

## Ultrasonographic evaluation of *Cricoaarytenoideus lateralis* muscle in Standardbred horse

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**Abstract:** The cricoarytenoideus lateralis muscle (CALM) is an adductor of the arytenoid cartilages but is not directly involved in the pathogenesis of recurrent laryngeal neuropathy (RLN) as the abductor cricoarytenoideus dorsalis muscle (CADM) is. Nevertheless, the CALM is the first muscle to experience a neurogenic atrophy in the course of RLN and this feature explains its potential importance in RLN diagnosis. On 30 gelding and 30 female Standardbred horses weighing about 500 kg and aged between 3 and 9 years, an ultrasound examination of the larynx was performed in order to assess shape, size, and echogenicity of the CALMs. The mean width, thickness, and area of the muscle were respectively 1.42 cm, 1.23 cm, and 1.36 cm<sup>2</sup> for the right side and 1.40 cm, 1.21 cm, and 1.34 cm<sup>2</sup> for the left side. No differences were found in relation to sex, age, or difference between right and left muscle. Focal calcifications of thyroid cartilage prevented visualization of the muscles, especially in females.

**Key words:** Horse, larynx, ultrasonography, hemiplegia, diagnosis

### Introduction

Upper airway diseases are among the most common causes of poor performance in horses (1,2) and diagnosis is often a challenge for clinicians. Direct clinical examination is not always sufficient to reach a definitive diagnosis, and endoscopic examination, sometimes on a treadmill, has to be performed in order to make a correct diagnostic and prognostic evaluation (3). Nevertheless, endoscopic examination, both at rest and during exercise, is not suitable for evaluating extraluminal structures (4). Up to now, palpation has been the only method for assessing laryngeal extraluminal musculature.

Ultrasonography of the larynx is largely used in human and small animals; in some instances, it can be preferable to a laryngoscopic examination (5–8).

Chalmers et al. (3) described the acoustic windows used for a systematic scanning of the equine larynx and highlighted the potential use of ultrasonography for a better understanding of the pathogenesis of some upper airway diseases and, in some instances, for differential diagnosis (e.g., hemiplegia vs. arytenoid chondritis). They demonstrated a significant association between the occurrence of dorsal displacement of the soft palate and the depth of the basihyoid bone when measured with percutaneous ultrasonography (9).

Recurrent laryngeal neuropathy (RLN), an important disease with unknown etiopathogenesis, is supposed to be the cause of laryngeal hemiplegia. In RLN, both the cricoarytenoideus lateralis muscle (CALM) and the cricoarytenoideus dorsalis muscle

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(CADM) undergo atrophy following the recurrent laryngeal nerve axonopathy. The CALM is an adductor muscle and therefore not directly involved in the pathogenesis of RLN, but, interestingly, it is the first to be involved in the atrophic process and is also the more severely histologically affected laryngeal muscle (10). Differently from the CADM, the CALM is not palpable. When investigated for its echogenicity, this muscle is abnormal (increased echogenicity) in horses affected by RLN, showing that a laryngeal ultrasound can be a useful diagnostic tool for RLN (3,4,10–12).

The aim of the present study is to investigate the differences among Standardbred horses in the CALM as, at the moment, no information is available about the variability of the ultrasonographic size of the CALM in Standardbred horses not affected by RLN in relation to breed, age, and sex.

### Materials and methods

Sixty Standardbred horses, 30 geldings and 30 females all weighing about 500 kg and aged between 3 and 9 years (42 horses between 3 and 6 years old, and 18 between 7 and 9 years old), were selected among horses hospitalized for diseases not concerning the respiratory apparatus (e.g., lameness) at the Veterinary Teaching Hospital of the University of Camerino. Horses were checked for normal function of larynx by endoscopy, at rest and after induction of apnea by nasal occlusion. Horses considered as belonging to laryngeal grade I or II, based on a

4-grade classification (13), were included in the study. During the endoscopy, only a nose twitch was used for restraint to avoid the use of sedative drugs and to minimize the influence on laryngeal motility.

An ultrasound examination (SonoSite Titan, 7.5-MHz convex probe) was then performed bilaterally (120 evaluations) through the left and right caudolateral windows (4) on a dorsal plane, without hair clipping and using isopropyl alcohol as an acoustic agent.

CALMs were visualized and their normal aspects were checked. The image was frozen when all 3 cartilages (thyroid, cricoid, and ipsilateral arytenoid) were simultaneously visible. Measurements of CALMs were performed on their rostral-caudal (width) and lateral-medial (thickness) axes (Figure 1) approximately in the middle of the muscle. The CALM area was calculated with the formula of an ellipse area.

Results were elaborated by chi-square test with Yates' correction factor when necessary. The level of significance was established at  $P < 0.05$  for all tests.

### Results

In 11 horses (9 females and 2 males), it was not possible to perform a correct evaluation because of acoustic shadows created by the focal mineralization of thyroid cartilage (Figure 2). In 1 male and 8 females, the problem was bilateral for a total of 20 missed measures (33%). In most of the cases, mineralization involved the caudolateral edge of thyroid cartilage.



Figure 1. Cricoarytenoideus lateralis muscle measurement.

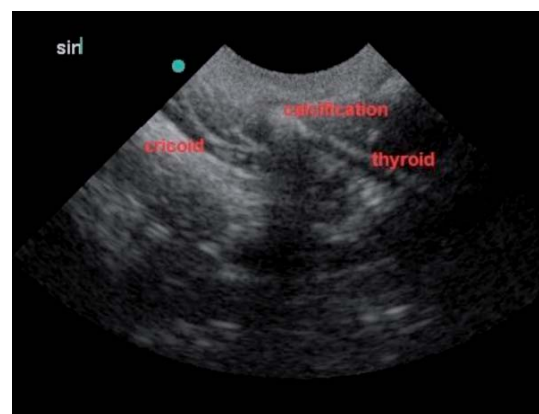


Figure 2. Focal thyroid calcification preventing measurement.

The CALM appeared in ellipsoidal shape, slightly flattened in the lateral-medial direction. No differences in echogenicity and shape were detected between males and females, between the right and left side, or when compared between horses of different ages.

The average and standard deviation of muscular measures are reported in the Table as the average of measures divided between the left and right side and based on the horses' age. Calculated areas are also reported.

No statistically significant differences were found between the measurement of the muscle from the left and right windows, nor between sexes and ages ( $P > 0.01$ ).

**Discussion**

Ultrasonographic evaluation of the CALM is not invasive and is a well-tolerated investigation. Only in a few cases was the application of the nose twitch necessary, because of the nervous nature of the animal. Lack of clipping never affected the proper evaluation, with the exception of one horse with long hair for which the images partially lost quality.

Because of the calcifications on the caudal edge of the thyroid, it was not possible to make assessments in 17 females and 3 males; this observation appears to validate the assumption that this occasional finding is related to sex in the Standardbred, with a higher incidence in females. However, this result needs further confirmation.

In order to identify changes in the left muscle in horses affected by recurrent laryngeal neuropathy, some authors recommended a comparison of sizes, shapes, and echogenicity with the contralateral (4).

Although Garret et al. (12) detected minor discrepancies in CALM size, they found that no significant differences existed among different group of horses (with or without abnormal arytenoid movement) or between the left and right muscle. These authors found a mean right area in all groups of horses of 1.48 cm<sup>2</sup>, slightly above but similar to our results (1.42 cm<sup>2</sup>). Such a small difference could be explained by the different techniques used for measuring (software in the ultrasound machine vs. geometrical evaluation by axis).

In our data, there is a slight difference between left and right measurements with respect to the age, although it is not statistically significant. Nevertheless, it should be noted that the groups of age were different in number, and so these results could have been influenced by the imbalance of group consistency.

It is interesting to note that the standard deviation values tend to be higher in the evaluations of the width than the thickness, probably due to the oblique direction of the muscle affecting the sectional area visualized. Therefore, the accuracy of the scan plane affects the rostral-caudal evaluation more than lateral-medial, making the latter more repeatable and more useful for comparative purposes also with respect to the areas.

Table. Mean ± standard deviation (SD) of width, thickness, and area of the CALM.

	Total		Male		Female		<6 years		>6 years	
	R	L	R	L	R	L	R	L	R	L
Width (cm) ± SD	1.42	1.40	1.40	1.40	1.41	1.40	1.39	1.37	1.43	1.42
	0.15	0.16	0.17	0.15	0.15	0.17	0.13	0.17	0.16	0.15
Thickness (cm) ± SD	1.23	1.21	1.21	1.21	1.23	1.21	1.20	1.20	1.24	1.22
	0.10	0.12	0.12	0.13	0.10	0.12	0.12	0.12	0.09	0.12
Area (cm <sup>2</sup> ) ± SD	1.36	1.34	1.37	1.34	1.36	1.34	1.30	1.29	1.39	1.36
	0.18	0.20	0.16	0.17	0.20	0.23	0.18	0.21	0.17	0.19

In our opinion, data about possible differences between left and right sides in healthy subjects of different breeds, sex, and age, especially those regarding the shape and size, need to be increased.

An important conclusion of the present work is to confirm that no significant differences exist between the assessments made in both sides in subjects without endoscopic signs of RLN, which further validates the diagnostic significance of ultrasonography in the course of this alteration.

It has not been our experience, but some horses can have CALM alterations without endoscopic signs of RLN (10,12). In this regard, it should be pointed out again that the CALM precedes the CADM regarding the phenomenon of degeneration in the course of laryngeal neuropathy, which may suggest the use of laryngeal ultrasound as a predictive tool, rather than diagnostic, with respect to the onset of this disease. The horses in this study will be monitored every 6 months by endoscopy and ultrasound in order to investigate this possibility.

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