DOI: 10.22059/IJVM.2022.323413.1005173 Iranian Journal of Veterinary Medicine Original Article

Online ISSN: 2252-0554

Post Mortem Diagnostic Imaging to Evaluate Idiopathic Hypertrophic Cardiomyopathy in a Roborovski Hamster

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Abstract

Idiopathic cardiomyopathy in hamsters can lead to death due to cardiac failure. The purpose of the current case study was to investigate the capability of imaging in revealing possible cardiomyopathy in a dead hamster. To this end, the cadaver of a six-month-old male *Roborovski* dwarf hamster, which showed acute respiratory symptoms a few days before his death, was examined by Virtopsy to discover the cause of death. Post-mortem radiography was not efficient enough for evaluation of the heart due to post-mortem lung atelectasis that increases lung opacity and diminishes the contrast between lung and heart. Post-mortem computed tomography can be helpful for assessment of the cardiac size. Consistent with post-mortem echocardiographic studies, an increased thickness of the left ventricular parietal wall and the interventricular septum and dilation of left atrium was observed. Thus, hypertrophic cardiomyopathy was determined by imaging and confirmed by the conventional necropsy approach that the cause of death was acute cardiac failure following idiopathic hypertrophic cardiomyopathy.

Keywords

Echocardiography, Hypertrophic cardiomyopathy, Post-mortem, Roborovski **hamster, Virtopsy**

Case history

The cadaver of a six-month-old male *Roborovski* dwarf hamster was referred by a breeder to the veterinary clinic of the University of Tehran due to its abrupt death and upon serial death of his brothers and sisters.

Clinical presentations

The case had clinical symptoms of respiratory disorders and received antibiotic therapy without significant improvement.

Diagnostic testing

Post-mortem computed tomography, digital radiography, and echocardiography were performed almost three hours upon its death. The cadaver had a moderate rigor-mortise, and during these three hours, it had been kept in a cold and dry bag. In this study, we aimed to uncover the cause of death of this hamster by Virtopsy.

Radiography: **Standard whole-body orthogonal left lateral and dorsoventral radiographs were performed on the cadaver. Wet hair artifact was visible around the body. Because**

of the rigor mortis, the forelimbs were superimposed in the cranial thorax and the hind-limbs were not extended resulting in compression in the abdominal cavity. Marked focal soft tissue swelling associated with gas inclusions was detected around the cervical region which seems to be as a result of post mortem changes. There are two small tubular structures with mineral opacity in cranioventral aspect of abdominal cavity on both side of the spine which seem to be related to gastrointestinal contents. No skeletal abnormalities including the dental arcade were detected. However, due to increased lung opacity caused by post-mortem atelectasis, the thoracic cardiac silhouette was not well delineated. Accumulation of gas within the gastrointestinal tract was also followed by post-mortem changes (Figure legends

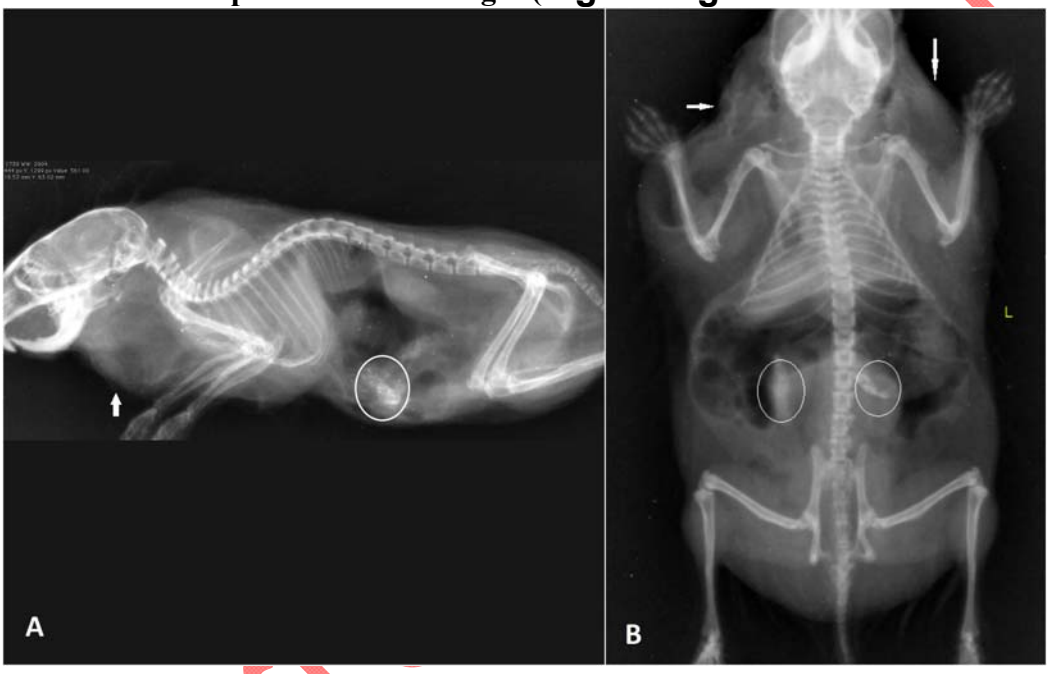

Figure 1 (A) lateral and (B) dorsoventral views of the cadaver of a Roborovski hamster. Marked focal soft tissue swelling associated with gas inclusions were detected around cervical region which seems to be as a result of post mortem changes (solid arrows). Fore-limbs were superimposed on the cranial thorax and the hind limbs were not extended resulting in compression in the abdominal cavity. Cardiac silhouette was not visible due to increased lung opacity caused by post-mortem atelectasis. Two mineral density visible at cranioventral aspect of abdominal cavity on both side of the spine which seem to be due to gastrointestinal contents (circles). Gas accumulation within the gastrointestinal tract was followed by post-mortem changes.).

Computed tomography: Native CT-Scan was performed using Siemens SOMATOM® 2 detector scanner and the images then reconstructed in orthogonal views. The maximum height, width and length of the heart were 7.5, 5.5, and 8.5 mm, respectively (**Error! Reference source not found.**). Two tubular heterogeneous mineral attenuating (HU=1000) structures were visible in the center of the abdomen in the intestinal segments that are dense intestinal contents; otherwise, the skeletal structures, thorax and abdomen were within normal limits (**Error! Reference source not found.**). The ratio of the heart diameter to the thoracic diameter was 8.47 mm/12.7 mm.

Echocardiography: Echocardiography was performed with a Vivid 7 ultrasonography machine (GE Medical Systems, USA), connected to a multi-frequency (6-13MHz) phased-array transducer. In the right parasternal long axis study, the collapsed lumen of the heart could be detected by linear intraluminal hyperechogenicity. The thickness of the left ventricular parietal septum was 2.796 mm and the thickness of the interventricular septum was 2.748 mm. Left atrium is dilated as well which is probably as a result of mitral valve regurgitation but since we could not use Color Doppler or Pulse Wave, we cannot say it with certainty (**Error! Reference source not found.**).

All the images then were reviewed and edited by horos software version 3.3.6.

Necropsy was performed. Macroscopically, the left ventricular hypertrophy was observed (Figure 5). Lungs and other organs exhibited normal appearance.

Assessments

In this research, we studied idiopathic cardiomyopathy in a deceased hamster by post-mortem echocardiography. To our best knowledge, this is the first report of forensic echocardiography in a veterinary practice and may open a new door into further post-mortem echocardiographic investigations.

Virtual autopsy (Virtopsy) is a novel approach in the veterinary necropsy procedure which is using different imaging modalities namely radiography, computed tomography, magnetic resonance imaging, and ultrasonography as an aide to post-mortem evaluations. Since Virtopsy is aiming at analyzing images as well as adding value to forensic medicine, its application can assist with the pre-autopsy diagnosis (Parry & Stoll, 2020; Thali *et al.*, 2009). Although conventional necropsy is extensively employed to determine the cause of death in veterinary practices, minimally invasive post-mortem imaging which is more economical and has more precise results can be a proper substitution for aggressive methods. In the field of veterinary post mortem examinations the smaller the animal is, the more we rely on histopathology than necropsy to spot lesions (McDonough & Southard, 2017). Even though thoracic radiography and CT scan are helpful in the determination of cardiac diseases in exotic animals (Krautwald *et al.*, 2010), they cannot be desirable for post-mortem inspection of the heart due to alveolar atelectasis which negatively affects the imaging contrast, compared to echocardiography. Post-mortem echocardiography has been performed on human heart as another diagnostic modality to

autopsy to reveal a specific cause of death in infants in an effort to increase the diagnostic yield of the autopsy (Ker *et al*., 2010) and to assess the chamber size and left ventricular wall thickness (chon *et al*., 2017). Echocardiography is similarly the modality of choice in dogs and cats for diagnosis of cardiac malfunction and cardiac geometry in exotic companion mammals or animal models (Tully, 2016; Babaei & Razmaraii, 2020) a. However, here, getting the advantage of the post-mortem echocardiography and based on normal cardiac limits of Syrian hamster (which is 0.1±0.01 cm for PWT and 0.1±0.01 cm for IVST), we came to the diagnosis of idiopathic cardiomyopathy in the deceased hamster (Salemi *et al*., 2005). Hamsters with heart disease show a variety of clinical signs including pulmonary manifestations, lethargy, and edema. Some of which may be very mild and take a long time to be diagnosed (Soroori *et al*., 2020). Some of the common heart diseases that affect geriatric hamsters are dilative cardiomyopathy, and atherosclerosis ,and can contribute to atrial thrombosis (Keeble & Meredith, 2009). Hypertrophic cardiomyopathy is less commonly prevalent (Kubiak, 2020; Dutton, 2020). There is not enough information about the *Roborovski* hamster breed, and most of the studies are based on Syrian hamster, because they are more popular as pet and also as laboratory animals (Keeble & Meredith, 2009).

Hypertrophic cardiomyopathy is a heart disease associated with abnormal thickening of the ventricular wall and interventricular septum, with normal or diminished left ventricular dimensions. Hypertrophic cardiomyopathy is prevalent most commonly among the feline and affects 10-15% of them compare to other animal species (Freeman *et al*., 2017; Simpson *et al*., 2017). Cardiomyopathy (both dilative and hypertrophic) in Syrian hamsters is a genetic trait that is inherited in an autosomal recessive pattern with a phenotypic expression in 100% of the

affected line (Factor *et al*., 1988). Notably, over 90% of hamsters with hypertrophic cardiomyopathy die of premature congestive heart failure (Factor *et al*., 1988; Strobeck *et al*., 1979).

The limitation of this paper is lacking histopathology and a control post-mortem study on a hamster with normal heart with the same age. However, this unique case-report can be a start for using post-mortem echocardiography in small animals.

In conclusion, post-mortem echocardiography can be performed in post-mortem hamsters as a non-invasive and quick method to evaluate possible heart diseases like cardiomyopathies.

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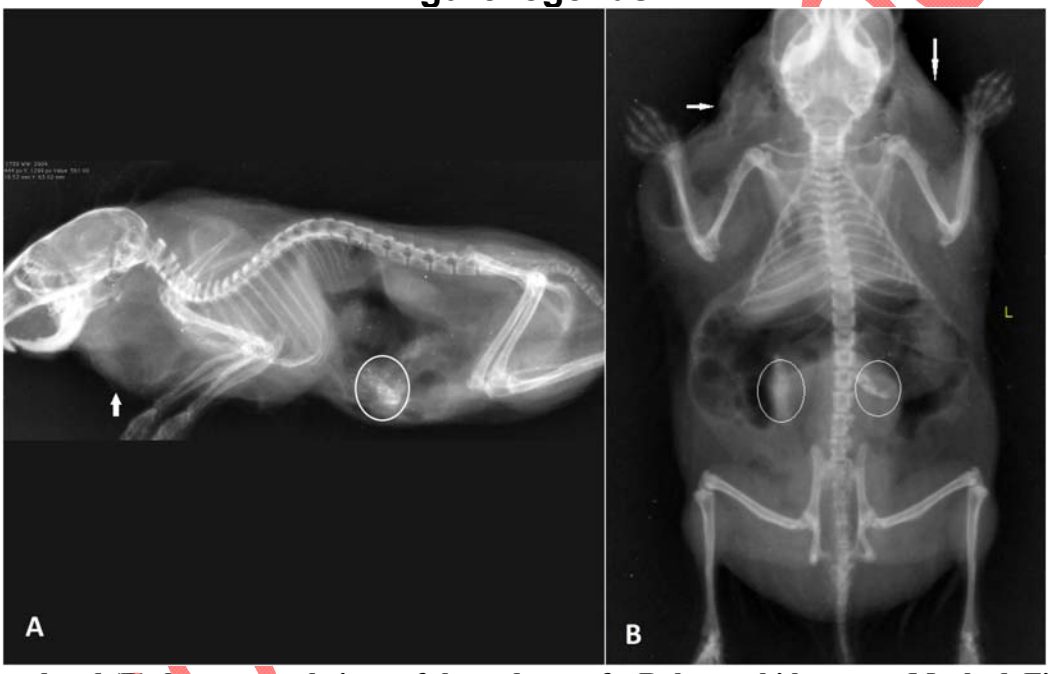
Figure legends



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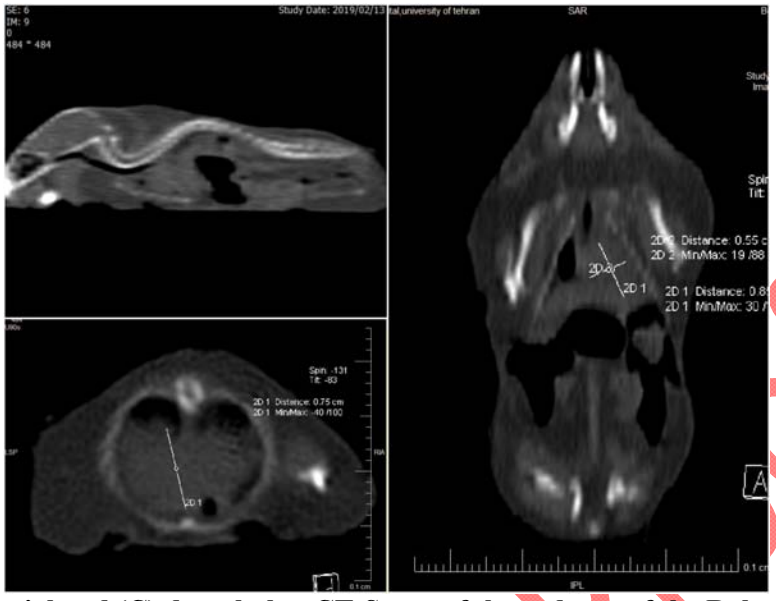

(A) sagittal (B) axial and (C) dorsal plan CT-Scans of the cadaver of the Roborovski hamster. The maximum height, width and length of the heart were 7.5, 5.5, and 8.5 mm. **Figure 2**

150 **(A) sagittal (B) axial and (C) dorsal plan CT-Scans of the cadaver of the Roborovski hamster. Two tubular mineral attenuating (HU=1000) structures are visible in the center of the abdomen (circles). The skeletal structures, thorax and abdomen are within normal limits.** **Figure 3**

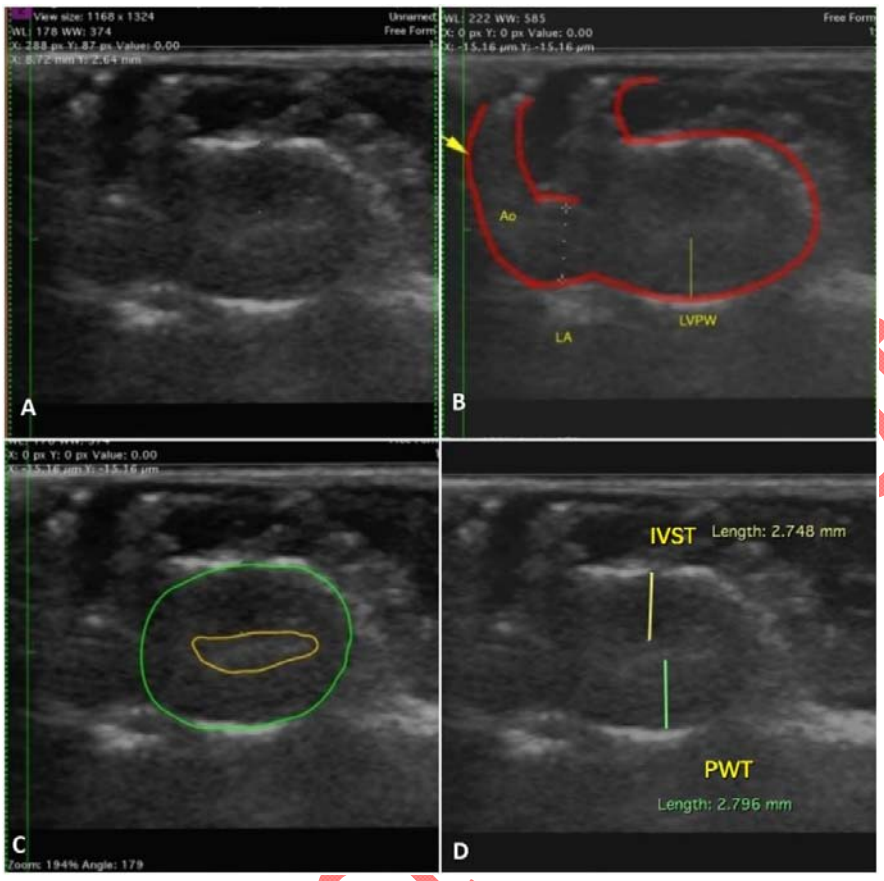

Figure 4 Echocardiographic examination of the Roborovski hamster heart, right parasternal long axis view (A, B, C, and D). (B) Red line depicts the heart contour. Aorta (AO), left atrium (LA), left ventricular parietal wall (LVPW). (C) The collapsed lumen of the heart could be detected by the linear intraluminal hyperechogenicity that is shown by the yellow line. (D) The thickness of the left ventricular parietal septum (PWT) was = 2.796 mm and The thickness of the interventricular septum (IVS) was=2.748 mm.

Figure 5 (A and B) Dissection of the heart. Note the left ventricular hypertrophy.

استفاده از اکوکاردیوگرافی در مطالعات پس از مرگ در تشخیص کاردیومیوپاتی هیپرتروفیک ایدیوپاتیک در لاشه‌ی یک رأس همستر نژاد روبروفسکی

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کاردیومیوپاتی ایدیوپاتیک در همسترها می تواند به دلیل ایجاد نارسایی قلبی منجر به مرگ شود. هدف این مطالعه موردی بررسی قابلیت روش‌های تصویربرداری تشخیصی در آشکارسازی کاردیومیوپاتی در لاشه ی یک همستر بود. به همین منظور، جسد همستر نر شش ماهه نژاد روبروفسکی، با علائم تنفسی حاد در مدت زمان چند روزه قبل از مرگش توسط روش‌های ویرتوپسی مورد مطالعه قرار گرفت. در تصاویر رادیوگرافی پس از مرگ به دلیل آتلکتازی ایجاد شده ناشی از تغییرات پس از مرگ، امکان بررسی ریه و قلب وجود نداشت. سپس سی‌تیا-سکن پس از مرگ به منظور ارزیابی قلب انجام شد که امکان بررسی ابعاد قلب را فراهم کرد. در نهایت در بررسی های اکوکاردیوگرافی پس از مرگ، افزایش ضخامت دیواره ی جانبی بطن چپ و دیواره ی بین بطنی و اتساع دهلیز چپ مشاهده شد. براساس نتایج بدست آمده توسط تصویربرداری پس از مرگ کاردیومیوپاتی هیپرتروفیک عارضه ی احتمالی بود که با انجام کالبدگشایی تایید شد و علت مرگ نارسایی حاد قلبی به دنبال کاردیومیوپاتی هیپرتروفیک ایدیوپاتیک تشخیص داده شد.

لغات کلیدی: اکوکاردیوگرافی، کاردیومیوپاتی هیپرتروفیک، مطالعات پس از مرگ، ویرتوپسی، همستر روبروفسکی

180