Direct electrical stimulation of the cochlea has been used to provide auditory cues to deaf patients. Stimulating devices range from single channel implants located on the round window to multichannel scala tympani electrode arrays. This study investigated the cochleotopic selectivity of the multichannel bipolar Melbourne/Cochlear scala tympani electrode array using the 2-Deoxyglucose (2-DG) technique.

Feline versions of these multichannel devices (six electrode array), were implanted in unilaterally deafened cats (induced by Neomycin), anesthetized with pentobarbital sodium (Nembutal, 45 mg kg\(^{-1}\) i.v.). Inserting the electrode array through the round window positioned the most apical electrode pair (1 & 2) 6 mm from the point of insertion, at a cochlear frequency place of approximately 12 KHz according to the frequency-position map of Greenwood (1990). The most basal electrode pair (5 & 6) was positioned 2 mm from the round window at a cochlear frequency place of approximately 27 kHz. Electrically evoked auditory brainstem response (EABR) thresholds and evoked auditory brainstem response (ABR) thresholds were determined for the implanted cochlea and the contralateral non-deafened cochlea respectively. Biphasic current pulses (200 \(\mu\)sec per phase presented at 200 pulses per second for 200 msec) were presented to the implanted cochlea via electrode pairs 1 & 2 or 5 & 6 at a level of either 3x or 10x EABR threshold. The contralateral cochlea received a pulsed acoustic stimulus of either 12 or 30 kHz of 200 msec duration with a 5 msec rise/fall time at 80 dB SPL. The acoustic pulse was alternated in time with the electrical burst. Following commencement of stimulation a bolus of 150 \(\mu\)Ci kg\(^{-1}\) 2-Deoxy-D-[1-\(^{14}\)C]glucose was administered via the radial vein. After 45 minutes of stimulation the animals were killed with an overdose of anesthetic (Nembutal, i.v.), the brain removed and processed for autoradiography.

Analysis of the autoradiographs indicated selective bands of labelling produced by both the electrical and acoustic stimulation in the three major divisions of the cochlear nucleus (CN) and the inferior colliculus (IC). Electrical stimulation at 3x EABR threshold on electrode pairs 1 & 2 produced a band of labelling in the contralateral IC which was slightly broader but in the same position as the band of labelling produced by 12 kHz acoustic stimulation in the other IC. Electrical stimulation at 10x threshold on electrode pair 1 & 2 led to a much broader band of labelling centred over exactly the same position as the labelling to the 12 kHz acoustic stimulus. Stimulation of the cochlea on electrode pair 5 & 6 at 3x EABR threshold produced a band of selective labelling of comparable width but at a slightly lower frequency region (24-27 kHz) than the band of labelling to the 30 kHz acoustic stimulation in the other IC. Similar patterns of selective labelling were obtained in the anteroventral CN, which indicates that the selectivity is reflecting the tuning of the cochlea.

These results show that electrical stimulation of the cochlea using the Melbourne/Cochlear multichannel scala tympani electrode array produces very selective cochleotopic labelling in the CN and IC. The degree of selectivity is dependent on the level of stimulation used relative to EABR threshold. These results indicate the great potential of the 2-DG technique for further work on the assessment of stimulus parameters involved in the electrical stimulation of the cochlea using such electrode arrays.


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