Neurocardiology as Integrative Science: Coordination with Traditional Chinese Medicine

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Introduction

- Brief history of Neurocardiology:
  - the birth in 1960s
  - evolution (monitoring instrumentation)

Multidisciplinary biomedical field that combines insights from cardiology and neurology with informational and engineering techniques of signal acquisition, processing and analysis.

1. Relations between brain and heart, neurologic and cardiologic problems
2. Influence of ans on heart
3. Complex cardiac neurons

The Basics of Neurocardiology
Biomedical engineering and technologies

1. Personal medical approach
2. Systematic diagnostics
3. Optimization of therapy

Nanotechnologies, pharmacology, other medicines, Traditional Chinese Medicine (TCM)
Neurocardiology and TCM

TCM concepts:
Qi, 气 (qì), 理气 (lǐ qì), Yin 阴 (yīn), Yang 阳 (yáng)

Analogies:
Qi congestion: impairment of autonomic regulation (very low total power of HRV spectrum)
Yang excess: sympathetic predominance (high value of LF band in TP spectrum of HRV)
Yin excess: parasympathetic predominance (high value of HF band in TP spectrum of HRV)

Not just conceptual equivalence; but, it has clinical significance: practical integrative approach of Neurocardiology and Traditional Chinese Medicine.
Does effectiveness of acupuncture/drug therapy depend from state of ANS?

State of ANS: characterisation by means of HRV and BPV parameters

Even and uneven groups in correspondence with Yi Jing

Therapeuticc effect:

- $\Delta HR = HR_{before} - HR_{after \, acupuncture}$
- $\Delta sBP = sBP_{before} - sBP_{after \, acupuncture}$
- $\Delta BRS = BRS_{before} - BRS_{after \, acupuncture}$
Application: case study 1

State of ANS

Therapeutic effect

<table>
<thead>
<tr>
<th>Par</th>
<th>Units</th>
<th>Before acupuncture</th>
<th>After acupuncture</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLF</td>
<td>ms²</td>
<td>686</td>
<td>907</td>
<td>32.2</td>
</tr>
<tr>
<td>LF</td>
<td>ms²</td>
<td>395</td>
<td>1027</td>
<td>260.0</td>
</tr>
<tr>
<td>HF</td>
<td>ms²</td>
<td>78</td>
<td>1023</td>
<td>1311.5</td>
</tr>
<tr>
<td>TP</td>
<td>ms²</td>
<td>1159</td>
<td>2957</td>
<td>155.1</td>
</tr>
<tr>
<td>LF/HF</td>
<td>-</td>
<td>5.014</td>
<td>1.004</td>
<td>-499.4</td>
</tr>
<tr>
<td>LFnu</td>
<td>%</td>
<td>83.37</td>
<td>50.09</td>
<td>-39.9</td>
</tr>
<tr>
<td>HFnu</td>
<td>%</td>
<td>16.63</td>
<td>49.9</td>
<td>300.1</td>
</tr>
</tbody>
</table>
Application: case study 2

Short term recording:

State of ANS

Therapeutic effect

### Baroreceptor Sensitivity (Sequence Method)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LFnu</th>
<th>HFnu</th>
<th>VLF</th>
<th>LFms</th>
<th>HFms</th>
<th>PSD</th>
<th>LF/HFms</th>
<th>LF/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before acupuncture</td>
<td>48.9</td>
<td>51.1</td>
<td>381</td>
<td>315</td>
<td>359</td>
<td>1055</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>During acupuncture</td>
<td>55.2</td>
<td>34.8</td>
<td>360</td>
<td>365</td>
<td>166</td>
<td>891</td>
<td>2.4</td>
<td>1.2</td>
</tr>
<tr>
<td>After acupuncture</td>
<td>74.6</td>
<td>25.4</td>
<td>485</td>
<td>435</td>
<td>149</td>
<td>1068</td>
<td>3.9</td>
<td>1.7</td>
</tr>
</tbody>
</table>
## Long-term recording (after 7 days of acupuncture):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HR</th>
<th>sBP</th>
<th>dBP</th>
<th>mBP</th>
<th>BRS</th>
<th>BEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sy acupuncture</td>
<td>55.9 ±3.4</td>
<td>167.7±4.4</td>
<td>121.5±3.6</td>
<td>136.3±3.9</td>
<td>20.37±6.71</td>
<td>118.42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LFnu</th>
<th>HFnu</th>
<th>VLF</th>
<th>LFms</th>
<th>HFms</th>
<th>PSD</th>
<th>LF/HFms</th>
<th>LF/HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sy acupuncture</td>
<td>78.7</td>
<td>21.3</td>
<td>124</td>
<td>813</td>
<td>203</td>
<td>1141</td>
<td>4.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

## Long-term recording (after 7 days of vagal acupuncture stimulations):

<table>
<thead>
<tr>
<th>Parameters</th>
<th>HR</th>
<th>sBP</th>
<th>dBP</th>
<th>mBP</th>
<th>BRS</th>
<th>BEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Va acupuncture</td>
<td>61.0 ±4.9</td>
<td>146.5±11.7</td>
<td>104.8±9.9</td>
<td>116.2±9.9</td>
<td>10.25±5.52</td>
<td>173.08</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>LFnu</th>
<th>HFnu</th>
<th>VLF</th>
<th>LFms</th>
<th>HFms</th>
<th>PSD</th>
<th>LF/HFms</th>
<th>LF/HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Va acupuncture</td>
<td>74.9</td>
<td>25.1</td>
<td>251</td>
<td>419</td>
<td>164</td>
<td>833</td>
<td>4.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Application: case study 2

Comparison:

Table 1
Fatal cases of acupuncture.

<table>
<thead>
<tr>
<th>Reference/year</th>
<th>Country</th>
<th>Age/sex</th>
<th>Adverse event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otsuka [9]/1998</td>
<td>Japan</td>
<td>41/m</td>
<td>Tissue-like syndrome</td>
</tr>
<tr>
<td>Iwade [10]/2003</td>
<td>Japan</td>
<td>72/f</td>
<td>Bilateral tension pneumothorax</td>
</tr>
<tr>
<td>Kasuda [6]/2004</td>
<td>Japan</td>
<td>71/f</td>
<td>Bilateral tension pneumothorax</td>
</tr>
<tr>
<td>Chang [14]/2005</td>
<td>Korea</td>
<td>80/f</td>
<td>Cellulitis, sepsis, and pneumonia</td>
</tr>
<tr>
<td>Simmons [8]/2006</td>
<td>UK</td>
<td>69/f</td>
<td>Tissue-like syndrome</td>
</tr>
</tbody>
</table>

Table 1: Fatal cases of acupuncture.

Case report

An autopsy case of vagus nerve stimulation

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ABSTRACT

Acupuncture is an ancient Chinese technique that is used to treat various conditions. This analysis demonstrates that acupuncture points to the clinical effects of acupuncture. This clinical corresponds to the lateral neck, strongly fundamental in producing the clinical effects of the acupuncture.

Acupuncture to Danzhong but not to Zhongting increases the cardiac vagal component of heart rate variability

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ABSTRACT

There is currently no convincing evidence that acupuncture has any specific effects on autonomic nervous function assessed by heart rate variability (HRV). We examined whether the stimulation of neighboring acupuncture points, Danzhong (CV17) and Zhongting (CV16) on the anterior median line of the thorax, induced different effects on HRV. In 14 healthy male rabbits, bilateral acupuncture stimulation (single instantaneous needle stimulation on the thorax surface without producing De-Qi sensation) was performed at CV17 and CV16 on different days in a clinical study utilizing a cross-over design. We found that the stimulation of CV17, but not of CV16, decreased the heart rate (P = 0.01, repeated measures ANOVA) and increased the power of the high-frequency component of the HRV, an index of cardiac vagal activity (P = 0.01). The low-frequency to high-frequency ratio, an index of sympathetic activity, showed no significant changes for either point. Our observations could not be explained as either nonspecific or psychological placebo effects of needle stimulation. This study provides strong evidence for the presence of a specific acupuncture point that causes the modulation of cardiac autonomic function.
Resume for Neurocardiac-TCM algorithm expertise

1. Neurocardiac electronic health record (initiatory inputs):
   - basic information, family and personal disease history;
   - neurocardiac anamnesis (marking and scoring symptom/s, energetic types signified from will, mood, gesticulation, ex. hyperactive versus phlegmatic behavioral manner);

2. Import of ECG data from ECG recorder

3. Processing of ECG data
   - Artifacts removal
     - automatic cleaning (filtering) and/or visual representation of signals
       - Erratic rhythm removal (for autonomic predominance classification)
       - Extraction of time, frequent, nonlinear ECG features (Fourier transformation or Wavelet transformation)

4. Determination of health status
   - increased/decreased HRV, loss of HRV complexity (SDNN or $a_1$ and $a_2$) → health/disease

5. General neurocardiac zheng: Multivariable scoring 1 - determination of disease class (cardiovascular, pulmonary, oncology, other, etc.):
   - Time domain parameters:
     - SDNN, rMSSD, pNN50, pNN10; PR duration, QRS duration, QT duration, QTc duration, T-wave duration
   - Frequency domain parameters:
     - LF, HF, VLF, LF/HF, TP, LF/nu, HF/nu, LF/nu/HF/nu

6. Specialized neurocardiac zheng: multivariable scoring II - determination of disease with minimal combination of parameters that gives highest prognostic accuracy.
   - Nonlinear parameters:
     - power-law slope ($b$), short-term scaling exponent ($a_1$), intermediate scaling exponent ($a_2$); HRT: turbulence onset (TO), turbulence slope (TS); GE: H, PPA: SD1, SD/SD2; SD: SDShannon, Fortward, wpsum2; STSD: amf, pfl, pflp)

7. Risk stratification for myocardial infarction and sudden cardiac death

Recommendation of therapy

8. Determination of type of ANS regulatory domination (using LF/nu):
   - sympathetic predominance
   - parasympathetic predominance

9. Determination of autonomic patterns
   - Level of autonomic predominance or/and ANS damage:
     - combination of LF/nu and TP; 4, 16 groups
     - combination of other parameters: LF/nu, TP, BRS, QRS, HR…: 4, 16, 32 groups
   - Autonomic disturbance (related to disease):

10. Cardiovascular risk
    - Summation of factors for cardiovascular risk: obesity, smoking, hypertension, lack of physical activity, pollution...
    - Evaluation of autonomic patterns for cardiac death (based on statistical significance and dependence of parameter combinations and ranges with mortality/survival)

11. Evaluation and recommendation of therapy
    - if/then algorithmic rule
      - if part:
        - previously determined diagnosis
      - then part:
        - recommendation of exact acupuncture nomenclature, type/drug that has the best effect for each patient

Inference engine:
- user interface (intuitive and fast representation of results and decision recommendations)
- learning machine (memories of neurocardiologist expertise)
- expert database (database of all acupuncture methods and drugs for each disease, indications, contraindications, dosages)
Conclusion

States of ANS significant incides for desired therapeutic outcome. Nonresponders to acupuncture—atypical ANS state (?) Application of integrative approach of Neurocardiology and TCM.

Heart in Neurocard-TCM research Development of decision syport systems: from ECG, ANS analysis, diagnostics to recommendation of right, precise and optimal therapy.


Studenica monastery, XII century
Neurocardiology as Integrative Science: Coordination with Traditional Chinese Medicine

Traditional Chinese medicine (TCM) is a broad range of medicine practices sharing common concepts which have been developed in China and are based on a tradition of more than 4,000 years, including various forms of: herbal medicine, acupuncture and moxibustion massage (Tui na) and acupressure, exercise (qigong), taiji..) and dietary therapy...

~ Cupping therapy, guasha, auriculo-scalp-puncture
The basic concepts of Traditional Chinese Medicine (TCM)

- Many concepts of Traditional Chinese medicine (TCM) are almost untranslatable or without analogues in classical medicine. Such are Qi, 氣 (qì), Yin 阴 (yīn) and Yang 阳 (yáng).
- Concept of Qi: kind of very active and refined substance that is in constant movement, which constitutes the human body and maintains its life activity.
- The theory of Yin–Yang includes basic contents of opposition and interdependence, restriction and reciprocity, wane-wax and transformation, balance and imbalance of yin and yang.

Qi congestion: impairment of autonomic regulation (very low total power of HRV spectrum)
Yang excess: sympathetic predominance (high value of LF band in TP spectrum of HRV)
Yin excess: parasympathetic predominance (high value of HF band in TP spectrum of HRV)

- As a rule, sANS and pANS are always acting antagonistic, synchronous, synergetic; they never act independently, action of one is always followed with inhibition of other.
Cardinal Characteristics of Traditional System of Chinese Medicine

1. Concept of Holism
2. Treatment Determination Based on Syndrom Differentiation

Treating hypertension using the basic principles of Traditional Chinese Medicine

-During anamnesis and diagnosis TCM physicians are getting multifactorial analysis to construct image of impairment in body or organic dysfunction. In the same time they are trying to find out the cause of disease. Syndrom is a pathological summary in a given state of a disease in its course made by doctor, which includes the cause of disease, focus of disease, nature of disease
According to holistic concept and treatment based on syndrome differentiation TCM principles for reducing BP are:

1. **Eliminating dampness and resolving phlegm:** this promotes excess body fluids and wastes to eliminate through urination. The action also lowers blood lipids, and promotes blood flow throughout the body.

2. **Soothing liver and extinguishing wind:** This can calm down and regulate the nervous system, expand blood vessels, promote urination, and regulate calcium metabolism.

3. **Activating blood and resolving stasis:** This can expand blood vessels, free blood circulation, also soothe the central nerve system, slow down heartbeat, and inhibit blood platelets clotting.

4. **Clearing heat and purging fire:** This can expand blood vessels, promote excretions, and calm down the body.
Acupuncture and moxibustion (针灸 zhen jiu)

**Acupuncture** (from Latin, *acus* (needle) and *punctura* (to puncture)) is a key component of traditional Chinese medicine (TCM) involving thin needles being inserted into the body, especially to cure disease or relieve pain.

-Acupuncture points (穴位 xuewei) are the points at which the Qi rises to the surface of the body. These points are specific points mapped out on the body which if stimulated have an influence on the internal organs they are correlated with.

-Results of the recent trials are showing a tendency that acupuncture can decrease high BP. Numerous case studies and uncontrolled trials provide evidences for efficacy of acupuncture for treating hypertension
The commonly used acupuncture points for curing are: 
Baihui ( DU20 ),
Quchi ( LI11 ),
Taichong ( LV3 ),
Taixi ( KI3 ),
Sanyinjiao ( SP6 ),
Suzanli ( ST36 ),
Hegu ( LI4 ), Renying ( ST9 ) with uniform reinforcing-reducing method.
Hypertensive patient that had parasympathetic predominance with high total power.

- Male, 39 years old;
- 7 days long acupuncture therapy, every day treatment, with one day pause, so all together six treatments.
- After taking a case, it was diagnosed that patient has stagnation of liver qi, and blood stagnation. The principles of: Soothing liver and extinguishing wind as well Activating blood and resolving stasis were used.
  - Every treatment acupuncture was used, and two times auriculo-acupuncture.
  - Every treatment was 20-25min long
  - Needles of 1 and 1.5 cun were used.
  - Needles were inserted perpendicularly and oblique, forming a 90 ° and 45° degree angle with the skin surface.
  - Manipulation techniques of lifting and thrusting were used;
  - Methods of reinforcing, tonifying and reducing were used
  - The changes of pulse quality (TCM diagnosis) were observed; When pulse changes its quality from tensed and rolled to soft, needles were removed.
The commonly used acupuncture points for curing are: Baihui (DU20), Quchi (LI11), Taichong (LV3), Taixi (KI3), Hegu (LI4), Renying (ST9) with uniform reinforcing-reducing method.

There was no therapeutic effect on HRV and BPV signals neither for short term (during and after 15 min of acupuncture treatment) or long term (after 7 days of acupuncture treatments) experimental procedures. Then, almost accidentally we decided to try with opposite principle - to treat acupuncture points that are connected with vagous. (Daimai (GB26), ST36 and Sanyinjiao (SP6)

**Therapeutic effects were achieved in both short term and long term experimental procedures.**

This atypical case deserves one note: usually in hypertensive patient increased activation of sANS is rising blood pressure. Here, in this patient is opposite; increased pANS activity is cause of hypertension.

This could be sign why acupuncture therapy is not effective in some people. Those are probably people with this kind of atypical ANS regulation. Thus, it is suitable to adjust acupuncture treatment in agreement with better ANS response.

感谢您的关注!
Thank you for your attention
References


