QRS Complex Characteristics in Patients with Eisenmenger Syndrome with Pre- and Post-Tricuspid Defects

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Abstract. *Eisenmenger syndrome (extreme pulmonary arterial hypertension due to congenital shunt lesion) results in severe right ventricular (RV) pressure overload. Patients´ prognosis depends on RV morphology and function and differs according to the shunt location. The aim of this study was to compare the echocardiographic and ECG signs of right ventricular hypertrophy (RVH) in patients with different location of the defect. The study population consisted of 43 patients (30F/13M, median age 41 years). The ECG and echocardiographic (ECHO) parameters as well as the serum N-terminal brain natriuretic peptide concentration (NTpBNP) were analyzed in a group of patients with pre-tricuspid (pre-TD) and post-tricuspid (post-TD) locations of defects. Sokolow-Lyon index for RVH and Butler-Leggett index exceeded the upper normal limits, however there were no significant differences between groups. Significant difference was found in QRSmax (16.6±6.8 vs 25.2±8.9mm). The RV wall thickness showed severe hypertrophy in both groups, significantly more prominent in the post-TD group (8.7±2.1 vs 10.4±2.9mm). The RV diameter showed significant dilatation in the pre-TD group (42.9±10.05 vs 28.5±6.9mm). ECG indexes correlated significantly ($p<0.0001$) with ECHO RV wall thickness. The NTpBNP concentrations exceeded the upper normal limits considerably in both groups, without significant difference between the groups. Despite significant difference in morphological RV configuration (hypertrophy and dilatation) between groups according to defect location and significant correlation of ECG and ECHO parameters, ECG criteria for RV hypertrophy did not differ between the groups, suggesting that the morphological configuration of RV was not the main factor influencing the QRS patterns.*

Keywords: Eisenmenger syndrome, pulmonary arterial hypertension, location of the defect, right ventricular hypertrophy, brain natriuretic peptide

1. Introduction

Eisenmenger syndrome is characterized by severe pulmonary arterial hypertension (PAH) associated with congenital heart disease [1,2]. Depending on the size and location of the underlying cardiac defect, severe PAH invariably results in severe right ventricular (RV) due to the pressure overload [3,4]. The most important factor for prognosis is considered the specific RV morphology and preserved good RV function, dominantly influenced by the presence of a shunt [7]. Additionally, the defect location enables a more-less effective utilization of RV own compensatory mechanisms [8]. Post-tricuspid defects (post-TD) are typically associated with severe RV hypertrophy (RVH) and only mild dilatation and good systolic RV function. On the contrary, the pre-tricuspid defects (pre-TD) tend to more prominent RV dilatation and less preserved RV systolic function [4,7]. Serum N-

terminal brain natriuretic peptide (NTpBNP) concentration is considered a good marker of RV dysfunction and is often used as a prognostic parameter in patients with PAH [5,8].

The aim of the study was to compare ECG, echocardiographic parameters (ECHO) and plasma neurohormone levels (serum NTpBNP) in patients with the pre-TD and post-TD locations of the defects.

2. Subject and Methods

The study population consisted of 43 patients with ES divided in two groups:

- Group Pre-TD: 19 patients (14 women/ 5 men, age ranged 33-78 years, median 57 years);
- Group Post-TD: 24 patients (16 women/ 8 men, age ranged 24-69 years, median 41 years).

The following parameters were measured:

12-leads ECG: Butler-Leggett formula (BL), Sokolow-Lyon index for RV hypertrophy (SL-RVH) and maximum spatial QRS vector magnitude (QRSmax)

Echocardiography: RV diameter (RVD), RV wall thickness (WT), RV function by the tricuspid annular plane systolic excursion (TAPSE) and RV ventricular fractional area change (FAC).

NTpBNP (ng/l) concentrations were determined by an electrochemiluminescence method.

3. Results

The values of parameters under study are presented in Table 1.

Table 1. The values of ECG and echocardiographic parameters under study in patients with pre-tricuspid and post-tricuspid location of defects. Pre-TD - Pre-tricuspid defect, Post-TD - Post-tricuspid defect, SD – standard deviation, QRSmax- maximum QRS spatial vector magnitude, RV WT - right ventricular wall thickness, RVd - right ventricular diameter, TAPSE - tricuspid annular plane systolic excursion, FAC - right ventricular fractional area change, NTpBNP-N - N-terminal brain natriuretic peptide, NS - not significant.

	Pre-TD average (SD)	**Post-TD average (SD)**	**T test p**
Sokolow-Lyon (mm)	14.76 (10.17)	18.67 (10.71)	NS
Butler-Legget (mm)	13.45 (10.25)	17.83 (12.49)	NS
QRS max (mV)	16.57 (6.76)	25.2 (8.85)	0.0004
RV WT (mm)	8.71 (2.09)	10.35 (2.91)	0.037
RVd (mm)	42.94 (10.05)	28.5 (6.85)	0.001
TAPSE (mm)	20.79 (5.49)	22.83 (4.14)	NS
FAC (%)	48.26 (12.38)	53.13 (11.67)	NS
NTpBNP (ng/l)	2140 (2962)	1679 (2847)	NS

The ECG parameters exceeded the upper normal limits in both groups (Sokolow-Lyon index for RVH 14.76 mm ±10.17 mm / 18.67 mm ±10.71 mm; Butler-Leggett formula 13.45 mm ±10.25 mm/ 17.83 mm ±12.49 mm), however there was no significant difference between the groups. Significant difference between groups was found in QRSmax values (16.57 mm ±6.75 mm/ 25.20 mm ±8.85 mm, P=0004).

The ECHO parameters showed signs of RVH: RV wall thickness 8.71mm ±2.09 mm /10.35 mm ± 2.91 mm (p=0,037); and RV diameter 42.94 mm ± 10.05 mm / 28.5 mm ± 6.85 mm

(P<0.001). The values of TAPSE and FAC were within normal limits, no significant difference was observed between the groups.

NTpBNP levels exceeded the upper normal limits in both groups, without significant differences between the groups.

Significant correlation of both ECG indexes for RV hypertrophy (Sokolow-Lyon criterion for RVH, Butler-Leggett formula) with ECHO RV wall thickness (p<0.0001) was observed (Figure 1 and 2).

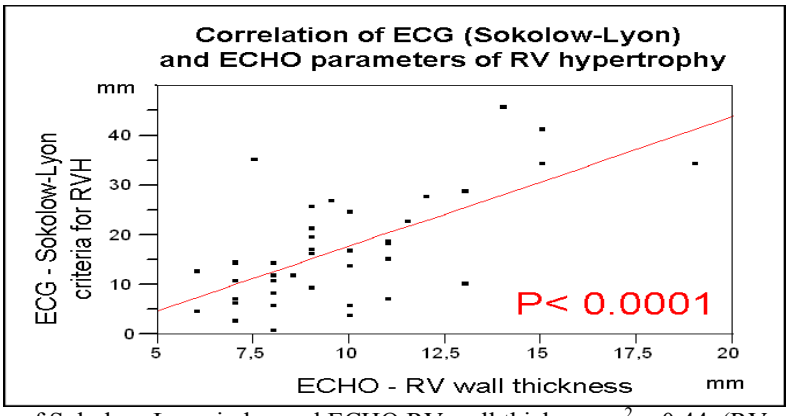

Figure 1. Correlation of Sokolow-Lyon index and ECHO RV wall thickness. $r^2 = 0.44$. (RV: right ventricle, RVH: right ventricular hypertrophy).

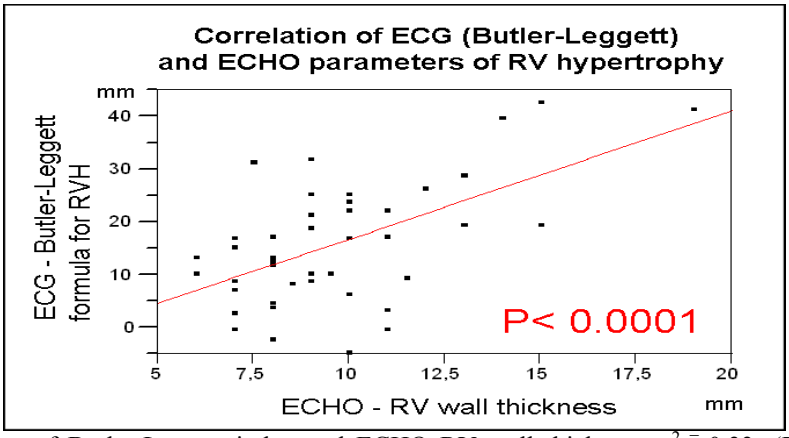

Figure 2. Correlation of Butler-Leggett index and ECHO RV wall thickness. $r^2 = 0.33$. (RV: right ventricle, RVH: right ventricular hypertrophy).

4. Discussion

Eisenmenger syndrome with severe pulmonary hypertension leads to compensatory RV hypertrophy and in some degree to RV dilatation. Due to different hemodynamic situation it is important to distinguish defects according to the shunt location (pre-TD versus post-TD). In our study the ECG as well as ECHO parameters confirmed the presence of severe RV hypertrophy in both group of patients and significant correlation between ECG signs of RVH and ECHO parameters. However, despite significant difference in morphological RV configuration in different defect locations (with significantly more prominent hypertrophy in post-TD and RV dilatation in pre-TD), ECG criteria for hypertrophy did not differ between the groups, except the spatial QRS vector magnitude, reflecting RV hypertrophy and dilatation. RV function according to ECHO was well preserved in both groups. However, positive NTpBNP levels (although without significant difference between groups) reflect severe RV overload in these patients. It can be concluded that that the morphological configuration of RV was not the main factor influencing the QRS patterns.

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