Kocatepe Veterinary Journal

Kocatepe Vet J (2020) 13(3):248-253
DOI: 10.30607/kvj.746494

RESEARCH ARTICLE

Evaluation of ECG and EMG Findings in Dogs Undergoing Abdominal Ultrasonography

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ABSTRACT

In this study, it was investigated that how the abdominal ultrasonography (USG) affect the ECG (for heart rate) and EMG data and whether it would be possible to apply both ECG and EMG simultaneously while applying USG. ECG and EMG data were recorded at least 15 seconds before and after 10 seconds during the USG procedure in 12 dogs. The biosignal recording system was set for 1 channel EMG and 1 channel ECG. The common mode rejection ratio of the amplifiers was over 85 dB. The transmission band of the EMG amplifier was set to 5-450 Hz according to the amplitude analysis, and the transmission band of the ECG amplifier was set to 0.5-40 Hz for heart rate detection. The system's 12-bit Analog digital converters were averaged 128 consecutive sampling data and transferred to the Android 7.0-based recording system. Then datas were processed with Matlab 2018 analysis program. As a result, when the EMG and ECG datas of the dogs included in the study were evaluated, a significant contraction was detected in the affected muscle groups, also heart rates increased statistically. However, it was observed that such applications did not cause any complications that would affect the patient's health.

Keywords: Dog, Ultrasonography, EMG, ECG

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Abdominal Ultrasonografi Uygulanan Köpeklerde EKG ve EMG Bulgularının Değerlendirilmesi

ÖZ

Bu çalışmada, köpeklerde uygulanan abdominal ultrasonografinin, eş zamanlı uygulanan EKG (kalp hızı için) ve EMG (kas kasılması için) verilerini ne şekilde etkilediği araştırılmış, ayrıca USG uygulanırken aynı anda hem EKG hem de EMG uygulanmasının her hangi bir komplikasyon oluşturup oluşturmayacağının ortaya konulması da amaçlanmıştır. Esaote My Lab Five VET marka renkli Doppler Ultrasonografi cihazı ve bu cihaza ait 5.0/8.0 MHz multi frekanslarında tarama yapabilen mikrokonveksprob kullanılarak yapılan 12 köpekteki USG işlemi esnasında en az 15 saniye öncesi ve 10 saniyesi sonrası EKG ve EMG verileri kayıt altına alınarak değerlendirildi. Biyosinyal kayıt sistemi, 1 kanal EMG ve 1 kanal EKG verisi için ayarlandı. Amplifikatörlerin ortak gürültüden kurtulma oranı 85 dB'in üzeri idi. EMG amplifikatörünün geçirme bandı amplitüd analizine uygun şekilde 5-450 Hz, EKG amplifikatörünün geçirme bandı ise 0.5-40 Hz olarak ayarlandı. Sistemin 12-bit Analog dijital çeviricileri 128 kez ardışık örneklemenin ortalamasını alarak veriyi, Android 7.0 temelli kayıt sistemine aktardı. Veriler daha sonra Windows temelli bir bilgisayarda Matlab 2018 bilimsel analiz programı ile işlendi. Sonuç olarak çalışmaya alınan köpeklerde EKG verileri değerlendirildiğinde kalp hızının istatistiksel olarak arttığı ayrıca EMG sonuçlarına göre de etkilenen kas gruplarında anlamlı derecede kasılma saptandı. Ancak bu tür uygulamaların hastanın sağlığını etkileyecek herhangi bir komplikasyona yol açmadığı görüldü.

Anahtar Kelimeler: Köpek, Ultrasonografi, EMG, EKG

To cite this article: Gözgören Y.T. Cıngı C.Ç. Evaluation of ECG and EMG Findings in Dogs Undergoing Abdominal Ultrasonography. Kocatepe Vet J. (2020) 13(3):248-253

Submission: 01.06.2020 **Accepted**: 20.07.2020 **Published Online**: 26.08.2020
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INTRODUCTION

Ultrasonography (USG) is the technique of examining soft tissues with high frequency sound waves (Nyland et al. 2002). With this method; the identification of the abdominal pathologies, imaging, recording of the images and taking biopsies can be applied by the surgeons (Alkan 1999, Şındak and Biricik 2006).

Electrocardiography (ECG) is the recording of the electrical signal that develops during the beating of the heart muscle (Tilley 1979, Başoğlu 1992), which created by the action potentials that occur during the contraction (depolarization) and relaxation (repolarization) of the heart. Electromyography (EMG) is a technique that results from physiological changes in muscle fibril membranes, develops, records and analyzes myoelectric signals. Superficial kinesiological EMG records signals from the targeted muscle with electrodes adhered to the skin. Superficial EMG focuses on exercise selection, training, functional movements and neuromuscular activation of muscles in postural positions. Kinesiological EMG applications are used in laboratory conditions to understand the contraction patterns of the muscles, to measure the amount of activation of the muscles, to evaluate the muscle synergistic activation profile and to define the formation of fatigue (Basmajian and De Luca 1985, De Luca 1997, Cerrah et al. 2010).

In this study, the aim was emphasized to determination of heart rate frequency via ECG technique and analysis of muscle contraction by quantitative processes by EMG during abdominal USG examination in healthy dogs which were handled to Afyon Kocatepe University (AKU) Veterinary Faculty Animal Hospital. Also, to reveal any complications that arises whether ECG and EMG application at the same time concurrently while applying USG.

MATERIAL and METHODS

The study was performed under the approval dated numbered 49533702/16 of the local ethics committee for animal experiments of Afyon Kocatepe University, in Turkey.

The material of the study consisted of 12 dogs between the ages of 1-9 who were brought to AKU Veterinary Faculty Animal Hospital for ovariohysterectomy, castration operation and general examination. General examination was performed to all dogs than after a 30-minute rest period; they were taken to the USG room following the shaving of the hair in the abdominal region.

USG, EMG and ECG Examinations

All dogs were placed in the lateral position and then the mid part of the *M. biceps femoris* muscles was clipped. After the skin was wiped, Ag / AgCl sticky electrodes were parallelly placed to the muscle fibers. The distance between two electrodes was 2 cm away from. For the ECG, two electrodes were sticked to both sides of the heart. After the EMG and ECG recording system was connected, waited for 5 minutes until the dog calmed down in this position. Later, Esaote My Lab Five VET color Doppler Ultrasonography device and a micro-convex probe capable of scanning at 5.0 / 8.0 MHz multi frequencies of this device were used at least 15 seconds before and 10 seconds after the abdominal USG examination. These signals were used in data analysis. The modular prototype device produced for this study was used for ECG and EMG examinations (Figure 1). The biosignal recording system was set for 1 channel EMG and 1 channel for ECG recording. The common mode rejection ratio of the amplifiers was higher than 85 dB. The transmission band of the EMG and ECG amplifier were 5-450 Hz and 0.5-40 Hz respectively. 1000 Hz sampled signals transferred to a Windows-based computer for analysis with the Matlab 2018 (Mathworks, USA) software. Artifact rejection and rms (root-mean-square) filters were applied to the EMG signals. Then, the maximum value of the first 5-second of the processed EMG; the maximum value of the first 5-second of the processed EMG before the USG probe touched the dog and the maximum value of the 5-second of processed EMG after the USG probe touched the dog (excluding the 1-second portion after touch) were used in the statistics (Figure-1). Heart rates were calculated from the same 5-second ECG segments as range (= max-min) using QRS wave peaks. In this way, the data of 5-second intervals; rest, the probe was labeled before and after touch.

Statistical Analysis

Descriptive statistics of the data obtained were determined by determining the average and standard deviation values. In dogs with abdominal USG, statistical findings of heart rate were evaluated with the ECG device by Student-t test. The EMG findings detected in the same dogs were processed with the Mann Whitney-U test and the data before and after the examination were statistically revealed.

RESULTS

ECG Measurements

Variance analysis for repeated measurements was used for evaluating the heart rate period statistics (Geisser-Greenhoused correction was also applied).

The periods of the heart rates after touching the probe was reduced ($p < 0.01$) when detecting by duration (milliseconds). It means that number of heart rates was significantly increased in 12 cases after the probe touched. When the number of heart beats taken 15 seconds before and 10 seconds after the probe touched (Table 1, Figure 2).

EMG Measurements

According to the data obtained from the electrodes placed on the *M. biceps femoris* of the study group dogs, when the muscle activation values occurred 15 seconds before the probe was touched and 10 seconds after being touched, it was observed that the muscle activation values increased statistically in ten cases after the probe was touched ($p < 0,02$) (Table 2, Figure 3, Figure 4).

Figure 1. Prototype moduler ECG and EMG device.

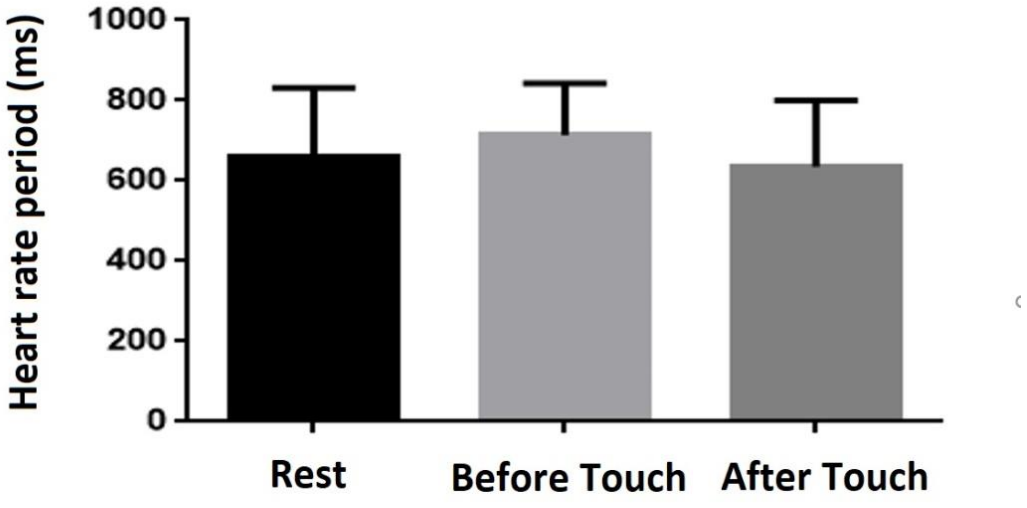

Figure 2. Heart rate periods (Mean,SD).

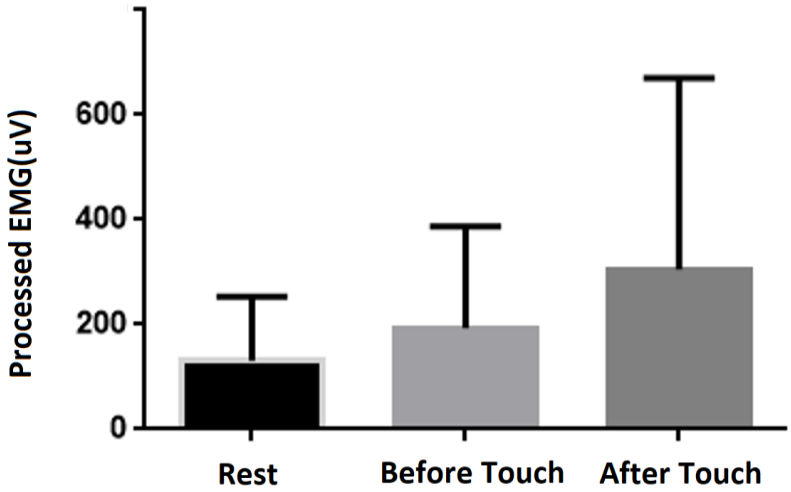

Figure 3. Processed EMG (Mean, SD).

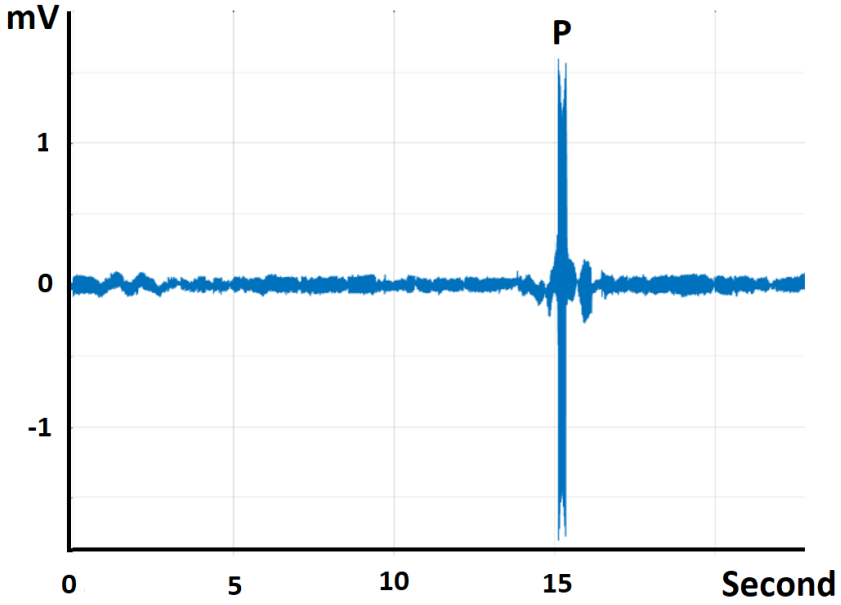

Figure 4. Raw EMG signal from a dog. P: USG probe touch artifact

Table 1. Heart rate period in dogs

Heart Beat Period (ms)		
Rest	**Before Touch**	**After Touch**
498	567	542
697	697	652
526	666	607
608	622	545
640	629	554
525	661	517
549	691	524
679	673	676
679	753	538
1029	906	983
960	1025	958
501	681	534

Table 2. EMG Datas in Dogs

EMG (MikroVolt)		
Rest	**Before Touch**	**After Touch**
20	21	97
62	61	102
85	93	124
126	381	478
118	147	165
153	173	146
267	362	770
51	53	58
30	29	39
30	47	68
434	651	1232
207	308	390

DISCUSSION and CONCLUSION

When faced with a live source of stress, the body shows war or run away response due to the activation of the sympathetic nervous system. As a result of the physical and chemical changes in the body during the war or run away response, the condition develops as the acceleration of heartbeat, high blood pressure, acceleration of breathing and sudden secretion of adrenaline (Güçlü 2001). Even if stress is experienced for a short period of time, it could cause permanent results in a short time such as tension and increased heart rate (Kahn and Cooper 1993). In this study, the results of the increase in heart rate following the probe contact were formed in all dogs with ECG accompanied by USG, and results consistent with the findings of sudden cardiac increase in environmental compliance were obtained.

Fear could be divided into two sections which are called conditionally and unconditionally. Stimuli that cause an unconditional fear response generate fear without the creature's learning experience related to these stimuli. In conditions of conditional fear, it is now possible for the organism to emerge conditional fear responses in the living as a result of the temporal-spatial matching of a previously neutral stimulus with an unconditional stimulus (such as electric shock). The main reactions used in measuring conditional fear used in the studies conducted are freezing behavior, tachycardia and ultrasonic vocalization (Borszcz 1995, Fendt and Fanselow 1999). In this study, USG application was accepted as an external stimulus and although the sound and light control was provided in the environment, following the touching of both the supine position and a solid material such as a probe to the abdominal muscles, the heart responds to this situation, which will increase the number of beats per minute.

EMG measurement results can be affected by many factors. Unlike invasive needle or thin wire EMG, where probes can be placed precisely in specific areas of the muscle, sEMG shows the total signal of target and nearby muscle activities. The formation of cross talk from other active muscles caused by skin movement is another problem. In addition, extensive research has proven the importance and validity of surface EMG measurements in humans (Bockstahler et al. 2012). Expressed as the maximum average and minimum average ratios to compare muscle activity data, a lower Min-average ratio is a rather low maximum activity value (indicative of less muscle activity during the rest phase) or a significantly higher average activity value (Zaneb et al. 2009). In this study, surface EMG was used to measure muscle activity during USG in dogs. Apart from these, the extent to which stress and excitement factors will affect muscle activation during the USG examination of the dogs, and considering the external factors, when we look at the EMG results obtained in 12 cases, it was determined that the amplitude showed significant increases after the probe touch. As a result, it was observed that the muscle contractions of the dogs increased excessively in accordance with the previous literature data ($p < 0.02$).

As a result; portable ECG and EMG device provides convenience to veterinary clinicians and academicians due to its compact structure. It was concluded that the device used in the study can be used safely in dogs for neuromuscular diseases and in detecting physiotherapy effectiveness above muscle activity. When the ECG data of the dogs included in the study were evaluated, the number of beats per minute was statistically increased and quantitative data were easily detected. In addition, according to the results of EMG, significant contraction was determined in the muscle groups, and in dogs, muscle contractions were displayed graphically by EMG during USG. It has been demonstrated that ECG and EMG examinations performed simultaneously with USG application can be easily applied in dogs. Thus, it is thought that veterinarians will save time by applying multiple advanced technical diagnostic methods at the same time. In veterinary clinics, as the time spent in both diagnosis and treatment lengthens, this creates a stress factor on patients. For this reason, in our study, multiple diagnosis methods were used simultaneously, and the time spent in patients in veterinary clinics and hospitals was shortened and thus, the stress factor on patients was tried to be minimized. However, it was also observed that the application of all three diagnostic methods at the same time did not cause any complications in affecting the patient's health. Nevertheless, the determination of heart rate especially with ECG and muscle contractions with EMG will shed light on further researches.

ACKNOWLEDGEMENT

This research article is summarized from Yağmur Tuba GÖZGÖREN's "Evaluation of ECG and EMG Findings in Dogs Undergoing Abdominal Ultrasonography" master thesis (Afyon Kocatepe University, Institute of Health Science Thesis No: 2020-006).

We thank to Assoc. Prof. Dr. A. Ruhi SOYLU (Hacettepe University) for technical consultancy and for contributing to the production of the prototype portable ECG and EMG device.

Conflict of Interest: The authors declare that they have no conflict of interest.

REFERENCES

Nyland TG, Mattoon JS, Herrgesell EJ, Wisner ER. Physical principles, instrumentation, and safety of diagnostic ultrasound. In Veterinary diagnostic ultrasound (Eds. Nyland TG, Mattoon JS); Philadelphia;WB Saunders Company, 2002. pp. 1-18.

Alkan Z. Veteriner Radyoloji, Ankara; Mina Ajans; 1999.

Şındak N, Biricik HS. Köpeklerde karın içi organ hastalıklarının ultrasonografi ile değerlendirilmesi. YYU Vet Fak Derg. 2006; 17 (1-2): 75-79.

Tilley LP. Basic canine electrocardiography. Wisconsin, USA Burdick Corp. 1979; p.1-50.

Basoglu A. Veteriner kardiyoloji. Ankara; Çağrı Basım Yayın Organizasyon; 1992.

Basmajian JV, De Luca CJ. Muscles Alive : their functions revealed by electromyography. Baltimore; Williams & Wilkens, 1985.

De Luca CJ. The use of surface electromyography in biomechanics. J Appl Biomech. 1997; 13(2): 135-163.

Cerrah AO, Ertan H, Soylu AR. Spor bilimlerinde elektromiyografi kullanımı. Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi. 2010; 8 (2): 43-49.

Güçlü N. Stres yönetimi. GÜ Eğitim Fakültesi Dergisi. 2001;21(1): 91-109.

Kahn H, Cooper CL. Stress in the dealing room: High performers under pressure. London; Cengage Learning Emea: 1993.

Borszcz GS. Pavlovian conditional vocalizations of the rat: a model system for analyzing the fear of pain. Behav Neurosci. 1995; 109 (4): 648-662.

Fendt M, Fanselow MS. The neuroanatomical and neurochemical basis of conditioned fear. Neurosci Biobehav Rev. 1999; 23(5):743-760.

Bockstahler B, Krautler C, Holler P, Kotschwar A, Vobornik A, Peham C. Pelvic limb kinematics and surface electromyography of the vastus lateralis, biceps femoris, and gluteus medius muscle in dogs with hip osteoarthritis. Vet Surg. 2012; 41 (1): 54–62.

Zaneb H, Kaufmann V, Stanek C, Peham C, Licka TF. Quantitative differences in activities of back and pelvic limb muscles during walking and trotting between chronically lame and nonlame horses. Am J Vet Res. 2009; 70 (9): 1129-1134.