

# Tutorial Article

## Acupuncture and 'traditional Chinese medicine' in the horse. Part 2: A scientific overview

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### Introduction

Of all the modalities covered under the umbrella of 'alternative' medicine, including veterinary medicine, acupuncture is perhaps the most extensively investigated. Myriad acupuncture studies can be accessed on search engines, such as Medline, but unfortunately only a small minority of those studies pertains to acupuncture treatment of horses. As a result, any review attempting an overview of equine acupuncture must necessarily refer to studies in other species in any attempt to draw conclusions about the therapy. However, when viewed in such a light, acupuncture does not appear to have significant clinical indications in equine therapy at this time.

### Acupuncture research

#### Human

Acupuncture has been assessed in hundreds of published comparative trials involving thousands of human patients in a variety of situations. The most common indication for the use of acupuncture in man has been for the relief of pain (interestingly, acupuncture analgesia is an invention of the late 1950s) (Hsu 1996). Unfortunately, most acupuncture trials in man are handicapped by their poor methodological quality. In addition, studies of the therapeutic utility of human acupuncture are fraught with methodological difficulties, including the choice of placebo, suitable control treatment and type of acupuncture applied. Over 30 years of active acupuncture research through the last part of the 20th century have failed to unequivocally demonstrate its clinical efficacy in human medicine (Moroz 1999).

Acupuncture appears to have some effect in the treatment of post operative human nausea (but not vomiting) (Lee and Done 2004). Unfortunately, the practical implications of these results may be limited, most notably because any number of treatment methods - needle insertion, finger pressure, wristbands, capsicum plaster or electrical stimulation - have been used to stimulate various points, which occur at

disparate locations. The fact that a variety of apparently unrelated interventions at different spots have achieved reported success suggests nonspecific and/or psychological factors (an important component of vomiting in people) are at work. Such factors have been also demonstrated in human pain research (Kalauokalani *et al.* 2001a). For example, in one study, although no statistically significant analgesic effect was observed between the acupuncture and placebo groups, participants in both groups who believed they received real acupuncture reported significantly less pain than patients who believed that they received a placebo; i.e. patients' beliefs regarding the receipt of acupuncture bore a stronger relationship to pain than any specific action possessed by acupuncture (Bausell *et al.* 2005). Almost certainly, such preconceived notions of efficacy would also affect anecdotal reports of acupuncture success in horses.

Unfortunately, in positive reports which exist on use of acupuncture for prevention of nausea and vomiting and treatment of migraine and headache, another condition for which there are some reports of efficacy (Vickers *et al.* 2004), researchers have sometimes failed to report important clinical details, or found effects only in selected subgroups, rendering readers of such reports largely unable to critically appraise them from a clinical standpoint. Furthermore, the design of those reports is such that they preclude potential reviewers from establishing valid conclusions about the usefulness of acupuncture for such conditions (Elorriaga *et al.* 2003). For the treatment of addictions such as alcohol or cocaine dependence, for post stroke rehabilitation, better quality clinical trials have failed to demonstrate efficacy for acupuncture (Rabinstein and Schulman 2003). For most of the remaining conditions for which it is used, such as for human back pain (Cherkin *et al.* 2003; Furlan *et al.* 2005), it is either impossible to draw conclusions about efficacy due to conflicting or poor quality data, or the conclusions are negative (Mayer 2000; Anon 2001; Ramey and Sampson 2001; Rabinstein and Schulman 2003; Birch *et al.* 2004).

In other areas for which acupuncture was previously advocated, such as for surgical anaesthesia, the use of acupuncture has been largely abandoned even in China

(Nishimura 2002). Published reports from surgeons in China forced to operate on human patients given only acupuncture anaesthesia illustrate this point. For example, on 22 October 1980, a report in the Chinese newspaper *Wen-hui-pao* reported the results of over 30,000 human operations conducted under acupuncture anaesthesia. Noting the political pressure on surgeons to use the technique, the authors noted:

*"If we apply these standards [safety, effectiveness, predictability, etc.] to an assessment of acupuncture anaesthesia then, first of all, it cannot achieve absence of pain or basic absence of pain. This is acknowledged in all treatises dealing with acupuncture anaesthesia, stated in common language, the suppression of pain is incomplete. The patient undergoes surgery in a state of full consciousness."* (His-chen and Nai-huang 1985)

Given the safety, effectiveness and reliability of local and general anaesthetic techniques, there is good reason to question why acupuncture was ever considered as a realistic option for modern anaesthesia.

## Equine

Public attention has been focused on acupuncture as a possible therapeutic intervention for their horses by the media, and veterinary interest has arisen primarily from books, uncritical presentations and publications on the subject. Therefore, in addition to practitioner curiosity about novel therapies, there appears to have been some degree of owner demand for it. However, evidence of the clinical efficacy of acupuncture from scientific trials in treating any clinical condition in any animal species is virtually nonexistent (Scott 2001). Instead, most veterinary studies on acupuncture are reported as case series.

The veterinary literature is remarkable for the number of conditions for which acupuncture has been advocated. However, it is just as remarkable that virtually all of those reports are based on uncontrolled observations. As a result, there is often a disconnection between these observations and the results of clinical studies. For example, whereas acupuncture may be advocated in the treatment of idiopathic headshaking in horses, owner surveys have indicated that acupuncture is of limited use in its treatment (Madigan and Bell 2001). Similarly, although acupuncture may be recommended for the treatment of horses with recurrent airway obstruction, a single acupuncture treatment causes no more improvement in lung function than does handling the horse (Wilson *et al.* 2004).

In particular, much research on acupuncture in animals pertains to pain modulation. Again, although acupuncture has been advocated in equine pain management (Gaynor 2000), controlled trials in lame horses and ponies (Steiss *et al.* 1989), and those with experimentally induced colic pain (Merritt *et al.* 2002) or laminitis (D. Hood, personal communication) have not supported its use. In fact, the purported pain-relieving effects of acupuncture, when they occur, may only represent

short-term hypalgesia, which is probably brought about by the mechanisms underlying stress-induced analgesia (Flor and Grusser 1999) and/or the activation of diffuse noxious inhibitory controls (Bing *et al.* 1990) (whereby a noxious stimulus at one site interferes with the perception of pain at another site).

Veterinary investigations of acupuncture are few compared to the human field. The only attempt at a systematic review of acupuncture completed in animals to date was conducted in horses (Ramey *et al.* 2001a). The authors found that western equine acupuncture literature on whether acupuncture is considered for diagnostic or therapeutic purposes does not focus on quantitative analyses and rarely fits any of the relevant criteria considered necessary for a good scientific investigation. Protocols such as randomisation, blinding and control groups, typical of quality studies, are lacking in virtually every published paper in the field (with a few exceptions). In general, equine acupuncture studies are quite small and vary in their endpoints, making a pooling of results impossible. Many publications on equine acupuncture are not clinical trials; rather, they evaluate such things as hormonal responses to needling or the diagnostic utility, or effects, of drugs placed at putative acupuncture points. With those caveats, the review concluded that investigations into equine acupuncture published in western language veterinary literature conducted under generally accepted criteria for good quality scientific investigations, do not favour use of the technique (Ramey *et al.* 2001a).

In addition to the western language literature, there is a body of 'eastern' literature pertaining to acupuncture in horses (from China and other east Asian countries). Such literature is not easily accessible and frequently not published in English (Yu 1984). The results of such studies are almost uniformly positive. However, it should be recognised that essentially none of this literature meets the criteria established for scientific quality; rather, it is most commonly uncontrolled case reports. The poor quality of the eastern language veterinary literature parallels conclusions regarding published information on Chinese studies in human medicine. For example, in a review of randomised controlled trials of traditional Chinese medicine (Tang *et al.* 1999), the method of randomisation was often described inappropriately. Blinding was used in only 15% of trials, trials were inhibited by small sample sizes and lack of controls and the long-term outcomes were not reported. Data pertaining to effectiveness was rarely expressed and reported quantitatively. Most trials claimed that the tested treatments were effective, which is in accordance with a previous report indicating that 99% of clinical reports from China (and 100% of reports on acupuncture) over a 30-year period were positive (Vickers *et al.* 1998). Rather than indicating the effectiveness of treatments, the high success rates in Chinese medical, and presumably veterinary, literature indicates that publication bias may be common.

Curiously, almost none of the studies performed in horses have evaluated filiform needle acupuncture; rather, they have looked at electrical stimulation of putative acupuncture points ('electroacupuncture') (Xie *et al.* 2001). This is consistent with

the majority of acupuncture research performed in the veterinary field (Carlsson 2002). One problem with such studies is that control nonacupuncture points are almost never used; therefore, it is essentially impossible to separate effects that may be due to interventions at putative acupuncture points from simple nonspecific responses to an electrical stimulus. Therefore, it is entirely reasonable to consider that such clinical or chemical effects may not relate to precise placement of needles at all, questions of efficacy notwithstanding.

For scientific results to be validated, replication of results is important. Unfortunately, such good quality papers as exist in equine acupuncture fail to provide consistent results when studies have been conducted attempting to replicate previously obtained data. For example, whereas one study of 9 horses in which electroacupuncture stimulation of placebo (distant from the acupuncture site), control (one vertebral space in front of or behind the point) or 'real' acupuncture points showed a decrease in plasma cortisol levels for 1 to 2 h post treatment compared with sham treatment points (Glaridon 1988), another study of 15 horses showed an increase in plasma cortisol levels when comparing 'real' to sham (nonacupuncture point) treatment (Cheng *et al.* 1980). Similarly, another well-conducted investigation did not show any effect of low-dose prostaglandin derivatives administered at lumbar acupuncture points (Nie *et al.* 2001) and therefore failed to replicate a previously reported study (Alvarenga *et al.* 1998).

The poor design of veterinary acupuncture studies is consistent with evaluations of other 'alternative' modalities in human medicine (Linde *et al.* 2001). There are exceptions, but as in human medicine, the best studies are least likely to show positive results. Therefore, given the general poor quality of equine acupuncture studies, there is at least the possibility that erroneous conclusions can be drawn about the value of equine acupuncture from taking poor quality studies or anecdotal reports of the 'success' of acupuncture at face value.

## Points and meridians

Research on the nature of acupuncture points and the channels along which those points are supposedly connected ('meridians') is often difficult to evaluate. This is due to the diverse nature of the claims made, the fact that incomplete data are often provided in published studies, and that there are a variety of parameters involved in the assessment of claims regarding such structures.

Obvious contradictions exist between current acupuncture practice and that described in the historical record (Panzer 1993). In addition, there appears to be little agreement on the 'correct' number of points and meridians among modern practitioners of both veterinary and human acupuncture. Furthermore, if one traces the historical record, points and meridians in human medicine have apparently moved over the centuries and both increased and decreased in number (i.e. different sources show different points, as well as numbers and location of meridians).

As anatomical entities, acupuncture points may be located in the vicinity of peripheral nerves, ligaments or tendons

(Dung 1984). However, there is no consistent association with any one specific gross anatomical structure. Several investigators have reported various histological findings at acupuncture points, such as nerve terminals, neurovascular bundles or mast cell accumulations; however, none of the studies used statistical evaluation of quantitative histological data to confirm the significance of their findings (Langevin and Vaillancourt 1999).

No method of determining acupuncture point locations has yet been shown to be precise, or repeatable. Electrical skin resistance, which can be detected by various devices, has been shown to be an inaccurate and unreliable method of locating acupuncture points and is influenced by factors such as the shape and surface area of the electrode, dryness of the skin, local variations in skin thickness, surface secretions, pressure placed on the electrode, inclination of the electrode, electrode gel used, scanning speed of the device, and even room temperature and humidity (Noordergraaf and Silage 1973; Yamamoto and Yamamoto 1977; Yamamoto *et al.* 1988; Cho and Chun 1994; Kwok *et al.* 1998; Hot *et al.* 1999).

Traditional methods of measuring to determine acupuncture point location in man rely on the *cun* unit, said to be equal to the width of the interphalangeal joint of the human thumb. However, this method, subject to individual anatomical variation, has also been shown to be unreliable (Coyle *et al.* 2000). Acupuncture points have failed to demonstrate sensitivity to palpation relative to other points on the human body; therefore, relying on point sensitivity as the sole form of point location is likely to be of dubious utility (Aird *et al.* 2000). Finally, directional and proportional methods for measuring acupuncture point locations - the most widely used methods for locating acupuncture points in man - have also been shown to be grossly imprecise (Aird *et al.* 2002). Such problems in point location have led Felix Mann, a cofounder of the British Acupuncture Society, to conclude that neither acupuncture points nor meridians exist and observe that, if modern human acupuncture texts are to be believed, there is no skin left which is not an acupuncture point (Mann 1998).

Further muddying the empirical waters is the fact that some types of acupuncture do not use a traditional theoretical basis. There are literally dozens of 'systems' of human acupuncture, as well as myriad approaches to using needles within those systems (Campbelle 1998). In some of these approaches, e.g. 'western' acupuncture, needle placement may be unrelated to the presence or absence of actual anatomical acupuncture point entities. The irrelevance of specific points for any effects of acupuncture is underscored by the fact that most studies that have compared 'sham' and 'real' acupuncture points have been unable to show a consistent difference in response to manipulation between sites (Sanchez-Aranjo 1998). In that same vein, similar efficacy has been asserted between 'traditional' and 'transpositional' points in horses (Panzer 1993) (i.e. points transposed onto horses from human acupuncture charts).

From a pragmatic standpoint, one might surmise that, if structures such as acupuncture points and meridians did exist and could reliably be demonstrated, they would be recognised

in the study of anatomy and physiology; however, no such recognition has been forthcoming to date. Whatever the clinical efficacy of needling, there is as yet no compelling evidence to show that acupuncture points or meridians exist as discrete entities (Ernst 1997; Ramey and Buell 2000).

### Mechanism of action

It should come as no surprise to anyone with an education in basic physiology that inserting needles into a body will invoke some sort of a physiological response. Although most animal studies have demonstrated some physiological response to needle insertion, the clinical relevance of such effects remains questionable.

In man, functional MRI studies, which measure increased oxygen uptake in areas of the brain, have suggested that the brain is aware when a needle has been placed in the body. However, such studies have generally failed to demonstrate that this response is specific, i.e. that the points stimulated with acupuncture needles correlate to those areas of the brain said to be influenced by those points (Hui *et al.* 2000; Li *et al.* 2003). The erythema and inflammation that result from needle insertion are not unique to acupuncture points, and human patients report identical sensations whether 'real' or 'sham' acupuncture points are used (Vincent *et al.* 1989). The distribution of the effects of acupuncture on pressure pain threshold does not support either neural segmental or traditional Chinese medicine channel theories, and needling nonacupoints leads to statistically significant increases in pain pressure threshold at 6 sites when needles are manipulated (Zaslowski *et al.* 2003). Finally, identical, transient, quick reflex responses of the sympathetic nervous system have been observed whether 'real' or 'sham' points are needled (Suter and Kistler 1999).

Purported scientific mechanisms of action for acupuncture generally involve suggestions that the procedure elevates circulating levels of various neurochemicals, especially endorphins ('endogenous opiates'). While elevations in endorphins are certainly associated with some acupuncture investigations, such an explanation is not convincing. Endorphins have a very short half-life and should not be responsible for the prolonged effects claimed by acupuncture proponents; endorphin levels in human serum have a half-life of around 22 mins (Iranmanesh *et al.* 1993), while those in the human CNS persist for approximately 317 mins and are of limited use in managing chronic human cancer pain under any circumstances (Max *et al.* 1985). Furthermore, fine needle acupuncture is not associated with rises in CNS endorphins in horses and neither fine needle acupuncture nor electroacupuncture elevations in opiates in either the CNS or plasma correlate with cutaneous analgesia (Bossut *et al.* 1983; Skarda *et al.* 2002). Further confusing the picture is the fact that endorphins may rise due to any number of stimuli. Stress, running and shipping may elevate plasma endorphins in horses (Li and Chen 1987). Endorphins are also credited for placebo analgesia responses (ter Riet *et al.* 1998). Other measured hormonal changes attributed to acupuncture do not appear to have any obvious clinical relevance.

Numerous plausible, and simpler, explanations for the 'effects' of acupuncture exist, including owner expectation (Kalaoukalani *et al.* 2001a), stress-induced analgesia, counter-irritation (Levine *et al.* 1976) and operant conditioning, as well as the diffuse noxious inhibitory stimulus; for example, while one study found that acupuncture suppressed the pain response to a cutaneous prick or electrical stimulation of a rat's tail, a simple pinch of the tail caused the most effective suppression (Murase and Kawakita 2000).

Other potential mechanisms of action of acupuncture-related therapies are perhaps not so surprising. For example, electroacupuncture has been shown to provide mild rectal analgesia in an experimental model in horses (although less than that provided by butorphanol) (Skarda *et al.* 2002). However, there is absolutely no reason to believe that the effects seen have anything to do with 'acupuncture,' given that precise needle placement was not shown to be important (i.e. the study lacked a sham control) and that electrical stimulation was involved. Indeed, such therapies as transcutaneous electrical nerve stimulation employ electricity for pain management (Rushton 2002) (albeit with conflicting results). Furthermore, there is reason to doubt that even needle skin penetration is important when using electrical stimuli in efforts to control pain; variants of electroacupuncture exist using skin patch electrodes, and identical clinical effectiveness is claimed (Ulett *et al.* 1998).

### Acupuncture diagnosis

Palpation of putative acupuncture points has also been used diagnostically. Such diagnostic attempts have not stood up to scrutiny. In human patients with chronic low back pain, there is certainly no consistency in diagnosis (or treatment), even when different acupuncturists evaluate the same patient (Kalaoukalani *et al.* 2001b). In man, palpation of a particular acupuncture point on the right leg was not found to be useful in the diagnosis of appendicitis (Alt-Epping *et al.* 2002). Palpation of the point considered most diagnostic for equine protozoal myelitis was considered poor when compared with diagnosis by conventional diagnostic methods (Fenger *et al.* 1997). Finally, the use of an 'acupuncture meridian test' was unable to confirm that horses with 'decreased performance' had either equine herpesvirus *type 1* or *type 4* infections, based on comparison of control and subject serological data, even though subjects were diagnosed with the viruses by point palpation (Chvala *et al.* 2004).

### Safety

Although reviews suggest that acupuncture is largely safe (Ernst *et al.* 2003), the complications of acupuncture, although infrequently reported, cannot be overlooked. In man, reported complications include infections (mainly hepatitis) and organ, tissue and nerve injury (Sato *et al.* 2003). Adverse effects in man include cutaneous disorders (Woo *et al.* 2003), hypotension, fainting and vomiting (Lao *et al.* 2003). In one prospective survey, the rate of adverse events

associated with human acupuncture was 107/1000, of which the most common were severe tiredness and exhaustion, pain at the site of needling, and headache (Macpherson *et al.* 2004). Complications can occasionally be severe, especially regarding infections related to nonsterile needles, as well as pneumothorax from inappropriate placement of needles in the thoracic region, and even needle migration into the *medulla oblongata* (Hama and Kaji 2004). However, most of these risks might be avoided by the use of more rigorous techniques and, in general, the risks of acupuncture do not appear to be considerable (Macpherson *et al.* 2001). In horses, adverse events are largely unreported, although one might easily imagine that some horses would resent the insertion of needles, or the introduction of electric current, into various locations on their bodies.

## Conclusions

Evaluation of acupuncture in the horse is often difficult because of the diverse nature of the claims made, the overall poor quality of published studies, inaccuracies in reporting the historical record (Ramey *et al.* 2001b) and the variety of parameters involved in assessment of the various claims made for the therapy. Obvious contradictions exist between current acupuncture practice and the historical record, the 'correct' number of points and meridians reported by current practitioners of acupuncture, and even the existence of acupuncture points or meridians themselves.

Clinical evidence for the diagnostic utility or therapeutic effectiveness of acupuncture in the horse is also not compelling. The few quality studies that exist in horses are almost uniformly negative in their assessment of the therapy, as per the majority of evidence in human medicine, indicating that acupuncture has limited clinical utility. Given that the putative longevity of the therapy is often given as an indicator of its usefulness, it is perhaps paradoxical that good evidence of efficacy seems to have been so difficult to come by. Indeed, most evidence suggests that, if acupuncture does have clinically relevant therapeutic effects in man or horses those effects are at best mild, unpredictable, transient, nonspecific and not related to specific sites of needle placement.

## References

- Aird, M., Cobbin, D.M. and Rogers, C. (2002) A study of the relative precision of acupoint location methods. *J. Altern. Complement. Med.* **8**, 635-642.
- Aird, M., Coyle, M., Cobbin, D. and Zaslowski, C. (2000) A study of the comparative accuracy of two methods of locating acupoint points. *Acupunct. Med.* **18**, 15-21.
- Alt-Epping, S., Ostermann, T., Schmidt, J. and Zirngibl, H. (2002) [Diagnostics of appendicitis in a particular consideration of the acupoint point lanwei - a prospective study]. *Forsch Komplementarmed. Klass. Naturheilkd.* **9**, 338-345 [German].
- Alvarenga, M.A., Ferreira, J.P.C., Luna, S.P.L. and Burns, P.J. (1998) Induction of luteolysis in mares utilizing a micro-dose of prostaglandin F<sub>2α</sub> in the sacral lumbar space. *J. equine vet. Sci.* **18**, 167-168.
- Anon (2001) Acupuncture: searching for benefits. *Prescrire Int.* **10**, 84-88.
- Bausell, R.B., Lao, L., Bergman, S., Lee, W.L. and Berman, B.M. (2005) Is acupuncture analgesia an expectancy effect?: Preliminary evidence based on participants perceived assignments in two placebo controlled trials. *Eval. Health Prof.* **28**, 9-26.
- Bing, Z., Villanueva, L. and Le Bars, D. (1990) Acupuncture and diffuse noxious inhibitory controls: naloxone-reversible depression of activities of trigeminal convergent neurons. *Neurosci.* **37**, 809-818.
- Birch, S., Hesselink, J.K., Jonkman, F.A., Hekker, T.A. and Bos, A. (2004) Clinical research on acupuncture: part 1. What have reviews of the efficacy and safety of acupuncture told us so far? *J. Altern. Complement. Med.* **10**, 468-480.
- Bossut, D.R.F., Leshin, L., Stomberg, M.W. and Malven, P.V. (1983) Plasma cortisol and beta-endorphin in horses subjected to electroacupuncture for cutaneous analgesia. *Peptides* **4**, 501-507.
- Campbell, A. (1998) Methods of acupuncture. In: *Medical Acupuncture: A Western Scientific Approach*, Eds: J. Filshie and A. White, Churchill Livingstone, London. pp 19-32.
- Carlsson, C. (2002) Acupuncture mechanisms for clinically relevant long-term effects - reconsideration and a hypothesis. *Acupunct. Med.* **20**, 82-99.
- Cheng, R.S.S., McKibben, L.S., Roy, B. and Pomeranz, B. (1980) Electroacupuncture elevates blood cortisol levels in naive horses; sham treatment has no effect. *Intl. J. Neurosci.* **10**, 95-97.
- Cherkin, D.C., Sherman, K.J., Deyo, R.A. and Shekelle, P.G. (2003) A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain. *Ann. intern. Med.* **138**, 898-906.
- Cho, S.-H. and Chun, S.I. (1994) The basal electrical skin resistance of acupuncture points in normal subjects. *Yonsei Med. J.* **35**, 464-473.
- Chvala, S., Nowotny, N., Kotzab, E., Cain, M. and van den Hoven, R. (2004) Use of the meridian test for the detection of equine herpesvirus type 1 infection in horses with decreased performance. *J. Am. vet. med. Ass.* **225**, 554-559.
- Coyle, M., Aird, M., Cobbin, D. and Zaslowski, C. (2000) The *cun* measurement system: an investigation into its suitability in current practice. *Acupunct. Med.* **18**, 10-14.
- Dung, H.C. (1984) Anatomical features which contribute to the formation of acupuncture points. *Am. J. Acupunct.* **12**, 139-144.
- Elorriaga, C.A., Hanna, S.E. and Fargas-Babjak, A. (2003) Reporting of clinical details in randomized controlled trials of acupuncture for the treatment of migraine/headaches and nausea/vomiting. *J. Altern. Complement. Med.* **9**, 151-159.
- Ernst, E. (1997) Complementary medicine: the facts. *Phys. Ther. Rev.* **2**, 49-57.
- Ernst, G., Strzyz, H. and Hagmeister, H. (2003) Incidence of adverse effects during acupuncture therapy - a multicentre survey. *Complement. Ther. Med.* **11**, 93-97.
- Fenger, C.K., Granstrom, D.E., Langemeier, J.L. and Cain, M. (1997) Equine protozoal myelitis: acupuncture diagnosis. *Proc. Am. Ass. equine Practnrs.* **43**, 327-329.
- Flor, H. and Grusser, S.M. (1999) Conditioned stress-induced analgesia in humans. *Eur. J. Pain* **3**, 317-324.
- Furlan, A., Tulder, M., Cherkin, D., Tsukayama, H., Lao, L., Koes, B. and Berman, B. (2005) Acupuncture and dry-needling for low back pain. *Cochrane Database Syst. Rev.* **1**, CD001351.
- Gaynor, J.S. (2000) Acupuncture for management of pain. *Vet. Clin. N. Am.: Small anim. Pract.* **30**, 875-884.
- Gardon, O.J. (1988) Variation of plasma cortisol values in horses after acupuncture. *Prat. vet. Equine* **20**, 32-34.
- Hama, Y. and Kaji, T. (2004) A migrated acupuncture needle in the *medulla oblongata*. *Arch. Neurol.* **61**, 1608.

- His-chen, K. and Nai-huang, T. (1985) The evaluation of acupuncture anesthesia must seek truth from facts. In: *Medicine in China: A History of Ideas*, Ed: P. Unschuld, University of California Press, Berkeley, pp 361-366.
- Hot, P., Naveteur, J., Leconte, P. and Sequeira, H. (1999) Diurnal variations of tonic electrodermal activity. *Int. J. Psychophysiol.* **33**, 223-230.
- Hsu, E. (1996) Innovations in acumoxa: acupuncture analgesia, scalp and ear acupuncture in the People's Republic of China. *Soc. Sci. Med.* **42**, 421-430.
- Hui, K.K., Liu, J., Makris, N., Gollub, R.L., Chen, A.J., Moore, C.I., Kennedy, D.N., Rosen, B.R. and Kwong, K.K. (2000) Acupuncture modulates the limbic system and subcortical gray structures of the human brain: evidence from fMRI studies in normal subjects. *Hum. Brain Mapp.* **9**, 13-25.
- Iranmanesh, A., Lizarralde, G. and Veldhuis, J.D. (1993) Coordinate activation of the corticotropic axis by insulin-induced hypoglycemia: simultaneous estimates of beta-endorphin, adrenocorticotropin and cortisol secretion and disappearance in normal men. *Acta Endocrinol.* **128**, 521-528.
- Kalauokalani, D., Cherkin, D.C., Sherman, K.J., Koepsell, T.D. and Deyo, R.A. (2001a) Lessons from a trial of acupuncture and massage for low back pain: patient expectations and treatment effects. *Spine* **26**, 1418-1424.
- Kalauokalani, D., Sherman, K.J. and Cherkin, D.C. (2001b) Acupuncture for chronic low back pain: diagnosis and treatment patterns among acupuncturists evaluating the same patient. *South Med. J.* **94**, 486-492.
- Kwok, G., Cohen, M. and Cosic, I. (1998) Mapping acupuncture points using multi channel device. *Aust. phys. Eng. sci. Med.* **21**, 68-72.
- Langevin, H. and Vaillancourt, P. (1999) Acupuncture: does it work and, if so, how? *Sem. Clin. Neuropsych.* **4**, 167-175.
- Lao, L., Hamilton, G.R., Fu, J. and Berman, B.M. (2003) Is acupuncture safe? A systematic review of case reports. *Altern. ther. health. Med.* **9**, 72-83.
- Lee, A. and Done, M. (2004) Stimulation of the wrist acupuncture point P6 for preventing postoperative nausea and vomiting. *Cochrane Database Syst. Rev.* **3**, (CD-ROM).
- Levine, J.D., Gormley, J. and Fields, H.L. (1976) Observations on the analgesic effects of needle puncture (acupuncture). *Pain* **2**, 149-159.
- Li, G., Liu, H.L., Cheung, R.T., Hung, Y.C., Wong, K.K., Shen, G.G., Ma, Q.Y. and Yang, E.S. (2003) An fMRI study comparing brain activation between word generation and electrical stimulation of language-implicated acupoints. *Hum. Brain Mapp.* **18**, 233-238.
- Li, W.I. and Chen, C.L. (1987) Running and shipping elevate plasma levels of beta-endorphin-like substance in Thoroughbred horses. *Life Sci.* **40**, 1411-1421.
- Linde, K., Jonas, W.B., Melchart, D. and Willich, S. (2001) The methodological quality of randomized controlled trials of homeopathy, herbal medicines and acupuncture. *Int. J. Epidemiol.* **30**, 526-531.
- Macpherson, H., Thomas, K., Walters, S. and Fitter, M. (2001) A prospective survey of adverse events and treatment reactions following 34,000 consultations with professional acupuncturists. *Acupunct. Med.* **19**, 93-102.
- Macpherson, H., Scullion, A., Thomas, K.J. and Walters, S. (2004) Patient reports of adverse events associated with acupuncture treatment: a prospective national survey. *Qual. Saf. Health Care* **13**, 349-355.
- Madigan, J.E. and Bell, S.A. (2001) Owner survey of headshaking in horses. *J. Am. vet. med. Ass.* **219**, 334-337.
- Mann, F. (1998) A new system of acupuncture. In: *Medical Acupuncture: A Western Scientific Approach*, Eds: J. Filshie and A. White, Churchill Livingstone, London, p 62.
- Max, M.B., Inturrisi, C.E., Kaiko, R.F., Grabinski, P.Y., Li, C.H. and Foley, K.M. (1985) Epidural and intrathecal opiates: cerebrospinal fluid and plasma profiles in patients with chronic cancer pain. *Clin. Pharmacol. Ther.* **38**, 631-641.
- Mayer, D.J. (2000) Acupuncture: an evidence-based review of the clinical literature. *Ann. Rev. Med.* **51**, 49-63.
- Merritt, A.M., Xie, H., Lester, G.D., Burrow, J.A., Lorenzo-Figueras, M. and 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. *Am. J. vet. Res.* **63**, 1006-1011.
- Moroz, A. (1999) Issues in acupuncture research: the failure of quantitative methodologies and the possibilities for viable, alternative solutions. *Am. J. Acupunct.* **27**, 95-103.
- Murase, K. and Kawakita, K. (2000) Diffuse noxious inhibitory controls in anti-nociception produced by acupuncture and moxibustion on trigeminal caudalis neurons in rats. *Jap. J. Physiol.* **50**, 133-140.
- Nie, G.J., Goodin, A.N., Braden, T.D. and Wenzel, J.G. (2001) Luteal and clinical response following administration of dinoprost tromethamine or cloprostenol at standard intramuscular sites or at the lumbosacral acupuncture point in mares. *Am. J. vet. Res.* **62**, 1285-1289.
- Nishimura, N. (2002) Anesthesiology in People's Republic of China in the year 2001. *Masui.* **51**, 314-317.
- Noordergraaf, S. and Silage, D. (1973) Electroacupuncture. *EEEE Trans. Biomed. Eng.* **20**, 364-366.
- Panzer, R. (1993) A comparison of the traditional Chinese vs. transpositional *Zangfu* Organ Association acupoint locations in the horse. *Am. J. Chinese Med.* **21**, 119-131.
- Rabinstein, A.A. and Schulman, L.M. (2003) Acupuncture in clinical neurology. *Neurolog.* **9**, 137-148.
- Ramey, D.W. and Buell, P.B. (2000) Do acupuncture points and meridians actually exist? *Comp. cont. Educ. pract. Vet.* **22**, 1132-1136.
- Ramey, D.W. and Sampson, W. (2001) Review of the evidence for the clinical efficacy of human acupuncture. *Sci. Rev. Alt. Med.* **5**, 195-201.
- Ramey, D.W., Lee, M.L. and Messer, N.T. (2001a) A review of the Western language equine acupuncture literature. *J. equine vet. Sci.* **21**, 55-58.
- Ramey, D.W., Imrie, R.H. and Buell, P. (2001b) Facts and fallacies in traditional Chinese veterinary medicine. *Comp. cont. educ. pract. Vet.* **23**, 188-193.
- Rushton, D.N. (2002) Electrical stimulation in the treatment of pain. *Disabil. Rehabil.* **24**, 407-415.
- Sanchez-Aranjo, M. (1998) Does the choice of placebo determine the results of clinical studies on acupuncture? *Forsch Komplementarmed., Suppl.* **5**, 8-11.
- Sato, M., Katsumoto, H., Kawamura, K., Sugiyama, H. and Takahashi, T. (2003) Peroneal nerve palsy following acupuncture treatment: a case report. *J. Bone Joint Surg. Am.* **85**, 916-918.
- Scott, S. (2001) Developments in veterinary acupuncture. *Acupunct. Med.* **19**, 27-31.
- Skarda, R.T., Tejawani, G.A. and Muir, W.W. (2002) Cutaneous analgesia, hemodynamic and respiratory effects, and beta-endorphin concentration in spinal fluid and plasma of horses after acupuncture and electroacupuncture. *Am. J. vet. Res.* **63**, 1435-1442.
- Steiss, J.E., White, N.A. and Bowen, J.M. (1989) Electroacupuncture in the treatment of chronic lameness in horses and ponies: a controlled clinical trial. *Can. J. vet. Res.* **53**, 239-243.

- Suter, B. and Kistler, A. (1999) Demonstration of the effect of acupuncture on the autonomic nervous system by examination of the microcirculation. *Forsch Komplementarmed., Suppl.* **6**, 32-34.
- Tang, J.-L., Zhan, S.-Y. and Ernst, E. (1999) Review of randomised controlled trials of traditional Chinese medicine. *Br. med. J.* **319**, 160-161.
- ter Riet, G., de Craen, A.J., de Boer, A. and Kessels, A.G. (1998) Is placebo analgesia mediated by endogenous opioids? A systematic review. *Pain* **76**, 273-275.
- Ulett, G.A., Han, S. and Han, J.S. (1998) Electroacupuncture: mechanisms and clinical application. *Biol. Psychiatry* **44**, 129-138.
- Vickers, A., Goyal, N., Harland, R. and Rees, R. (1998) Do certain countries produce only positive results? A systematic review of controlled trials. *Cont. Clin. Trials* **19**, 159-166.
- Vickers, A.J., Rees, R.W., Zollman, C.E., McCarney, R., Smith, C.M., Ellis, N., Fisher, P. and van Haselen, R. (2004) Acupuncture for chronic headache in primary care: large, pragmatic, randomised trial. *Br. med. J.* **328**, 744.
- Vincent, C.A., Richardson, P.H., Black, J.J. and Pither, C.E. (1989) The significance of needle placement site in acupuncture. *J. Psychosom. Res.* **33**, 489-496.
- Wilson, D.V., Lankenau, C., Berney, C.E., Peroni, D.L., Mullineaux, D.R. and Robinson, N.E. (2004) The effects of a single acupuncture treatment in horses with severe recurrent airway obstruction. *Equine vet. J.* **36**, 489-494.
- Woo, P.C., Lau, S.K., Wong, S.S. and Yuen, K.Y. (2003) *Staphylococcus aureus* subcutaneous abscess complicating acupuncture: need for implementation of proper infection control guidelines. *New Microbiol.* **26**, 169-174.
- Xie, H., Ott, E.A. and Colahan, P. (2001) Influence of acupuncture on experimental lameness in horses. *Proc. Am. Ass. equine Practns.* **47**, 347-357.
- Yamamoto, T. and Yamamoto, Y. (1977) Analysis for the change of skin impedance. *Med. Biol. Eng. Comput.* **15**, 219-227.
- Yamamoto, T., Yamamoto, Y., Yasuhara, K., Yamaguchi, Y., Yasumo, W. and Yoshida, A. (1988) Measurement of low-resistance points on the skin by dry roller electrodes. *IEEE Trans. Biomed. Eng.* **35**, 203-209.
- Yu, C. (1984) *Chinese Veterinary Acupuncture*, China Agriculture Press, Beijing.
- Zaslowski, C.J., Cobbin, D., Lidums, E. and Petocz, P. (2003) The impact of site specificity and needle manipulation on changes to pain pressure threshold following manual acupuncture: a controlled study. *Complement. Ther. Med.* **11**, 11-21.