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Original Research

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 Sixth and Seventh Cervical Vertebrae

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ABSTRACT

During the dissection of seven Thoroughbred (Tb) and two Thoroughbred derivative (TbD) horses (9) displaying the congenital malformation of C6 and/or C6 and C7; variations in the gross morphology of the *Longus colli* muscle were noted. In the absence of the caudal ventral tubercle (CVT) on C6 only, the insertion of the medial and ventral layers and thoracic portion of the *L. colli* muscle attached to the cranial ventral tubercle (CrVT) on C6. However, on transposition of the CVT from C6 to the ventral surface of C7, the medial and ventral layers, a single deep bundle, and thoracic portion of the *L. colli* muscle attached to the CrVT on C6 and the transposed CVT on C7. In the unilateral malformation, this placed a distinct asymmetry in the paired left-to-right longitudinal presentation and cross-sectional samples of the *L. colli* muscle. In the bilateral malformation, the CrVTs were longitudinally malaligned and the *L. colli* replicated the unilateral presentation to a lesser extent. In this presentation, asymmetry was noted in entheses patterns and articular process joints, implying abnormal mechanical load, as was confirmed in the cross sections. As the *L. colli* muscle has specific cybernetic roles linked to posture and locomotion, these anatomic variations imply dysfunction. Premortem examinations confirmed eight of the nine horses exhibited proprioceptive and neurologic dysfunction (stillborn not included). This raises questions as to the equilibrium of affected horses and therefore the safety in handling and riding such horses, as was found in this study.

1. Introduction

The relationship between the equine neck and its influence on locomotion has, in recent times, been better understood due to the advances in modern technology [1–4]. These advances have allowed studies to focus on specific areas such as intersegmental vertebral motion in response to biomechanical loading [5,6]. In addition, it was shown that the articulating function between the cervical vertebrae has a specific range of motion explained in flexion, extension, lateral bending, and axial rotation [1,3,5–8]. A study by Rombach et al [9] discussed these actions and noted the importance of multibundled muscles in segmental stability between cervical vertebrae and, in particular, the ventral multifascicular layered *Longus colli* muscle. This muscle is a paired juxtavertebral muscle that is located along the ventral surfaces of the cervical vertebrae from C1 to T5 or T6 [5,10–12]. Referred to as a deep ventral perivertebral muscle [8,9], its function is to stabilize, fixate, flex, and rotate the vertebrae [1,5,11,12].

It is believed that the thoracic portion of the *L. colli* muscle with its strong reinforced tendon helps to ventrally support the neck in the cervicothoracic junction [9]. This is

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of particular importance as C6, C7, and T1 are centrally placed in the ventral convex curve [1], and as this muscle inserts on the caudal ventral tubercle (CVT) of C6 [9], it implies that this specific tubercle is a necessary component involved in supporting the ventral convex curve in the equine neck. This places further emphasis on the supportive role that the *L. colli* muscle has, especially due to its anatomic proximity to the cervical and cranial thoracic articular joints [5,11]. In addition, there is no ventral longitudinal ligament until T8 [8]; hence, the need for precise cervical anchor points such as the CVT on C6 for the thoracic portion of the *L. colli* muscle to attach and provide intervertebral stability in the cervicothoracic junction [5,9,10].

Furthermore, Denoix and Pailloux [5] report that the *L. colli* is a cybernetic muscle with rich proprioceptive innervation that functions as a source of postural and locomotive information. This rich innervation transmits the muscle's state of tension to the brain and is achieved by one neuron servicing 20–30 myofibrils. This is in distinct contrast to gymnastic muscles, whereby muscles such as the biceps femoris are serviced by one neuron to every 1,000 or so myofibrils [5]. The main function of cybernetic muscles is to sense motion and produce adaptive postural responses, thus allowing for very precise and subtle control of movement [13]. Similarly, this was confirmed in humans, whereby the proprioceptors in the deep seated cervical muscles were also mechanoreceptors and that pathologic proprioceptive cervical afferentation results in considerable changes in the organization of spatial orientation [14]. In addition, Ridgway et al [15] noted that equine muscles used incorrectly or were improperly innervated, resulted in muscular asymmetry and that abnormal afferent or efferent input associated with hypomobilty or fixation of the vertebral segments caused a singular, or group of muscles, to remain in a hypertonic state.

Subsequently, the reported absence of the CVT on C6 in 19 of 50 Tb horses and three of three Thoroughbred derivative (TbD) horses [16] implies that the *L. colli* muscle must attach elsewhere to function. If so, the implications are most likely asymmetry of the *L. colli* muscle and the potential for postural and locomotive dysfunction due to the influence of muscle tonicity on neural pathways. Therefore, the purpose of this study was to establish the relocation patterns of the *L. colli* muscle in those horses exhibiting the reported congenital malformation of C6 and C7 [16] and where possible, observe horses premortem for postural and/or locomotive dysfunction.

2. Methods

According to Rombach et al [9], the ventral and medial layers of the *L. colli* muscle attach to the CVT of C6 from a cranial direction, whereas the thoracic portion and a single

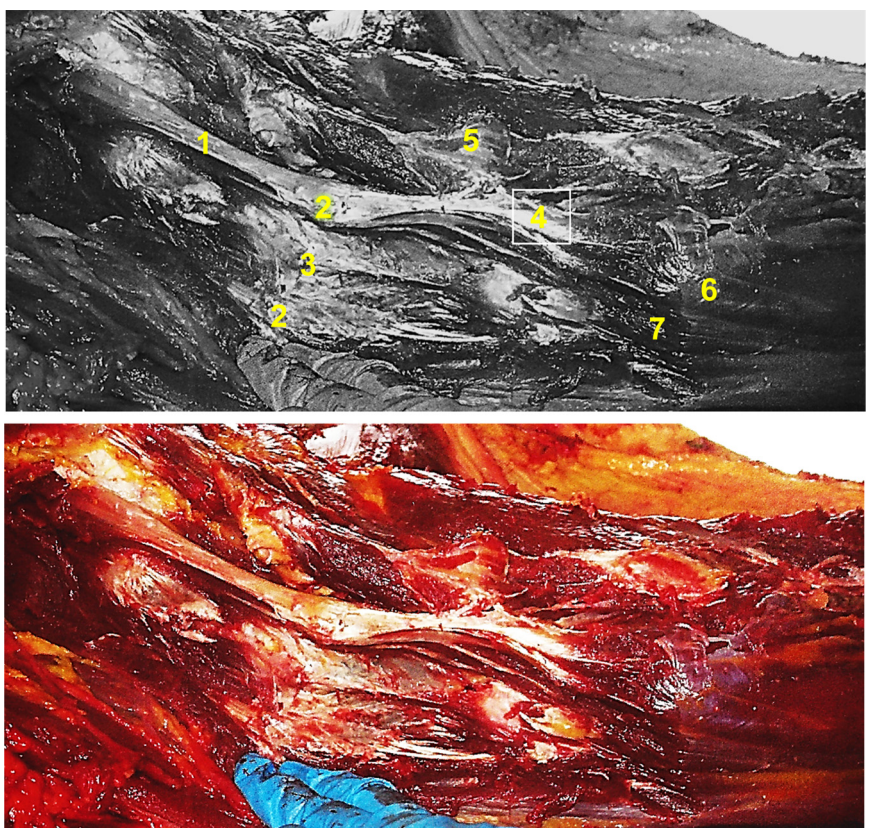

Fig. 1. A partially dissected normal presentation of the *Longus colli* muscle attaching to the CVT and CrVT of C6 in a 14-year-old Morgan mare. 1. The tendon of the thoracic portion. 2. Left and right CVTs. 3. The ventral crest. 4. Right CrVT. 5. Right transverse process. 6. Ventral layer. 7. Medial layer. CVT, caudal ventral tubercle; CrVT, cranial ventral tubercle.