Bone-conducted brainstem auditory evoked response in a dog with total bilateral ear canal ablation: a case report

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ABSTRACT: The bone-conducted brainstem auditory evoked response test was performed in an eight-year-old dog with total bilateral ear canal ablation. It was found that 12 months after bilateral surgical ablation of the external acoustic meatus the dog still maintained its hearing function due to the mechanism of acoustic bone conduction.

Keywords: bone conduction; hearing; dog

The auditory brainstem response (ABR) is an extremely valuable method of hearing assessment in animals (Concalves et al., 2008). The technique uses scalp electrodes to detect small changes in electroencephalographic activity in response to an acoustic signal. The responses are comprised of five or more waves, which occur within 10 milliseconds (ms) from stimulus onset, generated from the auditory pathway up to the level of the caudal colliculus. ABR has the advantage of being unaffected by sleep or sedation (Wilson and Mills, 2005). The conventional ABR test involves presenting the acoustic signal from an earphone. This is called air conduction stimulation because sounds travel to the eardrum via the air. This method is effective in the diagnosis of sensorineural deafness. An alternative test method is to stimulate the inner ear more directly with vibrations from a vibrator placed on the head. This stimulus is reported to bypass the outer and possibly the middle ear and directly activate the cochlea and/or ossicles so that an ABR can still be detected in subjects with conductive deafness. This method is known as bone conduction testing and is used to differentiate between conductive and sensorineural hearing loss (Georga et al., 1993; Wolschrijn et al., 1997).

The aim of this study was to determine the effect of bilateral total ablation of the external acoustic meatus on auditory function in dogs.

MATERIAL AND METHODS

A mixed-breed female dog aged eight years, with a body weight of 45 kg, was subjected to total ear canal ablation due to massive hypertrophy of the epithelium lining both ear canals. The left ear was operated on in August 2008, and the right ear – six months later. The auditory brainstem response test was conducted 12 months after the latter procedure (Figure 1).

ABR bone conduction procedure

The dog was sedated with intravenous medetomidine hydrochloride (Domitor, Phizer, D) at a dose of 0.04 mg/kg b.w. At the end of the examination the sedative effect was rapidly reversed by the antidote atipamezole hydrochloride 0.04 mg/kg b.w. (Antisedan, Pfizer, D). Four stainless steel needle electrodes were inserted subcutaneously into the dog's scalp. One was placed at the vertex (Cz) – defined as the junction of the midline and the line across the head joining the points of the most caudal aspect of the zygomatic arches – and one on each side of the head just below the tragus (A1 left; A2 right). The fourth (ground) electrode was placed midline, just caudal to the interorbital line (Fpz). An auditory bone conduction transducer

Figure 1. Left pinna view – 12 months after total ear canal ablation

(Viasys NeuroCare Inc., USA) was connected to the computer-based electrodiagnostic system (Nicolet Vikingquest, USA). A bone vibrator was placed on the mastoid process on the left and right side. The band-pass filter settings for the response ranged from 100 to 3 000 Hz. The frequency spectrum of the bone vibrator output was analyzed and centre frequency was found to be 2 000 Hz. ABR data were collected for stimulus intensity of 90 dB nHL (normal hearing level) from each ear separately. Latency was measured from stimulus onset to waveform peaks I, II, III, and V, and baseline-to-peak amplitudes were determined. Positive deflections were displayed upward.

RESULTS AND DISCUSSION

Both ears showed recordable brainstem auditory evoked responses to bone-conducted stimulation. Peak latency measurements of the ABR elicited with a bone stimulator at machine intensity settings of 90 dB nHL revealed no differences between ears (Figure 2). The peak latencies of waves I in the left and right ear was 1.83 ms. The peak latencies of waves V in A1 – Cz set and A2 –Cz set was 3.96 ms. Amplitude differences between ears were detected. The amplitude of peaks V was lower in the right ear (0.208 μV) than in the left ear (0.268 μV).

Total ear canal ablation is a standard surgical procedure performed in dogs in cases of chronic otitis externa that does not respond to pharmacological treatment, massive hypertrophy of ear canal epithelium, malignancies of the ear canal, and ossification in the elastic cartilage of the ear. The conductance of auditory stimuli in patients subjected to this routine procedure is an important consideration. There is scant information available in the literature regarding bone-conducted brainstem auditory evoked response in dogs with total bilateral ear canal ablation.

In our study, the values of peak latencies I, III and V were similar to those noted by other authors in normal dogs (Strain et al., 1993; Munro et al., 1997). This indicates that the bilateral surgical ablation of the external acoustic meatus did not affect the function of the cochlea. A previous study using seven dogs which had undergone surgical ablation of the external acoustic canal and bulla osteotomy as subjects has reported that three ears failed to respond after surgery (Krahwinkel et al., 1993). Amplitude differences between ears could be due to post-surgical inflammation of the right ear.

Vibrations from the bone vibrator placed on one side of the head will travel through the skull and arrive equally at both cochleae (Wilson et al., 2006). Therefore, it is possible to record responses from the test ear and from the non-test ear. Until recently, the main route for the transfer of vibration energy from the point of application of the bone vibrator on the skull to the inner ear was thought to be completely osseous. However, some authors are

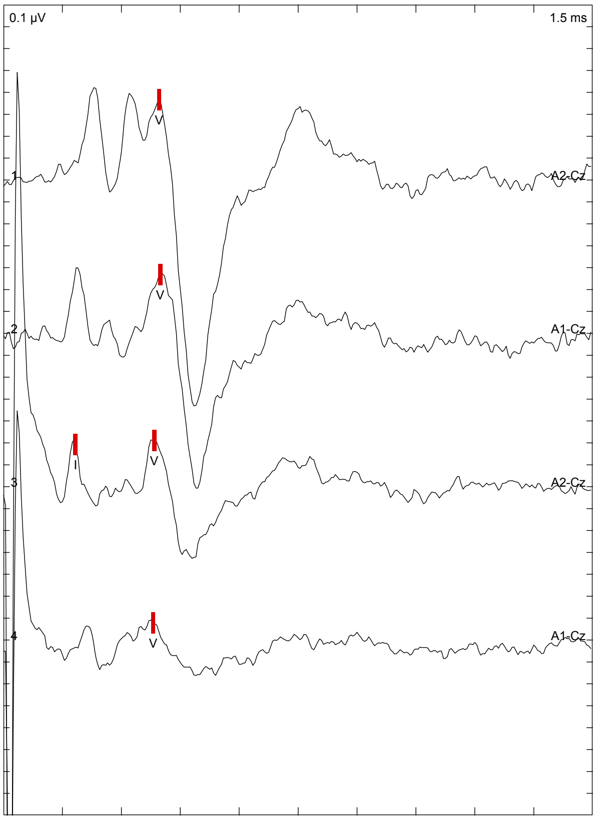

Figure 2. Bone conduction auditory brainstem response waveforms from the left ear (1, 2 channels) and right ear (3, 4 channels). Stimulus intensity: 90 dB nHL

of the opinion that an additional mechanism may play a prominent role in this process (Freeman et al., 2000). Bone conduction experiments in rats and guinea-pigs revealed that the classical bone conduction mechanism should be modified to include a major pathway for cochlear excitation which is non-osseous: when a bone vibrator is applied to the skull, bone vibrations may induce audio-frequency sound pressures in the skull contents (brain and cerebrospinal fluid) which are then communicated by fluid channels to the fluids of the inner ear.

Our study shows that after bilateral surgical total ear canal ablation, the dog still maintained its hearing function due to the mechanism of acoustic bone conduction.

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Received: 2010–01–21
Accepted: 2010–01–31

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