Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergikafkas.org
E-ISSN: 1309-2251

Kafkas Univ Vet Fak Derg
30 (3): 393-396, 2024
DOI: 10.9775/kvfd.2023.31186

Case Report

Persistent Left Cranial Vena Cava in a Cat

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How to cite this article?
Yılmaz Z, Kocatürk M, Koch J: Persistent left cranial vena cava in a cat. *Kafkas Univ Vet Fak Derg*, 30 (3): 393-396, 2024.
DOI: 10.9775/kvfd.2023.31186

Article ID: KVFD-2023-31186
Received: 16.11.2023
Accepted: 28.02.2024
Published Online: 02.04.2024

Abstract

A 9-year-old-male British fold cat was presented for a general health check before anesthesia. Clinical and laboratory examinations were unremarkable. Echocardiography showed that the cardiac anatomy and function were normal, and the presence of a dilated coronary sinus (CS), highly suggestive of a persistent left cranial vena cava (PLCVC). Clinicians should keep in mind that PLCVC may be present when a dilated CS is noted by echocardiography, and it could be confirmed simultaneously by agitated-saline-study as a non-invasive and cost-effective diagnostic tool in practice. Further research is required to elucidate whether PLCVC is an accomplice or an innocent finding in cats.

Keywords: Cat, Persistent left cranial vena cava, Thoracic venous anomaly

Introduction

Dogs and cats normally have bilateral symmetrical cranial and caudal cardinal veins in fetal life. As the fetus develops, while the right cranial cardinal veins are directly fused and transformed into the right cranial vena cava, left cranial cardinal veins usually become atrophied, and left caudal cardinal veins develop into the coronary sinus (CS). When the left cranial cardinal veins are not atrophied and remain as a left common cardinal vein at the CS, it is described as a persistent left cranial vena cava (PLCVC) [1,2]. Four different types of PLCVC were reported and among them type 1 is the most frequently diagnosed [3,4].

The prevalence of incidentally detected asymptomatic PLCVC in dogs (2.6%) [5] is almost similar to that in humans (0.2-3%) [2], but not known yet in cats. Up-to-date, according to PubMed records, there are almost 1000 studies in humans, but nearly 20 cases in dogs, and only 5 cases in cats [1,6-9]. PLCVC cases are primarily asymptomatic and may be identified incidentally during transthoracic echocardiography and CT angiography [5]. However, some cases with PLCVC may be symptomatic when a dilated CS leads to left atrial (LA) compression and arrhythmias [2].

There are a limited number of studies showing a diagnostic algorithm for PLCVC in cats [1,9]. Thus, herein, we reported how the PLCVC was diagnosed and confirmed using transthoracic echocardiography and an agitated-saline study in an asymptomatic cat in a clinical setting and discussed whether PLCVC might be an innocent finding.

Case History

A 9-year-old male intact British Fold (4.6 kg) was presented with a clinical sign of halitosis due to dental tartar. Just after the owner approved the informed consent form, clinical and laboratory examinations were performed to decide whether the cat was suitable for anesthesia of a dental scaling procedure. There were no abnormalities of body temperature (38.3°C), heart (220 bpm) and respiratory rates (24 rpm), conjunctive mucous membranes, capillary refill time (2 sec), and lymph node palpation. Lung sounds were considered normal on auscultation, and there was no audible heart murmur. A six-lead electrocardiogram revealed a normal sinus rhythm with a normal QRS axis (CareWell 1101G, MVM Medikal, Istanbul, Türkiye). Thoracic radiography showed no thoracic abnormality. A complete blood count and serum biochemistry profile, including cardiac biomarkers, were unremarkable (data

Table 1. *Some echocardiographic measurements in a cat with persistent left cranial vena cava (PLCVC)*

Parameters		**Cat with PLCVC**	**Reference Ranges** [11]
Body weight (Kg)		4.6	4.5-5.0
Heart rate/beat per minute		220	<240
M-mode/RPSAx	RVDd (mm)	4.4	0.0-7.0
	IVSd (mm)	4.5	2.9-5.2
	LVIDd (mm)	15.1	12.7-20.3
	LVPWd (mm)	4.7	2.9-5.1
	IVSs (mm)	6.5	4.4-8.9
	LVIDs (mm)	8.1	5.7-13.4
	LVPWs (mm)	7.9	4.8-9.0
	FS % (Teich)	46.2	44.6-45.5
	EF % (Teich)	81.1	59.5-68.9
2-D/RPSAx - Aortic level	LA mm	9.7	8.2-14.9
	Ao mm	7.1	7.5-12.3
	LA/Ao	1.37	0.88-1.43
Doppler measurement/left apical 5ch	AV Vmax mm/s	82	80-150
	MV E/A	1.27	>1 - <2
	TV E/A	1.38	>1 - <2
	PV S/D ratio	0.99	0.9-1.2
	TDI MV annulus septal - E/E'	14.41	<15

RVDd: *Right ventricular diameter at diastole,* ***IVSd:*** *Interventricular septum at diastole,* ***LVIDd:*** *Left ventricular internal diameter at diastole,* ***LVPWd:*** *Left ventricular postwall diameter at diastole,* ***IVSs:*** *Interventricular septum at systole,* ***LVIDs:*** *Left ventricular internal diameter at systole,* ***LVPWs:*** *Left ventricular postwall diameter at systole,* ***LA:*** *Left atrium,* ***Ao:*** *Aorta,* ***LA/Ao:*** *Left atrium to Aorta ratio,* ***FS:*** *Fractional shortening,* ***EF:*** *Ejection fraction,* ***MPA Vmax:*** *Mean pulmonary artery maximal velocity,* ***AV Vmax:*** *Aortic valve maximal velocity,* ***MV E/A:*** *Mitral inflow E/A ratio,* ***TV E/A:*** *Tricuspid inflow E/A ratio,* ***PV S/D:*** *Pulmonary vein systole (S)/diastole (D) ratio,* ***TDI MV:*** *Tissue Doppler Imaging Mitral Valve,* ***RPSAx:*** *Right parasternal short axis*

not shown). Feline serum amyloid A, a non-specific inflammatory marker, was within the reference range (3.4 µg/mL, reference <5 µg/mL; Vcheck, Bionote, USA).

Cardiac anatomy and function were assessed by a standard echocardiographic protocol with a phased-array cardiac transducer (Vetus 7, Mindray, China) [10]. All measurements were found within the reference ranges *(Table 1)*. Through 2-D echocardiography, dilated CS was detected as a symmetric circular shape (diameter 0.97 cm and an area of 0.76 cm^2) just beneath the LA in the right parasternal long axis (RPLAX) view *(Fig. 1-A)*, and as an elliptic shape through LA free wall in the left apical 4-5CH view *(Fig. 1-B)*. PW Doppler showed the maximal velocity of the CS 0.49 milliseconds at systole and 0.41 milliseconds at diastole at the left apical 4CH view. After agitated-saline administration into the left brachial vein, there was immediate and sequential opacification of the dilated CS, RA, and right ventricle *(Fig. 1-C)*, confirming the presence

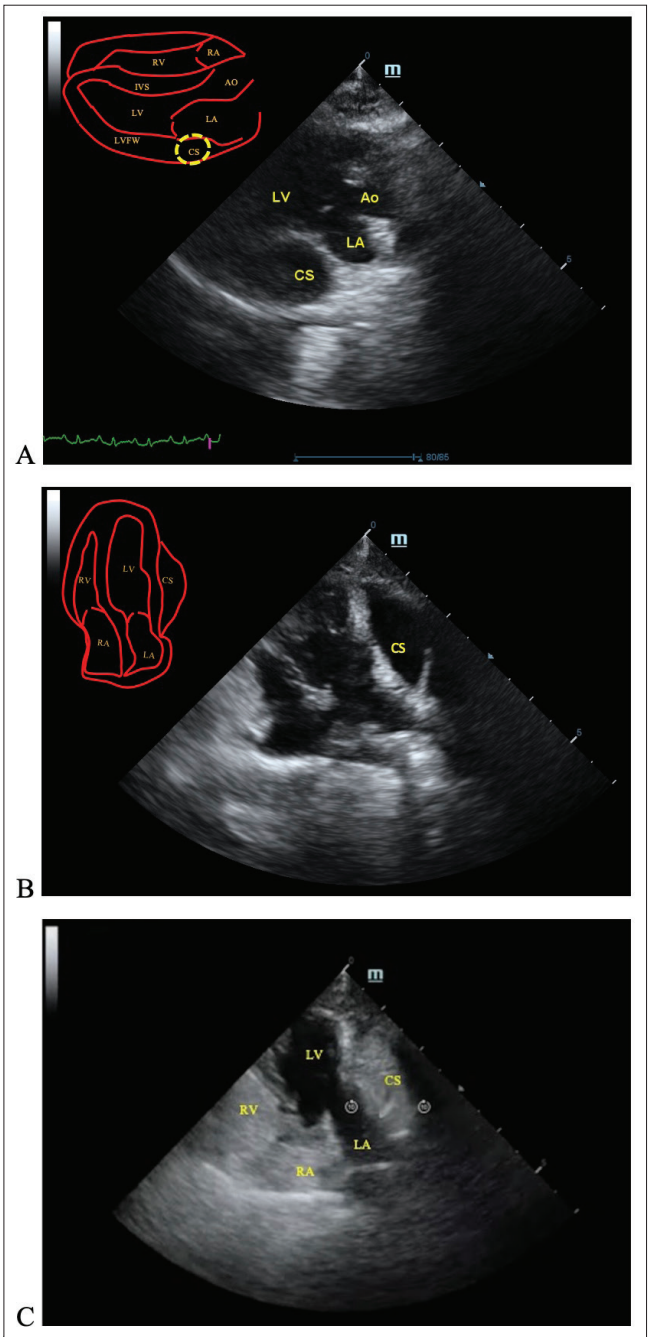

Fig 1. 2-D echocardiographic images showed a dilated coronary sinus (CS) just beneath of the left atrium (LA) at the right parasternal long axis view (A) and through the LA free wall at left apical 4-chamber views (B). CS was detected as a circular (A) or elliptic dark shape (B). 2-D echocardiographic images before (B) and just after agitated saline injection (C) at the left apical 4-chamber views. Microbubbles were seen firstly as hyperechoic content into the CS, and then right atrium (RA) and right ventricle (RV), confirming the presence of persistent left cranial vena cava (PLCVC). LV: left ventricle, Ao: aorta

of a PLSVC [1,9]. The same procedure was repeated from the right brachiocephalic vein, and microbubbles were seen firstly in the RA and not in CS, indicating the presence of normal venous return from the right superior vena cava into the RA. After the clinical evaluation, it was noted that the presence of PLCVC might not increase the risk of

anesthesia, and in case a central venous catheter would be placed, the right jugular vein should be preferred.

Discussion

The scarcity of research on this congenital anomaly in veterinary medicine, particularly in cats [1,6-9], may be attributed to the predominantly asymptomatic nature of PLCVC cases. According to PubMed records, the initial instances of PLCVC in cats were documented through necropsies, with Goodman reporting cases in 1950 [7] and Zeiner in 1957 [8]. After that, Heaney and Bulmer reported a case of PLCVC coexisted with cor triatriatum sinister in a kitten with a history of respiratory signs [6]. In recently published papers, PLCVC was detected with a polycystic renal disease in an older cat with anorexia [1] and a giant RA aneurysm in a young cat exhibited nasal stridor [9]. In the present study, the cat did not have any symptoms, except halitosis due to dental caries. Routine clinical and laboratory examinations did not show the presence of coexisting diseases.

In normal subjects, the CS is a small tubular structure just above the posterior left atrioventricular junction, and it is not remarkable during transthoracic echocardiography [2]. However, in the presented cat, CS seemed to be dilated just beneath the LA at RPLAX and through the LA free wall at the left apical-5ch view. There is no report indicating the diameter and Doppler flow characteristic of the CS in cats. Our measurement of CS (diameter = 0.97 cm) was comparable with that of a 24-year-old woman (1.5x1.6 cm) [12]. The range of potential diagnoses for dilated CS is extensive, primarily encompassing right-sided heart pathologies [2]. Specifically, in the context of CS, mild dilatation has been documented in patients with left ventricular systolic dysfunction, moderate dilatation in cases of PLCVC, and severe dilatation in PLCVC cases without a right superior vena cava (RSVC) [2,12].

The presented case had normal cardiac anatomy and functions despite a dilated CS, based on the echocardiographic evaluation. In the diagnostic workup, an agitated saline (bubble) transthoracic contrast echocardiography was performed to follow venous return from the main cranial veins to the RA in this cat [1,9]. When agitated-saline was injected into the left or right brachiocephalic vein, micro-bubbles appeared first in the CS or RA, respectively, confirming the presence of a PLCVC and normal RSVC, or double superior vena cava in this cat. PLCVC was classified as type 1 due to draining into the RA via the CS in our case; however, it drains into the RA through the CS and LA (unroofed CS) in type 2, directly into the LA in type 3, and connected to the left pulmonary vein in type 4 [2]. There is limited information on Doppler characteristics of CS in human and veterinary medicine. Spectral Doppler flow of CS in this cat was like those of humans and dogs and included two antegrade and a retrograde flow. Their maximal velocities were found lower than those of the previous study of a dog with PLCVC [2].

There are some limitations in this case. Firstly, in addition to agitated saline study, CT angiography could have been performed to demonstrate a connection between PLCVC and CS, as reported in a cat [1] and dogs [5]. However, the owner did not give permission for CT angiography because of anesthesia. Since there is a good correlation between both techniques diagnosis in practice. Secondly, left and right ventricular functions could have been evaluated by new echocardiographic methods, such as 2D speckle tracking.

In conclusion, accumulated evidence suggests that PLCVC may be more common in cats than previously reported in the literature. Therefore, clinicians should keep in mind that PLCVC may be present when a dilated CS is noted by echocardiography, and it could be confirmed by transthoracic echocardiography together with an agitated saline study as a non-invasive, safe, quick, and cost-effective diagnostic tool in a clinical setting. PLCVC was not associated with other clinical findings in the presented case. However, some cases with PLCVC may be symptomatic when a dilated CS leads to cardiopulmonary diseases. Future investigations should aim to elucidate whether PLCVC plays an active role or is merely an incidental discovery in feline cases.

Declarations

Availability of Data and Materials: The original images and video records obtained during transthoracic echocardiography in this case are available from the corresponding author (Z. Yilmaz) on request.

Acknowledgements: The authors would like to thank the owner of the cat, and Emel BAŞARAN (PhD, Vet Med, PetVet, Kadiköy, Istanbul, Türkiye).

Competing Interests: The authors declared that there is no conflict of interest.

Author Contributions: Echocardiographic examination was performed by ZY, and the article was written by ZY, MK, and JK. All approved the final version of the paper.

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