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Inhibition of muscle sympathetic nerve activity during yawning

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Case Report

Yawning is a complex event that depends largely on the autoi nomic nervous system. Microneurographic techniques were used to study the mechanism involved in yawning. A series of spontaneous yawns displayed by a healthy 39-year-old male offered us the opportunity to study the muscle sympathetic nerve activity (MSNA) during this phenomenon. It was found that 2 s of yawning inhibited the MSNA recorded at the right peroneal nerve in the lateral knee area, while 3 s of slow expiration succeeding a yawn provoked an MSNA discharge. Blood pressure decreased with each slow expiration by 5-6 mmHg, and increased again with the renewed MSNA discharge. We conclude that yawning is associated with a sympathetic suppression that favours a parasympathetic dominance, as indicated by the MSNA and the decrease in blood pressure. The slow expiration following a yawn is associated with a sympathetic activation marked by an MSNA discharge and an increase in blood pressure.

Introduction

Yawning involves a spontaneous and involuntary wide opening of the mouth and a widening of the jaw, together with a long, deep inhalation through the mouth and nose followed by a slow expiration associated with a feeling of comfort.

The complex neuronal reflex system of yawning appears te, be located in a reticular brainstem system closely related through the diencephalo-hypothalamic network with large associative cortical areas. In animals it subserves behaviour related to stressful situations, and in humans behaviour related to fatigue and boredom, suggesting an arousal defence reflex. It is well known that lung inflation can inhibit sympathetic outflow to limb vessels, se, that most of the sympathetic outflow to skeletal muscles takes place at the end of expiration or early during inspiration, but is inhibited by the peak of inspiration.

In this article we offer a new insight into the mechanism of yawning, which as fat as we know has not previously been studied by the microneurographic technique. During a microneurographic examination of the sympathetic nervous system, the appearance of spontaneous repeated yawning in a healthy control subject has made it possible to demonstrate the involvement of the autonomic nervous system in yawning.

Subject and methods

The subject was a healthy 39-year-old male volunteer who displayed “repetitive yawning”.
A tungsten microelectrode with a lip diameter of 2 μm and a resistance of 1-10 meg was inserted, without sedation, into the right peroneal nerve in the lateral knee area of the subject as he lay supine. The sympathetic axon fascicles were detected by delicate manipulation based on acoustic and visual techniques. The sympathetic output, filtered by a DAM50 differential amplifier (World Precision Instruments, Saratoga, FL, USA), gain 60 dB, passed through a Neurogram amplifier/integrator and noise rejector (Nagoya University, Japan). The resulting sympathetic signal, together with the blood pressure (BP) and pulse rate (recorded through a Finapres Ohmeda 2300, BOC Heaith Care, Louisville, CO, USA), were displayed on a Nihon Kohden thermal array recorder (Tokyo,Japan).

Results

A microneurographic recording of the volunteer is presented. Muscle sympathetic nerve activity (MSNA), BP and pulse rate were recorded and evaluated during a series of 33 spontaneous yawns lasting 5-7 s each, uttered by the subject as he lay supine. Two seconds of yawning were enough to suppress MSNA, while expiration provoked an MSNA discharge. With each yawn and MSNA suppression, the systolic and diastolic BP decreased, after a delay of 5 s. By increasing the MSNA, each expiration increased the BP, after a shorter delay of only 3 s. The mean decrease in the systolic and diastolic BP was 5-8 mmHg. Figure 1 shows MSNA, BP and pulse behaviour during regular breathing, VàIsa1va~s manoeuvre, forced breathing and repeated yawning.
The heart beat was not significantly affected by the variations in MSNA or BP, but a tendency to bradycardia during yawning was observed. Yawning provoked changes similar to those of forced breathing, while normal breathing and Valsalva~s manoeuvre did not.

Discussion

The similarities between forced breathing and yawning in this case study offer a possible explanation for the fact that 2 s of yawning inhibit MSNA, while 3 s of slow expiration provoke an MSNA discharge. During the deep inhalation associated with yawning, the efferent sympathetic nerve traffic is blocked and the autonomic nervous system moves to parasympathetic activity, which is simultaneously stimulated by the pulmonary vagal afférents. The associated changes in BE which are synchronized with each yawn and consist of a reduction of 5-6 mmHg of the systolic and diastolic arterial pressure, seem to be the direct consequence of the sympathetic outflow suppression. It may be suggested that the decreased BP excites baroreceptors, principally those of the carotid sinus afférents (through the glossopharingeus) and of the aortic arch (through the vagus). Once the stimuli have reached the tractus nucleus solitaris, the sympathetic ganglions enter a state of excitation which is expressed by MSNA discharges appearing 3 s after yawn cessation. Such a mechanism would explain why the BP rises by 5-6 mmHg until the next yawn or forced inspiration starts. The variation in heart rate observed during yawning and forced breathing was not significant, but as a consequence of the vagal effect of yawning there is a tendency for the heart beat to decrease. These variations are not synchronized with the BP.

The MSNA discharges blocked by yawning may explain the association with the peripheral vasodilatation, pende erection and increased peristalsis that have been described in animals and humans as the result of a cholinergic dominance.

This case study offers an explanation for the mechanism by which vaso-vagal syncope appears in the wake of repeated or prolonged yawning.

Conclusion

Yawning is a complex event that involves an extensive network of neurons and interneurons and a large number of neurotransmitters. Although our study deals with only one subject, the findings were so regular and consistent throughout a long series of yawns that we believe them to demonstrate the involvement of the autonomic nervous system in the yawning process: a parasympathetic response to yawning itself, and a sympathetic reaction to the slow expiration that succeeds it.

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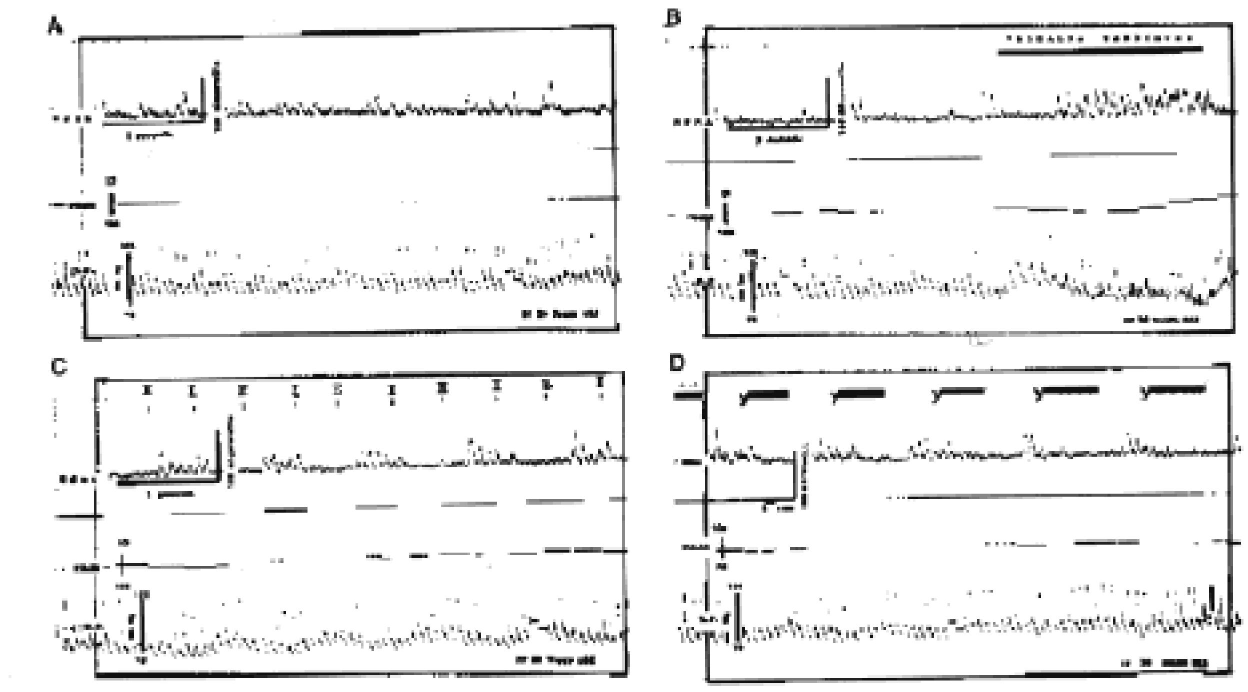

Figure 1. Muscle sympathetic nerve activity (MSNA), blood pressure (BP) and pulse during (A) regular breathing, (B) VaIsalva's manoeuvre, (C) forced breathing and (D) repeated yawning. In normal breathing, random MSNA activity is associated with a relatively stabilized BP and heart beat. In Valsalva's manoeuvre, the sudden drop in BP is associated with a sustained MSNA activity. During yawning and in forced breathing, there is a rhythmic inhibition of MSNA with each inspiration, associated with a drop in BP, and a rhythmic MSNA activation with each expiration, associated with an increase in BP. E, expiration; 1, inspiration; Y, yawning