聴性脳幹誘発反応による犬の聴覚障害の評価について

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Abnormal Wave Forms of Auditory Brainstem Response (ABR) in Two Dogs

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Clinical methods for evaluating the function of sensory, perceptual and even motor systems in animals have been limited. The recording of evoked potentials has, however, created new possibilities for the evaluation of the sensory system, and otologic and audiologic dysfunction [2, 5, 10]. This method is noninvasive neurophysiological test possible to evaluate animals without their cooperation.

The term auditory brainstem response (ABR) refers to the potentials recorded from scalp electrodes in human and animals following such an acoustic stimuli as click sound. A typical ABR tracing consists of five or six major peaks (Fig. 1) and it has been shown from experimental studies in the cat that they correspond to anatomical relay stations of the auditory pathway [4, 5]. The use of ABR has proved to be a useful tool in the field of human audiology [1, 5].

The first report of ABR in veterinary clinical medicine has been made by Morgan *et al.* [13]. They investigated that the wave form of ABR was affected by the antibiotics which had the toxic effect for the auditory system. In the middle of 1980's, several reports about the ABR in dogs were published [3, 8, 9, 11, 12, 15, 16]. These reports mainly described the clinical data base: latency [15, 16], body temperature [3] and stimulus intensity [3, 11]. Marshall has reported deaf dogs' group in Dalmatian breed judged from the ABR [12]. This paper describes two spontaneous hearing disorders of the dogs and the consequent abnormal ABR patterns.

The pateints were a 1 year old male Shetland sheep dog (Case A) and a three and a half months old male miniature duchshund (Case B) (Table 1). Case A was presented by dull or little response to sounds. Physical and neurologic examinations except the examination of the animal's response to sudden noise, including otoscopic examination, revealed no abnormal findings. Case B showed forced circling, ataxia and seizure at the initial course of the condition. Fluid therapy and vitamin complex administration were performed for 10 days but the patient did not show a remission and became myoclonic at the end of the course. The patient was euthanatized by the owner's request after electrophysiological examination. Either cases A and B didn't reveal any abnormal findings on electroencephalographic examination.

The ABR of the dogs were investigated. The ABR recording method was used with amendment referred to those of previous reports [3, 7, 8, 14] and described as follows briefly. The ABR recording method in detail will be described by another report. The animals were administered with atropine sulfate and xylazine (0.05 and 2 mg/kg, respectively) as preanesthesia by subcutaneous injection and followed by an intravenous administration of sodium pentobarbital (7~10 mg/kg). An active electrode was subdermally placed at the vertex and the reference one at the axis. The ground electrode was placed subcutaneously on the lateral side of the neck. Ordinarily, the reference electrode was positioned at the pinna or near the ear. Holliday and

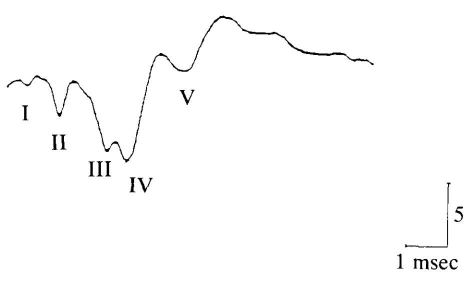

Fig. 1. An example of auditory brainstem response (ABR) in a normal dog, which was obtained by averaging individual 10 msec sweep after click. Click stimulation was presented monaurally at a rate of 10/sec and an intensity of 110 dB SPL. Stimulus is synchronous with onset of sweep and downward deflections indicate positive.

Table 1. Clinical data

	Case A	Case B
Breed	Shetland sheep dog	Miniature duchshund
Sex, Age	male, 1 year old	male, 3.5 months old
Chief complaint	no response to sound	forced circling, seizure
Clinical signs	no abnormal behaviors except the response to sudden sound	ataxia, weakness, myoclonus in the end term of the condition

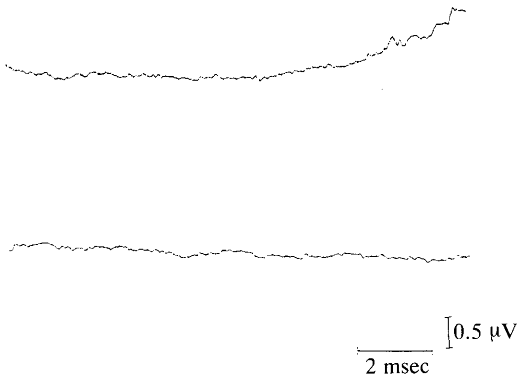

Fig. 2. ABR in case A that was bilaterally deaf. Both upper and lower tracings were averaged by presenting 110 dB SPL click unilaterally. Upper tracing was obtained by left side stimulus and lower tracing by right side stimulus, respectively. Stimulus is synchronous with onset of sweep. Note that no response appeared in both tracings.

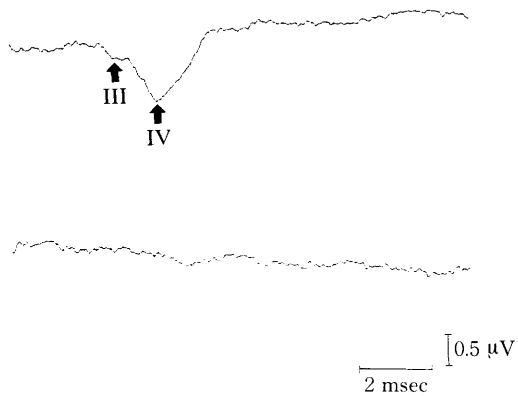

Fig. 3. ABR in case B that responded only unilaterally. Stimulus intensity and rate were the same as in Figs. 1 and 2. Only upper tracing which was obtained by the monaural stimulation to the left ear showed slight response.

Te Selle reported, however, this area wasn't a relatively inactive site for the reference electrode [8]. Also, in our preliminary experiment, wave form of ABR recorded with ear reference are different from that with neck reference. So the authors used the electrode on the axis subdermally as the reference because that is relatively inactive and better logically than ear reference. Enamel-covered copper wire (120 μm diameter and 1 mm bared tip) was employed for the electrodes mentioned above. They were connected to an amplifier in such a nammer that positive electrical activity produced a downward deflection on the tracings. Monaural clicks, alternating between condensation and rarefaction, at 110 dB SPL were delivered through a headphone from a sound stimulater (Nihon Kohden SSS-3100) at a stimulus rate of 10/sec. Evoked response was amplified by a preamplifier (system gain: 50,000) with 1.5 to 3000 Hz filter setting. Individual 10 msec sweep after each click was averaged (n=200) by a signal averager (Nihon Kohden DAT-1100) and displayed on a memory cathode ray oscilloscope (Nihon Kohden VC-10). Likewise, the signals were analyzed and printed out by a digital signal processor (NEC San-ei 7T17).

Fig. 2 shows the abnormal ABR patterns in case A. No waves emerged by either left or right click stimuli. This patient showed no abnormal findings of the both tympanic membranes by otoscopic examination. These results suggested that the lesion might locate between the tympanic membrane and the cochlear nerve or the 8th cranial nerve.

Fig. 3 shows the wave forms of ABR in case B. Right side stimuli produced no response. Moreover, although left ear stimuli gave rise to a ABR response, the ABR pattern was transformed. Wave IV was apparently existed and wave III faintly remained. The increase of both components' peak latencies was observed. The early components of ABR couldn't be recognized. Thus in this patient, right side hearing disorder was at least judged from these results although wave forms of bilateral ABR were affected. Right side hemispherical subdural hemorrhage was recognized by autopsy.

ABR has two aspects of functional test: hearing test and neurological test [5]. The examination of ABR is a typical hearing test in case A. In this dog, the fact that all waves, including wave I which seemed to originate from the cochlear nerve, were unobtainable and that no abnormal findings of the bilateral tympanic membranes by otoscopic examination was recognized suggested that the lesion might locate between the middle ear and the cochlear nerve. The likely causes of animals' deafness were listed by Parker [14]. In accordance with his paper, the anamnesis that this patient was about 1 year old, the history that he had not experienced clinical signs of any disorders and the chief complaint that an abnormal behavior had been suspected from his childhood indicated that his deafness was due to the congenital disorder.

In case B, ABR examination had a property of a neurological test rather than a hearing test. As shown in Fig. 3, ABR patterns demonstrated bilateral abnormalities. Since the ataxia and forced circling also occurred, ABR abnormalities might be signs of neurological lesion. However, the authors can't interpret certainly that abnormal wave forms came from the influence of hemispherical subdural hematoma. At least, no response to right side stimulus revealed unilateral hearing loss.

The examinatioin of auditory function in animals has ordinarily been evaluated how animals respond to the sound; however this method is conventional and not objective. The examination mentioned above are especially difficult to interpret in pups [9]. Another examination of auditory function in veterinary medicine is to observe changes of an electroencephalogram by giving the sound or noise to subject [6, 14]. This method is, however, not repeatable and poorly reliable because of various unstable condition such as the level of anesthesia. Besides, unilateral hearing loss in animals seemed to be often overlooked [6]. The ABR can be elicited at least 3 weeks of age [9]. The ABR is unambiguous, reproducible, rational and objective hearing test. The observation in these cases of the evidences of bilateral and unilateral deafness highlights a usefulness of the ABR applied as hearing test. Besides ABR has an aspect of a neurological examination. In case B, unilateral deafness may be sensorineural hearing loss. For this reason, the ABR recording should be more prevalent and that may involve higher probability of the proof of the hearing disorder in animals.

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要　　約

聴性脳幹誘発反応による犬の聴覚障害の評価について(短報)：宇塚雄次・松波健二[1]・徳力幹彦[1]・土井章三・増田千佳・河原貴子・松本治康・田中幹郎[2](山口大学農学部家畜内科学教室，[1]家畜生理学教室，[2]家畜外科学教室)――1歳齢のシェルテイと3.5カ月齢のミニダックス犬に対し，聴性脳幹誘発反応を適用して，聴覚障害を客観的に評価することができた．前者では左右の片側刺激でどちらでも誘発反応がI波から消失しており，両側性の聴覚欠損が存在することが確認された．後者では左側刺激に対してのみ反応が生じ，右側刺激では波形は現れなかった．この検査結果から，獣医学領域でも聴性脳幹誘発反応の有用性の確認ができたと考えられた．