An Experimental Study of the Cortical Somatosensory Evoked Potentials in the Cat

Yuji UZUKA, Mikihiro TOKURIKI¹⁾, Yasuhiro KAWASAKI¹⁾, and Haruyasu MATSUMOTO

Department of Veterinary Internal Medicine, and ¹⁾Department of Veterinary Physiology, Faculty of Agriculture, Yamaguchi University, 1677-1 Yoshida, Yamaguchi 753, Japan

(Received 12 March 1987/Accepted 30 May 1987)

Jpn. J. Vet. Sci. 49(5): 926-928, 1987

KEY WORDS; cat, cortical SEP, peak latency.

In clinical veterinary medicine, electroencephalography (EEG) has been used in order to investigate the neurological diseases [10]. EEG, however, can reveal most often only the abnormality of the cerebral cortex. Recently, there are some attempts to localize the lesions in the central and peripheral nervous disorders of the animal by means of evoked potentials such as visual evoked potential [4, 6] and auditory brainstem evoked response [8, 12, 13]. Another important method in the evoked potential, somatosensory evoked potential (SEP), has been employed as spinal SEP to investigate the disturbances of the spinal cord [5, 9], but the analysis of the cortical SEP, which can also demonstrated the disorders of the brainstem, is not enough to get available dates, although some researchers [1, 2, 3, 7] have reported short latency SEP in the cat as a human model. The purpose of the present study is to record normal cortical SEP of the cat and to give the basic data for applying it to the clinical veterinary medicine.

Neurologically normal six adult cats of either sex, weighing 2.0 to 4.0 kg, were used. Cats were anaesthetized with intravenous injections of sodium pentobarbital (30 mg/kg) and additional doses were given as required. Body temperature was maintained between 35°C and 37°C.

The animals were placed in a stereotactic frame, and the skull was exposed. Small stainless steel screw electrodes were symmetrically fixed in the bone overlying cat's somatosensory area (SI) and occipital area. A screw electrode inserted into the bone over the frontal sinus served for the reference electrode. This placement of recording electrodes is usually used in veterinary EEG in which the reference electrode is ordinarily put on the vertex [10].

An incision was made at the vicinity of the carpal joint in the right forelimb. The median nerve was isolated and placed on a bipolar silver electrodes which served as a stimulating electrode with the cathod being located proximally.

A pool formed by tying the edges of the skin flaps was filled with paraffin oil warmed at 37°C. Stimuli from an electrostimulator (Nihon Kohden SEN-7103) were rectangular wave of 0.1 msec duration and 500 msec interval between stimuli by stable voltage which was raised to immediately above motor threshold of the first digit and maintained to stimulate. During recording the cortical SEP, the animals were artificially ventilated and myogenic potentials were eliminated by the administration of gallamine triethiodide (10 mg/kg i. v.). Supplemental doses were given at half of the first dose every 40 minutes.

After the signals were amplified by a differential preamplifier between 0.5 or 50 Hz and 3000 Hz (system gain 50,000: Nihon Kohden AVB-10), they were swept (40 or 45 msec) and averaged (N=300) by a two channel averager (Nihon Kohden DAT-1100 MODEL) and displayed on an oscilloscope (Nihon Kohden VC-10). The cortical SEP was recorded on 35-mm films.

Fig. 1 shows typical evoked potentials obtained in response to stimulation to the right median nerve occurring within 40 msec after stimulation of the right median nerve. An initial positive peak was followed by a negative one and they

Fig. 1. Cortical SEPs in a cat recorded with the contralateral frontal electrode to the median nerve stimulation. Two independent recordings are superimposed. Downward deflection indicates positivity at the recording electrode with respect to the reference electrode.

Table 1. Mean values of onset latency, peak latency and peak amplitude of the cortical SEP in four recording sites after stimulation of the right median nerve

Lead		Onset Latency (msec)	PI Peak Latency (msec)	NI Peak Latency (msec)	PI Peak Amplitude (μ V)	NI Peak Amplitude (μ V)
LF ^{a)} -R ^{b)}	Mean	5.17	10.00	18.72	14.91	-16.02
	S.D.	0.41	0.67	3.39	4.26	6.31
	n	6	6	6	6	6
RF ^{c)} -R	Mean	5.69	9.95	17.28	-2.04 ^{f)}	1.25 ^{f)}
	S.D.	0.33	1.47	2.92	2.11	2.00
	n	4(2) ^{g)}	4(2)	4(2)	4(2)	4(2)
LO ^{d)} -R	Mean	5.42	10.78	20.10	5.37	-4.69
	S.D.	0.31	1.05	3.92	2.47	3.35
	n	5(1)	6	6	5(1)	5(1)
RO ^{e)} -R	Mean	5.03	9.74	18.72	0.61	-0.22
	S.D.	—	—	—	—	—
	n	3(3)	3(3)	3(3)	3(3)	3(3)

a) left frontal area.

b) reference (frontal sinus).

c) right frontal area.

d) left occipital area.

e) right occipital area.

f) Expressed and calculated as negativity when the SEP appeared with opposite polarity.

g) Number of individuals in which the component was not measured because of no existence of clear wave.

Table 2. The Value of onset latency, peak latencies, and peak amplitudes of the cortical SEP recorded at the area contralateral to the stimulation site with low frequency filters of 0.5 and 50 Hz in six cats using a high frequency filter of 3000 Hz.

Animal No.	Body Weight (kg)	0.5 – 3000Hz					50 – 3000Hz				
		Onset Latency (msec)	PI Peak Latency (msec)	NI Peak Latency (msec)	PI Peak Amplitude (μ V)	NI Peak Amplitude (μ V)	Onset Latency (msec)	PI Peak Latency (msec)	NI Peak Latency (msec)	PI Peak Amplitude (μ V)	NI Peak Amplitude (μ V)
1	2.0	5.05	9.91	18.30	20.24	-12.06	4.80	8.98	- ^{a)}	12.70	—
2	4.0	5.73	9.52	25.09	8.42	-27.96	5.72	10.96	21.24	2.87	-10.19
3	3.4	4.79	9.04	15.26	11.73	-10.04	5.03	9.53	14.43	7.32	-8.99
4	3.8	5.54	10.12	16.60	14.95	-15.00	5.57	9.55	14.43	9.22	-13.18
5	2.0	4.68	10.64	18.84	17.63	-14.24	4.68	10.36	16.05	10.49	-17.00
6	3.6	5.20	10.81	18.20	16.49	-16.81	5.49	10.72	16.35	9.13	-16.75
Mean		5.17	10.00	18.72	14.91	-16.02	5.22	10.02	16.56	8.62	-13.37
S.D.		0.41	0.67	3.39	4.26	6.31	0.44	0.78	2.74	3.33	3.53
n		6	6	6	6	6	6	6	5	6	5

a) Unable to define as peak wave

were designated P1 and N1 respectively, referring the data in several researchers [3, 11]. P1 is termed as primary cortical evoked potential. The

2nd positive component, P2 was recorded in some animals, but it was not analyzed because it was difficult to obtain P2 consistently. In addi-

tion, small waves appeared inconsistently before the peak of P1, and they were supposed to be the far-field potentials which had origins in subcortical structures.

Table 1 shows measurements of cortical SEP with a 0.5 Hz low frequency filter at each recording site. Cortical SEP recorded at the frontal area contralateral to the stimulating site showed the clear-cut waves with the greatest amplitudes. Latencies and amplitudes of the cortical SEP were easily measured at the contralateral frontal area in all cases, although it was impossible to measure them at other recording positions of some individuals, the number of which was indicated in parentheses of Table 1. In most cases, the cortical SEP at ipsilateral areas to the stimulating site had opposite polarity to that at contralateral ones. There was little difference between averaged value of latencies in each recording position.

Peak latencies and peak amplitudes of P1 and N1 as well as the onset latency of P1 recorded at the contralateral frontal area to the stimulating site were measured with two kinds of low frequency filters of 0.5 and 50 Hz (table 2). The peak amplitude of P1 with the low frequency filter of 50 Hz, which sometimes reduced the sharpness of a wave, decreased than that with the filter of 0.5 Hz, although the values of each latency did not change. It may be suggested that the use of bandpass restriction of low frequency filter should be minimized.

As a human model, short latency SEPs in the cat have been reported, in which the peak latencies of P1 were 10.1 [1], 11.4 [2] and 13.4 msec [7]. Their differences may be caused by the condition of anesthesia [11], body temperature and the site of stimulation. So, it is very important whether we get a stable condition of the cat in order that the cortical SEP is available in clinical veterinary medicine.

As the SEPs can evaluate the central conduction time and the integrity of the somatosensory system, it may be useful for the detection of the

change of the central conduction time in demyelinating disorders such as the distemper, the diagnosis disintegrity of the somatosensory system in metabolic disorders such as vitamin deficiency, and the indicator of the level of anesthesia. The authors could demonstrate that the cortical SEP can be recorded from all recording positions used in EEG tracings, which may mean the simpleness that the latency of the cortical SEP is evaluated, therefore the disorder of the subcortical structure may be revealed if this method is adopted.

REFERENCES

1. Allison, T., Goff, W. R., and Serman, M. B. 1966. *Electroencephalogr. Clin. Neurophysiol.* 21: 461-468.
2. Allison, T., and Hume, A. L. 1981. *Exp. Neurol.* 72: 592-611.
3. Alpsan, D. 1981. *Electroencephalogr. Clin. Neurophysiol.* 51: 589-598.
4. Gregory, N. G., and Wotton, S. B. 1983. *Res. Vet. Sci.* 34: 315-319.
5. Holliday, T. A., Weldon, N. E., and ealand, G. G. 1979. *Am. J. Vet. Res.* 40: 326-333.
6. Howard, D. R., and Breazile, J. E. 1972. *Am. J. Vet. Res.* 33: 2155-2157.
7. Lragui-Madoz, V. J., and Wiederholt, W. C. 1977. *Ann. Neurol.* 1: 569-574.
8. Morgan, J. L., Coulter, D. B., Marshall, A. E., and Goetsch, D. D. 1980. *Am. J. Vet. Res.* 41: 1077-1081.
9. Morrison, G., Lorig, R. J., Brodkey, J. S., and Nulsen, F. E. 1975. *J. Neurosurg.* 43: 737-741.
10. Redding, R. W. 1978. canine electroencephalography. pp. 151-156. In: *Canine Neurology*, 3rd ed. (Hoerlein, B. F. ed.), W. B. Saunders Company, Philadelphia.
11. Shaw, N. A., and Cant, B. R. 1981. *Electroencephalogr. Clin. Neurophysiol.* 51: 674-677.
12. Sims, M. H., and Moore, R. E. 1984. *Am. J. Vet. Res.* 45: 2019-2027.
13. Sims, M. H., and Moore, R. E. 1984. *Am. J. Vet. Res.* 45: 2028-2033.

要 約

ネコにおける皮質体性感覚誘発電位の実験的研究 (短報): 宇塚雄次・¹⁾徳力幹彦・¹⁾川崎安弘・松本治康 (山口大学農学部家畜内科学教室, ¹⁾家畜生理学教室) ——非動化したペントバルビタル麻酔下のネコにおいて、皮質体性感覚誘発電位 (SEP) を脳波検査と同様の電極部位を記録部位として、正中神経刺激により300回加算を行って記録したところ、刺激反対側の前頭部で最も大きな波形が得られ、最初の陽性波 (P₁) のピーク潜時は 10.00 ± 0.67 msec であった。0.5 Hz と 50 Hz 低周波フィルターは出現する波形にはほとんど影響しなかった。