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Monosynaptic Reflex (H Wave) in Evoked Muscle Potential of the Cow

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ABSTRACT. The reflex-evoked muscle potential (REMP) was examined in normal cows. The common peroneal nerve was stimulated with rectangular pulses, and muscle potentials were recorded in the peroneus tertius muscle with needle electrodes. REMP appeared after the M wave (direct-evoked muscle potential) had a lower threshold but was obliterated by increasing the intensity of the stimulus before the appearance of the maximal M wave. The latency increased as the stimulation point was moved from proximal to distal. T wave in the same muscle was similar in the wave form and the duration as REMP but the latency was slightly longer. When the nerve was blocked proximally to the stimulation site, REMP was obliterated. These results indicate that REMP is due to a monosynaptic reflex (H wave).—**KEY WORDS:** cow, EMG, H wave.

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The electrical response of the skeletal muscle to the stimulation of its innervated nerve has been used for electrodiagnosis. The reflex-evoked muscle potential (REMP) which appeared with longer latency and lower threshold after the direct evoked muscle potential (M wave) has been reported in human [1, 4], and canine [2, 5]. REMP was first described and termed as H wave by Hoffmann [1]. The wave has been proved due to a monosynaptic reflex involving muscle spindle, G_{Ia} fiber, one synapse within the spinal cord, α -motoneuron, neuromuscular junction and muscle fiber. This paper described the REMP in the peroneus tertius muscle of the cow obtained by the stimulation of the common peroneal nerve.

Fourteen adult cows (Holstein, 1 year of age and older) were sedated with xylazine at a dose of 0.1 mg/Kg i.v. after premedication with atropine. A decrease in rectal temperature was not observed during the experiment. Animals were positioned in lateral recumbency and hindlimbs were fixed in an extended position. Needle electrodes were used for

Fig. 1. Location of the electrodes.

the stimulation, recording and grounding. A 19-gauge injection needle or stainless steel needle coated with epoxyresin except the terminal 3 mm was used. The distance between the anode and cathode of the bipolar

Fig. 2. Muscle potentials in the peroneus tertius muscle evoked by stimulation of the common peroneal nerve.

Fig. 3. The evoked muscle potentials corresponding to the respective stimulus intensities.

Table 1. M wave and REMP of the peroneus tertius muscle of cows (n=10) evoked by stimulating the common peroneal nerve

Stimulation site	Latency (msec)	Duration (msec)	Amplitude (mV)
M wave			
Proximal	7.40 ± 1.23^a	9.90 ± 1.25	17.65 ± 3.34
Distal	3.84 ± 0.67	10.18 ± 1.26	19.50 ± 4.30
REMP			
Proximal	18.52 ± 3.48	8.05 ± 1.20	1.70 ± 1.10
Distal	21.95 ± 4.09	7.61 ± 1.21	1.91 ± 1.26

a) Mean $\pm$ S.D.

Table 2. Nerve conduction velocity of the common peroneal nerve in cows (n=10)

Nerve	Conduction velocity (m/sec)
Motor nerve	77.7 ± 8.1^a
Sensory nerve	79.3 ± 8.3

a) Mean $\pm$ S.D.

stimulating electrode was 25 mm. The positions of the stimulating and the recording electrodes were shown in Fig. 1. The stimu-

lating electrodes were so placed percutaneously near the common peroneal nerve (over the sciatic nerve at the proximal stimulation site) as to elicit the maximal M wave by the minimal voltage of rectangular pulses. Stimulus pulses 0.5 msec in duration were applied at a frequency of 2.5 Hz by an electrostimulator (San-ei, 3F46). The exploring electrode was inserted at a depth of 10 mm within the belly of the peroneus tertius muscle. The reference electrode was placed subcutaneous-

Fig. 4. Recruitment curves of M wave and REMP by the distal stimulation.

Fig. 5. The effect of nerve block on the amplitude of M wave and REMP.

Fig. 6. T wave and REMP evoked in the peroneus tertius muscle.

ly and approximately 10 mm distal to the exploring electrode. The ground electrode, a stainless steel needle without coating was placed subcutaneously between the exploring and distal stimulation sites. Evoked muscle potentials were fed to an amplifier (San-ei, 1261) set at a time constant of 0.03 sec without a 50 Hz filter. Amplified potentials being monitored by a cathode ray oscilloscope (Kokuyo, KS-501) were led to a transient memory (Nihonkoden, Rat-1100), and written out on a pen recorder (San-ei, Rectigraph-8S). The motor nerve conduction velocity (MCV) was calculated from the difference of the latency of the M wave elicited by two, proximal and distal stimulations. The sensory nerve conduction velocity (SCV) was similarly calculated from the REMP elicited by two stimulations. The REMP in the peroneus tertius muscle had a longer latency and appeared after the M wave by the electrical stimulation to the common peroneal nerve (Figs. 2 and 3). M wave showed the wave form of 2–4 phases and REMP was analogous except that the amplitude of the potential was 1/10 of the M wave. Evaluations of the M wave and REMP in 10 cows are given in Table 1. Amplitudes of M wave were 17.65 ± 3.34 mV for the proximal and 19.50 ± 4.30 mV for the distal, and its durations were 9.90 ± 1.25 msec for the proximal and 10.18 ± 1.26 msec for the distal stimulation. Likewise, amplitudes of REMP were 1.70 ± 1.10 mV for the proximal and 1.91 ± 1.26 mV for the distal, and durations were 8.05 ± 1.20 msec for the proximal and $7.61 \pm$

1.21 msec for distal stimulation. Significant differences between the proximal and the distal stimulations were not observed. The latency was shorter by the distal (3.84 ± 0.67 msec) than the proximal stimulation (7.40 ± 1.23 msec) in the M wave, however, conversely longer by the distal (21.95 ± 4.09 msec) than the proximal (18.52 ± 3.48 msec) stimulation in the REMP. The nerve conduction velocity were 77.7 ± 8.1 m/sec for MCV and 79.3 ± 8.3 m/sec for SCV (Table 2). The recruitment curves of M wave and REMP were shown in Fig. 4, in which most of REMP appeared at lower stimulus intensity than that for M wave. REMP reached the maximal amplitude level before M wave did and obliterated by increasing the stimulus intensity. The nerve was blocked by an injection of procaine hydrochloride proximally to the stimulation site. The recruitment curves before and after the nerve block were shown in Fig. 5. The amplitudes of M wave was not affected as was expected, however REMP was not elicited at any stimulus intensity after the nerve block. These results indicated that REMP was a potential converted through the central nervous system. The tendon reflex (T wave) which has been accepted to have a monosynaptic nature was compared with REMP to clarify the nature of REMP. The reflex was evoked by tapping the tendon of the peroneus tertius muscle. The wave form and the duration of T wave were similar to those of the REMP and neither of them had after-discharge. However, T wave had slightly longer latency than the REMP (Fig. 6). Although tendon and H reflex share the common neural pathway in a part of the arc, two reflexes are not synonymous. In the H reflex, afferent fibers are stimulated directly, whereas in the tendon reflex the stimulus arises from the muscle spindle. Thus, it may be reasonable that the latency of T wave is longer than that of H wave [6]. In conclusion, REMP which was evoked in the peroneus tertius muscle by

stimulating the common peroneal nerve in the cow satisfied the criteria [3] for that of a monosynaptic reflex (H wave). This response involving two neurons may be useful for the diagnosis of neuropathies in cows.

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要 約

牛の誘発筋電図における単シナプス性反射(H波)の発現(短報): 矢野雅之・峯尾 仁・加藤清雄・牛島純一(酪農学園大学獣医学科)——牛において, 単シナプス性反射(H波)と考えられる反射性誘発筋活動電位(REMP)を導出した。総腓骨神経(近位では坐骨神経)を矩形波で刺激し, 第3腓骨筋から誘発筋活動電位を針電極で記録した。REMPはM波(直達性筋活動電位)のあとに低閾値で発現し, 刺激電圧を順次上げていったときM波が最大振幅に達する以前に消失した。潜時は刺激部位を近位から遠位に移すと, かえって延長した。さらに, 同一筋から導出したT波はREMPと波形, 持続時間は相似であったが, 潜時はやや長かった。また, 刺激部位より近位の神経遮断によりREMPは消失した。