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RELATIONSHIP BETWEEN EJECTION FRACTION AND BAROREFLEX SENSITIVITY IN PATIENTS AFTER MYOCARDIAL INFARCTION

HONZÍKOVÁ N. [1], FIŠER B. [1], SEMRÁD B.[2]

[1]Department of Physiology and [2]First Department of Internal Medicine – Cardiology, Faculty of Medicine, Masaryk University, Brno

A b s t r a c t

Baroreflex sensitivity expressed in ms/mmHg (BRS) is correlated with the pulse interval (PI) in healthy subjects, but is PI-independent when expressed in Hz/mmHg (BRSf). The relationship between the ejection fraction (EF) and BRS and BRSf values in patients after myocardial infarction (MI) was the aim of the present study.

BRS and BRSf were determined by spectral analysis of PI and systolic blood pressure fluctuation in 117 patients, 7 to 14 days after the first signs of MI. EF was determined by echocardiography.

At EF between 40–70% (n=92), BRS and BRSf remained constant (mean±SD: 5.5±3.38 ms/mmHg, 0.00779±0.00511 Hz/mmHg). At EF 30–40% (n=17), lower values of BRS and BRSf were observed (BRS: 58.1±48.5%, BRSf: 67.5±54.7% of the values at high EF). The difference between BRS and BRSf was significant ($p<0.05$). At EF 20–30% (n=8), the values of BRS and BRSf were similarly lower (BRS: 33.9±23.6%, BRSf: 34.9±21.3% of the values at high EF).

The results show that the values of the PI-dependent BRS correspond to the baroreceptor sensitivity and to the activity of the autonomic nervous system, altered at EF below 40%. The PI-independent BRSf corresponds only to the baroreceptor sensitivity decreased at very low EF, probably due to an aldosterone influence.

K e y w o r d s

Baroreflex sensitivity, Spectral analysis, Myocardial infarction, Ejection fraction, Heart failure

INTRODUCTION

After myocardial infarction (MI) patients are at risk of cardiac death (CD). Prediction of the risk of CD is currently important, because implantation of a cardioverter may provide protection against it. Many indices of cardiac and circulatory functions have been investigated to determine their predictive role. Many studies, and especially the multicentre ATRAMI study *(1),* have shown that increased sympathetic and/or decreased parasympathetic autonomic nervous system activity (indicated by a decrease in baroreflex sensitivity, BRS) and decreased contractility (indicated by a decrease in the ejection fraction, EF) are two of the three most important independent predictors of the risk.

In most studies, baroreflex sensitivity is expressed in ms/mmHg, and this index is correlated with the pulse interval (PI) in both healthy subjects and in

patients after MI *(2).* BRS mainly reflects the heart rate baroreflex component, including parasympathetic and sympathetic tonic nervous activity, and the sensitivity of receptors.

Baroreflex sensitivity, when expressed in Hz/mmHg (BRSf), is PI independent *(3)* but, in children, it decreases with age, as does the compliance of arteries *(4).* BRSf correlates with the second value obtained by repeated investigation after a 1-year interval, as was shown by the examination of 88 young adults (4). It seems that BRSf corresponds more to the sensitivity of baroreceptors than to a central gain of the baroreflex. In patients after MI, both the activity of the parasympathetic autonomic nervous system and the sensitivity of baroreceptors may be impaired.

In many patients after MI, the number of risk factors increases and, therefore, the overall risk to patients is increased. Decreased contractility, indicated by a decrease in the ejection fraction under 40% *(5),* is one of these risk factors. In heart failure, not only an increased sympathetic activity may be present, but also a decreased excitability of the baroreceptors. It has been demonstrated in dogs with experimental heart failure that the depressed carotid sinus baroreceptor reflex is a result of depressed baroreceptor responsiveness and of a poor end-organ response *(6).* The aim of the present study was to establish the relationships between EF and BRS and EF and BRSf in patients after myocardial infarction.

MATERIALS AND METHODS

We studied 117 patients (56.8±9.0 years old) 7 to14 days after the first signs of myocardial infarction. The diagnosis of acute myocardial infarction was based on conventional clinical, electrographic and enzymatic criteria.

Indirect, continuous blood pressure recordings from finger arteries (Finapres, Ohmeda), lasting for 3 min, were performed in sitting and resting patients between 9 a.m. and noon. Recordings were taken during spontaneous and synchronised breathing. During the latter, the rhythm of breathing was controlled by metronome (0.33 Hz; 20 breaths per min) but the subjects were allowed to adjust the tidal volume according to their own comfort. Beat-to-beat values of systolic pressure and pulse intervals were measured for further analysis. For spectral analysis, the parameters were linearly interpolated and equidistantly sampled at 2 Hz. The linear trend was removed. The auto-correlation and cross-correlation functions, power spectra and cross-spectra, coherence and the modulus between pulse intervals and systolic pressure were calculated. The gain factor, e.g., modulus of the transfer function between variations in systolic blood pressure and PI at a frequency of 0.1 Hz, was taken as the index of BRS (ms/mmHg) *(7).* The values of BRS were taken into account only if the coherence between systolic blood pressure and PI at 0.1 Hz was higher than 0.5 Hz. Sensitivity of the baroreflex was also expressed in Hz/mmHg as BRSf *(8).*

EF was determined by a two-dimensional echocardiogram (Accuson 128 XP/10).

The patients were separated into 5 groups according to EF (EF value, number of patients: group 1, 20–29%, 8; group 2, 30–39%, 17; group 3, 40–49%, 37; group 4, 50–59%, 38; group 5, >60%, 17). The difference between BRS and BRSf in each group was tested by the Wilcoxon test for paired values.

RESULTS

The values (mean±SD) of BRS and BRSf calculated for the five groups are presented in *Table 1*. At EF of 40–70% (groups 3 to 5, n=92), BRS and BRSf remained constant (5.5±3.38 ms/mmHg and 0.00779±0.00511 Hz/mmHg). These values were taken as 100% and compared with those in lower EF ranges (groups 1 and 2) and the relative decrease in BRS and BRSf values was calculated. At EF of 30–40% (group 2, n=17), lower values of BRS and BRSf were observed (58.1±48.5% and 67.5±54.7% of the values at high EF). The difference between BRS and BRSf was significant ($P<0.05$). At EF of 20–30% (group 1, n=8), the values of BRS and BRSf were similarly lower (33.9±23.6 % and 34.9±21.3% of the values at high EF). These results are illustrated in *Fig. 1*.

DISCUSSION

Our results support the hypothesis that the value of baroreflex sensitivity is not a fully independent factor in patients after MI; it responds to a decrease in EF value lower than 40%. The relatively decrease of BRS than BRSf at EF below 40% might have indicated the primarily altered gain of the heart rate baroreflex component of the autonomic nervous system activity, which is accompanied by an alternation of the sensitivity of baroreceptors for even lower EF. Our results are in agreement with the experiments in dogs. Depressed responsiveness of the sinus node to an increase in pressure and to cholinergic stimuli was proven in heart failure experimentaly induced in dogs *(9)*. Ouabain administration increases the sensitivity of the carotid sinus node in heart failure in dogs *(10)*. It can be speculated that, in our patients, there was an increased activity of aldosterone, which is present in heart failure. Aldosterone diminishes the baroreceptor's sensitivity by activation of Na^+-K^+ ATPase. Therefore, the effect of aldosterone can also be involved in the decrease in baroreflex sensitivity found in our study. It was also shown in dogs that a depressed baroreceptor reflex in heart failure was not solely the result of depressed baroreceptor responsiveness but might have been related to poor end-organ responses *(6)*.

A c k n o w l e d g e m e n t s

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Honzíková N., Fišer B., Semrád B.

VZTAH MEZI EJEKČNÍ FRAKCÍ A CITLIVOSTÍ BAROREFLEXU U PACIENTŮ PO INFARKTU MYOKARDU

S o u h r n

Citlivost baroreflexu vyjádřená v ms/mmHg (BRS) koreluje u zdravých lidí s pulsovým intervalem (PI). Je-li vyjádřená v Hz/mmHg (BRSf), je na PI nezávislá. Cílem této práce bylo sledování vztahu mezi ejekční frakcí (EF) a BRS a BRSf.

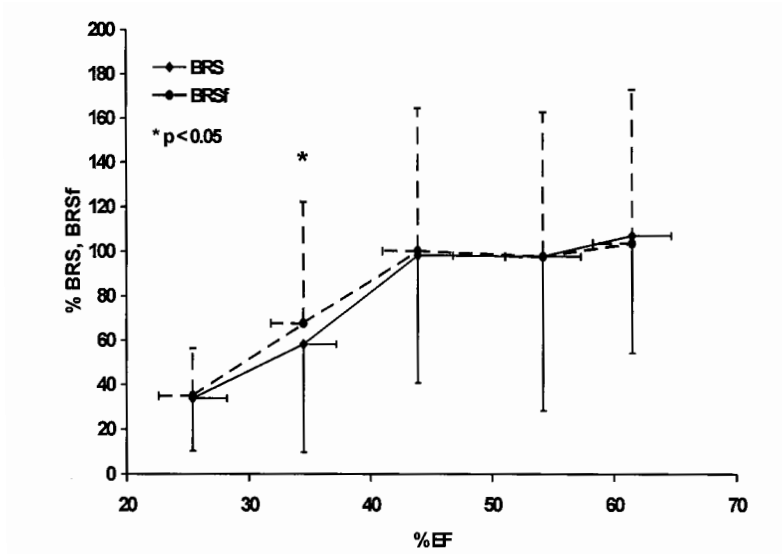

Fig. 1

Relationship between the ejection fraction (EF) and two indices of baroreflex sensitivity, BRS and BRSf , expressed in %. The mean values of BRS and BRSf at EF in the range of 40-70% are taken as 100%.

Table 1

Groups of patients according to the ejection fraction (EF) and the corresponding baroreflex sensitivity values expressed in ms/mmHg as BRS and in Hz/mmHg as BRSf

EF mean±SD [%]	BRS mean±SD [ms/mmHg]	BRSf mean±SD [Hz/mmHg]
25.4±2.8	1.9±1.3	0.0027±0.0017
34.5±2.7	3.1±2.6	0.0053±0.0043
43.9±2.9	5.4±3.1	0.0078±0.0050
54.2±3.1	5.4±3.8	0.0076±0.0051
61.5±3.2	5.9±2.9	0.0081±0.0054

BRS a BRSf byly určeny pomocí spektrální analýzy kolísání PI a systolického krevního tlaku (Finapres, záznam 3 min., regulované dýchání 0.33Hz) u 117 pacientů 7–14 dnů po prvních příznacích infarktu myokardu. EF byla stanoven echokardiograficky (Accuson).

Při EF mezi 40–70% (n=92) se BRS a BRSf nemění (střední hodnota±SD: 5.5±3.38 ms/mmHg, 0.00779±0.00511 Hz/mmHg). Při EF 30–40% (n=17) byly pozorovány nižší hodnoty BRS a BRSf (BRS: 58.1±48.5%, BRSf: 67.5±54.7% hodnoty při vysoké EF). Rozdíl mezi BRS a BRSf byl signifikantní ($p<0.05$, Wilcoxonův test pro párové hodnoty). Při EF 20–30% (n=8) byly hodnoty BRS a BRSf podobně nízké (BRS: 33.9±23.6%, BRSf: 34.9±21.3% hodnoty při vysoké EF).

Výsledky podporují hypotézu, že hodnoty BRS závislé na PI odpovídají citlivosti baroreceptorů a aktivitě autonomního nervového systému, které jsou změněny při EF 30–40%. BRSf, která je na PI nezávislá, odpovídá pouze sensitivitě baroreceptorů a je snížena při velmi nízké EF, snad vlivem aldosteronu.

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