Alterations in Wave Form of the QRS Complex of Domestic Animals in the Fetal and Neonatal Stages

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Few reports have been published on electrocardiographic and physiological investigations, except morphological ones, about the conduction system of the fetal heart, though fetal electrocardiographic studies were made for the purpose of clinical diagnosis [1, 3–5, 9–11]. As is mentioned in the previous reports [7, 8], the wave form of the QRS complex is almost Rs(R) type in Pisces, Amphibia and Reptilia, rS type in Aves and Ungulata, and Rs(RS) type in any other order of the

Mammalia, and the chicken heart is analogous to the goat heart and remarkably different from the dog heart from an electrocardiographic and phylogenetic point of view. From an ontogenetic point of view, the electrocardiograms (ECGs) of chick embryos from the 5th day of incubation to the hatching day were recorded in A-B lead along the longitudinal heart axis [6]. They indicated a variation in wave form of the QRS complex from R type to rS type, or a final type, by way of the RS type, as shown in Fig. 1. The adult type of QRS complex in the chicken was founded completely in the latter half of the incubation period.

In the present paper, the characteristics of ECGs of goats and dogs from fetal to neonatal stages were investigated from the above-mentioned point of view. In several stages of pregnancy, abdominal operations were carried out under spinal anesthesia and fetal ECGs recorded in A-B lead in the same manner as mentioned in the previous papers. The ECGs of fetal and neonatal goats are shown in Fig. 2. ECGs recorded on the 60th day of pregnancy indicated
that the P wave and QRS complex were distinguished obviously, while the T wave was not clear. The deflection of the QRS complex showed RS type and the P wave was already positive. A decrease of amplitude in the R spike and an increase in the S spike appeared in a period from the 60th to 80th day of pregnancy. Therefore, the wave form of the QRS complex indicated a shifting pattern from the RS to rS type. Since the 113th day of pregnancy, the QRS complex remained constantly in the rS type. After parturition it retained the same type as on the 113th and 143rd day of pregnancy. From the results obtained it was presumed that the electrocardiographic characteristics in the goat might have been completed by the 113th day of pregnancy.

On the other hand, the P wave and QRS complex of fetal and neonatal dogs were identified distinctly, as shown in Fig. 3. On the 45th day of pregnancy, the deflection of the P wave was positive and the QRS complex took RS type. ECGs recorded after the 45th day of pregnancy showed a great increase in amplitude, but the QRS complex remained in RS type. The deflection of the QRS complex manifested little change before and after parturition. The R spike increased in amplitude.

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**Fig. 2.** Electrocardiograms of goats in fetal and newborn stages

- **Fetus:**
  - 60th day
  - 80th day
  - 113th day
  - 143rd day

- **Newborn:**
  - 3 days
  - 9 days
  - 1 month

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**Fig. 3.** Electrocardiograms of dogs in fetal and newborn stages

- **Fetus:**
  - 35th day
  - 45th day
  - 54th day

- **Newborn:**
  - 3 days
  - 9 days
  - 16 days
  - 1 month

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in the newborn over a period from 3 to 9 days of age, while the S spike changed little in amplitude. Therefore, the QRS complex of Rs type was observed in dogs at 9 days of age and later.

From these results, it was assumed that the variations of the QRS complex might have been formed in goats and chickens by the same process in the fetal to neonatal stage, and that the adult type of this complex might have been completed in the later half of the fetal stage. In the dog, however, the shift of the QRS complex was different from that in the goat or chicken, and the QRS complex of Rs type was shown over a period from the middle and/or the later half of the fetal stage to several days after parturition. The adult type of the QRS complex, Rs type, was indicated in the early neonatal stage. It was presumed that the differences in the QRS complex among chicken, goat, and dog might be derived from those in the distribution of Purkinje fibers in the free ventricular walls [2].

The results of the present study suggest that fetuses harbored by such adult animals as dogs, which show the local distribution of these fibers in the subendocardial layer, may indicate the same deflection of the QRS complex as the adults of their species in the early neonatal stage.

Relationship among the shift in type of the QRS complex, the formation of specific cardiac muscles, and the wall thickness of both ventricles will be discussed in another paper.

References