Whereas 55% of the 62 subjects acknowledged orgasm at home, only 44% were orgasmic in the lab. Women with upper motor neuron (UMN) lesions were more likely to achieve orgasm in the lab (59%) than women with complete lower motor neuron (LMN) lesions (17%). Heart rate and blood pressure readings were compared between able-bodied and SCI subjects every 3 minutes and at orgasm, and readings in both groups were statistically increased at orgasm versus baseline but were similar in both groups.

In a controlled laboratory-based analysis, Whipple et al[25] studied 16 women with complete SCI above the level of T10 and 5 able-bodied subjects and found that women with spinal cord lesions could reach orgasm with cervix stimulation. The orgasmic response was also accompanied by significant changes in blood pressure and heart rate; these were statistically similar in control and SCI subjects. In another study of 5 women with SCI at arousal and orgasm while undergoing fMRI of the brain, 3 women, including 2 with complete injuries, achieved orgasm. Findings in this pilot study were interpreted to reveal activity in the brainstem solitary nucleus,[26] a region of the medulla oblongata to which the vagus nerves project. As recommended by Salonia et al,[27] this finding would need to be repeated in a larger group of subjects; 10 to 20 subjects are usually needed in a study using this type of cerebral imaging.

Altogether these findings indicate that even women with complete SCI can self-stimulate to orgasm through genital, clitoral, or cervical stimulation. Although women with SCI have not been directly studied for anterior vaginal wall or nipple stimulation, findings from women with and without SCI suggest that anterior vaginal wall and nipple stimulation contribute to sexual arousal and orgasm; these structures are mediated by different peripheral or spinal nerves.[28,29]

Neurological pathways can therefore convey sexual responses in women with spinal cord lesions through at least 3 routes involving (1) the dorsal clitoral (pudendal) nerve (somatosensory) innervating the clitoris and external labia, (2) the pelvic nerve and inferior hypogastric nerve feeding into the uterovaginal plexus (parasympathetic) and innervating the vagina and cervix, and (3) the hypogastric nerves (sympathetic) innervating the cervix and uterus.[29-32] Recent murine studies[19] have shown that stimulation of the sensory branch of the pudendal nerve results in increased vaginal blood flow, likely via activation of spinal pathways triggering pelvic nerve efferents. A climactic-like response of firing of the pudendal motor nerve also occurs in response to stimulation of the pudendal sensory nerve but does not require intact pelvic or hypogastric nerves. As these afferent fibers and their corresponding efferent pathways convey genital responses through sacral reflexes (S2-S4), psychogenic responses can also be mediated through the TL pathway running through the sympathetic chain and feeding into the uterovaginal plexus or the hypogastric nerves to innervate the cervix and uterus.[28,29]

Evidence has documented the presence of a spinal pattern generator for ejaculation in males.[33] In a murine model,[22] evidence of specific areas in the medial dorsal horn, dorsal gray commissure,

lamina VI and X, and dorsal lateral gray were activated in response to both pudendal sensory and pelvic stimulation and are likely related to interspinal circuitry regulating female sexual function. Additionally a spinal fMRI study of 9 healthy women that assessed spinal responses to varying types of sexual stimulation[34] revealed evidence of increased spinal activity in the region of the lumbar spinothalamic cells prior to orgasm, thus this area of the spinal cord may receive both cervical and supraspinal input and begin to integrate these inputs with autonomic outflow from the intermediolateral columns and the sacral parasympathetic nucleus, possibly as a trigger for orgasm.

Based on the above studies, further research is necessary to determine the neurologic pathways involved in sexual responses in spinal cord–injured and able-bodied women. Advance imaging techniques need to be utilized to determine the spinal and cortical circuitry involved in orgasm. Controlled studies such as that of Georgiadis et al[35] with adequate sample sizes are difficult to perform in this study population, so translational methods merging basic science and clinical findings must also be emphasized.

Clinical Approach to Sexual Dysfunction in Women with SCI

Although the previous findings are optimistic about the ability for women to maintain genital responses with relatively independent sources of stimulation, they must not be taken to suggest that genital responses are the only goal of sexual rehabilitation in women with SCI. Sexual rehabilitation must use a holistic approach[3] consistent with Basson's[36,37] theory emphasizing the emotional, cognitive, couple, and past history of women in their sexual perceptions. Genital function in women with SCI must therefore be assessed along with other aspects of sexuality, including physical concerns associated with SCI (eg, incontinence, spasticity) and psychosocial adaptations.[3,38] Foley and Iverson[39] have developed a model for multiple sclerosis that is suitable for other conditions including SCI; this model approaches sexual rehabilitation in terms of primary, secondary, and tertiary impacts of disability on sexual function.

Primary Impact of SCI on Women's Sexual Function

The primary impact of SCI on sexual function concerns the direct neurological consequences of the spinal lesion. Women with SCI may differentially preserve a potential for psychogenic or reflexogenic responses (through the TL pathway for psychogenic responses and through the sacral pathway for reflexogenic responses). Reflexogenic potential should be explored not only with clitoral stimulation but also with vaginal, G spot, and cervix stimulation.

As a first step of sexual rehabilitation, women with SCI should be assessed for TL dermatomes, as suggested by Sipski et al's work[11-14] on psychogenic potential, and vulvar sensitivity and perineal reflexes for reflexogenic potential. Vulvar sensitivity may be assessed with different sensory modalities, including light touch as involved in sexual caresses and pressure and vibration as involved in vaginal penetration and sex toys. Assessment should target not only the glans clitoris, but also the labia minora, the vaginal entry, and the anal sphincter to help women with SCI recreate a "mental image" of their vulva despite their impaired sensations.[28,40]

Documentation of women's sexual potential is recommended using the international standards to document remaining autonomic function after spinal cord injury[41] in addition to the international spinal cord injury female sexual function basic data set.[42] The autonomic standards are recommended as a quick method to describe the remaining sexual function a person has along with the type of neurologic dysfunction that is affecting the sacral segments. In contrast, the data set is designed to be used clinically and as a research tool to document the specific sexual dysfunctions that are present.

Assessment should be followed by exercises, ideally performed in the rehabilitation setting where coaching can be offered, or at home where self-explorations should be encouraged with stimulation of the clitoris (manual or vibrator stimulation), the vaginal entry (G spot), and deeper vaginal tissue including the cervix. Nipple exploration should also be encouraged as an additional source of stimulation to feed into sexual arousal and to help in reaching orgasm.[28]

When these rehabilitation options are not sufficient for women's sexual satisfaction, other options can be offered, including phosphodiesterase type 5 (PDE5) inhibitors. Although they were beneficial in a laboratory-based study of women with SCI,[43] positive results were not observedin an international clinical trial.[44] Other studies have also shown inconclusive results,[45-52] and these results may be related to the primary outcome measures that were chosen and the difficulty determining a beneficial effect of sexual treatments in women. Thus, these medications can be offered on an individual basis to improve genital congestion.[36,47,53] Although not tested on women with spinal cord lesions, the recently developed flibanserin may also be considered; its action may resemble that of an antidepressant and it has negative side effects such as hypotension, which warrants study in women with SCI.[54,55]

Women may also be encouraged to explore devices such as the Eros Clitoral Therapy Device (CTD) or its equivalent to improve sexual congestion and orgasm.[56,57]

Secondary Impact of SCI on Women's Sexual Function

The secondary impact of SCI involves the consequences of the neurological lesion on other body functions that are important for sexuality. Reduced mobility, which limits sexual positions, spasticity, contractures, pain, concerns with incontinence, and side effects of medications are recurrent concerns that can limit the willingness of women with SCI to engage in sexual activities.[3,5,58]

Rehabilitation strategies may focus on providing practical advice, for example, instructing the woman to compensate for reduced mobility by using pillows (eg, under the hips), wedges, or cushions to relieve pressure and to provide support during intercourse.[59] Various sexual positions may be discussed to facilitate motion and to prevent fatigue. Longer foreplay and perception of other body sensations (breast, ear lobes, inner thighs) may provide additional pleasure; behaviors such as kissing, hugging, fantasies, or sexual memories can provide alternatives to intercourse.[3,60] Massages may be used during foreplay to reduce spasticity,[60] although women should be advised that mild to moderate spasticity is a sign of sexual responsiveness or upcoming orgasm.[61-65] Similarly, mild to moderate signs of autonomic dysreflexia (AD) should not be assumed to be necessarily pathological,[66-68] and women should be advised that mild AD may be a sign of impending orgasm rather than a concerning event. Yet severe AD should always be avoided and reported whenever it occurs.[69-75]

Women receiving perineal training for urinary incontinence may find it beneficial to sexual function, as it involves similar strategies to Kegel exercises (ie, voluntary pelvic contractions). No formal studies have been conducted on this issue in women with SCI. The use of sex toys, assistive devices (eg, straps for vibrators, dildos), and substitution systems[76] may be suggested to facilitate stimulation, overcome positioning issues, and increase sexual adjustment.[60]

A regular revision of medications, including antispasmodics, pain killers (especially opioids), and antidepressives, that are known to be associated with increased risks of sexual dysfunction is advisable.[60] Patients should be taught to develop awareness of their own needs for adjustment.

Tertiary Impact of SCI on Women's Sexual Function

The tertiary impact of SCI concerns the psychosocial effects on sexuality. Readiness for sexuality is an important aspect in determining a client's motivation to reengage in sexual activities. Rehabilitation professionals should be aware of the importance of providing sexual information during rehabilitation, whether the patient has asked for specific information or not. Patients expect professionals to provide information regardless of whether they have demonstrated a readiness for sexuality during rehabilitation.[28,60]

Psychological effects of SCI such as major depression, anxiety, and alcohol and drug abuse[7] are usually managed during rehabilitation, but they may reappear after hospital discharge. The relationship between partners may change at home, and regular habits may have to be reinvented.[60]

Facilitating dating, leisure, and social activities prevents social isolation and can help prevent depression. Social activity improves self-esteem, self-confidence, and psychological well being.[60] Regular physical activity also improves health and body image and contributes to women's sexual satisfaction.[5]

Guides on sexuality and reproductive issues must be made available for all women (and men) with SCI, for example, the Consortium for Spinal Cord Medicine,[77] the SCIRE sexual health following spinal cord injury,[78] PleasureAble,[79] and websites from SCI organizations (eg., http://www.sci-u.ca/; parent plus-Centre de réadaptation Lucie-Bruneau, SCI-bc.ca; http://sciparenting.com/info/).

Reproduction and Pregnancy in Women with SCI

The neurological changes in women following an SCI may affect their reproductive and obstetrical health. Responses of the reproductive system to SCI-related conditions determine how women with SCI experience issues related to menstruation, fecundity, pregnancy, labor, delivery, and postpartum state.

Following an SCI, a woman's menstrual cycle is usually disrupted and gynecologic dysfunction may occur. Secondary amenorrhea, menorrhagia, metrorrhagia, and neurogenic prolactinemia with and without galactorrhea[80-82] have been described in the initial postinjury months. Neurogenic prolactinemia-galactorrhea syndrome mimics lactation, whereby the thoracic nerves are stimulated and initiate disinhibition of dopamine control, thereby producing breast milk. If, after 6 months, a woman's menstruation has not returned to preinjury patterns, the clinician should check her FSH, LH, estradiol, testosterone, thyroid stimulating hormone, Vitamin D, and prolactin levels to detect underlying imbalances and target a correction.

Some data suggest[83] that women with SCI become pregnant for the first time at an older age than able-bodied women, but social issues rather than physiological issues may play a major role. In a cross-sectional study, 66 (13.9%) out of 472 women with SCI (average age 40 years) reported having had a total of 101 pregnancies after injury. The relatively lower pregnancy rate makes prospective studies about obstetrical complications difficult. Although some studies have addressed incidence of pregnancy, no studies have examined the physiological factors involved with fertility following SCI. Unique medical problems, however, appear to occur in these women during pregnancy, labor, and delivery.

In a recent publication, Iezzoni et al[84] examined the prevalence of pregnancy in a large cohort of 1,907 women with SCI. Utilizing the US National Spinal Cord Injury Database (NSCID), an SCI registry that interviews participants at 1, 5, and then every 5 years post injury, they analyzed 3,054 interviews for associations with sociodemographic and clinical factors among women with SCI. In this study, women 18 to 49 years old were asked about hospitalizations within the last year (of the interview) related to pregnancy or its complications ("current pregnancy"). Only 2.0% reported pregnancy during the prior 12 months—far less than what would be expected from the able-bodied population. This annual prevalence differed significantly by years elapsed since injury with the highest rate occurring 15 years after injury (3.7%). In addition, analysis revealed that younger age at injury was significantly associated with current pregnancy ($p < .0001$). Compared with nonpregnant women, those reporting current pregnancy were significantly more likely to be married or partnered, have sport-related SCI, have higher motor scores, and have more positive psychosocial status scores. Multivariable analyses found significant associations between current pregnancy and age, marital status, motor score, mobility, and occupation scale scores.

Although it has often been reported that the ability of a woman to conceive is not affected by SCI, the evidence for this has not been shown conclusively. A low 2% pregnancy rate implies that neurological, physical, physiological, and psychosocial factors contribute to a woman with an SCI becoming pregnant. Examining these aspects of health following SCI will further elucidate the changes that occur during pregnancy. Little has been written on the major pregnancy determinants for women with SCI, but Iezzoni's study[84] gives insight into 2 important conditions: (1) disability-specific issues and (2) age-induced concerns. Disability-related factors

include physical/physiological and psychosocial consequences of the SCI that affect the woman's degree of functioning and psychological adjustment. Age-related factors are commonly implicated as determinants for fertility and pregnancy rates; these are also considerations in the able-body population.

Women with SCI who experienced a pregnancy self-reported better functional abilities than nonpregnant women with SCI. Of course the degree and level of SCI dictates the amount of assistance that the woman may require and the level of functioning for self-care, ambulation, and upper extremity tasks. Women with higher motor FIM® scores (determined at time of discharge from rehabilitation) were significantly more independent and more likely to respond affirmatively to "current pregnancy" than women in the nonpregnant group. Although we do not know whether this latter group was pregnant at any other time after injury, the significance ($p < .0001$) strongly indicates that women who became pregnant were more independent with feeding, grooming, bathing, dressing upper and lower body, toileting, bladder and bowel control, transferring (to and from bed, chair, toilet, tub or shower), locomotion, and stair climbing. Furthermore, the higher functioning neurological impairment rating (AIS D and Para ABC) statistically corroborates the importance of independence with becoming pregnant. Conversely, women with higher neurological lesions may show important complications including AD, urinary infections, respiratory problems, and thrombophlebitis.[85-90]

Many other factors can impact functional abilities after SCI. Physical restrictions may occur when spasticity develops in those women with UMN levels of injury. Contractures can fuse joints and prevent movement in the lower extremities. Heterotopic ossification may occur following a central nervous system insult, with the most common site being the hips followed by the knees, shoulders, and elbows. This condition would prevent mobility, transfers, and ambulation. Another type of skeletal deformity that may affect pregnancy after SCI is spinal misalignment. Significant kyphosis or scoliosis anatomically interferes with posture and mobility and can also alter circulation and the capacity to carry a fetus.

Mobility may be affected physiologically by the secondary medical conditions that are exacerbated by the growing fetus. Depending on level of injury, varying degrees of pulmonary dysfunction occur following SCI. When the gravid uterus enlarges, it creates diminished vital capacity with poor oxygenation and aggravation of fatigue and immobility. Development of decubitus ulcers, lower extremity edema, weight gain, urological complications, gastrointestinal dysfunction, postural hypotension, and AD are secondary conditions of SCI that negatively impact independence. These effects are even greater when a woman is pregnant. Breastfeeding may be associated with some difficulties for which there are adaptations (slings, positions, etc) and with some risks of AD, which have been mentioned in case reports on tetraplegic women.[91-93]

Psychological influences of the disability may affect a woman's decision to become pregnant and thus result in lower pregnancy rates in this population. Literature is conflicting about whether women with SCI experience more anxiety and fear regarding pregnancy and caring for a child than able-bodied women. Some women with disabilities frequently remark that they receive negative reactions to their plans for becoming a mother from family members, health care providers, and society.[94] Ghidini[95] described reasons for the decision about pregnancy in 50 women who desired pregnancy and 64 women who did not desire pregnancy following SCI. In the former group, 36% of women who desired pregnancy and successfully conceived statistically ($p < .001$) cited more frequently that they feared pregnancy or rearing of children but did not allow it to become a determinant. These women were not statistically influenced by level of injury, occurrence of preinjury pregnancies, lack of postinjury SCI reproductive information, nor psychological stress associated with risks of pregnancy or raising children.

Tebbet et al[96] utilized a qualitative interpretative phenomenology analysis (IPA) technique in interviewing women with SCIs to explore their

feelings and knowledge about childbirth and parenting. The results were categorized into 5 themes with the conclusions that "childbirth is perceived by SCI women as unique and positive," "person-centered care and control are critical," and "there is a need to recognize the biopsychosocial framework with women in this setting."

Statistically significant indicators for predicting pregnancy in the NSCID report were "younger age at injury" and "younger age at time of pregnancy." Confirmed by previous studies concerning women with SCI, it is not surprising that a reproductively active population is younger when choosing to become pregnant. It is also a prevalent theme for pregnancy rate predictability in the able-bodied populations. Aging has the primary impact on the psychosocial and physiological parameters of reproductive decisions. Investigations concerning the interrelationships of aging and pregnancy usually focus on the consequences of fertility and the predisposition for obstetrical and perinatal complications.

Over the past few decades, the trend of women deciding to postpone having children has been growing.[97,98] From 1970 to 2011, published statistics report that the mean age for first-time pregnancies rose in the United States from 21.4 years to 25.6 years.[97,98] This trend has also been observed in Canada, Sweden, and the Netherlands, with maternal mean ages being 29.6, 28.3, and 28.7 years, respectively, for first-time pregnancies.[99,100] Many reasons are noted; often career-directed goals, availability of effective contraception, and changes in societal expectations of women are mentioned. The fecundability (ie, capacity or probability of achieving pregnancy within one menstrual cycle) begins to significantly decrease for a woman at 32 years old and then again – even more rapidly – at 37 years old. Therefore women who want to delay having children need to be aware that they have an increased risk of infertility. Furthermore, with advancing maternal age, women have a significantly longer average length of time to achieve conception.

As maternal age increases, so do pregnancy complications. Maternal age greater than 35 years is associated with increased risk of miscarriage or spontaneous abortion, ectopic pregnancy, pregestational diabetes, eclampsia, and pregnancy-induced hypertension. The older parturient is more likely to have placenta previa, caesarean section, and induction of labor. There is also a greater risk for perinatal and neonatal death. The infant risks are also greater and include low birth weight, preterm delivery, and chromosomal disorders.

The clinician must be cognizant of all coexisting conditions of the women who are planning for pregnancy. Concomitant medical problems are more frequent in women as they get older, and these considerations impact the health of the mother and the baby. In the NSCID study,[84] women with SCI with "current pregnancies" were statistically younger (31.2 ± 6.7 vs 35.7 ± 9.1 years, respectively) than those without pregnancies at the time of their SCI and at the annual date of the questionnaire. This younger cohort of women was relatively older than the mean average age for nondisabled mothers pregnant for the first time. This implies that the older group of women in the NSCID either did not want to be pregnant or were attempting pregnancy but were not able to conceive. If the latter is a prevalent issue, then aging effects on SCI and fertility need further research.

Pregnancy, labor, and delivery outcomes have been reported anecdotally. Past reviews reveal that the parturient with SCI has a 2 times higher risk of experiencing a preterm birth. Estimates range from 20%[101] to 40%[102] for pregnant women with SCI to undergo labor and delivery between 32 and 37 weeks. Other studies report that about one-third of deliveries are spontaneous, one-third are assisted, and one-third are by caesarean.[103,104] By far the most critical complication of labor and delivery is AD. It has been reported that 60% to 80%[105,106] of women with SCI with lesions above T6 and a small percentage below T6[107] will experience AD during labor and delivery uterine contractions. Sequelae of fetal distress, maternal intracranial hemorrhage, coma, seizures, and even death have been described,[108,109] if this condition goes unrecognized and untreated. Urinary tract infections, which are common in all individuals with SCI, become more problematic during pregnancy. Studies[110,111] have shown

that urinary tract infections are associated with preterm and low-birth-weight infants. Only in the past few years have closer management of the neurogenic bladder and use of weekly oral cyclic antibiotic (WOCA) regimens been studied for pregnant women with SCI.[112-114]

In contrast to pregnancy, few (if any) recommendations are found about contraceptives in women with SCI. While data indicate that oral or chemical contraceptives, intrauterine devices (IUDs), and condoms are used to varying degrees,[83,88,115,116] reports also indicate that up to 44% of women with SCI are not sexually active[116] and 41% do not use any contraceptives.[117] In the absence of recommendations, statistics do not seem to favor chemical contraceptives over IUDs; estrogens are associated with increased risks of thrombophlebitis (and encourage the use of progestatives) and IUDs are potentially associated with increased AD risks.

Conclusion

The information obtained in this review of the literature regarding sexual function and SCI shows that sexual pleasure, orgasm, and pregnancy are possible for women with SCI. Primary, secondary, and tertiary impacts of SCI may affect sexual adjustment and should be addressed during rehabilitation. Determinants to childbearing and care of women with SCI who are pregnant require consideration of physical, physiological, and psychosocial factors. Communication with and education of women with SCI are mandatory after injury in order for women to understand their sexual and reproductive health and to learn about the options that are available for a safe pregnancy, labor, and delivery.

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REFERENCES

1. Biering-Sørensen I, Hansen RB, Biering-Sørensen F. Sexual function in a traumatic spinal cord injured population 10-45 years after injury. *J Rehabil Med.* 2012;44(11):926-931.
2. Hess MJ, Hough S. Impact of spinal cord injury on sexuality: Broad-based clinical practice intervention and practical application. *J Spinal Cord Med.* 2012;35(4):211-218.
3. Kreuter M, Taft C, Siösteen A, Biering-Sørensen F. Women's sexual functioning and sex life after spinal cord injury. *Spinal Cord.* 2011;49(1):154-160.
4. Anderson KD, Borisoff JF, Johnson RD, Stiens SA, Elliott SL. Spinal cord injury influences psychogenic as well as physical components of female sexual ability. *Spinal Cord.* 2007;45:349-359.
5. Cramp JD, Courtois FJ, Ditor DS. Sexuality for women with spinal cord injury. *J Sex Marital Ther.* 2015;41(3):238-253.
6. Ferreiro-Velasco ME, Barca-Buyo A, de la Barrera SS, Montoto-Marqués A, Vázquez XM, Rodríguez-Sotillo A. Sexual issues in a sample of women with spinal cord injury. *Spinal Cord.* 2005;43:51-55.
7. Lombardi G, Del Popolo G, Macchiarella A, Mencarini M, Celso M. Sexual rehabilitation in women with spinal cord injury: A critical review of the literature. *Spinal Cord.* 2010;48(12): 842-849.
8. Lysberg K, Severinsson E. Spinal cord injured women's views of sexuality: A Norwegian survey. *Rehabil Nurs.* 2003;28(1):23-26.
9. Singh R, Sansar C, Sharma MS. Sexuality and women with spinal cord injury. *Sex Disabil.* 2005;23(1): 21-33.
10. Bérard E. The sexuality of spinal cord injured women: Physiology and pathophysiology. A review. *Paraplegia.* 1989;27(2):99-112.
11. Sipski LM, Alexander CJ, Rosen R. Orgasm in women with spinal cord injuries: A laboratory-based assessment. *Arch Phys Med Rehabil.* 1995;76: 1097-1102.
12. Sipski ML, Alexander CJ, Rosen RC. Physiological parameters associated with psychogenic sexual arousal in women with complete spinal cord injuries. *Arch Phys Med Rehabil.* 1995;76(9):811-818.
13. Sipski ML, Alexander CJ, Rosen RC. Physiological parameters associated with sexual arousal in women with incomplete spinal injury. *Arch Phys Med Rehabil.* 1997;78:305-313.
14. Sipski LM, Alexander CJ, Rosen R. Sexual arousal and orgasm in women: Effects of spinal cord injury. *Ann Neurol.* 2001;49:35-44.
15. Bors E, Comarr AE. Neurological disturbances of sexual function with special reference to 529 patients with spinal cord injury. *Urol Surv.* 1960;10:191-222.
16. Comarr AE. Sexual function among patients with spinal cord injury. *Urol Int.* 1970;25:134-168.
17. Courtois FJ, Charvier KF, Leriche A, Raymond DP. Sexual function in spinal cord injury men: I. Assessing sexual capability. *Paraplegia.* 1993;31:771-784.
18. Sipski ML, Alexander CJ, Gomez O, Spalding J. The effects of spinal cord injury on psychogenic sexual arousal in males. *J Urol.* 2007;177(1):247-251.
19. Cai RS, Alexander MS, Marson L. Activation of somatosensory afferents elicit changes in vaginal blood flow and the urethrogenital reflex via autonomic efferents. *J Urol.* 2008;180(3):1167-1172.

20. Courtois FJ, MacDougall JC, Sach BD. Erectile mechanism in paraplegia. *Physiol Behav.* 1993;53:721-726.
21. Yaïci ED, Rampin O, Tang Y, et al. Cathecholaminergic projections on to spinal neurons destined to the pelvis including the penis in rat. *Int J Impot Res.* 2002;14(3):151-166.
22. Wiedey J, Sipski Alexander M, Marson L. Spinal neurons activated in response to pudendal or pelvic nerve stimulation in female rats. *Brain Res.* 2008:1197:106-114.
23. Sipski ML, Rosen RC, Alexander CJ, Gómez-Marín O. Sexual responsiveness in women with spinal cord injuries: Differential effects of anxiety-eliciting stimulation. *Arch Sex Behav.* 2004;33(3):295-302.
24. Sipski ML, Rosen R, Alexander CJ, Hamer R. A controlled trial of positive feedback to increase sexual arousal in women with spinal cord injuries. *NeuroRehabilitation.* 2000:15(2):145-153.
25. Whipple B, Gerdes CA, Komisaruk BR. Sexual response to self-stimulation in women with complete spinal cord injury. *J Sex Res.* 1996;33(3):231-240.
26. Komisaruk BR, Whipple B, Crawford A, Liu WC, Kalnin A, Mosier K. Brain activation during vaginocervical self-stimulation and orgasm in women with complete spinal cord injury: fMRI evidence of mediation by the vagus nerves. *Brain Res.* 2004;1024(1-2):77-88.
27. Salonia A, Giraldi A, Chivers ML, et al. Physiology of women's sexual function: Basic knowledge and new findings. *J Sex Med.* 2010;7(8):2637-2660.
28. Courtois F, Charvier K. Sexual dysfunction in patients with spinal cord lesions. *Handb Clin Neurol.* 2015; 130:225-245.
29. Rees PM, Fowler CJ, Paas, CP. Sexual function in men and women with neurological disorders. *Lancet.* 2007;369:512-525.
30. Giuliano F, Rampin O, Allard J. Neurophysiology and pharmacology of female genital sexual response. *J Sex Marital Ther.* 2002;28(suppl 1):101-121.
31. Hubscher CH. Ascending spinal pathways from sexual organs: Effects of chronic spinal lesions. *Prog Brain Res.* 2006;152:401-414.
32. McKenna KE. The neural control of female sexual function. *NeuroRehabilitation.* 2000;15(2):133-143.
33. Truitt WA, Coolen LM. Identification of a potential ejaculation generator in the spinal cord. *Science.* 2002;297(5586):1566-1569.
34. Alexander MS, Kozyrev N, Bosma RL, Figley CR, Richards JS, Stroman PW. fMRI localization of spinal cord processing underlying female sexual arousal. *J Sex Marital Ther.* 2016 2;42(1):36-47.
35. Georgiadis JR, Simone Reinders AA, Paans AM, Renken R, Kortekaas R. Men versus women on sexual brain function: Prominent differences during tacile genital stimulation, but not during orgasm. *Human Brain Mapp.* 2009;30:3089-3101.
36. Basson R. A model of women's sexual arousal. *J Sex Marital Ther.* 2002;28:1-10.
37. Basson R, Leiblum S, Brotto L, et al. Revised definitions of women's sexual dysfunction. *J Sex Med.* 2004;1:40-48.
38. Lombardi G, Macchiarella A, Cecconi F, Aito S, Del Popolo G. Sexual life of males over 50 years of age with spinal-cord lesions of at least 20 years. *Spinal Cord.* 2008;46(10):679-683.
39. Foley FW, Iverson J. Sexuality and multiple sclerosis. In: Kalb RC, Scheinberg LC, eds. *Multiple Sclerosis and the Family.* New York: Demos; 1992:63-82.
40. Courtois F, Charvier K, Bélanger D, et al. Clinical approach to anorgasmia in women with spinal cord injury. *J Sex Med.* 2011;8(suppl 5):380.
41. Alexander MS, Biering-Sorensen F, Bodner D, et al. International standards to document remaining autonomic function after spinal cord injury. *Spinal Cord.* 2009;47(1):36-43.
42. Alexander MS, Biering-Sorensen F, Elliott S, Kreuter M, Sonksen J. International spinal cord injury female sexual function basic data set. *Spinal Cord.* 2011;49:787-790.
43. Sipski ML, Rosen RC, Alexander CJ, Hamer RM. Sildenafil effects on sexual and cardiovascular responses in women with spinal cord injury. *Urology.* 2000;55(6):812-815.
44. Alexander MS, Rosen RC, Steinberg S, Symonds T, Haughie S, Hultling C. Sildenafil in women with sexual arousal disorder following spinal cord injury. *Spinal Cord.* 2011;49(2):273-279.
45. Berman JR, Berman LA, Toler SM, Gill J, Haughie S; Sildenafil Study Group. Safety and efficacy of sildenafil citrate for the treatment of female sexual arousal disorder: A double-blind, placebo controlled study. *J Urol.* 2003;170(6 Pt 1):2333-2338.
46. Caruso S, Intelisano G, Farina M, Di Mari L, Agnello C. The function of sildenafil on female sexual pathways: A double-blind, cross-over, placebo-controlled study. *Eur J Obstet Gynecol Reprod Biol.* 2003;110(2):201-206.
47. Dasgupta R, Wiseman OJ, Kanabar G, Fowler CJ, Mikol D. Efficacy of sildenafil in the treatment of female sexual dysfunction due to multiple sclerosis. *J Urol.* 2004;71(3):1189-1193.
48. Laan E, van Lunsen RH, Everaerd W, et al. The enhancement of vaginal vasocongestion by sildenafil in healthy premenopausal women. *J Women Health Gend Based Med.* 2002;11(4):357-365.
49. Mayer M, Stief CG, Truss MC, Uckert S. Phosphodiesterase inhibitors in female sexual dysfunction. *World J Urol.* 2005;23(6):393-397.
50. Munarriz R, Kim SW, Kim NN, Traish A, Goldstein I. A review of the physiology and pharmacology of peripheral (vaginal and clitoral) female genital arousal in the animal model. *J Urol.* 2003:170(2 Pt 2): S40-4,S44-5.
51. Rosen RC. Sexual function assessment and the role of vasoactive drugs in female sexual dysfunction. *Arch Sex Behav.* 2002;31(5):439-443.
52. Rosen RC, McKenna KE. PDE-5 inhibition and sexual response: Pharmacological mechanisms and clinical outcomes. *Ann Rev Sex Res.* 2002;13:36-88.
53. Basson R, Brotto LA. Sexual psychophysiology and effects of sildenafil citrate in oestrogenised women with acquired genital arousal disorder and impaired orgasm: A randomised controlled trial. *BJOG.* 2003;110(11):1014-1024.

54. Gao Z, Yang D, Yu L, Cui Y. Efficacy and safety of flibanserin in women with hypoactive sexual desire disorder: A systematic review and meta-analysis. *J Sex Med.* 2015;12(11):2095-2104.
55. Jaspers L, Feys F, Bramer WM, Franco OH, Leusink P, Laan ET. Efficacy and safety of flibanserin for the treatment of hypoactive sexual desire disorder in women: A systematic review and meta-analysis. *JAMA Intern Med.* 2016;176(4):453-462.
56. Billups KL, Berman L, Berman J, Metz ME, Glennon ME, Goldstein I. A new non-pharmacological vacuum therapy for female sexual dysfunction. *J Sex Marital Ther.* 2001;27(5):435-441.
57. Wilson SK, Delk JR 2nd, Billups KL. Treating symptoms of female sexual arousal disorder with the eros-clitoral therapy device. *J Gend Specif Med.* 2001;4(2): 54-58.
58. Forsythe E, Horsewell JE. Sexual rehabilitation of women with a spinal cord injury. *Spinal Cord.* 2006;44:234-241.
59. www.drmitchelltepper.com
60. Hess MJ, Hough S. Impact of spinal cord injury on sexuality: Broad-based clinical practice intervention and practical application. *J Spinal Cord Med.* 2012;35(4):211-218.
61. Alaca R, Goktepe AS, Yildiz N, Yilmaz B, Gunduz S. Effect of penile vibratory stimulation on spasticity in men with spinal cord injury. *Am J Phys Med Rehabil.* 2005;84(11):875-879.
62. Biering-Sørensen F, Laessøe L, Sønksen J, Bagi P, Nielsen JB, Kristensen JK. The effect of penile vibratory stimulation on male fertility potential, spasticity and neurogenic detrusor overactivity in spinal cord lesioned individuals. *Acta Neurochir Suppl.* 2005;93:159-163.
63. Courtois F, Geoffrion R, Landry E, Bélnager M. H reflex and physiologic measures of ejaculation in men with spinal cord injury. *Arch Phys Med Rehabil.* 2004;85:910-918.
64. Laessøe L, Nielsen JB, Biering-Sørensen F, Sonksen J. Antispastic effect of penile vibration in men with spinal cord lesion. *Arch Phys Med Rehabil.* 2004;85(6):919-924.
65. Sonksen J, Ohl DA, Wedemeyer G. Sphincteric events during penile vibratory ejaculation and electroejaculation in men with spinal cord injuries. *J Urol.* 2001;165(2):426-429.
66. Courtois FJ, Charvier KF, Leriche A, Vézina JG, Côté M, Bélanger M. Blood pressure changes during sexual stimulation, ejaculation and midodrine treatment in spinal cord injured men. *BJU Int.* 2008;101(3): 331-337.
67. Courtois FJ, Charvier KF, Leriche A, Vézina JG, et al. Perceived physiological and orgasmic sensations at ejaculation in spinal cord injured men. *J Sex Med.* 2008;5(10);2419-2430.
68. Courtois F, Charvier K, Vézina, J-G, et al. Assessing and conceptualizing orgasm following a spinal cord injury. *BJU Int.* 2011;108(10):1624-1633.
69. Courtois F, Rodrigue X, Côté I, et al. Sexual function and autonomic dysreflexia in men with spinal cord injuries: How to treat. *Spinal Cord.* 2012;50(12): 969-877.
70. Ekland MB, Krassioukov AV, McBride KE, Elliott SL. Incidence of autonomic dysreflexia and silent autonomic dysreflexia in men with spinal cord injury undergoing sperm retrieval: Implications for clinical practice. *Spinal Cord Med.* 2008;31(1):33-39.
71. Elliot S, Krassioukov A. Malignant autonomic dysreflexia in spinal cord injured men. *Spinal Cord.* 2005;44(6):386-392.
72. Krassioukov A, Warburton DE, Teasell R, Eng JJ; Spinal Cord Injury Rehabilitation Evidence Research Team. A systematic review of the management of autonomic dysreflexia after spinal cord injury. *Arch Phys Med Rehabil.* 2009;90(4):6826-95.
73. McBride F, Quah SP, Scott ME, Dissmore WW. Tripling of blood pressure by sexual stimulation in a man with spinal cord injury. *J R Soc Med.* 2003;96:349-350.
74. Sheel AW, Krassioukov AV, Inglis JT, Elliott SL. Autonomic dysreflexia during sperm retrieval in spinal cord injury: Influence of lesion level and sildenafil citrate. *J Appl Physiol.* 2005;99(1):53-58.
75. Teasell RW, Arnold MO, Krassioukov A, Delaney GA. Cardiovascular consequences of loss of supraspinal control of the sympathetic nervous system after spinal cord injury. *Arch Phys Med Rehabil.* 2000;81: 506-516.
76. Borisoff JF, Elliott SL, Hocaloski S, Birch GE. The development of a sensory substitution system for the sexual rehabilitation of men with chronic spinal cord injury. *J Sex Med.* 2010;7(11):3647-3658.
77. Consortium for Spinal Cord Medicine. Sexuality and reproductive health in adults with spinal cord injury: A clinical practice guideline for health-care professionals. *J Spinal Cord Med.* 2010;33(3): 281-336.
78. Abramson CE, McBride KE, Konnyu KJ, Elliott SL; SCIRE Research Team. Sexual health outcome measures for individuals with a spinal cord injury: A systematic review. *Spinal Cord.* 2008;46(5): 320-324.
79. Naphtali K, MacHattie, E, Elliott SL, et al. *Pleasurable: Sexual Device Manual for Persons with Disabilities.* Vancouver: ICORD; 2010.
80. Berezin M, Ohry H, Shemesh Y, Zeilig G, Brooks ME. Hyperprolactinemia, galactorrhea and amenorrhea in women with spinal cord injury. *Gynecol Endocrinol.* 1989;3:159-116.
81. Boyd AE, Spare S, Bower B, Reichlin S. Neurogenic galactorrhea amenorrhea. *J Clin Endocrinol Metabol.* 1978;47:1374-1377.
82. Jackson AB. Hyperprolactinemia following SCI. Presented at the 18th Annual Scientific Meeting of the American Spinal Cord Injury Association; 1992; San Diego, CA.
83. Jackson AB, Wadley VA. A multicenter study of women's self-reported reproductive health after spinal cord injury. *Arch Phys Med Rehabil.* 1999;80: 1420-1428.
84. Iezzoni LI, Chen Y, McLain AB. Current pregnancy among women with spinal cord injury: Finding from the US National Spinal Cord Injury Database. *Spinal Cord.* 2015;53(11):821-826.

85. Bertschy S, Bostan C, Meyer T, Pannek J. Medical complications during pregnancy and childbirth in women with SCI in Switzerland. *Spinal Cord.* 2016;54(3):183-187.
86. Ghidini A, Simonson M. Pregnancy after spinal cord injury: A review of the literature. *Top Spinal Cord Inj Rehabil.* 2011;16:93-103.
87. Pannek J, Bertschy S. Mission impossible? Urological management of patients with spinal cord injury during pregnancy: A systematic review. *Spinal Cord.* 2011;49:1028-1032.
88. Perrouin-Verbe B. Lésions médullaires IV: Procréation, grossesse et suivi gynécologique. In: Courtois F, Bonierbale M. *Médecine sexuelle : fondements et pratiques*. Paris: Lavoisier; 2016:367-374.
89. Skowronski E, Hartman K. Obstetric management following traumatic tetraplegia: Case series and literature review. *Aust N Z J Obstet Gynaecol.* 2008;48:485-491.
90. Sterling L, Keunen J, Wigdor E, Sermer M, Maxwell C. Pregnancy outcomes in women with spinal cord lesions. *J Obstet Gynaecol Can.* 2013;35(1):39-43.
91. Cowley KC. Breastfeeding by women with tetraplegia: Some evidence for optimism. *Spinal Cord.* 2014;52(3):255.
92. Dakhil-Jerew F, Brook S, Derry F. Autonomic dysreflexia triggered by breastfeeding in a tetraplegic mother. *J Rehabil Med.* 2008;40(9):780-782.
93. Liu N, Krassioukov AV. Response to "Breastfeeding by women with tetraplegia: Some evidence for optimism." *Spinal Cord.* 2014;52(3):256.
94. Smeltzer SC. Pregnancy in women with physical disabilities. *J Obstet Gynecol Neonatal Nurs.* 2007;36:88-96.
95. Ghidini A, Healey A, Andreani M, Simonson MR. Pregnancy and women with spinal cord injuries. *Acta Obstet Gynecol Scand.* 2008;87(10):1006-1010.
96. Tebbet M, Kennedy P. The experience of childbirth for women with spinal cord injuries: An interpretative phenomenology analysis study. *Disabil Rehabil.* 2012;34(9):762-769.
97. Lombardi G, Mondaini N, Macchiarella A, Del Popolo G. Female sexual dysfunction and hormonal status in spinal cord injured (SCI) patients. *J Androl.* 2007;28(5):722-726.
98. Berezin M, Ohry H, Shemesh Y, Zeilig G, Brooks ME. Hyperprolactinemia, galactorrhea and amenorrhea in women with spinal cord injury. *Gynecol Endocrinol.* 1989;3:159-163.
99. Martin JA, Hamilton BE, Ventura SJ, Osterman MJ, Mathews TJ. Births: Final data for 2011. *Natl Vital Stat Rep.* 2013;62(1):1-69.
100. United Nations Economic Commission for Europe. *Trends in Europe and North America: The Statistical Yearbook of the Economic Commission for Europe 2005*. Geneva: The Commission; 2005. www.unece.org/stats/trends2.
101. Westgren N, Hulting C, Levi R, Westgren M. Pregnancy and delivery in women with a traumatic spinal cord injury in Sweden, 1980-1991. *Obstet Gynecol.* 1993;81:926-930.
102. Morton C, Le JT, Shahbander L, Hammond C, Murphy EA, Kirshner KL. Pregnancy outcomes of women with physical disabilities: A matched cohort study. *Phys Med Rehabil J.* 2012;91(suppl 12):1935.
103. Pereira L. Obstetric management of the patient with spinal cord injury. *Obstet Gynecol Surv.* 2003;58(10):678-687.
104. Camune BD. Challenges in the management of the pregnant woman with spinal cord injury *J Perinat Neonat Nurs.* 2013;27(3):225-231.
105. Guttman L, Paeslack V. Cardiac irregularities during labor in paraplegic women. *Paraplegia.* 1965;3:144-147.
106. Sharpe EE, Arendt KW, Jacob AK, Pasternak JJ. Anesthetic management of parturients with pre-existing paraplegia or tetraplegia: a case series. *Int J Obst Anes.* 2015:74-83.
107. Gimousky ML, Ojeda A, Ozaki R, Zerne S. Management of autonomic hyperreflexia associated with low spinal cord lesion. *Am J Obstet Gynecol.* 1985;153(2):223-224.
108. Young BK, Katz M, Klein SA. Pregnancy after spinal cord injury: Altered maternal fetal response to labor. *Obstet Gynecol.* 1983;62(1):59-63.
109. Tabsh KMA, Brinkmau CR, Reff RA. Autonomic dysreflexia in pregnancy. *Obstet Gynecol.* 1981;60:119-121.
110. Solomon J, Schnitzler A, Vile Y, et al. Prevention of urinary tract infection in six spinal cord-injured pregnant women who gave birth to seven children under a weekly oral cyclic antibiotic program. *Int J Inf Dis.* 2009;13:399-402.
111. Pannek J, Bertschy S. Mission impossible? Urological management of patients with spinal cord injury during pregnancy: A systematic review. *Spinal Cord.* 2011;49,1028-1032.
112. Galusca N, Charvier K, Courtois F, Rode G, Rudigoz RC, Ruffion A. [Antibioprophylaxy and urological management of women with spinal cord injury during pregnancy]. *Prog Urol.* 2015;25(8):489-496.
113. Salomon J, Schnitzler A, Ville Y, et al. Prevention of urinary tract infection in six spinal cord-injured pregnant women who gave birth to seven children under a weekly oral cyclic antibiotic program. *Int J Infect Dis.* 2009;13(3):399-402.
114. Salomon J, Denys P, Merle C, et al. Prevention of urinary tract infection in spinal cord-injured patients: Safety and efficacy of a weekly oral cyclic antibiotic (WOCA) programme with a 2 year follow-up--an observational prospective study. *J Antimicrob Chemother.* 2006;57(4):784-788.
115. Burns AS, Jackson AB. Gynecologic and reproductive issues in women with spinal cord injury. *Phys Med Rehabil Clin N Am.* 2001;12(1):183-199.
116. Charlifue S, Gerhart K, Menter R, Whiteneck G, Manley M. Sexual issues of women with spinal cord injuries. *Paraplegia.* 1992;30:192-199.
117. Anderson K, Borisoff J, Johnson R, Stiens S, Elliott S. Spinal cord injury influences psychogenic as well as physical components of female sexual ability. *Spinal Cord.* 2007;45:349-359.