

Sympathetic skin responses of the face and neck evoked by electrical stimulation [☆]

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Abstract

The sympathetic skin responses (SSRs) were recorded from different facial regions and neck in 25 subjects evoked by electrical stimulation of the median nerve at the wrist. Recordings from all regions were cross-compared with each other and within right and left sides individually. In one subject postauricular SSR, and in another subject upper lip SSR could not be elicited on both sides. Other responses could be obtained in all the remaining subjects. In 11 subjects, the responses did not appear by the first stimulus, and began to appear by repeated stimuli. Mean latencies and the highest amplitudes of the responses were similar for both sides. Gradual amplitude increase was observed in the first three or four set of responses in 20 subjects, although the stimulus intensity was constant. In conclusion, face and neck SSRs are symmetric, can be evoked by electrical stimulation and can be used to investigate the sympathetic innervation of these areas.

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1. Introduction

Sympathetic skin response (SSR) is an easy and a non-invasive test for analyzing autonomic sympathetic function (Shahani et al., 1984; Gutrecht, 1994). In many diseases, such as primary headaches and Meniere's disease, sympathetic nervous system dysfunction is considered to play a role in pathogenesis (Uemura et al., 1980; Drummond, 1996; Yamada et al., 1999; Mylius et al., 2003; Atasoy et al., 2004). In these diseases, autonomic nervous system functions were investigated by different tests, i.e., presence of abnormality in cardiac rhythms, sweating tests, vascular responses and pupillary reaction to different types of stimuli.

Nordin (1990) recorded sympathetic discharges in the human supraorbital nerve by microneurography and explained the properties of the sympathetic nervous innervation of the forehead region. In one case report of pediatric Harlequin syndrome, the skin conductance response in the face was used to show sympathetic interruption (Padma et al., 1999).

SSRs from palmar and plantar skin have been extensively studied. However, there have been few studies of the facial SSR evoked by electrical stimulation. Even in diseases involving the face that possibly result from autonomic dysfunction, there is little or no use of SSR in the face and neck regions. There is only a small number of reports on SSRs recorded from the face among which Nordin's study is a notable exception. One such study was performed by magnetic stimulation of the neck (Okuda-Matsuoka et al., 1996) and another recorded forehead SSRs but the authors did not report the features of these responses (Elie and Guiheneuc, 1990). It has been shown that SSRs can be recorded from facial regions,

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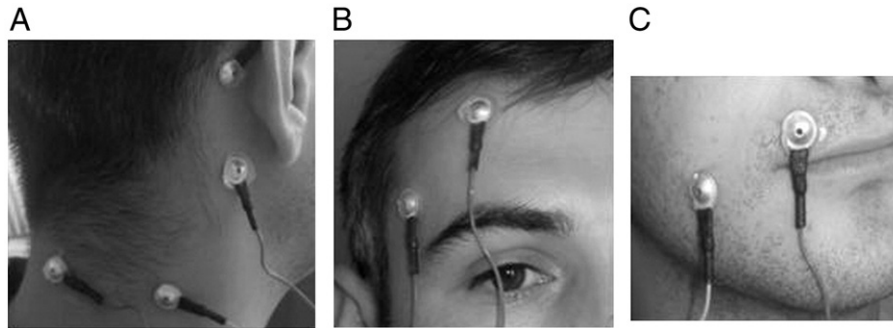


Fig. 1. Electrode locations: A. Neck sympathetic skin response (SSR): The active electrode is placed 1 cm lateral to the vertebra, on the midpoint of the line connecting the hair line and seventh cervical spinous process. The reference electrode is placed approximately 3–4 cm lateral on the horizontal plane. Postauricular SSR: The active electrode is placed on the mastoid process and reference electrode is placed approximately 3–4 cm below behind the ear lobe. B. Forehead SSR: The active electrode is placed to the frontal bone and the reference is placed approximately 3–4 cm lateral and 2 cm below the active one. C. Upper lip SSR: The active electrode is placed to the midpoint of the line connecting the filtrum and the corner of the mouth. The reference electrode is placed approximately 1–1.5 cm lateral to the corner of the mouth.

but the fundamental properties of the responses elicited by electrical stimulation have not been provided.

The aim of the present study was to obtain SSRs by electrical stimulation of different facial regions and the neck. If it is possible to evoke the facial region responses with electrical stimulation and record them with standard surface electrodes, this will be a practical and available method to assess the autonomic nervous system innervation of the facial area in various related diseases.

2. Materials and methods

Twenty-five healthy young adult volunteers (students of the medical school; aged 18–27, mean 19.8 years; 9 female and 16 male) took part in the study. Informed consent was obtained from each subject and the protocol was approved by the local ethics committee.

SSRs were recorded between 15:00 and 17:00 h. To avoid a connection failure of the electrode to the skin, we asked the male subjects to shave cleanly before coming to the experiment. Subjects lay in a comfortable supine position in a quiet, brightly lit air-conditioned room maintained 24 ± 1 °C. The skin temperature of each subject was over 32 °C. They were instructed to keep their eyes open, not to move, not to breathe deeply, not to cough and not to talk during the procedure.

The experiment was performed with a Nicolet Viking IV channel electromyograph. SSR recordings were made by standard surface electrodes of Ag–AgCl (10 mm diameter, Nihon Kohden, NM-312S). The frequency bandpass was 0.2–100 Hz. The time window for recording was 10 s and the gain was 500 μ V per division.

The electrical stimulation (square pulse with 0.2 ms duration and 100 mA intensity) was applied over the left median nerve at the wrist. The stimuli were delivered at irregular intervals not less than 20 s. Ten to twenty stimuli were delivered to each subject in every single examination (examinations 1, 2 and 3).

The recording locations were shown in Fig. 1A, B and C. In each subject, the right side of the face and neck were

studied (examination1). Neck (N-SSRs), postauricular region (PA-SSRs), forehead (F-SSRs) and upper lip responses (UL-SSRs) were recorded (Fig. 2). To assess the symmetry of the responses, recordings were made from any two selected locations on both right and left sides (because there were four channels available to record) in a total of 20 subjects on the same day (examination 2). Thus, we have gathered 10 sets of data that would enable us to perform comparisons for each selected locations on both right and left sides (Fig. 3). Examination 2 was performed immediately after the completion of examination 1. We defined the gradual increase of amplitude occurring in at least three

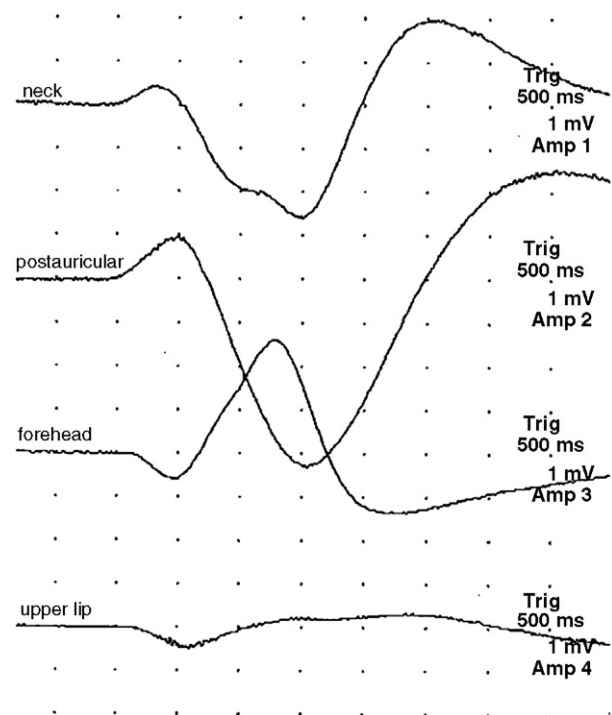


Fig. 2. Neck, postauricular, forehead and upper lip sympathetic skin responses recorded from the right side in a subject (examination 1).

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