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·*Original Article*·

Semen parameters in men with spinal cord injury: changes and aetiology

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Abstract

Aim: To assess the changes in semen parameters in men with spinal cord injury (SCI) and the possible causes of these changes. **Methods:** The study included 45 subjects with SCI. Semen retrieval was done by masturbation (2), vigorous prostatic massage (n = 13), penile vibratory stimulation (n = 13) or electroejaculation (n = 17). **Results:** The semen of men with SCI showed normal volume (2.3 ± 1.9 mL) and sperm count (85.0 × 10^6 ± 83.8 × 10^6/mL) with decreased motility (11.6% ± 10.1%), vitality (18.5% ± 15.2%) and normal forms (17.5 ± 13.4%), and pus cells has been increased (6.0 × 10^6 ± 8.2 × 10^6/mL). Total (13.4 ± 9.9 *vs.* 7.1 ± 6.8) and progressive (4.4 ± 3.9 *vs.* 2.2 ± 2.1) motility were significantly higher in subjects with lower scrotal temperatures. There was no statistical significant difference between electroejaculation and penile vibratory stimulation groups as regards any of the semen parameters. Subjects' age, infrequent ejaculation, injury duration and hormonal profile showed no significant effect on semen parameters. **Conclusion:** The defining characteristics of the seminogram in men with SCI are normal volume and count with decreased sperm motility, vitality and normal forms, and the increased number of pus cells. The most acceptable cause of the deterioration of semen is elevated scrotal temperature. *(Asian J Androl 2007 Sep; 9: 684–689)*

Keywords: electroejaculation; infertility; penile vibratory stimulation; prostatic massage; semen; spinal cord injury

1 Introduction

Infertility affects more than 90% of men with spinal cord injury (SCI). According to the published literature, seminograms of men with SCI usually show normal semen volume, which is sometimes brown in color; a condition known as rusty pipe syndrome of unknown aetiology. Sperm count is usually consistent with that of the normal population. Sperm motility is markedly reduced, with decreased sperm vitality and leukocytospermia [1–3]. Abnormal sperm morphology is common in semen specimens of men with SCI with vacuolated heads being the most prominent morphological change [4].

Most men with SCI (85%–97%) permanently lose their ability to ejaculate, worsening their infertility problem. In these cases, different methods of assisted ejaculation

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(e.g. rectal probe electroejaculation [EEJ] and penile vibratory stimulation [PVS]) help in obtaining semen [5].

Several theories have been suggested to explain why poor semen quality might be found in men with SCI, including: (i) the electric current of EEJ [6]; (ii) elevated scrotal temperature found in men with SCI as a result of abnormal vasoregulatory mechanisms or sitting for long periods in a wheel chair [7]; (iii) stasis of semen because of infrequent ejaculation or anejaculation [8]; and (iv) hormonal disturbances in the form of low serum follicle stimulating hormone (FSH) and leutinizing hormone (LH) (but mean serum testosterone and prolactin are comparable with normospermic men) [9].

The aim of the present study is to evaluate the semen changes occurring in men with SCI and to assess the possible causes of these changes.

2 Subjects and methods

2.1 Subjects

The present study was carried out on 45 men with SCI. Subjects were recruited from the andrology outpatient clinic, Kasr ElEini, Cairo University (Cairo, Egypt), the ElWafaa and ElAmal Institute (Cairo, Egypt), the Military Center of Rehabilitation (Giza, Egypt) and the Adam International clinic (Giza, Egypt). The subjects had either complained of infertility or were presenting for premarital checkups.

All subjects in the present study were examined, and their full history was recorded. Testicular temperature was assessed while the subject was sitting in his wheel chair by placing a thermometer in the folded skin between the two testes for 3 min. Hormonal profile was also checked, including FSH, LH, prolactin and testosterone levels, using the IMMULITE system (Diagnostic Products Corporation, Bad Nauheim, Germany). The reference ranges for normal values were: for FSH, 1.5–14.0 IU/L; for LH, 0.8–7.6 IU/L; for prolactin, 8.7–58.9 nmol/L; and for testosterone, 9.0–55.2 nmol/L.

For semen retrieval, the subject was first asked about his ability to obtain semen by masturbation. In the cases where the subject was unable to ejaculate, prostatic massage (PM) was first tried [9]. If this failed, PVS was tried [10], and if this also unsuccessful, EEJ was finally used [11].

Semen was collected in a sterile cup and then analyzed [12]. Analysis was carried out in the Andrology Laboratories of the Kasr El Eini Hospital, the Cairo University and the Adam International Clinic.

The retrograde samples were obtained by catheterization after acquiring the semen samples using any of the abovementioned procedures. The native samples were analyzed for the presence of sperm and sperm motility and vitality.

The obtained semen was used for either diagnosis (evaluation of fertility potential) or therapy (artificial insemination, cryopreservation or intracytoplasmic sperm injection).

Penile vibratory stimulation was performed using a WAHL 2-speed massager (Model 4120-Type, USA), and EEJ was carried out using a Seager electrostimulator power unit (Model 14, USA). We changed EEJ probe size (a bigger size) and type (transverse or longitudinal) for subjects who did not initially respond to EEJ.

All procedures were thoroughly described to all subjects, including semen retrieval methods and intracorporal injection. Written consent was provided by the subject before any procedure.

To evaluate whether repeated ejaculation yields semen samples with better quality in men with SCI, 29 married subjects with primary infertility were offered the possibility of repeated trials of sperm retrieval for intrauterine insemination. Only 12 subjects agreed to participate in the repeated trials of retrieval of semen.

2.2 Statistical tests

Descriptive statistics are presented as mean ± SD, median, number and percentage (frequency distribution). The unpaired *t*-test (two-sided) was used for comparison between two groups. Analysis of variance and the post hoc test were used for comparison between more than two groups. Pearson's correlation was also used. A significance level of 0.05 is used throughout all statistical tests.

3 Results

The study was carried out on 45 subjects with mean age of 37.0 ± 8.7 years, of whom 29 complained of primary infertility, four complained of secondary infertility and 12 single subjects had presented for checkups regarding their potential fertility. The infertility duration ranged from 1 to 20 years, with a mean of 5.7 ± 4.2 years.

Psychogenic erection was preserved in 5 cases (11.1%), whereas reflexogenic erection was preserved in 29 cases (64.4%). Of cases, ten (22.2%) used intracorporal in-

jection of a vasoactive substance to attain and maintain erection and one had had an inflatable penile prosthesis implanted prior to the first visit. Of the 45 subjects, 43 complained of anejaculation (95.6%), and only 2 were able to ejaculate (4.4%).

Different semen retrieval methods were used with different success rates (two subjects with masturbation, 13 with PM, 13 with PVS and 17 with EEJ) (Table 1). Semen retrieval was repeated for some subjects, and the total number of successful semen retrieval trials using various semen retrieval methods was 66 (two masturbation, 17 PM, 17 PVS and 30 EEJ).

Figures of the antegrade and retrograde samples are illustrated in Table 2. The samples generally showed normal semen volume. Semen color was normal in 58 semen samples (87.9%) and brownish in eight (12.1%). Sperm count was normal, with low total and progressive motility and decreased sperm vitality, with a decreased percentage of normal forms. The increased percentage of pus cells was a constant finding in all antegrade samples. Retrograde ejaculate was examined in only 37 trials because in the rest of the trials post-ejaculation urine samples were difficult to obtain.

Subjects were subdivided according to the method of semen retrieval: EEJ group, PVS group and PM group. Table 3 illustrates the comparison of semen parameters

Table 1. Successful semen retrieval rate using different methods.

Method	Number of trials	Number of successful trials	Percentage
Masturbation	45	2	4.4
Prostatic massage	43	13	30.2
Penile vibratory stimulation	30	13	43.3
Electroejaculation	17	17	100.0

Table 2. Semen parameters of antegrade and retrograde portions.

	Antegrade portion (mean ± SD)	Retrograde portion (mean ± SD)
Volume (mL)	2.3 ± 1.8	38.4 ± 25.2
Count ($\times 10^6$/mL)	122.8 ± 122.3	28.2 ± 17.8
Total motility (%)	11.3 ± 9.1	8.5 ± 7.4
Progressive motiltiy (%)	4.0 ± 3.8	2.4 ± 2.2
Sluggish motility (%)	7.3 ± 6.1	6.1 ± 5.7
Vitality (%)	18.8 ± 15.7	
Pus cells ($\times 10^6$/mL)	6.0 ± 8.2	
Normal forms (%)	17.5 ± 13.4	

Table 3. Comparison of semen parameters (mean ± SD) between electroejaculation (EEJ), penile vibratory stimulation (PVS) and prostatic massage (PM) groups (using analysis of variance). $^bP < 0.05$.

	EEJ (n = 26)	PVS (n = 17)	PM (n = 14)	P value
Volume (mL)	2.7 ± 2.1	2.1 ± 1.4	1.7 ± 1.6	0.17
Count ($\times 10^6$/mL)	147.5 ± 138.9	116.7 ± 82.3	91.3 ± 26.7	0.32
Total motility (%)	13.5 ± 9.4	10.6 ± 8.9	6.9 ± 6.6	0.04^b
Progressive motiltiy (%)	5.1 ± 4.0	3.4 ± 3.3	2.1 ± 2.0	0.02^b
Sluggish motility (%)	8.4 ± 6.3	7.2 ± 6.5	4.9 ± 4.7	0.18
Vitality (%)	18.8 ± 13.7	22.7 ± 19.4	11.4 ± 9.4	0.03^b
Pus cells ($\times 10^6$/mL)	4.3 ± 3.3	6.3 ± 5.9	8.5 ± 8.1	0.25
Normal forms (%)	18.0 ± 9.3	15.7 ± 9.3	19.0 ± 21.8	0.31

between the three groups. The sperm total and progressive motility as well as sperm vitality were significantly higher in the EEJ group than in the PM group. Sperm vitality was also significantly higher in the PVS group than in the PM group. All other parameters showed no significant differences between the three groups.

Table 4 illustrates the correlation of the voltage used to retrieve semen by EEJ and semen parameters of obtained samples. We found that with increased voltage there was a significant increase in semen volume and there was a significant decrease in sperm total and progressive motility as well as sperm vitality and normal forms.

According to scrotal temperature, subjects were classified into those with scrotal temperature less than or equal to 35.5ºC and those with scrotal temperature above 35.5ºC. This cut-off value was chosen as 35.5ºC is the upper limit of normal scrotal temperature [13]. Semen parameters were compared between these two subgroups (Table 5). We found that with lower scrotal temperatures there were significantly better sperm totals and progressive motility.

Subjects were classified according to age: below and above 35 years. This cut-off value of 35 years was chosen on the basis that semen changes are reported in men after the age of 35 years [14]. We found no statistical significant difference in semen parameters between the two groups.

To determine whether infrequent ejaculation or anejaculation found in subjects with SCI effects semen parameters, 12 subjects were included in repeated trials of semen retrieval over different time intervals ranging from 1 day to 8 months. We found that there was no constant relationship between frequency of ejaculation and semen parameters in these subjects. Repeated ejaculation led to either an increase or a decrease or no change in count, motility or vitality of sperm.

The injury duration ranged from 6 months to 29 years, with a mean of 12.46 ± 9.39 years. When correlating injury duration with semen parameters obtained from the first trial of semen retrieval in the 45 subjects, we found positive correlation between injury duration and negative correlation with normal forms (P = 0.02), whereas all other correlations were insignificant.

Hormonal profile of subjects was normal. FSH ranged from 1.8 to 11.2 IU/L (mean ± SD, 4.9 ± 1.8 IU/L), LH ranged from 0.9 to 7.3 IU/L (mean ± SD, 4.8 ± 1.4 IU/L), testosterone ranged from 9.01 to 28.08 nmol/L (mean ± SD, 15.3 ± 4.9 nmol/L) and prolactin ranged from 9.7 to 48.5 nmol/L (mean ± SD, 26.7 ± 9.7 nmol/L). Scrotal temperature was mildly elevated, ranging from 35ºC to 37ºC (mean ± SD, 35.7 ± 0.6ºC).

Table 4. Correlation of voltage used for electroejaculation applied and semen parameters (n = 26). $^{b}P < 0.05$, $^{c}P < 0.01$.

	Voltage	
	Pearson correlation	P value
Volume (mL)	0.72	0.001[c]
Count (× 10^6/mL)	–0.11	0.6
Total motility (%)	–0.58	0.009[c]
Progressive motiltiy (%)	–0.51	0.02[b]
Sluggish motility (%)	–0.56	0.01[b]
Vitality (%)	–0.45	0.04[b]
Pus cells (× 10^6/mL)	0.21	0.4
Normal forms (%)	0.46	0.04[b]

4 Discussion

Table 5. Semen parameters (mean ± SD) in different scrotal temperature groups. $^{b}P < 0.05$.

	Temperature < 35.5ºC (n = 21)	Temperature > 35.5ºC (n = 24)
Volume (mL)	2.4 ± 1.9	1.8 ± 1.4
Count (× 10^6/mL)	111.9 ± 98.3	91.8 ± 89.3
Total motility (%)	13.4 ± 9.9	7.1 ± 6.8[b]
Progressive motiltiy (%)	4.4 ± 3.9	2.2 ± 2.1[b]
Sluggish motility (%)	9.1 ± 7.1	4.9 ± 4.7[b]
Vitality (%)	23.0 ± 20.2	14.0 ± 13.3
Pus cells (× 10^6/mL)	5.5 ± 4.3	6.6 ± 5.9
Normal forms (%)	20.6 ± 20.4	13.6 ± 7.4

It has been recognized for many years that the fertility prospects of young men suffering from SCI are severely compromised. There are two causative factors: loss of ejaculatory function, which occurs in between 85% and 97% of men after SCI, and reduced semen quality, which is a constant finding in men with SCI [2].

Several methods have been proposed to assist in retrieving semen from men with SCI. Such methods can be used with assisted reproductive techniques, to overcome infertility problems [15].

In the present study, the semen analysis of men with SCI showed normal semen volume and sperm count, with decreased sperm total and progressive motility and vitality, and an increased number of pus cells and a decreased percentage of normal forms. These semen changes do not differ from that described in the published literature [1–4].

Semen retrieval rates differ for each method. To our knowledge, there is no study describing the success rates of PM in men with SCI. However, two studies reported success rates of approximately 60% [9, 16] in patients with anejaculation due to other causes than SCI. These results are not consistent with those obtained in the present study (30.2%). This might be a result of the difference in the aetiology of anejaculation because all subjects included in the present study had SCI, whereas in the other studies anejaculation was caused by diabetes mellitus, retroperitoneal lymph node dissection, antihypertensives (iatrogenic) or psychogenic aetiology.

Reports on successful retrieval rates with PVS vary widely, ranging from 54.4% to 96%, with high amplitude stimulation undergoing PVS at home [10, 17]. Our result (43.3% success rate of PVS) is lower than that reported by previous authors, which might be attributed to the more relaxing atmosphere provided to the subject at home with the ability to repeat the PVS trial at different states of sexual excitation and at different intervals. In the present study, the PVS trials were only done at the hospital with no home therapy trials.

In the present work, EEJ was successful in obtaining semen samples in 100% of trials (n = 30), which represents the highest retrieval rate of all the methods used. In the published literature, successful semen retrieval rates in EEJ varies from 76% to 89% [18, 19]. Although these figures are high, they are still lower than ours. This might be because the EEJ technique was not still well established in the early 1990s, when these studies occurred. Nowadays we use the interrupted current method instead of the the continuous current previously used. In addition, we changed the EEJ probe size (a bigger size) and type (transverse or longitudinal) for subjects who did not respond initially to EEJ. This might also contribute to the high retrieval rate achieved in the present study.

The effect of the electric current of EEJ is a proposed cause for poor semen parameters in men with SCI. One study states that the total sperm count that they obtained by PVS was similar to that obtained by EEJ, with the mean concentration of sperm in antegrade fraction significantly higher in PVS than that in EEJ [20]. The authors also stated that the mean percent of motile sperm and the mean percent of sperm with rapid linear motion were significantly higher in the total ejaculate in samples obtained with PVS than in those obtained with EEJ and were even greater in the antegrade fraction. In contrast, another report stated that electrical stimulation during clinical rectal probe EEJ seemed to have no effect on sperm motility [21].

The results obtained in the present study were consistent with those of the later study as we found no statistical significant difference between the semen parameters obtained by PVS and EEJ. In fact, some semen parameters might be higher with EEJ than those with PVS (mean semen volume, mean sperm count, total and progressive motility in the antegrade fraction), although the differences were not significant.

In the present study, elevated scrotal temperature is reported to adversely affect total and progressive motility, which is also found in previous studies [7]. Other studies state that scrotal temperature has no effect on sperm motility or vitality [22].

Stasis of semen as a result of infrequent ejaculation might lead to the aging of spermatozoa and, therefore, lead to poor semen quality. However, in the present study, repeated ejaculation did not consistently lead to improvements in semen quality. This is also reported by Sønksen *et al.* [10], who find no significant changes in semen parameters between sequential semen samples in a one-year follow-up study. Another report recorded improvement in sperm motility with frequent ejaculation [8].

No direct relation has been shown between the numbers of leukocytes found in semen of subjects with SCI and reduced sperm motility. However, increased number of leukocytes might be a contributing factor to sperm abnormality because activated leukocytes are known to produce large amounts of reactive oxygen species [23]. This

postulation is supported by the results of the present study given the prevalence of leukocytospermia in nearly all subjects with repeated histories of urinary tract infection.

In the present study, the hypothalamic-pituitary-gonadal axis was proven to be competent in men with SCI. This contradicts what is reported by Brackett *et al.* [22], who found in their study that the mean serum FSH and LH levels were lower but that testosterone and prolactin were similar in men with SCI compared to men without SCI. Elliott *et al.* [24], in contrast, found no significant correlation between serum hormonal level and sperm motility or other semen changes found in subjects with SCI.

From our study, it can be concluded that the seminogram of men with SCI is characterized by normal volume and sperm count with decreased sperm total and forward motility, vitality and normal forms with increased leukocytic count. The aetiology of poor semen quality in these subjects is more likely multifactorial. Elevated scrotal temperature and leukocytospermia are the most acceptable but not the only causes for the deterioration of semen parameters. The electric current of EEJ was also found to have no delirious effect on semen quality.

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