Evoked Cavernous Activity: Normal Values

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Purpose: We present normative data for evoked cavernous activity, an electrodiagnostic test that evaluates the autonomic innervation of the corpora cavernosa.

Materials and Methods: We enrolled 37 healthy, sexually active and potent men for the study. Each subject completed an International Index of Erectile Function questionnaire, and underwent simultaneous evoked cavernous activity and hand and foot sympathetic skin response testing. The sympathetic skin response tests were performed as autonomic controls.

Results: A total of 36 men had discernible evoked cavernous activity and sympathetic skin responses. The mean International Index of Erectile Function erectile domain score was 27. Evoked cavernous activity is a low frequency wave that is morphologically and temporally similar in both corpora. The amplitudes of the responses were highly variable. The latencies, although variable, always occurred after the hand sympathetic skin response. There was no change in the quality or the latency of the evoked cavernous activity with age.

Conclusions: Evoked cavernous activity is measurable in healthy, potent men in a wide range of ages. Similar to other evoked responses of the autonomic nervous system, the measured waveform is highly variable but its presence is consistent. The association between evoked cavernous activity and erectile function is to be determined.

Key Words: penis; autonomic pathways; diagnostic tests, routine; galvanic skin response

In healthy men neural impulses travel through the cavernous nerves to mediate penile vascular changes during erection and detumescence. In men with erectile dysfunction due to neurological causes the impairment is either in the branches of the somatic pudendal nerve or the autonomic fibers of the cavernous nerve. In most instances of neurogenic ED the cavernous nerve pathways are impaired. However, an accurate diagnosis is difficult without some means of assessing the extent of nerve impairment. A reliable, easy to use diagnostic method to accurately confirm cavernous nerve impairment would improve urologists' ability to accurately diagnose and treat neurogenic ED.

Diagnosing cavernous nerve impairment has been difficult because of problems measuring electrical activity within the corpus cavernosum. Recent advances in clinical electrophysiology now allow for consistent recording of intrapenile electrical activity. One promising method called evoked cavernous activity can be recorded following a brief, startling stimulus. The noxious stimulus results in a generalized, sympathetic nervous system discharge that manifests throughout the body including the corpus cavernosum. When the discharge is carried through the cavernous nerves it can be recorded in the corpora cavernosa.[1,2] If the sympathetic innervation to the corpus cavernosum is disrupted then ECA will not be present following the startling stimulus.

Our earlier study showed that the presence of ECA is absent in men with dysautonomias[2] and in most men following nonnerve sparing radical pelvic surgery compared to a group of men after nerve sparing pelvic surgery.[3] We report the results of normative ECA data collected from a group of healthy men with intact erectile function to answer 4 questions. 1) What is the normal range of amplitude and latency of ECA in healthy men with intact erectile function? 2) Is there a relationship between ECA and SSR? 3) Is ECA similar in both corpora cavernosa? 4) Does ECA change with age?

METHODS

The study protocol was approved by the Human Subjects Review Committee of our hospital, and a written informed consent was obtained from each subject. A total of 37 men 19 to 68 years old (mean 38.9, SD 16.8) were recruited from advertisements posted in our medical center and medical center website. The men were healthy and sexually active. Exclusion criteria included moderate to severe systemic disease including but not limited to cardiovascular disease, obstructive pulmonary disease, autoimmune disorder, untreated hypertension, morbid obesity (body mass index greater than 40), and neurological disease such as stroke, neuropathy, multiple sclerosis, spinal injury or diabetes; use of medications that impair central or peripheral autonomic nerve function, particularly sympatholytics (eg alpha adrenergic blockers); current drug or alcohol abuse, or major psychiatric disorder; and unwilling or unable to complete the questionnaire. Each subject underwent a history and physical examination, with a detailed neurourological examination of the

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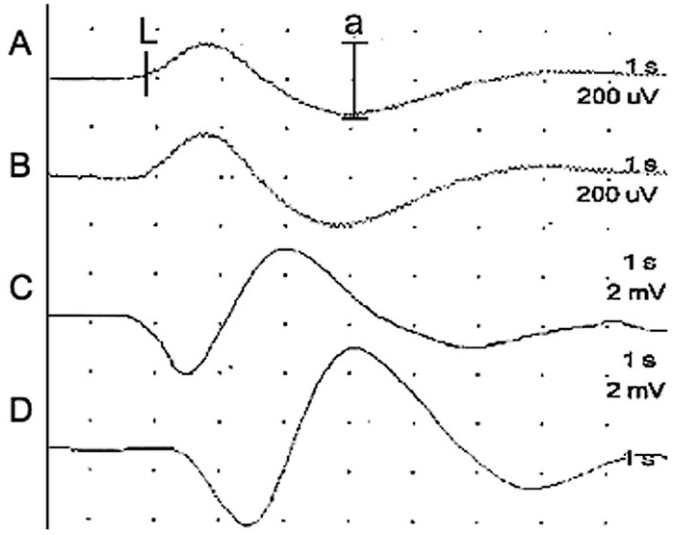

FIG. 1. ECA and SSR responses. *A*, left corpus cavernosum ECA. *B*, right corpus cavernosum ECA. *C*, hand SSR. *D*, foot SSR. Stimulus is delivered at time zero, designated by vertical line on left. Latency (*L*) is measured from onset of stimulus to start of response. Amplitude (*a*) is measured from peak to peak. ECA responses from both corpora are similar in morphology and latency, temporally related to SSR responses from hand and foot, supporting autonomic nature. Time base 1 second/div.

lower extremities and genitalia. Each subject completed the IIEF.[4]

ECA Testing

With the subject supine and comfortable a startling but nonpainful electrical stimulus was delivered to the left median nerve from a Viking IV electrophysiology machine (Viasys Healthcare, Madison, Wisconsin) via surface electrodes. The single stimulus was in the range of 5 to 7 mA and lasted approximately 0.5 msec. This brief stimulus was adequate to activate a generalized sympathetic nervous system response. ECA, which is a manifestation of the sympathetic (and therefore, autonomic) activity within the penis, was recorded from both corpora cavernosa through concentric 28 gauge needle electrodes placed into the corpora at the lateral aspect of the base of the penis. The tip of the electrode was positioned in the center of the corporal body. The recording electrodes were connected to an amplifier on the electrophysiology machine and waveforms stored for further analysis. The bandpass filters were set to low (0.2 to 100 Hz) frequencies. A ground plate was affixed to the skin overlying the right anterior/superior iliac crest.

The median nerve stimuli were delivered at irregular intervals of 60 to 120 seconds. The ECA response can fade (habituation) if the subject is drowsy or is no longer startled by the stimulus. If ECA was reproducibly present following the first 6 stimuli, then no further stimuli were given. If ECA was not readily identifiable following all of the first 6 stimuli, then more stimuli were delivered, up to a total of 12. The latency was measured at the first deflection from baseline following the stimulus delivery and amplitude measurements were made peak to peak (fig. 1). The measurements of 3 of the most readily identifiable responses were averaged for a final latency or amplitude value.

Sympathetic skin responses, which are electrophysiological measures of dermal sympathetic activity, were measured simultaneously from the hand and foot contralateral to the median nerve stimulus. These responses were recorded as a control for the presence of a generalized sympathetic discharge. Latency and amplitude measurements of the SSRs from the hand and foot were measured in standard fashion using the values from the waveforms obtained during the same trials as the selected ECA responses.[5]

Statistical Methods

Descriptive analysis was performed for all variables collected. Histograms were created to show the distribution of the amplitude and latency by left/right sides. Pearson correlation, visual displays and linear regression analysis were used to study whether and how the right and left sides were correlated, as well as to study changes in amplitude and latency by age.

RESULTS

Of the 37 men enrolled in the study 36 had discernible SSRs and ECA. One subject had SSRs that were not easily interpretable, likely due to anxiety with a resultant sustained sympathetic discharge and no discernible voltage differences in the end organs following the stimuli. Mean IIEF erectile domain score was 27.

Morphology

ECA is a low frequency wave, and the most notable component is a negative (upward) deflection from baseline (fig. 1). Both corpora cavernosa demonstrate simultaneous or nearly simultaneous occurrence of the ECA waveform and both negative waves share the same or nearly the same slope/degree of incline. In no instance did we find ECA in 1 corpus but not the other. Some subjects had an ECA waveform that began with a small positive (downward) deflection, followed by a negative deflection. Occasional spontaneous discharges occurred during the ECA wave and were shorter in duration than the ECA response (fig. 2).

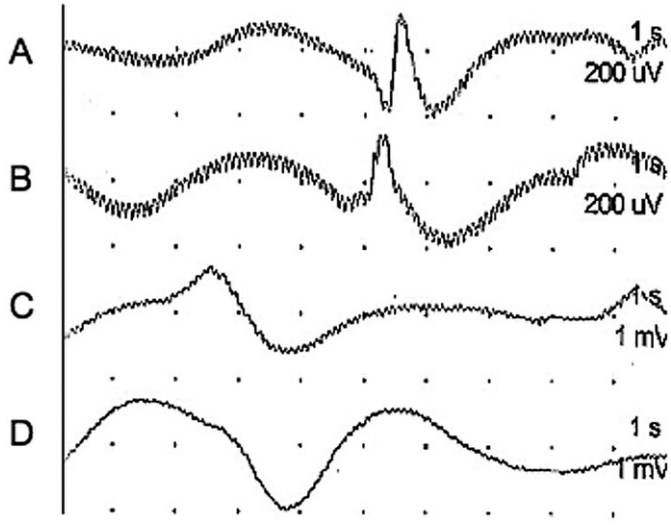

FIG. 2. Demonstration of spontaneous corporal activity (spikes) occurring between 5 and 6 seconds. It occurs in both corpora, is not simultaneous and does not appear in SSRs. *A*, left corpus cavernosum ECA. *B*, right corpus cavernosum ECA. *C*, hand SSR. *D*, foot SSR. Time base 1 second/div.