REDUCTION IN EXCITABILITY OF THE AUDITORY NERVE IN GUINEA PIGS FOLLOWING ACUTE HIGH RATE ELECTRICAL STIMULATION

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Electrical stimulation of neural tissue involves the transfer of charge to tissue via electrodes. Safe charge transfer can be achieved using biphasic current pulses designed to reduce the generation of direct current (DC) or the production of electrochemical products. However, neural stimulators must also use capacitors in series with electrodes, or electrode shorting between current pulses, to further minimize DC due to electrode polarization. We have recently shown that high rate electrical stimulation, using stimulus intensities above clinical levels, can induce a significant decrement in the excitability of the auditory nerve[1]. While these changes have been attributed to neuronal hyperactivity, DC levels of up to 2.8 μA were also reported in this study. The present investigation was designed to establish the extent to which this DC contributed to the decrement in auditory nerve excitability. Twenty adult guinea pigs were anaesthetized with ketamine (40 mg/kg) and xylazine (4 mg/kg), bilaterally implanted and unilaterally stimulated for two hours using charge balanced biphasic current pulses. Animals were stimulated using rates of 200, 400 or 1000 pulses/s (pps) at a high stimulus intensity (0.34 μC/phase). Two techniques were used to minimize DC; i) electrode shorting, and ii) capacitive coupling. Electrically evoked auditory brainstem responses (EABR's) were recorded before and periodically following the acute stimulation. Significant post-stimulus reductions in the EABR amplitude were observed following both stimulus regimes. Furthermore, only partial EABR recovery was observed during the three hour post-stimulus monitoring period. Stimulation using capacitive coupled electrodes, which eliminated all DC, showed a highly significant reduction in the response amplitude of wave III as a function of stimulus rate; 200 pps, 85% of prestimulus amplitude ($p < 0.01$); 400 pps, 30% ($p < 0.001$); and 1000 pps, 10% ($p < 0.001$) at EABR probe currents approximately 16 dB below the intensity of the acute stimulus. Significantly, these reductions in amplitude were similar to the changes observed following stimulation using electrode shorting techniques. The present findings indicate that the majority of the stimulus induced changes observed are associated with prolonged neuronal hyperactivity and are not related to DC.

1 Tykocinski, M., Shepherd, R. K. & Clark, G. M. (in press) Hear. Res.

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