Acupuncture and Chiropractic Care in Veterinary Medicine

Amari Anderson

Abstract

Acupuncture and chiropractic care have gained popularity in human and veterinary medicine. These two healing methods have roots ranging back thousands of years and have been employed to manage various conditions in domestic animals, often with varying outcomes. Acupuncture is thought to be a valuable pain reliever in domestic animals and can be used to treat conditions such as infertility, lameness, and seizures. Chiropractic care is typically applied to equine animals in the veterinary medicine field for musculoskeletal issues such as back pain and lameness. This paper explores the applications, effectiveness, and challenges of acupuncture and chiropractic care in veterinary medicine, highlighting the need for standardized protocols and further research in this field.

Introduction

Acupuncture is defined as the insertion of needles into defined points of the body to stimulate the body and produce a healing response by affecting certain physiological changes (International Veterinary Acupuncture Society, 2021). According to traditional Chinese medicine, *qi*, otherwise known as energy or life force, circulates throughout the body using pathways called meridians (Cantwell, 2010). Acupuncture points, or acupoints, are specific points on or near meridians that have increased bioactivity (Cantwell, 2010). Some subcategories of acupuncture, such as laser acupuncture or acupressure, may avoid the use of needles and instead opt for alternative methods to stimulate acupoints. Although acupuncture is typically used in conjunction with Western medicine, some may opt for it to replace conventional medicine. Additionally, acupuncture can serve as a treatment option as well as a preventative medicine option. Although the efficacy of acupuncture is debated among veterinary practitioners, it is considered a valid modality within veterinary medicine by the AVMA.

Chiropractic is a form of manual therapy that applies controlled force to specific anatomic locations with the intention of inducing a therapeutic response via changes in joint structure, muscle function, and neurologic reflexes (Haussler, 2000). Chiropractic care focuses on the relationship between structure (spine) and function (nervous system) (Haussler, 2000). As both a therapeutic treatment option and diagnostic technique, chiropractic involves examination techniques that can help determine if patients have chronic neck or back disorders (Haussler, 1999). Additionally, chiropractic can serve as a preventative treatment option, as it helps manage subclinical systems that may result in future musculoskeletal disorders (Haussler, 1999). In veterinary medicine, chiropractic therapy is primarily applied to equines, as companion

animals usually do not receive chiropractic treatment, and it is rare to find evidence surrounding the use of chiropractic care on companion animals.

Acupuncture and chiropractic have become increasingly popular within human and veterinary medicine. Since the two treatment options have been documented to be beneficial to humans, it is unsurprising that pet owners and veterinarians alike are interested in the possible benefits of these alternative medicine options on domesticated animals.

It's difficult to determine the true efficacy of acupuncture and chiropractic therapy. The ability to consistently predict the response that acupuncture and chiropractic can evoke from the body is extremely difficult. The effectiveness of acupuncture is primarily reliant on the technique and method used by the acupuncturist. A change in targeted acupoint, treatment frequency, and treatment duration can tremendously change the results. Additionally, descriptions of acupoints on animals may be ambiguous and vague, prompting differing results and inaccurate conclusions regarding the effectiveness of the therapy on animals. Veterinary acupuncture lacks widespread treatment protocols, leading researchers to develop treatment methods that are largely based on opinions. The chiropractic field in veterinary medicine is filled with veterinary chiropractors who are not professionally trained in veterinary medicine and/or chiropractic. This leads to improper techniques that cause more harm than good, prompting people to believe that veterinary chiropractic is not a field worth exploring. Additionally, veterinary chiropractic also lacks standardized protocols to treat certain conditions, causing practitioners to employ different techniques with varying results. These factors severely hamper the reliability of the evidence produced in the veterinary alternative medicine field, both positive and negative, causing those interested in exploring the efficacy of the field to observe conflicting results.

Acupuncture

Acupuncture can be used to treat various conditions. Pain relief or analgesia is a primary focus of veterinary acupuncture research. Although pain is typically a symptom of an existing condition, it can also cause secondary conditions or signs, such as lameness. Acupuncture can also aid in the treatment of neurological, musculoskeletal, skin, gastrointestinal, and certain reproductive disorders (International Veterinary Acupuncture Society, 2021).

Acupuncture is used differently depending on the animal species. For example, if acupuncture is used to treat musculoskeletal issues in a dog, the dog may have arthritis or a traumatic nerve injury (International Veterinary Acupuncture Society, 2021). Horses may receive acupuncture treatment for musculoskeletal problems such as a sore back or lameness. No matter the species of the animal, acupuncture can assist the body in healing itself by stimulating nerves, increasing blood circulation, relieving muscle spasms, and causing the release of hormones.

Musculoskeletal Conditions

Electroacupuncture can significantly aid the recovery of dogs with thoracolumbar intervertebral disc disease (IVDD). Dogs with IVDD who receive a mix of conventional medical treatment and electroacupuncture may experience a shorter recovery time of ambulation and pain perception compared to dogs who receive only conventional medical treatment (Hayashi et al., 2007). Similarly, paraplegic dogs with IVDD with deep pain perception may experience a higher rate of recovery, a lower amount of pain, and a decreased risk of relapse when treated with a combination of conventional medicine, electroacupuncture, and acupuncture (Han et al., 2010). Surprisingly, dogs with long-standing severe neurological disease due to IVDD that received only electroacupuncture treatment had a higher clinical success rate and shorter recovery time compared to dogs that only received conventional treatment or a combination of both electroacupuncture and conventional treatment (Joaquim et al., 2010). A case of feline multifocal intervertebral disc disease showed that cats with IVDD may also benefit from a combination of acupuncture treatment and conventional medicine (Choi and Hill, 2009). The cat received multiple acupuncture therapies (dry needle acupuncture, electroacupuncture, and scalp acupuncture) and physical therapy and exhibited significant improvements in mobility and spinal posture four months after starting acupuncture treatments (Choi and Hill, 2009). Previously severely limited in musculoskeletal functions, the cat was eventually able to rise, walk, and run after treatment (Choi and Hill, 2009). Additionally, dogs with induced spinal cord injuries who received a combination of corticosteroid and electroacupuncture experienced a shorter recovery time than dogs who were treated with only one option, further showing that acupuncture may be most therapeutically effective in conjunction with conventional medicine.

Pain Relief

Horses with chronic back pain can experience significant improvements after receiving acupuncture treatment (Rungsri, 2022). Electroacupuncture in particular is effective in relieving pain, more so than traditional acupuncture (Skarda et al., 2002). In sport horses, back pain is prevalent, and many horse owners look to alternative methods of treating the conditions. Out of 15 horses with chronic back pain who were unable to train or compete in sport at an acceptable level, 13 were able to function normally after receiving acupuncture treatment (Klide, 1984). Electroacupuncture treatment can alleviate signs of back pain in horses within 3 sessions, with a lasting effect of at least 2 weeks (Xie et al., 2005). Surprisingly, electroacupuncture may be a better treatment option for back pain than phenylbutazone, or bute, which is a non-steroidal anti-inflammatory drug commonly administered to horses exhibiting a pain response (Xie et al., 2005).

Lameness or abnormal gaits in horses can indicate that the horse is experiencing pain. Horses who receive acupuncture treatment can exhibit a significant positive change in gait, even if the horse did not have an abnormal gait beforehand (Dunkel et al., 2017). Horses who receive acupuncture treatment typically have a “better” gait and decreased lameness score, which is

typically determined subjectively, compared to horses who do not, suggesting a lower level of discomfort or pain due to acupuncture treatment (Dunkel et al., 2017). Electroacupuncture reduces lameness in horses through the release of β-endorphin, which has a pain-relieving effect on the horse (Xie et al., 2001). However, electroacupuncture treatment doesn't seem to have significant effects on horses with navicular disease or chronic laminitis (Steiss, 1989).

Electroacupuncture can significantly reduce rectal pain in the horse, with less of a clinical effect on pain relief compared to the conventional treatment of butorphanol (Skarda and Muir, 2003). Interestingly, electroacupuncture is ineffective in reducing clinical signs of discomfort in horses with induced colic, suggesting the therapy should not be used as an analgesic treatment option for horses with colic (Merritt et al., 2002).

Electroacupuncture also has the potential to act as an effective analgesic agent in sheep by affecting hormones that play a role in pain modulation (Bossut et al., 1986). Furthermore, electroacupuncture is a remarkable analgesic agent that can be the only analgesic agent during bovine surgery. Cattle stimulated by electroacupuncture in dorsal acupoints can experience systemic analgesic effects across the whole body (Kim et al., 2004).

Cardiovascular and Respiratory System

Electroacupuncture can significantly affect the cardiovascular system of dogs under anesthesia by increasing the heart rate, arterial pressure, pulse pressure, cardiac output, and stroke volume of the dogs (Lee et al., 1980). Remarkably, acupuncture has such a significant effect on the respiratory and cardiovascular system that it can restore respiration and cardiac activity to normal rates for companion animals under anesthesia who are experiencing apnoea or cardiac arrest (Janssens et al., 1979).

Interestingly, despite claims that acupuncture can affect the cardiovascular system of all domestic animals, there is limited evidence of the cardiovascular effect of acupuncture on horses. For example, anesthetized ponies appear to experience no significant change in cardiovascular function during acupuncture treatment compared to stimulation of a non-acupoint (Dill et al., 1989). Similarly, aquapuncture also does not have an effect on cardiovascular capability and function in horses (Angeli and Luna, 2008).

Neurological System

Acupuncture may act as a therapeutic option for animals who experience seizures. Results of implanting gold wire into acupuncture points for dogs with uncontrolled idiopathic seizures showed promising results (Goiz-Márquez et al., 2009). Nine of the fifteen dogs experienced a 50% reduction in seizure frequency almost 4 months after treatment (Goiz-Márquez et al., 2009). Interestingly, none of the dogs exhibited a significant change in EEG recordings (Goiz-Márquez et al., 2009).

Reproduction and Fertility

Acupuncture is known as an anecdotal therapy option for various reproduction issues in horses and cows (Schofield, 2008). Although acupuncture is typically used to improve fertility rates in dairy cows, the techniques used to increase fertility in cows are usually applied to horses as well (Lin et al., 2002). Stallions with musculoskeletal pain may experience decreased libido and a hampered ability to breed. Acupuncture treatment may aid in the pain management and relief of these stallions and improve their breeding ability. Additionally, acupuncture has been used to treat hormone-based libido and aggression issues in stallions. Older mares who have given birth more than once may receive acupuncture treatment to help improve issues related to fluid and/or urine pooling, which can increase fertility rates (Schofield, 2008). Mares that have abnormal cycles or exhibit excessive behavioral estrus issues can receive acupuncture treatment to help regulate their reproductive hormones within 2 weeks of initial treatment (Schofield, 2008). Other reproductive conditions in mares, including endometritis, retained placenta, and Cushing's disease, have also been treated with acupuncture (Schofield, 2008). However, consistent and conclusive data regarding this topic is limited, and most evidence regarding the effectiveness of acupuncture treatment for these conditions is anecdotal.

Other Conditions

Acupuncture bead treatment can control the formation of exuberant granulation tissue in equine skin wounds in specific locations, with results observed after just one session (Frauenfelder, 2008). Acupuncture bead treatment can have long-term effects on wound healing and fibrosis reduction in horses (Frauenfelder, 2008).

Preweaning diarrhea in piglets is an extremely common issue that affects production on pig farms. Acupuncture, specifically aqua-acupuncture, is a viable treatment option for the illness and significantly reduces the recovery time when compared to control groups (Lin et al., 1988). Similarly, traditional acupuncture can increase the recovery rate of preweaning pigs with induced Escherichia coli diarrhea and is more effective at controlling E. coli in the early stages compared to neomycin (Hwang and Jenkins, 1988; Park et al., 2003). Surprisingly, electroacupuncture has proven ineffective in treating preweaning diarrhea in pigs.

Chiropractic Care

Although chiropractic is a common treatment option for horses who exhibit back or neck issues, it is not a cure for every back problem (Haussler, 1999). Chiropractic also cannot reverse severe degenerative processes and pathology, although it may help manage these conditions and reduce pain in the horse (Haussler, 1999). Horses exhibiting poor performance, back or neck pain, reduced neck or back flexibility, uneven or asymmetric gaits, and pelvic asymmetry may benefit from chiropractic treatment (Haussler, 2000). Although chiropractic can produce remarkable results, it can also have dangerous side effects, including stiffness, worsening of the

condition, paralysis, injured muscles, and permanent articular damage (Haussler, 1999). However, these reactions are uncommon and typically only last for 24-48 hours.

Chiropractic is used to treat and manage musculoskeletal issues in horses, such as back pain and lameness. Although the use of chiropractic as a treatment option for musculoskeletal disorders is widespread in the equine veterinary industry, the results vary from case to case. Not every musculoskeletal issue is caused by the same condition, and the causes play a role in the treatment outcome. Horses with multi-limb lameness, for example, reap small benefits from chiropractic care but are not effectively treated by the therapy option (Maldonado et al., 2022).

Horses with clinically diagnosed back problems had a less extended thoracic back, reduced inclination of the pelvis, and improvement of the symmetry of the pelvic motion pattern after receiving chiropractic care, despite the horses not exhibiting significant changes in limb angles at the walk or trot (Alvarez et al., 2008). However, 3 weeks after the initial treatment, the horses showed a decreased range of motion even though initial observations immediately after treatment showed an increased flexion-extension range of motion. This indicates that chiropractic treatment may prompt a small, although significant, change in the musculoskeletal system of the horse for only a short amount of time, indicating that additional treatments may be needed to prompt a permanent change. Additionally, the results showed that chiropractic treatment is not effective for every musculoskeletal issue in horses.

Chiropractic treatment can also increase spinal mechanical nociceptive (MNTs), which is the minimum pressure that induces pain or a pain response (Sullivan et al., 2008). The higher the MNT, the lower the amount of pain perceived by the horse. Chiropractic treatment is a documented pain reliever that may be effective in relieving back pain in horses (Sullivan et al., 2008). However, the long-term effects of chiropractic treatment on spinal MNTs have not been documented. Combined with the knowledge from past studies that indicate chiropractic treatment may not have long-term results, chiropractic care may be most effective when repeated over time.

Conclusion

Acupuncture and chiropractic care are two developing fields in Western veterinary medicine due to an increased amount of interest in these fields. Veterinary acupuncture has shown promising results in treating various conditions of different systems. With the ability to manage seizures in dogs, proud flesh in horses, chronic back pain in horses, and act as an effective analgesic agent across species, acupuncture is clinically effective for a variety of conditions. It has also been shown that some conditions are better treated by a combination of acupuncture and conventional medicine, while others are best treated by acupuncture or conventional medicine alone. This phenomenon should be further researched and developed to provide a better understanding of acupuncture treatment in domestic animals. Despite promising

results, the efficacy and use of veterinary acupuncture are limited by the lack of protocols and techniques in the field, similar to chiropractic care. Chiropractic is an effective treatment option for back problems in horses. It may also be a therapy option that provides better results when repeated at regular intervals. Unfortunately, the veterinary chiropractic field is underdeveloped and is filled with untrained individuals who do more harm than good. Regardless of the downfalls of each field, acupuncture and chiropractic are two popular modalities in veterinary medicine that can prove to be very valuable for patient care.

Works Cited

1. International Veterinary Acupuncture Society. (2021, September 22). *What is Veterinary Acupuncture?* IVAS. https://www.ivas.org/about-ivas/what-is-veterinary-acupuncture/
2. Cantwell, S. L. (2010). Traditional Chinese Veterinary Medicine: The mechanism and management of acupuncture for Chronic pain. *Topics in Companion Animal Medicine*, *25*(1), 53–58. https://doi.org/10.1053/j.tcam.2009.10.006
3. Haussler, K. K. H. (2000). Equine Chiropractic: General Principles and Clinical Applications. In *AAEP* (Vol. 46).
4. Hayashi, A. M., Matera, J. M., & De Campos Fonseca Pinto, A. C. B. (2007). Evaluation of electroacupuncture treatment for thoracolumbar intervertebral disk disease in dogs. *Javma-journal of the American Veterinary Medical Association*, *231*(6), 913–918. https://doi.org/10.2460/javma.231.6.913
5. Han, H., Yoon, H., Kim, J., Jang, H., Lee, B., Choi, S. H., & Jeong, S. (2010). Clinical effect of additional electroacupuncture on thoracolumbar intervertebral disc herniation in 80 paraplegic dogs. *The American Journal of Chinese Medicine*, *38*(06), 1015–1025. https://doi.org/10.1142/s0192415x10008433
6. Joaquim, J. G. F., Luna, S. P. L., Brondani, J. T., Torelli, S. R., Rahal, S. C., & De Paula Freitas, F. (2010). Comparison of decompressive surgery, electroacupuncture, and decompressive surgery followed by electroacupuncture for the treatment of dogs with intervertebral disk disease with long-standing severe neurologic deficits. *Javma-journal of the American Veterinary Medical Association*, *236*(11), 1225–1229. https://doi.org/10.2460/javma.236.11.1225

7. Choi, K. H., & Hill, S. A. (2009). Acupuncture treatment for feline multifocal intervertebral disc disease. *Journal of Feline Medicine and Surgery*, *11*(8), 706–710. https://doi.org/10.1016/j.jfms.2008.11.013
8. Rungsri, P. R. D. (2022, January 17). *The Effectiveness of Electro-acupuncture on Pain Threshold in Sport Horses with Back Pain*. American Journal of Traditional Chinese Veterinary Medicine. https://ajtcvm.org/downloads/the-effectiveness-of-electro-acupuncture-on-pain-threshold-in-sport-horses-with-back-pain/#:~:text=After%205%20treatments%2C%20pressure%20induced%20pain%20was%20significantly,EA%20and%20rest%20over%20a%2015%20day%20period
9. Klide, A. M. (1984). ACUPUNCTURE FOR TREATMENT OF CHRONIC BACK PAIN IN THE HORSE. *Acupuncture & Electro-therapeutics Research*, *9*(1), 57–70. https://doi.org/10.3727/036012984816714848
10. Skarda, R., Tejwani, G. A., & Muir, W. W. (2002). Cutaneous analgesia, hemodynamic and respiratory effects, and β-endorphin concentration in spinal fluid and plasma of horses after acupuncture and electroacupuncture. *American Journal of Veterinary Research*, *63*(10), 1435–1442. https://doi.org/10.2460/ajvr.2002.63.1435
11. Xie, H., Colahan, P. T., & Ott, E. A. (2005). Evaluation of electroacupuncture treatment of horses with signs of chronic thoracolumbar pain. *Javma-journal of the American Veterinary Medical Association*, *227*(2), 281–286. https://doi.org/10.2460/javma.2005.227.281
12. Dunkel, B., Pfau, T., Fiske-Jackson, A., Veres-Nyéki, K., Fairhurst, H., Jackson, K., Chang, Y., & Bolt, D. M. (2017). A pilot study of the effects of acupuncture treatment on

objective and subjective gait parameters in horses. *Veterinary Anaesthesia and Analgesia*, *44*(1), 154–162. https://doi.org/10.1111/vaa.12373

13. Xie, H. X., Ott, E. A. O., & Colahan, P. C. (2001). *Influence of Acupuncture on Experimental Lameness in Horses* (Vol. 47). AAEP Proceedings.
14. Steiss, J. E. (1989, April 1). *Electroacupuncture in the treatment of chronic lameness in horses and ponies: a controlled clinical trial.* PubMed Central (PMC). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1255553/
15. Skarda, R., & Muir, W. W. (2003). Comparison of electroacupuncture and butorphanol on respiratory and cardiovascular effects and rectal pain threshold after controlled rectal distention in mares. *American Journal of Veterinary Research*, *64*(2), 137–144. https://doi.org/10.2460/ajvr.2003.64.137
16. Merritt, A. M., Xie, H., Lester, G. D., Burrow, J. A., Lorenzo-Figueras, M., & Mahfoud, Z. (2002). 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. *American Journal of Veterinary Research*, *63*(7), 1006–1011. https://doi.org/10.2460/ajvr.2002.63.1006
17. Bossut, D., Stromberg, M., & Malven, P. (1986). Electroacupuncture-induced analgesia in sheep: measurement of cutaneous pain thresholds and plasma concentrations of prolactin and beta-endorphin immunoreactivity. *American Journal of Veterinary Research*. https://europepmc.org/article/med/2938527
18. Kim, D., Cho, S., Song, K., Lee, S., Lee, S., Kwon, G., Kim, I., Kim, Y., Cho, J., Kwon, Y., & Kim, J. (2004). Electroacupuncture analgesia for surgery in cattle. *The American Journal of Chinese Medicine*, *32*(01), 131–140. https://doi.org/10.1142/s0192415x0400176x

19. Lee, D. C., Lee, M. O., & Clifford, D. H. (1980). Comparison of sodium salicylate, morhine sulfate, and acupuncture at Jen-Chung (GO-26) on the cardiovascular system of dogs. *The American Journal of Chinese Medicine*, *08*(03), 245–253. https://doi.org/10.1142/s0192415x80000219
20. Janssens, L. a. A., Altman, S. D., & Rogers, P. a. M. (1979). Respiratory and cardiac arrest under general anaesthesia: treatment by acupuncture of the nasal philtrum. *Veterinary Record*, *105*(12), 273–276. https://doi.org/10.1136/vr.105.12.273
21. Dill, S., Gleed, R., Matthews, N., & Erb, H. (1988). Cardiovascular effects of acupuncture stimulation at point Governing Vessel 26 in halothane-anesthetized ponies. *American Journal of Veterinary Research*. https://europepmc.org/article/med/3189985
22. Angeli, A. L., & Luna, S. P. L. (2008). Aquapuncture improves metabolic capacity in thoroughbred horses. *Journal of Equine Veterinary Science*, *28*(9), 525–531. https://doi.org/10.1016/j.jevs.2008.07.023
23. Goiz-Márquez, G., Caballero, S. Z., Solís, H., De La Cruz Rodríguez, C., & López, H. S. (2009). Electroencephalographic evaluation of gold wire implants inserted in acupuncture points in dogs with epileptic seizures. *Research in Veterinary Science*, *86*(1), 152–161. https://doi.org/10.1016/j.rvsc.2008.05.019
24. Schofield, W. (2008). Use of acupuncture in equine reproduction. *Theriogenology*, *70*(3), 430–434. https://doi.org/10.1016/j.theriogenology.2008.05.001
25. Lin, J. H., Wu, L., Wu, Y. L., Lin, C., & Yang, N. (2002). Aquapuncture therapy of repeat breeding in dairy cattle. *The American Journal of Chinese Medicine*, *30*(02n03), 397–404. https://doi.org/10.1142/s0192415x02000296

26. Frauenfelder, H. (2008). The use of acupuncture beads to control exuberant granulation tissue in equine skin wounds: A preliminary study. *Equine Veterinary Education*, *20*(11), 587–595. https://doi.org/10.2746/095777308x374703
27. Lin, J., Lo, Y., Shu, N., Wang, J., Kung, S., & Chan, W. W. (1988). Control of preweaning diarrhea in piglets by acupunture and Chinese medicine. *The American Journal of Chinese Medicine*, *16*(01n02), 75–80. https://doi.org/10.1142/s0192415x88000121
28. Hwang, Y., & Jenkins, E. (1988). Effect of acupuncture on young pigs with induced enteropathogenic Escherichia coli diarrhea. *American Journal of Veterinary Research*. https://europepmc.org/article/med/3066247
29. Park, E. S., Jo, S., Seong, J. K., Nam, T. C., Yang, I., Choi, M., & Yoon, Y. S. (2003). Effect of Acupuncture in the Treatment of Young Pigs with Induced Escherichia coli Diarrhea. *Journal of Veterinary Science*. https://doi.org/10.4142/jvs.2003.4.2.125
30. Haussler, K. K. (1999). Chiropractic evaluation and management. *Veterinary Clinics of North America-equine Practice*, *15*(1), 195–209. https://doi.org/10.1016/s0749-0739(17)30172-4
31. Maldonado, M. D., Parkinson, S. D., Story, M., & Haussler, K. K. (2022). The effect of chiropractic treatment on limb lameness and concurrent axial skeleton pain and dysfunction in horses. *Animals*, *12*(20), 2845. https://doi.org/10.3390/ani12202845
32. Alvarez, C. G., L'ami, J., Moffat, D. A., Back, W., & Van Weeren, P. (2008). Effect of chiropractic manipulations on the kinematics of back and limbs in horses with clinically diagnosed back problems. *Equine Veterinary Journal*, *40*(2), 153–159. https://doi.org/10.2746/042516408x250292

33. Sullivan, K. A., Hill, A. E., & Haussler, K. K. (2008). The effects of chiropractic, massage and phenylbutazone on spinal mechanical nociceptive thresholds in horses without clinical signs. *Equine Veterinary Journal*, *40*(1), 14–20. https://doi.org/10.2746/042516407x240456