

# ***“The Congenital Malformation of the 6<sup>th</sup> and 7<sup>th</sup> Cervical Vertebrae in Horses”***

**Presenter: Sharon May-Davis**

At the Bowker Lectures in 2013, Sharon May-Davis presented a discussion on;

***“An Observation in Thoroughbred Horses of a Congenital Malformation in C6 and C7.”***

Since then it has been published in the Journal of Equine Veterinary Science 34 (2014), pp. 1313-1317 DOI information: 10.1016/j.jevs.2014.09.012 under the following title;

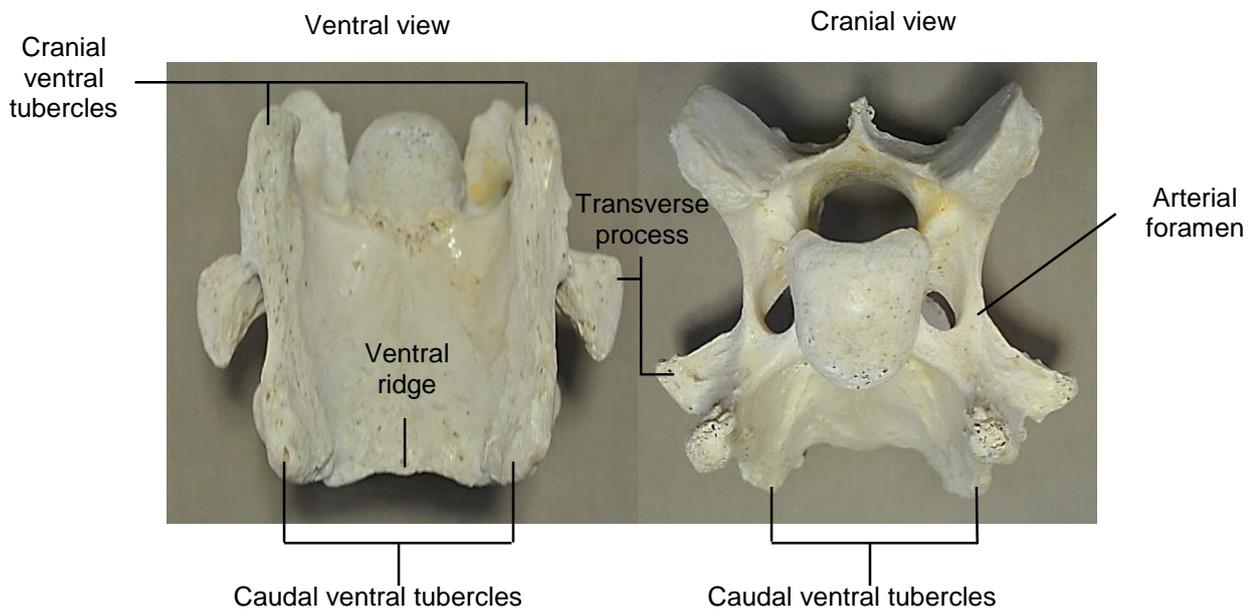
***“The Occurrence of a Congenital Malformation in the 6<sup>th</sup> and 7<sup>th</sup>  
Cervical Vertebrae predominately observed in Thoroughbred Horses.”***

## **Abstract**

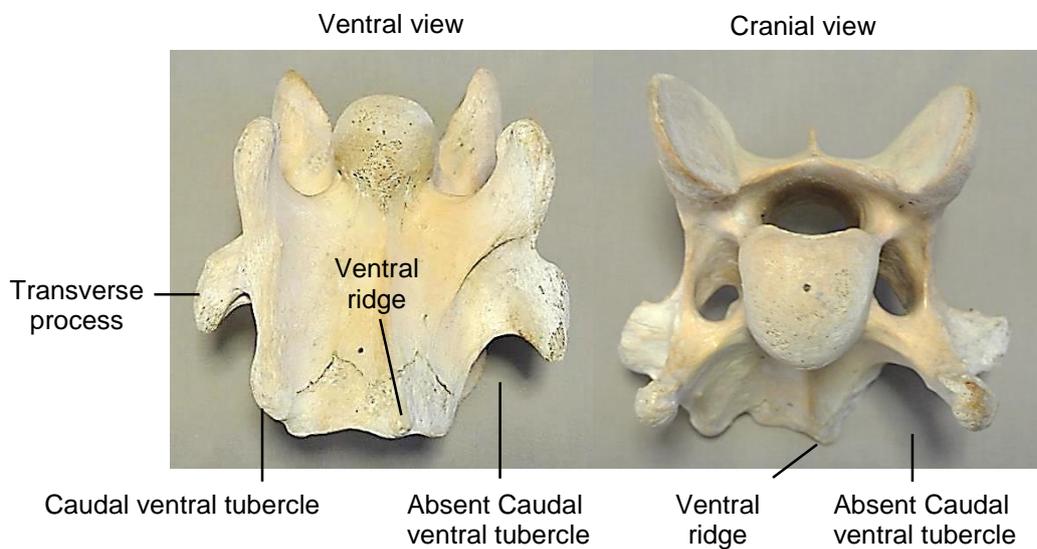
During the dissection and skeletal examination of 123 horses, it was observed that a significant number had a gross skeletal congenital malformation of the 6<sup>th</sup> and 7<sup>th</sup> cervical vertebrae. In the 6<sup>th</sup> cervical vertebra (C6), either a unilateral or bilateral absence of the caudal ventral tubercle (CVT) was noted. In the presence of the C6 malformation, the 7<sup>th</sup> cervical vertebra (C7) presented either as normal, or, with a unilateral or bilateral transposition of the CVT from C6 onto the ventral surface of C7 with an arterial foramen. This transposition onto C7 was noted to be present on the corresponding side as the absent CVT on C6. Of the 123 horses examined, the congenital malformation of C6 was noted in 19 of 50 Thoroughbred horses; 3 of 3 Thoroughbred derivative horses; 1 of 15 non-descript bred horses and 0 of 55 purpose bred horses of mixed breeds. In total, 23 horses expressed a C6 congenital malformation of which, 22 were Thoroughbreds or Thoroughbred derivatives. Of these 22 Thoroughbred and Thoroughbred derivative horses, 11 of 22 expressed either a unilateral or bilateral transposition of the CVT from C6 onto the ventral surface of C7 with an arterial foramen on the corresponding side. This malformation could have functional and clinical ramifications in the postural and locomotive properties of the equine neck and cervicothoracic junction as reported in other species.

Since publication, the new stats are 23:60 Thoroughbreds and 3:4 Thoroughbred derivatives AND a C6 unilateral absence of a CVT on the left side has now been reported in a STANDARD BRED. This breed stems from two Thoroughbred foundation sires born in the latter half of the 1700's, notably Messenger and Diomed. Both stallions were exported to America from the United Kingdom and became prolific sires in Thoroughbred and Standardbred breeding programs.

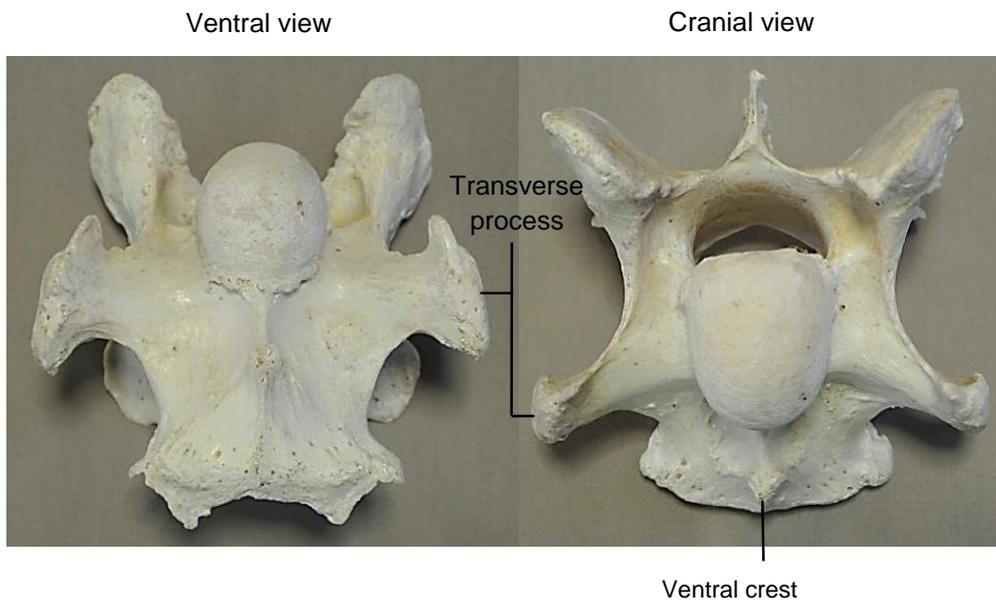
**Figure 1.** The ventral and cranial view of a normal C6 in a 19 year old Australian Stock Horse.



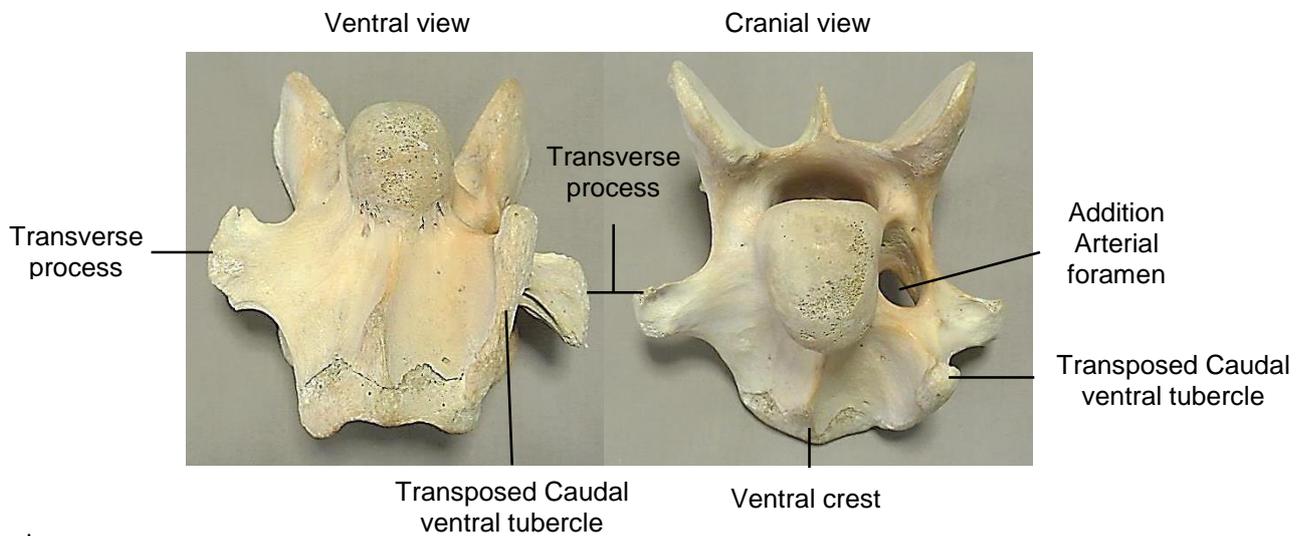
**Figure 2.** The ventral and cranial view of an absent CVT on C6 in a 6 year old Thoroughbred racehorse.



**Figure 3.** The ventral and cranial view of a normal C7 in a 19 year old Australian Stock Horse.

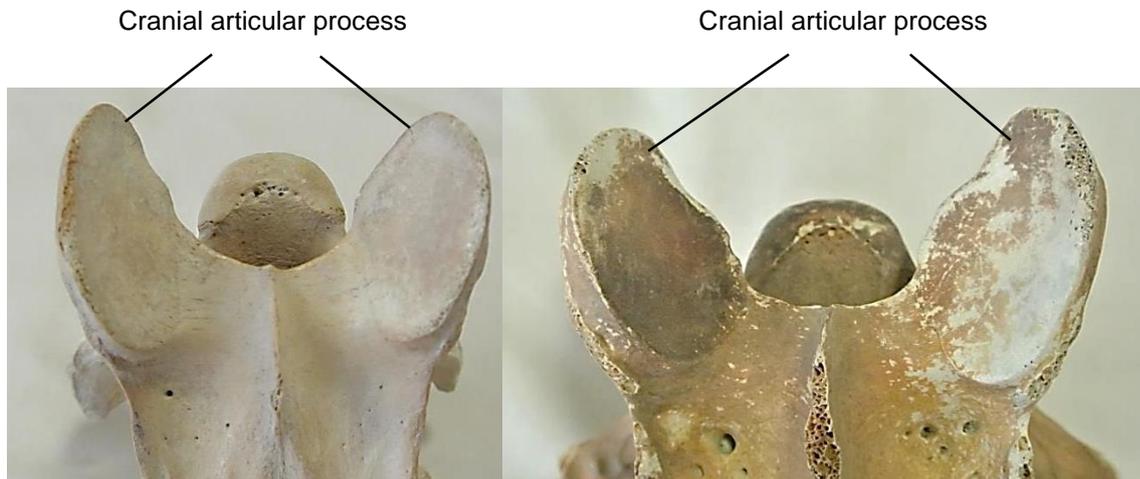


**Figure 4.** The ventral and cranial view of a transposed CVT from C6 onto the ventral surface of C7 in a 6 year old Thoroughbred Racehorse.



One significantly noted aspect of this malformation was that the Articulating process joints were asymmetrical in every unilateral horse (Fig. 5) and that the horses had a tendency to place the forelimb in a forward postural position (Fig. 6).

**Figure 5.** Noted asymmetry in cranial articular processes of C6 in 2 Thoroughbred horses. Left: a 6 year old Thoroughbred racehorse with left absence of the CVT. Right: a 12 year old Thoroughbred Eventer (purpose bred for Eventing) with right absence of the CVT.



### Thoroughbred -サラブレッド

“Sarabureddo”

**Figure 6.** A 23 year old Thoroughbred stallion in Japan, base wide in the hind and left forelimb forward. He was healthy, bright and a 1/5 condition score with a severe overbite. He presented with a left unilateral C6 and displayed typical neurological posture. He had difficulty holding his forelegs up and lateral bending at the base of the neck was impaired. Left hind was a 2/5 lame from an old pelvic fracture with sacro iliac strain. He had 9 starts as a race horse and an unknown career afterwards.

# **“So what happens to the muscles – where do they go?”**

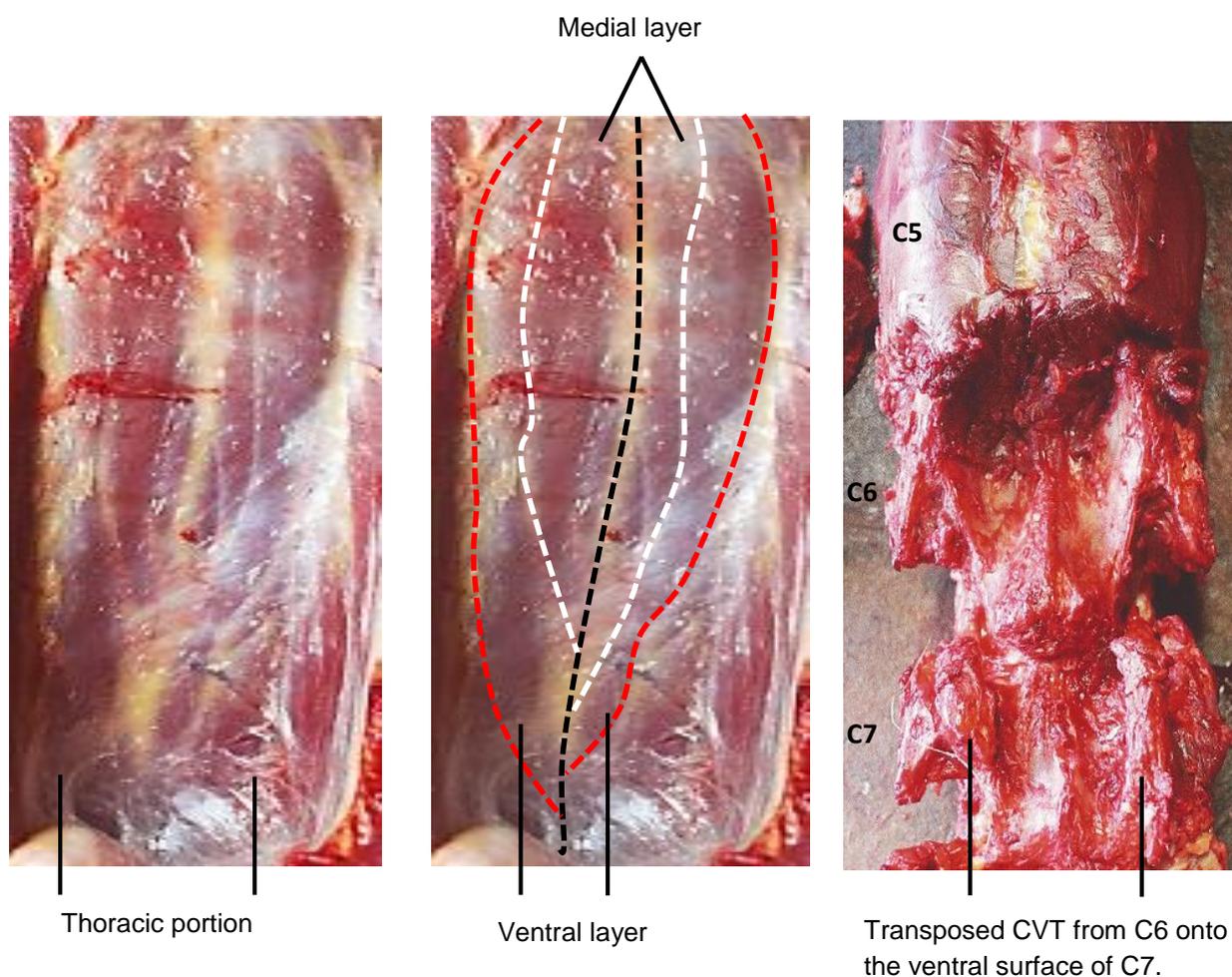
**Authors: Sharon May-Davis and Catherine Walker**



*“Variations and Implications of the gross morphology in the Longus colli muscle in Thoroughbred and Thoroughbred derivative horses presenting with a congenital malformation of the 6<sup>th</sup> and 7<sup>th</sup> cervical vertebrae.”*

## **Abstract**

During the dissection of 7 Thoroughbred (Tb) and 2 Thoroughbred derivative (TbD) horses (9) displaying an absence of the caudal ventral tubercle (CVT) on C6, with 5 of 9 transposing the CVT from C6 onto the ventral surface of C7; it was noted that variations in the gross morphology of the Longus colli muscle existed. In the absence of the CVT on C6 only, the insertion of the ventral and medial layers, and thoracic portion of the L. colli muscle attached to the cranial ventral tubercle (CrVT) on C6. However, when transposition of the CVT from C6 onto the ventral surface of C7 was noted, the ventral and medial layers, a single deep bundle and the thoracic portion of the L. colli muscle attached to the CrVT on C6 and the transposed CVT on C7. In the unilateral malformation, it placed a distinct asymmetry in the paired left and right longitudinal arrangement of the L. colli muscle and a distinct left to right cross sectional asymmetry in the ventral and medial layer and the thoracic portion. In the bilateral malformation, the CrVTs were longitudinally malaligned and the L. colli replicated the unilateral presentation to a lesser extent. This implies the L. colli muscle is dysfunctional in the presence of this congenital malformation and as a cybernetic muscle; it raises questions as to the postural and locomotive equilibrium in affected horses as found in this study.



**Fig. 7.** The L. colli muscle in a 10 year old Tb from C5 to C7. He was bilateral C6 and C7 that were longitudinally malaligned. Note the curvature in the midline (black line) and associated layer deviations in the L. colli muscle (red and white line).

This study showed that the function of the L. colli muscle had been severely compromised in the presence of the congenital malformation in C6 and C7 and furthermore, that mechanical forces placed an asymmetric load at the points of attachment. Thus with impeded function the L. colli muscle has faltered in its role as an intersegmental stabiliser, subsequently leading to vertebral instability, degenerative joint changes and asymmetrical articular processes. In addition, as a cybernetic muscle its associative congenital presentation in C6 and or C6 and C7, would lead to the brain receiving incorrect neural messages due to abnormal paired left and right tension in the muscle and as a direct consequence, the horse would adjust its posture accordingly (Table 1).

**Table 1**

Observations of 8 mature horses exhibiting a congenital malformation of C6 and or C6 and C7.

No.	Sex	Age @ death	C6 L R	C7 L R	Forelimb base wide	Forelimb forward	Reported Stumbling	Proprio. Dysfun.	Abnorm. Ribs	Observed by	Lifting limbs
1	M	23	L	-		L				V A	D
2	F	20	L R	-	Yes		Yes	Yes		V A	D
3	F	18	L R	-	Yes					-	U
4	F	17	L R	L Rr	Yes		Yes	Yes	L R	A	D
5	F	15	R	R		R	Yes	Yes		Vv A	D
6	M	10	L R	L R	Yes		Yes	Yes	R	Vv A	D
7	F	8	L	L		L R	Yes	Yes		V A	D
8	M	4	L	L		L	Yes	Yes	L	V	U
<b>8</b>	<b>3M 5F</b>	<b>Av. 14.4</b>	<b>6L 5R</b>	<b>4L 3R</b>	<b>4</b>	<b>3L 2R</b>	<b>6</b>	<b>6</b>	<b>2L 2R</b>	<b>4V 2Vv 6A</b>	<b>6D 2U</b>

Key: M=male, F=female, L=left, R=right, r=rudimentary, V=veterinarian, A=author, Vv=veterinarian viewed video, D=difficult, U=unknown

Note: the stillborn foal has been removed from the pre mortem observations table.

Neurological dysfunction in equines is multifaceted and Thoroughbreds are a predisposed breed due to factors such as nutrition and growth rates [1]. However the occurrence of the C6 congenital malformation at 38% in Thoroughbreds [2] has not been previously factored into the discussion as a causative agent nor the C6 and C7 collective malformation. Furthermore, the mechanical forces of the L.colli muscle clearly place an asymmetric load onto its points of attachment and falters in its role as an intersegmental stabiliser, subsequently leading to vertebral instability, degenerative joint changes and asymmetrical articular processes [3]. In addition, as a cybernetic muscle its associative congenital presentation in C6 and or C6 and C7, would lead to the brain receiving incorrect neural messages due to abnormal paired left and right tension in the muscle and as a direct consequence, the horse would adjust its posture accordingly [4-6]. In fact, this study has shown that the function of the L. colli muscle has been severely compromised in the presence of the congenital malformation in C6 and C7 as previously reported and that new strategies will need to be implemented in order to limit the potential damage to affected horses and riders.

## **Conclusion**

This study has clearly demonstrated that the L.colli muscle has altered its points of attachments and loss of function in the presence of the congenital malformation in C6 and C7. The potential ramifications are neurological dysfunction, loss of performance and potential harm to horse and rider. It would be a recommendation of the authors to investigate management programs to stabilise the musculoskeletal system in the cervicothoracic junction in order to prevent further potential wastage within the industry.

## **Acknowledgements**

To the many horses who made this journey possible. Lynnette Eggleston for cadaver preparation; Janeen Kleine and Robert Hunter for manuscript advice; Australian College of Equine Podiotherapy for the use of their facilities and to the many support persons who helped along the way.

## Since the Publications of these Papers New Research has been completed.

*“Anatomical variation of the spinous and transverse processes in the caudal cervical vertebrae and the first thoracic vertebra in horses”*



I. SANTINELLI, F. BECCATI\*, R. ARCELLI and M. PEPE

**Reasons for performing study:** There are scant data on the incidence of different anatomical variants of the equine caudal cervical spine, despite interest in cervical pathology.

**Objectives:** To identify morphological radiographic variation in the 6th and 7th cervical vertebrae and the first thoracic vertebra in horses of different breeds and to determine whether there are breed and sex-related differences.

**Study design:** Retrospective descriptive study.

**Methods:** Radiographs of the cervical spine of 270 horses were assessed retrospectively. The Chi-square test, or Fisher's exact test when appropriate, was used to test for associations between radiographic findings and sex or breed, and residual analysis was performed to localise differences. Chi-square tests and calculation of phi coefficient ( $\phi$ ) were used to test for associations between different types of radiological variation.

**Results:** Three variants were identified in the spinous process of the 7<sup>th</sup> cervical vertebra, and 2 variants were identified in the spinous process of the first thoracic vertebra. The presence of the spinous process of the 7<sup>th</sup> cervical vertebra was associated with breed, and transposition of the ventral process of the 6th cervical vertebra onto the ventral aspect of the 7th cervical vertebra was associated with sex. The shape of the spinous process of first thoracic vertebra was associated with the shape of the spinous process of the 7<sup>th</sup> cervical vertebra and with the presence of transposition of the ventral process of the 6th cervical vertebra onto the ventral aspect of the 7th.

**Conclusions:** A large number of anatomical variants can be detected radiographically in the caudal cervical area; some of these have a higher frequency, depending on sex and breed. Knowledge of the different shapes is very important in avoiding misdiagnosis of periarticular new bone formation. The spinous process of the first thoracic vertebra has 2 morphological variants.

**Sig. findings abs. CVT C6: 5/26 Anglo-Arabs; 3/28 Arabians; 13/36 Tb's; 2/12 Q'horse; 31/126 Wb's**

***“PREVALENCE OF ANATOMICAL VARIATION OF THE SIXTH CERVICAL  
VERTEBRA AND ASSOCIATION WITH VERTEBRAL CANAL STENOSIS  
AND ARTICULAR PROCESS OSTEOARTHRITIS IN THE HORSE”***

Authors: ANTHONY DEROUEN, MATHIEU SPRIET, MONICA ALEMAN

The sixth cervical vertebra (C6) has unique morphology due to a ventral extension from the transverse process known as the ventral lamina. Little information was found regarding the prevalence and clinical relevance of morphologic variations. Aims of this observational, retrospective study were to characterize C6 morphologic variations in a large sample of horses. Cervical radiographic studies of 100 horses were retrieved. Data recorded were signalment, clinical history, morphology of the C6 ventral lamina, presence of articular process osteoarthritis, and presence of static vertebral canal stenosis. Morphologic variations were found in C6 vertebrae for 24/100 horses, with symmetric absence of the ventral lamina in nine horses and asymmetric absence in 15. Anomalous C6 vertebrae were more common in Warmbloods, with 19/55 Warmbloods in the population being affected ( $P = 0.006$ ). No association was found with sex. There was no significant difference in the mean of the intravertebral sagittal ratios between horses with normal or anomalous C6 vertebrae; however, there was a significantly greater proportion of horses with anomalous C6 vertebrae that had an intravertebral sagittal ratio of less than 0.5 at C6 ( $P = 0.047$ ). There was no association between the morphology of C6 and articular process osteoarthritis. Anomalous C6 vertebrae in our population were associated with a higher likelihood of cervical pain ( $P = 0.013$ ). Authors propose that morphologic variations in the C6 ventral laminae could be linked to other developmental abnormalities such as vertebral canal stenosis, might affect regional biomechanics and should therefore be considered clinically relevant in horses. Future, controlled prospective studies are needed to test this theory.

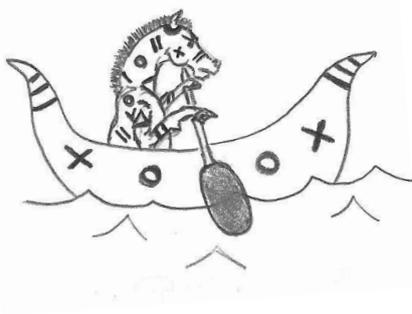
## ***“Congenital Malformations of the 1<sup>st</sup> Sternal Rib”***

Author: Sharon May-Davis

### **Abstract**

During the dissection and skeletal examination of 151 horses, a congenital malformation (CM) of the 1<sup>st</sup> sternal rib that influenced the aperture of the Thoracic inlet was noted in 6 horses. The presentation of this CM was variable between horses in gross anatomic appearance, notably; an absent 1<sup>st</sup> sternal rib; a bifid articulating tubercle; bifid insertions onto the sternum; flared shaft; normal 1<sup>st</sup> sternal rib inserting onto the cranial branch of a bifid 2<sup>nd</sup> sternal rib; straight shaft; and articulating rudimentary tubercles with ligamentous extensions replacing the bony shaft and attaching to a rudimentary bony insertion onto the sternum. Of the 151 horses examined, the CM of the 1<sup>st</sup> sternal rib was noted in 6/60 Thoroughbred horses; 0/4 Thoroughbred derivatives; 0/67 purpose bred horses and 0/20 non-descript horses. The CM of the 1<sup>st</sup> sternal rib was only noted in Thoroughbred horses with an expression of either a unilateral or bilateral absence of the caudal ventral tubercle (CVT) on C6 and the transposition of the CVT from C6 onto the ventral surface of C7 with an arterial foramen. The normal anatomic presentation of the thoracic inlet was altered, along with associative musculoskeletal structures including neurological pathways. This is likely to produce clinical and functional ramifications of the thoracic inlet, thoracic limb and thoracic viscera, with the probability of altering postural and locomotive function as noted in 4 horses demonstrating the CM.

**This current paper on the 1<sup>st</sup> Sternal Rib has recently been accepted**



**and is currently in the editorial process.**

**The Journey Continues!**

## References

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