

## THE BREATHING BRIDLE

Scientists have to be willing to change their mind about a hypothesis if refuting evidence becomes available. This article requires that readers be willing to change any preconceived ideas they may have about the acceptability of the bit as a method of control, until they have heard the following evidence to the contrary. As the bit has been in use for over 4000 years, such a switch may be difficult. It has been said that one of the most painful things to man is a new idea. If you are currently believe that it is perfectly all right to place a bit in a horse's mouth, be aware that this chapter may be bad for your blood pressure. On the other hand, if you can keep an open mind, you may enjoy hearing about an acceptable alternative to the bit.

In the practice of traditional or what has been called *normal* horsemanship (with the customary use of the bit), man has applied his greatest force at one of the most sensitive parts of the horse...its mouth. We have grown so accustomed to the bit method of control that its major physiological disadvantages have passed unrecognized. The bit constitutes an invasive method of control, for a body cavity is violated. Admittedly, the lack of awareness of an alternative has been a factor in the bit's long acceptance but this excuse is no longer tenable for the reasons to be given. The objective of this chapter is to draw attention to the preferable alternative of what is now widely known as the school of *natural* horsemanship and the welcome fact that it is now possible to control a horse more humanely and more effectively without a bit<sup>1</sup>.

The following criticisms of the bit apply particularly to its traditional usage in *normal* horsemanship. In this mode, it is customary to use one or more bits (often of considerable severity) to govern a horse's speed by simultaneous traction (often of many pounds psi) on both reins simultaneously. Poll flexion is a significant part of control and bit pressure is often maintained over long periods. In addition, many riders use the reins as an aid to balancing in their seat.

In *natural* horsemanship, control can be achieved effectively and non-invasively, without a bit. Yes...without a bit. But, when a bit is used it is confined to a snaffle; bit pressure is transient and limited to 4 oz psi. from one rein at a time; poll flexion is minimal; and the rider has an independent seat<sup>1</sup>. Under these conditions, a bit is less harmful but still hazardous.

### JOWL ANGLE AS A SIGN OF SUFFOCATION

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<sup>1</sup> In fairness it must be conceded that the horse has, in certain parts of the world, been controlled without a bit for hundreds of years but it is only in recent years that the practicality of this approach has been shown to be available to horseman in general

The joint at the poll between the skull and the first vertebra of the neck (the atlanto-occipital joint) can be thought of as the *respiratory joint*, as its position governs airflow<sup>2</sup>. Movement of the joint is limited to flexion and extension. Its position correlates with jowl angle; the angle between the bottom line of the jaw (the horizontal ramus of the mandible) and the ventral line of the neck. Full extension corresponds to a jowl angle in the region of 140° to 150°, full flexion to about 30° and a neutral position to about 90°. The jowl angle, in turn, correlates with patency of the airway at the level of the throat. The greater the angle the more open is the airway; the smaller the angle the more restricted is the airway.

- *Full extension.* When galloping at liberty, the horse's head and neck straightens out, like a swan in flight, and the bottom line of the jaw lies almost parallel to the ground (Fig 1a and 2a).
- *Full flexion.* This position is unlikely to occur in the wild except in the resting horse, as it is only suitable for quiet breathing. The nasal bone is vertical to the ground and the nasopharynx is maximally obstructed (Fig 1b, 2d and 3c).
- *Neutral.* The position adopted when at rest with head erect and breathing slowly (Fig 2b,4a), or when walking (Fig 1a: inset).

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<sup>2</sup> The joint of the larynx that controls the position of the 'flappers' (the crico-arytenoid joint) is another such *respiratory joint*, as it controls the flow of air through the larynx but this 'flapper' joint cannot be seen with the unaided eye.

## WHAT IS WRONG WITH A BIT?

The handicaps to performance that are caused by a bit can be described under seven headings, though there is considerable interdependence of all the items:

### 1. EATING AND EXERCISING AT THE SAME TIME IS DANGEROUS

The respiratory and digestive pathways are structurally (*anatomically*) separated, except at the level of the throat (pharynx). But even here, they should be functionally (*physiologically*) separated.<sup>8,9</sup> When galloping, the larynx should be fully open and the esophagus fully closed; when swallowing, these positions are reversed (Fig 4). Nature never intended that horses should eat and exercise simultaneously, any more than nature intended that we humans should do this. Every parent knows that their child should not be allowed to run around the garden and, at the same time, eat an apple.

Yet when a bit is in place, sensory reflexes signal the horse's brain to think *eat*. Accordingly, the horse starts lip, tongue and jaw movements. Salivation is also stimulated. Now the horse is saddled and set in motion, which signals the brain to think *exercise*. In this way a physiological conflict is set up between two incompatible functions, eating and rapid breathing.

Episodes of dorsal displacement of the soft palate in racehorses are likely to result from this confusion. Racehorses at the gallop can be seen to swallow, which is not something I would expect to observe in a horse at liberty. The saliva-stimulating presence of a bit is likely to be responsible. The presence of abnormal quantities of saliva in the throat would also explain the regular occurrence of a swallowing motion as soon as a bitted horse finishes any fast work.<sup>10</sup>

### 2. A BIT CAUSES UPPER AIRWAY OBSTRUCTION

With *normal* horsemanship, the mechanism for slowing the pace or braking depends on using a bit to flex the poll<sup>3</sup>. But without poll extension, the horse is unable to breathe freely. The reduction of speed, therefore, is achieved at the expense of respiration. This restriction of breathing varies from mild or moderate poll flexion (e.g., in the rating of a racehorse) to severe poll flexion (e.g., in the collection of a dressage horse). But even mild obstruction of the airway is to be avoided in a racehorse, as it handicaps performance and causes asphyxia-induced pulmonary edema ("bleeding").<sup>2-4</sup> Similarly, the performance of a dressage horse is not facilitated by partial suffocation. It is my belief that the common and hitherto intractable phenomenon of headshaking in dressage horses may often be caused by the bit.<sup>5-8</sup>

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<sup>3</sup> The braking method employed in *natural* horsemanship is to disengage the hindquarters by lateral flexion of the neck, using one rein.<sup>1</sup>

Although the atlanto-occipital joint is capable of extension to produce a jowl angle of 150° (Fig 4b), I have yet to find an action photograph of a Thoroughbred racehorse with a jowl angle greater than 112° and most are in the region of 107° or less.

The tongue and larynx are both fixed to a scaffolding of bone called the hyoid apparatus (Fig 6). Any tongue movement results in laryngeal movement and, at fast exercise, this in itself will interfere with breathing, as the smooth contours of the airway so vital to uninterrupted airflow are disrupted during this agitation. Airway obstruction also occurs if the horse evades the bit by drawing the tip of its tongue behind the bit ( Fig 7). Some abnormal inspiratory noises at exercise can be eliminated, instantly, by the simple expedient of removing the bit. There was a time when I was of the opinion that 90% of those horses which exhibited noise on inspiration at exercise were showing signs of recurrent laryngeal neuropathy (RLN). I still believe that RLN is a common cause of noisy and difficult breathing but perhaps not to the extent of being 90% responsible. As a result of experience with the new bitless bridle, I now recognize that many breathing difficulties are caused by the bit.

The soft palate lies on the root of the tongue, any movement of which promotes upward (dorsal) displacement of the soft palate (Fig 7). It is perfectly normal for the soft palate to rise during swallowing or coughing but not during rapid breathing. For unobstructed breathing at exercise, the soft palate should be kept firmly in the lowered position, in order to maintain full patency of the throat airway (Fig 4).

If, when at racing speed (respiratory rate 120-140/min), the horse needs to swallow saliva, the soft palate rises and gets caught in the hurricane blowing through the respiratory portion of the throat (the nasopharynx). Dorsal displacement of the soft palate (DDSP) is a normal function of swallowing but not of rapid breathing (Fig 4).

If the horse resists the temptation to swallow, saliva in the digestive portion of the throat (the oropharynx) cannot flow into the esophagus because the esophagus is closed. Its only option is to flow into the larynx. Saliva, as we know, is highly irritant to the laryngeal mucosa and precipitates in us a paroxysm of coughing. In the galloping horse, if cough reflexes are initiated, the soft palate will rise, and a choking attack will follow. Alternatively, the irritation may precipitate reflex closure of the larynx (laryngospasm), which is an even more potent source of suffocation.

### 3. THE BIT INTERFERES WITH THE HORSE'S STRIDE

As already explained, a running horse should take one stride for every breath.<sup>10</sup> As breathing and striding are linked in this fashion, it follows that anything which interferes with the freedom and rhythm of breathing (such as the bit) must also interfere with the freedom and rhythm of striding. This statement is strongly supported by the simple expedient of removing the bit. Elimination of the bit does wonders for the gait of a horse, restoring in large part that grace of movement which the same horse has when at liberty<sup>4</sup>. Just as, in man, the most important part of

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<sup>4</sup> The restoration would only be complete, of course, if the rider too was eliminated

swimming is breathing so, in the horse, the most important part of running is breathing.

#### 4. A BIT CAUSES HEAVINESS ON THE FOREHAND

The point of balance (center of mass) of a standing and riderless horse lies on a vertical line just behind the 13<sup>th</sup> thoracic vertebra, that is, close to the lowest point of the back. Measurements show that, at rest, the forelegs support about two thirds of a horse's weight and the hind legs support one third. I have no knowledge of what happens to the weight distribution when the standing horse is carrying a rider but presumably the forelegs still carry the lion's share of the weight, only more so. When the horse is mounted and in motion it remains balanced (until it falls) but the distribution of weight is difficult to measure and I am not aware of any studies on this point. Presumably, the horse becomes even more (unnaturally) heavy on the forehand. The presence of one or more bits in the mouth would further contribute to this imbalance. First, the dead weight of the bits, at the distal extremity of the head, would shift the point of balance cranially. Secondly, because the horse tends to lean on a bit, this too adds weight to the forehand. As soon as the bit is removed from the mouth of a given horse, it is noticeable that the sound of its foreleg footfall softens. This can be convincingly demonstrated by listening to the soundtrack of a video taken of the same horse being ridden over the same ground on the same day, first with and then without a bit in its mouth<sup>5</sup>.

A horse that is heavy on the forehand has a shorter stride. The show horse develops a 'choppy' action and loses 'self-carriage'. In the performance horse, shorter stride means slower speed. Heavier forehand concussion puts greater stress on the hard and soft tissues of the forelegs. It follows from this that a bitted racehorse is at greater risk of breakdown than it would be without a bit..

#### 5. A BIT INTERFERES WITH ACTION

Bit control results in many horses 'resisting' or 'fighting' the bit. The degree of resistance varies from mild pulling to shoulder-aching tugging. In addition, many riders use the reins to balance themselves in the saddle. Drivers of harness horses, with lines (reins) that are 8 or 10 feet long have, if they wish, the ability to exert tremendous leverage on the horse's mouth.

- Constant drag on the bit must lead to bone ache in the mandible but also to a waste of energy in locking-up the neck muscles. This neck brace effect does not happen in the horse at liberty nor when ridden without a bit. Neither is rigidity of the neck compatible with optimum athletic performance. A horse galloping at liberty, uses the normal vertical swing of its head and neck as an aid to hind limb propulsion, conserving energy by taking advantage of the elastic recoil in the

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<sup>5</sup> It occurs to me now that the same method could be used to assess the distribution of weight of a galloping horse, with and without a rider.

strong elastic ‘rope’ (the ligamentum nuchae) that runs from the withers to the head and forms the top line of the neck.<sup>11</sup> If the normal swing of the head and neck is prevented, the horse wastes energy not only in tightening the neck muscles but also by losing the energy saving device offered by the ligamentum nuchae. No human athlete could perform well without complete freedom of the neck. Years ago, James Rooney pointed out that when Standardbred trainers employ overchecks and head poles they are causing fixation of the neck and causing ‘irregular breathing’ but also making fast exercise difficult for the horse. “Try” he said to readers “running a few hundred meters with your neck in a cast”.<sup>12</sup> The same authority writes “...it appears that the more successful racehorses have more movement of the head and neck than others.”<sup>11</sup> The gallop style of Secretariat, for example, was remarkable for its unusual degree of head/neck mobility.<sup>11</sup>

## 6. A BIT CAUSES BEHAVIORAL PROBLEMS

Non-acceptance of the bit is so common that its many forms have been given common names. Horses are described as ‘spitting the bit’, getting their ‘tongue over the bit’, getting their tongue ‘behind the bit’, ‘lolling’ their tongue, incessantly moving their tongue, chewing or champing the bit, sucking the bit, ‘getting the bit between their teeth’, pulling, boring and leaning on the bit, crossing the jaws, opening the mouth, foaming at the mouth, head tossing or head shaking. Some of these items are illustrated in figures 7 - 10. Other behavior modifications relate to many a bitted horse’s aversion to exercise and to the gait modifications already described.

Non-acceptance of the bit negates control. Acute or chronic pain inflicted by the bit, impels a horse to immobilize it by grasping it between the premolars. Once this happens, the rider has no control and the horse may bolt. Shakespeare describes it succinctly

*“The iron bit he crushes ‘tween his teeth,  
Controlling what he was controlled with.”*

In recent years, tongue movement and the ensuing DDSP has led, in Thoroughbred and Standardbred racing, to the almost routine practice in the USA of tongue-tying and the addition of yet another invasive foreign body in the mouth. Unlike Thoroughbreds, the majority of Standardbreds race with *two* bits in their mouth, a snaffle or curb and an overcheck bit. This and other reasons already mentioned may well explain why DDSP is so common in Standardbreds. It is of interest in this respect that, in January 1997, the racing authority in Switzerland banned the use of tongue ties in all racehorses.

Some instances of racetrack breakdowns, choking up, “bleeding” and sudden death are other examples of abnormal behavior attributable to use of the bit.

## 7. A BIT CAUSES ORAL AND DENTAL PROBLEMS

At exercise, a horse's lips should be sealed and mouth closed, to prevent air entering the digestive part of the throat (the oropharynx) and causing soft palate displacement. Use of a bit breaks this 'set' of the lips and often results in a frank opening of the mouth.

The mouthpiece of a bit lies in part on the tongue (if not retracted) and in part on the bars of the mouth, which is the virtually unprotected bone of the jaw. At this region, the bone is covered only by a thin but sensitive sheet of mucous membrane, with little or no 'cushion' between the mucous membrane and the bone.. Any pressure on the gums at this region is likely to be more painful than it would be to man if a human athlete was being controlled by a bar of metal applied across the shin. The various rings and shanks of the bit lie in contact with the delicate commissures of the lips which, like the gums, are richly supplied with sensory nerves. The horse has extremely sensitive lips, as demonstrated by the fastidious way in which it sorts through its food and, unlike the cow, rejects foreign bodies. The bit is, in fact, lying almost directly above a point on the side of the jaw where the sensory nerve (a branch of the Trigeminal nerve) emerges from the bone.

Prolonged pressure of bit on bone must be expected to initiate deep and lasting pain. It is possible that this source of irritation of the trigeminal nerve could be responsible for setting up a trigeminal neuralgia which, in turn, could explain much about a cause of headshaking in horses. If the bit initiated a trigeminal neuralgia (tic douloureux) this may well explain the puzzling and intractable headshaking phenomenon in many instances. It would also explain why some headshakers appear to get some comfort from a net applied over the muzzle. Tingling sensations or frank pain in the upper or lower lip may be relieved to some extent by mild pressure on the soft tissues. Headshakers are also sometimes relieved following Trigeminal neurectomy.

Bits can also cause other problems. For example, star fracture of the bars of the mouth is a well documented occurrence, as is laceration of the tongue and lips. Dental problems are numerous. A bit lies close to any wolf teeth that are present under the gum or just erupting through the gum at a point in front of the first cheek tooth. Pain is caused if the bit clashes up against or rolls over these vestigial teeth. The cheek pieces of a snaffle and curb bridle press the buccal mucosa against the sharp enamel edges of the upper cheek teeth. Buccal ulceration is common. There is also the problem of relying on a method of control that requires a bit in the mouth of an animal whose permanent dentition is erupting between the ages of two and five. Thoroughbred racehorses are at the height of their careers during this teething period.

If one asks a Thoroughbred or Standardbred trainer what percentage of horses in their barn do they expect at any one time to have mouth problems of one sort or another, the answer ranges from 20 to 60%. These and many other problems can be eliminated if, as is true, horses can be effectively controlled without a bit.

## CONCLUSION

A bit is an unyielding foreign body in a sensitive body cavity and is capable of causing pain, injury, disease and even death. A bit in the mouth of an exercising horse is physiologically contraindicated and, from the rider's point of view, counter-productive. The wonder is that all horses do not resent the bit. It is possible, however, that we may not be recognizing signs of bit discomfort in many horses. Much improvement in performance might be gained, even in a horse that is thought to be untroubled by the bit, by its removal. This step can certainly be an enormous relief, for example, to the headshaking horse<sup>6</sup>.

It takes a little study to realize that simply removing a piece of metal from a horse's mouth provides more effective and safer control; helps the horse to breathe and move better; and improves its whole attitude to work. Horses prefer bridles "with a bit missing"...they are happier.<sup>12</sup>

Riders and drivers need to be aware of the constraints that a bit places on the horse's natural functions. The less horsemen depart from what is natural, the less will they generate man-made problems for the horse and themselves. As a horse can be more safely controlled without a bit and as this brings benefits to both horse and rider, these are compelling reasons to re-evaluate the bit's time honored place in equitation.

## A NEW BITLESS BRIDLE

As has been convincingly demonstrated in recent years, the bitless option is now available by adopting the methods of *natural* horsemanship, such as those taught by the Dorrance brothers, Tom and Bill, Ray Hunt, John Lyons, Pat Parelli, Monty Roberts and others.. The option has been facilitated by the introduction of a new design for a bitless bridle<sup>6</sup>. This is not a mechanical hackamore or a bosal, both of which rely primarily, as does the bit, on poll flexion for their control. Instead the new bridle works by painless pressure on skin (Fig 11). It permits humane, effective, and non-invasive control without interfering with respiration<sup>6,7</sup>.

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<sup>6</sup> Spirit bridle (Patent pending): Spirit Horse Ltd., PO Box 2329, Ramona, CA 92065.

## SUMMARY

The use of one and often two bits, in traditional or *normal* horsemanship, constitutes a welfare problem, a hazard to health, and a handicap to performance.

- The bit method of control is invasive, physiologically contraindicated and counter-productive
- A bit often causes discomfort, pain and injury
- It can be responsible for a horse's poor attitude to exercise and many behavioral problems in all types of equitation from dressage (eg., headshaking) to racing (eg., dorsal displacement of the soft palate). Horses are happier in a bridle with a bit missing
- The bit can be the sole cause of abnormal inspiratory noise (stridor) at exercise
- To govern a horse's speed using a bit and traction on both reins depends on poll flexion, which obstructs the airway and leads to premature fatigue, poor performance, and asphyxia-induced pulmonary edema ("bleeding")
- A bit triggers digestive tract reflexes, which are physiologically opposed to rapid breathing. Horses are being expected to *eat* and *exercise* simultaneously, two activities that are mutually exclusive
- As the bit interferes with breathing and as breathing is coupled with locomotion, the bit also interferes with locomotion
- A horse that leans on the bit loses self-carriage, and becomes heavier on the forehand. Its stride becomes shorter and, therefore, slower. In addition, greater stress is placed on the tendons, ligaments, joints and bones of the forelegs. In racing, this factor coupled with fatigue, renders breakdowns and fatal accidents more likely
- Resistance to the bit causes rigidity of the neck, which is incompatible with optimum performance. Human athletes need complete freedom of their neck
- At exercise, a horse's lips should be sealed and mouth closed so that no air enters the digestive tract. A bit breaks this seal
- "Non-acceptance of the bit" includes problems such as buccal ulcers, wolf tooth sensitivity, pain during eruption of cheek teeth, star fractures of the mandible, lacerations of the lip, tongue and gingiva, open mouth, tongue movement, tongue behind the bit, tongue over the bit, 'swallowing the tongue', 'flipping the palate', headshaking, fighting the bit, chewing on the bit, 'bit between the teeth', boring, pulling and bolting
- The safety of rider and horse are imperiled when justifiable resentment of bit-induced pain, leads a horse to take the bit between its teeth and bolt

In the practice of *natural* horsemanship, horses can be controlled with a snaffle bit, or entirely without a bit. In this way, the above problems can be either minimized or solved. A new design of bitless bridle, that is neither a mechanical hackamore nor a bosal, permits control by painless pressure on skin and facilitates the humane, non-invasive and *natural* approach.

### ***Acknowledgments***

Many of the diagrams were first published in previous articles. They are reproduced by the editorial permission of the Veterinary Record, the Proceedings of the American Association of Equine Practitioners, and Equine Practice.

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## CAPTIONS

Fig 1. Showing the correlation between patency of the upper airway and the atlanto-occipital joint.

*Key:* Dense black areas = bone or cartilage; cross-hatched areas = soft tissues

a) *Full poll extension* (jowl angle 140°): The airway is fully patent (Fig 2a corresponds with this diagram). The soft tissue boundaries of the nasopharynx are stretched longitudinally, which helps them resist the otherwise collapsing force of inspiration.

*Inset:* Showing the entire airway at rest and its swan-like straightening at exercise

b) *Partial poll flexion* (jowl angle 70°): The airway is sharply bent and seriously obstructed. The soft tissues of the pharynx further collapse into the airway (see broken lines) during inspiration. This diagram corresponds to Fig 2d. If, as in dressage, the horse works with its nasal bone vertical to the ground (Fig 3c: full flexion) or, even worse, behind the vertical ('overbent'), the degree of airway obstruction would be even more severe.

Fig 2. Showing the shape of the upper airway with the atlanto-occipital joint in three different positions (a, b, & d). The nasopharynx is cross-hatched and the squares have been counted in each of the diagrams to measure the percentage reduction in sagittal section area that occurs as full extension is lost. As a measure of the logarithmic increase in airway resistance that accompanies reduction in cross-sectional area, the sagittal section area percentages grossly underestimate the problem but offer a rough reminder.

- a) *Full poll extension:* This airway corresponds to that shown in Fig 1a (jowl angle 140°). The nasopharynx is unobstructed and the area measurement is taken as representing 100%. The soft palate and epiglottis form a nearly level floor to the nasopharynx. The posterior nares are fully patent.
- b) *Neutral position of the poll:* This airway corresponds to that shown in figure 4a (jowl angle 87°). The nasopharyngeal area is 90% of what it is when fully extended. This obstruction, therefore, represents a serious handicap for a racehorse.
- c) *Neutral position DDSP;* The nasopharyngeal area is 43% of potential and severely obstructed. A bottleneck occurs at the posterior nares and leads to a cascade effect. The abnormally negative pressure on inspiration in the nasopharynx, increases further at every subsequent section of the airway between here and the lungs,. In the nasopharynx, the negative pressure can cause the soft palate to rise even further and make contact with the roof of the nasopharynx, plugging the airway completely and causing the horse to choke. In the small airways of the lungs, where the negative pressure is at its most intense, it leads to asphyxia-induced pulmonary edema and so-called 'hemorrhage'.<sup>4</sup>
- d) *Partial poll flexion:* This airway corresponds to that shown in Fig 1b (jowl angle 70°). The nasopharyngeal area is 53% and, accordingly, inspiratory resistance is much more than doubled. The diameter of each posterior nares is probably halved. The airway will be at risk for the same problems described under Fig 2c.

Fig 3. Diagrams based on photographs of bitted horses competing in three different activities. In none of the photographs are the reins slack. Considerable traction is being applied to the bars of the mouth in all three examples.

- a) *The galloping racehorse:* The angle at the jowl is  $87^\circ$ , close to the neutral position for quiet breathing (see Fig 4a & 2b). The mouth is partially open, the throat latch is creased and the 'set' of the lips is broken. The airway is significantly obstructed and the horse is being deprived of oxygen..
- b) *The show jumper:* The angle at the jowl is  $75^\circ$  and only a little better than the partially flexed position shown in Fig 1b and 2d. The throat latch is considerably creased, the mouth is ajar and the 'set' of the lips is broken. The airway is significantly obstructed and the horse is being deprived of oxygen. Many show jumpers are expected to perform with their polls even more severely flexed.
- c) *The dressage horse;* The angle of the jowl is  $33^\circ$  and the nasal bone is vertical to the ground. The degree of airway obstruction will be several stages greater than that depicted in Fig 1b. Note the multiple creases in the throat latch. Many dressage horses perform in the 'overbent' position, in which the airway obstruction is even more severe.

Fig 4. Relationship of soft palate and larynx. At exercise, the larynx should fit tightly into a 'button-hole', the ostium intrapharyngium, in the soft palate. There should be an airtight seal between the two so that no air gets into the digestive tract, i.e., the oropharynx. If it does, then the soft palate rises and starts to vibrate (Fig 8). One way in which the seal can be broken is for a horse to be given fast exercise with its poll in any position other than full extension, something which is particularly likely to occur with *normal* bit control (Fig 1b). Other ways caused by the bit include the soft palate being dorsally displaced by root of tongue mobility; by gag reflexes triggered by the bit; and by a horse opening its mouth to evade the bit.

- a). *Neutral poll position* (jowl angle  $87^\circ$ ):. Note the position of the bit in relation to the tongue and soft palate. The double-ended arrow indicates the direction of airflow.
- b). *Full poll extension* (jowl angle  $150^\circ$ ): An enlarged and perspective view of the ideal airway for galloping.

Fig 5. Showing the switching processes needed to change pharyngeal function from exercising to eating. For the sake of clarity, the mouth, oropharynx and esophagus are shown as actual spaces. However, except for those times when they contain food or liquid, these are - in normality - potential spaces only.

*Key:* OP = ostium intrapharyngium; E = epiglottis; AC = arytenoid cartilages; NP = nasopharynx; OP = oropharynx; L = larynx; SP = soft palate; LP = laryngopharynx; EP = esophageal pharynx

- a). *Exercising:* The soft palate is lowered to seal off the oropharynx and enlarge the nasopharynx. The arytenoid cartilages are raised to close the esophagus and open the larynx. The epiglottis is lowered to form a seal with the soft palate and, more than is apparent in this diagram, to smooth off airflow. The larynx now fits snugly into the button-hole of the soft palate.
- b). *Eating dry food or swallowing liquids:* The soft palate is raised to close off the nasal cavity and prevent food or water entering. The arytenoid cartilages swing down to open

the esophagus and close the larynx, so preventing food or liquid from inundating the lungs. Finally, the epiglottis swings back over the arytenoid cartilages.

Fig 6. Showing how the larynx and tongue are both suspended from the base of the skull by the hyoid apparatus. As both share a common anchorage, any movement of the tongue caused by the bit is likely to move the larynx, which interferes with breathing.

Fig 7. The pathophysiology of “swallowing the tongue”. If the tip of the tongue is retracted and comes to lie caudal to the bit, the root of the tongue pushes the soft palate dorsally (obstructing the nasopharynx) and the epiglottis caudally (obstructing the aditus laryngis). The horse chokes-up and partially asphyxiates.

Fig 8. Companion figure to Fig 4, showing the turbulent airflow that results when the soft palate becomes dorsally displaced.

a). The arrows indicate how, once the palate is raised, air enters the oropharynx at each expiration. This maintains the problem until such time as the horse can slow up and swallow.

b). An enlarged view of the throat in Fig (a), showing the soft palate button-hole in perspective.

Fig 9. Showing how dorsal displacement of the soft palate may happen when a horse opens its mouth in response to bit traction, allowing air to enter the oropharynx.

Fig 10. Showing the dorsiflexion and ventroflexion of the neck described as head tossing or head shaking.

Fig 11. The design of the new bitless bridle. The diagram bottom left is a ventral view of the head and shows how, with transient traction on one rein, firm but painless pressure can be applied to the poll, base of ear and side of face. This bridle *pushes*, non-invasively and painlessly, on skin, whereas a bit *pulls*, invasively and often painfully, on the oral cavity.