

## Dextrocardia and *Situs inversus* in a dog

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### Abstract

**Aim:** The aim of this study was to report a case of dextrocardia with *Situs inversus totalis*.

**Case History and Observation:** A nine-year-old male Cocker Spaniels dog was referred for cardiologic evaluation due to non-productive cough. Thoracic radiography and ultrasound examination showed the reversed position not only of the heart but also of the abdominal organs such as liver and gallbladder, stomach, spleen, aorta and caudal vena cava. Except dextrocardia itself, the echocardiogram was normal. On the electrocardiogram the P-QRST waves were inverted in lead D1. On the base of these results, the case was diagnosed as dextrocardia and *Situs inversus totalis*.

**Discussion:** Dextrocardia and *Situs inversus* (DSI) is a rare congenital anomaly characterized by mirror-image of the normal anatomic arrangement of all internal organs. In dogs, the majority of reported cases were associated with Kartagener's syndrome (KS), but our patient had no evidences of this ciliary disorder. Besides radiography and ultrasound examination, the ECG can be of great value to diagnose DSI as demonstrated in this report.

**Key Words:** Cardiac malposition, Congenital anomaly, Dog, Dextrocardia, *Situs inversus totalis*.

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### Introduction

Congenital cardiac malpositions are curious disorders that have been fascinating medical scientists since ancient observations of *Situs inversus* by Aristotle in animals and by Fabricius in humans [1]. Dextrocardia is an anomaly meaning the heart located within the right hemithorax with his base-to-apex axis pointed toward to the right. It is intrinsic to the heart and not secondary to other cardio-thoracic disorders. Primary dextrocardia with *Situs solitus* (normal arrangement of other viscera) usually is a benign condition sporadically seen in dogs [2]. Another form of malposition is Dextrocardia with *Situs inversus totalis* (DSI), an anatomical disorder due to visceral inversion in a mirror-image of the normal. It is rarely identified in animals but probably is more common than is believed [3]. Similarly to as observed in man, DSI in dogs is not a pathologic entity *per se* and the affected individual usually has no other cardiac disorder except dextrocardia itself and may have normal longevity. However, the majority of canine cases of DSI have been found to be associated with Kartagener's syndrome (KS) a serious disease first

described by Carrig *et al* [4]. The incidence of DSI has been calculated to represents 0.2 % of congenital heart defects in dogs in Italy [5]. Canine DSI without KS seems to be very rare because of the exceptional low number of reported cases, but his prevalence in the general dog population is unknown. In general, DSI is identified as an incidental finding during a radiographic exam. Regarding other identification methods, the electrocardiogram has been said to be diagnostically very important in human medicine [6], but in the dog it is not well characterized.

### Case history and clinical observation

In February 2010, a nine-year-old male Cocker Spaniels dog was referred for cardiologic evaluation because of short history of non-productive cough. The dog didn't have clinical evidence of sino-respiratory disorder before. Upon physical examination the femoral pulse was regular, strong and synchronous to normal heart beats, the heart rate was 160 beats per minute and the systolic blood pressure was 143 mmHg. Dorsoventral plain chest radiography showed dextrocardia and the gastric gas bubble was on the right side (Figure-1). Ultrasonography showed the

reversed position not only of the heart but also of the abdominal organs such as liver and gallbladder, stomach, spleen, aorta and caudal vena cava.



Figure-1. Dorsoventral plain chest radiography shows dextrocardia and the gastric gas bubble on the right side

The echocardiogram was normal. The 10-lead computed electrocardiogram revealed sinus rhythm and heart rate at 156 beats per minute. On the frontal

plane mean QRS electrical axis was deviated to the right and the P wave was negative in D1, positive in D2, D3 and from Rv2 to V4 (Figure 2). After reversing the forelimbs electrodes and also of the thoracic leads RV2, V2 and V4 the ECG showed trend toward "normality" (Figure. 3).

Discussion

Like all vertebrates, dogs have a normal anatomical left-right asymmetry, established during embryogenesis. In early stages of fetal life with situs solitus and formation of a D-bulboventricular loop, the apex of the heart is located rightward. Subsequently, the apex migrates from the right to the left but in situs inversus with formation of the L-loop, the apex of the heart twists from left to right [7]. Imaging examination is important to confirm of DSI because situs of the viscera and that of the atria are the same and the atrial situs can be discernible in cross-sectional tomograms. In this case, visualization of the liver, spleen and gastric air bubble is possible by chest radiograph and ultrasound. In clinical practice, however, reversal of

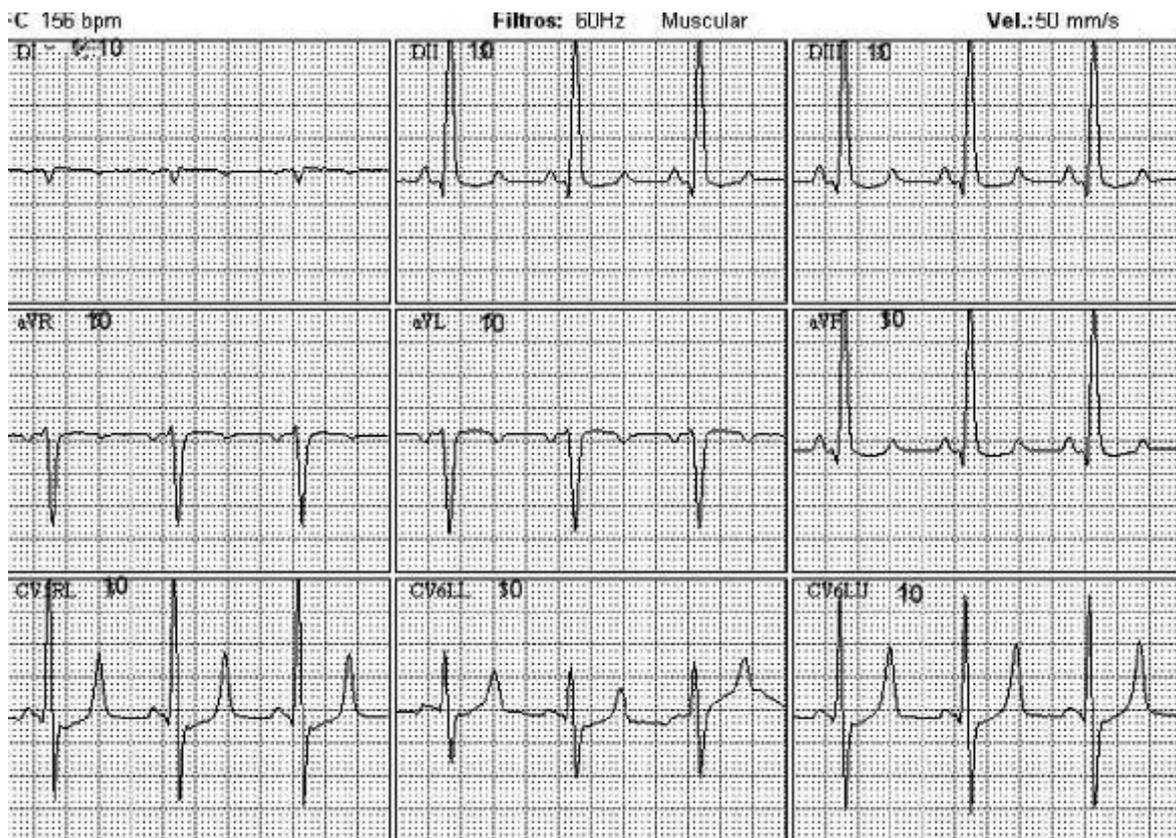


Figure-2. On the frontal plane mean QRS electrical axis was deviated to the right and the P wave was negative in D1, positive in D2, D3 and from Rv2 to V4.

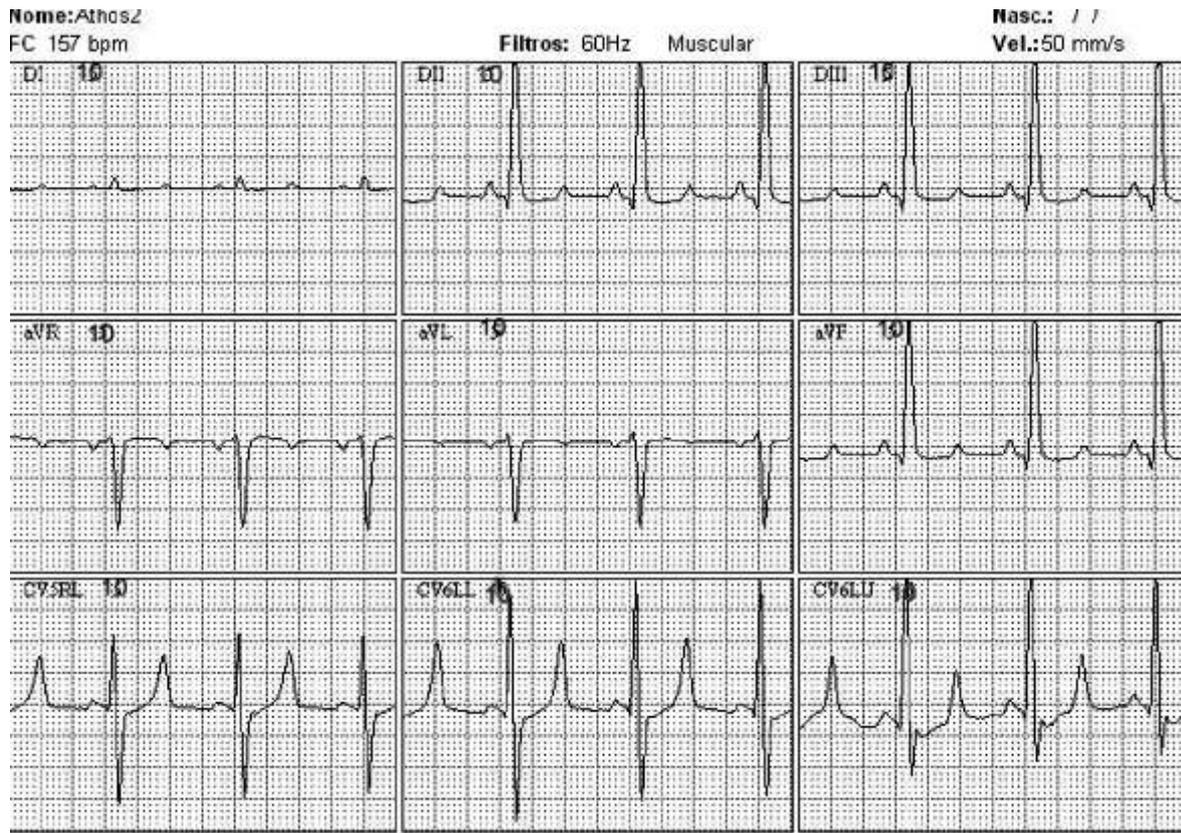


Figure-3. After reversing the forelimbs electrodes and also of the thoracic leads RV2, V2 and V4 the ECG showed trend toward "normality".

the organs may represent a diagnostic challenge because of an eventual undiagnosed case of situs inversus can be due to improper body positioning, non-ideal radiographic projection, mislabeling or even neglected interpretation. Also, some changes seen in an ECG as the negativity of the P-QRST complex could be assumed to be due to a technical error and the diagnosis of DSIT may be missed [3, 8]. In normal dogs the atrial depolarization is orientated leftward, caudad and ventrad, pointing his mean vector between  $+60^\circ$  and  $+90^\circ$  in the frontal plane, giving a P wave positive or isoelectric in D1 and always positive in D2, and aVF and may be negative in leads III, aVR, aVL, RV2 and V10. The QRS activation loop is orientated to left, with main ventricular electrical axis between  $40^\circ$  and  $100^\circ$  [8]. In case of DSI, however, the cardiac electrical activation is processed in an inverse fashion causing the QRS to be negative in D1 but remaining positive in D2, D3 and aVF as seen in Fig-2.

The negativity of the P wave is due to atrial inversion and in this case the sinus node is located in the left side, instead of right, pointing the P vector

toward right and ventral. So, in our case study D1 was a mirror-image of the normal while D2 and D3 as well as aVR and aVL appeared to be interchanged. In the thoracic leads, some modifications were also observed but they were less dramatic than typically seen in humans with DSI [6] and repositioning of electrodes on the right side produced some trend toward "normalization" (figure 3). The V-10 lead showed no modifications. The ECG changes observed in our case-report seems to be of great diagnostic value and fulfill the criteria to confirm mirror-image dextrocardia as observed in the historical case reported by Carrig *et al* [4].

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