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"A CHARITABLE CORP. DEDICATED TO THE CARE OF THE INJURED HORSE"

Lay article

Morphological studies on the pathophysiology of dorsal displacement of the soft palate: Development of a disease model

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A racehorse's performance can be compromised by displacement of the soft palate, but veterinarians and horsemen know little about what causes it and thus find the condition difficult to treat. In some cases it appears to be not so much the palate displacement as perhaps a malfunction of one of the four muscles in the throatlatch area. Therefore, our research team conducted a study to investigate that possibility and found that when the *thyrohyoid muscle* was cut in four horses, all experienced palate displacement. With this model in place, we plan to focus on a treatment that restores function to this muscle in the hope that a way to treat the condition may be found that gives a better success rate than current methods.

What is palate displacement?

Displacement of the soft palate is a common cause of upper respiratory noise and exercise intolerance (i.e., poor performance) in racehorses. Horses affected with this disease are described as "choking-down" or making a gurgling noise, and they seem to be running well until they "hit a wall." Palate displacement was first described in 1949 by Dr. Quinlan, a New Zealand veterinarian. What is especially surprising is that Dr. Quinlan was able to figure out that the palate obstructed the airway during exercise even though endoscopes were not available at the time.

What is the soft palate? It is a structure that separates the food pathway from the airways (Figure 1, which shows a normal horse). Air flows in and out of the lungs through the voice box (larynx) above the soft palate. Palate displacement results in the palate moving up into and obstructing the airway when the horse exhales (Figure 2). Note that in the left view of Figure 2 you can clearly see the voice box from top to bottom (normal), while the bottom is partially obstructed in the right view of Figure 2 (displaced). The right view is what a displaced palate looks like when the horse inhales. When the horse exhales, airflow catches and lifts the palate so that half or more of the airway is blocked (Figure 3).

What causes palate displacement?

This disease is more than half a century old, yet we know little about its cause. We do know that some young racehorses experience palate displacement due to inflammation of the throat area or lack of fitness. In a study of Thoroughbred racehorses in Japan, it was noted that airway inflammation, called pharyngitis, decreased with age, and this decrease paralleled the number of horses with palate displacement (Figure 4). This is evidence supporting the theory that inflammation plays a role in the ability of the palate to maintain its normal position and resist pressure changes in the airway. Understanding how the palate moves in relation to the voice box leads to an understanding of how inflammation or lack of fitness causes palate displacement.

The cause of the displacement could be at two levels. It could be the palate's fault or it could be the position of the voice box and tongue in relation to the palate. When this disease was first discovered in 1949, it was thought that the palate itself was abnormal—that the palate was too weak or long. This perspective led to the surgical treatment of removing a small portion of the palate. Sixty percent of horses responded to this treatment, but chronic coughing has been a complication. (Some horses aspirate water and feed into the windpipe after this surgery.).

The next treatment approach was based on the assumption that palate displacement was due to a problem with the larynx (voice box): It is the voice box's fault. That was based on the theory that the voice box was a button that fit tightly into the soft palate (the buttonhole). When the button (voice box or larynx) slipped back, the palate was left in the middle of the voice box and blocked the airway. In response to this belief, the popular treatment in the late 1970s and 1980s consisted of cutting the strap muscles on the underside of the neck, thus preventing the voice box from being pulled back and away from the palate. Curiously, this procedure is also associated with a 60% success rate. But it has fewer serious complications, and they are usually

limited to incisional infections and abscesses.

In the last decade, it became fashionable to do both procedures at the same time, based on the assumption that one or the other would have a beneficial effect. Dr. Llewellyn cleverly modified the procedures to decrease complications, and this is the current "in vogue" treatment. However, this modified procedure is still associated with a 60% success rate.

Recent palate research

Recently, by measuring airway pressure in exercising horses, it was discovered that strap-muscle resection (previously thought to be a harmless procedure) caused respiratory obstruction in normal horses and may not be so harmless after all. Dr. Holcombe and her colleagues recently reported the important information that when the nerve going to the soft palate was paralyzed with a local anesthetic, the palate displaced, giving the first conclusive evidence that it could be the palate's fault if a displacement was seen. They suggested that airway inflammation causes nerve damage, which in turn results in paralysis of the palate and displacement. This fit nicely with the observation that horses with inflamed airways had a higher rate of displacement (Figure 4). Equine practitioners now know that before considering surgery on a horse with displacement, it is crucial to look in a horse's guttural pouch (where the palate's nerve is) to see if any inflammation is present. If inflammation is present, it should be treated first to see if that resolves the problem.

Preliminary research in our laboratory

However, most horses have displacement without significant inflammation near the palate nerve, leading us to evaluate the cause of displacement further. The fact that all surgical treatments result in a similar 60% success rate raises questions about whether the surgery is helpful or whether it is the few weeks rest after surgery or the medication given around the

surgery time that is responsible for the apparent success. Furthermore, the standard medical treatments like the tongue-tie that appear to work do not affect the palate but do affect the structures near the palate, such as the root of the tongue and its relation to the voice box.

Investigating this idea further, we began looking at the muscle that may control the position of the root of the tongue and the voice box. In one study, we noted that a specific throat muscle's function decreased immediately before displacement in a horse with naturally occurring palate displacement. In a follow-up study, we were able to reproduce palate displacement in horses by transecting four muscles in the throatlatch area (including the muscle first identified with decreased function before displacement). Therefore, we suspect that palate displacement is not the fault of the palate—at least in some horses—but is due to an abnormal position and tension between the palate and voice box, which is controlled by the muscles in the throatlatch area.

What was our plan?

We believe that the palate region of the horse is a soft tube, much akin to a "wet sock," because it is the only part of the airways that is not rigidly supported by bone or cartilage. We think that various muscles exert traction to tense this tube and keep it from collapsing.

Because we knew from our preliminary study that one of four muscles could be responsible for this, we proposed cutting each of them separately in six horses to see if displacement would occur. At the same time, we placed small ultrasound probes that measure distances between various structures so that we could measure the effects of cutting each muscle on the structures near the palate. Once we identified which muscle(s) was responsible for displacement, we would have a model to use in logically developing a rational treatment for this frustrating disease.

Findings of this year's research

This study allowed us to find out more about what normally happens to select structures in a horse's throat area during exercise. We have confirmed that the voice box moves closer to the root of the tongue during swallowing. We found out what happens to the voice box and root of the tongue when we cut specific muscles in that area, so we have more knowledge about the function of those muscles in horses.

The most interesting finding was that four out of four horses that had the *thyrohyoid muscle* cut first experienced palate displacement. Three of these horses had displacement for at least two months. The fourth horse was released from the project shortly after his last trial, so he was not available for long-term observation.

Using the ultrasound probes that were placed, we found that palate displacement was associated with an increased range of movement between the root of the tongue and the voice box. There was also a backward movement of the root of the tongue with displacement. This is consistent with the observation that a tongue-tie, which should bring the root of the tongue forward, also helps prevent palate displacement. Perhaps it does so by preventing that backward movement associated with displacement.

This exciting finding must be tempered with the knowledge that the inflammation and scarring associated with surgery and the measurement techniques may have created the observed palate displacement. We do not think this happened, however, because there was no displacement when the other muscles were cut.

Conclusion

It appears that cutting the *thyrohyoid muscle* renders the voice box and the root of the tongue more mobile. This mobility may render these structures vulnerable to excessive

movement in response to upper airway irritation, perhaps associated with reflex contraction of adjacent muscles. Backward movement of the root of the tongue and voice box is associated with palate displacement.

Since four out of four horses treated similarly developed palate displacement, we feel a fairly reproducible and realistic model has been developed. Study of this disease—particularly its treatment—has been significantly hampered by lack of such a model. Horses with DDSP in this study very closely resemble the clinical disorder, in that their palate was displaced only during high-speed exercise. Now we plan to focus on a treatment that restores function to this muscle.

Legends for figures

Figure 1: Schematic representation of a horse's head showing the soft palate separating the food pathway from the airway.

Figure 2: Throat of two horses as viewed by an endoscope. Left view is of a normal palate and right view is of a palate displacement. (Black stars are on the edge of the palate.)

Figure 3: Throat of a horse with a displacement while exhaling.

Figure 4: Chart comparing the frequency of palate displacement and pharyngitis in a group of racehorses in Japan.