

THE HORSE'S BIT: A Bronze Age anachronism and cause of many an idiopathic problem

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TAKE HOME MESSAGE

A physiological critique of the bit method of control revealed that it was painful, contraindicated, counterproductive, inefficient and unsafe. The traditional bitless methods of control all have their limitations and disadvantages but a new method of bitless control provided a painless, physiologically acceptable, and safer alternative.

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INTRODUCTION

The bit method of control was an early development in the 6000 year history of the horse's domestication. Because of this, depictions of bits and bridles from 1300 BC can appear remarkably 'modern', there being only a limited number of ways that a series of straps can be devised for suspending a metal rod in a horse's mouth. At the other end of the time scale, the veterinary profession was a late development, having only appeared in the last 200 years. Long before the profession became established, much had been written about bits and biting. Perhaps this is one reason why veterinarians, as a whole, have tended to regard the subject as the province of horsemen and one into which veterinarians enter at their peril. Though the literature on the subject has undergone a logarithmic growth in the last 200 years, few veterinarians have entered the lists. An early contender was Bracy Clark, one of the first graduates of the fledgling veterinary school in London. Clark wrote a fascinating, 63-page treatise on the history, use and abuse of bits, vigorously condemning the leverage 'wrenching iron' of the 16th century and pleading for the use of the mildest bit possible¹. Contemporary veterinarians have contributed shorter, less iconoclastic articles.²⁻⁵ To my knowledge, Bennett is the only veterinarian to have co-authored a book on the subject.⁶ These modern-day contributions have, in general, represented a horseman's view of the bit rather than that of an anatomist or physiologist. Yet control of the horse at exercise is fundamental to the whole of sports medicine.

The absence of a basic science analysis of the bit's influence constitutes a gap in the literature on exercise physiology.

In 1997, I rode a 5 year-old Thoroughbred (ex-racehorse) and experienced for the first time the instant improvement in behavior and performance that occurred when its snaffle bridle was replaced with a newly developed bitless bridle.^a This experience led me to ask myself what it is that the bit method of control really does to a horse, in terms of pathophysiology. The question initiated a broad new line of investigation. Six articles have already been published,⁷⁻¹² yet much of the work has still to be reported. Some articles have been submitted for publication but are not yet in press.^b

As the publications are scattered in location, the first purpose of this paper is to provide an update of the work for the convenience of practitioners and to document that the bit has a wide-ranging influence on behavior and exercise physiology, harming five of the major bodily systems. The second purpose is to introduce a non-invasive, painless, physiologically effective, and safer alternative to the bit method of control.

MATERIALS AND METHODS

A physiological critique of the bit method of control was initiated by observing what changes occurred at exercise when the bit was removed and replaced by the new bitless bridle. Over a period of six years, personal observations have been supplemented by witnessing others carry out the same test. In addition, 440 unsolicited written reports have been reviewed from riders who, in the period 1997-2002, have switched their horses from bitted to bitless control, using the new bridle, and have documented the changes in behavior and performance that have resulted. These reports refer to 535 horses used in almost every discipline from the training of racehorses to dressage. Numerically, the collection is considered to be reasonably representative of the domestic horse population in the USA. Horses placed in a category of 'general equitation' accounted for 249 (47%), 'trail riding and endurance' accounted for 147 (27%) and, collectively, the remaining disciplines accounted for 139 (26%). The actual bits removed have covered the spectrum of designs from snaffle to leverage bits, and from single bridles to double bridles. The reports are available online, where they are classified according to discipline and also under categories such as unsoundness of wind, and head shaking.^c

^a *The Bitless Bridle*TM. The Bitless Bridle Inc. 2020, South Queen Street, York, PA 17403-4829

^b Cook WR "The effect of the bit on the behavior of the horse." Unpublished data. March 2002.
Cook WR. "On 'mouth irons', 'hoof cramps' and the dawn of the metal free horse." Unpublished data. March 2002,

Both articles are available online at www.bitlessbridle.com

^c At www.bitlessbridle.com

The critique was based on previous studies of the applied anatomy of the equine upper airway.^{13,14} The effect on nasopharyngeal patency of tongue and jaw movement triggered by the bit was observed endoscopically in the resting horse and during treadmill exercise.

A survey of the mandibular diastema in 65 *Equus caballus* skulls in Natural History Museums was completed, studying the prevalence of bone damage caused by the bit.¹² This was followed by a palpation survey of the bars of the mouth in a sample of 45 riding school and event horses.

Finally, various bits and bit combinations were weighed.

RESULTS

In 440 written reports on 535 different horses, a total of 50 different problems were described as having resolved when a bitted bridle was replaced with the new bitless bridle. Most of the 50 problems were cited many times, as there were 634 resolutions in all. The four most common problems caused by the bit were to instill fear (68 of 634 citations; 11%), to make the horse fight back (62:634; 10%), to trigger a flight response (59:634; 9%), and to cause headshaking (46:634; 7%)

The interaction of bodily systems is such that they cannot function in isolation. Nevertheless, it is necessary to assume that they can be so described, even though this involves some overlapping.

The Bit's Effect on the Nervous System:

The bit method of control results in most riders applying a highly focused force, either constantly or intermittently, on one of the most sensitive and potentially painful parts of the horse, its mouth.^d Huge numbers of sensory nerves innervate the lips and oral cavity. Using an analogy derived from the classification of diagnostic methods, it can be said that the bit is an invasive method of control, because a body cavity is invaded.^{9,10} In view of this it is not surprising that the trigger mechanism behind almost all of the 50 bit-induced problems cited in the reports was pain. The effect of this pain was most prominently expressed in the

^d Peak rein tensions recorded from riders of different levels of ability are reported to be most frequently in the range of three to ten pounds. In horses that are allowed to lean on the bit, peaks of 15 to 20 pounds are not uncommon. When a horse (or rider) snatches on the reins, peaks exceed 30 pounds.¹⁵ If one translates these figures into pounds per square inch at the level of the mouth from, say, a snaffle bit measuring 3/8" diameter by 4" long, a 3 to 30 lb peak translates to a pressure on the tongue ranging between 2 to 20 psi. If, on the other hand, the tongue is retracted and the same pressure falls on the knife edge of the mandibular diastema, the area of contact is infinitely smaller and the pressures would range from c.200 to 2000 psi or greater. It hardly bears imagining what the pressures might amount to if these same rein tensions are applied to a leverage bit that has the effect of multiplying the psi by a factor of three or four.

form of adverse behavior (29:50 or 58%) but clinical signs predominantly affecting the musculoskeletal system were also common (13:50 or 26%), as were those affecting the respiratory system (8:50 or 16%).

A complete listing, description and classification of all 50 problems requires another article (see footnote b) but many of the problems will be mentioned in the following text. For example, acute pain from the bit was responsible for problems such as rearing, bolting, bucking, and running backwards. Any of these problems may be the horse's response to being hit in the mouth by the bit. Undoubtedly the most common effect of the bit was to instill fear in the horse. This was expressed as nervousness, apprehension, tenseness, a tendency to take fright easily, and to develop panic attacks. Fear was reported in 68 out of 634 citations regarding 50 different problems (11%).

Tangible evidence of the pain that a bit causes came from finding a high prevalence (75%) of bone spurs on the bars of the mouth (see below).¹²

Bit-induced pain resulted in the horse attempting to evade the pain in one of two ways. First, by either raising the head and extending the atlanto-occipital joint ('poking the nose') or by lowering its outstretched head, a horse can place the bit against the rostral edge of the first cheek teeth where it causes less pain than when pressed against the tongue and bars of the mouth.^e Under these circumstances, the rider is no longer in control and the horse may bolt in any direction. The possibility of such a radical evasion of the bit constitutes a dangerous flaw in the bit method of control. Secondly, the horse can trap the bit under its tongue and partially disarm it in a similar fashion. Under these circumstances the horse leans on the bit, becomes heavy on the forehand and is blamed for being 'hard-mouthed' or a 'puller'.

The bit method of control may also cause pain during the four years in a horse's life, from two to five, when its oral cavity is naturally sensitive because of erupting permanent dentition. Unfortunately, this period coincides with the entire working life of most racehorses. Eruption of the incisors and cheek teeth represent a source of general sensitivity. But eruption of the canine tooth in the male is likely to be of special significance, as the horizontally disposed root of this tooth develops close to the point at which the bit applies pressure on the bars of the mouth.^f

The occasional presence of unerupted wolf teeth in the lower jaw represents another source of pain and one that is easily overlooked. The bit rides over the

^e It is I believe this maneuver that in the past has been referred to as 'getting the bit between its teeth.' But I doubt whether this is actually what is happening, as the horse would have to have its mouth open at all such moments and this does not appear to be the case.

^f The proximity of this root and its nerve supply may well explain why the head shaking syndrome is reported to occur more frequently in the male horse.¹⁶

bars of the mouth in exactly the place that these vestigial first premolars are located. Wolf teeth in the upper jaw are more apparent and are frequently removed but we should, I think, be more concerned about the effect of the bit pressing on submucosal wolf teeth in the lower jaw.

A scourge is defined as an instrument of punishment. The term is particularly apt when applied to the bit and its potential for bruising the gums, excoriating the lips, lacerating the tongue, ulcerating the buccal mucosa, and generating exostoses and star fractures of the mandible at the diastema. Racehorses are commonly found to be bleeding from the mouth after exercise. Trainers may, at any one time, have 20% of their horses with sore mouths. Collectively these injuries to the extremely sensitive mouth must be a source of severe pain. Manifestations of pain may be exhibited in a number of ways. At rest, the horse may show loss of appetite, quidding, an aversion to being bridled, constant 'mouthing', grinding of the teeth, and excessive salivation or slobbering. At exercise, pain may be responsible for an open mouth (yawing), veering (lugging to one side), tongue lolling, pulling, bolting, rearing, head tossing, poor performance, and a general lack of enthusiasm for exercise.

The preceding paragraphs all refer to localized pain in the mouth. A feature that has not previously been recognized is the bit's role as a source of more widespread and persistent pain in the form of facial neuralgia. Many years ago, I wrote a series of articles on the vexed but, at the time, inadequately studied problem of head shaking in the horse. The first article reviewed the literature and provided a description of the syndrome.¹⁷ The second article contained a questionnaire that owners could complete before calling in their veterinarian.¹⁸ The third article recommended what I then considered to be appropriate preliminary examinations.¹⁹ The final article described a number of special diagnostic tests that could be done in the hope of discovering the cause in any one horse.²⁰ Sadly, in 32 pages of print, no convincing causes could be described and, therefore, no cures were claimed. In a fifth article published 12 years later I confessed my continued bafflement as to what caused the head shaking syndrome and, therefore, what cured it.²¹

I provide this review of my own unsuccessful efforts thus far to find a cause, in order that when I now announce that I have something tangible to offer on this topic, readers may take note of the unexpectedly cheering news. As the result of clinical evidence collected over the last six years, I am now convinced that constant pressure from a metal bit on the mandible triggers trigeminal neuralgia and that this is the most common cause of the head shaking syndrome in the exercising horse.⁷⁻¹¹ Pain generated in the mandibular branch of the fifth cranial nerve is I propose referred, by a process of 'talk-back', to the maxillary and ophthalmic branches of this same nerve. Such a hypothesis is consistent with and provides an explanation for all the clinical signs of the syndrome. Apart from head shaking at exercise, stumbling, and a general inability to focus on the work in hand (presumably a direct central effect via the mandibular branch of the

nerve), these include head rubbing at rest, striking at the muzzle with the forelegs during exercise, sneezing, and snorting (maxillary branch effects), and blepharospasm and photophobia (ophthalmic branch effects).²² As trigeminal neuralgia in man is aggravated by high ambient temperatures and bright light, it seems likely that these factors also explain the seasonal occurrence of trigeminal neuralgia in the horse.

The validity of a hypothesis depends on its ability to be tested and its vulnerability to refutation. Because the new bitless bridle can be used on any type or temperament of horse and in all disciplines, it has been a relatively simple matter to test the hypothesis by removing the bit.⁹ Unlike all other treatments, this has proved to be unusually rewarding. So much so that removal of the bit and use of the bitless bridle should be, in my opinion, the first step in the clinical work-up of these previously difficult cases. The validity of a tentative diagnosis of bit-induced trigeminal neuralgia at exercise can be judged by a convincing response to elimination of the bit, the trigger factor.^{9,10}

Finally, the bit has to be indicted for inappropriately stimulating the parasympathetic nervous system, when exercise demands dominance of the sympathetic nervous system (see below).

The Bit's Effect on the Digestive and Respiratory Systems

In common with all mammals, horses have evolved to either eat or run. They are not able to do both simultaneously. The anatomical crossover of the digestive and respiratory pathways at the level of the pharynx dictates that the two activities are mutually incompatible.^{9,10,12} And yet this is what we have been expecting of a horse for the last 6000 years.

As soon as a bit is placed in a horse's mouth, the horse is being signaled, physiologically, to 'think eat'. The seal of the lips is broken, and reflex salivation commences, together with movement of the lips, jaw and tongue. These are digestive system responses dominated by the parasympathetic nervous system. But then a rider mounts and asks for motion. As a result, the horse is simultaneously being signaled to 'think exercise'. Accordingly, an entirely opposite set of 'fight and flee' reflexes are initiated, dominated by the

⁹ In 440 written reports, problems that had been eliminated by removal of the bit were cited 634 times. Head shaking was the problem cited on 46 occasions (7%). My experience of head shaking comes from working in England and then mainly the northeast coast of the USA, where the head shaking syndrome typically occurs at exercise. Nevertheless, I recognize that in the warmer parts of the United States, the syndrome does occur in the resting horse, under which circumstances it is proposed that it is associated with a primary hypersensitivity to bright light.²² However, it is possible that this hypersensitivity may still be caused by a pre-existing bit-induced trigeminal neuralgia, even though a bit is not present in a horse's mouth at the time head shaking occurs.

sympathetic nervous system. As the horse is an obligate nose-breathing animal, stimulation of the oral cavity during exercise is counter-productive.

I conclude that at exercise the horse suffers from neurological confusion, as its nervous system is trying to respond to two conflicting requirements, each tugging in the opposite direction. A horse can either graze or gallop but it should not be expected to do both at the same time. To summarize, the bit method of control initiates a set of responses that are diametrically opposed to those required for exercise.

- For eating, the horse needs to salivate and therefore has a wet mouth (parasympathetic)
For galloping, salivation should be in abeyance and the horse should have a relatively dry mouth (sympathetic)
- For eating, the horse needs to be in a relaxed frame of mind, dominated by cholinergic responses
For galloping, it needs to "... stiffen the sinews, summon up the blood ... set the teeth, and stretch the nostril wide", a state of mind dominated by adrenergic responses
- For eating, the horse needs an open mouth and it is physiological for some air to be present in the oral cavity and oropharynx.
For galloping, its lips should be sealed and there should be no air in the oral cavity. The presence of air constitutes a hazard. Because of the orientation of the head, any air in the oral cavity will tend to creep upwards and invade the oropharynx. Tongue and jaw movement will encourage this process. Air now breaks what should be a natural seal between the root of the tongue and the soft palate. Elevation of the soft palate on its cushion of air will cause stenosis of the nasopharynx and the galloping horse may develop inspiratory stridor (become 'thick in its wind' or a 'roarer').^{} Once air is present in the cavities above and below the soft palate, aerodynamic conditions are favorable to the development of soft palate vibration during galloping. This will be especially likely to occur if the atlanto-occipital joint is flexed (as when the horse is being 'rated') and the soft palate is no longer under longitudinal tension. The soft palate may start flapping like a wet blanket in the wind and the vibration may become audible ('gurgling'). Subsequently the soft palate may become dislocated from the ventral half of the ostium intrapharyngium (dorsal displacement of the soft palate) and the horse will asphyxiate ('choke-up').¹²*
- For eating, the horse needs a mobile jaw, tongue and lips. As the tongue and larynx are both suspended from the base of the skull by the hyoid

^{*} The same effect results when a horse evades the bit by retracting the tip of its tongue behind the bit. The root of the tongue, now rendered bulkier, elevates the soft palate.

apparatus, any movement of the tongue inevitably results in movement of the larynx. During swallowing, the larynx shifts its position.

*For galloping, it needs immobility of all these structures. Referring to the above example, it becomes apparent that a constant backward and forward shuffling of the larynx is incompatible with laminar airflow through the rima glottidis. Such movement also imperils the airtight seal at the level of the ostium intrapharyngium, so predisposing to dorsal displacement of the soft palate.*¹³

- For eating (swallowing), the horse needs a mobile and dorsally elevated soft palate
For galloping it needs an immobile and ventrally placed soft palate
- For eating, the horse enlarges its oropharynx at the expense of the nasopharynx
For galloping it enlarges the nasopharynx at the expense of the oropharynx
- For eating, the horse needs its head at ground level and its atlanto-occipital joint extended.
For galloping, it needs its head to be raised and its atlanto-occipital joint extended.

Endoscopy at rest and on the treadmill, with and without a bit in the horse's mouth, demonstrated that tongue movement is more active when a bit is present. It also revealed that tongue movement resulted in elevation of the soft palate (not necessarily dorsal displacement) and that this, in turn, resulted in nasopharyngeal stenosis and moments of complete airway obstruction.

The following case record serves to illustrate the bit's role in the etiology of laryngeal stridor:

A two-year-old Thoroughbred filly that had made an abnormal inspiratory noise at exercise since first being schooled was found to have no more muscle wasting on the left side of the larynx than average. On endoscopy, there was no evidence of advanced recurrent laryngeal neuropathy and this finding was supported by a nerve conduction test of the thoraco-laryngeal reflex arc.^{11,23} Yet,

The bit introduces a paradox into the training of Thoroughbreds because, except when a horse is breezed, trainers require the horse to be rated. This is done by rein pressure (and sometimes draw reins) and the bit produces varying degrees of poll flexion. The result is that many horses are regularly cantered with their heads in positions that obstruct the upper airway. This is bad enough, as it can lead to pulmonary 'hemorrhage'. But worse is possible, as pain caused by the bit will often have the opposite effect to that of restraint, as the horse may run from pain and bolt. Under these conditions, a horse may gallop with its poll still flexed, with the result that its lungs are severely damaged by the effects of negative pressure pulmonary edema (see later). Such a horse may 'bleed' from the lungs. I suspect that such an episode occurring on the day prior to the race has spoiled many a promising racing performance.

even at slow exercise the filly made a significant inspiratory noise and, immediately after exercise, palpation of the larynx revealed considerable fremitus. The snaffle bit was now removed and, ten minutes later, the filly was exercised again using the new bitless bridle. The inspiratory noise was no longer present and post-exercise fremitus was no longer detectable. The rider reported a marked improvement in the filly's gait and in her attitude to exercise. I concluded that the inspiratory noise was caused by nasopharyngeal obstruction, triggered by avoidance of the bit.

In the past, I have been of the opinion that the most likely cause of an abnormal inspiratory noise at exercise was recurrent laryngeal neuropathy.^{24,25} In future, before assuming that recurrent laryngeal neuropathy is the cause of 'thickness of wind' or blatant 'roaring', it is now my opinion that the bit as an etiological factor should first be excluded.

With regard to the bit's effect on the respiratory system, I conclude that it is:

- A cause of upper airway obstruction and, therefore, premature fatigue and poor performance. In my opinion, it can have this effect long before a horse begins to develop an audible inspiratory noise.
- A frequent cause of abnormal inspiratory stridor at exercise ('roaring' and general 'thickness of wind') associated with elevation of the soft palate.
- The most frequent cause of dorsal displacement of the soft palate (DDSP, 'gurgling' and 'choking-up'). The evidence for this statement has been published recently.¹² It involves a combination of tongue retraction, poll flexion, the presence of air in the oropharynx, the occurrence of pharyngeal spasm induced by gagging reflexes, and abortive attempts to swallow saliva during exercise.
- The prime cause of epiglottal entrapment.¹⁰ This is so because the soft palate elevates and exposes the flaccid mucosa of the oropharynx to the negative pressure of inspiration, a vacuum pressure that it should not have to experience and has not been evolved to withstand.^j
- A probable cause of dynamic collapse of the dorsal membrane of the cervical trachea on inspiration at fast exercise. In the long term this may, I believe, result in tracheal deformity ('scabbard' trachea) and would explain the high incidence of this problem in a random survey of trachea at a horse slaughterers¹⁰
- A cause of asphyxia-induced pulmonary edema ('bleeding'). This conclusion follows for the reason that the bit causes obstruction of the upper airway and this, in turn, is in my opinion the prime cause of pulmonary hemorrhage.^{26-32,34}
- A cause of chronic small airway disease following repeated episodes of asphyxia-induced pulmonary edema.^{10,31}

^j A cleft of the soft palate exposes the oral mucosa to the same negative pressure, which explains why epiglottal entrapment is sometimes seen as an accompaniment to this deformity in those horses that live long enough to be put into training.

The Bit's Effect on the Musculoskeletal System:

The concept of locomotor/respiratory coupling at fast paces is now familiar. A galloping horse takes one stride for every breath.³³ It follows from this principle that anything which interferes with breathing must also interfere with striding. In the preceding section, evidence is advanced to explain the many ways in which the bit interferes with breathing. I conclude, therefore, that the bit must, by definition, interfere with the normal rhythm and grace of the stride. This is born out by the frequency with which a short and choppy stride in a bitted horse has lengthened and become more graceful when the bit was removed. An important result of lengthening is that speed is increased.^k

The bit method of control is particularly effective at bringing about something that is incompatible with an unobstructed airway at exercise. It allows a rider or driver to flex a horse's neck at the poll. This, is how 'brakes' are often applied and how a racehorse is 'rated'. Because of the great mechanical advantage and leverage that a rider or driver can invoke by means of a bit in the sensitive body cavity at the rostral extremity of a horse, the degree of atlanto-occipital flexion that can be achieved varies from partial to almost complete. But it should be remembered that even partial flexion of this joint constitutes a degree of airway obstruction.^{10,13,14} When a horse is required to run fast, anything less than complete extension of the atlanto-occipital joint constitutes an obstruction to airflow. Flexion of the poll, therefore, is another way in which the upper airway is obstructed and this, in turn, must have an effect on the stride.

Excessive poll flexion also interferes with the stride by 'locking-up' the neck. The natural reaction of a horse to the mechanical force applied by a bit in its mouth is to resist this force by means of tension in the cervical musculature. But tension in the neck is incompatible with free movement of the legs. If the neck is abnormally rigid, so is the rest of the spine and this, in turn, will impede the free movement of the limbs. No human athlete could perform well with his or her neck in plaster.

Because horses commonly disarm the bit by trapping the offending object under their tongue, they now 'lean on the bit' and become 'hard-mouthed'. They also become abnormally 'heavy on the forehand.' Such interference with the balance of a galloping horse has a harmful effect on its stride. It also places extra strain on the forelegs and is likely to be a factor in the etiology of such familiar problems as sore shins, foreleg lameness and breakdowns.

There is another cause of heaviness on the forehand that has, I believe, been overlooked. I refer to the unbalancing effect of the bit's weight. Bits range in weight from a pony-sized snaffle at 180g (6 oz) to the combined weight of the bits and curb chain for a horse's double bridle at 780g (26 oz). If one adds to these weights the weight of the bridle necessary to suspend these bits in the mouth,

^k Cook WR. Unpublished data 2002

the total dead weight we place on the most rostral extension of the horse's balance arm must surely be significant.¹ Yet this weight is immeasurably increased by even the slightest traction on the reins and by the pendulum effect of the 'head bob'.^m The total effect is to make horses 'heavy on the forehand'.

Neck restraint brought about by the bit reduces the 'head bob', i.e., the natural swing of the head and neck pendulum in the galloping horse. As this swing is an energy saving device, it follows that the bit results in a waste of energy and is, therefore, a cause of premature fatigue and poor performance.¹⁰

With regard to the skeletal system, it is well known that the bit is occasionally responsible for causing star fractures of the mandible at the diastema. These draw attention to themselves when a bone sequestrum develops and a chronically discharging sinus tract occurs on the bars of the mouth. The sinus tract persists until such time as the sequestrum is shed spontaneously or surgically removed.

There is, however, an additional abnormality of bone that frequently occurs at this site, which has not to my knowledge been previously recorded. I refer to the presence of extensive bit-induced exostoses that develop on the spine of the mandibular diastema, dorsal to the mental foramen¹². The nature and shape of these exostoses vary but it is not uncommon for them to be 4.5cm long, 6mm high, and 4mm thick. When they first develop, the bone growths occur in a dorsal direction and, in lateral profile, they look like an irregular series of small mountain peaks. In the course of time these irregular encrustations, best described as bone spurs, take on a wave formation. The relatively flat crest of the 'wave' is dorsal and the 'wave' appears to be preparing to break laterally, so that the edge of the new bone growth is on the labial side of the mandible. It appears that, over time, the constant downward pressure of the bit causes the mandibular spine at the diastema to grow, first in a dorsal direction and then to bend over sideways in a flange formation. In a lateral view, the abnormal diastema presents a convex profile rather than its normal straight or shallow concavity.ⁿ In a survey of 65 skulls from horses five years old and older, bone spurs on the bars of the mouth were found in 49 (75%).¹²

¹ The bridle and bits for a Standardbred racehorse weigh in the region of 2.8 Kg (6lbs)

^m A farrier's saying points out that "one ounce at the toe equals one pound at the shoulder." The same principle applies to weight added to the extremity of the head. A heavy bridle and bit must upset the natural mechanics of the head and neck pendulum at the canter and gallop

ⁿ An example of both these types of lesion can be seen at the Smithsonian Institute (American Museum of History), on the skeleton of LEXINGTON, the famous Thoroughbred racehorse that died in 1875 at the age of 25. The more advanced lesion is on the left side of the mandible, which is what one might expect in a racehorse that ran on racetracks with left-hand turns. As a five-year-old, LEXINGTON set a world speed record in a match race over four miles. The record of 7 minutes 19 and three-quarter seconds stood for 20 years (an average speed of 13.4 seconds

Palpation of the bars of the mouth in the live horse indicated the presence of the larger exostoses. An examination of 45 unsedated riding school horses and event horses revealed diastema irregularities on one or both sides of the mouth in not less than 8 (18%). I assume that this is an underestimate of the real prevalence, as many fully conscious horses are so touchy about the mouth that they are difficult to examine and small lesions will be missed. In future, prior sedation will facilitate palpation. Some of the smaller bone spurs may only be detectable with the aid of radiography or ultrasonography. Nevertheless, even small bone spurs are significant, for even the smallest must be excruciatingly painful when further traumatized by daily bit pressure.

By tradition, the soft tissues of the gum above the diastema are referred to as the 'bars' of the mouth, which suggests a flat area and one on which it has been thought appropriate for a rod of metal to lie. And indeed, the soft tissues at the bars of the mouth are relatively flat. However, the conformation of the horizontal rami of the mandible, which provide the support for this soft tissue, is the very antithesis of a flat area. A transverse section of the rami at this level (dorsal to the mental foramen) reveals a pair of dorsal spines. The spines are normally smooth but, nevertheless, they present a relatively sharp edge of bone. Viewed from the side, the healthy spine is characterized by a straight edge or a shallow concavity that extends from the rostral edge of the second premolar to the point at which the dorsal spine fuses into the symphysis of the mandible. Awareness of the way in which the bit rocks like a see-saw on these two dorsal spines draws attention to the pain that the horse must suffer during the time when bone spurs are active. As the bit is constantly buffeting the region, the activity is likely to be prolonged during the life of the horse. Bone spurs might be expected to be particularly active in a young horse between the ages of two and five years. The presence of these lesions should be searched for by palpation in any horse that is evading the bit.

The Bit's Effect on the Cardiovascular System

The presence of a bit in the mouth, by stimulating a parasympathetic response, may have an inhibitory (cholinergic) effect on the heart that would be counter to the adrenergic response required for fast exercise.

The mechanism that I have proposed to explain a phenomenon that I believe is inappropriately referred to as exercise-induced pulmonary hemorrhage (EIPH)³⁰ is illustrated in Figure 1. Obstruction of the upper airway from whatever cause (including the bit) generates an abnormally low negative pressure in the alveoli and small airways, increasing transmural pressure at the air/blood barrier. This, in turn, increases the flow of venous blood into the lungs, promoting pulmonary

a furlong). The intense interest that this record generated, initiated the first mass-production of the stopwatch.

congestion and edema. Pulmonary edema raises pulmonary capillary pressure and further increases transmural pressure at the level of the air/blood barrier. Because of the great difference between the negative pressure in the air sacs and the positive pressure in the capillaries, heavily blood-stained edema fluid

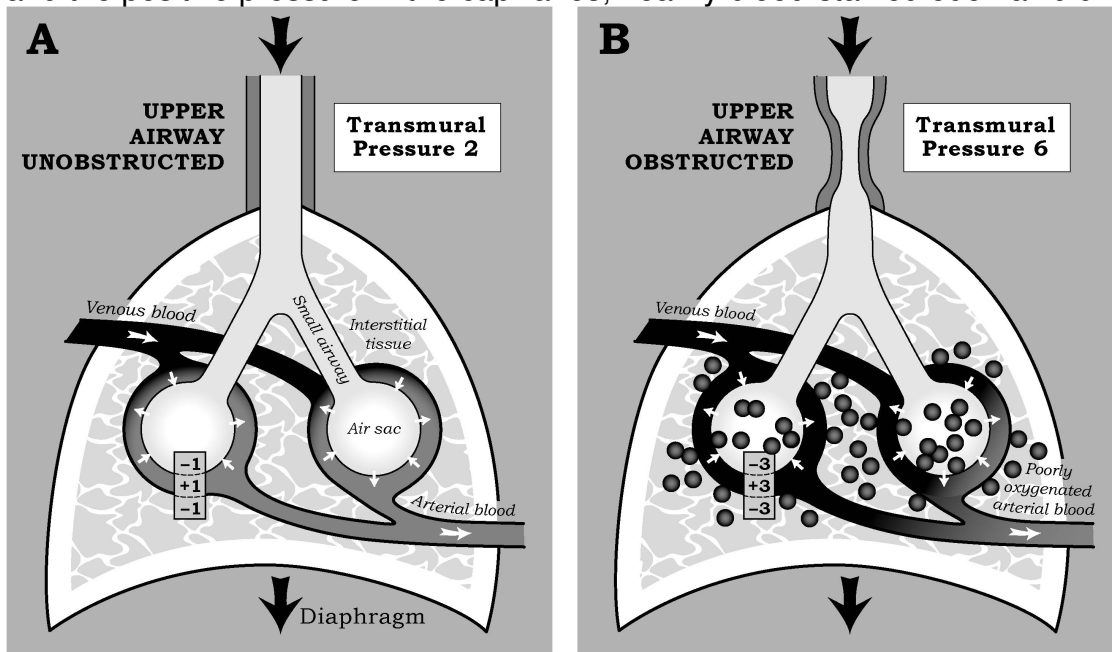


Fig 1. Showing the pressure changes that occur in the lung on inspiration, with and without obstruction of the upper airway

A: Upper airway unobstructed. In the absence of great resistance, the diaphragm draws air into the lungs easily and with minimal effort. The negative pressure generated in the air sacs is within physiological limits (say -1 ; as for the purpose of this explanation fictitious figures will be used). Similarly, pulmonary capillary pressure is also physiological (say $+1$). Under these conditions, the transmural pressure is 2. The pressure difference is not enough to suck bloodstained fluid from the capillaries into the air sacs, so normal gas exchange can take place.

B: Upper airway obstructed. Inspiratory effort has now to be increased and, as a result, the negative pressure in the air sacs is abnormally low (-3). Pulmonary congestion occurs, pulmonary edema follows and capillary pulmonary pressure rises ($+3$). Transmural pressure is now 6 and the pressure difference at the blood/air barrier sufficiently high to cause bloodstained edema fluid to be drawn into the airways. Gas exchange is poor and the horse becomes hypoxic.

gets drawn across the barrier from capillaries to air sacs. It is this edema fluid in the airways that, in my opinion, has been mistakenly referred to as 'hemorrhage'. The name I prefer for the phenomenon is asphyxia-induced pulmonary edema (AIPE)^{30,31}. In man, pulmonary edema associated with negative airway pressure

caused by upper airway obstruction is a serious complication in anesthetic practice. The complication is well recognized and known as negative pressure pulmonary edema (NPPE). It is always associated with the appearance of copious bloodstained edema fluid in the airways. To quote from an abstract on NPPE which supports the same mechanism occurring in the horse "markedly negative intrathoracic pressure due to forced inspiration against a closed upper airway (results) in transudation of fluid from pulmonary capillaries to the interstitium."³⁴

Alternative Bitless Methods of Control

The traditional bitless methods of control have an even longer history than the bit but they have not been so universally adopted. Today, they comprise use of the Hackamore, the bosal and the sidepull. But all of these have limitations and disadvantages. The primary disadvantage is that they depend on poll flexion for restraint and they work primarily by means of painful pressure across the nose. The hackamores and the bosals provide brakes^o, but are weak on steering. The mechanical hackamores have the additional disadvantage of causing pain in the chin groove and being dangerous in the wrong hands. Horses can be asphyxiated by inappropriate rein pressure producing excessive poll flexion at speed and fractures of the peak of the nasal bone also occur. Sidepulls are less painful than hackamores and are better on steering than the others but are weak on brakes.

The new bitless method of control

The new bitless bridle works on a different principle from all the bitless methods mentioned above. Essentially it controls by two loops, one over the poll (a direct continuation of the reins) and one over the nose (Fig 2). The reins cross under the chin and control is provided by the application of a gentle squeeze to the whole of the head (for stopping) or half of the head (for steering).

Braking is also effected by alternate pressure on both reins. This allows the rider to embrace the whole of the head in what can be described as a benevolent headlock. Pressure is distributed evenly over the whole of the head and the amount of pressure at any one point is slight to the point of trivial. It amounts to nothing more than a gentle squeeze. Nevertheless, this inoffensive pressure is enough to communicate the rider's wishes, supplementing the other aids of legs, seat and balance. It may be that the bridle stimulates a proprioceptive reflex by applying pressure behind the poll, and/or by stimulating a cluster of acupressure points at the poll and behind each ear. Whatever the actual mechanism, the total

^o Skilled riders will shudder at this misrepresentation of the correct use of the aids, as proper communication comes from balance, seat and legs, rather than reliance on the reins for 'brakes'. Nevertheless, the average rider and most drivers use the reins for traction.

effect seems to trigger a 'submit' response from the horse and provide effective yet non-aggressive 'brakes'. What it does not do is to inflict pain and provoke bolting.

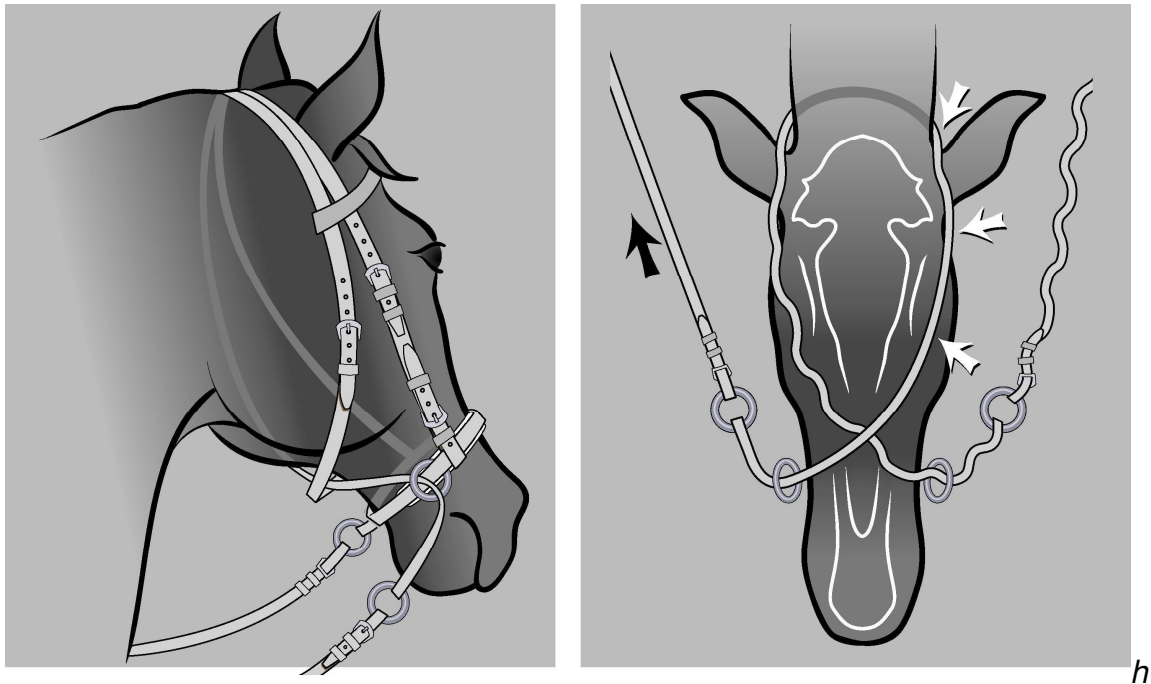


Fig 2: Showing the basic design of the new Bitless Bridle. The diagram on the right is a ventral view of the head, illustrating the manner in which the reins cross over under the chin. For steering, pressure on one rein (black arrow) applies diffuse pressure on the contralateral half of the head (white arrows) and provides an inoffensive directional aid. For stopping, alternate pressure on both reins generates a benevolent squeeze of the whole of the head and triggers a 'submit' response.

Traction on one rein (Fig 2: black arrow) pushes inoffensively on the opposite half of the head (Fig 2; white arrows) and provides excellent steering. Where the head goes, the horse follows. Because the whole of the head is involved in the response to pressure, the turn of the head is more natural than that invoked by a bit through focal pressure on the mouth. The bit pulls rostrally on a small area of highly sensitive tissues and tends to twist the head at the poll. In contrast, the new bridle pushes on a large area of relatively insensitive skin and the turning movement is more physiological, with the head remaining upright and the ears level. As horses respond better to being pushed than pulled, this is another advantage of the bridle.

A great deal more could be written about this new method of control but at this point I wish to disclose that, since 2000, I have been chairman of a company that markets the new bridle. I hope that my critique of the bit and my evaluation of

the new bridle as a contribution to the welfare of the horse will not be dismissed because of this conflict of interest. Nevertheless, for this reason, I will not expand further on the results achieved with the bridle. Rather, I will leave readers to review the online texts of the rider's reports (c. 150,000 words). Readers may now judge for themselves on the basis of evidence that, though some might regard as anecdotal, is extraordinarily compelling.

DISCUSSION

The pathophysiological effects of the bit method of control, on five body systems crucial to athletic performance, have not previously been reported. It has been widely assumed that it is physiologically acceptable to place one or more rods of metal in the horse's mouth and to use these as a method of communication.

Because the bit method of control has been in use for 6000 years, we have – as a profession - become so accustomed to its place in equitation that we have not seriously questioned its physiological or humanitarian legitimacy. The result is that no one has previously remarked on the physiologically inappropriate nature of the method. The fundamental contradiction has been overlooked because of the bit's time-honored place in history but also, it has to be admitted, because of the lack of any truly satisfactory alternative. As a result the bit method of control is basically the same as first devised in the Bronze Age. Against this long-established historical background, it is inevitable that the following conclusions about the bit are likely to be considered somewhat outrageous. Nevertheless, my summary conclusions are that the bit method of control is:

- incompatible with the welfare of the horse
- a common cause of bone spurs on the bars of the mouth
- a source of acute and chronic pain and, because of this, the cause of at least 50 different behavioral problems. The four most common of these are to instill fear (11% of 634 citations), to make the horse fight back (10%), to trigger a flight response (9%), and to cause facial neuralgia (7%)
- physiologically contra-indicated because it frequently produces a negative attitude to exercise and interferes with the freedom of breathing and striding
- frequently the initiator of an adversarial relationship between horse and rider and, therefore, destructive of the partnership that is so essential for good horsemanship
- counter-productive in terms of equine athletic performance because of the way it interferes with major body systems
- a frequent cause of upper airway obstruction. It is now my opinion that the bit is the prime cause of elevation of the soft palate, dorsal displacement of the soft palate, and epiglottal entrapment. Furthermore, it should now be considered as a cause of laryngeal stridor and asphyxia-induced pulmonary edema (pulmonary 'hemorrhage')

- a major cause of premature fatigue and, therefore, must take its share of responsibility for many musculoskeletal problems such as strained tendons, torn ligaments, joint injuries and bone fractures
- conducive to accidents and, therefore, hazardous to the health and safety of not only the horse but also the rider/driver. As a corollary to this, it was found that by removing the bit and using a new design of bitless bridle, the art and science of riding was simplified and training progress expedited

A useful therapeutic light was shed on a number of previously recalcitrant problems as a result of recognizing the pathophysiological effects that arise from placing a foreign body in the mouth of a running horse. Horses do not behave better when they are hurt and have not evolved to eat and exercise concurrently. From the recognition of these basic principles of ethology and physiology, much else follows. An explanation of the cause and, therefore, a logical guide to treatment is provided for a number of troublesome problems, the cause of which had previously been unknown or poorly understood.

For example, it is now proposed that the bit commonly causes upper airway obstruction at exercise, due to

- the ease with which it causes atlanto-occipital flexion
- stimulation of tongue movement, resulting in laryngeal movement, therefore turbulent airflow
- tongue retraction and nasopharyngeal obstruction
- its presence breaking the airtight seal of the lips and often causing a frankly open mouth at exercise, so admitting air into the oropharynx
- elevation of the soft palate and laryngeal stridor, &/or dorsal displacement of the soft palate and asphyxia
- air in the oropharynx exposing the ventral epiglottic mucosa to negative pressure on inspiration and so causing epiglottal entrapment

It follows that the bit should be considered as a differential diagnosis for recurrent laryngeal neuropathy and all other causes of upper respiratory obstruction. It is further proposed that the bit is the most frequent cause of dorsal displacement of the soft palate¹² and epiglottal entrapment.¹⁰

Evidence that I have previously published which supports the hypothesis that asphyxia-induced pulmonary edema ('bleeding') is caused by any upper airway obstruction, now gains further support.^{26-32,34} Whatever it is that causes 'bleeding' must be extremely common because 'bleeding' itself is so common. We now have another frequent cause to consider, in addition to recurrent laryngeal neuropathy. The bit causes upper airway obstruction and it follows that the bit must be considered as a common cause of 'bleeding'.

A most satisfying result was to finally uncover a convincing explanation for the head shaking syndrome and, therefore, a rational cure. It transpires that all the many and varied clinical signs which constitute the headshaking syndrome are

compatible with a bit-induced trigeminal neuralgia (tic douloureux). Such an etiological hypothesis was readily put to the test and supported by the simple expedient of removing the bit. Many headshakers responded most gratifyingly to this approach and it was certainly the most rewarding treatment for this previously recalcitrant problem that I have yet encountered. This etiological hypothesis is not really in disagreement with previous hypotheses but rather represents a unifying hypothesis.

A further result of the work was to realize that removal of the bit improved a horse's balance, took weight off the forehead, lengthened its stride, improved its gait and changed for the better a horse's whole attitude to exercise. It is reasonable to argue, as a corollary, that removal of the bit might well reduce the incidence of sore shins, foreleg lameness and breakdowns of all sorts.

A final result was the realization that removal of the bit is likely to decrease accidents to both horse and rider. A horse that can be exercised without pain, physiological confusion, or premature fatigue is less likely to stumble, fall, bolt, rear, and generate any number of other accidents or emergencies.

A review of the only three bitless methods of control that have been available until recently, draws attention to the fact that, though all of them have some merit by comparison with the bit, none of them are entirely satisfactory. The hackamore is potentially harmful to the horse and neither the hackamore nor the bosal provide good steering (lateral control).

The paper draws attention to a new method of bitless control. This is found to provide better control than the bit or existing methods of bitless control, is physiologically compatible with exercise, kinder to the horse, and safer for both horse and rider. Using the new bitless bridle, many a horse that had been classified as difficult or even dangerous to ride, became compliant and cooperative. For further articles, for information on the bridle, and for feedback on practical results from a large cross-section of owners and trainers, readers are referred to the website already cited.

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The author is currently Chairman of The Bitless Bridle Inc.

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