H-Reflex and Physiologic Measures of Ejaculation in Men With Spinal Cord Injury

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Objective: To investigate the various physiologic parameters characterizing and predicting ejaculation.

Design: Single case-control study.

Setting: A referred care center and university setting.

Participants: Two men with spinal cord injury (SCI) and 2 control subjects.

Intervention: Subjects were asked to self-stimulate with a Ferticare vibrator to induce ejaculation over 5 to 8 independent sessions.

Main Outcome Measures: Penile tumescence, blood pressure, heart rate, electromyographic activity of the bulbocavernosus muscles, abdominal muscles, soleus H-reflex, and occurrence of ejaculation.

Results: Changes on all measures were observed, with penile tumescence being more stable in control subjects. Blood pressure increased in both groups, whereas tachycardia was observed in controls and bradycardia in subjects with SCI. H-reflex dropped slightly in controls but increased in subjects with SCI. Muscular patterns differed on ejaculatory success or failure.

Conclusions: Physiologic changes on all measures can be observed in men with SCI as a function of ejaculation. Changes include hypertension and bradycardia, characteristic of hyperreflexia, and tachycardia in controls. The neural mechanisms underlying these patterns are discussed. H-reflex showed increased spinal cord excitability in subjects with SCI after ejaculation, which suggests spasticity. The results support investigation of the H-reflex to predict ejaculatory success or failure in men with SCI, along with specific analysis of muscular patterns.

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Injuries to upper segments of the spinal cord (ie, above T6) are characterized in humans by an early phase of spinal shock, followed by a recovery of reflexes often developing into spasticity.1-2 The main clinical feature and limitation of spasticity is that it interferes with the recovery of basic functions and with movement. Because spasticity can further interfere with neural recovery, it can jeopardize rehabilitation strategies. Various studies have therefore investigated its underlying mechanism and have explored the various treatment modalities that could control spasticity during the posttraumatic phases of recovery.

The Hoffmann reflex, or H-reflex, is an Ia afferent-mediated monosynaptic reflex that involves the alpha motoneurons innervating the splanchnic muscles implicated in spasticity. Because of its monosynaptic nature, any changes in the H-reflex reflect supraspinal or suprasegmental influences acting on the spinal cord.3 Studies have therefore investigated the underlying mechanism of spasticity using the H-reflex to assess the level of spinal cord excitability during the acute phase of injury (characterized by spinal shock) and during the chronic phase of injury (characterized by spasticity).4-7

The results from these studies have shown that the H-reflex is a sensitive measure of spinal cord excitability. H-reflex amplitude was depressed in subjects with spinal cord injury (SCI) compared with controls,4,6 and the changes in the H-reflex amplitude moved from a depressed, or nearly absent level, in the acute phase of injury compared with the chronic phase of injury.2 The H-reflex was also more sensitive than clinically elicited reflexes, because it was elicited during the acute phase of injury, when mechanically tapped reflexes were still absent.5-7 The ability of the H-reflex to assess the development of spasticity in chronic injuries, however, was not clearly shown.4,5 The results suggested that spasticity involves more than alpha motoneuron excitability and may involve gamma motoneuron excitability or multifactorial mechanisms as well.3 The H-reflex is therefore a clear measure of spinal cord excitability, but although it is not yet optimal as a physiologic measure of spasticity, it remains among the most sensitive measures currently available to physiologically assess spasticity.

Studies on the treatment modalities that control spasticity have investigated various means, among which rectal probe stimulation has been found to relieve spasticity in both men and women with SCI.8 Studies on fertility tests have also shown that, although ejaculation in men with SCI is accompanied by spasticity in conjunction with hyperreflexia,9-15 the level of spasticity decreased after ejaculation and for a time period that could vary from several hours to several days.8

Because ejaculation in higher cord injuries is associated with various signs of hyperreflexia—including muscle spasms, hypertension, and bradycardia, to name only a few16-20—we investigated various physiologic signs of hyperreflexia during ejaculation in men with SCI to assess the prognostic value of these measures for ejaculatory success.

METHODS

Participants

Four subjects recruited from the Institut de Rédadaptation de Montréal and the Université du Québec à Montréal participated...
in the study. Two of the men had tetraplegia and were in their late thirties to early forties. The first had sustained a complete C6 lesion about 20 years before the experiment; the second had an incomplete C4 lesion 7 years before the experiment. The selection criteria for subjects with SCI involved reported capability for penile vibratory stimulation, absence of medical conditions other than the spinal injury, and reduced risks of hyperreflexia, defined as an increase in systolic blood pressure (SBP) that did not exceed 20mmHg and that was not accompanied by a general feeling of malaise or headaches.

The other 2 subjects were noninjured (non-SCI) controls, in their mid twenties. They were recruited from the university setting and were used as comparisons for the subjects with SCI. All subjects were tested under the same general conditions, and all subjects signed informed consent forms approved by the institutional ethics committee.

Procedure

Before the experimentation, subjects with SCI were scheduled for a neurologic examination at a rehabilitation center to verify the level and extent of their lesion and to eliminate excessive risks of hyperreflexia, as defined above. The level and completeness of the lesions were assessed by a physician using the American Spinal Injury Association scale.

Experimental testing was done in the university setting, in a laboratory room equipped with a bed, a screen, and electrophysiologic equipment. All subjects were tested for ejaculation during 5 positive sessions (ie, leading to ejaculation). Each session was performed on a separate day, and the testing intervals were at least 1 week. Negative sessions (ie, not leading to ejaculation) were also recorded but were analyzed separately from the positive ones (see below).

Subjects with SCI were given assistance in preparing for the test and were then left alone for penile vibratory stimulation. Consistent with the recommendations for optimal results, the stimulation was achieved with a FertiCare Personal* vibrator, set at a frequency of 110Hz and an amplitude of 2.5mm. The subjects were instructed to self-stimulate their glans penis until ejaculation occurred or for up to 3 minutes if ejaculation failed to occur (they were told that the 3min were up through a small speaker). Consistent with other studies,12,15,21 when ejaculation failed within this first 3-minute bout of stimulation, the subjects were given 1 minute to rest, after which a second bout of penile vibratory stimulation was performed for up to 3 more minutes. Five such bouts of stimulation were allowed during a given session. If a subject failed to ejaculate during these 5 bouts of stimulation, testing was discontinued and the session was considered a failure.

Non-SCI subjects were tested under the same general conditions. However, because vibratory stimulation was somewhat aversive to these participants (while manual stimulation was subthreshold to subjects with SCI), manual stimulation (masturbation) was used to trigger ejaculation.

During the experimental sessions, recordings of 7 physiologic measures were achieved from the beginning of stimulation to ejaculation and for 20 minutes after ejaculation. Measures included penile tumescence; electromyographic activity for the bulbocavernous, rectus abdominals, and soleus muscles; heart rate; diastolic blood pressure (DBP); and SBP. In addition, the H-reflex responses were recorded after stimulation in the popliteal fossae (see below).

Penile tumescence was recorded with a mercury strain gauge that was installed at the base of the penis and connected to a plethysmograph (model F78 MGA). Electromyographic activity of the bulbocavernous and rectus abdominals muscles were recorded with bipolar Ag-AgCl surface electrodes connected to an amplifier (model P-511). Bulbocavernous recordings used electrodes 4mm in diameter that were placed in line with muscle fiber orientation over the skin area between the scrotum and the anus. The electrode placement involved a center-to-center spacing of 0.5 to 1.0cm. Rectus abdominals recordings used electrodes 8mm in diameter that were placed on the left side of the umbilicus, with a center-to-center spacing of 1.0 to 1.5cm. Heart rate measures were collected with surface Ag-AgCl electrocardiogram (ECG) electrodes, which were placed on the sixth rib on both sides of the chest, with the ground electrode located on the sternum. DBP and SBP were collected with an electronic sphygmomanometer, which was placed on the left arm (all subjects were right-handed) and which recorded pressure at baseline and every 2 minutes for 20 minutes after ejaculation.

The H-reflex response was recorded from the soleus muscle using 8-mm surface electrodes. The reflex was triggered by monophasic electric pulses (S88 stimulator) of 1-ms duration, delivered at a rate of 8 to 10 per minute on the tibial nerve, located in the popliteal fossae. The intensity of stimulation was determined according to the standard 2-step H-reflex procedure. Before the onset of each trial, the stimulation intensity was gradually increased to obtain the maximal motor (Mmax) response. The stimulation intensity was then adjusted during testing to produce a small M response that corresponded to 10%±1% of this Mmax.

Generally speaking, electrocardiographic and electromyographic signals were amplified (PS11), filtered (ECG, 1–100Hz; electromyography, 10–300Hz), and digitized at 1kHz on a personal computer using the commercial software and hardware Axoscope and Digidata 1200A. Similarly, penile tumescence signals were amplified with a direct-current amplifier (P122), filtered (0–10Hz), and fed to the same acquisition system. Blood pressure data, taken with the electronic sphygmomanometer, were inserted as tags on the Axoscope file.

Data Analysis

Data analysis was performed for each subject individually, on each measure and for all 5 positive trials. Data points were selected at baseline (B) and every 2 minutes from ejaculation (P0) to 20 minutes postejaculation (P2 to P20). Heart rate data, coinciding with the discrete DBP and SBP values recorded from the sphygmomanometer, were selected from continuous electrocardiographic trace of the Axoscope file. The H-reflex responses, in which M waves conformed to the 10%±1% of Mmax response (eg, usually around 5–10 good responses), were averaged together over the 2-minute periods. Statistical analyses were performed using 1-way analyses of variance with repeated measures on each subject. Significant findings (P<.05) were analyzed with the Tukey post hoc procedure.

Data from negative trials were analyzed similarly. Data points were selected from baseline and up to 20 minutes after the last bout of stimulation (because ejaculation never occurred in these cases).

RESULTS

Overview

Figure 1 shows a representative sample of the continuous physiologic recordings of 1 non-SCI and 1 SCI subject. Part A illustrates the findings from the first non-SCI subject, where ejaculation occurred with a longer delay from the start of the stimulation than the subject with SCI (see below). A portion of the tracing from figure 1A, which corresponded to the time unit...
Fig 1. Sample recordings of (A) 1 non-SCI and (C) 1 SCI subject, along with an expanded tracing of the (B) non-SCI subject to match the time unit of the SCI subject. Abbreviations: PT, penile tumescence; BS, bulbocavernosus; RA, rectus abdominis; HR, heart rate.
for ejaculation in the subject with SCI, was therefore expanded in figure 1B. As illustrated in these figures, the noninjured subject (non-SCI) exhibited a sustained erection from the beginning of stimulation to ejaculation, where tumescence decreased rapidly. During tumescence, electromyographic activity from the bulbocavernosus and rectus abdominis muscles built up gradually and showed sporadic bursts that became longer and stronger as ejaculation approached. Ejaculation coincided with an inhibition of bulbocavernosus and rectus abdominis activity. After ejaculation, bulbocavernosus activity became silent, and the rectus abdominis showed a strong burst followed by a few sporadic bursts that disappeared rapidly. The time to reach ejaculation from the onset of manual self-stimulation averaged 5.45 minutes in the 2 non-SCI subjects across all sessions, with a range of 1.97 minutes (118s) to 9.15 minutes (549s).

Figure 1C illustrates the tracings from a positive session of a subject with SCI. The figure shows that a positive session in these subjects resulted in a similar pattern of recordings to those found in non-SCI. In general, erection was present but was more unstable from the beginning of stimulation to ejaculation. Muscular patterns similarly showed a gradual building up of activity with some bursts that became longer and stronger as ejaculation approached. Ejaculation also coincided with silent bulbocavernosus and rectus abdominis activity, followed by a burst in bulbocavernosus and rectus abdominis immediately after ejaculation. The time to reach ejaculation occurred faster in subjects with SCI than in controls, the latency averaging 1.34 minutes across the 2 subjects for all trials and ranging from 0.8 minute (48s) to 2.72 minutes (163s).

The tracings from heart rate measures, not clearly visualized on these figures because of the time units used to match the other measures, were submitted to further analysis with the cardiovascular parameters below. However, the visual tracings of figure 1 suggest an increase in heart rate for the non-SCI subject as ejaculation approached (ie, increased density of heart rate tracing) and a decrease in heart rate for the subject with SCI as ejaculation approached (larger spacing in heart rate tracing).

Cardiovascular Parameters

Figure 2 illustrates the changes that occurred in the cardiovascular measures for each subject (averaged over their 5 sessions) as a result of stimulation and ejaculation. Discrete measures from the sphygmomanometer included SBP and DBP. These measures were matched with the corresponding data points from the continuous heart rate tracings.
As illustrated in figure 2, SBP from the non-SCI subjects (figs 2A, 2B) increased significantly from baseline to ejaculation (non-SCI, F=9.25, P<.001; non-SCI, F=3.01, P<.005), after which it rapidly decreased back to baseline. The SCI subjects (figs 2C, 2D) also showed a significant increase in SBP from baseline to ejaculation (SCI, F=13.46, P<.001; SCI, F=4.15, P<.001), but the return to baseline was slower and remained significantly elevated for the 20 minutes postejaculation in the first case and for 2 minutes after ejaculation (P2) in the second case.

DBP mirrored the patterns of the SBP, with the non-SCI men exhibiting an increase in DBP from baseline to ejaculation (only significant for non-SCI, F=3.68, P<.002) and quickly dropping back to baseline. The subjects with SCI similarly exhibited an increase in DBP at ejaculation, to a significant extent in both cases (SCI, F=14.89, P<.001; SCI, F=7.13, P<.001), and that remained elevated for the 20 minutes after ejaculation in the first case and for 4 minutes after ejaculation (P4) in the second case.

In contrast with blood pressure measures, heart rate measures showed opposite patterns for SCI and non-SCI subjects. The non-SCI subjects generally exhibited an increase in heart rate at ejaculation (non-SCI, F=3.44, P<.003; non-SCI, F=2.67, P<.01), after which the values quickly returned to baseline. The SCI subjects, in contrast, exhibited a decrease (rather than an increase) in heart rate at ejaculation, although only significant in 1 case (SCI, F=29.32, P<.001), and that remained depressed for the 20 minutes after ejaculation.

**H-Reflex**

Figure 3 illustrates the changes that occurred in the H-reflex for the non-SCI and SCI subjects as a result of stimulation and ejaculation. As illustrated, the non-SCI subjects (figs 3A, 3B) showed slight drops in H-reflex amplitude, significant in 1 case at 4 minutes after ejaculation (non-SCI, F=2.65, P<.01). The H-reflex also showed some drop in the SCI subjects (figs 3C, 3D) at the time of ejaculation, but the initial drop immediately increased after ejaculation to a significant extent in both cases (SCI, F=3.10, P<.009; SCI, F=3.03, P<.007) and for a period lasting 12 minutes.

**Ejaculatory Failure**

As described in the procedure, when the subjects failed to ejaculate during 5 consecutive bouts of stimulation, the session was discontinued and was considered a failure. Overall, the non-SCI subjects never exhibited a negative session. The SCI...
subjects, in contrast, completed 13 sessions, of which 10 were positive and 3 were failures. All failure sessions were from the same subject (SCI1). The data from his various physiologic measures during these sessions are illustrated in figures 4A–C.

Figure 4A is an example of a failure session. The figure shows that, in that session, the electromyographic activity of the bulbocavernosus muscle exhibited a continuous pattern during the 5 consecutive bouts of penile vibratory stimulation. Continuous bursts of activity were recorded, with no gradual building up (as in positive sessions) and with no sporadic bursts becoming stronger and longer as stimulation persisted (and as ejaculation approached in positive sessions). Rectus abdominis activity similarly showed some continuous activity, which gradually decreased and completely faded out before the end of each bout of penile vibratory stimulation, rather than showing the gradual building up of positive sessions, where sporadic bursts increased in amplitude and duration as ejaculation approached.

Contrary to muscular activity, the cardiovascular changes (fig 4B) during these failure sessions did not show any specific pattern of unsuccessful results. Recall that when the session was negative, the data could be collected for up to 20 minutes after the last bout of penile vibratory stimulation. Figure 4B shows that the SBP mirrored those of successful sessions, although not significantly so. SBP increased with stimulation over successive bouts of penile vibratory stimulation (F1 to F5) and returned to baseline after stimulation, from 2 minutes to 8 minutes after stimulation. DBP showed little variation during the bouts of stimulation, slightly increasing and gradually returning to baseline by the end of 8 minutes after stimulation. Heart rate measures also mirrored those of successful sessions, with an initial decrease noted on the first bout of self-stimulation and remaining so on each new bout of stimulation leading to failure (F1 to F5). Heart rate measures then returned to baseline by 6 to 8 minutes after stimulation.

In contrast with these cardiovascular measures, the H-reflex responses exhibited an interesting pattern in the unsuccessful sessions. Figure 4C shows that the decrease in H-reflex amplitude became weaker and weaker as new bouts of stimulation were attempted in these unsuccessful sessions. Indeed, figure 4C shows that the H-reflex amplitude corresponded to 30% of the Mmax response before stimulation was started. At the end of the first bout of penile vibratory stimulation, the H-reflex amplitude corresponded to 13% of the Mmax response, a
smaller drop compared with prestimulation levels. When further bouts of stimulation were attempted, fewer drops in H-reflex amplitude were recorded.

Figure 4D translates these changes into histograms, comparing each bout of stimulation over the failure sessions (F1 to F5) to the average responses obtained during positive sessions (S). As illustrated, the decreases in H-reflex amplitude averaged 27% of Mmax for successful (S) sessions. In contrast, drops in the H-reflex amplitude for the failure sessions corresponded to 17% of Mmax for the first bout of penile vibratory stimulation (F1), 13% of Mmax for the second bout of stimulation (F2), 4% for the third bout (F3), and 7% and 4% for the fourth (F4) and fifth (F5) bouts of penile vibratory stimulation. The H-reflex amplitude was thereby less and less depressed as the number of trials were increased over the unsuccessful sessions.

DISCUSSION

The general results of our study show that when vibratory stimulation triggers ejaculation in subjects with SCI, it also triggers physiologic changes that are similar to those obtained from non-SCI subjects, although they are not necessarily in the same direction or to the same extent. Physiologic changes nevertheless appeared consistently throughout the measures and the testing procedures, which suggests underlying mechanisms and clinical implications that will be discussed below. Also of interest is the potential predictive value of these physiologic measures for ejaculatory success (or failure) that will be discussed below.

Measures of Penile Tumescence and Muscular Activity as Predictors of Forthcoming Ejaculation

The sample recordings of penile tumescence and perineal muscle activity during sexual stimulation showed similar changes among subjects with and without SCI. Generally speaking, both groups exhibited penile tumescence from the onset of stimulation, with the control subjects exhibiting an increase that remained stable until ejaculation and that quickly returned to baseline after it. Subjects with SCI similarly showed penile tumescence on the onset of stimulation, but the response was more unstable throughout the testing procedures and could drop from time to time or even completely subside before ejaculation but without preventing it. These results are generally consistent with our earlier findings on erectile function in SCI men and with the literature on fertility tests in men with SCI. This latter literature shows that ejaculation is not necessarily associated with erection or that it may be variable during the vibratory procedure. It therefore appears that measures of penile tumescence are not an adequate predictor of ejaculatory success in men with SCI, and although it may be subjectively desired by patients as a physical reflection of their sexual arousal, they must be advised not to rely on erection as a cue for forthcoming ejaculation. Furthermore, patients should be advised and encouraged to pursue stimulation on a flaccid or an unstable penis if ejaculation is sought.

Contrary to these results on penile tumescence, the pattern of muscular contractions from the bulbocavernousus and rectus abdominus muscles were practically identical among SCI and non-SCI subjects and may be predictive of ejaculatory success (or failure) in SCI. During positive tests, both groups of subjects exhibited a progressive increase in electromyographic activity of the bulbocavernousus and rectus abdominals muscles, and both showed small bursts of activity that became longer and stronger as ejaculation approached. On ejaculation, both groups showed a silent bulbocavernosus, followed by a few bursts of rectus abdominis activity. In contrast, the recordings from ejaculatory failures showed a continuous burst of muscular activity that appeared without showing the sporadic building up characteristic of positive tests. These results suggest differing patterns on forthcoming ejaculation or ejaculatory failure. Although ejaculatory success seems to be characterized by a building-up of muscular contractions, ejaculatory failure seems to be associated with an initial tension in the muscles that renders them apparently inadequate to sustain the building up of sexual tension.

Although the potential of muscular activity to serve as a predictor of ejaculatory success or failure remains to be shown on a larger scale, the results from our positive tests are consistent with the expected role of perineal muscles during erection and ejaculation. Masters and Johnson have long considered perineal muscles to be responsible for the expulsion of the semen outside the urethra at the time of ejaculation. Kara, Lavoisier and Courtois and colleagues have all considered the bulbocavernosus and ischiocavernosus muscles to be responsible for the different phases of erection, with the ischiocavernosus muscle contractions being responsible for penile rigidity and the bulbocavernosus muscle being responsible for the erection of the glans penis. Many researchers have further shown that muscular contractions, especially in the form of abdominal spasms, frequently occurred during ejaculatory tests in men with SCI, although the presence of these contractions was not necessarily predictive of ejaculatory success.

The precise nature of these muscular contractions must therefore be shown on larger scales and must be analyzed more specifically to understand which specific pattern, if any, is predictive of ejaculatory success or failure in men with SCI. It nevertheless remains interesting to note that bulbocavernosus activity, in our study, showed a building up until ejaculation and became silent at the very moment of it. This pattern, recorded repeatedly on our few subjects, may suggest that the silent activity coincides with the emission phase of ejaculation, where the smooth muscles of the internal reproductive organs contract, while the skeletal muscles surrounding the penis may become silent to prevent the detrusor-sphincter dyssynergia that triggers retrograde ejaculation in men with SCI. Physiologic Measures Indicative of Supraspinal Inhibition

Just as muscular activity may predict ejaculatory success or failure in SCI, other physiologic measures may be indicative of supraspinal inhibition that facilitates or inhibits ejaculation. Assessment of the delay to reach ejaculation is one of these measures, because shorter delays were found in SCI subjects compared with noninjured subjects. It could be suggested that these shorter delays resulted from using the vibrator in subjects with SCI (instead of masturbation, which was subthreshold for them, whereas vibratory stimulation was somewhat aversive to non-SCI subjects). However, it may also be that shorter delays result from the removal of supraspinal inhibition in spinally transected persons, which facilitates ejaculation, unlike in noninjured controls.

Other physiologic measures reflected the removal of supraspinal inhibition in subjects with SCI. Both SBP and DBP consistently increased on vibratory stimulation in all subjects, but it remained elevated in subjects with SCI after ejaculation, whereas it immediately decreased on ejaculation in noninjured controls. These findings suggest that the inhibition of supraspinal influences in subjects with SCI is inefficient in bringing the blood pressure back to normal and that the subjects have to wait for a gradual fading of the responses before it returns to baseline.
Physiologic Measures Indicative of Autonomic Hyperreflexia

The results from the vascular responses not only showed differences in supraspinal inhibition in SCI and non-SCI subjects, but they also reflected differences in the autonomic control of cardiovascular function. Noninjured subjects responded to genital stimulation with ejaculation, which elicited a general autonomic response translated into genital, muscular, and cardiovascular responses. As illustrated in figure 2, the cardiovascular responses involved an increase in SBP and DBP, as well as a change in heart rate that peaked at ejaculation and immediately returned to baseline after it.

Subjects with SCI similarly reached ejaculation on genital stimulation and exhibited a general activation of the autonomic system that translated into genital, muscular, and cardiovascular responses. However, cardiovascular changes involved a decrease, rather than an increase, in heart rate in this case. This bradycardia associated with hypertension is typical of the clinical complex of hyperreflexia. Its occurrence in higher cord injuries is illustrative of the role of the baroreceptors in cardiovascular function in men with SCI.

Baroreceptors are located in the carotid sinus above the lesion level in SCI. When changes in blood pressure are detected by baroreceptors, they are translated into messages that reach the cardiovascular center of the medulla to bring function back to normal. Restoration of a normal heart rate is achieved through the vagus nerve that exits the spinal cord above the lesion level (through cranial nerves). Because ejaculation triggers an increase in blood pressure, baroreceptors activate the vagus nerve to depress heart rate. Bradycardia therefore appears, but because blood pressure can only be modulated above the lesion level, hypertension overall persists.

These results, which associate hypertension and bradycardia, are consistent with other reports of autonomic hyperreflexia in spinal injuries. Such injuries, especially those above the splanchnic innervation at T6, are associated with other symptoms, including sweating, flushing of the skin above the lesion level, feeling of fullness in the head, and muscular spasms, as well as negative signs of headaches and nausea in extreme cases. The results from our study suggest that autonomic hyperreflexia—that is usually triggered by an aversive stimulus—may appear during ejaculation to translate into a paroxysmic sensation of sexual completion. If this is the case, the perceived sensations of autonomic hyperreflexia could perhaps be reattributed to orgasmic sensations in subjects with SCI, when it is relatively mild and controlled. Such an interpretation would suggest that vibratory training, along with physiologic recordings, could be used as a sexual rehabilitation program to train persons with SCI to rediscover sexual sensations.

The H-Reflex as an Indicator of Ejaculatory Success or Failure

Of all the physiologic measures recorded in this study, perhaps the most interesting is the H-reflex, which was found to differ between the SCI and the non-SCI subjects, and which was found to differ within the SCI subjects as a function of ejaculatory success or failure.

Noninjured control subjects exhibited little change in the H-reflex amplitude at the time of ejaculation. If anything, ejaculation slightly reduced spinal cord excitability, which may relate to the feelings of relaxation or fatigue that are commonly described by men after ejaculation.

Subjects with SCI, in contrast, initially showed a slight decrease in H-reflex amplitude immediately followed by a significant increase that remained for 12 minutes after ejaculation. This increase in spinal cord excitability is consistent with the reported spasticity that builds up as a function of vibratory stimulation and ejaculation in men with SCI. The sustained excitability is further consistent with the finding that spasticity remains despite the termination of stimulation.

The results from the unsuccessful sessions also showed interesting findings that may support the utility of the H-reflex in predicting ejaculatory success or failure in men with SCI. During unsuccessful sessions, the H-reflex amplitude was less depressed than during successful ones, and it was depressed to a lesser extent as the number of bouts of stimulation were increased (from 1 to 5 consecutive failure trials). Spinal cord excitability was therefore less depressed during the unsuccessful sessions or as successive bouts of vibration were attempted.

These findings suggest that when the H-reflex is not sufficiently depressed at the beginning of a session, the excitability of the spinal cord is not ideal to induce ejaculation. Indeed, the subject who was tested during these unsuccessful sessions spontaneously stated that he was tired at the beginning of the unsuccessful sessions. Furthermore, successful ejaculations reported in other studies generally occurred, as in our study, within 2 minutes of vibratory stimulation. It may be therefore that when the H-reflex shows this specific pattern of activity and when ejaculation fails during the first bout of stimulation, further attempts to trigger ejaculation are useless. Because repeated sexual stimulation may not increase the probability of ejaculatory success, it may augment the risk of autonomic hyperreflexia or of skin damage to the glans penis when stimulation exceeds 20 to 30 minutes.

Although the H-reflex may be an interesting predictor of ejaculatory success in men with SCI, it may not be readily assessed in a clinical setting. However, because the H-reflex is the electric analog of the stretch H-reflex, this latter reflex could be used in clinical settings to assess the level of excitability of the spinal cord. Because both of these reflexes are indexes of spasticity, further investigation could determine the threshold required for ejaculatory success. Our results suggest that an ideal level of spasticity is required for ejaculation. The data from the failure sessions indicated that when spasticity was below an initial threshold (as defined by the amplitude of the H-reflex), penile vibratory stimulation did not trigger ejaculation. Furthermore, repeated trials in these cases appeared to further inhibit ejaculation by bringing spasticity levels further below the threshold for ejaculation. Further investigation of the H-reflex and its clinical correlate, the stretch reflex, are therefore warranted to assess whether its pattern consistently varies as a function of ejaculatory success (or failure) in men with SCI.

CONCLUSIONS

Our study indicates that ejaculation in men with SCI triggers changes on many physiologic measures, all of which were also recorded in noninjured control subjects. Parameters of blood pressure, heart rate, and muscular activity all showed significant variations as a function of sexual stimulation to ejaculation. Measures of the H-reflex also showed an increase in spinal cord excitability in men with SCI after ejaculation, which is consistent with the spastic phenomenon reported during autonomic hyperreflexia. Further measures of the H-reflex during unsuccessful trials showed interesting patterns, which suggests avenues to assess ejaculatory success or failure in men with SCI.
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