The Effect of Carotid Sinus Nerve Stimulation on Muscle and Skin Nerve Sympathetic Activity in Man

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Summary. Microelectrode recordings of multi-unit sympathetic activity were made in the right peroneal nerve of 4 awake human subjects during carotid sinus nerve stimulation. 36 periods of CSN-stimulation gave in all cases an inhibition of the muscle nerve sympathetic activity and there was good temporal agreement between this effect and the reduction of heart rate and blood pressure. The neural inhibition was marked during the first part of the stimulation but with continued stimulation the sympathetic activity reappeared, in most cases with reduced strength. In contrast, 20 periods of CSN-stimulation had no reproducible effect on skin nerve sympathetic activity. In most cases, the neural activity remained unchanged but both increases and decreases could occur. The results demonstrate that stimulation of carotid sinus baroreceptors in man has different effects on sympathetic outflow to different regions: A clear inhibition of the outflow to the muscles but no discernable effect on impulses destined to the skin.

Key words: Sympathetic Activity — Baroreceptors — Carotid Sinus Nerve Stimulation — Baropacing.

In most investigations concerning the influence of the carotid sinus reflex upon different vascular beds, various haemodynamic parameters have been used as indices of the strength of the sympathetic vasoconstrictor outflow to the vessels. On the basis of such studies it is now generally agreed that the vascular bed of skeletal muscle is an important target of the carotid sinus reflex [1,2,4,11,18,24,25]. In contrast, the skin vascular bed has been considered unresponsive to baroreceptor stimuli [12,21]. On this point, however, the experimental evidences are somewhat conflicting and although the conclusion seems to apply for cutaneous veins [11] and arterio-venous anastomoses [16] it has been reported that carotid sinus stimuli have reflex effects on skin resistance vessels [1,16,20].

With the development of a technique for recording sympathetic action potentials in human peripheral nerves [14] a new way of studying
the effect of baroreflex stimuli on different vascular beds in man was introduced. In such recordings, an analysis of the temporal pattern of the spontaneously occurring muscle nerve sympathetic activity (MSA) revealed an intimate correlation between the nerve activity and the arterial blood pressure variations, indicative of a baroreflex modulation of the neural outflow \[6, 23\]. Although no direct evidence was available from these experiments, the effects were supposed to be brought about to a large extent by the aortic arch and carotid sinus baroreceptors. In contrast no similar signs of baroreflex modulation were detected in skin nerve sympathetic activity (SSA) \[13\].

In the investigation to be reported here, MSA and SSA have been recorded during electrical stimulation of the carotid sinus nerves in angina pectoris patients with chronically implanted stimulation electrodes. The aim of the experiments was: a) To provide direct evidence that the carotid sinus baroreceptors affect the outflow of sympathetic impulses in human muscle nerves. b) To investigate whether any reproducible effects of the stimulation could be detected in the SSA. A preliminary report of part of the results has been given previously \[9\].

**Methods**

*Material.* 7 recordings were made on 4 males, 40—51 years of age. They suffered from severe angina pectoris and were selected for treatment with carotid sinus nerve stimulation (CSN-stimulation) because conventional treatment had been inadequate in controlling the chest pain. The CSN-stimulating electrodes were implanted bilaterally at least 6—8 weeks before the recordings were made. At the time of the study the subjects were all in sinus rhythm and showed no clinical symptoms of congestive heart failure. 3 subjects were on Digitalis and 1 on Verapamil. None had \(\beta\)-adrenergic blocking drugs.

The CSN-stimulating system used was the Angistat model 4001 (Medtronic Inc., U.S.A.) generating electric pulses with a duration of 350 \(\mu\)sec at a fixed frequency of 100 Hz. The amplitude of the stimulating pulses could be varied between 1—8 volts and was adjusted individually.

The nerve recordings were made by insulated tungsten microelectrodes with a tip diameter of a few \(\mu\), which were inserted manually through the intact skin into a muscle or skin nerve fascicle in the right peroneal nerve at the fibular head. Details about the technique as well as the methods for storing and displaying the nerve signals have been described previously \[6\]. The nerve fascicles were identified by the type and site of the peripheral test stimuli required to induce afferent responses. For skin nerve fascicles the receptive field was mapped with touch stimuli and the muscle nerve fascicles were identified by taps on the muscle belly and muscle stretch. After having identified the fascicle minute electrode adjustments were made until a recording position was found where spontaneously occurring sympathetic impulses could be recorded. At rest the multi-unit sympathetic impulses recorded in muscle nerve fascicles occurred in rather distinct pulse synchronous burst sequencies during temporary blood pressure reductions. In skin nerve fascicles, on the other hand, they occurred in more irregular bursts without sign of pulse synchrony and during all phases of the spontaneous blood pressure variations.