EFFECTS OF ELECTROACUPUNCTURE ON MINIMUM ALVEOLAR CONCENTRATION OF ISOFLURANE IN ANESTHETIZED HORSES DURING MRI EXAMINATION

Laura Romanò, DVM,
Coordinator of the Acupuncture Horse Practitioners of the SIAV – ItVAS

G. Ravasio, DVM, PhD - A. Elli, DVM -
D. D. Zani, DVM, PhD; - F. Longo, DVM, Repr Spec.
ETHICAL CONSIDERATIONS

Funding Sources – NONE

Financial Interests – NONE

Conflicts of Interest - NONE
Inhalational anesthetics are commonly used to maintain general anesthesia in horses.

Potential advantages and disadvantages

Isoflurane (ISF) causes dose-dependent cardiovascular adverse effects


The risk of onset of post-anesthetic myopathy

(Duke T, Vet Anaesth Analg, 2006)
High anesthetic mortality in horses

(Jones RS, Br J Anaesth, 2001)

- man: 0.0075% - 0.0079% (1 of 12,000)
- dog: 0.11% (1 of 909)
- horse: 0.6% - 0.9% (1 of 111)

(Mee AM et al, Vet Rec, 1998)
The risk of performing general anesthesia for diagnostic procedure is the same that for surgery

(Franci et al, Equine Vet J, 2006)
FURTHER RISK FACTOR

Long time of MRI examination
(low field MRI)
Reduce ISF requirements to minimize dose-dependent side effects.

Partial Intra-Venous Anesthesia (PIVA) to produce a "balanced" anesthesia.

Potential disadvantages reduced.
ACUPUNCTURE:
healing science that considers
the entire animal’s organism
as an energetic being

MERIDIANS:
network of channels
in which energy flows

ACUPOINTS:
specific points where the energy of the meridians rises close to the
surface of the body

The acupoints stimulation allows the flowing of energy through the
meridians’ network
Could ELECTROACUPUNCTURE reduce the ISF requirements in anesthetized horse?
15 HORSES under general anesthesia scheduled for MRI examination

EA group
(electroacupuncture) EAP treatment

C group (control) no treatment

Same anesthetic protocol for both groups (no opioids)

premedication
ACP (0.03 mg/kg)
XYL (0.05 mg/kg)

induction
EGG (50-100 mg/kg)
KET (~2.2 mg/kg)

maintenance
ISF + O₂
### Physiological Parameters:

- **Temperature (T°)**, Heart Rate (HR), Arterial Blood Pressure (ABP)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ABSENCE OF EYELID REFLEX-LACRIMATION-NYSTAGMUS-ANAL REFLEX</td>
</tr>
<tr>
<td>1</td>
<td>MILD EYELID REFLEX OR MILD LACRIMATION</td>
</tr>
<tr>
<td>2</td>
<td>MILD EYELID REFLEX + LACRIMATION OR ANAL REFLEX</td>
</tr>
<tr>
<td>3</td>
<td>MARKED EYELID REFLEX</td>
</tr>
<tr>
<td>4</td>
<td>MARKED EYELID REFLEX + ANAL REFLEX</td>
</tr>
<tr>
<td>5</td>
<td>NYSTAGMUS</td>
</tr>
</tbody>
</table>
### Recovery Quality *(Subjective Descriptive Scale)*

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VERY LONG RECOVERY (&gt; 1.5 H) AND / OR MANY COORDINATED ATTEMPTS OF THE HORSE TO STAND</td>
</tr>
<tr>
<td>2</td>
<td>SLOW (&gt; 40 MIN) AND / OR UNCOORDINATED RECOVERY AND 3 ATTEMPTS OF THE HORSE TO STAND</td>
</tr>
<tr>
<td>3</td>
<td>SLOW (&gt; 40 MIN) AND / OR UNCOORDINATED RECOVERY AND 1 OR 2 ATTEMPTS OF THE HORSE TO STAND</td>
</tr>
<tr>
<td>4</td>
<td>FAST AND COORDINATED RECOVERY (30/40 MIN) AND / OR THE HORSE STAND UP AT THE FIRST OR SECOND ATTEMPT AND / OR THE STATION IS FALTERING</td>
</tr>
<tr>
<td>5</td>
<td>FAST RECOVERY (&lt;30 MIN) AND THE HORSE STANDS WITH A SINGLE COORDINATED ATTEMPT</td>
</tr>
</tbody>
</table>

*Ravasio et al. 2011*
EA group

GV1 – YAO BAI HUI
GV 6 – GV 8
GV 11 – GV 12
ST 36 bilateral
LI 4 - PC 6 (bilateral when possible)

elettrostimulation:
20 Hz for 30 minutes (continuous wave)
EA group + C group

end-tidal ISF concentration: 2% (30 min)

EA group: EAP treatment

MAC: MEAN VALUE BETWEEN THE MAXIMUM ISF CONCENTRATION WHICH ALLOWS NYSTAGMUS AND THE MINIMUM ONE WHICH PREVENTS IT

physiological parameters, depth of anesthesia and end-tidal ISF were recorded every 5 min

C group: no treatment

decreased 0.2% every 5 min
STATISTICAL ANALYSIS

One-way analysis of variance (ANOVA) test was used to compare intra-operative variables (physiological parameters and Et-ISF%) between groups.

Descriptive statistics was expressed as mean (SD)

Normal distribution of data was assessed by a Shapiro–Wilk test

Statistical significance was accepted for \( p < 0.05 \)
# RESULTS

**SIGNALMENT, TIME OF ANESTHESIA:** no significant differences

<table>
<thead>
<tr>
<th>HORSE</th>
<th>AGE (years)</th>
<th>WEIGHT (kg)</th>
<th>SEX</th>
<th>BREED</th>
<th>ATTITUDE</th>
<th>PROCEDURE</th>
<th>TIME OF ANESTHESIA (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 EA</td>
<td>12</td>
<td>450</td>
<td>F</td>
<td>POL</td>
<td>jumping</td>
<td>MRI RF fetlock</td>
<td>130</td>
</tr>
<tr>
<td>2 EA</td>
<td>14</td>
<td>500</td>
<td>G</td>
<td>DEU</td>
<td>dressage</td>
<td>MRI RF tendon sheath</td>
<td>135</td>
</tr>
<tr>
<td>3 EA</td>
<td>8</td>
<td>522</td>
<td>G</td>
<td>KWPN</td>
<td>jumping</td>
<td>MRI LF foot and fetlock</td>
<td>165</td>
</tr>
<tr>
<td>4 EA</td>
<td>7</td>
<td>520</td>
<td>F</td>
<td>IT</td>
<td>jumping</td>
<td>MRI RF fetlock</td>
<td>180</td>
</tr>
<tr>
<td>5 EA</td>
<td>11</td>
<td>560</td>
<td>F</td>
<td>IT</td>
<td>jumping</td>
<td>MRI RF + LF foot</td>
<td></td>
</tr>
<tr>
<td>6 EA</td>
<td>7</td>
<td>560</td>
<td>F</td>
<td>KWPN</td>
<td>jumping</td>
<td>MRI RF foot</td>
<td></td>
</tr>
<tr>
<td>7 EA</td>
<td>12</td>
<td>527</td>
<td>G</td>
<td>TRAK</td>
<td>jumping</td>
<td>MRI LF fetlock</td>
<td></td>
</tr>
<tr>
<td>8 EA</td>
<td>13</td>
<td>570</td>
<td>G</td>
<td>IT</td>
<td>jumping</td>
<td>MRI RF foot</td>
<td></td>
</tr>
<tr>
<td>9 EA</td>
<td>6</td>
<td>650</td>
<td>M</td>
<td>SPA</td>
<td>dressage</td>
<td>MRI RF fetlock</td>
<td></td>
</tr>
<tr>
<td>10 EA</td>
<td>12</td>
<td>498</td>
<td>F</td>
<td>KWPN</td>
<td>jumping</td>
<td>MRI LF foot</td>
<td></td>
</tr>
</tbody>
</table>

Mean time of anesthesia: 150 min in EA group
137 min in C group

<table>
<thead>
<tr>
<th>HORSE</th>
<th>AGE (years)</th>
<th>WEIGHT (kg)</th>
<th>SEX</th>
<th>BREED</th>
<th>ATTITUDE</th>
<th>PROCEDURE</th>
<th>TIME OF ANESTHESIA (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 C</td>
<td>7</td>
<td>620</td>
<td>F</td>
<td>KWPN</td>
<td>jumping</td>
<td>MRI RF + LF foot</td>
<td>170</td>
</tr>
<tr>
<td>2 C</td>
<td>2</td>
<td>403</td>
<td>F</td>
<td>TROT</td>
<td>trot</td>
<td>MRI LH fetlock</td>
<td>120</td>
</tr>
<tr>
<td>3 C</td>
<td>5</td>
<td>446</td>
<td>F</td>
<td>APP</td>
<td>raining</td>
<td>MRI RF foot</td>
<td>135</td>
</tr>
<tr>
<td>4 C</td>
<td>1</td>
<td>290</td>
<td>M</td>
<td>Q.H.</td>
<td>–</td>
<td>MRI LF foot</td>
<td>110</td>
</tr>
<tr>
<td>5 C</td>
<td>13</td>
<td>590</td>
<td>F</td>
<td>KWPN</td>
<td>jumping</td>
<td>MRI LF foot</td>
<td>150</td>
</tr>
</tbody>
</table>
RESULTS

- **INTRA-ANESTHETIC PARAMETERS:**
  - Temperature ($T^\circ$), Heart Rate (HR), Arterial Blood Pressure (ABP)
  - No significant differences
  - $p<0.593$

- **DEPTH OF ANESTHESIA:**
  - High significant differences
  - $p<0.002$

- **ISF MAC:**
  - High significant differences
  - $p<0.000$

- **RECOVERY QUALITY:**
  - No significant differences
  - $p<0.344$
RESULTS

ISF MAC: high significant
p<0.000

-31.3

0.9%

1.34%

1.31%
Cutaneous analgesia, hemodynamic and respiratory effects, and β-endorphin concentration in spinal fluid and plasma of horses after acupuncture and electroacupuncture

Roman T. Skarda, Dr med vet, PhD; Gopi A. Tejwani, PhD; William W. Muir III, DVM, PhD

AJVR, Vol 63, No. 10, October 2002

β – endorphines to increase inhalational anesthetics hypnotic effect


Plasma cortisol and beta-endorphin in horses subjected to electro-acupuncture for cutaneous analgesia.

Bossut DF, Leshin LS, Stromberg MW, Malven PV.
Acupuncture: neuropeptide release produces different effects in dogs

Ji-Sheng Han
Neuroscience Research Center

Effect of Acupuncture in Dogs

Seong Mok Jin

1) Department of Anesthesiology, Seoul 151-742, Korea

Fig. 2. Neural pathways mediating the analgesic effect elicited by low-frequency (2 Hz, red) or high-frequency (100 Hz, blue) electroacupuncture stimulation. Abbreviations: DHN, dorsal horn neuron of the spinal cord; Dyn, Dynorphin A; β-End, β-endorphin; Enk, enkephalin; PAG, periaqueductal grey matter. Modified, with permission, from Ref. (29).

the residual effect produced by the low frequency stimulation could overlap with that produced by the high frequency and, therefore, elicit an synergistic effect.
Traditional Chinese Medicine (TCM)

- GOVERNING VESSEL (DU MAI)
  - GV nourishes brain and spinal cord
  - reservoir of energy
  - GV (Sea of Yang)
  - Du Mai starts in the pelvis, goes up past the umbilicus, up past the heart, enters the throat, circulates around the lips and up to the eyes...
  - (Su Wen)
  - Du Mai starts at a point that is below the pole. It comes to the lining of the spine and up to fengfu, entering the brain...
  - (Nan Jing)
  - Du Mai can control all vessel and becomes like the capital city of the yang vessels...
  - (Wang Shu He)

- GV nourishes brain and spinal cord
Neural mechanism underlying acupuncture analgesia

Zhi-Qi Zhao

Institute of Neurobiology, Institutes of Brain Science and State Key Laboratory of Medical Neurobiology, Fudan University, Shanghai 200032, China
GV 20a
Yao Bai Hui
Point of 100 Meetings

GV 1
Chang Qiang
Long Strong

➢ increases energy of the body and in particular the Wei Qi (superficial defensive energy)
  ➢ controls the going up of Yang
  ➢ sensitizes the vertebral column to the acupuncture treatment
  ➢ nourishes the brain (as GV20 does) keeping the animal in a kind of conscious yet anesthetized state

➢ LUO connecting point of GV headed for brain
  ➢ calms the Shen
  ➢ intersecting point of GV – CV – KD – GB
GV6
Ji Zhong
Spinal Center

- tonifies SP and KD supporting blood circulation
- removes Tan (phlegm) from Tai Yin
- reinforces back shu of SP (seat of Yi)
- spinal local problem

GV8
Jin Suo
Sinew Contraction

- removes contraction of skeletal and smooth muscles
- sinew spasm and general muscles tightness
- removes tremores (excess of Wind)
- reinforces back shu of LV (seat of Hun)
- “opens” and relax the vertebral column
**GV11 Shen Dao**

*Spirit Path*

- strong effect on mind, spirit problems
- calms the Shen
- regulates the flow of Qi and Yang of HEART
- calms anxiety and palpitation

**GV12 Shen Zhu**

*Body Pillar*

- calm the Shen
- act on HEART and LUNGS supporting the most important organs during general anesthesia

**Key Points**

- Supporting point of the body → head and neck
- General chest pain and chronic conditions affecting the lungs
- Diffuses the LUNG Qi if deficient
- In Nan Jing “sedation point” → calms the Shen
Acupuncture Analgesia: I. The Scientific Basis

Shu-Ming Wang, MD*
Zeev N. Kain, MD, MBA†‡
Paul White, PhD, MD§

Acupuncture has been used in China and other Asian countries for the past 3000 yr. Recently, this technique has been gaining increased popularity among physicians and patients in the United States. Even though acupuncture-induced analgesia is being used in many pain management programs in the United States, the mechanism of action remains unclear. Studies suggest that acupuncture and related techniques trigger a sequence of events that include the release of neurotransmitters, endogenous opioid-like substances, and activation of c-fos within the central nervous system. Recent developments in central nervous system imaging techniques allow scientists to better evaluate the chain of events that occur after acupuncture-induced stimulation. In this review article we examine current biophysiological and imaging studies that explore the mechanisms of acupuncture analgesia.

(Amph. Analg. 2008;106:602-10)
The first clinical study which shows the efficacy of EAP in reducing ISF requirement in horses general anesthesia.

Side effects during general anesthesia could be reduced diminishing ISF requirement.

Great result because it shows the possibility to reduce ISF MAC with non pharmacological methods.
Effectiveness of electroacupuncture analgesia compared with opioid administration in a dog model: a pilot study

D. Groppetti¹*, A. M. Pecile¹, P. Sacerdote², V. Bronzo³ and G. Ravasio¹

¹ Department of Veterinary Clinical Science, ² Department of Pharmacology, Chemotherapy and Medical Toxicology, and ³ Department of Veterinary Pathology, Hygiene and Public Health, Università degli Studi di Milano, Italy

* Corresponding author. E-mail: debora.groppetti@unimi.it

POSSIBLE USE OF THIS EAP PROTOCOL for patients affected by
PLASMA β-ENDORPHINE concentrations to confirm neural mechanism underlying EAP
Giuliano Ravasio, DVM, PhD anesthetist
and Annalisa Elli, DVM

The Other Authors

Francesco Longo, DVM, Repr Spec
Master of acupuncture

Davide Zani, DVM, PhD Radiologist