The Course of Inhibition of Sympathetic Activity during Various Patterns of Carotid Sinus Nerve Stimulation*

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Summary. In 63 chloralose-urethane anaesthetized dogs both carotid sinus nerves (CSN) and cervical vagal nerves were cut and the sympathetic activity was recorded.

During bilateral CSN-stimulation for 2 min the following pattern of sympathetic inhibition was observed:

a) A complete inhibition took place after a latency of 181 ± 23 msec. This initial inhibition increased with increasing stimulation frequency up to a maximal tested frequency of 150/sec.

b) After this initial inhibition sympathetic activity increased and reached a steady state level. The time required for this adaptation increased up to stimulation frequencies of 30-40/sec and remained constant at 20-30 sec at higher frequencies. Maximal steady state inhibition was obtained with frequencies of 20-30/sec.

c) In comparison to CSN stimulation with continuous and interrupted trains the latter reduced the adaptation and was more effective in steady state inhibition of sympathetic activity.

Key-Words: Carotid Sinus Nerve Stimulation — Sympathetic Activity — Central Adaptation — Frequency Response Curve — Baropacing.

Schlüsselwörter: Carotissinusnervenreizung — Sympathicusaktivität — Zentrale Adaptation — Frequenzantwortkurve — Baropacing.

The initial reduction of heart rate brought about by carotis sinus baroreceptor stimulation with constant pressure returns partly toward the control level if the stimulation is continued [23]. This could also be demonstrated after exclusion of the residual baroreceptor afferents in the aortic nerve [23]. After Landgren’s [27] analysis of the adaptation process of the baroreceptors themselves these results were generally taken as the explanation for the adaptation in the whole baroreceptor reflex system. At the same time an additional adaptation process was suggested to take place within the central pathway of baroreceptor activity [5, 26, 39]. The existence of this central adaptation as indicated in blood pressure and sympathetic activity was recently shown during electrical stimulation of the carotid sinus nerves [24].

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Sympathetic Inhibition Induced by Carotid Sinus Nerve Stimulation

The purpose of this investigation was a quantitative analysis of this central adaptation, its time course and its relation to various frequencies and patterns of the stimulation of baroreceptor afferents. Preliminary results were already published [32].

Methods

63 mongrel dogs of both sexes and different weights were used. They were anaesthetized by intravenous injection of chloralose-urethane (chloralose: 50–60 mg/kg; urethane: 250–300 mg/kg).

The femoral vein and artery were catheterized and a tracheotomy was performed. The animals were paralyzed with Gallamine triethiodide (1–2 mg/kg intravenously) and artificially ventilated. Body temperature was maintained within 35–38°C. The carotid sinus nerves, cervical vagal nerves, right phrenic nerve and in some experiments the left aortic nerve and/or the cervical sympathetic nerve were exposed through a ventral approach and cut distally. The abdominal sympathetic chain and the splanchnic nerves were exposed from the abdominal side.

In order to record the resistance to flow in muscle vessels in some experiments the m. gracilis was completely isolated from the systemic circulation while the connection with the nervous system was left intact. This preparation was artificially perfused with blood of the same or of a donor animal.

Recording and Stimulation Techniques

The central ends of the sympathetic and the phrenic nerves were suspended on bipolar platinum electrodes in a pool of warm liquid paraffin. The action potentials of the sympathetic nerve were differentially amplified and displayed on a cathode-ray oscilloscope and monitored by a loudspeaker. Simultaneously the impulse activity of the sympathetic nerve, its averaged value and the impulse activity of the phrenic nerve were continuously written on a penrecorder. The resistance to blood flow of the perfused isolated m. gracilis was recorded by a differential pressure method [25].

The central end of the carotid sinus and aortic nerves were stimulated through bipolar platinum electrodes with square wave pulses of 0.01–0.1 msec in duration and 2–14 V in intensity at various frequencies. During stimulation with trains the train duration was 330 or 500 msec with an interval of 500 or 660 msec between the trains. The frequency of pulses within the trains was set so that the total number of pulses for any stimulation period was identical to that of continuous stimulation pattern.

Results

1. Adaptation in Blood Pressure, Resistance to Flow in Isolated Muscle Perfusion, Sympathetic and Phrenic Nerve Activity

After the onset of the carotid sinus nerve (CSN) stimulation the blood pressure was reduced, reaching its minimum value in about 10–20 sec and then returned partly toward control level although the stimulation was continued with the same intensity (Fig.1). The time course of the reduction was dependent on the stimulation frequency. The steady state level was reached within about 60 sec after the stimulus.