Electroacupuncture Suppresses the Cortical Evoked Responses in Somatosensory I and II Areas after Tooth Pulp Stimulation in Rat

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Summary Rat cortical evoked responses (CERs) of the somatosensory area I and II following tooth pulp stimulation were decreased in amplitude by electroacupuncture stimulation. Suppression was more marked with the contralateral CERs than with the ipsilateral ones. Onset latencies of somatosensory II CER of both sides were lengthened after electroacupuncture stimulation.

It is well known that electroacupuncture stimulation can relieve pain sensation in clinical treatment (Shanghai Acupuncture Anesthesia Coordinating Group, 1975). On the other hand, it has been reported that tooth pulp afferents, which produce solely the pain sensation (Anderson et al., 1970), project bilaterally to the somatosensory I (SI) and II (SII) areas in the cerebral cortex (Matano et al., 1972). Therefore, the present study was undertaken to investigate the effects of electroacupuncture stimulation on the cortical evoked responses (CERs) recorded from SI and SII following tooth pulp stimulation.

The experiments were carried out on 23 Wistar albino rats, weighing about 400 g, under the thiamylal anesthesia as reported previously (Toda, 1978). A bipolar stimulating electrode (interpolar distance, 1.5 mm) of stainless steel wire of 0.1 mm in diameter, insulated except for the tips, was inserted into the tooth pulp of the lower incisor. The whole tooth was covered with dental cement or wax to prevent short-circuiting by saliva. By this method of stimulation, the stimulus current from the intrapulpal electrodes is confined only to the pulp (Sakai, 1974). To apply noxious stimuli, the pulp nerve was stimulated by rectangular constant current pulses which were of 0.1 msec duration with an intensity about 2.5 times as strong as the threshold of CERs at 1 Hz.

Both sides of the cortex were exposed and an indifferent electrode was in-
serted into the neck muscle. The CERs in SI and SII were recorded bilaterally with glass micropipets of about 6 μm in tip diameter filled with 2 M NaCl. The largest-amplitude CERs were recorded from two areas both ipsi- and contralaterally: one recording site extended from F: 10.0 to 11.5 mm and from H: 1.5 to 2.0 mm in König and Klippel's brain atlas (1963) and the other, from F: 7.0 to 7.5 mm and from H: −0.5 to 1.0 mm. The former is almost coincident with the rat SI and the latter with the SII as reported by Matano et al. (1972). The amplitude of CER in these sites was maximal when recorded from depths of about 100 to 200 μm from the surface of the cortex.

Cathodal electroacupuncture pulses (5 msec duration, 45 Hz) were delivered for 15 min to the Geiko points of both sides, which were at the lateral margin of the nasolabial fold. Geiko point is chosen since it is well known as one of the most effective sites for tooth pain relief (Toda and Iriki, 1979; Toda et al., 1979). An anodal electrode consisting of a 3×4 cm silver plate was placed on the center of the abdominal wall. The intensity of electroacupuncture stimulation was the one with which a weak twitch was evoked from the Geiko point.

The CERs following tooth pulp stimulation appeared with a negative deflection (Fig. 1A, oblique arrows), whose amplitude increased exponentially with stimulus intensities. The onset latencies of the contralateral SI and SII CERs were 6.2±0.3 msec (mean±SE, N=23) and 7.9±0.1 msec (N=23), respectively and those of the ipsilateral SI and SII were 10.2±0.2 msec (N=23) and 12.2±0.3 msec (N=23), respectively.

Figure 1A shows typical examples of the effects of electroacupuncture stimulation of the Geiko points on the contralateral CERs in SI (upper traces) and SII (lower traces). In both SI and SII the negative amplitudes of the CERs were reduced to about 40% (b) of the control (a) immediately after electroacupuncture stimulation was terminated; the CERs recovered from suppression about 90 min later (f). Effects of electroacupuncture on the CERs recorded from the ipsi- (B) and contralateral (C) SI and SII in 23 experiments are summarized in Fig. 1B and C. The following are evident from these graphs: 1) Electroacupuncture stimulation suppresses CERs in SI and SII to the same degree. This was true in both ipsi- and contralateral sides. 2) The contralateral CERs are more markedly suppressed than the ipsilateral ones. 3) In the contralateral side, suppression of CERs was sustained longer in SI than in SII.

Immediately after the 15 min electroacupuncture stimulation, the onset latencies of the contralateral CERs in SI and SII were 6.8±0.1 msec (N=23) and 9.6±0.2 msec (N=23), respectively, while those of ipsilateral CERs in SI and SII were 10.1±0.1 msec (N=23) and 13.9±0.6 msec (N=23), respectively. The onset latencies of the SII CERs of both sides after electroacupuncture stimulation were significantly longer than those before stimulation (p<0.05). In neither side of the cortex was this proved for SI CERs.

The tooth pulp has generally been regarded as the source of nociceptive af-
Fig. 1. A: Effects of electroacupuncture on the contralateral cortical evoked responses (CERs) in SI (upper traces) and SII (lower traces) following tooth pulp stimulation. a: CERs before electroacupuncture stimulation (control). b: CERs recorded immediately after the cessation of 15-min electroacupuncture stimulation. c: CERs recorded 30 min after the onset of electroacupuncture stimulation. d: 45 min after. e: 75 min after. f: 105 min after. A horizontal bar indicates a period of 15-min electroacupuncture stimulation. Oblique arrows indicate negative deflections of the CERs. Each trace consists of three superimposed responses. B, C: Effects of electroacupuncture on the ipsi- (B) and contralateral CERs. Cont. represents small changes of the CERs in SI (○) and in SII (●) before electroacupuncture stimulation, and Acup. shows those of the CERs in SI (○) and in SII (●) after electroacupuncture stimulation. Ordinate: relative amplitude of the negative deflection of the CERs. Abscissa: time during and after electroacupuncture stimulation. Horizontal bars indicate the 15-min period of electroacupuncture stimulation. Vertical bars indicate SE (N=23).

Denters (Anderson et al., 1970) and it has been reported that rat pulpal afferent information is transmitted through dual projection systems to the SI and SII areas via the ventrobasal complex (VB) and the posterior nuclear group (PO) of the thalamus (Shigenaga et al., 1974). Although the roles of these dual projection systems are uncertain, the present study revealed that electroacupuncture stimulation modified the nociceptive impulses along the dual projection pathways. In a previous paper (Toda and Iriki, 1979), we reported that electroacupuncture suppressed the magnitudes of PO responses to about 40% of the control and those of VB responses to about 60%, and that it lengthened the latencies of PO responses without changing those of VB ones. In the present study, the amplitudes of the CERs in SI and SII were suppressed by electroacupuncture to the same degree, whereas the latencies of the CERs were lengthened only in SII.
These results suggest that SI might receive pulpal nociceptive inputs mainly from VB, and SII mainly from PO.

The fact that electroacupuncture was more effective on the contralateral CERs than ipsilateral ones is not easily explained. This problem is now under investigation in our laboratory.

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REFERENCES


