Original Article

Reflexes and somatic responses as predictors of ejaculation by penile vibratory stimulation in men with spinal cord injury

VG Bird¹, NL Brackett^{*2}, CM Lynne¹, TC Aballa² and SM Ferrell²

¹Department of Urology, University of Miami School of Medicine, Miami, Florida, USA; ²The Miami Project to Cure Paralysis, University of Miami School of Medicine, Miami, Florida, USA

Study design: Retrospective chart review.

Objective: To identify factors in addition to level of injury (LOI) that may predict ejaculation by penile vibratory stimulation (PVS) in spinal cord injured males.

Setting: Major urban medical school and teaching hospital.

Materials and methods: Presence of a bulbocavernosus response (BCR) and a hip flexor response (HR) before PVS ($n = 123$ patients), and somatic responses during PVS ($n = 204$ trials performed on a subset of 44 patients) were evaluated for their frequency of occurrence on trials with and without ejaculation.

Results: Overall ejaculation success rates for cervical, T1–T6, and T7–T12 LOI were 71%, 73%, and 35%, respectively. Eighty per cent of patients who were positive for both BCR and HR ejaculated with PVS, while only 8% of patients who were negative for both BCR and HR ejaculated with PVS. For cervical injuries, BCR and HR were no more predictive of ejaculation by PVS than LOI alone. T1–T6 patients were more likely to ejaculate when at least one reflex was present. T7–T12 patients with no BCR were unlikely to ejaculate by PVS. Except for abdominal contractions, somatic responses were not present in the majority of PVS trials. When they were present, however, they occurred in a high percentage of ejaculation trials: withdrawal response (hip flexion, knee flexion and thigh adduction) (90%), piloerection (84%), extremity spasms (83%), thigh abduction (80%), and thigh adduction (72%).

Conclusion: We recommend that patients with cervical injuries initially undergo PVS. Patients with T1–T6 LOI with at least one reflex present, and patients with T7–T12 LOI with both reflexes, or only BCR present, may undergo PVS. Certain somatic/autonomic responses, when seen, may help in deciding whether to continue with a given trial, or give a repeat trial, of PVS.

Sponsorship: The Miami Project to Cure Paralysis and the State of Florida Specific Appropriations.

Spinal Cord (2001) 39, 514–519

Keywords: spinal cord injuries; ejaculation; infertility; paraplegia; vibrator; sperm

Introduction

Approximately 90% of men with spinal cord injury are unable to ejaculate during sexual intercourse and require medical assistance to produce a semen specimen.¹ Semen retrieval may be accomplished by rectal probe electroejaculation (EEJ),^{2,3} or by penile vibratory stimulation (PVS).^{4,5} Of these two methods, PVS has been recommended as first line treatment due to its safety, efficacy, and low investment of time and money.^{4,6} If PVS fails, patients may be referred for

EEJ, since success with EEJ does not rely on an intact ejaculatory reflex, as does PVS.

Reports of ejaculation success rates with PVS are varied,^{6–12} and are related to the amplitude of the vibratory stimulus and to the patient's level of injury.^{4,13} For example, in a recent report of a large series of patients, 49.8% overall could ejaculate with PVS. This rate increased to 65.6% when a high amplitude vibrator was used on patients with cervical injuries.⁴ Even with these indicators of success, however, ejaculation is not predictable with PVS. It is currently not possible to determine which patients will respond to PVS, or to determine which PVS trials

*Correspondence: NL Brackett, The Miami Project to Cure Paralysis, University of Miami School of Medicine, PO Box 016960, R-48, Miami, Florida, FL 33101, USA

will result in ejaculation, since a given patient's response to PVS is sometimes inconsistent.⁴ This adds a degree of uncertainty to decision making in algorithms using PVS. Specifically, the decision of which patients to select, how many trials to administer, or how many minutes per trial before considering the patient or the trial PVS a failure, is in question. More precise indicators are necessary to guide this decision making.

There were two goals of this study. First, to determine if the presence of specific reflexes could be useful in selecting candidates for PVS. Second, to determine if the presence or absence of certain somatic responses seen during PVS could predict ejaculation success or failure during any given PVS trial.

The reflexes examined in this study were the bulbocavernosus response (BCR) and the hip flexor response (HR). The BCR and the HR are indicative of intact spinal reflex arcs which are required for ejaculation. Vibratory induced ejaculation in men with SCI requires at least an intact S2–S4 spinal cord segment.¹⁴ The BCR, when present, measures the integrity of this segment.^{15,16} The HR is a pathological flexion reflex seen commonly in patients with SCI.¹⁷ In these patients, firmly stroking the sole of the foot (S1) and eliciting a hip flexion response (L2–L4) presumes the integrity of the spinal cord immediately superior to the S2–S4 segments.

The somatic responses recorded in this study were: abdominal contractions below the level of injury, thigh abduction, thigh adduction, lower extremity spasms, and a 'withdrawal response' (hip flexion accompanied by knee flexion and thigh abduction). In addition, the autonomic response of piloerection was also recorded. For the sake of brevity, these responses have been referred to collectively as 'somatic responses' throughout this paper. These responses were chosen based on our observation of the ejaculatory response of more than 300 men with SCI prior to this study. We observed the responses below the level of the injury of many patients when a vibrator was applied to the penis during the conduct of a PVS trial. Initially, the responses were accepted as part of the SCI condition, and were not consistently recorded. Increasingly, we noticed that these responses seemed to occur on PVS trials that resulted in ejaculation *versus* PVS trials that did not result in ejaculation, yet we could find no report on the significance of these responses in PVS trials of men with SCI. Our goal in this study was to determine if these somatic responses were, in fact, predictive of ejaculation with PVS in men with SCI.

Materials and methods

Inclusion criteria

The medical records of all spinal cord injured patients undergoing assisted ejaculation at our institution from 1995 to 1998 were reviewed. All patients who had undergone at least one trial of PVS were identified.

Only patients with traumatic spinal cord injury who had been injured for at least 2 years were included. The cause of the injury was: motor vehicle accident (47.9% of patients), gun shot wound (17.9%), falls (16.3%), sports (15.5%), other (2.4%). Patients who had a neurological impairment related to other factors such as cerebrovascular accident, multiple sclerosis, and excision of central nervous system neoplasms were excluded. A total of 123 patients met all of the necessary criteria and these patients were referred to as Group 1. The data from Group 1 included: age, time since spinal cord injury, level of injury, BCR response, HR response, and response to PVS.

In 1997, additional data collection was instituted at our center. One autonomic and five different somatic responses occurring below the level of injury were noted during each trial of PVS. For the sake of brevity, these responses have been referred to collectively as 'somatic responses' throughout this paper. The responses were: piloerection, abdominal contractions, thigh abductions, thigh adduction, lower extremity spasms, and a 'withdrawal response' (hip flexion accompanied by knee flexion and thigh abduction). A response was recorded as 'present' if two observers noted the response during the trial of PVS. These somatic response data were recorded during 204 trials from 44 consecutive patients who were a subset of Group 1. This subset of patients was called Group 2. Thus, in this study, the BCR and HR data were from a group of 123 patients, and the somatic response data were from a group of 44 patients.

Reflex testing

Patient's level and completeness of injury were assessed according to the University of Miami Neurospinal Index (UMNI).^{18,19} This index determines neurological sensory and motor level of injury in the same manner as the Standards for Neurological Classification recommended by the American Spinal Injuries Association (ASIA), ie, the neurological level of injury is assigned to the last level of normal function. The UMNI classifies complete/incomplete injury differently than the ASIA scale. With the UMNI, the injury is termed complete if there is no motor or sensory sparing below the zone of injury (three segments below the level of injury). With the ASIA scale, the injury is termed complete if no motor or sensory function is preserved in the sacral segments S4–S5. The BCR and HR were tested during each patient's initial visit. For this reflex testing, patients were placed supine with hips and lower extremities exposed. A BCR was considered positive if the bulbocavernosus muscles contracted (as detected by palpation of the bulbocavernosus muscles in the perineum) when the glans penis was squeezed. The HR was considered positive if contraction of the ipsilateral hip flexors was noted when a tongue depressor was scraped from heel to toe on the plantar

surface of the foot. Any such contraction, whether small or large, was considered a positive response.

PVS procedure

The PVS procedure used in this study has been previously described^{4,5} and is summarized here. Patients were transferred from their wheelchair to an exam table and placed in a reclining or supine position. Men with a history of autonomic dysreflexia were given between 10 and 40 mg nifedipine, sublingually. In patients with a history of retrograde ejaculation, the bladder was emptied by catheterization, and 25–50 cc of sperm washing medium was instilled in the bladder. All such patients were catheterized after the procedure, and the fluid obtained was analyzed for the presence of sperm. In most patients, a low amplitude vibrator (Oster Model 129-01A or Sunbeam model 1850) was tried first. If no ejaculation occurred after 5 min, stimulation was stopped for 1 min, then resumed for another 5 min. These steps were repeated until ejaculation occurred, no ejaculation occurred after 15 min of stimulation, or there was a medical reason to stop the procedure. If there was no ejaculation with a low amplitude vibrator, a high amplitude vibrator (FERTI CARE[®] clinic or FERTI CARE[®] personal, Multicept, Denmark) was tried on subsequent trials. If no antegrade or retrograde ejaculate was obtained, the trial was considered a failure. If a patient ejaculated on one or more trials of PVS, he was considered an ‘ejaculator’. During each procedure, blood pressure was continuously monitored with an automatic blood pressure cuff.

Data analysis

Differences in means were compared using analysis of variance. Differences in frequencies were compared using Chi Square.

Results

Age and years post injury

There were no statistically significant difference in the mean age or mean years post-injury between Group 1 and Group 2 (Table 1). A total of 717 PVS trials was administered to 123 patients in Group 1 (mean of

5.63 ± 0.66 trials per patient). Of these patients, 73 (59%) ejaculated at least once with PVS. There was no statistically significant difference in age or years post injury between ejaculators and non-ejaculators in Group 1 (Table 2).

Results of hip flexor response and bulbocavernosus response testing

Reflexes and ejaculation The most common reflex pattern was a positive BCR (BCR+) with a positive HR (HR+). Seventy-four out of 123 patients (60%) showed this pattern. This was followed in frequency by the patterns: negative BCR (BCR–) with a negative HR (HR–) = 21%; BCR+/HR– = 12%; and BCR–/HR+ = 7%. Table 3 shows the distribution of ejaculators and non-ejaculators in each reflex pattern. The highest success rates of ejaculation were seen when

Table 1 Age and time post-injury in group 1 versus group 2

	Group 1 (n = 123)	Group 2 (n = 44)
Mean age ± SEM (years)	33.3 ± 0.59	33.0 ± 1.04
Median age (years)	34.2	33.0
Age range (years)	17.4–48.2	17.3–48.0
Mean time post injury ± SEM (years)	10.0 ± 0.6	9.92 ± 0.96
Median years post injury	8.8	9.1
Range (years) post injury	2.0–28.8	2.17–28.8

SEM = standard error of the mean

Table 2 Comparison of ejaculators versus non-ejaculators in Group 1

	Ejaculators (n = 73)	Non-ejaculators (n = 50)
Mean age ± SEM (years)	32.8 ± 0.74	34.2 ± 0.96
Median age (years)	32.8	35.2
Age range (years)	17.4–48.0	20.0–48.2
Mean time post injury ± SEM (years)	10.3 ± 0.70	9.6 ± 0.90
Median years post injury	9.7	7.1
Range (years) post injury	2.1–28.8	2.0–24.6

SEM = standard error of the mean

Table 3 Distribution of ejaculators and non-ejaculators in each reflex group

	Number of ejaculators in each reflex group	Number of non-ejaculators in each reflex group	% of reflex group ejaculating
(BCR+)(HR+)	59	15	59/74 = 80%
(BCR–)(HR–)	2	24	2/26 = 8%
(BCR+)(HR–)	9	6	9/15 = 60%
(BCR–)(HR+)	3	5	3/8 = 40%

BCR+, Presence of a bulbocavernosus reflex; BCR–, Absence of a bulbocavernosus reflex; HR+, Presence of a hip flexor reflex; HR–, Absence of a hip flexor reflex

both reflexes were present, followed by presence of BCR only, then presence of HR only.

Level of injury and ejaculation We have previously shown that the success rate of ejaculation with PVS in men with SCI is related to the level of injury – the higher the level of injury, the higher the success rate of ejaculation.⁴ In the present study, we wished to understand if the predictive value of the HR, BCR, or somatic responses for ejaculation by PVS was any better than the level of injury alone. To determine the relative predictive strength of the level of injury *versus* reflexes, the two were combined in Table 4. The highest rates of ejaculation were obtained in subjects with both reflexes or with injuries above T6. Reflexes had the greatest predictive value in the T7–T12 group, with 12/18 (67%) ejaculating who had both reflexes, and only 1/19 (5%) ejaculating who did not have both reflexes. Below the cervical level, ejaculatory success was 0% (0/21) for those with neither reflex. All three patients with lumbar injuries had no reflexes and no ejaculation by PVS.

Results of somatic responses testing

Somatic responses and ejaculation The next analyses examined somatic responses as predictors of successful ejaculation trials. A total of 204 trials of PVS were administered to 44 patients (mean of 4.6 ± 0.59 trials per patient, range 1–16, median = 3). Out of 204 trials, 144 (70.6%) resulted in ejaculation. Somatic responses as a group, appeared significantly more often on ejaculatory trials *versus* non-ejaculatory trials (Table 5, $P=0.011$). Individual somatic responses, however, were differentially associated with ejaculation. For example, abdominal contractions appeared with a similar frequency on ejaculatory (97%) and non-ejaculatory trials (90%). Compared to abdominal contractions, piloerection, withdrawal response, and extremity spasms appeared with significantly higher frequency on ejaculatory trials *versus* non-ejaculatory

trials ($P=0.03$, $P=0.004$, $P=0.021$, respectively, Table 5). To evaluate the usefulness of a response for predicting ejaculation, its per cent frequency on ejaculation trials was divided by its per cent frequency on non-ejaculation trials. The resulting dividends were: withdrawal = 3.7, piloerection = 2.2, extremity spasms = 2.0, thigh abduction = 1.6, thigh adduction = 1.1, abdominal contractions = 1.1. To evaluate the usefulness of no response for predicting no ejaculation, the per cent frequency of no response on trials with no ejaculation was divided by the per cent frequency of no response on trials with ejaculation. The dividends were: abdominal contractions = 3.3, extremity spasms = 1.6, thigh abduction = 1.4, piloerection = 1.3, withdrawal = 1.3, thigh adduction = 1.0.

Somatic responses and level of injury Abdominal contractions appeared with similar frequencies on ejaculatory and non-ejaculatory trials at all levels of injury (Table 6). In contrast, other somatic responses were more predictive of ejaculation in patients with specific levels of injury. For example, piloerection was more associated with ejaculation in patients with

Table 5 Occurrence of somatic responses on ejaculation *versus* non-ejaculation trials

<i>Ejaculation</i>	<i>Yes</i>	<i>No</i>	<i>Total trials</i>
Total trials	144 71%	60 29%	204
Abdominal contractions	140 97%	54 90%	194
Piloerection	53 37%	10 17%	63
Withdrawal response	38 26%	4 7%	42
Extremity spasms	79 55%	16 27%	95
Thigh abduction	72 50%	18 30%	90
Thigh adduction	39 27%	15 25%	54

The number of trials in which a particular somatic response occurred is shown for trials that did (Yes) and did not (No) result in ejaculation. Numbers in boldface are the per cent of ejaculation trials in which each somatic response occurred (Yes column) and the per cent of non-ejaculation trials in which each somatic response occurred (No column)

Table 4 Ejaculation by level of injury and by reflex group

<i>Level of injury</i>	<i>% Ejaculating per LOI</i>	<i>% Ejaculating in each reflex group per level of injury</i>			
		<i>(BCR+)(HR+)</i>	<i>(BCR+)(HR–)</i>	<i>(BCR–)(HR+)</i>	<i>(BCR–)(HR–)</i>
Cervical	35/49 71	28/36 78	3/6 50	2/3 67	2/4 50
T1–T6	22/30 73	17/18 94	4/6 67	1/1 100	0/5 0
T7–T12	13/37 35	12/18 67	1/2 50	0/4 0	0/13 0
Lumbar	0/3 0	–	–	–	0/3 0

LOI = level of injury; T = thoracic. % Ejaculating per LOI calculation: Denominator = the number of subjects in each LOI. Numerator = the number ejaculating in each LOI. Per cent = the numerator divided by the denominator. Four patients had an unknown LOI. % Ejaculating in each reflex group per LOI calculation: Denominator = the number of subjects at each injury level who showed the reflexes listed. For example 36 subjects with a cervical injury had (BCR+)(HR+). Numerator = the number of ejaculators in each injury/reflex group. For example, 28 subjects ejaculated out of the group of 36 above. Per cent = the numerator divided by the denominator

Table 6 Per cent of trials with somatic responses

	<i>Cervical</i>	<i>T1–T6</i>	<i>T7–T12</i>	<i>P=</i>
Abdominal contractions	98 95	98 100	88 92	NS
Piloerection	25 14	59 45	42 8	0.004
Withdrawal response	23 10	31 9	19 4	NS
Extremity spasms	60 10	50 27	54 44	0.001
Thigh abduction	63 57	39 9	42 24	0.002
Thigh adduction	33 19	36 0	15 24	0.001

Per cent of ejaculation trials (boldfaced numbers) *versus* % of non-ejaculation trials (non boldfaced numbers) in which each somatic response occurred. LOI=level of injury; T=thoracic; Two PVS trials were administered to one subject with a lumbar injury. The trials did not result in ejaculation. No somatic responses were observed on either trial, hence data are not shown for patients with a lumbar LOI. *P* values: For each somatic response, the distribution on ejaculation *versus* non-ejaculation trials was compared across different levels of injury

injuries at T7–T12 than in patients with other levels of injury ($P=0.004$). Extremity spasms were more associated with ejaculation in patients with cervical injuries than in patients with other levels of injury ($P=0.001$). Interestingly, both thigh abduction ($P=0.002$) and thigh adduction ($P=0.001$) were more associated with ejaculation in patients with injuries between T1–T6 than in patients with injuries at other levels, but thigh adduction was more associated with non-ejaculation in patients with injuries at T7–T12 ($P=0.001$).

Discussion

PVS has been recommended as the first line of treatment for an ejaculation of men with spinal cord injury, due to its safety, effectiveness, reliability, and low investment of time and money.^{4–6,20} Compared to the alternative treatment of electroejaculation, PVS is less invasive, is preferred more by patients,²¹ and results in better semen quality.^{21,22} PVS, however, is not successful in all patients, and there are currently no established guidelines for selecting patients for this method. While previous studies have shown that higher success rates of ejaculation are obtained with high compared to low levels of injury,^{4,23} and high compared to low amplitude vibration,^{4,13} these parameters are not completely predictive of ejaculation. It is important to search for factors that will predict who is likely to have an ejaculation by PVS, so that those who require ejaculation by other means are spared the time and expense of excessive attempts at PVS. The purpose of the present study was to determine if additional parameters could be used to select PVS candidates and to predict ejaculation by PVS in men with spinal cord injury. Specifically, BCR, HR, and somatic responses were examined for their predictive value. After reviewing the data as presented in Tables 3 and 4, we recommend the following guidelines for selecting spinal cord injured patients for PVS.

Level of injury Recommendation

Cervical	The presence or absence of BCR and/or HR is no more useful in predicting ejaculation than level of injury alone. All patients should have PVS as a first choice.
T1–T6	All patients who have at least one reflex present (BCR or HR) should be offered PVS first. The absence of both reflexes is predictive of no response to PVS.
T7–T12	Patients with no BCR are poor candidates for PVS.
Lumbar	The number of subjects in this study is too small to make a definitive statement.

In addition to determining which patients have a reasonable chance of success with PVS by eliciting reflexes, it is useful to note somatic signs seen during PVS to determine if stimulation should be continued. Historically, the guiding principle in determining when to terminate a PVS session (other than ejaculation or medical risk) has been the total minutes of stimulation delivered. For example, it has typically been recommended that PVS be delivered for 3–5 min, followed by a 1–2 min break. If no ejaculation occurs after three such cycles (a total of 15 min of stimulation), the trial has usually been terminated.^{4,20} Although somatic responses have been noted in some previous studies,^{6,20,24} their usefulness in predicting ejaculation has not been determined.

The presence or absence of a specific somatic response is not easily explained simply on the basis of the level of injury. For example, abdominal muscles are segmentally innervated from T6–T12, and the presence of abdominal muscle contractions below any given level of injury should reflect the integrity of those segments. In our study, abdominal contractions were present on the majority of trials, regardless of the patient's level of injury. On the other hand, the other somatic responses require only intact lumbar and sacral cord segments. All but three of our patients had a level of injury above L1, and theoretically, had the capacity to demonstrate all of the somatic responses. This was not our finding, however. None of the other responses was present greater than 55% of the time (Table 5). The reason for this finding is unknown, but may have more to do with the extent of injury rather than the level of injury.

In our study, abdominal contractions were present in most trials regardless of ejaculation, thus giving it limited predictive value. The other somatic responses: piloerection, withdrawal, extremity spasms, thigh abduction and thigh adduction were not present in the majority of cases. The trials in which they were present, however, were more likely to result in ejaculation. This was especially true for withdrawal, piloerection, and extremity spasms. For example,

withdrawal was seen in a total of 42 of 204 trials (21%), and 38 of the 42 trials (90%) resulted in ejaculation. For the other responses, the percentage of trials resulting in ejaculation (in which that specific somatic response was seen) was piloerection (84%), extremity spasms (83%), thigh abduction (80%) and thigh adduction (72%).

In practice, it is useful to know if a patient has a high or low likelihood of success based on his level of injury and his reflex parameters, and then utilize the presence of the more predictive somatic responses to judge whether or not to continue the PVS session if no ejaculation occurs promptly. In many instances we will bring a patient back for another PVS trial at another time if all indicators are favorable but no ejaculation has occurred on the first attempt.

Conclusion

The results of our analysis, done in a large population of SCI men, indicates that BCR and HR may aid in selecting patients for PVS. In SCI patients with lesions T12 or higher, the majority will ejaculate if both BCR and HR are present, and if only BCR is present, at least 50% will ejaculate. If neither reflex is present, most patients with injuries T1 or lower, will not ejaculate. When determining candidacy for PVS, the level of injury alone (except in patients with a cervical injury) should not be the sole factor. The presence or absence of the BCR and HR should be considered when making this choice. Once PVS is initiated, the presence of somatic responses is helpful in deciding whether to continue that trial or even offer a second trial if no ejaculation is obtained initially.

References

- Bors E, Comarr A. Neurological disturbances of sexual function with special reference to 529 patients with spinal cord injury. *Urol Surv* 1960; **10**: 191–222.
- Halstead L, VerVoort S, Seager S. Rectal probe electrostimulation in the treatment of anejaculatory spinal cord injured men. *Paraplegia* 1987; **25**: 120–129.
- Buch J, Zorn B. Evaluation and treatment of infertility in spinal cord injured men through rectal probe electroejaculation. *J Urol* 1993; **149**: 1350–1354.
- Brackett N et al. An analysis of 653 trials of penile vibratory stimulation on men with spinal cord injury. *J Urol* 1998; **159**: 1931–1934.
- Brackett N. Semen retrieval by penile vibratory stimulation in men with spinal cord injury. *Human Reprod Update* 1999; **5**: 216–222.
- Nehra A et al. Vibratory stimulation and rectal probe electroejaculation as therapy for patients with spinal cord injury: semen parameters and pregnancy rates. *J Urol* 1996; **155**: 554–559.
- Piera JB. The establishment of a prognosis for genitosexual function in the paraplegic and tetraplegic male. *Paraplegia* 1973; **10**: 271–278.
- Brindley G. The fertility of men with spinal injuries. *Paraplegia* 1984; **22**: 337–348.
- Sarkarati M, Rossier A, Fam B. Experience in vibratory and electro-ejaculation techniques in spinal cord injury patients: a preliminary report. *J Urol* 1987; **138**: 59–62.
- Szasz G, Carpenter C. Clinical observations in vibratory stimulation of the penis of men with spinal cord injury. *Arch Sex Behav* 1989; **18**: 461–474.
- Beretta G, Chelo E, Zanollo A. Reproductive aspects in spinal cord injured males. *Paraplegia* 1989; **27**: 113–118.
- Siosteen A et al. Quality of semen after repeated ejaculation treatment in spinal cord injury men. *Paraplegia* 1990; **28**: 96–104.
- Sonksen J, Biering-Sorensen F, Kristensen J. Ejaculation induced by penile vibratory stimulation in men with spinal cord injuries. The importance of the vibratory amplitude. *Paraplegia* 1994; **32**: 651–660.
- Wieder JA et al. Anesthetic block of the dorsal penile nerve inhibits vibratory-induced ejaculation in men with spinal cord injuries. *Urol* 2000; **55**: 915–917.
- Dyro F. Electrophysiology of the lower urinary tract. In: Yalla S et al (eds). *Neurology and Urodynamics: Principles and Practice*. Macmillan Publishing Co., New York, 1988, pp. 45–58.
- Diokno A. Neurologic examination. In: Yalla S et al (eds). *Neurology and Urodynamics: Principles and Practice*. Macmillan Publication Co., New York, 1988, pp. 150–154.
- Siroky M, Krane R. The history and examination in neuro-urology. In: Krane R, Siroky M (eds), *Clinical Neuro-Urology*, Second, Little, Brown and Co., Boston, 1991, pp. 275–284.
- Klose K et al. University of Miami Neuro-Spinal Index (UMNI): a quantitative method for determining spinal cord function. *Paraplegia* 1980; **18**: 331–334.
- Green B, Klose K, Goldberg M. Clinical and research considerations in spinal cord injury. In: Becker D, Povlishock J (eds). *Central Nervous System Trauma Status Report*, National Institutes of Health: Bethesda, 1985, pp. 341–368.
- Ohl D, Sonksen J. Penile vibratory stimulation and electroejaculation. In: Hellstrom W (ed.) *Male Infertility and Sexual Dysfunction*, Springer-Verlag: New York, Inc., New York, 1997, pp. 219–229.
- Ohl D et al. Electroejaculation versus vibratory stimulation in spinal cord injured men: sperm quality and patient preference [see comments]. *J Urol* 1997; **157**: 2147–2149.
- Brackett N, Padron O, Lynne C. Semen quality of spinal cord injured men is better when obtained by vibratory stimulation versus electroejaculation. *J Urol* 1997; **157**: 151–157.
- Sonksen J et al. Quality of semen obtained by penile vibratory stimulation in men with spinal cord injuries: observations and predictors. *Urology* 1996; **48**: 453–457.
- Brindley G. Reflex ejaculation under vibratory stimulation in paraplegic men. *Paraplegia* 1981; **19**: 299–302.