Dysregulation in Blood Pressure Homeostasis during Spinal Anaesthesia in Elderly Patients

G Röhrle, S Wajserg*, JH Baumert, M Adt, AW Frey *
Institut für Anästhesiologie, Deutsches Herzzentrum Berlin, Augustenburger Platz 1, 13353 Berlin, Germany;
*Jüdisches Krankenhaus Berlin, Iranische Straße 2-4, 13347 Berlin, Germany; *Herz-Zentrum Bad Krozingen, 79188 Bad Krozingen, Germany

1. Introduction:
Cardiovascular stability is based under SPA non-invasively, using power spectral analysis of HRV.

HRV has been explored since the 18th century [1], but in the last decades it has become possible to investigate sympatho-vagal activity by computerized systems. The sympathetic, sensoric and motoric blockade in variable extension. Since 1898 SPA [9] is used to cause reversible interruption of homeostasis, transient lower extremity sympathectomy causes hypotension. This is accompanied by a variable regulatory response of the unaffected part of the body, that depends on quantity, quality and speed of application of the anesthetic drug [10]. In result, surgery of lower extremity, pelvis, perineum or lower abdomen is possible. With regard to homeostasis, transient lower extremity sympathectomy causes arterial dilation, which leads to a decrease in venous return and often to hypotension. This is accompanied by a variable regulatory response of the unaffected part of the body, that depends on the level of the autonomic block. In clinical practice, the anaesthesiologist tries to compensate hypotension by fluid infusion. Aim of our study was to investigate autonomic response to "sympathectomy" in lower body.

2. Methods:
35 elderly patients, who were scheduled for elective hernia repair or lower extremity surgery, were included. They were allocated to two groups, dependent on their blood pressure history: we investigated 19 normotensive patients (group N) and 16 hypertensive patients (group H). Not included in the study were patients, who had diseases with possible influence on the autonomic system: diabetes mellitus, cardio-pulmonary disease or any medication, which can influence the cardiovascular system directly. Premedication was performed with pethidine and promethazine i.m. 1 hour before surgery; atropine was not given. 2 ECG-recordings were made: the first recording was started after installation of an intravenous line and during infusion of colloids up to 100 ml; the second one after SPA, which has been performed with hyperbaric bupivacaine 0,5%. The mean level of analgesia was Th 10 (range L2 - Th7/8) by injection of 17.5 mg bupivacaine in mean in group N, versus Th 11 (range L2-Th6/7) by injection of 17.7 mg bupivacaine in mean in group H. Mean values of heart rate (HR), breathing rate (BR), systolic blood pressure (SBP) and RSA (as the relative part of respiratory variability) were compared before and after onset of SPA. Changes after SPA were reported as percentages of control values and were compared to them by Wilcoxon's test with p < 0.05 considered significant. Mann-Whitney U-test was used for comparison between the groups. As a control group, younger patients have been tested under the same conditions (group Y; n = 23, mean age 44,6 years), mean extension level of analgesia was Th 10/11 by injection of 18.1 mg bupivacaine in mean.

3. Results:
In both groups there were minor changes in HR and significant decreases in SBP. Differences between the groups occurred in BR and in RSA. As increases in BR and in RSA were shown in group N, only a moderate decrease in BR and no change in RSA appeared in the hypertensive patients. The change in RSA in normotensive patients was significant, as was the fall in SBP in both groups. The differences between the groups were not significant.

Table 1: mean values with standard deviation (SD) of the variables investigated in both groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group N (n=19)</th>
<th>Group H (n= 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ HR (%) + SD</td>
<td>+ 2.7 ± 8.0</td>
<td>+ 0.9 ± 10.7</td>
</tr>
<tr>
<td>Δ SBP (%) + SD</td>
<td>- 18.2 ± 12.2 *</td>
<td>- 18.4 ± 13.9 *</td>
</tr>
<tr>
<td>Δ BR (%) + SD</td>
<td>+ 8.6 ± 25.3</td>
<td>- 1.8 ± 11.5</td>
</tr>
<tr>
<td>Δ RSA (%) + SD</td>
<td>+ 10.7 ± 16.9 *</td>
<td>- 0.5 ± 16.6</td>
</tr>
</tbody>
</table>

HR = heart rate; SBP = systolic blood pressure; BR = breathing rate; RSA = respiratory sinus arrhythmia; SD = standard deviation; * = significant;

Abbreviations used: BR = breathing rate; HR = heart rate; HRV = heart rate variability; RSA = respiratory sinus arrhythmia; SPA = spinal anesthesia; SVRI = systemic vascular resistance index; N = normotensive elderly group; H = hypertensive elderly group; Y = normotensive young group;
Heart Rate Variability

Discussion:
Due to SPA there is a blockade of sympathetic vasomotor innervation followed by vasodilatation and hypotension in the lower part of the body. Therefore, the autonomic nervous system increases sympathetic tone and decreases vaso tone to the heart and to the unaffected part of the vascular bed, but full compensation to maintain homeostasis is not always successful. Therapeutical volume replacement to stabilize blood pressure is performed frequently. Results in group Y demonstrate the effects, expected [10]: moderate decrease in SPA and a marked, significant decrease in RSA occurred. In group N there is a marked, significant decrease in SBP in spite of fluid infusion; heart rate did not change either, but there is a significant, obviously paradoxical increase in vagal activity. These patients did not compensate SPA related hypotension and the given fluid infusion could not be used for maintaining blood pressure homeostasis. In group H there is also a marked, significant fall in SBP, but no change in RSA. As BR was increased in group N, there was a tendency to decrease in group H. In both groups there were significant decreases in SBP, but different effects on BR and on RSA, we suggest different mechanisms of failure for the unopposed reaction to SPA. In the elderly the arterial vessel system underlays on a higher sympathetic tone, but the heart is very sensitive to changes in intravascular volume. Secondly, arterial baroreceptors may respond less to hypotension: as a result elderly could not use fluid infusion to maintain homeostasis. Coe [11] has described this phenomenon in a former publication. His intention was to investigate, if there is any difference in SPA related hypotension in elderly without or with fluid infusion in different quantity. He suggested, that there were no different effects as to the incidence of hypotension. He found, that preloading with 16ml/kg of cristalloid fluid failed to maintain adequate SBP in several patients. By fluid infusion, only venodilatation, caused by subarachnoid block, could be compensated for the first 10 minutes. Critchley [12,13] demonstrated in his study in elderly, that there was a significant decrease in SVRI, rather than a decrease in cardiac output, that appeared to him to be the main reason for the decrease in SBP. The changes in SVRI were related closely to SBP and fluid administration appeared to him to cause a further decrease in SVRI, particularly in those patients, that failed to respond to colloid. He suggested, that volume loading before subarachnoid block caused peripheral vasodilatation and a decrease in SVRI, which may have been the result of increased peripheral flow or the effect of volume expansion on baroreceptors and volume receptors in the atria and great vessels.

The failure to compensate the decrease in blood pressure in group N may be explained by volume load to the heart with the consequence of increased vagal activity together with insufficient baroreceptor sensitivity not opposing this effect. As described by Radaelli [14], baroreflex sensitivity is reduced in hypertensive patients, resulting in impaired sympato-vagal balance. From our data, it is, however, not clear, why in group H, where the „vagal“ reaction to volume load is not seen, the decrease in systolic pressure is not different compared to group N. Possibly, an impaired baroreceptor function in sclerotic vessels is the main explanation for this finding.