Evaluation of a method to experimentally induce colic in horses and the effects of acupuncture applied at the Guan-yuan-shu (similar to BL-21) acupoint

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Objective—To evaluate the reliability of a method for inducing colic via small intestinal distention in horses and to examine the analgesic potential of bilateral electroacupuncture (EAP) at the Guan-yuan-shu (similar to BL-21) acupoint.

Animals—5 healthy adult horses, each with a gastric cannula.

Procedure—A polyester balloon connected to an electronic barostat was introduced into the duodenum via the gastric cannula. At 2 specified intervals (before and after commencement of EAP), the balloon was inflated to a barostat-controlled pressure that induced signs of moderate colic. Each inflation was maintained for 10 minutes. Heart and respiratory rates were continuously recorded. Frequency of various clinical signs of colic was recorded by 2 trained observers during various combinations of balloon inflation and EAP. Each horse received each of 5 treatment protocols (EAP at 20 Hz, sham EAP at 20 Hz, EAP at 80 : 120 Hz dense:disperse, sham EAP at 80 : 120 Hz dense:disperse, no treatment). Sham EAP was at a point located 2 cm lateral to the Guan-yuan-shu acupoint.

Results—Duodenal distention consistently induced a significant increase in frequency of signs of colic. None of the EAP protocols caused a significant reduction in frequency of these clinical signs during distention.

Conclusions and Clinical Relevance—The method described is reproducible and highly controllable method for inducing colic that involved duodenal distention that should be useful in evaluating the efficacy of various analgesic strategies. Bilateral EAP at the Guan-yuan-shu acupoint was ineffective in reducing signs of discomfort induced by this method. (*Am J Vet Res* 2002;63:1006–1011)

Causes of colic in horses can range from simple gas colic or obstruction that is amenable to medical management to life-threatening displacements or strangulating obstructions that require surgical intervention for relief. A few horses have a condition that is analogous to irritable bowel disease in humans (ie, recurrent bouts of pain without an identifiable organic cause). Reasonably successful models for the induction of colic in conscious horses have been described whereby the large intestine or cecum is distended by a balloon inserted through an indwelling cannula,[1,2] the small intestine is blocked by use of a slipknot system that was surgically inserted a few weeks prior to the study,[3] or the stomach is distended by a balloon attached to a nasogastric tube.[4] Clearly, models that involve balloon distention are reversible, whereas the slipknot technique is not.

According to Gebhart and Ness,[5] criteria that are important when developing a model to induce visceral pain include use of animals that are not anesthetized and an experimental stimulus that mimics the natural stimulus, is minimally invasive, and is controllable, reproducible, and quantifiable. We have developed a reliable, highly controllable duodenal distention model for evoking visceral pain in horses that we believe meets these criteria. This is a noninflammatory model with the principle nociceptive effect being activation of serosal stretch receptors that would be most relevant to nonsurgical gas-type colic involving the small intestine. We believe that this model is highly suited to investigate the effect of putative analgesic treatments of horses with colic, including treatments that are within the realm of **Traditional Chinese Medicine (TCM)**.

Acupuncture, the stimulation of specified body points with needles with or without application of electrical charge, is a basic component of TCM that may be directed at amelioration of pain, presumably through physiologic modification of the pain threshold.[6-9] There are a number of reports[10-18] from Chinese literature concerning the effectiveness of acupuncture in the treatment of horses with colic; however, these reports are largely testimonial in nature and determined on the basis of experiences and subjective evaluation rather than well-controlled studies. The same applies to the few reports[19-21] that have been published in American journals. The Guan-yuan-shu acupuncture point is located at the Bladder Meridian in the depression caudal to the last rib between the longissimus and iliocostalis muscles and is analogous to acupoint BL-21 in humans. Application of **electroacupuncture (EAP)** at this acupoint has been described for treatment of horses with impaction colic of the large intestine.[12]

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The objective of the study reported here was to investigate the effect of EAP applied at the Guan-yuan-shu acupoint on visceral nociception induced by barostatically controlled balloon distention of the duodenum in horses to see whether stimulation at this acupoint could be applied to ameliorate pain arising from small intestinal problems. Two electrical stimulation variables were tested, because it has been reported that stimulation frequency can determine the specific type of opioid peptide that is released within the CNS of humans and rats.[22,23]

Materials and Methods

Animals—Five adult horses that were between 4 and 15 years old and of various breeds and both sexes were used in the study. Horses weighed between 350 and 600 kg. An indwelling silastic gastric cannula had been surgically implanted in each horse between 1 and 8 years prior to this study.[24] For 12 to 18 hours before the start of an experiment, each horse was placed in a stall and allowed access only to water. During the interval between experiments, horses were kept in an outdoor paddock and provided a diet supplemented with 0.5 kg of a grain ration (10% protein) twice daily. While in the paddock, water, mineral mix, and Bermuda grass hay were available ad libitum.

During each experiment, horses were lightly restrained in stocks. Prior to commencement of an experiment, a number of procedures were performed. A catheter with an attached polyester balloon[a] was placed via the gastric cannula into the proximal portion of the duodenum by use of endoscopic guidance. The balloon was positioned in the proximal portion of the duodenum approximately 100 cm distal to the pylorus and was used to distend the duodenum; distention was measured with a barostat.[b] Electrodes were attached to enable recording of a base-apex ECG. A respirometer was attached around the caudal portion of the thorax to enable recording of respiratory movements. All described experiments were conducted under the auspices of the University of Florida Institutional Animal Care and Use Committee.

Experimental design—Experiments were designed to evaluate a pretreatment effect on the reduction of visceral nociceptive response to distention of the proximal portion of the duodenum. The pretreatment approach for acupuncture studies has been reported elsewhere.[25,26] Furthermore, many studies for the evaluation of synthetically manufactured drugs are also designed in a similar pretreatment format, at least during the exploratory stages.

Each horse was subjected to balloon distention of the duodenum and each of 5 treatment protocols during the study. The specific treatment sequence for each horse varied. The 5 treatments were EAP at 20 Hz, sham EAP at 20 Hz, EAP at 80:120 Hz dense:disperse, sham EAP at 80:120 Hz dense:disperse, and no treatment. The active acupuncture point used was Guan-yuan-shu, which is analogous to BL-21 in humans and is located in the depression caudal to the 18th rib (between the 18th rib and the transverse process of L1) in the groove along the ventral border of the longissimus dorsi muscle. This point was selected on the basis of TCM testimony of its efficacy in alleviating signs of colic in horses.[10-14] The sham acupuncture point was located 2 cm lateral to the Guan-yuan-shu acupoint.

Acupuncture needles (0.3 $\times$ 50 mm)[c] were inserted bilaterally to a depth of 3 cm into the subcutaneous tissues, and a piece of adhesive tape was applied next to each acupuncture site. The control (ie, no treatment) application involved bilateral attachment of needles to the Guan-yuan-shu sites by use of adhesive tape without penetration of the skin. Direct electrical current was applied by use of an electronic stimulator[d] in an alternated dense-disperse wave pattern at frequencies that ranged from 80 to 120 Hz every 2 seconds or in a continuous wave pattern at 20 Hz. Signal intensity was 25 mA. There was an interval of at least 1 week between successive experiments on any given horse.

Each experiment lasted 80 minutes. Experiments began shortly after the aforementioned instrumention of a horse was completed. Once the experiment began, respiratory rate, volume and pressure of the intraduodenal balloon, and an ECG were recorded continuously at 200 Hz/channel by use of commercially available data-acquisition and storage software.[e]

Recording was begun at time = 0 minutes, and manipulations or observation of clinical signs was not conducted during the initial 25 minutes. Between 25 and 30 minutes after starting the experiment, baseline clinical signs were recorded by 2 trained observers (JAB and MLF). Each observer was unaware of the treatment received by each horse. At 30 minutes, barostatically controlled inflation of the intraduodenal balloon was initiated, starting at 20 mm Hg and increasing in increments of 5 mm Hg every 30 seconds until signs of discomfort, initially signaled by the horse becoming alert and restless, were detected by the observers. At this point, balloon pressure was held constant until 40 minutes. The balloon then was deflated. Between 30 and 45 minutes, signs of nociception were recorded as specific events by the observers. Between 45 and 50 minutes, 1 of the 5 treatment protocols described previously was initiated, and this treatment was continued until 70 minutes. At 65 minutes, the intraduodenal balloon was inflated to the same pressure as that which induced signs of colic during the initial inflation period (ie, at 30 minutes); this pressure was maintained for 10 minutes (ie, 65 to 75 minutes). Thus, the treatment protocol was applied for only the first 5 minutes of the second inflation period; inflation was continued for an additional 5 minutes after discontinuation of treatment to evaluate any possible prolongation of treatment effect. At 75 minutes, the balloon was deflated, and clinical signs were recorded by the observers for an additional 5 minutes. Thus, clinical signs were recorded from the time when treatment was begun (50 minutes) until the experiment was concluded (80 minutes). At the end of an experiment, all of the monitoring equipment was removed, the gastric cannula was closed, and the horse was returned to the paddock.

During each experiment, observers were seated in front of and slightly to 1 side of the horses; thus, they did not have a clear view of the acupuncture sites on the dorsum of each horse. In addition, the adhesive tape helped to further disguise the site of needle placement. The following accepted signs of clinical indications of visceral discomfort in horses[27] were recorded by the observers. Pawing of the floor was defined as lifting a forefoot and dropping it back to the floor with a caudal motion that drags the toe caudally. Shifting was defined as a change in weight-bearing stance from 1 hind limb to the other. Stretching of the neck was defined as a horse sticking its nose straight out and down to form a slight arch of the neck. Looking at the flank was recorded when a horse bent its neck to either side to a point at which its nose was directed toward a respective flank. Kicking at the abdomen was defined as lifting of a lower part of a hind limb above the level of the tibiotarsal joint.

Statistical analysis—Data were organized into the following 7 periods of specified durations that had **duodenal balloon inflation (INF)** with inflated (+) or not inflated (–) possibilities and EAP with applied (+) or not applied (–) conditions. Period 1 (duration, 5 minutes) was –INF and –EAP to determine baseline values; period 2 (duration, 10 minutes) was +INF and –EAP to determine effective nociceptive inflation pressure; period 3 (duration, 5 minutes) was –INF and –EAP; period 4 (duration, 15 minutes) was –INF and +EAP;

period 5 (duration, 5 minutes) was +INF and +EAP; period 6 (duration, 5 minutes) was +INF and –EAP; and period 7 (duration, 5 minutes) was –INF and –EAP.

Heart rate (HR), **respiratory rate (RR)**, and frequency of each specific clinical sign were expressed on a per-minute basis for each of the 7 periods. Data on clinical signs that were statistically analyzed included the mean value for the 2 observers.

The experiment was treated as a repeated-measures design imbedded in a randomized complete block design in which horses were the blocks, and each horse was administered all 5 treatments. The block design was used instead of a crossover design, because we did not expect carryover effects between successive treatments. Analyses were performed by use of commercially available statistical software.[f] Analyses were separated into 2 parts. The first part involved repeated-measures analysis of the first 3 periods, concerning only period effects because of the fact that there were not any treatments during these periods. Horses were treated as random effects, and period was considered a fixed effect. When period effects were detected, the least-square means were compared, and a Bonferroni adjustment also was used. For the second part, data for specific variables obtained during period 3 (–INF and –EAP) were subtracted from data for those variables in each of periods 4 through 7 to enable us to evaluate the effect of the treatment and not a mixed effect of a horse-by-treatment interaction. Again, a repeated-measures analysis was performed in which we evaluated period and treatment effects and the period-by-treatment interaction, with horses considered as random effects. Significance was designated at values of $P < 0.05$ for all comparisons.

Results

Animals—All horses remained in good health throughout the study. With regard to specific results, there was a large variability in the overall data set. One of the most obvious contributors to this variability was a wide difference among horses. Also, variability for the clinical signs depended to a certain degree on the subjective decision-making ability of the 2 observers, although the correlation of agreement between the 2 observers was acceptable (correlations were 0.7 to 0.9, depending on the specific clinical sign).

Periods 1 to 3—During the pretreatment period, inflation pressure required to induce clinical signs of nociception, most commonly indicated by shifting and looking at the flank, ranged from 25 to 45 mm Hg (mean ± SEM, 33.75 ± 1.32 mm Hg; median, 29.8 mm Hg).

Mean ± SEM values for HR and RR were summarized (**Table 1**). When the pooled data (n = 25) were compared among the first 3 periods, there was not a significant difference in HR and RR, although the mean value for both variables was increased slightly during period 2 when the intraduodenal balloon was inflated. Furthermore, the pattern of respiration changed in a consistently predictable fashion during balloon inflation, whereby the respiratory movements became noticeably shallower.

For the pooled data, frequency of the various clinical signs was significantly higher during period 2 than during periods 1 and 3 (**Fig 1 to 5**). We did not detect significant differences between values obtained during periods 1 and 3.

Periods 4 to 7—During the treatment and posttreatment periods, analysis of HR and RR did not reveal significant interaction, indicating that results for all treatments were similar over all the periods. For HR, there was not a significant treatment effect during any of the periods, but for all treatments, HR was significantly greater during period 6 than during period 7 (Table 1). For RR, there was not a significant treatment or period effect, although the RR for the treatment that involved EAP at 80 to 120 Hz was consistently lower throughout periods 4 through 7.

Significant interactions or treatment effects within a given period were not detected for any of the clinical signs (Fig 1 to 5). However, when pooled data for periods 4 to 7 were compared (n = 25), there were significant differences among periods. For all clinical signs (ie, pawing of the floor, shifting, stretching of the neck, and looking at the flank), frequency during period 6 (+INF and –EAP) was significantly greater than that during periods 4 (–INF and +EAP) and 7 (–INF and –EAP) but was not significantly different from that during period 5 (+INF and +EAP). In addition, frequency of pawing of the floor during period 4 was significantly greater than that during period 7.

Once pressure within the balloon was released after periods 2 and 6, the frequency of clinical signs

Table 1—Mean ± SEM values for heart rate (HR) and respiratory rate (RR) for 5 horses during each of 5 treatments for experimentally induced colic

Variable	Treatments*	1 (–INF:–EAP)	2 (+INF:–EAP)	3 (–INF:–EAP)	4 (–INF:+EAP)	5 (+INF:+EAP)	6 (+INF:–EAP)	7 (–INF:–EAP)
HR†								
	EAP at 20 Hz	34.04 ± 2.80	34.12 ± 2.68	36.56 ± 2.23	34.64 ± 2.12	35.40 ± 2.27	36.50 ± 1.79	34.76 ± 1.70
	Sham EAP at 20 Hz	33.36 ± 2.39	35.12 ± 3.09	34.40 ± 2.66	34.31 ± 2.69	36.50 ± 2.94	37.46 ± 3.18	32.48 ± 2.69
	EAP at 80–120 Hz	34.12 ± 1.76	34.60 ± 2.25	34.28 ± 2.05	34.46 ± 1.73	34.78 ± 2.61	35.14 ± 1.86	35.02 ± 1.71
	Sham EAP at 80–120 Hz	34.36 ± 1.41	38.28 ± 0.90	34.84 ± 0.98	36.54 ± 1.80	36.42 ± 2.05	38.30 ± 0.65	33.60 ± 1.33
	No treatment	33.96 ± 2.29	37.80 ± 3.10	36.52 ± 2.13	36.10 ± 3.00	35.27 ± 1.95	38.48 ± 2.16	35.94 ± 2.85
RR								
	EAP at 20 Hz	9.28 ± 1.60	12.00 ± 2.38	14.52 ± 3.36	12.63 ± 2.98	15.82 ± 4.16	17.33 ± 3.11	13.94 ± 1.63
	Sham EAP at 20 Hz	13.24 ± 5.01	15.12 ± 3.75	12.44 ± 3.62	12.60 ± 4.23	13.03 ± 3.30	15.58 ± 3.90	13.96 ± 3.64
	EAP at 80–120 Hz	10.88 ± 2.41	13.88 ± 2.66	11.24 ± 1.77	10.14 ± 1.82	10.29 ± 1.49	10.93 ± 1.54	10.28 ± 1.93
	Sham EAP at 80–120 Hz	9.86 ± 1.33	16.76 ± 2.78	10.84 ± 1.27	11.84 ± 3.23	13.09 ± 3.91	16.92 ± 2.15	12.04 ± 2.45
	No treatment	13.80 ± 3.56	16.96 ± 2.29	15.24 ± 4.02	15.25 ± 3.66	17.58 ± 3.58	19.38 ± 3.08	17.12 ± 3.95

*Electroacupuncture (EAP) was applied at the Guan-yuan-shu acupoint; sham EAP was applied 2 cm lateral from the Guan-yuan-shu acupoint. †Overall, HR for period 6 differed significantly ($P < 0.05$) from HR for period 7.

Inflation (INF; – indicates not inflated and + indicates inflated) of the intraduodenal balloon and application of EAP (– indicates not applied and + indicates applied) were varied as indicated throughout the 7 periods of each experiment.

that were used as nociceptive indicators decreased rapidly. There was not a significant difference in this frequency among periods 1, 3, and 7 when the balloon was not inflated.

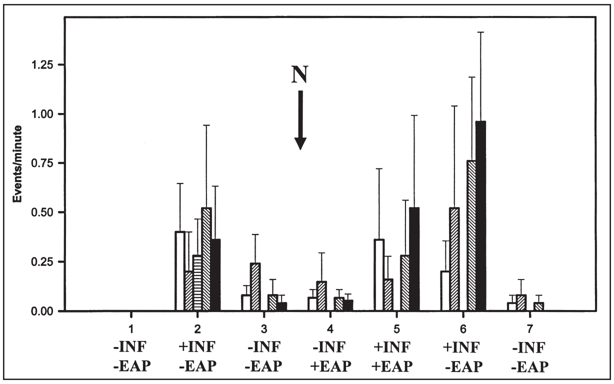

Figure 1—Mean ± SEM number of events per minute for the clinical sign pawing of the floor during each of 5 treatments for experimentally induced colic. Treatments were as follows: electroacupuncture (EAP) at 20 Hz at the Guan-yuan-shu acupoint (white column), sham EAP at 20 Hz (diagonal lines descending from right to left), EAP at 80 to 120 Hz at the Guan-yuan-shu acupoint (horizontal lines), sham EAP at 80 to 120 Hz (diagonal lines descending from left to right), and no treatment (black column). Status for inflation (INF; + indicates inflated and – indicates not inflated) and EAP (+ indicates applied and – indicates not applied) during each of the 7 time periods is indicated on the x-axis. N = Application of EAP; acupuncture needles were removed at the end of period 5.

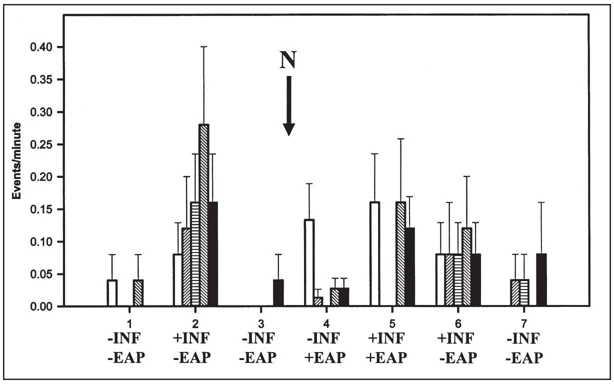

Figure 2—Mean ± SEM number of events per minute for the clinical sign kicking at the abdomen during each of 5 treatments for experimentally induced colic. *See* Figure 1 for key.

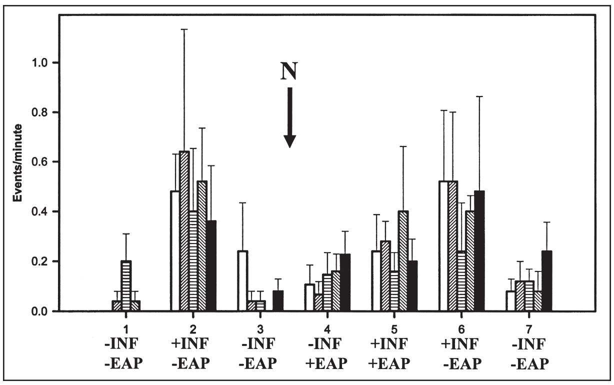

Figure 3—Mean ± SEM number of events per minute for the clinical sign stretching of the neck during each of 5 treatments for experimentally induced colic. *See* Figure 1 for key.

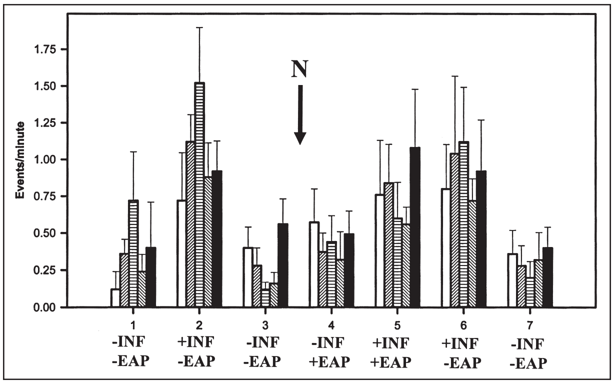

Figure 4—Mean ± SEM number of events per minute for the clinical sign shifting during each of 5 treatments for experimentally induced colic. *See* Figure 1 for key.

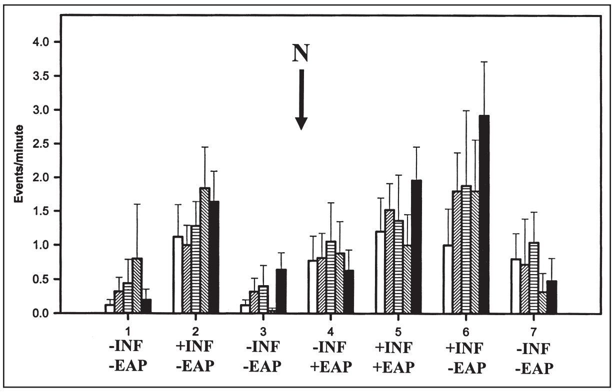

Figure 5—Mean ± SEM number of events per minute for the clinical sign looking at the flank during each of 5 treatments for experimentally induced colic. *See* Figure 1 for key.

Discussion

To our knowledge, the study reported here represents the first time that the effectiveness of a single-point acupuncture procedure for analgesia of abdominal pain in horses has been evaluated in accordance with a rigid experimental design that used sham-treated and nontreated control groups and in which the horses served as their own control animals. This was accomplished only because the method we used to induce colic was consistently reproducible with respect to signs of nociception, which was statistically verified (Fig 1 to 5). It must be emphasized that this method involved distention of a small segment (approx 20 cm) of the duodenum, thus mimicking only 1 of many potential causes of visceral pain in horses. It was somewhat surprising, however, that we did not see a clinically noticeable increase in HR during the periods when the balloon was inflated and the horses had signs of colic, because reflexive tachycardia is a common finding for other models used to induce visceral pain.[6,28]

A number of reasons could account for the fact that EAP at the Guan-yuan-shu acupoint did not have a significant effect on frequency of the recorded nociceptive signs. First, it is possible that the acupoint chosen was inappropriate for amelioration of the particular problem. Second, it is possible that the acupoint was appropriate, because it is a commonly used point for gastrointestinal conditions,[18] but the electrical stimulation was not correct. Third, it is possible that involvement of only 1 acupoint may have been insufficient with respect to the type or source of pain. Fourth, in view of the large intra-animal variability, it is possible that too few horses were included in the study to enable us to adequately evaluate the effects. We do not believe that the experimental design (with an inflation period prior to treatment) altered the responses to the second inflation, because there was not a significant difference in frequency of nociceptive signs between inflation periods for the sham-treated group.

In TCM, the most commonly used acupuncture protocol for a horse with colic is to select 4 to 8 acupoints. The reason that only 1 acupoint was used in the study reported here was to control the specificity of the approach. With regard to appropriateness of the acupoint, the Guan-yuan-shu acupoint has classically been used for the treatment of horses with mild colic.[12,17,18] We believe that the degree of abdominal discomfort that we induced in our horses could be considered mild to moderate on the basis of the clinical signs that were observed. The Guan-yuan-shu acupoint is located at the Bladder Meridian between the last intercostal space and first lumbar transverse process, which is similar to acupoint BL-21 in humans. In another controlled study,[12] investigators were not able to document successful treatment of horses with colic attributable to large intestinal impaction by use of application of EAP at acupoint Guan-yuan-shu. Interestingly, however, that report is the only 1 that specifically designates the type and site of the problem, which may have had special importance for use of the Guan-yuan-shu acupoint in horses. In another study,[17] alternative acupoints San-jiang, Jiang-ya, Er-jian and Wei-jian, which are similar to ST-2, LI-20, Tip of Ear, and Tip of Tail, respectively, were used in 306 horses with colic, and analgesic relief was provided in 284 horses. Another investigator[10] used those same acupoints to treat 943 horses with colic and reported that colic was relieved in 218 horses within 30 minutes, 230 horses within 1 hour, 295 horses within 2 hours, and 135 horses > 2 hours after treatment. In another report,[13] 57 horses with colic were treated in the same manner, and 51 had clinical resolution after treatment. Of 121 horses with colic that were treated by use of conventional acupuncture of the left Jue-yin-shu (similar to BL-13), right Du-shu (similar to BL-14), and bilateral San-jiao-shu (similar to BL-18) acupoints, all had a satisfactory outcome.[17] Eight horses with colic attributable to colonic impaction were treated by use of electric stimulation at the Er-ding (similar to TH-21) and Guan-yuan-shu acupoints for 20 minutes twice each day for 1 to 3 days; treatment relieved colic in all horses.[18] A combination of hemoacupuncture and electroacupuncture was used to treat 285 horses with colic.[14] In that study, a bleeding needle was used to bleed the acupoints San-jiang (similar to ST-2), Jiang-ya (similar to LI-20), Fen-shui (similar to GV-26), Er-jian (Tip of Ear), Wei-jian (Tip of Tail), Da-mai (Great Vessel) and Ti-tou (TH-1), and EAP was applied bilaterally to the Guan-yuan-shu acupoint. Colic in all horses resolved after the acupuncture treatments. In another report,[11] 100 horses with colic attributable to constipation were treated by use of EAP for 30 minutes at the acupoint Jian-wei (Mi-jiao-gan, similar to LI-18). Signs of abdominal pain were clinically resolved in 29 of those horses within 2 hours, 20 horses between 3 and 8 hours, and 40 horses > 8 hours after the treatment; 11 horses did not have resolution of the condition by use of this treatment. Twenty-one horses with colic attributable to colonic impaction were treated by use of EAP at the acupoint Er-men (Gate of Ear), with 16 horses responding satisfactorily, whereas 4 horses had some improvement, and 1 horse died.[15] Fire-needling acupuncture at the single acupoint Pi-shu (similar to BL-19) was used to treat 35 animals with colic (16 horses, 8 mules, and 11 cattle).[16] In that report, 14 animals clinically recovered after a single treatment, 13 clinically recovered after 2 treatments, and 8 clinically improved after 3 treatments. Finally, there have been several reports[26,29,30] concerning the use of acupuncture to control abdominal pain in humans attributable to postoperative pain or part of an irritable bowel syndrome. In those reports, investigators used acupoints such as ST-25, ST-36, LIV-3, and LI-4, rather than BL-21, which is the equivalent of the Guan-yuan-shu acupoint in horses. Thus, we cannot totally discount the possibility that EAP at only the Guan-yuan-shu acupoint was inappropriate or inadequate for the site and type of problem induced by our method.

Voltage, frequency, amplitude, and method of application of electrical charge used for EAP are extremely variable. Thus, we chose to examine 2 disparate protocols. In 1 study,[31] investigators compared analgesia resulting from low- and high-frequency EAP in mice and found that the lower frequency (4 Hz) of EAP was associated with endogenous opioid release, the effect of which was blocked by naloxone, whereas the high frequency (200 Hz) of EAP was associated with the serotonergic system. Therefore, analgesia attributable to EAP could be mediated by at least 2 pain-relieving mechanisms (ie, endorphin and nonendorphin systems). For example, in a study[32] in horses in which a noxious stimulus was directed onto the pastern to elicit the classic flexion-withdrawal reflex, with latency of the hoof withdrawal reflex as the variable used to define pain threshold, EAP stimulation of local acupuncture points at high frequency (80 to 120 Hz) was more effective than the use of distal points at low frequency (20 Hz). Therefore, acupoints close to the painful areas may need to be stimulated with high-frequency EAP, whereas those that are farther from the painful areas may require stimulation with low-frequency EAP.

When conducting such studies on conscious animals that have idiosyncratic behavior patterns and often react to duodenal distention in their own particular way, small numbers can make it difficult to attain values of $P < 0.05$ to detect significant differences, even when strong patterns in the data may be consistent with expectations. In the study reported here, the data clearly supported the effectiveness and reproducibility of the method used to induce colic but did not support a significant treatment effect for the clinical variables monitored, despite the encouraging pattern for some variables such as pawing of the floor, stretching of the neck, and kicking at the abdomen in response to the 80:120 Hz dense:disperse EAP at acupoint Guan-yuan-shu (Fig 1 to 3). Nonetheless, had we used the consistently obtainable effect of a chemical analgesic, such as xylazine hydrochloride, as the criterion-referenced standard for a desired consistent antinociceptive effect of EAP for this method of induced colic,[g] neither of the 2 protocols used for application of EAP to acupoint Guan-yuan-shu would have been considered successful.

The study reported here documented that our barostatically controlled technique for duodenal distention provided a reliable method for induction of colic in horses that can be used to evaluate various potential analgesic strategies. Regarding the alternative medicine strategy investigated here, it should be considered as a focused attempt to objectively evaluate the potential for EAP at the Guan-yuan-shu acupoint to provide relief of pain of small intestinal origin. Concerning failure of the treatment to provide significantly detectable analgesia, we regard our choice of acupoint to have been incorrect with respect to site and type of problem rather than concluding that EAP does not have a place in the management of visceral pain in horses.

[a]Commercial mylar balloon, 20 cm diameter, The New Garden, Gainesville, Fla.

[b]ISOBAR-3, G&J Electronics, Willowdale, ON, Canada.

[d]Hwato singles, Lhasa Medical Inc, Accord, Mass.

[d]Belectronic acupunctoscope, model No. 6F(57-6F), Beijing Haidian District Donghua, Beijing, China.

[e]CODAS, Dataq Instruments Inc, Akron, Ohio.

[f]SAS, version 8.01, SAS Institute Inc, Cary, NC.

[g]Merritt AM, Burrow JA, Caldwell S, et al. Development and characterization of a highly controllable equine colic model (abstr), in *Proceedings*. 6th Equine Colic Res Symp 1998;43.

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