Incidence of Autonomic Dysreflexia and Silent Autonomic Dysreflexia in Men With Spinal Cord Injury Undergoing Sperm Retrieval: Implications for Clinical Practice

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Abstract

Background/Objective: To determine the incidence of symptomatic autonomic dysreflexia (AD) and asymptomatic autonomic dysreflexia (silent AD) in men with spinal cord injury (SCI) undergoing sperm retrieval procedures.

Design: Descriptive study.

Methods: Thirteen men underwent cardiovascular monitoring during vibrostimulation (or self-stimulation) to the point of ejaculation. Cardiovascular results were compared with objective and subjective signs of AD to determine the incidence of symptomatic and silent AD. Past history and knowledge of AD were correlated to participants' experience of AD in the clinical setting.

Outcome Measures: Change in diastolic and systolic blood pressure is the primary outcome data that will be compared to AD history and data from each participant's questionnaire.

Results: Twelve of the 13 men experienced a rise in blood pressure consistent with AD (defined as an increase in blood pressure > 20 mmHg). Men with incomplete tetraplegia were able to identify symptoms associated with AD, and those with complete tetraplegia did not experience symptoms. Eleven of the 13 men knew that sexual activity could cause AD; however, only 2 of the 13 men acknowledged a history of AD with sexual activity and/or ejaculation.

Conclusions: Symptomatic and silent AD occur frequently during sperm retrieval in men with SCI above T6. Knowledge and past history of AD are not accurate indicators of who will experience AD with sexual activity and/or ejaculation.

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Key Words: Autonomic dysreflexia; Sexuality; Spinal cord injuries; Tetraplegia; Infertility; Blood pressure; Ejaculation; Sperm retrieval

INTRODUCTION

Autonomic dysreflexia (AD) is an important and potentially life-threatening complication of spinal cord injury (SCI). Persons who have sustained a SCI at thoracic level T6 or above are at risk for development of this condition. AD occurs when intact afferent nerves carry signals from

noxious and nonnoxious stimuli below the level of the lesion to the spinal cord, stimulating the sympathetic nerves and resulting in the release of norepinephrine, dopamine-beta-hydroxylase, and dopamine. The resultant increase in blood pressure is detected by using the intact carotid and aortic baroreceptors, but compensatory responses are inadequate because descending inhibitory control is blocked by the SCI. The signs and symptoms experienced during AD are a result of this faulty feedback loop and include headache, bradycardia, cardiac arrhythmias, sweating, piloerection, flushing, visual changes, nasal congestion, and feelings of apprehension (1). These symptoms can have a significant

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impact on quality of life and, in their most severe form, can be life-threatening due to the risk of stroke (2,3).

A long history of interest and research into AD exists, stemming back to Guttman in 1947. His work with Whitteridge (4) began to explain the mechanism behind AD. Since then, research has focused on both the causes and mechanisms of cardiovascular changes after SCI in both human and animal studies (5–9). Bladder and bowel distension are the most common triggers of AD and have received the most research and clinical attention (10–13). Table 1 outlines the possible triggers of AD as identified in the Consortium for Spinal Cord Medicine Clinical Practice Guidelines (1). Another area of AD research has focused on silent AD, which involves a substantial rise in blood pressure without concomitant symptoms. Silent AD has been reported with bladder and bowel incidents (10,11); however, there are no data available on the incidence of silent AD relating to ejaculation or sexual activity.

Research specific to AD associated with sexual activity or sperm retrieval procedures such as vibrostimulation (VS) and electroejaculation is limited. Scheutzow and Bockenek (14) reported on a case study of a man with SCI who experienced AD with subsequent atrial fibrillation as a result of electroejaculation. McBride et al (15) reported on the case of a man whose blood pressure tripled during sexual stimulation: blood pressure readings as high as 325/210 mmHg were recorded. This man chose to cease sexual activity in response to the high blood pressures and symptoms he was experiencing. Elliott and Krassioukov (16) reported 3 cases of men with atypical AD and referred to these cases of prolonged and severe episodes as malignant AD. These 3 men with SCI experienced severe AD with sexual activity, followed by weeks of AD that continued to return each time the men would experience a previously benign provocation such as voiding.

Sexuality encompasses all the feelings, attitudes, and behaviors that contribute to a person's own sense of manhood or womanhood (17). Anderson (18) highlights

the importance of sexual activity as a priority for men and women after SCI. Her study showed sexual function as the number-one priority for individuals with paraplegia and the number-two priority for individuals with tetraplegia. Other previous studies are congruent with these findings and continually stress the importance of sexual adjustment after SCI (19–21). Clinically, we have encountered many persons with SCI who were experiencing AD with sexual activity, and this was impacting their sexual adjustment. As clinicians, we found it difficult to provide accurate information to clients as to the risks of AD with sexual activity due to the lack of research. This concern was the driving force behind a number of research initiatives focused on investigating the incidence, signs, and symptoms of AD with sexual activity.

The first step in our research initiative was to ascertain the incidence of AD for men undergoing VS procedures for fertility purposes. The Vancouver Sperm Retrieval Clinic, a clinic within the Sexual Health Rehabilitation Service located at the British Columbia Centre for Sexual Medicine at Vancouver General Hospital, is a comprehensive program that addresses the fertility concerns of men with SCI and their partners. A chart review of all VS procedures that were conducted at the clinic from 1987 through 2002 revealed that the prevalence of AD with VS was significant. The analysis included 144 men with a total of 296 VS procedures. In 195 of the 296 procedures (65.9%), the men did experience AD. Of those 195 procedures, 122 (62.9%) were classified as silent AD (Elliott S, McBride K, Ekland M, Krassioukov A. [unpublished manuscript]). These results indicate that AD is a significant risk for men who undergo VS for the purposes of ejaculation. Further research is clearly warranted to better understand the cardiovascular response of men experiencing ejaculation after SCI.

The purpose of this study was to assess the cardiovascular response (beat-to-beat blood pressure and heart rate) and subjective experience of AD of 13 men undergoing VS (or self-stimulation) to the point of

Table 1. Potential Triggers for AD*

System	Potential Triggers
Urological	Bladder distension, kidney stones, blocked catheter or tubing, urological procedures, urinary tract infection, detrusor sphincter dyssynergia
Gastrointestinal	Appendicitis, bowel distension, bowel impaction, hemorrhoids, ulcers, gallstones, gastrointestinal instrumentation
Integumentary	Constrictive clothing, contact with sharp objects, blisters, burns, frostbite, insect bites, ingrown toenails, pressure ulcers
Reproductive	Sexual intercourse, sexually transmitted infections, ejaculation, epididymitis, scrotal compression, electroejaculation, VS, menstruation, pregnancy (labor and delivery), vaginitis
Other	Boosting, deep vein thrombosis, excessive alcohol consumption, excessive caffeine intake, fractures or other trauma, functional electrical stimulation, heterotopic bone, over-the-counter or prescribed stimulants, pulmonary emboli, substance abuse, surgical or invasive procedures.

*Consortium for Spinal Cord Medicine Clinical Practice Guidelines (1).

ejaculation and to categorize results into AD, silent AD, or no AD. These classifications were then compared with each subject's knowledge and history of AD with sexual activity. We felt these findings would have implications for health care providers and provide directions for future research.

METHODS

The initial study had two parts: subjects underwent VS to ejaculation on and off sildenafil citrate to see the effect of the latter on cardiovascular parameters. This paper focuses on the blood pressure changes during the unmedicated VS trials (without sildenafil citrate). Sheel et al (22) reported on the full cardiovascular results of the initial study, and further details of the study methodology can be found in their report.

Subjects

This research was approved by the Clinical Research Ethics Board at the University of British Columbia and by the Research Committee at Vancouver General Hospital. All subjects were required to sign informed consent. Inclusion criteria stipulated that all subjects had to have sustained an SCI of at least 1-year's duration, to have experienced ejaculation since injury, and to be able to speak English. Exclusion criteria included symptomatic cardiovascular disease, unstable medical or psychiatric conditions, and any contraindications to the use of sildenafil citrate (eg, retinitis pigmentosa, concomitant use of nitrate medication). Sixteen subjects signed informed consent, 2 subjects voluntarily discontinued participation, and 1 subject did not complete the study protocol.

Study Design

This neurophysiologic study of AD involved provoking ejaculation by using VS or self-stimulation. The initial study design was an unblinded, crossover design in which each subject served as his own control. A medical history was completed on all subjects, which focused on past sexual experience, sexual experience after injury, and experience with AD. Subjects also completed a written questionnaire that assessed their past experience, history, and knowledge of AD (23). Subjects with limited hand function who were not able to complete the questionnaire independently were assisted by a sexual health clinician who helped record the answers. Subjects were allowed to ask questions if they were unclear on the question, information was provided to clarify the intent of the question, and subjects were encouraged to complete the entire questionnaire. One physician did all the neurological testing to determine level and completeness of SCI as per the American Spinal Injury Association (ASIA) standards (24).

Ejaculation was provoked in all subjects using either the Ferticare (Multicept, Gorlose, Denmark) or Wahl (Wahl Clipper Corporation World Headquarters, Sterling,

IL) vibrators, or subjects self-stimulated to the point of ejaculation. Beat-to-beat blood pressure and heart rate were measured before, during, and after ejaculation. All subjects were questioned during and after the trial as to whether they were experiencing any unusual signs (subjective symptoms) indicative of AD. The principle investigator and study staff noted any objective signs of AD in the study subject during the trial. All subjective and objective signs and symptoms were recorded. After the trial was completed, the principle investigator and 2 sexual health clinicians reviewed results from all trials, and those subjects whose blood pressure increased by more than 20 mmHg were classified as AD, silent AD, or no AD, depending upon subjective signs. Silent AD referred to those subjects whose blood pressure increased by at least 20 mmHg, but who did not experience any subjective symptoms indicative of AD (10,11), even when the clinician or principal investigator noted an objective sign of AD (ie, the subject had to be aware of the symptom to be classified as AD).

RESULTS

Table 2 reviews the subjects' demographics, level of injury, and ASIA score. A total of 13 subjects completed the unmedicated (ie, no sildenafil citrate) VS procedures to the point of ejaculation. Table 3 reports on the change in heart rate and systolic and diastolic blood pressure and classifies each subject trial as AD, silent AD, or no AD, according to the criteria outlined above. Maximum blood pressures were recorded. In 6 subjects, systolic blood pressure rose higher than 200 mmHg; of the other subjects, 1 subject's systolic blood pressure rose higher than 170 mmHg, and 1 subject's systolic blood pressure rose higher than 150 mmHg. Table 4 summarizes the key findings related to knowledge about AD and past experience with AD according to injury classifications and relates this to the subjects' AD classification from the study.

DISCUSSION

This study builds on the cardiovascular results reported in the study by Sheel et al, (22) with further evaluation of subjective symptoms experienced by the subjects and then classifying each subject trial as silent AD, AD, or no AD. Table 3 also identifies whether each subject had a history of AD and a history of AD with sexual activity. Only 5 men, all with incomplete tetraplegia, experienced subjective symptoms of AD. Of the remaining 8 subjects, the majority (7 men) experienced silent AD. All 3 subjects with complete quadriplegia experienced silent AD. In fact, subject F experienced a peak blood pressure of 229/139 mmHg and still did not experience any subjective symptoms of AD. Subject M, with a T6 ASIA A injury, did experience a 21-mmHg increase in his systolic blood pressure, but he did not experience any symptoms of AD and was thus classified as silent AD. Most men with SCI experience a drop in heart rate with AD. However, Subject

Table 2. Client Demographics

Subject	Level of Injury	ASIA Score	Time Since Injury (m)	Cause Of Injury	Age (y)	Height (cm)	Weight (kg)	BMI†
A	C4	B	65	Other	29	160	84	32.8
B	C5	C	115	Sport	29	157	67	27.2
C	C4	B	285	Sport	44	172	64	21.6
D	C5	B	49	Other	24	159	77	30.5
E	C4	B	73	MVC*	26	161	62	23.9
F	C7	A	110	Sport	34	160	67	26.2
G	C2	A	187	MVC	34	161	91	35.1
H	C4	A	194	Sport	35	161	77	29.7
I	T5	A	191	MVC	37	157	82	33.3
J	T4	A	47	Sport	28	161	82	31.6
K	T5	C	239	MVC	45	157	80	32.5
L	T3	A	99	Other	34	166	68	24.7
M	T6	A	257	Sport	32	161	70	27.0

*MVC = motor vehicle crash.

†BMI = body mass index.

M's heart rate increased, and that combined with the level of injury may be indicative of a normal cardiovascular response to ejaculation (as in the able-bodied) vs silent AD. These results indicate that those subjects with complete injuries may not experience the symptoms of AD and, thus, be unaware of the risks of silent AD.

The second objective of this study was to look at the subjects' AD classification and compare this to their past knowledge and history of AD. Table 4 summarizes some key data on AD history and knowledge, and Table 3 provides methods to compare their AD history and knowledge to what happened in the laboratory setting. All subjects had general knowledge about AD, and most of them knew that sexual activity could cause AD. Only 2 of the subjects, both with incomplete tetraplegia, identified that sexual activity was a trigger of AD for them. Both of

these subjects did experience symptomatic AD during the trial, and their blood pressure results corroborate their past history of AD with sexual activity and ejaculation.

All of the subjects with complete tetraplegia denied a history of AD with sexual activity, and they all experienced silent AD in the study. Because these subjects were not experiencing any symptoms of AD (silent AD), it is understandable they were not aware of their significant blood pressure increases during private sexual activity and ejaculation.

These results indicate that past knowledge and experience with AD are not good predictors of who will experience AD and the associated risks with sexual activity. This has implications for clinicians counseling their clients with SCI. All men with SCI at risk for AD need to be informed of the potential for AD and silent AD with

Table 3. Change in Cardiovascular Parameters and AD Classification

Subject	Injury Level	ASIA Score	HR* Change (bpm)	Max. SBP† (mmHg)	SBP Change (mmHg)	Max. DBP (mmHg)	DBP‡ Change (mmHg)	AD Class	History of AD	History of AD with Sexual Activity?
A	C4	B	-18	125	47	62	17	AD	Yes	Yes
B	C5	C	-13	214	117	136	72	AD	Yes	Yes
C	C4	B	12	225	165	180	140	AD	Yes	No
D	C5	B	18	224	124	96	55	AD	Yes	No
E	C4	B	5	207	93	152	78	AD	Yes	No
F	C7	A	4	229	153	139	75	Silent	Yes	No
G	C2	A	-41	167	48	141	56	Silent	Yes	No
H	C4	A	-28	149	75	137	74	Silent	Yes	No
I	T5	A	0	147	43	97	42	Silent	Yes	No
J	T4	A	2	221	83	125	52	Silent	Yes	No
K	T5	C	37	170	33	121	39	Silent	No	No
L	T3	A	12	114	4	86	3	No AD	Yes	No
M	T6	A	15	133	21	91	-9	Silent	No	No

*HR = heart rate.

†SBP = systolic blood pressure.

‡DBP = diastolic blood pressure.

Table 4. AD Knowledge and History Summary

Level and Type of Injury	Number of Subjects in Group	AD Classification with Ejaculation	Knowledge of AD	History of AD	Are You Aware That Sexual Activity Can Cause AD?	Do You Experience AD with Sexual Activity?
Cervical incomplete	5	AD	100%	100%	80%	40%
Cervical complete	3	Silent AD	100%	100%	100%	0%
Thoracic complete	4	Silent AD/AD	100%	75%	80%	0%
Thoracic incomplete	1	Silent AD	100%	100%	100%	0%

ejaculation. Specific education about silent AD and ejaculation should be emphasized for those men with complete tetraplegia, because our results indicate they may be at increased risk for silent AD.

In able-bodied individuals, it is well established that even small elevations above optimal blood pressure values (<120/80 mmHg) increase the likelihood of developing hypertension (blood pressure $\geq$ 140/90 mmHg) and incurring target organ damage (25). Although the resting arterial blood pressure in individuals with SCI is predominantly low, the frequent and asymptomatic hypertensive episodes associated with AD could lead to the changes that are commonly observed in individuals with hypertension: high plasma fibrinogen levels, platelet dysfunction, and endothelial dysfunction, which could contribute to atherogenesis (26). The combination of episodic hypertension (systolic blood pressure >200 mmHg) and factors contributing to the endothelial damage may act synergistically to increase atherogenesis and may explain the high risk of atherosclerotic vascular disease in individuals with SCI (27,28).

This research has two key limitations. First, the results of this research are not directly generalizable to the sexual experience of men with SCI at home because the experience of sexual arousal either with self- or partner-stimulation is different from that used in our lab setting. Our laboratory design cannot mimic sexual arousal at home, which may include varying types of stimulation for longer or shorter periods than were tested in our clinical setting. Our clinical experience suggests the longer the stimulation, the more severe the signs and symptoms of AD. Future research will need to explore this and look at the cardiovascular response of men during sexual stimulation in a more private setting.

The second limitation of this study is that subjects were simply questioned whether they experienced any sensations or symptoms that were out of the norm. Because some of the symptoms of AD are very subtle, the development of a more sensitive objective and subjective questionnaire to accurately distinguish the symptoms of AD is needed. Objective signs would include those noted by the study staff (eg, flushing, piloerection). Subjective symptoms would include those identified by the subject. The purpose of questioning subjects would be to explore whether the subject is aware of observable signs noted by an observer and whether more subtle subjective symp-

toms would be recognized if specifically asked about. This information would have important teaching implications for counseling clients about AD and sexual activity. Subjects (or their sexual partners) could be taught to monitor for the more subtle objective symptoms of AD (piloerection, flushing) and therefore be able to better manage the risk of AD.

CONCLUSIONS

Our research results and clinical experience indicate that there is a significant risk of AD and silent AD when men experience ejaculation after SCI. Knowledge about AD and past history of AD with sexual activity and ejaculation are not accurate indicators of who will actually experience AD with ejaculation. There are two major clinical implications of this research: counseling clients at risk of AD with sexual activity and ejaculation and implications for fertility clinics.

Sexuality is a difficult and sensitive topic, and clients may not feel comfortable raising concerns with their health care providers, therefore clinicians must be comfortable and have the skills to discuss the topic (29). The skilled clinician who is comfortable with the topic of sexuality will be able to explore the client's sexual experience and help identify whether AD is a concern. Men must be made aware that sexual activity and ejaculation may trigger AD. Manual stimulation (by hand or assistive devices), oral stimulation, intercourse, anal stimulation or penetration, ejaculation, and orgasm may all be potential triggers for AD.

Clients who experience AD with sexual activity will require information and support as to how to manage this phenomenon. As discussed earlier, sexual rehabilitation is a priority for many men after SCI, and those who experience AD with sexual activity may find this deters them from entering into or having a satisfying sexual experience (16). Changing position during sexual activity (including raising the head up), shortening or changing the type of sexual stimulation, or emptying the bladder prior to sexual activity may help in reducing the incidence or severity of AD. A client's susceptibility to AD with sexual activity may also vary from day to day based on the existence of any other possible triggers. For example, if a client has a urinary tract infection, he may be more susceptible to experiencing AD with sexual activity. Clients who are using a phosphodiesterase

Figure 1. Management of AD associated with sexual activity/ejaculation.

inhibitor for erection enhancement should also consider the impact of AD. If AD with sexual activity is not resolved and requires medication, nitropaste may be suggested, which is contraindicated with phosphodiesterase (PDE) type 5 use. There is a risk of AD regardless of the method of erection enhancement. Any suggestions made to prevent or manage AD with sexual activity must be balanced with as little interference as possible with the client's sexual experience and overall satisfaction. Clients may not be able to prevent AD with sexual activity, but they can learn how to understand their body's response to AD and learn how to manage and minimize negative consequences. We have developed a simple algorithm (Figure 1) to help guide management of AD with sexual activity. Although this algorithm has not undergone formal testing, we have found it a useful tool to guide clinical practice and client education. This algorithm is only useful for those men who are experiencing symptomatic AD. Men experiencing silent AD may need to take their blood pressure to identify when they are experiencing AD. This group could then follow the algorithm in the same manner.

The second clinical implication of our research involves the need for medical assessment prior to the use of VS, which is known to be an effective technique for sperm retrieval for clients with injuries above T10 (30).

Clients wishing to learn this technique for fertility purposes should be assessed to determine whether they are at risk for AD. The availability of the Internet makes it easy for clients to learn about this technique and access vibrators, and some clients may be tempted to try learning this method on their own. The risk of AD with VS is significant; therefore, all men wishing to learn VS should be introduced to this technique in a controlled setting. Risk for AD can then be assessed, and those clients who do experience symptomatic AD or silent AD can be taught appropriate management techniques.

Changing position or altering the stimulation type may reduce AD severity, but some clients will experience AD regardless of behavioral changes to sexual activity. Clients who experience AD with ejaculation may need to consider the use of prophylactic medication in order to dampen the severity of blood pressure rise or modify the symptoms of AD. The use of medication such as nifedipine or captopril has been discussed as a treatment for acute AD (31–33). Future research from our laboratory will explore a prophylactic antihypertensive that may be helpful in managing AD associated with ejaculation.

Our research has provided new insights into the cardiovascular response of men undergoing VS and self-stimulation for ejaculation. Further education and attention to AD and sexual activity need to be addressed

during the initial rehabilitation phase. Men who are experiencing AD with sexual activity and/or ejaculation will require careful assessment and education so that they may be able to manage their AD without impeding their sexual adjustment.

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