

BALNEAL THERAPY AND BAROREFLEX SENSITIVITY IN CHILDREN WITH BRONCHIAL ASTHMA

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Abstract

The balance between the reflex and tonic autonomic control of the heart with special respect to baroreflex sensitivity in children with bronchial asthma was the aim of this study. We examined 15 children with a diagnosis of bronchial asthma at the beginning (group A1) and after 6 weeks of balneal therapy (group A2), and a control group of 45 healthy children, age and sex matched. BRS measurement (spectral method, Finapres blood pressure monitoring for 5 minutes, metronome controlled breathing 0.33 Hz) was performed in each subject. We calculated the mean value \pm SD of the following variables: age, mean pulse interval (PI), systolic and diastolic blood pressures (SBP, DBP), baroreflex sensitivity expressed in ms/mmHg (BRS) and in Hz/mmHg (BRSf), body height and weight, and body mass index (BMI). Spearman correlation coefficient, Mann-Whitney test, and Wilcoxon test were used for statistical analysis.

Results: In both groups, height correlated with age (controls: $r=0.7560$, $p<0.01$, group A1, A2: $r=0.6324$, $p<0.05$). An age-dependent increase of SBP ($r=0.4872$, $p<0.01$) and PI ($r=0.4578$, $p<0.01$) and a decrease of BRSf ($r=-0.4685$, $p<0.01$) were found in the control group. None of these parameters correlated with age in children with bronchial asthma before balneal therapy (A1). In controls, age-dependent development of SBP and PI was not accompanied by any significant change of BRS, but BRS correlated with mean pulse interval ($r=0.4214$, $p<0.01$). Correlation between BRS and mean PI was not present in asthmatic children before balneal therapy. The relationships between BRS and PI ($r=0.6571$, $p<0.01$) and between SBP and age ($r=0.5577$, $p<0.05$) were normalised after 6 weeks of balneal therapy.

Conclusion: We found the age-dependent values of circulatory parameters (PI, SBP) with the exception of BRS in the control group. We did not find any age-dependent development of these circulatory parameters in children with bronchial asthma. In addition, no correlation between PI and BRS was present in asthmatic children, either. It seems that these changes in asthmatic children are not stable, because they were partially readjusted during the 6 weeks' balneal therapy. We conclude that the relationship between BRS and PI is a very sensitive indicator of balance between the tonic and reflex autonomic control of the heart.

Key words

Bronchial asthma, Baroreflex sensitivity, Balneal therapy, Spectral analysis

INTRODUCTION

Bronchial asthma is the most common chronic lung disease not only in children and adolescents. It is defined as reversible obstruction of large and small airways due to hyperresponsiveness to various immunologic and non-immunologic stimuli. The disease is intermittent and characterised by recurrent episodes of cough, chest tightness, dyspnoea, and wheezing. Three major pathological events contribute to airway obstruction: mucosal oedema with inflammation, smooth muscle contraction, and production of thick, tenacious mucus. These symptoms are reversible spontaneously or by treatment (1).

The influence of bronchial asthma on the autonomic nervous control of circulation is poorly understood. The measurement of baroreflex sensitivity is a sensitive method for the estimation of dysbalance of the autonomic nervous system; for example it was shown that the baroreflex control may have a diagnostic as well as a prognostic value in several forms of disease, including myocardial infarction (2), heart failure (3), hypertension (4), and diabetes mellitus (5).

The balance between the reflex and tonic autonomic control of the heart with special respect to baroreflex sensitivity in children with bronchial asthma was the aim of this study.

MATERIALS AND METHODS

SUBJECT POPULATION

We examined 15 children (mean age \pm SD: 12.9 \pm 1.5 years, range 11–15 years) with a diagnosis of bronchial asthma. This examination was held at the beginning (group A1) and after 6 weeks of balneal therapy (group A2) in the Paediatric Health Centre in Luhačovice.

Balneal therapy included: drinking of the "Vincentka" mineral water 2x100ml daily, inhalation of "Vincentka" 2x10 ml daily, bath in mineral water 3x20 minutes weekly, rehabilitation in groups daily, and dietary therapy.

We estimated a control group of 45 healthy children, age and sex matched in a relationship of 3 controls to one diseased child. The characteristics of the study groups are shown in *Table 1*.

The study was approved by the institutional ethics committee, and the parents of each child gave their informed consent.

PROTOCOL

We recorded the pulse interval (PI), systolic (SBP) and diastolic blood pressure (DBP) beat-to-beat on finger arteries by the Peñáz non-invasive method (Finapres, OHMEDA, USA) in all children. The recordings were taken in a sitting resting position during a 5-minute period. Breathing was synchronised by a metronome at 20 breaths per minute (0.33 Hz) and the subjects were allowed to adjust the tidal volume according to their own comfort.

BAROREFLEX SENSITIVITY DETERMINATION

The baroreflex sensitivity, assessed on the basis of spectral analysis (6), was expressed in ms/mmHg and in Hz/mmHg (7). The gain factor, e.g. modulus $H(f)$ of the transfer function among variations in systolic blood pressure and pulse intervals, was calculated at a frequency of 0.1 Hz according to the formula: $H(f) = G_{xy}(f)/G_x(f)$, where $G_{xy}(f)$ corresponds to the cross-spectral density between systolic blood pressure and pulse intervals, and $G_x(f)$ corresponds to the spectral

Table 1

Characteristics of study groups

	Control group (C)	Groups of patients (A1 – A2)
Age (years)	12.9±1.5	12.9±1.5
Body weight (kg)	48.3±11.8	50.8±12.3
Body height (cm)	161.2±10.7	156.9±11.7
MI (kg/m ²)	18.3±2.6	20.4±3.1

Values are presented as mean ± standard deviation; BMI – body mass index.

A1 – A2 – characteristics of the groups of children with bronchial asthma at the beginning (A1) and after 6 weeks of balneal therapy (A2). No significant differences were found between controls and patients. The growth parameters did not change during this period of balneal therapy.

Table 2

Characteristics of circulatory parameters and baroreflex sensitivity

Group	C	A1	A2
PI (ms)	697.5±96.1	799.3±117.4**	732.3±134.3 +
SBP (mmHg)	110.9±12.8	88.2±8.1**	90.5±8.3**
DBP (mmHg)	67.9±9.8	48.8±11.2**	51.5±5.2**
BRS (ms/mmHg)	9.6±3.9	12.4±5.8*	6.9±3.7* ++
BRSf (Hz/mmHg)	0.01976±0.00718	0.01639±0.00845	0.0102±0.0039** ++

Values are presented as mean ± standard deviation; PI – pulse interval, SBP and DBP-systolic and diastolic blood pressure, BRS and BRSf – baroreflex sensitivity expressed in ms/mmHg and in Hz/mmHg, C – control group of healthy children, A1–A2 – the groups of children with bronchial asthma before (A1) and after 6 weeks of balneal therapy (A2).

Statistical analysis: * p<0.05; ** p<0.01: C versus A1, C versus A2 (Mann-Whitney test);

+ p<0.05; ++ p<0.01: A1 versus A2 (Wilcoxon test)

density of systolic blood pressure. The value of the modulus at a frequency of 0.1Hz was taken as a measure of baroreflex sensitivity, BRS (ms/mmHg).

Using the same formula, the modulus at a frequency of 0.1 Hz was also calculated for the instantaneous value of the heart rate and systolic blood pressure as the second index of baroreflex sensitivity (BRSf, expressed in Hz/mmHg).

STATISTICAL ANALYSIS

The mean values and standard deviations of pulse intervals, SBP and DBP, baroreflex sensitivity (BRS and BRSf), and body growth parameters (body weight, height, body mass index – BMI) were determined. Differences among the mean values were tested by the Mann-Whitney test. Wilcoxon test was used for searching of differences between the groups before and after 6 weeks of balneal therapy. The correlations among the parameters were evaluated by Spearman's correlation coefficient.

RESULTS

The mean values±standard deviation of circulatory parameters (PI, SBP, DBP) and of baroreflex sensitivity (BRS, BRSf) for the study groups are shown in *Table 2*.

In both groups, body height correlated with age (*Table 3*). Changes of characteristics, which are age-dependent, such as an age-dependent increase of SBP and prolongation of PI and decrease of BRSf were found in the control group. None of these parameters correlated with age in children with bronchial asthma before balneal therapy (A1).

In controls, the age-dependent development of SBP and PI was not accompanied by any significant change of BRS, but BRS correlated with mean pulse interval (*Fig.1a*). Correlation between BRS and mean PI was not present in asthmatic children before balneal therapy (*Fig.1b*). The relationships between BRS and PI (*Fig.1c*) and between SBP and age (*Table 3*) were normalised after 6 week's of balneal therapy.

Table 3

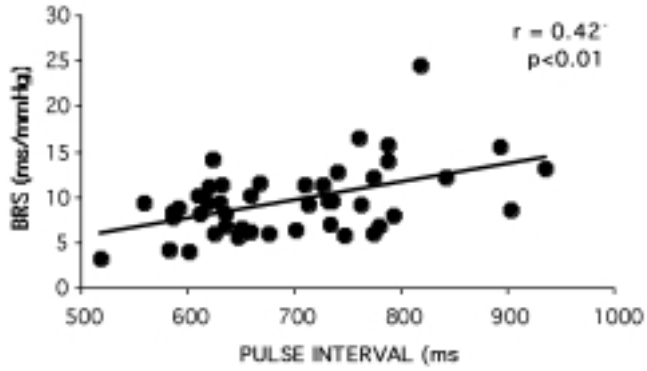
Correlations of study parameters with age

Group	C	A1	A2
Body height	0.7560 **	0.6324 *	0.6324 *
Body weight	0.7204 **	0.1824	0.1824
Body mass index	0.4950 **	-0.0401	-0.0401
Pulse interval	0.4578 **	-0.0785	-0.2334
Systolic BP	0.4872 **	0.3456	0.5577 *
BRS	0.0097	-0.0492	-0.0274
BRSf	-0.4685 **	-0.1039	-0.1232s

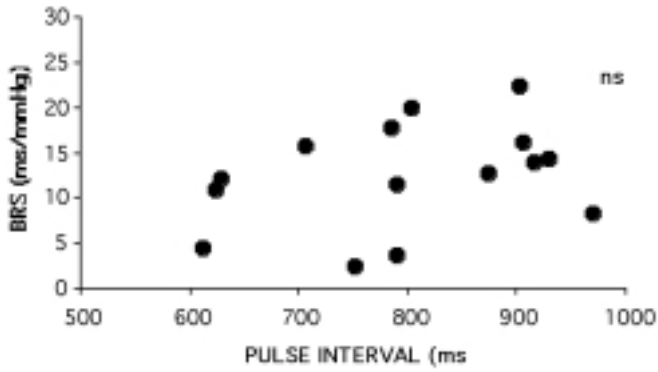
Values are presented as Spearman's correlation coefficient; systolic BP - systolic blood pressure, BRS and BRSf - baroreflex sensitivity expressed in ms/mmHg and Hz/mmHg, C - control group, A1 - A2 - groups of children with bronchial asthma before (A1) and after 6 weeks of balneal therapy (A2).

Statistical evaluation: * p<0.05; ** p<0.01

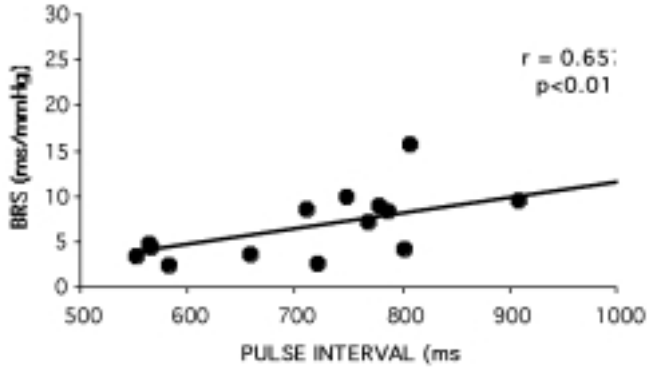
1a)



1b)



1c)



Figs 1 a – c

Correlations between baroreflex sensitivity (BRS) and mean pulse interval in controls (1a), group of asthmatic children before – A1 (1b) and after 6 weeks of balneal therapy – A2 (1c).

Statistical analysis: p, ns – not significant, r – Spearman's correlation coefficient

DISCUSSION

We found the age-dependent values of circulatory parameters (pulse interval, systolic blood pressure) with the exception of baroreflex sensitivity (BRS) in the control group. This finding supports the results of our previous study (8).

We did not find any age-dependent development of these circulatory parameters in children with bronchial asthma. In addition, no correlation between PI and BRS was present in asthmatic children, either. It seems that these changes in asthmatic children are not stable, because they were partially readjusted during the 6 weeks' balneal therapy. We conclude that the relationship between BRS and PI is a very sensitive indicator of balance between the tonic and reflex autonomic control of the heart.

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VLIV LÁZEŇSKÉ LÉČBY NA CITLIVOST BAROREFLEXU U DĚTÍ S ASTHMA BRONCHIALE

Souhrn

Ve studii jsme hodnotili vzájemné vztahy citlivosti baroreflexu (BRS) a oběhových parametrů (tepový interval – PI, systolický a diastolický krevní tlak – SBP, DBP) u dětí s asthma bronchiale. Sledované parametry jsme získali neinvazivním měřením krevního tlaku tep po tepu přístrojem Finapres, Ohmeda u 15 dětí (věk \pm SD:12,9 \pm 1,5 let) v klidovém stadiu asthma bronchiale, a to na začátku (skupina A1) a po 6 týdnech lázeňské léčby (skupina A2). S ohledem na věk a pohlaví bylo k nim párově (v poměru 3:1) vybráno 45 zdravých dětí (kontrolní skupina C). Pomocí spektrální analýzy kolísání PI a SBP jsme stanovili baroreflexní citlivost srdce (BRS v ms/mmHg; BRSf v Hz/mmHg). Dále jsme počítali průměrné hodnoty a směrodatné odchylky oběhových i růstových parametrů (výška, hmotnost, index tělesné hmotnosti – BMI).

V kontrolní skupině se s věkem prodlužoval PI ($p < 0.01$), rostl SBP ($p < 0.01$) a klesala BRSf ($p < 0.01$). U astmatických dětí před lázeňskou léčbou nesouvisel s věkem žádný z těchto parametrů. U zdravých dětí korelovala také BRS s průměrným PI ($p < 0.01$). V obou skupinách korelovala výška s věkem (kontroly $p < 0.01$, astmatici $p < 0.05$). Na konci lázeňské léčby jsme našli u dětí s asthma bronchiale obnovené korelace mezi BRS a průměrným PI ($p < 0.01$) a mezi SBP a věkem ($p < 0.05$).

U astmatiků na začátku lázeňské léčby jsme nenašli charakteristiky vývoje oběhových veličin (PI, SBP) a BRSf, ani charakteristický vztah BRS k PI. Zdá se však, že tyto změny nejsou fixovány, protože se v průběhu šestitýdenního pobytu v lázních částečně upravily. Studie navíc ukazuje, že vyšetření citlivosti baroreflexu ve vztahu k tepovému intervalu je citlivým ukazatelem vyváženosti tonického a reflexního působení autonomního nervového systému na srdce.

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