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Penile and perianal pudendal nerve somatosensory evoked potentials in the diagnosis of erectile dysfunction

T Kaiser[1], WH Jost[2], J Osterhage[1]*, H Derouet[3] and K Schimrigk[1]

[1]*Neurologische Klinik der Universität des Saarlandes, Homburg Saar, Germany;* [2]*Deutsche Klinik für Diagnostik, Wiesbaden, Germany; and* [3]*Urologische Klinik der Universität des Saarlandes, Homburg Saar, Germany*

Neurophysiologic examinations in differential diagnosis of erectile dysfunction comprise electromyogramme of the pelvic floor, pudendal nerve terminal motor latency (PNTML) and evaluation of pudendal somatosensory evoked potentials (SSEP). We focused our interest on comparing diagnostic importance of penile and perianal pudendal nerve SSEP.

We examined 20 patients suffering from erectile dysfunction and 20 patients without any manifestation of impotence. The stimulus was administered using penile ring electrodes at the base of the penis (cathode) and distally on the penis shaft (anode), as well as a perianal surface electrode applied at 3 o'clock in lithotomy position and 5 cm laterally on the gluteal skin. The potentials were recorded with intradermal needle electrodes at C_z–2 cm (different) and F_z (indifferent). 500 stimuli were averaged for a single tracing. The stimulus strength was set at an average of 3–4 times the stimulus threshold.

Cortical latency of P 40 ranged from 39.0 to 45.6 ms (penile) and from 33.6 to 43.2 ms (perianal) in the control group, in the patient group latencies ranged from 38.8 to 51.6 (penile) and 34.0 to 44.8 ms (perianal). In two patients no potential was recordable after perianal stimulation, one patient showed a marked prolongation of the penile response with a normal perianal latency. Penile and perianal latencies of P 40 were significantly prolongued in the patient group compared to the control group ($P < 0.05$).

The combination of penile and perianal pudendal SSEP may provide valuable additional information in differential diagnosis of erectile dysfunction, especially allowing to identify different sites of neurogenic lesions. In contrast to perianal pudendal SSEP, penile stimulation may help to discover pathologic changes in the distal course of the pudendal nerve, especially the dorsal nerve of the penis. *International Journal of Impotence Research* (2000) **12**, 89–92.

Keywords: erectile dysfunction; pudendal-SSEP; evoked potentials; penile latency; perianal latency

Introduction

Routine diagnosis of erectile dysfunction should include a comprehensive neurourophysiological evaluation in order to obtain additional information for the differentiation between organic (vascular, neurogenic) and functional causes.[1–4]

Clinical studies estimate that 10–15% of erectile disorders are of neurologic origin.[5] Together with a comprehensive history and physical examination of the patient, the neurophysiologic diagnostic evaluation remains important, since the clinical findings such as urogenital sensation, bulbocavernosus and cremaster reflex are rarely clearly pathologic.[1] Thus, these examinations form a necessary completion of urological tests that comprise hormonal profile, intracavernous pharmacological testing and sonography of the penile vessels. Amongst the well established neurophysiological methods are pelvic floor electromyography, assessment of the bulbocavernous reflex, but also more recently developed diagnostic tools such as pudendal nerve terminal motor latency (PNTML) and somatosensory evoked potentials of the pudendal nerve (pudendal-SEP).[2,6] However, these methods remain only indirect means to evaluate neurogenic control of erection, since they only assess the functions of the somatic nerve fibres. Evaluation of the penile sympathetic skin response (PSSR) and electromyogram of the corpus cavernosum allow additionally the evaluation of the integrity of the autonomic nervous system.[7]

Since the first publication of evoked potentials from stimulation of the dorsal penile or clitoral branches of the pudendal nerves by Haldeman *et al* in 1982,[8] numerous physicians have tried to define normal values for cortical latency of P1. A review of the current literature shows consistent normal

Correspondence: J Osterhage, Neurologische Klinik der, Universität des Saarlandes, 66421 Homburg Saar, Germany.
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values of penile latency not exceeding 45.0 ms. For the perianally evoked potentials, sufficient data are not yet available and, to our knowledge, the two methods have not been previously correlated. In 1988 Tackmann *et al* described the possibility of localizing neurogenic lesions in patients with neuro-urological disorders by combining somatosensory evoked potentials with the latencies of sacral reflexes. Especially with regards to topographic relations of presumed sites of neurogenic lesions, the possibility to examine selectively the different branches of the pudendal nerve becomes more and more interesting.[9] This will also facilitate a differentiation between central and peripheral lesions. Our interest therefore was focused on evaluation of the diagnostic relevance of penile and perianal pudendal SSEP by direct comparison of the methods.

Patients and methods

Patients

We examined 20 patients with underlying erectile dysfunction (mean age 45.5 y, ranging from 30 to 60 y) and 20 patients without any signs of erectile dysfunction or any other neuro-urological disturbance (mean age 50.8 y, ranging from 28 to 68 y). In the patient group, four patients had a long history of insulin-dependent diabetes mellitus, two patients had undergone extensive pelvic floor surgery (rectectomy), one patient suffered from spondylolisthesis L5/S1 and one other patient had Peyronie's disease that had been operated several times.

Methods

Stimulation was done with bipolar penile ring electrodes at the base of the penis (cathode) and further distally on the penile shaft (anode), perianal stimulation was performed using perianally placed surface electrodes at 3 o'clock in lithotomy position (cathode) and 5 cm lateral on the gluteal skin (anode). The potentials were recorded with intradermal needle electrodes from C_z–2 cm and F_z (reference electrode) according to the 10–20 system. A ground electrode was placed between the site of stimulation and the recording site (around the abdomen) in order to decrease stimulus artefacts. During the recording the patient was in supine position on the examination table with a slightly opened mouth and with the room lights dimmed.

Intensity of the stimuli in average were 3–4 times the threshold level, ie in penile stimulation ranged from 14.8 to 50.6 mA (mean 26.1 mA) in the patient group and from 13.0 to 50.0 mA in the controls (mean 25.1 mA). Threshold was considered the intensity at which the patient was first able to perceive the stimulus. In perianal stimulation the intensity of the stimuli ranged from 9.2 to 22.4 mA (patient group, mean 14.2 mA) and from 9.0 to 33.0 mA in the controls (mean 16.8 mA). First, the sensory threshold was determined, then the stimulation was done at maximally tolerable intensities (at least 2–3 times the threshold level) and with a frequency of 5 Hz. Sampling was done using the averaging-method from 500 responses. Measurements were repeated 2–3 times in order to ensure reproducibility of the response potentials.

Latency of P1 was defined as the first positive (downward) flection of the W-shaped averaged cortical waveform (Figure 1). If the response could not be reproduced at least twice or if the cortical response could not be clearly identified, the P1 was classified as not evokable. Statistical analysis was performed using the Student's *t*-test. A *P*-value of ≤ 0.05 was considered statistically significant.

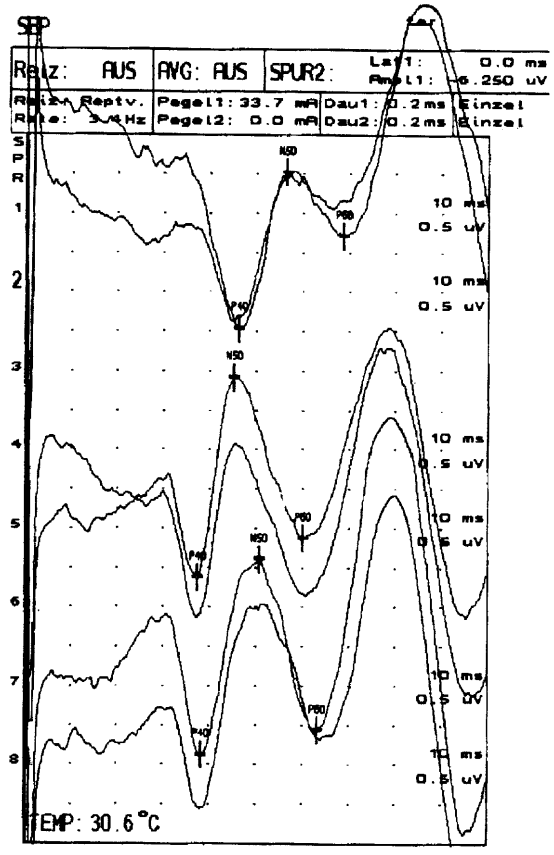

Figure 1 Examples of penile (upper trace) and perianal pudendal somatosensory evoked potentials (lower traces, left and right stimulation) positive peak 1 (P 40), negative peak (N 60), positive peak 2 (P 60) marked.

Results

Cortical latencies of P1 in the healthy subjects ranged from 39.0 to 45.6 ms (penile stimulation, mean 41.4 ms) and from 33.6 to 43.2 ms (perianal stimulation, mean 36.8 ms). The patients with erectile dysfunction had P1 latencies ranging from 38.8 to 51.6 ms (penile stimulation, mean 43.8 ms) and 34.0 to 44.8 ms (perianal stimulation, mean 39.1 ms). Considering normal latencies = 45.0 ms, one subject from the healthy group had a prolonged latency of 45.6 ms (5%), whereas three patients with erectile dysfunction had pathologic latencies of P1 (15%).

P1 latencies were significantly prolonged in the patient group compared with the healthy controls, both in penile and perianal stimulation ($P = 0.05$; Table 1). In two patients with erectile dysfunction (10%) and one healthy subject (5%), no perianal response could be obtained. One patient with erectile dysfunction had a normal perianal response but a markedly prolonged penile latency. In all of the healthy controls a reproducible penile response was obtained.

One patient, who suffered from Peyronie's disease and had been operated several times over the years, had normal perianal P1 latency but no recordable penile response, which underlined an iatrogenic lesion of the dorsal nerve of the penis.

Discussion

Comprehensive neuro-urological diagnostic evaluation of erectile dysfunction requires not only a combination of clinical and urological examination, but also a careful neuro-physiological evaluation of the pelvic floor.[2,10]

In our 20 patients that all suffered from year-long erectile dysfunction, both the penile and perianal pudendal SSEP performed on them were significantly prolonged compared with our control group of healthy subjects.

Although only three patients had latencies that were clearly pathologic according to the reference values from literature, it is our opinion that at least in some patients the relatively prolonged latencies may be related to a beginning neuropathy. In some cases, diabetic neuropathy is the most likely cause for the prolonged latencies,[10,11] while in other cases we found no distinct pathology. Normal latencies were also found in the patient group, in these subjects a neurogenic cause for erectile dysfunction is less probable, if additional electrophysiological testing (such as PNTML, penile sympathetic skin response, pelvic floor electromyography) is also normal.

The difference in mean latency of P1 between penile and perianal stimulation (in both the patient group and the controls) is partly due to the longer anatomic pathway between the site of stimulation and that of recording. In penile stimulation, which is done on the base of the penile shaft and transmitted via the dorsal nerve of the penis, the pathway is usually longer than in perianal stimulation, where the stimulus is transmitted via the perineal branches of the pudendal nerves. This requires separate reference values for perianal and penile latencies, which have only been scarcely mentioned in the literature.

Independent from the difference in latency, the combination of penile and perianal pudendal nerve SSEP may provide valuable additional information in differential diagnosis of erectile dysfunction, especially with regards to different sites of neurogenic lesions.[12] The examinations were well tolerated by the test patients, since all were able to determine the maximum stimulus intensity by themselves. In contrast to the perianally evoked potential, penile stimulation facilitates the detection of pathological changes within the distal course of the pudendal nerve, especially the dorsal nerve of the penis. This seems to be an important fact, since there is reference in the literature that penile sensory disorders may play an important role in erectile dysfunction.[6,13] Especially in elderly patients, increased deposition of collagen, arteriosclerotic changes and progressive peripheral neuropathy are thought to be responsible for these sensory deficits. In this context it is notable that in our study an increased stimulus threshold, ie tolerance of higher stimulus intensities, was frequently associated with a relative shortening of P1 latency. Nevertheless, in the case of both pathological penile and perianal pudendal somatosensory evoked potentials, complementary diagnostic evaluation with tibial nerve SSEP should take place, which in combination would allow a clear

Table 1 Comparison of cortical latencies of P1 after penile and perianal stimulation in the patient group and healthy controls

	Patient group n = *20* *P1 latency (ms)*	*Controls* n = *20* *P1 latency (ms)*	P-*value*
Penile stimulation	43.8 ± 3.89	41.4 ± 2.38	≤ 0.05
Perianal stimulation	39.1 ± 2.70	36.8 ± 2.86	≤ 0.05

distinction between central and peripheral lesions.[11,13] With a normal result in tibial nerve SSEP a relevant lesion of the dorsal spinal column as a cause of erectile dysfunction can usually be ruled out.

Although at present the evidence of a pudendal lesion yields almost none or only limited therapeutic options, neurophysiological testing of the nerval and muscular structures of the pelvic floor should, at least in some cases, enable the detection of previously unknown organic causes of erectile dysfunction when urological examinations are normal.

Conclusions

Diagnostic considerations in erectile dysfunction should be based on an extensive multispeciality neuro-urological approach in order to exclude subclinical neurogenic lesions.

As was seen in one of our patients suffering from Peyronie's disease that had been operated on several times, additional simultaneous evaluation of penile and perianal pudendal nerve SSEP in some cases may allow the differentiation between lesions of separate branches of the pudendal nerve, especially in the course of the dorsal nerve of the penis. In combination with other electrophysiological tests such as tibial nerve SSEP, EMG of the pelvic floor, PNTML and penile sympathetic skin response, neurogenic causes of erectile dysfunction may be ruled out or, if present, the site of the lesion may be localized.

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