https://dergipark.org.tr/tr/pub/ataunivbd
2021; 16(2): 176-181

Research Article/Araştırma Makalesi
DOI: 10.17094/ataunivbd.828343

Atatürk Üniversitesi Veteriner Bilimleri Dergisi
Atatürk University Journal of Veterinary Sciences

The Use of Two Dimensional Speckle Tracking Echocardiography in Veterinary Cardiology

Osman Safa TERZI[1a]✉, Cansu TOKSOZ[2b], Murat AKBABA[1c], Gokce EMREALP[1d]

1. Ankara University, Faculty of Veterinary Medicine, Department of Internal Medicine Department, Ankara, TURKEY.
2. Kirikkale University, Institute of Health Sciences, Kirikkale, TURKEY.

ORCID: 0000-0002-7877-8897[a], 0000-0002-9255-5016[b], 0000-0002-6665-7190[c], 0000-0002-9056-1770[d]

Geliş Tarihi/Received	Kabul Tarihi/Accepted	Yayın Tarihi/Published
25.01.2021	03.04.2021	31.10.2021

Bu makaleye atıfta bulunmak için/To cite this article:
Terzi OS, Toksoz C, Akbaba M, Emrealp G: How to Use Two Dimensional Speckle Tracking Echocardiography in Veterinary Cardiology. Atatürk University J. Vet. Sci., 16(2): 176-181, 2021. DOI: 10.17094/ataunivbd.828343

Abstract: The aim of this study is to present short-axis radial and circumferential strain and strain rate measurements by speckle tracking echocardiography technique in healthy cats and dogs. The study was performed at Small Animal Training and Research Hospital, Ankara University. Retrospective data from cats (n=5) and dogs (n=5), which are applied to the animal hospital for cardiological examination, were analyzed. Two-dimensional speckle tracking echocardiography was performed without sedation, and patients were manually restrained in the right and left lateral positions. Peak systolic radial strain, radial strain rate, circumferential strain, circumferential strain rate means were 24.47 ± 1.22%, 0.29 ± 0.20 s-1, -15.33 ± 2.56%, 0.05 ± 0.27 s-1 respectively for cats and were 39.33 ± 14.02%,-0.47s -1 ± 0.55 s-1, -23.13 ± 1.53%, -0.63 s-1± 0.18 s-1 respectively for dogs. It is thought that speckle tracking echocardiography can be included in routine echocardiographic examinations because this technique provides detailed information for determining the systolic potential of the left ventricle and the examination time is not much different compared to conventional echocardiographic examinations.

Keywords: Cats, Dogs, Strain,Strain rate, Speckle tracking echocardiography.

İki Boyutlu Benek Takibi Ekokardiyografinin Veteriner Kardiyolojide Kullanımı

Öz: Bu çalışmanın amacı sağlıklı kedi ve köpeklerde yapılan iki boyutlu benek takibi ekokardiyografide, kısa eksen papillar kas seviyesinde radiyal, sirkümferensiyal gerilim ve gerilim hızı ölçümlerinin yapılarak bu tekniğinin tanıtılmasıdır. Ankara Üniversitesi Küçük Hayvan Eğitim ve Araştırma Hastanesi'ne kardiyolojik muayene amacıyla getirilen kardiyolojik yönden sağlıklı kediler (n = 5) ve köpeklerin (n = 5) kaydedilen ekokardiyografi görüntüleri retrospektif olarak analiz edildi. Muayene sağ ve sol lateral pozisyonda ve hayvanlar sedasyona alınmadan yapıldı. Kediler için sırasıyla ortalama zirve sistolik radyal gerilim, radyal gerilim hızı, sirkümferensiyal gerilim, sirkümferensiyal gerilim hızı 24.47 ± % 1.22, 0.29 ± 0.20 s-1, -15.33 ± % 2.56, 0.05 ± 0.27 s-1 ölçülürken, köpekler için bu ortalama değerler sırasıyla 39.33 ± % 14.02, -0.47 s-1 ± 0.55 s-1, -23.13 ± % 1.53, -0.63 s-1 ± 0.18 s-1 olarak ölçülmüştür. Konvansiyonel ekokardiyografi ile karşılaştırıldığında benek takibi ekokardiyografi tekniğinin sol ventrikülün sistolik fonksiyonunu belirlemesi noktasında daha detaylı bilgi sağlaması ve muayene süreleri arasında çok ciddi bir fark olmaması gibi sebeplerle iki boyutlu benek takibi ekokardiyografinin rutin ekokardiyografik incelemeler arasına dahil edilebileceği düşünülmektedir.

Anahtar Kelimeler: Benek takibi ekokardiyografi, Gerilim, Gerilim hızı, Kediler, Köpekler.

✉ Osman Safa Terzi
Ankara University, Faculty of Veterinary Medicine, Department of Internal Medicine, Ankara, TURKEY.
e-mail: osmansafaterzi@gmail.com

INTRODUCTION

Two-dimensional speckle tracking echocardiography (2-D STE) is a new technique based on following ultrasound points, defined by a user, on the myocardium during systolic and diastolic events. In standard echocardiographic techniques, M mode results are used to determine the systolic function of the left ventricle (1). M mode echocardiography only assesses the data of the area through which the cursor passes, while speckle tracking echocardiography (STE) can show both regional and global myocardial deformations (2).

Strain and Strain Rate

Strain (St); refers to the percentage of displacement of points (ultrasonographic spots) that occur in a myocardial area during a cardiac cycle. For this reason, St is expressed by percentage (%). Negative St indicates thinning or shortening of myocardial fibrils, while positive St indicates lengthening or thickening. It basically measures the amount of contraction and relaxation of muscle fibers (3). Strain rate (SR) determines the relationship of this displacement with time (4).

Deformation parameters can be calculated with specific vectors. Three-way movement can be tracked at STE. These are; radial, longitudinal and circumferential movements. Longitudinal contraction reflects the movement from base to apex. Radial contraction is perpendicular to the long axis or epicardia, and it refers to the thickening and thinning movement of the myocardium on the short axis. Circumferential strain is perpendicular to the radial and longitudinal contraction, and it refers to the change in diameter of the myocardium on a short axis view (3).

Reference intervals were determined in both pediatric (5) and adult (6,7) patients in human medicine. There are similar studies on healthy dogs of different breeds in veterinary medicine (2,8,9,10). In Turkey, studies for determining reference intervals have not yet been carried out in healthy animals.

MATERIAL and METHODS

Animals

The study was performed at the Small Animal Training and Research Hospital, Ankara University. Retrospective data from cats *(n=5)* and dogs *(n=5)*, which are applied to the animal hospital for cardiological examination, were analyzed. Gender distribution for cats and dogs was 2 males and 3 females (Ethics Decision Number: 2021-6-32).

Speckle Tracking Echocardiography Examination

STE was performed without sedation, and patients were manually restrained in standing or right and left lateral positions (Figure 1A, 1B, 1C). Right parasternal imaging was preferred for short-axis views while left parasternal imaging were preferred for apical long-axis views for conventional echocardiographic examinations. A special echocardiographic examination table can be useful for acquiring parasternal views of patients (Figure 1D). Echocardiographic examination tables can be either a platform on top of normal examination tables or an examination table with holes for using ultrasound probes under the table. Because STE measurements are based on the following user-determined ultrasonographic spots, high-quality images and frame rates (FPS) are required. For this reason, the patient's position and stable posture are extremely important in this examination. Examination tables must be electrocardiography (EKG) compatible because simultaneous EKG limb lead II was recorded during the examination. Imaging software differs in echocardiography devices. In this study Echolab Das-RS1 software was used in Hitachi, Arietta V60 model ultrasound device.

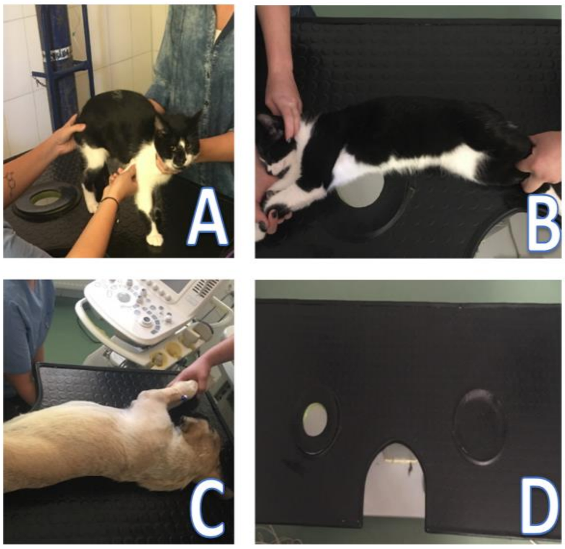

Figure 1 A. STE examination at standing position. **B.** Cat STE examination in right lateral recumbency. **C.** Dog STE examination in right lateral recumbency. **D.** STE examination table.
Şekil 1 A. Kedide ayakta benek takibi ekokardiyografi muayenesi. **B.** Kedide sağ lateral pozisyonda benek takibi ekokardiyografisi muayenesi**. C.** Köpekte sağ lateral pozisyonda benek takibi ekokardiyografi muayenesi. **D.** Benek takibi ekokardiyografi muayene masası.

By using EKG data, peak systolic point was determined. Points of interest (POI) were determined circularly by taking endocardial limits into account. The determined points were tested with “test tracking” tab of the software. Points that have been determined correctly remain yellow, while incorrect turn red during the test cycle. Speckles were tested until there were no red spots within a cycle period. After setting the epicardial points, analysis can be started by the “processing” tab. And then, the level of the image (base, papillary muscle, apex) on the short axis can be selected. A graph was formed as a result of this analysis. In this graph, myocardial thickness, radial strain, circumferential endocardial strain, epicardial circumferential strain, average circumferential strain, radial strain rate, endocardial circumferential strain rate, epicardial circumferential strain rate, average circumferential strain rate data were recorded every 15 milliseconds (Figure 2).

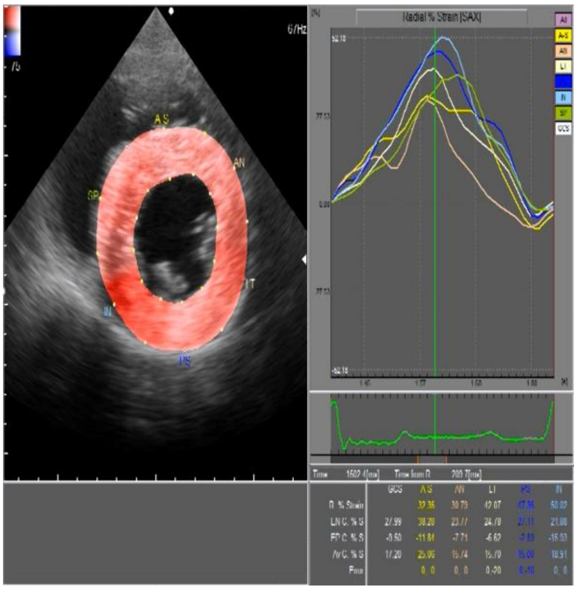

Figure 2. STE analysis at papillary muscle level (short axis).
Şekil 2. Papillar kas seviyesinde benek takibi ekokardiyografi analizi (kısa eksen).

Statistical Analysis

Measurements were recorded, and descriptive statistics were performed. Standard deviation and mean value of the data were calculated by commercial software Graph Pad Prism 6.

RESULTS

Two dogs and four cats were excluded due to signs of systemic or cardiovascular disease and poor image quality. The mean age was 34±5.54 months for cats and 37.2±9.51 months for dogs. St analysis were performed on images obtained from echocardiographic examinations of cats and dogs at papillary muscle level on the short axis. Individual results of 2-D STE measurements are presented in Figure 1 and 2. Statistical results are expressed in Table 1 and 2.

Table 1. Cat STE data. Radial strain (RSt), radial strain rate (RSR), circumferential strain (CSt), circumferential strain rate (CSR).
Tablo 1. Kedi STE verileri. Radiyal gerilim (RSt), radiyal gerilim hızı (RSR), sirkümferensiyal gerilim (CSt), sirkümferensiyal gerilim hızı (CSR).

	RSt (%)	RSR (s^{-1})	CSt (%)	CSR (s^{-1})	Age (months)
Minimum	23.33	0.01	-19.31	-0.28	28
Maximum	25.99	0.52	-13	0.41	45
Range	2.66	0.51	6.31	0.69	17
Mean	24.47	0.292	-15.33	0.052	34
Std. Deviation	1.223	0.2008	2.569	0.2725	6.782
Std. Error of Mean	0.5469	0.0898	1.149	0.1219	3.033

Table 2. Dog speckle tracking echocardiography data. Radial strain (RSt), radial strain rate (RSR), circumferential strain (CSt), circumferential strain rate (CSR).
Tablo 2. Köpek benek takibi ekokardiyografi verileri. Radiyal gerilim (RSt), radiyal gerilim hızı (RSR), sirkumferansiyel gerilim (CSt), sirkumferansiyel gerilim hızı (CSR).

	RSt (%)	RSR (s^{-1})	CSt (%)	CSR (s^{-1})	Age (months)
Minimum	26.4	-1.18	-25.38	-0.8	22
Maximum	62.13	0.17	-21.36	-0.36	52
Range	35.73	1.35	4.02	0.44	30
Mean	39.33	-0.474	-23.13	-0.638	37.2
Std. Deviation	14.02	0.5538	1.532	0.1803	11.65
Std. Error of Mean	6.269	0.2477	0.6851	0.08065	5.21

Peak systolic radial St (RSt), peak systolic radial SR (RSR), peak systolic circumferential St (CSt), peak systolic circumferential SR (CSR) were 24.47 ± 1.22 %, 0.29 ±0.20 s^{-1}, -15.33 ± 2.56%, 0.05 ± 0.27s^{-1}, respectively for cats. (Table 1, Figure 3).

Peak systolic radial St (RSt), peak systolic radial SR (RSR), peak systolic circumferential St (CSt), peak systolic circumferential SR (CSR) were 39.33 ± 14.02%, -0.47s -1 ± 0.55 s^{-1}, -23.13 ± 1.53%, -0.63s -1 ± 0.18 s^{-1} respectively for dogs (Table 2, Figure 4).

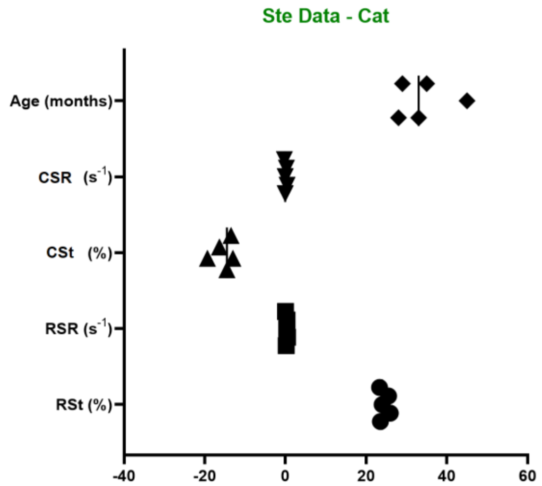

Figure 3. Individual STE variables of cats**.** Radial strain (RSt), radial strain rate (RSR), circumferential strain (CSt), circumferential strain rate (CSR).
Şekil 3. Kedilerde bireysel benek takibi ekokardiyografi değişkenleri. Radiyal gerilim (RSt), radiyal gerilim hızı (RSR), sirkumferansiyel gerilim (CSt), sirkumferansiyel gerilim hızı (CSR).

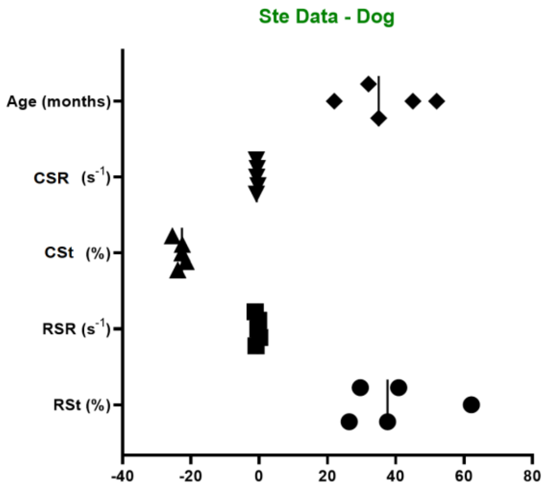

Figure 4. Individual STE variables of dogs. Radial strain (RSt), radial strain rate (RSR), circumferential strain (CSt), circumferential strain rate (CSR).
Şekil 4. Köpeklerde bireysel benek takibi ekokardiyografi değişkenleri. Radiyal gerilim (RSt), radiyal gerilim hızı (RSR), sirkumferansiyel gerilim (CSt), sirkumferansiyel gerilim hızı (CSR).

DISCUSSION and CONCLUSIONS

With this study, STE analysis was performed on images obtained from echocardiographic examination in dogs and cats. Since this analysis is not one of the routinely performed echocardiographic examination procedures in Turkey, every stage is reported in detail. In this study, St and SR values of radial and circumferential directions were measured only on the short axis at the papillary muscle level. Current studies on the left atrium (9), right ventricle (10), and left ventricle (11) are also available in the literature. In this study, the technique is intended to be explained practically; therefore, measurements were performed only on the short axis.

Based on data obtained from our results, this technique is thought to be available in routine echocardiographic examinations. Breed-specific studies are conducted worldwide (12,13,14,15). Pedro et al. (16) compared STE data in healthy and dilated cardiomyopathy groups in Great Dane dogs. Suzuki et al. (17) evaluated STE data in healthy Beagle dogs in their study. Takano et al. (18) evaluated STE data in cats with and without hypertrophic cardiomyopathy. Researchers (19,20) used STE technique in dogs with degenerative mitral valve disease, which is the most common acquired canine heart disease. In addition to these studies, there are many publications, especially for determining reference intervals (21).

As a result, compared to tissue Doppler imaging and conventional 2D echocardiographic methods, the STE technique has many advantages. Requirements like; software, device, high-resolution image recording, experienced practitioner, STE is not an easily accessible technique. Apart from these aspects, it is thought that STE can be included in routine echocardiographic examinations because this technique provides detailed information for determining the systolic potential of the left ventricle and the examination time is not much different compared to conventional echocardiographic examinations.

Acknowledgments

This research was presented at the 2nd International 13th National Veterinary Internal Medicine Congress.

Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Chetboul V., Serres F., Gouni V., Tissier R., Pouchelon JL., 2007. Radial strain and strain rate by two-dimensional speckle tracking echocardiography and the tissue velocity based technique in the dog. J Vet Cardiol, 9, 69-81.
2. Morita T., Nakamura K., Osuga T., Yokoyama N., Khoirun N., Morishita K., Sasaki N., Ohta H., Takiguchi M., 2017. The repeatability and characteristics of right ventricular longitudinal strain imaging by speckle-tracking echocardiography in healthy dogs. J Vet Cardiol, 19, 351-362.
3. Blessberger H., Binder T., 2010. Non-invasive imaging: Two dimensional speckle tracking echocardiography: basic principles. Heart, 96, 716-722.
4. Pellerin D., Sharma R., Elliott P., Veyrat C., 2003. Tissue Doppler, strain, and strain rate echocardiography for the assessment of left and right systolic ventricular function. Heart, 89 Suppl 3, iii9-17.
5. Bussadori C., Moreo A., Di Donato M., De Chiara B., Negura D., Dall'Aglio E., Lobiati E., Chessa M., Arcidiacono C., Dua JS., Mauri F., Carminati M., 2009. A new 2D-based method for myocardial velocity strain and strain rate quantification in a normal adult and paediatric population: assessment of reference values. Cardiovasc Ultrasound, 7, 1-11.
6. Hurlburt HM., Aurigemma GP., Hill JC., Narayanan A., Gaasch WH., Vinch CS., Meyer TE., Tighe DA., 2007. Direct ultrasound measurement of longitudinal, circumferential, and radial strain

using 2-dimensional strain imaging in normal adults. Echocardiography, 24, 723-731.
7. Marwick TH., Leano RL., Brown J., Sun JP., Hoffmann R., Lysyansky P., Becker, M., Thomas, JD., 2009. Myocardial strain measurement with 2-dimensional speckle-tracking echocardiography: definition of normal range. JACC Cardiovasc Imaging, 2, 80-84.
8. Dickson D., Shave R., Rishniw M., Patteson, M., 2017. Echocardiographic assessments of longitudinal left ventricular function in healthy English Springer spaniels. J Vet Cardiol, 19, 339-350.
9. Dermlim A., Nakamura K., Morita T., Osuga T., Nisa K., Sasaoka K., Leela-Arporn R., Sasaki N., Ohta H., Takiguchi M., 2019. The Repeatability and Left Atrial Strain Analysis Obtained via Speckle Tracking Echocardiography in healthy Dogs. J Vet Cardiol, 23, 69-80.
10. Morita T., Nakamura K., Osuga T., Yokoyama N., Morishita K., Sasaki N., Ohta H., Takiguchi M., 2019. Effect of acute volume overload on echocardiographic indices of right ventricular function and dyssynchrony assessed by use of speckle tracking echocardiography in healthy dogs. Am J Vet Res, 80, 51-60.
11. Corda A., Pinna Parpaglia ML., Sotgiu G., Zobba R., Gomez Ochoa P., Prieto Ramos J., French A., 2019. Use of 2-dimensional speckle-tracking echocardiography to assess left ventricular systolic function in dogs with systemic inflammatory response syndrome. J Vet Intern Med, 33, 423-431.
12. Terzi O., Albasan H., 2017. Radial strain and strain rate assessed by speckle-tracking echocardiography in Turkish Kangal dogs. Turkish J Vet Res, 1, 12-15.
13. Chetboul V., 2010. Advanced Techniques in Echocardiography in Small Animals. Vet Clinics of North America: Small Anim Pract, 40, 529-543.
14. Westrup U., McEvoy FJ., 2013. Speckle tracking echocardiography in mature Irish Wolfhound dogs: technical feasibility, measurement error and reference intervals. Acta Vet Scand, 55, 1-11.
15. Suzuki R., Matsumoto H., Teshima T., Koyama H., 2013. Influence of heart rate on myocardial function using two-dimensional speckle-tracking echocardiography in healthy dogs. J Vet Cardiol, 15, 139-146.
16. Pedro B., Stephenson H., Linney C., Cripps P., Dukes-McEwan J., 2017. Assessment of left ventricular function in healthy Great Danes and in Great Danes with dilated cardiomyopathy using speckle tracking echocardiography. J Vet Cardiol, 19, 363-375.
17. Suzuki R., Matsumoto H., Teshima T., Koyama H., 2013. Effect of age on myocardial function assessed by two-dimensional speckle-tracking echocardiography in healthy beagle dogs. J Vet Cardiol, 15, 243-252.
18. Takano H., Isogai T., Aoki T., Wakao Y., Fujii Y., 2015. Feasibility of radial and circumferential strain analysis using 2D speckle tracking echocardiography in cats. J Vet Med Sci, 77, 193-201.
19. Chetboul V., Tissier R., 2012. Echocardiographic assessment of canine degenerative mitral valve disease, J Vet Cardiol, 14, 127-148.
20. Suzuki R., Matsumoto H., Teshima T., Koyama H., 2013. Clinical assessment of systolic myocardial deformations in dogs with chronic mitral valve insufficiency using two-dimensional speckle-tracking echocardiography. J Vet Cardiol, 15, 41-49.
21. Visser LC., Scansen BA., Schober KE., Bonagura JD., 2015. Echocardiographic assessment of right ventricular systolic function in conscious healthy dogs: repeatability and reference intervals. J Vet Cardiol, 17, 83-96.