

QRS Complex Changes after Pulmonary Endarterectomy in Patients with Chronic Thromboembolic Pulmonary Hypertension

¹M. Boháčková, ¹T. Valkovičová, ²M. Kaldarárová, ¹I. Šimková, ³L. Bachárová

¹National Institute of Cardiovascular Diseases, Bratislava, Slovak Republic

²National Institute of Cardiovascular Diseases – Children’s Cardiac Center, Bratislava, Slovak Republic

³International Laser Center, Bratislava, Slovak Republic

Email: marcela.bohacekova@gmail.com

Abstract. Chronic thromboembolic pulmonary hypertension (CTEPH) is a progressive disease with persistent thrombotic occlusion of pulmonary artery bed with consequent right ventricular dilation and hypertrophy affecting ECG findings. The aim of the study was to analyze QRS complex changes after pulmonary endarterectomy in patients with CTEPH. **Material and Methods:** The study population consisted of 33 patients with CTEPH divided in two groups: Group (1): 21 operable patients (6F/15M, average age 64.1 years) undergoing endarterectomy; and Group (2): 12 non-operable patients (9F/3M, average age 68.9 years). The following ECG parameters were analyzed: maximum QRS spatial vector magnitude (QRSmax), Butler-Leggett formula for RVH (BL), Sokolow-Lyon criterion for RVH (SL-RVH). The right ventricular diameter (RVD) was measured by echocardiography. **Results:** A significant differences in SL-RVH (12.9±6.2mm vs 8.9±4.5mm) as well as in RVD (57±6.8mm vs 38.5±4.3mm) were found between the groups at the beginning of study. After endarterectomy the values of BL and SL-RVH decreased significantly (13.7±7.6mm vs 7.4±5.4mm and 12.9±6.2mm vs 6.4±3.3mm) as well as the RVD values (57±6.8mm vs 32.7±3.3mm). However, the changes in QRS and RVD did not correlate significantly. **Conclusion:** The lack of correlation in changes of QRS complex and RVD indicates that the decrease in RVD was not the main factor influencing the QRS complex voltage.

Keywords: CTEPH, ECG, right ventricular hypertrophy, pulmonary endarterectomy

1. Introduction

Chronic thromboembolic pulmonary hypertension (CTEPH) is a progressive disease, defined as the mean pulmonary artery pressure ≥ 25 mm Hg following an episode of pulmonary thromboembolism. CTEPH is characterized by persistent thrombotic occlusion of pulmonary artery bed due to non-resolved and organized thrombus leading to vascular remodeling and resulting in pulmonary hypertension. The combination of persistent macrovascular obstruction, small vessel arteriopathy, and vasoconstriction results in pulmonary hypertension and right ventricular pressure overload. Presumed gradual progression of pulmonary hypertension occurs in the absence of documented recurrent pulmonary embolic events and is thought to reflect progressive remodelling of the unobstructed pulmonary vasculature, stimulated by increased blood flow through these vessels. If left untreated, the condition is fatal due to increased right ventricular afterload and right heart failure. Pulmonary endarterectomy (PEA) is the surgical procedure which removes the obstructing thromboembolic material, resulting in significant improvements of right ventricular hemodynamics and function.

The aim of the study was to study the ECG signs of right ventricular hypertrophy (RVH) in patients with CTEPH and their changes after pulmonary endarterectomy.

2. Material and Methods

The study population consisted of 33 patients with CTEPH (15 women/18 men, average age 66.5 years, ranged 42 to 81 years). The diagnosis of CTEPH was confirmed by right heart catheterization (RHC), with a mean pulmonary arterial pressure (PAP) equal or over 25 mmHg and a pulmonary wedge pressure (PCWP) equal or under 15 mmHg in accordance with ESC/ERS guidelines for the diagnosis and treatment of pulmonary hypertension [1].

The patients were divided in two groups:

Group 1: 21 operable patients (6 women/ 15 men, average age 64.1 years, ranged 42 to 74 years) who underwent pulmonary endarterectomy;

Group 2: 12 non-operable patients (9 women/ 3 men, average age 68.9 years, ranged 52 to 81 years) treated conservatively (anticoagulant therapy: warfarin/ low molecular weight heparin).

The 12 leads ECG was recorded and the following parameters were analyzed:

- the maximum spatial QRS vector magnitude (QRS max), calculated as:

$$\text{QRS max} = \sqrt{[V_5^2 + aVF^2 + V_2^2]} \quad (1)$$

- Butler Leggett (BL) formula for RVH [2], calculated as:

$$\text{BL} = [\text{tallest R or R' in } V_1 \text{ or } V_2 \text{ lead}] + [\text{deepest S in } V_1 \text{ or } V_6 \text{ lead}] + [\text{S in } V_1 \text{ lead}] \quad (2)$$

- Sokolow - Lyon (SL-RVH) criteria for RVH [3], calculated as :

$$\text{SL} = [\text{R in } V_1 \text{ lead}] + [\text{S in } V_5 \text{ or } V_6 \text{ lead}] \quad (3)$$

The ECGs were examined by one trained person; the QRS amplitudes were measured manually. The right ventricular diameter (RVD) was measured echocardiographically.

All results are expressed as the mean \pm standard deviation. The differences between groups were tested using Student's t-test, values of $p < 0.05$ were considered to be significant. Statistical analysis was performed using Windows Microsoft Excel 2007.

3. Results

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

Table 1. Values of parameters under study. SL-RVH: Sokolow-Lyon criterion for right ventricular hypertrophy; BL: Butler-Leggett formula; QRSmax: maximum QRS spatial vector magnitude; RVD: right ventricular diameter. ***: $p < 0.001$. Group 1: patients undergoing endarterectomy, Group 2: inoperable patients, treated conservatively.

		BL [mm] average (SD)	SL - RVH [mm] average (SD)	QRS max [mm] average (SD)	RVD [mm] average (SD)
Group 1	before PEA	13.7 (7.6)	12.9 (6.2)	16.4 (4.8)	57.0 (6.8)
	after PEA	7.4 (5.4)***	6.4 (3.3)***	15.1 (5.2)	32.7 (3.3)***
Group 2	before th	9.2 (7.1)	8.9 (4.5)	17.0 (4.6)	38.5 (4.3)
	after th	11.7 (10.2)	8.9 (4.6)	17.5 (5.2)	39.4 (7.8)

At the beginning of the study, there was a significant difference between the groups in SL-RVH (12.88 mm \pm 6.15 mm vs 8.89 mm \pm 4.48 mm), as well as in RVD (57 mm \pm 6.76 mm vs 38.5 mm \pm 4.30 mm).

In patients who underwent PEA, the values of SL-RVH and BL decreased significantly after the endarterectomy (12.88 mm ± 6.15 mm vs 6.37 mm ± 3.26 mm; and 13.65 mm ± 7.55 mm vs 7.35 mm ± 5.40 mm). No significant changes were observed in QRSmax. The echocardiographically measured RVD decreased significantly after the endarterectomy (57 mm ± 6.76 mm vs 32.67 mm ± 3.26 mm)

The changes in QRS complex and RVD in patients after endarterectomy did not correlate significantly (Figure 1).

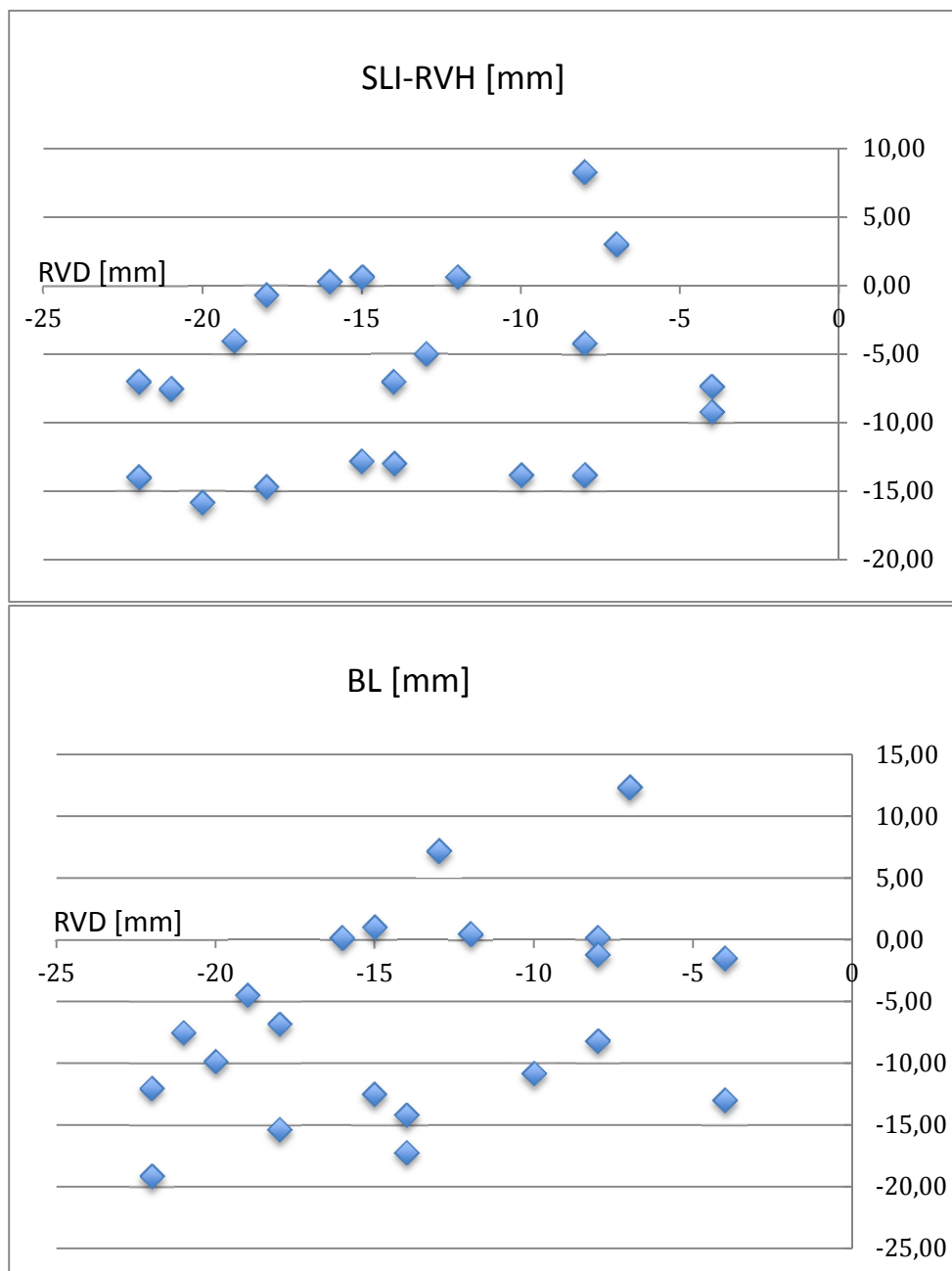


Fig. 1. The relation between the right ventricular diameter and Sokolow-Lyon criterion for RVH (top) and Buttler-Leggett criterion (bottom).

In contrary, no significant differences in SL-RVH and BL, as well as in RVD were observed in patients treated conservatively.

4. Discussion

There was a significant difference between groups at the beginning of the study. The Group 2 consisted of patients that were not indicated for endarterectomy because of the more severe clinical status and/or co-morbidities.

After endarterectomy the values of RVH-ECG indicators as well as RVD decreased significantly, on the other hand, in the patients treated conservatively this effect was not observed. It can be therefore suggested that these changes can be attributed to the improvement of the hemodynamic overload of the right ventricle. However the QRS changes and the decrease in the dimension of the right ventricular diameter did not correlate significantly, indicating that the reduction in the right ventricular diameter due to decreased volume overload did not affect the QRS amplitude as could be theoretically expected.

5. .Conclusions

The study results showed that patients with CTEPH after endarterectomy have significantly decreased ECG indices for RVH as well as decreased RVD. However these changes did not correlate, suggesting that the decrease in RVD was not the main factor influencing the QRS complex voltage.

References

- [1] Galie N et al.: The Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS), endorsed by the International Society of Heart and Lung Transplantation (ISHLT). *Europ Heart J* 30: 2493-2537, 2009.
- [2] Buttler PM, Leggett SI, Howe CM et al.: Identification of electrocardiographic criteria for diagnosis of right ventricular hypertrophy due to mitral stenosis. *Am J Cardiol* 57: 639-643, 1986.
- [3] Sokolow M, Lyon TP: The ventricular complex in left ventricular hypertrophy as obtained by unipolar and limb leads. *Am Heart J* 37: 161–186, 1949.