

## Letter to the Editor

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**D**ear Editors, We read the recent publication entitled “Naturally Occurring Biventricular Noncompaction in an Adult Domestic Cat” by Dr. Kittleson, et al. with great interest. They reported the first case of feline left ventricular noncompaction (LVNC), describing morphologic features of the condition by echocardiography and a necropsy specimen.<sup>1</sup> Despite the patient remaining asymptomatic, characteristics of LVNC, including hypertrabeculation of the left ventricular (LV) wall and color Doppler flow in deep intertrabecular recesses, were well demonstrated. These conspicuous findings definitely meet the current criteria of LVNC in human cardiology.<sup>2</sup>

One of the most important findings in this study is that hypertrophic cardiomyopathy (HCM) and LVNC are related diseases, sharing the same genetic etiology involving a sarcomere mutation (*MYBPC3-A31P*). Considering its impact as a new clinical entity and utility as an animal model for the academic research, the identification of feline LVNC would have applications in cardiomyopathy research and cardiac embryology, as well as feline clinical relevance. However, in the whole heart image published with the article, we fear that the hypertrophied ventricular wall may exaggerate the deep intertrabecular valleys, affecting the final diagnosis. There seems to be plenty of room for debate regarding whether this is truly a case of LVNC.

Left ventricular noncompaction is a rare disease, considered a new and an unclassified cardiomyopathy according to the World Health Organization classification of cardiomyopathies. Originally, LVNC was thought to arise from the arrest of intrauterine myocardial morphogenesis (embryogenic hypothesis).<sup>3</sup> During the early developmental stages, the loose meshwork of trabeculations becomes compacted; in LVNC cases, it is thought that this compaction is prohibited owing to genetic mutation. Morphologically, LVNC is characterized by prominent LV myocardial trabeculation, deep recesses, and intertrabecular blood flow.<sup>2</sup> Despite this simple explanation, the diagnostic imaging and pathogenesis of LVNC are heterogeneous and under dispute.

Echocardiography is the best modality to visualize the specific morphology of LVNC. Three distinct standards are available, but unfortunately, there is no gold standard because of overdiagnosis, interobserver variation, and intraobserver errors.<sup>4</sup> Even if multiple standards are combined to reduce overdiagnosis, specificity remains quite low (67% using two standards and 30% using three standards).<sup>4</sup> Of note, overdiagnosis occurs partly because prominent LV trabeculation may be recognized as a benign variant (identified in up to 68% of healthy adult human hearts).<sup>5</sup> Furthermore, morphologic features of hypertrabeculation are frequently found in healthy populations, especially athletes (8%)<sup>6</sup> and pregnancy (25%).<sup>7</sup> The etiology of this acquired condition is thought to be owing to physiologically increased preload (nonembryogenic hypothesis).<sup>3,4</sup> Intriguingly, the hypertrabeculation of pregnancy is

completely resolved after delivery, indicating that at least one component of LVNC is reversible depending on physiologic conditions. These data clearly point out the dangers of using echocardiographic diagnosis to identify the malignant “true” LVNC for risk stratification. In human medicine, additional factors such as electrocardiogram and genetic factors should be considered to make a final diagnosis.<sup>2</sup>

As described above, we should not rely on echocardiographic findings too heavily, although echocardiography is commonly utilized in veterinary clinics, and its utility is well-recognized. Among many indices evaluated by echocardiogram, the quantitative ratio of the noncompaction (NC) layer thickness to the compaction (C) layer thickness (NC/C ratio) is a frequently used index representing noncompaction.<sup>2</sup> Although the initial concept of NC/C ratio was based on the idea that arrested compaction of the LV wall during development results in a smaller C and the larger NC/C ratio, the NC/C ratio also increases in the presence of larger NC values and normal C values. Examining the current case,<sup>1</sup> hypertrabeculation seems to be affected by the hypertrophied ventricular wall, increasing the NC value. In addition, the circumference of the hypertrophied ventricular wall provides evidence for HCM, not LVNC. The presence of three or more distinct trabeculae is currently suggested as criteria for LVNC in human medicine,<sup>8</sup> but there are no other visible trabeculae beyond the two papillary muscles in the case. Should this condition be diagnosed as “noncompaction”? This is why it is too early to definitively identify the Kittleson case as LVNC.

Our second concern is the possibility of right ventricular noncompaction in feline patients. While LV noncompaction is uniformly recognized in LVNC cases, some cardiologists claim difficulties in distinguishing normal variants in the highly trabecular right ventricle from the pathologic noncompacted ventricle in humans.<sup>4</sup> Unfortunately, there are no statistical evaluations of the right ventricular trabeculation in the healthy feline population. This issue is worthy of discussion in future studies.

In summary, we encourage veterinary clinicians to survey the echocardiographic characteristic and the prognosis of feline LVNC-suspected cases. We anticipate that the diagnosis of feline LVNC is difficult, because the deep intertrabecular recesses are exaggerated by the hypertrophied LV wall often seen in feline cardiac disease. To clearly and accurately describe the diseased heart, the usage of left ventricular hypertrabeculation, abbreviated LVHT, may be a more appropriate alternative choice.<sup>4</sup> Now that Dr. Kittleson has demonstrated the tentative morphology of feline LVNC-suspected cases, we may begin accumulating further cases, providing opportunities to establish and characterize feline LVNC as an isolated cardiomyopathy. The diagnosis and its criteria of feline LVNC should be discussed after the full consideration of the feline physiologic and pathophysiologic condition.

## References

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