Kyphosis and Kyphoscoliosis Associated with Congenital Malformations of the Thoracic Vertebral Bodies in Dogs

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KEYWORDS

• Congenital • Malformation • Hemivertebrae • Thoracic • Kyphosis

KEY POINTS

- Malformations of the vertebral bodies often occur in the thoracic region of the vertebral column, primarily in small-breed dogs.
- These malformations are thought to represent errors in embryonic/fetal vertebral center ossification and/or fusion and typically result in kyphosis and scoliosis.
- The terms "hemivertebrae" and "butterfly" vertebrae are commonly, and often anatomically incorrectly, used to refer to these abnormalities; a more descriptive classification scheme has recently been reported.
- Most of these malformations are considered incidental findings, but some result in clinical signs of T3-L3 myelopathy of varying degrees of severity.

GENERAL OVERVIEW AND TERMINOLOGY

Malformations of the vertebral bodies in the thoracic spinal region of dogs are generally believed to be caused by failure of vertebral ossification centers to form, fuse properly, or both during embryonic or fetal development. The cause of this abnormal development is not fully understood, but such factors as genetic defects, teratogenic insults, and abnormal intersegmental blood supply to the developing vertebral column have been

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implicated.[1–5] In humans with vertebral body malformations, genetic mutations have been identified in genes responsible for regulating normal fetal vertebral segmentation.[6] In humans and dogs, the vertebral malformations that tend to cause neurologic deficits are primarily those that lead to kyphosis (dorsal curvature) of the vertebral column.[3,5,7–9]

Terminology for the wide array of congenital vertebral anomalies encountered in small animal practice has been inconsistent and often confusing.[5] There are a variety of different shapes of aberrant vertebral bodies encountered in dogs with kyphosis, but the terms "hemivertebrae" and "butterfly vertebrae" are traditionally used to describe all of them.[1–3,8] Although incorrect, these two terms are sometimes used interchangeably in clinical parlance. A hemivertebra, or cuneiform vertebra, has been defined as one in which a portion of the vertebra fails to form correctly, resulting in a wedge shape to the vertebral body; the base of the wedge in most cases is oriented dorsally (**Fig. 1**).[1–3] This term, as it has been used most commonly, may also be an inaccurate description of most thoracic vertebral malformations that lead to neurologic dysfunction in dogs. A true hemivertebra is actually one where half of the vertebra (the centrum and neural arch) fails to form; this abnormality would lead to scoliosis, rather than kyphosis. The wedge-shaped thoracic "hemivertebra" typically encountered in clinically affected dogs is most likely caused by a failure of a portion of the body (centrum) of the vertebra to form, rather than representing a true hemivertebra.[5,10] When the central aspect of a vertebra fails to form, a more midline defect results, creating a shape that resembles the wings of a butterfly when viewed in a dorsal plane; this is the characteristic appearance of a "butterfly vertebra" (**Fig. 2**).[1,2,5,8,9] A more comprehensive radiographic classification system for thoracic vertebral anomalies in dogs has recently been proposed by Gutierrez-Quintana and colleagues,[8] and is based on schemes similar to those used in humans (**Fig. 3**). According to this scheme, kyphosis is more likely to develop with ventral hypoplasia (ventral wedge shape), ventral aplasia, and ventrolateral aplasia of the vertebral body. A butterfly vertebra is the result of ventral and median aplasia of the vertebra. In this study, dorsal and dorsolateral hemivertebrae (ventral and ventrolateral vertebral body aplasia, respectively) were more likely to be associated with neurologic deficits than other types of anomalies, including butterfly vertebrae.[8] The authors refer to abnormalities in this region of the vertebral column as congenital vertebral body malformations, and focus more on the individual shape of the abnormal region and effects on the spinal cord than specific terminology.

In both dogs and humans, the degree of kyphosis associated with the vertebral malformations determines the likelihood of developing neurologic dysfunction. Although some of these abnormalities often also produce some degree of scoliosis (lateral deviation of the vertebral column), this does not seem to have a substantial additional impact on the development of neurologic impairment.[5,7–9]

Fig. 1. Lateral radiograph of the vertebral column showing a hemivertebra or cuneiform vertebra at the level of T13. The malformation has resulted in a wedge-shaped vertebral body with the base oriented dorsally.