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Araştırma Makalesi ***Research Article***

Electrocardiographic Studies on Neonatal Period of Holstein Dairy Calves

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Abstract

Several physiological alterations may occur in cardiovascular system during fetal life to the neonatal period. Electrocardiographic studies in neonatal period may assist veterinarians to evaluate cardiovascular system in this period. Five multiparous high producing Holstein dairy cows were monitored at close-up dry period to calving. Electrocardiograms were recorded from their calves immediately and 5, 10, 15, 20, 25, 30 and 35 days after birth and all electrocardiographic parameters were evaluated. Durations of P, R and T waves were increased significantly from birth to the end of neonatal period ($P<0.05$). R and T amplitudes were significantly elevated but P amplitude declined significantly. There were significant increasing patterns in PR, RR, QT and ST intervals during neonatal period ($P<0.05$). Based on these findings, it may be suggested that physiological alterations of the electrocardiographic parameters occur during the neonatal period of the Holstein dairy calves at neonatal period. These data could provide a better understanding of interpretation of the electrocardiographic alterations among neonatal calves.

Özet

Yeni Doğan Holştayn Buzağılarda Elektrokardiyografik Çalışmalar

Fötal hayattan yeni doğan dönemine kadar kardiyovasküler sistemde çeşitli fizyolojik değişiklikler meydana gelebilir. Yeni doğan dönemindeki elektrokardiyografi çalışmaları, bu dönemdeki kalp-damar sisteminin durumunu değerlendirmek için veteriner hekimlere yardım edebilir. Yüksek süt üretimine sahip, birden fazla doğum yapmış olan beş adet Holştayn inek kuru dönemden buzağılamaya kadar takip edilmiştir. Elektrokardiyogramlar doğumdan hemen sonra buzağıların doğumunu takibinden 5, 10, 15, 20, 25, 30 ve 35 gün sonra kaydedilmiştir ve tüm elektrokardiyografik parametreler değerlendirilmiştir. Doğumdan yeni doğan dönemin sonuna kadar P, R ve T dalgalarının süreleri anlamlı olarak artmıştır ($P<0,05$). R ve T amplitüdleri anlamlı olarak yükselmiş ancak P amplitüdünde önemli ölçüde düşüş bulunmuştur. Yeni doğan döneminde PR, RR, QT ve ST aralıklarında önemli artışlar gözlenmiştir ($P<0,05$). Bu bulgulara dayanarak, yeni doğan döneminde Holştayn buzağılara ait elektrokardiyografik parametrelerdeki fizyolojik değişikliklerin, yeni doğan döneminde ortaya çıktığı söylenebilir. Bu veriler, yeni doğan buzağılarda elektrokardiyografik değişikliklerin yorumlanmasının daha iyi anlaşılmasını sağlayabilir.

Introduction

The term neonate in bovine medicine defines calves under 28 days old (Poulsen and McGuirk, 2009). Several physiological alterations and adaptations occur rapidly in the transition from fetal life to the neonatal period. At parturition the neonate needs to assume responsibility for oxygenating its own blood from atmospheric air, and maintaining a normal blood pH and body temperature (Kasari, 1994). *In utero*, the numerous placentomes that are distributed on the endometrial surface provide oxygen and nutrient-rich blood to the fetal placenta. Distribution of the oxygen and nutrients is accomplished by the fetal circulation shunting blood away from the pulmonary circulation by way of the ductus arteriosus and foramen ovale, which is facilitated by hypoxia-induced pulmonary arterial constriction (Ardran et al., 1952). The fetus is quite hypoxic relative to the dam, but adapts well to this environment because of efficient oxygen extraction from maternal placental blood with fetal hemoglobin's high affinity for oxygen (Detweiler and Riedesel, 1993) and by increasing blood flow from nonessential organs to the brain, heart, and adrenal glands (Rurak et al., 1990).

Numerous changes take place in cardiovascular system during and after birth such as closing ductus arteriosus. Furthermore, several situations such as acidosis, infectious and non-infectious stress factors can affect this system (Radostits et al., 2007). Hence, evaluating the cardiovascular system during neonatal period can assist veterinarians to make diagnosis, represent prognosis and assess responsiveness to treatments.

Electrocardiography is one of the common and practical tools to evaluate cardiovascular system performance and efficiency. Some of the cardiac problems could not be detected via clinical examinations and electrocardiography can cover the failures of clinical examinations (Radostits et al., 2007). There are several literatures on electrocardiographic evaluations of large animal neonates (Chalmeh and Pourjafar, 2013; Pourjafar et al., 2011 and 2012), but information regarding the changing patterns of each electrocardiographic parameter after birth to the end of neonatal period in bovine neonates is lacking. The current research was designed to represent changing patterns of electrocardiographic parameters during neonatal period of Holstein dairy calves. Furthermore, the results of the present study can provide the guidelines to evaluate the electrocardiograms (ECGs) tracing from different states of this period.

Materials and Methods

The current research was performed at spring 2014, in an industrial dairy farm. Five multiparous high producing Holstein dairy cows were monitored at close-up dry period to calving. These cows had not dystocia and periparturient problems. Their calves were female, examined after birth and proved their healthiness and absence of congenital problems. Disinfecting the umbilicus was performed using glycerin iodine by dipping method. The ECGs were recorded from the calves immediately and 5, 10, 15, 20, 25, 30 and 35 days after birth. Their body weight was 42.3±2.4 kg at birth and 48.4±1.7 kg at the final ECG recordings. All ECGs were obtained on a bipolar base apex lead, using limb lead I by alligator-type electrodes which were attached to the skin after cleaning it with ethanol and applying electrocardiographic jelly. Their position at the first ECG recording was sternally and standing at other samplings. The positive electrode (left arm) of lead I was attached to the skin of the left thorax at the 5th intercostal space, immediately caudal to the olecranon. The negative electrode (right arm) was placed on the jugular furrow in the caudal third of the left neck and the neutral electrode (right foot) was used on the skin of thoracic inlet (Radostits et al., 2007). ECG was obtained on a single channel electrocardiographic machine (Kenz-line EKG 110, Suzuken Co., Ltd., Japan) with the paper speed 25 mm/sec and calibration of 10 mm equal to 1 mV. Duration and amplitude of the P, QRS complexes and T waves and the PR, RR, QT and ST intervals were measured and averaged from successive beats following the usual conventions (Figure 1).

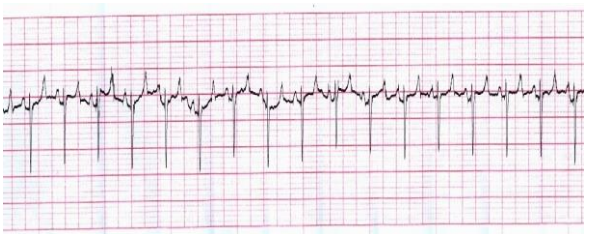

Figure 1. An ECG tracing from a 10-day-old Holstein dairy calf reveals normal sinus rhythm (base-apex lead system; paper speed 25 mm/sec; sensitivity 10 mm/mV).

Şekil 1. 10 günlük bir Holştayn buzağıda normal sinüs ritmine ait bir EKG (baz apeks uç sistemi; 25 mm/sn kağıt hızı; hassasiyet 10 mm/mV).

Mean and standard deviation (SD) were calculated for all parameters in different days after birth. The changing pattern of each electrocardiographic parameter was analyzed statistically by Repeated Measures ANOVA using SPSS software (SPSS for Windows, version 11.5, SPSS Inc, Chicago, Illinois). $P<0.05$ was considered statistically significant.

Results

Durations of P, R and T waves were increased significantly from birth to the end of neonatal period (Figure 2; $P<0.05$). There were no significant changing patterns of Q and S durations during neonatal period. R and T amplitudes were significantly increased but P amplitude decreased significantly (Figure 3; $P<0.05$). Q and S amplitudes had not significant changing patterns during the neonatal period of studied calves. There were significant increasing patterns in PR, RR, QT and ST intervals from birth to the end of neonatal period (Figure 4; $P<0.05$).

Discussion

There are several literatures on electrocardiographic parameters and their changing patterns in large animals (Chalmeh et al., 2013; Chalmeh, 2014); but no comprehensive report was found on the changing patterns of electrocardiographic factors during neonatal period of Holstein dairy calves.

The results of the present study showed that some of the electrocardiographic parameters were changed

during neonatal period of the calves. Other researchers mentioned that several changes occur in cardiac muscle and its conduction system after birth (O'Connor et al., 2008). Furthermore, many of the changes that occur in the ECG reflect the anatomical dominance of the right ventricle during neonatal period. At birth, the right ventricle is thick on account of high pulmonary artery pressure *in utero*. Falling pulmonary artery pressure after birth, causes decreasing the right ventricular pressure lower than *in utero* period (Garson et al., 1998).

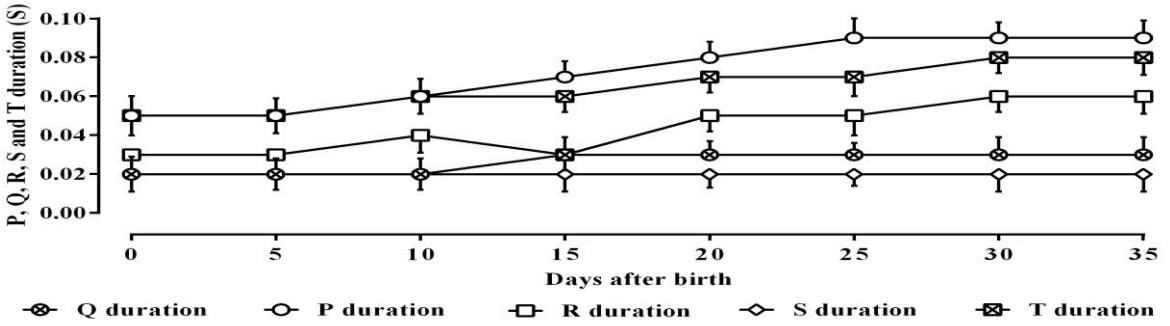

Figure 2. Alterations of the electrocardiographic wave's durations during neonatal period of Holstein dairy calves (base apex lead, paper speed 25 mm/sec, sensitivity 10 mm/mV).

Şekil 2. Holştayn buzağıların yeni doğan döneminde elektrokardiyografik dalga sürelerindeki değişiklikler (baz apeks uç, kağıt hızı 25 mm/sn, hassasiyet 10 mm/mV).

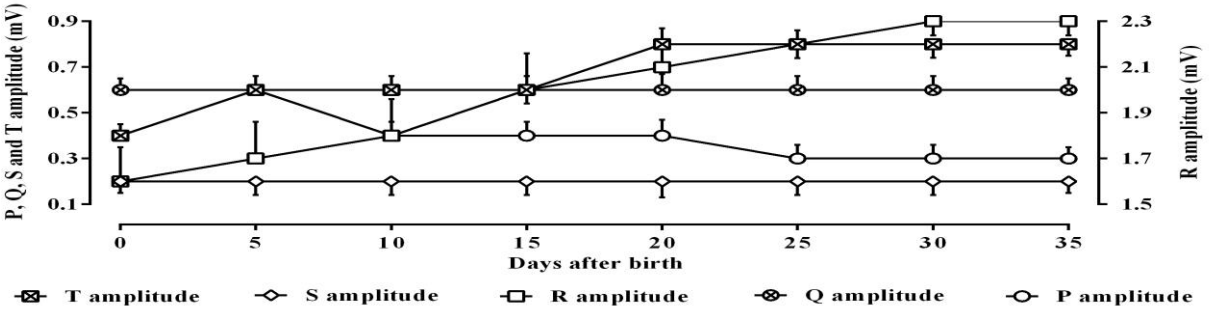

Figure 3. Alterations of the electrocardiographic wave's amplitudes during neonatal period of Holstein dairy calves (base apex lead, paper speed 25 mm/sec, sensitivity 10 mm/mV).

Şekil 3. Holştayn buzağıların yeni doğan döneminde elektrokardiyografik dalganın genişliklerindeki değişiklikler (baz apeks uç, kağıt hızı 25 mm/sn, hassasiyet 10 mm/mV).

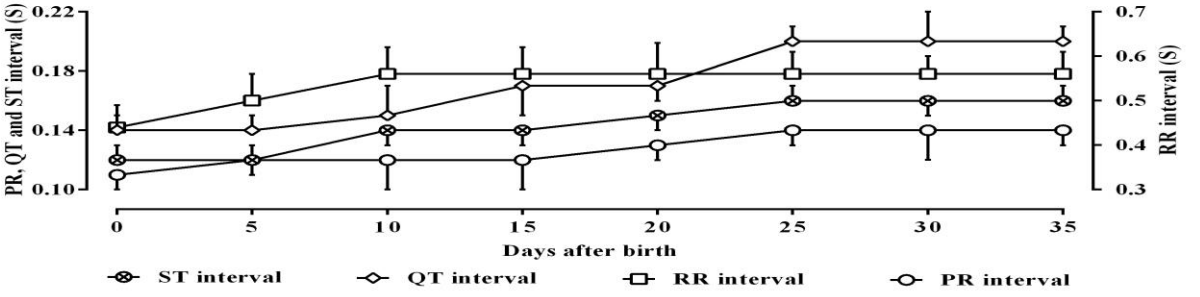

Figure 4. Alterations of the electrocardiographic wave's intervals during neonatal period of Holstein dairy calves (base apex lead, paper speed 25 mm/sec, sensitivity 10 mm/mV).

Şekil 4. Holştayn buzağıların yeni doğan döneminde elektrokardiyografik dalganın aralıklarındaki değişiklikler (baz apeks uç, kağıt hızı 25 mm/sn, hassasiyet 10 mm/mV).

P, T and R durations in the studied calves were increased during neonatal period (Figure 2; P<0.05). R-R interval increased during neonatal period which indicates the decreasing pattern of heart rate in these calves. It can be suggested that the lower heart rates in older calves cause increased durations in these animals at the end of neonatal period.

R and T amplitudes were significantly increased during the neonatal period. It may be suggested that the more developed conduction system in older calves allows the fast transmission of cardiac electrical waves to electrocardiographic machine. But, P amplitude was decreased during this period. The conductive properties of the body mass of ruminants, attributable to the volume of the gastrointestinal tract, also influence the distribution of body surface potentials comprising the ECG (Santamarina et al., 2001). It is possible that gradual development of body mass may cause difficulty in reaching the waves to the body surface due to relative electrical insulation by increasing body mass and changing in amplitudes can occur. It could be suggested that as the mass of heart in older calves became larger in the process of growth, the duration of transfer of cardiac electrical activity also increases. Furthermore, ruminants have a deeply penetrating purkinje system, and depolarization from ventricular endocardium to epicardium occurs explosively and in many directions at once (Pennisi et al., 2002).

P-R, R-R, Q-T and S-T intervals were significantly increased during neonatal period, which may probably be due to the larger size of the heart in older calves. With advancing age, widespread anatomical changes in the conduction system occur. These changes may alter several features of the aging ECG, including duration of the P-R and Q-T intervals, orientation of the electrical axis, duration and morphology of the atrial and ventricular complexes, and characteristics of the ventricular activity (Jones et al., 1990).

R-R interval is the most obvious manifestation of age related variability within the neonatal ECG. This change can be accounted for by the gradual increase in vagal tone that accompanies aging. Younger animals also may be anxious during ECG acquisition, causing an artifactual decrease in the R-R interval (O'Connor et al., 2008).

Atrioventricular conduction is assessed via the P-R interval. Physiological prolongation of the P-R interval suggests conduction delay within the atrioventricular node. Larger mass of cardiac musculature in older calves causes delay in heart conduction system (Radostits et al., 2007).

The QRS duration in young animals is shorter than that of adults, once again, because of smaller cardiac muscle mass (O'Connor et al., 2008). The Q-T interval, measured from the beginning of the QRS complex to the termination of the T wave, represents ventricular activity. Macfarlane et al. (1994) reported that the Q-T interval increased during aging in human beings.

In conclusion it may be stated that several physiological changes of the electrocardiographic parameters take place during the neonatal period of the Holstein calves. Furthermore, information regarding the physiological alterations of the ECG can provide a better basis for judging the ECGs in neonatal calves.

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