

ORIGINAL ARTICLE

Semen quality in ejaculates produced by masturbation in men with spinal cord injury

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Study design: Retrospective study.

Objectives: Most men with spinal cord injury (SCI) are anejaculatory. Much has been reported about their semen quality collected by penile vibratory stimulation (PVS) and electroejaculation (EEJ). What is not well-described is the nature of semen quality in SCI patients who can ejaculate by masturbation. This study was performed to understand the degree to which their semen quality differed from that of anejaculatory SCI patients versus that of healthy non-SCI control subjects.

Setting: University of Miami.

Methods: Retrospective chart review of Male Fertility Research Program participants from 1991 to 2011.

Results: Of 528 SCI subjects, 444 met inclusion criteria of completing an algorithm in which ejaculation occurred by masturbation ($n=43$), PVS ($n=243$), or EEJ ($n=158$). Sperm motility was higher in the SCI-masturbation group (36.9%) than the PVS group (25.9%, $P<0.001$) or EEJ group (15.0%, $P<0.001$), but lower compared with a control group of 61 non-SCI healthy men who collected their semen by masturbation (58.0%, $P<0.001$). The SCI-masturbation group had similar antegrade sperm concentration ($83.3 \times 10^6 \text{ cc}^{-1}$) as the PVS group ($77.4 \times 10^6 \text{ cc}^{-1}$) and control group ($82.0 \times 10^6 \text{ cc}^{-1}$), but higher than the EEJ group ($49.8 \times 10^6 \text{ cc}^{-1}$, $P<0.001$). The SCI-masturbation group had significantly more men with incomplete injuries (84%) than the PVS group (54%, $P<0.01$) or EEJ group (41%, $P<0.001$).

Conclusion: This is the first report focusing on semen quality obtained by masturbation in men with SCI. Sperm motility was higher in men with SCI who could, versus could not, ejaculate by masturbation. Completeness of injury may contribute to this difference.

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INTRODUCTION

Spinal cord injury (SCI) results most often from traumatic events such as motor vehicle accidents, gunshot wounds, falls and sports-related accidents.¹ Young men comprise the majority of new SCI cases.¹ Similar statistics are found in countries worldwide.^{2–4} Infertility is a sequella of SCI in men.⁵ The majority of men with SCI are anejaculatory and require penile vibratory stimulation (PVS) or electroejaculation (EEJ) to retrieve their semen.⁵ Much has been reported about semen quality obtained by PVS and EEJ;⁵ however, the features of semen quality obtained by masturbation in men with SCI have not been well-described. Contributing to this lack of information is that few men with SCI can achieve ejaculation via masturbation.

After 20 years of studying semen quality in 528 men with SCI, our research program has accumulated data on 43 men with SCI who could achieve ejaculation via masturbation. The goal of the present study was to characterize semen quality in these men. We further compared the ejaculates of these men to ejaculates of healthy, non-SCI men, as well as to SCI men who could not achieve ejaculation via masturbation.

MATERIALS AND METHODS

Patients

We retrospectively reviewed our database of 528 men with SCI who participated in the Male Fertility Research Program of the Miami Project to Cure Paralysis between 1991 and 2011. All men were in good general health and had no known causes of infertility other than SCI. Men in the control group were non-SCI, healthy men with no history of infertility. All participants signed an informed consent before entry into the study.

Sperm collection

In the control group, semen was collected by masturbation. In the group of men with SCI, semen was collected according to our sperm retrieval algorithm, which has been previously published.⁶ Each SCI subject was assigned to a group based on his ability to ejaculate. If he could ejaculate by masturbation, he was assigned to the SCI-masturbation group. If he could not ejaculate by masturbation, but could ejaculate by PVS, he was assigned to the PVS group. If he could not ejaculate by masturbation or PVS, but could ejaculate with EEJ, he was assigned to the EEJ group. Each man was assigned to only one group. If a subject was unresponsive to masturbation, PVS and EEJ, he was excluded from further analysis.

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Semen analysis

Only antegrade specimens, that is, no retrograde specimens, were analyzed in this study, because of the variability in sperm motility introduced by the bladder contents.⁷ Antegrade specimens were allowed to liquefy for 20 to 30 minutes at room temperature. Semen volume, sperm concentration and sperm motility were determined according to WHO criteria⁸ using manual microscopy.

Data collection and statistical analysis

For all men with SCI, demographic information was collected and included level and completeness of injury as assessed by standard methods,⁹ age, years post injury and cause of injury. The following variables were collected for all SCI and control subjects: antegrade semen volume (cc), sperm concentration (millions of sperm per cc ejaculate), and sperm motility (percent of sperm with forward progression).

Statistical analysis was performed using SPSS 18 for Windows (SPSS Inc., Chicago, IL, USA). For each subject, data from multiple ejaculation trials were averaged. Means were calculated \pm s.e.m. The Mann–Whitney *U*-test was used

to compare continuous variables including age, years post injury, semen volume, sperm concentration and sperm motility. Chi-square tests were used to analyze nominal data including level of injury and completeness of injury. Statistical significance was considered at $P < 0.05$.

Statement of ethics

We certify that all applicable institutional regulations concerning the ethical use of human volunteers were followed during the course of this research.

RESULTS

Of the 528 men analyzed, 444 men met the inclusion criteria for this study. The 84 men who were excluded from the study were those who did not return for PVS after failing masturbation, or those who did not return for EEJ or did not complete EEJ, after failing masturbation and PVS. Demographic data for SCI subjects are shown in Table 1. There was no significant difference in the mean age or mean years post injury between groups.

Table 1 Demographic information for SCI subjects

	All SCI subjects n = 444	MAS n = 43	PVS n = 243	EEJ n = 158
Mean years of age (range)	34.4 \pm 0.4 (17.5–63.6)	35.5 \pm 1.1 (23.0–51.5)	33.7 \pm 0.5 (17.5–61.0)	35.2 \pm 0.6 (19.5–63.6)
Mean years post injury (range)	10.4 \pm 0.4 (0.1–44.6)	9.6 \pm 1.0 (0.4–26.0)	10.7 \pm 0.5 (0.7–38.0)	10.2 \pm 0.6 (0.1–44.6)
<i>Level of injury</i>				
Cervical	176 (40%)	18 (44%)	123 (51%)	35 (22%)
T1–T10	193 (44%)	17 (41%)	106 (44%)	70 (45%)
T11-caudal	70 (16%)	6 (15%)	13 (5%)	51 (33%)
<i>Completeness of injury</i>				
Complete	115 (48%)	4 (16%)	59 (46%)	52 (59%)
Incomplete	126 (52%)	21 (84%)	69 (54%)	36 (41%)
<i>Cause of injury</i>				
MVA	207 (47%)	21 (49%)	108 (45%)	78 (50%)
Violence	90 (20%)	6 (14%)	49 (20%)	35 (22%)
Fall	50 (11%)	5 (12%)	25 (10%)	20 (13%)
Sports	26 (6%)	1 (2%)	17 (7%)	8 (5%)
Diving	47 (11%)	4 (9%)	36 (15%)	7 (4%)
Nontraumatic	14 (3%)	3 (7%)	3 (1%)	8 (5%)
Other/Unknown	10 (2%)	3 (7%)	5 (2%)	2 (1%)
Total trials per group	2520	138	1,520	862
Mean trials per patient	5.7 \pm 0.4	3.2 \pm 0.8	6.3 \pm 0.6	5.5 \pm 0.5
Range	1–97	1–32	1–97	1–38
Median	3	2	3	3
Mode	1	1	1	1
<i>P-values</i>				
	MAS versus PVS	MAS versus EEJ	PVS versus EEJ	
Years of age	0.198	0.779		0.098
Years post injury	0.556	0.988		0.365
Level of injury	0.088	<0.01		<0.001
Completeness of injury	<0.01	<0.001		0.072

Abbreviations: EEJ, SCI electroejaculation group; MAS, SCI-masturbation group; MVA, motor vehicle accident; PVS, SCI penile vibratory stimulation group; SCI, spinal cord injured. Means are expressed \pm s.e.m.

For level of injury, completeness of injury and cause of injury, the number of subjects is provided, and the percent of subjects is shown in parentheses.

Differences between groups in years of age were assessed using the Mann–Whitney *U*-test.

Differences between groups in years post injury were assessed using the Mann–Whitney *U*-test.

Differences between groups in level of injury were assessed using the Chi-Square test.

Differences between groups in completeness of injury were assessed using the Chi-Square test.

$P \leq 0.05$ was considered statistically significant.

The level of injury and completeness of injury were unknown in 1% and 52% of patients, respectively. When comparing patients for whom the level of injury was known, the SCI-masturbation group had significantly more men with cervical injuries than the EEJ group, but was not significantly different from the PVS group. In patients for whom completeness of injury was known, the SCI-masturbation group had significantly more men with incomplete injuries compared with the PVS group and the EEJ group (Table 1). There were no significant differences between the PVS and EEJ groups with respect to completeness of injury. Table 1 shows the total number of ejaculation trials per group. Some patients had a large number of trials because they participated in several research studies performed by our group.

Table 2 shows semen quality in all groups of subjects. In the SCI-masturbation group, the mean \pm s.e.m. semen volume was significantly higher than that of the EEJ group, and significantly lower than that of the control group. There was no statistically significant difference between the mean semen volume in the SCI-masturbation group and the PVS group.

The SCI-masturbation group had a higher mean sperm concentration than that of the EEJ group. There was no statistically significant difference in mean sperm concentration between the SCI-masturbation group and the PVS group or between the SCI-masturbation group and the control group.

The mean sperm motility was significantly higher in the SCI-masturbation group compared with both the PVS group and EEJ group. The mean sperm motility of the SCI-masturbation group, however, was significantly lower than that of the control group. Similar to previous reports,⁵ the mean sperm motility was significantly higher in the PVS group compared with the EEJ group.

The SCI-masturbation group had significantly higher mean total motile sperm count than the EEJ group, but significantly lower than the control group. There was no significant difference in mean total motile sperm count between the SCI-masturbation group and the PVS group.

Within the SCI-masturbation group, information regarding erectile dysfunction was collected from 43 men. Twenty-four men retained reflexogenic erection (56%), six retained psychogenic erection (14%), nine retained both types of erections (21%) and four had no erections (9%).

DISCUSSION

The majority of men with SCI cannot ejaculate by masturbation and require medical assistance for sperm retrieval. The methods of PVS and EEJ have been the primary methods of sperm retrieval in couples with SCI male partners undergoing assisted conception procedures.^{10,11} Previous studies have shown that sperm motility is better when collected by PVS versus EEJ in men with SCI.^{12,13} While the exact mechanism is unknown, it has been speculated that ejaculation by PVS is more physiologically normal than ejaculation by EEJ.⁷

Previous reports indicate that approximately 10% of men with SCI retain the ability to ejaculate by masturbation.^{14,15} In line with these reports, our study found that 8.1% (43 of 528 SCI subjects) retained this ability. The goal of the present study was to characterize semen quality in this subgroup of SCI subjects and compare it with semen quality of SCI subjects who could not ejaculate by masturbation. A secondary aim was to compare semen quality collected by masturbation in SCI subjects to that collected by masturbation in control subjects.

The present study found that men with SCI who were able to ejaculate by masturbation had significantly higher sperm motility than men with SCI who were not able to ejaculate by masturbation. However, semen collected by masturbation in SCI subjects had significantly lower sperm motility than semen collected by masturbation in control subjects.

Our finding of higher sperm motility in the SCI-masturbation group versus the PVS group differs from data we presented in 2000 in which there was no statistically significant difference in sperm motility between these two groups, that is, 29.0% versus 26.0%.⁷ We attribute this discrepancy to the low number of subjects ($n=15$) in the SCI-masturbation group of the previous study.

The findings of the present study raise questions as to why sperm motility was higher in the SCI-masturbation group compared with the PVS group. We hypothesize that the difference may be attributable to neurological differences between the groups, and not to the method of ejaculation itself. These differences in neurological injury may cause differing degrees of dysinnervation to the seminal vesicles and prostate glands, which may result in abnormal constituents to the seminal plasma that are toxic to sperm. In a previous case-control study of 500 men with SCI, completeness of injury was found to be a significant factor influencing semen quality.¹⁶ In our study, the SCI-masturbation group had a significantly higher percentage of men with

Table 2 Comparison of antegrade semen quality in SCI and control subjects

	MAS <i>n</i> = 43	PVS <i>n</i> = 243	EEJ <i>n</i> = 158	CON <i>n</i> = 61		
Mean semen volume (cc) (range)	2.2 \pm 0.2 (0.3–6.0)	1.9 \pm 0.1 (0.1–7.5)	1.2 \pm 0.1 (0.0–7.3)	3.0 \pm 0.2 (0.8–6.9)		
Mean sperm concentration ($\times 10^6$ cc ⁻¹) (range)	83.3 \pm 10.8 (0.1–279.4)	77.4 \pm 5.0 (0.0–354.3)	49.8 \pm 5.2 (0.0–460.3)	82.0 \pm 5.4 (6.1–219.4)		
Mean sperm motility (%) (range)	36.9 \pm 3.3 (0.0–79.0)	25.9 \pm 1.2 (0.0–69.0)	15.0 \pm 1.2 (0.0–64.0)	58.0 \pm 1.5 (16.0–78.0)		
Mean total motile sperm count ($\times 10^6$) (range)	67.7 \pm 11.7 (0.0–332.2)	56.0 \pm 5.8 (0.0–384.5)	15.1 \pm 2.7 (0.0–155.4)	135.7 \pm 10.4 (4.7–302.2)		
<i>P</i> -values	MAS versus PVS	MAS versus EEJ	MAS versus CON	PVS versus EEJ	PVS versus CON	EEJ versus CON
Semen volume	0.183	<0.001	<0.01	<0.001	<0.001	<0.001
Sperm concentration	0.410	<0.001	0.501	<0.001	0.049	<0.001
Sperm motility	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total motile sperm count	0.127	<0.001	<0.001	<0.001	<0.001	<0.001

Abbreviations: CON, non-SCI control group; EEJ, SCI electroejaculation group; MAS, SCI-masturbation group; PVS, SCI penile vibratory stimulation group; SCI, spinal cord injured.

Means are expressed \pm s.e.m.

Groups were compared using the Mann-Whitney *U*-test.

P \leq 0.05 was considered statistically significant.

incomplete injuries (84%) compared with the PVS group (54%). Incomplete injuries in the SCI-masturbation group were associated with better semen parameters, and therefore may be a significant factor affecting sperm quality in this population.

In a study of six non-SCI healthy men, no significant differences were found in semen quality obtained by masturbation versus PVS, indicating that the method of PVS does not lead to lower sperm motility.¹⁷ We performed our own comparison of PVS versus masturbation in the same group of SCI subjects ($n = 7$). Though our results may be limited due to a small sample size, we found no statistically significant difference in sperm motility between the two groups (data not shown), indicating that neurological status, rather than method of ejaculation, contributes to the difference. For example, all patients in this small sub-analysis could ejaculate by masturbation and PVS, while the PVS group of the present study could not ejaculate by masturbation and had significantly fewer men with incomplete injuries compared with the SCI-masturbation group.

It may be of interest to note that we routinely collect retrograde fractions on all SCI subjects at their initial visit. In our 20-year experience, we have found that retrograde fractions are uncommon with masturbation or with PVS, but fairly common with EEJ. When necessary, retrograde fractions can be a useful source of sperm for insemination procedures.^{10,11}

Our study is limited by a possible selection bias. The extent to which our study is representative of the general population of men with SCI is uncertain. It is possible that our sample size reflects a select group of men with SCI that are healthy and motivated to seek assistance with fertility at a university setting. However, our participants had demographic and clinical characteristics similar to those reported in other studies, and therefore may be representative of the general population of men with SCI. In addition, our study is also limited by the number of men with SCI where completeness of injury was unknown.

This is the first report to focus on semen quality obtained by masturbation in men with SCI. These men had higher sperm motility than men with SCI who could not ejaculate by masturbation, but lower sperm motility than healthy non-SCI control subjects. These differences may be attributable to the neurological completeness of injury. This study contributes significant new information to our understanding of semen quality in this small but important subgroup of SCI patients.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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