"Meridian-like channels" in dead human subjects?: A negative result
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Citation

Abstract
Background: At the moment generally accepted proof for meridians in Traditional Chinese Medicine (TCM) cannot be considered as being given. Goal of this study was to examine whether possible stimulation-induced meridian-like structures, as recently described by other authors, can be visualized and objectified in dead human subjects using infrared thermography.

Methods: Two infrared cameras at different wavelength ranges (2 - 5 µm and 7.5 - 13 µm) were used. To validate the method described by other authors, investigations in two dead subjects (72 and 84 years) were performed.

Results: After moxibustion of the body, different structures appear on thermographic images of the human body which are technical artifacts and which are not identical to what are known as meridians in TCM.

Conclusion: The findings raise questions about the validity of the method described by other authors. Further studies in alive human subjects are necessary regarding the possible visualization of meridians.

BACKGROUND
The scientific and technological progress has truly revolutionized clinical medicine. Scientists attempt to shine scientific light upon the most spectacular of the eastern medical procedures: acupuncture. The usage of advanced exploratory tools, such as multidirectional transcranial ultrasound, cerebral near infrared spectroscopy, and magnetic resonance imaging, provides revealing insights [1,2,3,4,5]. Attempts to visualize the course of “energetic paths” in acupuncture (called meridians in Traditional Chinese Medicine (TCM)) are described by different authors. However, the results are controversial, and at the moment generally accepted proof for meridians cannot be considered as being given [6,7,8,9].

Meridian-like channels [8,9] as well as thermographic artifacts [6,7] have been described by two research groups recently. The present study in dead subjects was designed to test whether these artifacts could also be observed in dead subjects without any “energetic flow”. To our knowledge no post mortem studies have been conducted on this topic, neither in animals nor in humans. In this study the first data from infrared thermographic (IR) registrations using two IR-cameras with different wavelengths in dead adults are presented.

METHODS
THERMOGRAPHY
Similar to our first study in healthy volunteers, two infrared cameras at different wavelength ranges were used for thermographic control of possible stimulation effects (Fig. 1) [6].

The Agema Thermovision™ 470 PRO infrared camera system with optics of 20° (Flir Systems Inc., Portland, USA) operates at a wavelength range from 2 - 5 µm. The temperature measurement range lies between -20 °C and +500 °C and can be increased to 2000 °C using filters. Sensitivity is 0.1 °C at 30 °C.

The second infrared camera was used simultaneously with the system above during all measurements. Here, a FLIR ThermaCAM™ S65 system with 24° optics was used. The spectral range of this camera was between 7.5 and 13 µm and the temperature range lies between -40 °C and 1500 °C (2000 °C optional). Temperature differences of less than
0.08 °C (30 °C, 50 Hz) can be registered with this camera. Using a special detector (FPA) with 320 x 240 pixel geometric resolution of 76.800 pixel per picture can be achieved.

The data was transferred to a Notebook using ThermaCAM QuickView™ software and analysed with ThermaCAM Researcher Pro 2.8 software (Flir Systems Inc., Portland, USA).

Figure 1
Figure 1: Infrared analytical measurement set-up. Two IR cameras were used (2 – 5 Åμm, right; and 7.5 – 13 Åμm, left). In addition, the stimulation with a moxa-cigar at the Institute of Pathology at the Medical University of Graz is shown (modified from []).

Advantages and limitations of infrared thermography can be found in previous review reports [10] and in previous reports on the specific topic [6, 7].

STIMULATION METHOD
A burning moxibustion-cigar made of mugwort (length 20 cm, diameter 1.5 cm, Hunan, China) was used for stimulation. This radiates an average temperature of 550 °C (measured with FLIR ThermaCAM S65) with an energy maximum ranging from 3 to 3.5 µm [6].

DEAD SUBJECTS
Two dead adults (one woman, 84 years, and one man, 72 years) were studied. The investigations were approved by the chairman of the ethics committee of the Medical University of Graz (March 2006), and all work was conducted in accordance with 10 requirements of the local Institute of Pathology and with the Declaration of Helsinki. The investigations were performed 14 hours (woman) and 18 hours (man) after determination of death. Both patients died in hospital. The causes of death and underlying diseases are listed in Table 1. The time of death was documented by the responsible staff physician on the ward when the patient died. Death was defined by irreversible cessation of the entire brain (brain death in male subject) and by irreversible cessation of heart and respiratory activity, loss of spontaneous motor movements and ophthalmic brainstem reflexes, and by the presence of livor mortis. The study was conducted in the autopsy room of the Institute of Pathology of the Medical University of Graz at an average room temperature of 21 °C.

Figure 2
Table 1: Characteristics of two dead subjects undergoing infrared thermography.

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Age (years)</th>
<th>Sex (M, F)</th>
<th>Diagnosis</th>
<th>Interval death – study (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>84</td>
<td>F</td>
<td>Cardiac failure</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>72</td>
<td>M</td>
<td>Coma despacité</td>
<td>18</td>
</tr>
</tbody>
</table>

F...female; M...male

PROCEDURE
Different areas of the body (left leg, right leg, upper body) were stimulated at a distance of about 10 cm for several minutes as described in earlier investigations [6, 7, 8, 9]. After a resting period of 5 minutes, the procedure was repeated in both subjects.

RESULTS
Typical technical artifacts (reflection artifacts) can be seen in Figures 2 – 5.

Figure 2 shows the stimulation with the burning moxa-cigar on the right side. Additionally the original thermogram is presented. The moxa-cigar is shown as a red area in the middle of the image. Below this heat source a reflection artifact appears on the left leg in the shape of a yellow and red structure similar to a line. Body temperature in this case is calculated to be 20.5 °C (blue color, marker no. 1).
Figure 3
Figure 2: Original thermogram from a 84-year-old dead subject with reflection artifacts (note the line on the left side of marker 1). The moxa-cigar is visible as a circular red and white area above this line (modified from []).

In Figure 3 the reflection artifacts are demonstrated on the leg of the dead subject (red arrows) and also on the metal surface (grey arrows). Stimulation using the moxa-cigar was performed at a distance of about 10 cm from the body.

Figure 4
Figure 3: One photographic documentation and three thermograms showing artifacts. Dependent on the angle of reflection, technical reflection effects visible as lines at optional parts of the body can occur. The thermographic scale was defined from dark blue (15 °C) to red/white (40 °C). The red arrows indicate the reflections on the body (leg) and the grey arrows those on the metal surface (modified from []).

Figure 4 and Figure 5 show similar artifacts, registered with an IR camera that operates at a wavelength range of 2 – 5 µm. In this case, the artifacts are more pronounced than those recorded with the camera at a wavelength of 7.5 – 13 µm. Note the different geometric characteristics of the artifacts (line structures and larger areas). It is also interesting to observe that the artifacts appear on the body (comp. Figs. 2 – 5) as well as on the linen sheet (comp. Fig. 5) and on the metal (comp. Fig. 3).
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**DISCUSSION**

Non perfused and non biologic structures can yield artifacts in thermographic images which are not meridian channels. These artifacts can occur in healthy volunteers \([6,7]\) as well as in dead subjects. Our results of the present study demonstrate that while burning a moxibustion stick as a directed heat source in proximity to a dead body region, artifacts in form of structures or areas can be revealed. However, these artifacts are not identical or similar to what are known as meridians in all textbooks of TCM. After removing the stick, the effects disappear. When moving the moxibustion stick, the artifacts of course move too.

The technical, but obviously not biological reflection phenomena described in this study in dead subjects and in previous studies, which were performed in healthy volunteers, can be applied to any desired area of the body. The fact that we are here dealing with technical artifacts and not biological phenomena can be justified by the following, as partly discussed in a previous publication \([6]\).

Reflections can be applied to optional parts of the body depending on the position of the moxa-cigar in connection with the angle of incidence of both cameras. Thus, correspondence with the meridian structures according to Traditional Chinese Medicine is not given (compare Fig. 4). The moxa-cigar radiates more than 550 °C with maximum energy ranging between 3 and 3.5 µm. The radiation curve flattens markedly between 7.5 and 13 µm, thus, stronger reflections in the range of 2 - 5 µm occur than in the long-wave infrared range. This has been illustrated for the first time in a previous publication \([6]\) and in the present post-mortem study by using two infrared cameras simultaneously (compare Fig. 3 and 4). The artifacts are also reproducible in both wavelength ranges in non-vital structures other than the human body such as linen sheets (compare Fig. 5) or a metal surface (compare Fig. 3). The artifacts can be projected horizontally or diagonally at any angle on a dead subject (compare Fig. 4). In addition, no path equivalent meridians on the body surface could be visualized in any healthy volunteer during acupuncture stimulation (manual needle acupuncture and laserneedle stimulation as well as moxibustion) as demonstrated in an earlier publication \([6]\).

**CONCLUSIONS**

In this study we have visualized thermographic artifacts in dead subjects in whom generally no energy flow is supposed to occur. The present study failed to find any kind of meridian-like structures using an already described stimulation method. The measurements demonstrate once again clearly that it is not allowed to interpret these artifacts as any kind of meridian-like structures according to TCM.

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