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Initial bradycardia in hypotensive (hemorrhagic) patients in a prehospital setting – does it have a prognostic value?

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ABSTRACT

Introduction. *Some studies have shown that the presence of bradycardia in hemorrhage-caused-hypotension is associated with a better prognosis. The aim of this retrospective study was to compare bradycardic and tachycardic responses to hemorrhaging in a pre-hospital setting and to evaluate the outcome.*

Patients and methods. *All patiens were adults (>18 years) with tachycardia and bradycardia hypotension (hemorrhaging) in a pre-hospital setting. We compared a tachycardic group with a bradycardic group using the following criteria: age, gender, APACHE II on admission, trauma vs. non-trauma patients, outcome (survival) and the use of vasopressors.*

Results. *Over a two year period, 107 patients were screened. The tachycardic group was younger in age than the bradycardic group. Tachycardia was significantly more common in males. The bradycardic group had better APACHE II on admission and also better outcome (survival). Mortality was lower in bradycardic patients than in tachycardic patients.*

Conclusion. *Bradycardia is a real phenomenon in hemorrhaging patients in a prehospital setting. It might be associated with both better APACHE II on admission and better outcome.*

Key words: bradycardia, hypotensive (hemorrhagic) patients, prehospital setting, APACHE II, prognosis.

Introduction.

Traditional teaching associates increasing tachycardia with progressive hypovolemic shock and a decrease in heart rate as indicator of irreversible shock (terminal responsive) (1). Recent works support such a biphasic ("form M") pattern in response to hemorrhaging suggesting that the bradycardic response is reversible and not terminal,(2-13). The inability of the heart to respond to the shock with tachycardia has been described as relative bradycardia (2,15), paradoxical bradycardia (11) or the absence of tachycardia (1,12). Some clinical studies (15,16) and animal studies (6,23) have shown that the presence of relative bradycardia in hypotension (hemorrhaging) is associated with a better prognosis than the presence of tachycardia. The aim of this study was: to investigate whether preclinically registered bradycardia in hemorrhagic shock class II- IV is a real phenomenon and has a better prognosis than tachycardia, and if so, what are the possible explanations for it.

Patients and methods.

This is a descriptive, retrospective study. It took place in Maribor, a medium sized city with a population of around 180.000. The setting for this study was The Centre for Emergency Medicine (CEM), with an annual patient turnover of approximately 26.400. The study started in January 2002 and finished in February 2004. To be eligible for inclusion in the study, the patients had to have the following criteria:

- admission through CEM;
- systolic blood pressure of 90 mmHg or less;
- in-hospital confirmed traumatic or non-traumatic hemorrhage;
- class III – IV hemorrhagic shock ;
- tachycardia (> 100/min) or bradycardia (< 60/min);
- exclusion criteria: use of opiates before initial monitoring, coronary heart disease, the presence of left ventricular hypertrophy, the use of β-blockers and calcium channel antagonists, abuse of cocaine, cannabinoids or opiates, "athletic" bradycardia, ECG abnormality

(old or new AMI, sick sinus syndrome, AV-blocks, HLV, atrial fibrillation with bradycardia or tachycardia, intoxication, hypothermia, disturbance of electrolytes with ECG changes).

The initial data were collected from the pre-hospital protocol records and further data were obtained from the internal hospital records. We determined the incidences of patients with tachycardia and absolute paradoxical bradycardia. We compared the tachycardic group with the bradycardic group using the following criteria: age, gender, APACHE II on admission, trauma vs. non-trauma patients, outcome (survival) and the use of vasopressors. The cause of death (hemorrhagic shock) was confirmed at autopsy.

APACHE II was determined using criteria from the literature (17,18). At least 6 hours of hospitalization were required for determining the APACHE II scoring. As a matter of fact, the APACHE II was determined with all patients who were hospitalized at least 6 hours and had undergone all laboratory tests necessary for determining the APACHE II scoring. All patients in question were not hospitalized in ICU since they died in the process. Laboratory tests for all the patients and injured persons were carried out in the same laboratory.

To determine the incidence and mortality of tachycardia and bradycardia we defined patient subgroup according to the following criteria (15): age of 55 years or less; male versus female; APACHE II score >20 versus APACHE II score of 20 or less, blunt abdominal trauma versus other injuries.. Factors with p values <0.20 in the bivariate analysis were considered to be potentially related. These factors were then entered into a multivariate logistic regression analysis to derived adjusted relative mortality risk values for the two study groups.

We expressed incidence rates as percentages. Continuous data were expressed as median values with a range. Proportions were reported with 95% confidence interval. Analyses for categorical variables were performed using a χ^2-test (with Yates correction, if appropriate) and Fisher test. Comparisons between groups were performed using t-test (normally distribution) and Mann-Whitney test (normality test failed).

Analyses of independent predictors for survival from univariate analysis were performed using a multivariate logistic regression. For statistical analysis we used computer software SPSS12.01 Inc.Chicago, Illinois, USA and Systat software (Systat Inc.,Evanstan,IL,USA). Lifepak 12 – Medtronic Physiocontrol, Corporate Headquarters, Redmond, USA was used.for determination of parameters (blood pressure, heart rate, etc.).

Results.

During the two year period in pre-hospital settings, 107 patients had systolic blood pressure = or < 90 mmHg; 56 (52.3%) were tachycardic, 21 (19.6%) were normocardic and 30 (28.1%) were bradycardic. Table 1 presents the differences between the tachycardic and bradycardic hypotension group of patients according to demographic, clinical and APACHE II on admission.

The tachycardic group was younger in age than the bradycardic group. Tachycardia in hypotensive patients was significantly more common among males. The bradycardic group had better APACHE II on admission and better outcome (survival). Hospital mortality was lower in bradycardic patients (4 out of 26= 13.3%) than in tachycardic patients (14 out of 42= 33,3%), (p=0,008). All together, 18 patients died, 7 of whom died in the operating room, 8 died within 24 hours in ICU and 3 after 24 hours, also in ICU. The primary cause of death of the patients in the operating room and 6 of those that died in less than 24 hours was hemorrhagic shock. Based on the 86 patients, the overall crude death rate was 33,3% among tachycardic patients (14 out of 42) and 13,3% among bradycardic patients (4 out of 26) for relative risk 1.83 (95% CI = 1.31 – 2.29; p = 0.019).

Bradycardia in hypotensive patients was significantly more common among patients with blunt abdominal trauma (12 out of 29 patients) with gynecological bleeding, ectopic pregnancy, hemorrhagic ovarian cysts and postoperative bleeding (6 out of 17 patients)

Table 1. Clinical, demographic and APACHE II scoring characteristics of a tachycardic and a bradycardic group of patients.

	Bradycardic group	Tachycardic group	P –value
Age	56,8 +/- 18,7	41,7 +/- 15,7	0,02
Gender (male/female)	18/12	49/7	0,008
Trauma / non-trauma	15/15	25/31	0.58
APACHE II (average)	14,2 +/- 6,3	23,6 +/- 12, 8	0.032
Vasopressors (Y /N)	9 / 21	19 / 37	0.63
Endotracheal intubation (Y / N)	8 /23	25 /31	0,01
Outcome (survive / death)	26 / 4	42 / 14	0,0008

and patients with nontraumatic bleeding from gastrointestinal tract (10 out of 19) patients. In other injuries (head, thorax and extremities) 2 out of 19 patients had a bradycardic response. By comparing tachycardic and bradycardic patients we established that the adjusted relative mortality risk was significantly lower in the bradycardic patients and:

- patients with APACHE II = or > 20 (odds ratio=1,65; 95% CI 1.12 – 1.97; p=0.013)
- patients older then 55 years (odds ratio=1.56; 95% CI 1.21 – 1.85; p=0.034)
- patients with blunt abdominal injury (odds ratio=2,41; 95% CI 1.32 –3.65; p=0.037).

Discussion.

The results of our clinical research have shown the following:

a) in case of hypotensive hemorrhage, bradycardia is a real phenomenon as indicated by the incidence of 28,1% in our study,

b) the group of patients with bradycardia (28 out of 30) is classified within the group of patients with abdominal bleeding,

c) patients with bradycardia have better APACHE II and bigger chances of survival than patients with tachycardia.

Bradycardic hypotension is a common presentation in hypotensive hemorrhaging. The incidence in our study was 28.1%! Demetriades et al. (15) in a study with 750 hypotensive trauma patients reported an incidence of 28.9% (they defined relative bradycardia as an admission blood pressure = or < 90 mmHg and a pulse rate = or < 90 beats per minute). Barriot and Riou (11) in a study involving 273 patients with severe traumatic or non-traumatic shock (systolic blood pressure < or = 70 mmHg) found an occurrence of an absolute paradoxal incidence (pulse = or < 60 beats per minute). In our study the incidence was 8.4% with these strict criteria! Whitwell and Clancy (16) reported similar incidences. In the largest series (13), 29% of 750 major trauma patients with systolic blood pressure = or < 90 mmHg exhibited relative bradycardia (heart rate = or < 90/min). Thompson (22) reported an incidence of 35,2 % among hypotensive trauma patients (criteria: systolic blood pressure < 100 mmHg with pulse < 100/min). Hick et al. (20) reported an incidence of 37% in patients with hemoperitoneum, resulting from the ruptured ectopic pregnancies (criteria: systolic blood pressure = or < 90 mmHg and heart rate = or < 100/min).

The case of relative bradycardia is not clear. Some authors suggested, that the presence of blood in the peritoneal cavity may trigger a parasympathetic reflex (vagus nerves, pelvic parasympathetic nerves) (2,13). Demetriades et al. (15) detected a greater number of patients with bradycardic hypotension who had major abdominal trauma, including rupture. In our study we also detected a significantly greater incidence of bradycardic hypotension in blunt abdominal trauma than in other injuries.

Thompson (22) showed there is no difference in the incidence of the relative bradycardia among isolated extremity injuries and isolated penetrating abdominal trauma. Thus the theory of peritoneal irritation and parasympathetic stimulation becomes questionable.

Barriot and Riou (11) suggested that paradoxical bradycardia indicates rapid and major hemorrhaging more specifically than in patients with tachycardia, and that bradycardia, in acute hypotonic shock, is similar to the events associated with a vasovagal faint (1). The effects of hemorrhaging on the heart rate have been investigated in cats by Oberg and Thoren (23). They noted an increase in the heart rate during moderate bleeding. At the time of a decrease in blood pressure, heart rate frequently decreased. Reinfusion of blood resulted in tachycardia. Direct stimulation of cardiac afferents elicited bradycardia, which could also be elicited by partial occlusion of the aorta; by an intrapericardial injection of nicotine. With this knowledge, they suggested that bradycardia during hemorrhaging may be due to a vagal-vagal reflex arch involving nicotine sensitive mechanoreceptors located in the ventricles. Thus the reflex is possibly an explanation for bradycardia in extraabdominal bleeding!

Kawase et al. (6) investigated heart rate variability during massive hemorrhaging and progressive hemorrhagic shock in dogs. They concluded that massive bleeding caused two types of heart rate response: bradycardia followed by tachycardia and tachycardia only. In the bradycardic group (by spectral analysis of heart variability) both low-frequency (LF) and high frequency (HF) increased after massive hemorrhaging, but during progressive hemorrhagic shock these components decreased while the heart rate increased. In the tachycardic group LF increased after massive hemorrhaging, but during progressive hemorrhagic shock LF decreased with continuous suppression of HF. The authors suggested that the bradycardic group was more inclined towards parasympathetic nervous activity than the tachycardia group. In the bradycardic group parasympathetic nervous activity might have been activated to prevent cardiac collapse and then the sympathetic activity might have been activated to keep the autonomic balance thereafter. In progressive hemorrhagic shock the heart rate increased and sympathetic-parasympathetic nervous activities were suppressed in both groups.

Jacobson et al. (8) suggested that a reversible hypovolemic shock is associated with bradycardia and that hypovolemic shock with tachycardia may present a transition to an irreversible stage.

Oberg and Thorg (23) argued that such results are the effects of the protective role of bradycardia, which reflexively increases ventricular diastolic filling.

The increased parasympathetic activity in bradycardia may be associated with better tissue perfusion attributable to peripheral vasodilatation (1,6, 14).

Regardless of the mechanism (vagus nerves, pelvic parasympathetic nerves, nicotine sensitive mechanoreceptors located in the left ventricle, two types of response to hemorrhage with sympathetic-parasympathetic balance or other causes), the absence of tachycardia in hemorrhagic hypotensive patients is a real phenomenon .

Results of the research might confirm

the theory that the bradycardic response is characteristic of abdominal bleeding and is caused by the parasympathetic reflex. The reason for a better outcome for patients with bradycardia is perhaps the better reflexive filling of ventricles in diastole, better perfusion of the tissue due to vasodilatation (vagus) or activation of the parasympathetic nervous system before the sympathetic, which has a protective effect.

Our study had strong limitations. This retrospective study was limited by the small number of patients included. We are aware that the retrospective setting in which our study was conducted dilutes the value of our conclusions but, in a field in which there are few clinical investigations, we believe that the study provides additional data that may help to improve recognition of this phenomenon in the prehospital setting and outcomes in patients with hemorrhagic hypotension.

There was a mixture of trauma and non-trauma patients (the characteristics of trauma patients are different from those of non-trauma patients; those suffering from a disease). This method is similar to that of Barriot and Riou (11). The relative physical condition of the patients prior to the shock episode was evaluated against the history of morbidity (of patients or relatives). The data, given by the relatives, regarding the physical condition of the patients before the occurrence of shock was not reliable and therefore was possibly an added limitation to our studies. Our finding that the bradycardic group was significantly older perhaps speaks in favor of the deduction that, to a lesser extent, bradycardia is the result of the physical fitness of the patients.

Conclusion: A bradycardic response concerning the hypotensive hemorrhage is a real phenomenon and is by far the most frequent in abdominal bleedings. Patients with bradycardia have a better prognosis.

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