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Penile Electromyography in the Diagnosis of Impotence

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Abstract
Cavernous electromyography of the flaccid penis was done in 93 impotent patients that were evaluated with several types of electrodes. We found that the potentials are generated by the cavernous tissue and are not the reflections of distant electromyographic events. Using monopolar needle electrodes, accurate interpretation of the electromyographic tracings seems possible. Our results confirm the value of penile electromyography as a way to objectivate penile smooth muscle atrophy as well as pelvic autonomic neuropathy with subsequent penile smooth muscle desynchronization. A neuromuscular dysfunction may be the causative factor in 39% of our impotent patients.

Introduction

Electromyography of cavernous smooth muscle during flaccidity has recently been proposed as a new method for the evaluation of the pelvic cavernous nerve pathway [1–3].

Indeed, the existing neurological tests only objectivated the somatic efferent and afferent pathways of the penis.

We routinely performed penile electromyography in the evaluation of our impotent patients. Specifically, we tried to examine if the measured potentials were generated by penile smooth muscle and were no reflections of distant electromyographic events or skin potentials. Several types of electrodes were compared.

Materials and Methods

Test Population

Ninety-three impotent patients with a mean age of 57 years (range 23–81) were evaluated. The standard evaluation consisted of a physical examination and thorough history as well as a sexual interview. Further, laboratory blood tests, dynamic colour Doppler evaluation of the cavernous arteries and veins and finally, a Rigiscan® (Dacomed, USA) monitoring during 3 consecutive nights were performed. A pharmacocavernography was only done on specific indications.

Electromyographic Equipment

Mainly the SPACE 7500 (single potential analysis of cavernous electrical activity) developed by Wiest was used. This is a two-channel electromyographic amplifier with two external pre-amplifiers. The registration band is opened at its maximum which is 0.3–32 Hz. The amplitude range is set at ± 200 μV. The speed of the thermowriter is set at 5 mm/s. The printer resolution is limited to 20 pixels/s, and continuous averaging of the measured signal is done automatically to print curves which are true to frequency.

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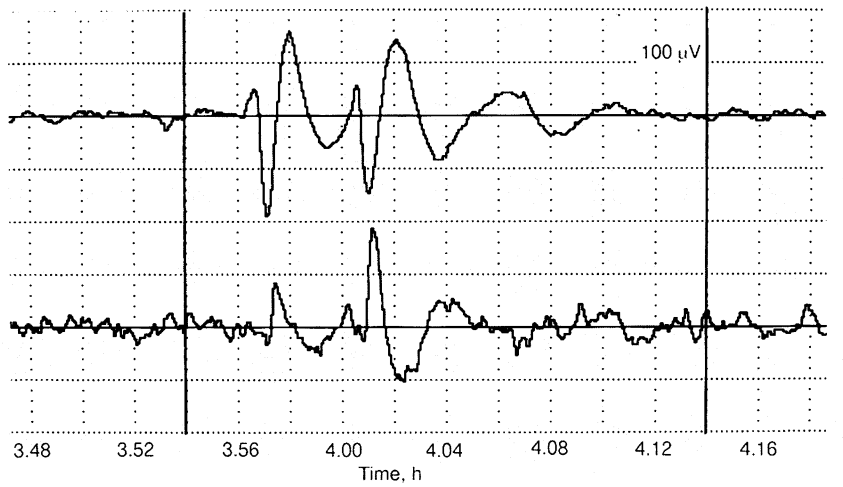


Fig. 1. Normal potentials as measured with surface electrodes (upper tracing) and coaxial needle electrodes (lower tracing).

For scientific purposes the Schwartzer ED24 multichannel electro-encephalographic amplifier was used in 6 psychogenically impotent patients. This system allows simultaneous electromyographic recordings with monopolar needle electrodes and surface electrodes at the penis as well as surface electrodes on one foot and one hand. The tested electrodes were Dantec coaxial needle electrodes type 9013L in 57 patients, Dantec monopolar sensory needle electrodes type 13L64 in 35 patients and finally Dantec surface electrodes type 13L20 in all patients.

Methods of Examination

All measurements are done in a relaxed atmosphere and in the absence of electrical interference. Patients are well informed about the relative non-invasiveness of the test and are asked not to move during the whole procedure.

The patients are placed in a 45-degree sitting position. Surface electrodes are connected to one pre-amplifier and applied as follows: one earth electrode on the pubis, the different electrode at the base of the right corpus cavernosum and the indifferent electrode 2–3 cm further down the penile shaft.

The coaxial electrode, when used, is inserted in the left corpus, mid-penile, with the tip in the centre of it and oriented proximally. Monopolar electrodes are inserted at the mid-penile site with their tips in the centre of the left corpus and 1 cm apart.

The mean duration of the test is 30 min, but only the last 20 min are evaluated. After installation, the patients are instructed to relax as much as possible, and the examiner leaves the room.

Results

Ninety-three impotent patients with a mean age of 57 years (range 23–81) were evaluated. Among these patients 30 were psychogenically impotent, 17 had a venous leakage, 11 an arterial insufficiency and 14 had diabetes. One patient received radiotherapy for prostate cancer, and one was evaluated after a period of priapism. Another one suffered from pudendal nerve trauma. Finally, 18 patients had a completely normal evaluation, except for the nightly penile rigidity and tumescence evaluation.

The first 57 patients were evaluated with surface electrodes over one cavernous body and a coaxial needle electrode simultaneously in the other. There was a distinct influence of electrode positioning and relaxation of the patient on the recordings with the surface electrodes. The more the patient was stressed, the more irregular, high-amplitude complexes were recorded. Retraction of the penis during the examination, as well as high skin impedance adversely affected the quality of the recordings. Moreover pain and rotations as well as position of the coaxial needle electrode influenced those recordings: whenever pain lasted for the whole duration of the test, there was excessive background activity and desynchronisation which made interpretation impossible. Twenty-five patients had repetitive potentials which were very similar for the same individual as well as symmetrical for each cavernous body (fig. 1).

Another group of 8 patients with diabetes mellitus showed a trace characterized by very long intercomplex intervals or no activity over periods of more than 20 min. The mean amplitude of the wave-like potentials was 100 µV or less (fig. 2).

Finally there was a group of 16 patients who displayed potentials of very long duration, very irregular shapes and sometimes complete 'anarchy' despite correct placement

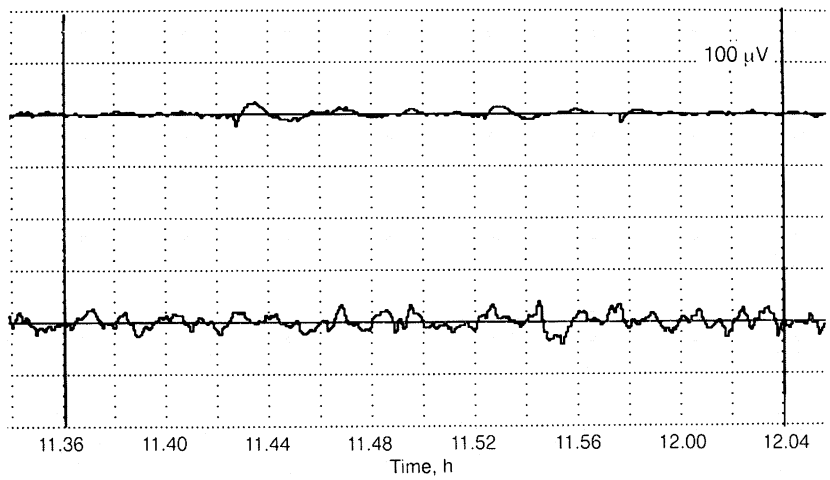


Fig. 2. Very low amplitude recordings in a patient with diabetes mellitus (upper tracing: surface electrodes lower tracing: coaxial needle electrode).

Table 1. Normal potential characteristics (means ± SD) for surface and monopolar needle electrodes measured in 23 impotent patients (median age = 57 ± 6.5 years)

	Surface electrodes	Monopolar needle electrodes
Potential shapes	3±1.76	2±1.38
Frequency, n/min	0.95±0.51	0.90±0.46
Potential duration, s	15±5.7	12.5±6
Polyphasity	11±4.4	10.5±4.7
Amplitude, μV	225±81	350±92

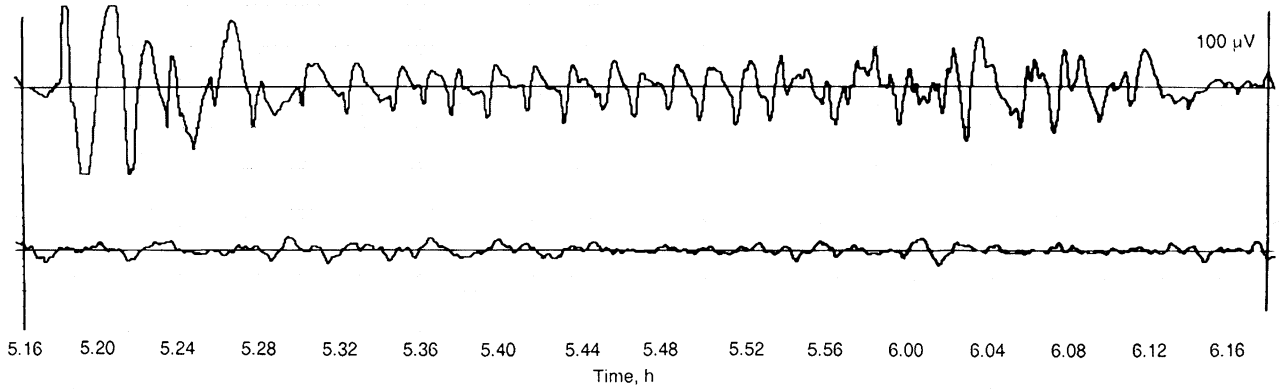
of electrodes and complete relaxation (fig. 3), among these, the 3 patients with upper motor neuron lesions. Overall potentials measured by coaxial electrodes were sharper and of shorter duration when compared with the surface electrode recordings.

Our last 36 patients were evaluated with a similar technique, but we used monopolar needle electrodes instead of coaxial electrodes. The main advantage of the monopolar needle recordings was that stress and electrode positioning rarely influenced recordings. We were able to interpret the recordings in all of the patients in this group.

In this last group of patients 24 recordings were considered as normal since similar and repetitive potentials were recorded for each patient (fig. 4). Characteristics of these potentials are summarized in table 1. Twelve patients (mean age 57 ± 13.6 years) had registrations which were considered abnormal. Of these, 8 were completely flat apart from some wave-like activity with an amplitude of less than 100 μV. Six of these patients suffered from insulin-dependent diabetes mellitus; one had experienced a priapism of 24 h; one had received radiotherapy for prostate cancer. Four patients showed 'anarchic' registrations with long salvos of electrical activity and lack of any analogy. Among these was one young patient with a unilateral posttraumatic pudendal nerve lesion (fig. 5).

Comparing the recordings done with different electrode types, the potentials measured by needle electrodes were sharper and of higher amplitude when compared with surface electrodes. Except for the first 10 min of registration, recordings were comparable for both types of electrodes. However in 10 patients interpretation of surface electrode recordings alone was not possible: low amplitude potentials could be recorded only with needle electrodes (fig. 6), and stress sometimes caused excessive activity measured by surface electrodes but did not influence the monopolar needle electrode measurements (fig. 7).

One patient was highly anxious during the recording with a vagal syncope consequently. At first, his trace showed potentials with very high amplitudes although they were similar and repetitive. After this syncope however the recordings were completely flat during more than 20 min. Table 2 shows the distribution of the 93 impotent patients with respect to penile electromyographic interpretations.



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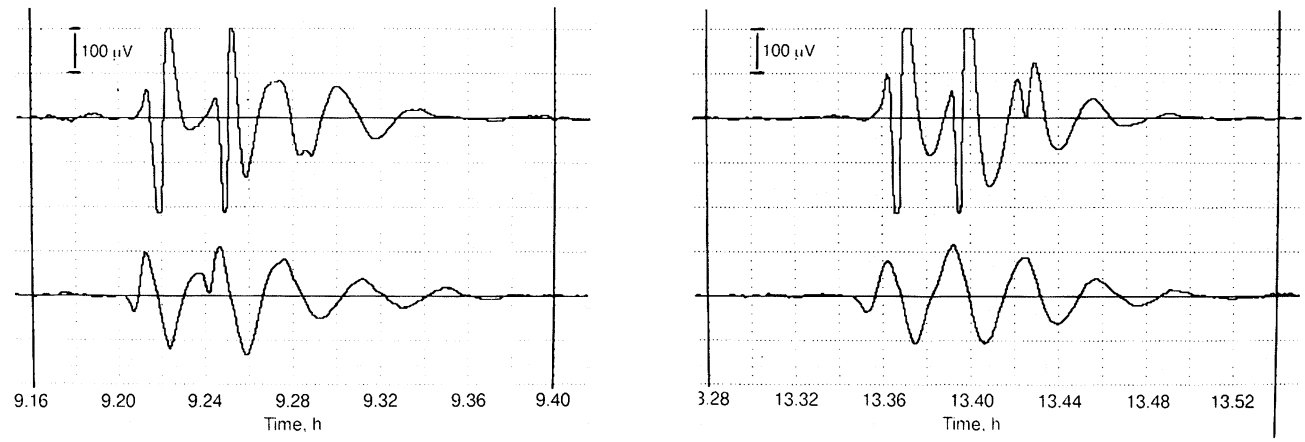

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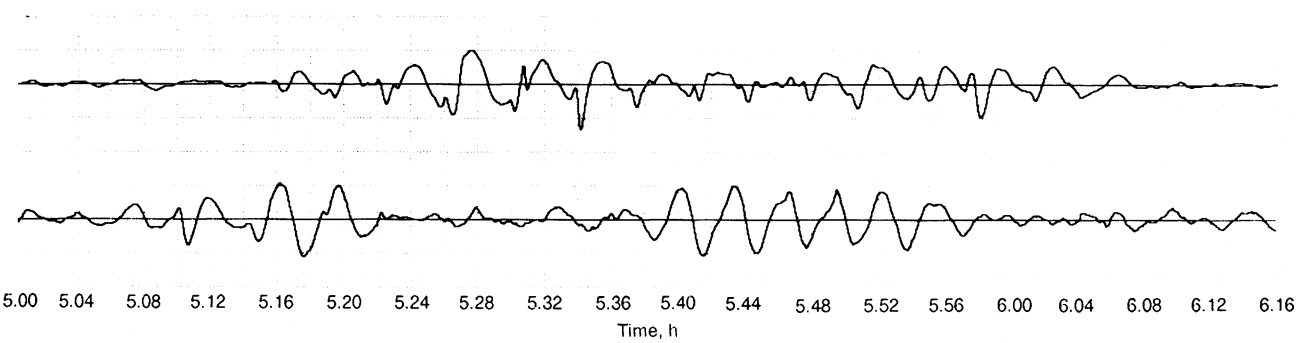

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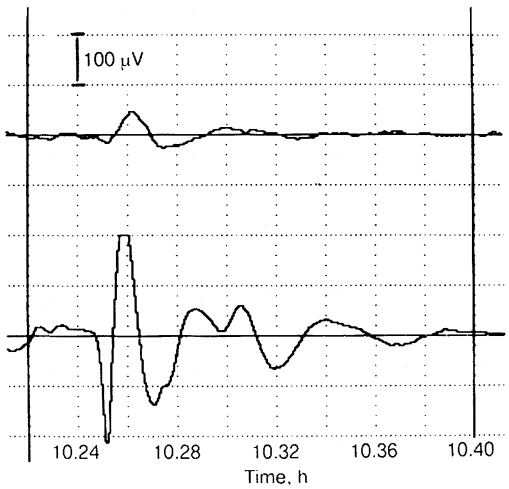
Fig. 3. Abnormally long potential in a recording made with a coaxial needle electrode in a patient with a cauda equina syndrome (lower tracing: electromyography of the pelvic floor).

Fig. 4a, b. Normal registrations made with monopolar needle electrodes (upper trace) and surface electrodes (lower trace) simultaneously. Potentials are similar and repetitive.

Fig. 5. Long volleys of electrical activity in a patient with a unilateral pudendal nerve lesion (upper trace: monopolar needle; lower trace: surface electrodes).



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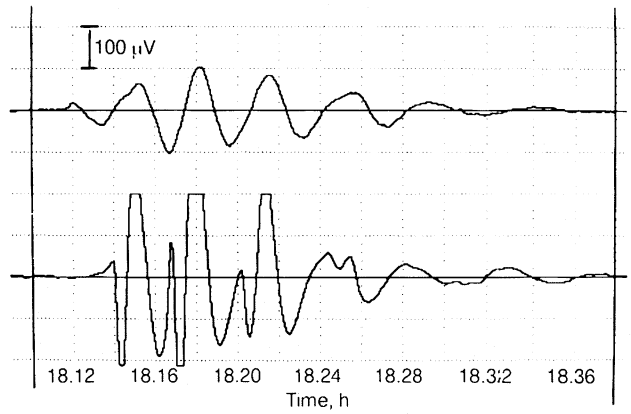

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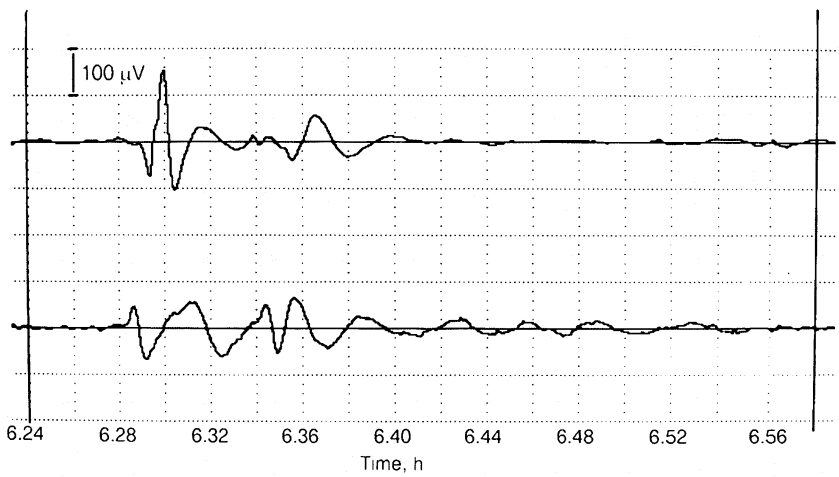

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Fig. 6. a Very low amplitude potential as measured with surface electrodes (upper trace) in contrast to monopolar needle recording (lower trace). **b** Registration of a higher amplitude potential in the same patient as in **a**.

Fig. 7. a Normal potential (upper trace: monopolar needle; lower trace: surface electrodes). **b** Measurement of SSR (lower trace) with surface electrodes only in the same patient.

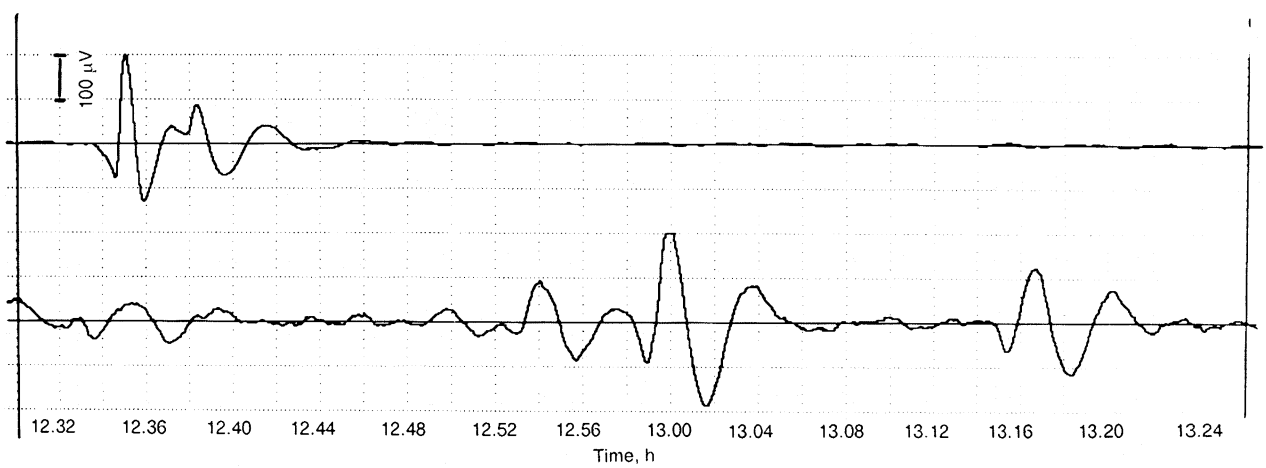

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Table 2. Distribution of 93 impotent patients with respect to penile electromyographic interpretation

	Normal (mean age = 52, range 23–81 years)	Abnormal (mean age = 49, range 28–77 years)	Not interpretable (mean age = 50, range 46–52 years)
Psychogenic	26	1	5
Venous leakage	11	8	2
Arterial insufficiency	9		
Diabetes	2	12	
After priapism		1	
Iatrogenic		1	
Neurotrauma		1	
Others	1	12	1
Total	49	36	8

Discussion

Fundamental neuropharmacological research has shown that detumescence is an active rather than passive process [4, 5]. It is most likely the sympathic penile outflow which is the important contributing system in this process [6].

Since norepinephrine release induces smooth muscle contraction in the corpora and penile vessels, it is reasonable to search for electrical activity in the flaccid penis.

Inserting coaxial needle electrodes in the corpora has enabled Gerstenberg et al. [7] and Stief et al. [1, 2] to make registrations of periodical wave-like smooth muscle contractions. These potentials are much like the sympathic skin responses (SSR) which can be measured at hands and feet after a painful or emotional stimulus [8]. SSR are typically 'flight or fight' reactions and are generally accepted as an objectivation of the sympathetic autonomic system.

We have been able to reproduce the results of Stief et al. [1, 2] by examining 93 impotent patients and 15 normal volunteers [9]. However we still found it unproven that the measured potentials were actually generated in the corpora and not reflections of SSR or other distant electromyographic events.

Our results have shown that skin electrodes and coaxial needle measurements are most susceptible to the patients' stress and anxiety: the first 10 min of most registrations are not interpretable due to desynchronisation secondary to high adrenergic tone. Simultaneous registration at hands and feet and in the penis in 6 psychogenically impotent patients has shown that even after 10 min some potentials measured are SSR and not penile smooth muscle potentials.

Therefore we used a type of electrode which is coated over its shaft in such a manner that only the inserted tip would pick up potentials. Monopolar sensory needle electrodes fulfil this requirement. Using this type of electrode has largely facilitated interpretation of the recordings. Firstly they enable an organ-specific registration which is not disturbed by SSR as proven by simultaneous recordings at hands and feet (fig. 8). For the same reason, even the first 10 min of the registrations proved interpretable. Secondly, since sharper potentials with higher amplitudes are measured than with surface electrode recordings, we consider this an argument that these potentials are generated in the penis itself. Lastly, orientation of the needles did not influence the recordings, as it would be expected in case the registered potentials were of skin origin.

Since potentials are of equal duration and they are as polyphasic as surface electrode potentials, we can assume that monopolar needle electrodes give an equally general appreciation of corporeal smooth muscle status. This is actually a shortcoming of the coaxial needle which only records a very small area of smooth muscle, reflected by shorter duration of measured potentials.

Finally we compared normal surface electrode recordings in 23 impotent patients with a mean age of 57 years (table 2) with our own normal values. In comparison with potential characteristics of 15 normal volunteers with a mean age of 33 years [9] we see a declining frequency (0.9 complexes/min versus 2.3 complexes/min) and a declining amplitude (350 vs. 540 μV). This may indicate an age-related decline in smooth muscle activity. A possible explana-

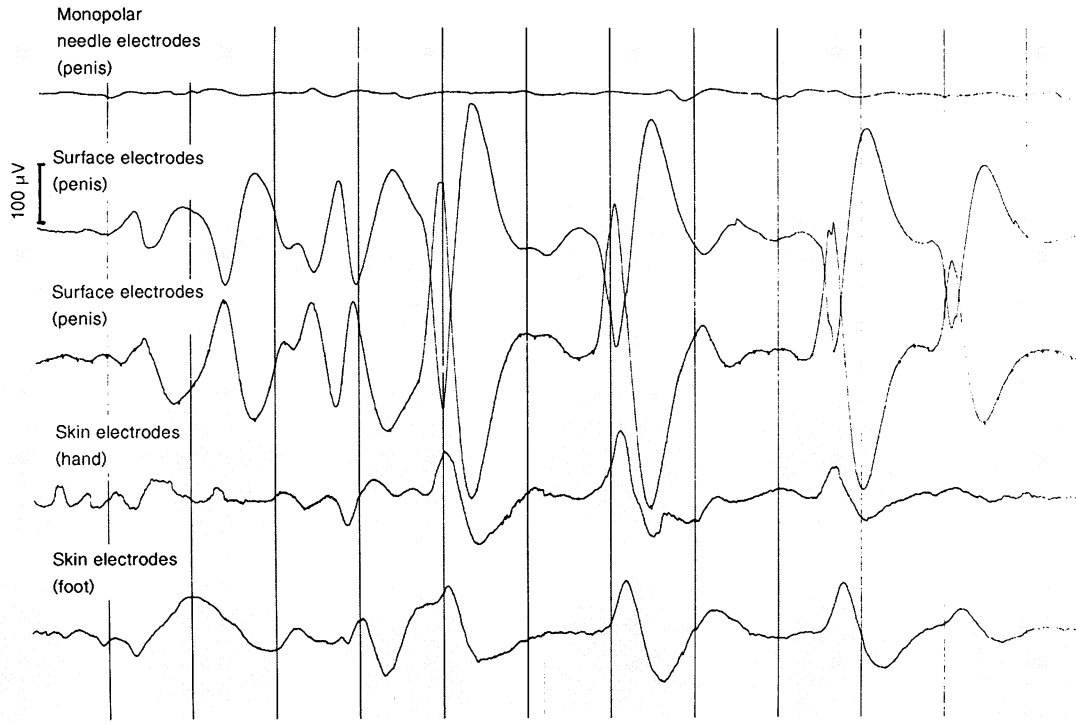

Fig. 8. Registration made with Schwartzer electro-encephalographic equipment. SSR was measured on the hand and foot and with surface electrodes on the penis. It was not present, however, at the penile needle electrodes.

tion is progressive smooth muscle atrophy which has been confirmed by others with computerized microscopic studies [10]. However it may also be secondary to a declining neuromuscular excitability or a central dysregulation.

Our study strongly suggests that penile electromyography is measuring a periodical and coordinated penile smooth muscle contraction. This sympathetically mediated activity however can be mimicked by sympathic skin responses. Insulated monopolar needle electrodes seem an appropriate way to filter out these confusing skin potentials, rendering a diagnosis of cavernous autonomic dysfunction and/or smooth muscle atrophy possible.

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