Intra-operative pulse and blood pressure recordings from neurosurgeons. A pilot study of cardiovascular performance

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This paper deals with the cardiovascular response of neurosurgeons to the mental stress of performing an operation where the slightest error may result in an instantaneous loss of human life, professional reputation and self esteem apart from the institution of medicolegal litigation.
Introduction

Unique study

To compare neurosurgeons’

Pulse (P) and Blood pressure (BP) recordings

Intra-operative (IOP), rest (R) & exercise (Ex)
Prospective single blind comparative analysis

Inclusion criteria

Neurosurgeon > 5 years experience
Expertise in aneurysm clipping/ VS excision

Exclusion criteria

> 15% readings (rest) SBP/DBP > 140/90 mm Hg
Cardiovascular risk factor
Materials and Methods

Ambulatory blood pressure (ABP) device

*Cardiette BP one oscillometric monitor*

Preprogrammed to check P and BP
- 10 minutes intervals - IOP
- 20 minutes intervals - R
- Ex
Materials and Methods

**Hypertension grade**

<table>
<thead>
<tr>
<th>Grade</th>
<th>SBP (mmHg)</th>
<th>DBP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>140-159</td>
<td>90-99</td>
</tr>
<tr>
<td>Moderate</td>
<td>160-179</td>
<td>100-109</td>
</tr>
<tr>
<td>Severe</td>
<td>≥ 180</td>
<td>≥ 110</td>
</tr>
</tbody>
</table>

**Tachycardia:** $P > 100$ bpm
Materials and Methods

- **Variables**
  - SBP, DBP, MBP, P - Individual & pooled
  - Average & peak
    - Incidence of tachycardia
    - Abnormal BP readings (≥ 140/90 mmHg)
    - Episodes of severe hypertension (≥ 180/110 mmHg)

- **Statistical analysis**
  - Student’s paired t test & Chi square test
  - Statistical significance: P value ≤ 0.5

12/22/2009
Results

5 neurosurgeons – 11 surgical procedures

Average age: 40.2 years (33-55 years)

Average post residency experience: 10.4 years

During non call days: 154 readings

During exercise: 320 minutes

Intra-operative: 164 BP readings over 27 hrs
Pooled average data of cohort

- **SBP (mmHg)**
  - Rest: 116
  - Exercise: 116
  - Intra-operative: 140

- **DBP (mmHg)**
  - Rest: 75
  - Exercise: 89
  - Intra-operative: 103

- **MBP (mmHg)**
  - Rest: 89
  - Exercise: 98
  - Intra-operative: 116

- **Pulse Rate (bpm)**
  - Rest: 76
  - Exercise: 94
  - Intra-operative: 112
Pooled peak values of cohort

- SBP (mmHg)
  - Rest: 152
  - Exercise: 146
  - Intra-operative: 181

- DBP (mmHg)
  - Rest: 134
  - Exercise: 118
  - Intra-operative: 150

- Pulse Rate (bpm)
  - Rest: 103
  - Exercise: 171
  - Intra-operative: 122
Resting and Intra-operative MBP

- Average Resting (mmHg)
- 1 hour pre-op (mmHg)
- Peak intra-op (mmHg)
- Average intra-op (mmHg)
- 2 hour post-op (mmHg)
Abnormal Blood Pressure (SBP/DBP > 140/90 mmHg)

<table>
<thead>
<tr>
<th>P_{IOP/R}</th>
<th>P_{IOP/Ex}</th>
<th>Intra-operative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000^</td>
<td>0.000^</td>
<td>66.20%</td>
</tr>
</tbody>
</table>

- Rest: 8.10%
- Exercise: 31.10%
Severe Hypertension
(SBP/DBP >180/110 mmHg)

<table>
<thead>
<tr>
<th>$P_{IOP/R}$</th>
<th>$P_{IOP/Ex}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000^</td>
<td>0.149</td>
</tr>
</tbody>
</table>

- Rest: 3.30%
- Exercise: 18.80%
- Intra-operative: 28.00%
Episodic incidence of DBP >120 mmHg
Incidence of Tachycardia (>100 bpm)

<table>
<thead>
<tr>
<th></th>
<th>P_{IOP/R}</th>
<th>P_{IOP/Ex}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>4.60%</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
<td>68.80%</td>
</tr>
<tr>
<td>Intra-operative</td>
<td></td>
<td>32.90%</td>
</tr>
</tbody>
</table>
Peak and Average IOP
Blood Pressure and Pulse Rate

<table>
<thead>
<tr>
<th>Comparison of intra-operative variables</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak and average systolic blood pressure</td>
<td>0.000(^\wedge)</td>
</tr>
<tr>
<td>Peak and average diastolic blood pressure</td>
<td>0.039(^\wedge)</td>
</tr>
<tr>
<td>Peak and average mean blood pressure</td>
<td>0.007(^\wedge)</td>
</tr>
<tr>
<td>Peak and average pulse rate</td>
<td>0.001(^\wedge)</td>
</tr>
</tbody>
</table>

\(^\wedge\) Significant
Discussion

Physiology

Cardiovascular stress response

Vasomotor center - Sympathetic pre-ganglionic neurons

Mental stress activates limbic system

AV constriction, tachycardia and increased cardiac contractility
Discussion

‘Fight or Flight’ physiological response
Transient
Dissipates rapidly with the removal of stimulus

However, in the confines of an operating room
No rationale/ vent
Prolonged surgery- no escape

*Physiological response / pathological malresponse*
Discussion

*Mal-response* may adversely impact

- The health of the surgeon
- Judgment – jeopardize the patient’s health
Discussion

Literature

Hines et al (1936): Psychological stress - risk factor for hypertension
  *Am Heart J 1936; 11: 1–9*

Kivimäki et al: industrial employees
  2.2 x CV mortality in employees (high job stress)
  *BMJ 2002: 325, 857-863*

  ABP, 50 healthy surgeons (laboratory setting)
  *JAMA 1994; 272: 1724*
Discussion

Unique study

Pilot study of real-time operative stress

Significant cardiovascular mal-response to operative stress vis-à-vis rest and vigorous exercise
Limitations

Limited numbers *but emerging trends cannot be ignored*

Heterogeneity

Operator age and experience

Individual stress response reactivity
Radical Emerging Questions

Can high BP during surgery impair skill & judgment?

Simultaneous intra-operative recording of a neurosurgeon’s vitals?

Selection criteria for neurosurgical residency?

Extra compensation for neurosurgeons?
Discussion

Answers probably lie in

Mortality analysis

Morbidity analysis

Longevity studies

*Further prospective trials across ethnic lines*
Conclusions

1. Neurosurgeons experience *extreme and significant cardiovascular mal-response* following exposure to surgical stress vis-à-vis at rest and vigorous exercise.

2. Diastolic blood pressures exceed 120 mmHg during 10% of the operation period- sufficient to produce an intracranial hemorrhage.

3. This *stress induced mal-response* may pose a *serious long term occupational hazard* to health and longevity
Neurosurgeons have no leeway. What it comes down to is this: if a brain surgeon screws up, it means a multi-million-dollar malpractice suit, but if a rocket scientist screws up, it means a multi-million-dollar hit movie starring Tom Hanks.

*Michael J Fox*

*Lucky Man (2002)*
Thank You