Near infrared spectroscopy (NIRS) monitoring of paraspinal muscles to reflect SCI: How Does it Work and initial results

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ONSET TIME OF POSTOPERATIVE PARAPLEGIA

Concept: Delayed Paraplegia, timing of delayed paraplegia, and clinical support of the “Griep/Etz Observation”

<table>
<thead>
<tr>
<th>Patient Number</th>
<th>Hours</th>
<th>Days</th>
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<tbody>
<tr>
<td>11</td>
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<tr>
<td>10</td>
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<td>9</td>
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<tr>
<td>8</td>
<td></td>
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<tr>
<td>7</td>
<td>Emergence</td>
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<tr>
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<td>Emergence</td>
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</table>

Mean: 36.8 ± 38.9 hrs (1st Episode)
Median: 21.6 hrs (1st Episode)
7.3 Days or 176 hrs (2nd episode)

COURTESY OF JOE BAVARIA
NIRS optode
paraspinal cnNIRS

HYPOTHESIS
Collateral Network Near-infrared spectroscopy (cnNIRS)
Lumbar Paraspinal Network

ASA

Spinal canal

cranial

caudal
Non-invasive real-time collateral network NIRS

2. Etz et al., Eur J Vasc Endovasc Surg. 2013 Dec;46(6):651-6
Paraspinal cnNIRS

VALIDATION
Experimental Sequence

✧ Baseline
✧ X-clamping (ischemia: 8 min.)
✧ Clamp release (recovery)
Experimental setup

- Seven juvenile male pigs
- Subcutaneous cnNIRS at T5/6 and L2/3
- Direct muscle and spinal cord oxygenation + flow by Laser Doppler (LDF)
paraspinal cnNIRS

EXPERIMENTAL X-clamping
Experimental Aortic X-clamping

Collateral Network

Spinal Cord

Direct Invasive Laser Doppler (LDF)
HYPOTHESIS: oxygenation of the CN = spinal cord?
Paraspinal CN oxygenation directly reflects spinal cord tissue oxygenation
Non-invasive cnNIRS

Lumbar cnNIRS
Lumbar spinal cord oxygenation

Question: lumbar cnNIRS = Spinal cord oxygenation? ✔
Lumbar cnNIRS directly reflects spinal cord tissue oxygenation.
paraspinal cnNIRS

EXPERIMENTAL RESULTS: X-clamping

regional CN oxygenation reflects spinal cord oxygenation

lumbar cnNIRS reflects lumbar spinal cord oxygenation
paraspinal cnNIRS

EXPERIMENTAL serial segmental artery occlusion (MIS²ACE)
Intraoperative lumbar cnNIRS monitoring

Anaesthesia

SA exposure T4-L5

120 min. surveillance

T4-T13

L1-L5

10 min.
Lumbar cnNIRS and neurological outcome

- recovery group (N=8) -

- paraplegic group (N=4) -
Lumbar cnNIRS significantly correlates with neurological outcome after experimental consecutive segmental artery occlusion (R = 0.7, P<0.001)
paraspinal cnNIRS

EXPERIMENTAL RESULTS serial segmental artery occlusion (MIS²ACE)

Lumbar cnNIRS reacts to consecutive occlusion of regional segmental arteries in real-time

Lumbar cnNIRS correlates with postoperative neurological outcome
paraspinal cnNIRS

CLINICAL SET-UP
# Cohort

Table 1. Patient demographics and procedural details.

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>TAAA</th>
<th>TEVAR</th>
<th>Hybrid</th>
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<tr>
<td><strong>n</strong></td>
<td>20</td>
<td>15</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Patients</td>
<td>11</td>
<td>7</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Age (y ± SD)</td>
<td>66 ± 10</td>
<td>68 ± 11</td>
<td>57 ± 8</td>
<td>56 ± 5</td>
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<td>Connective tissue disease</td>
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<td>Diabetes (IDDM)</td>
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<td>Chronic obstructive pulmonary disease</td>
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<td>Coronary artery disease</td>
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<td>Previous aortic surgery</td>
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<td>Aneurysm diameter (mm ± SD)</td>
<td>66.1 ± 9</td>
<td>67.1 ± 8</td>
<td>59.7 ± 3</td>
<td>70.0 ± 14</td>
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<td>Crawford I</td>
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<td>Type B dissection</td>
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<td>5</td>
<td>3</td>
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<td>CPB time (min ± SD)</td>
<td>127.9 ± 61</td>
<td>148.8 ± 40</td>
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<td>207.5 ± 77</td>
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<tr>
<td>Cross-clamp time (min ± SD)</td>
<td>31.9 ± 18</td>
<td>35.1 ± 15</td>
<td>0</td>
<td>64.5 ± 40</td>
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<td>Lowest body temperature (°C ± SD)</td>
<td>32.1 ± 2</td>
<td>31.7 ± 2</td>
<td>36.4 ± 1</td>
<td>25.5 ± 1</td>
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<td>Distal perfusion</td>
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<td>Tracheotomy</td>
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<td>Died</td>
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</table>

*Note. IDDM = insulin-dependent diabetes mellitus; CPB = cardiopulmonary bypass; TAAA = thoracoabdominal aneurysm repair, TEVAR = thoracic endovascular aortic repair.*
paraspinal cnNIRS

CLINICAL RESULTS OPEN TAAA / X-CLAMPING
THORACIC

LUMBAR

CN oxygenation (in % baseline)

* $p < .01$ (ThS vs. LbS)
paraspinal cnNIRS

CLINICAL RESULTS open TAAA repair

Near-infrared Spectroscopy Monitoring of the Collateral Network Prior to, During, and After Thoracoabdominal Aortic Repair: A Pilot Study

C.D. Etz a,b,*d, K. von Aspern a,d, S. Gudehus c, M. Luehr a, F.F. Girrbach a, J. Ender c, M. Borger a, F.W. Mohr a

Lumbar cnNIRS sensitive to
X-clamping & distal perfusion

Diminished lumbar cnNIRS =
postoperative SCI*
paraspinal cnNIRS

CLINICAL RESULTS MIS²ACE / TEVAR:

PAPAartis
fighting spinal cord injury
Near infrared spectroscopy (NIRS) monitoring of paraspinal muscles to reflect SCI: How Does it Work and initial results

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