Electrophysiological Effects of Valsalva Maneuver during Early Pregnancy in Patients with Paroxysms of Orthodromic Ativoventricular Tachycardia

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Abstract

We examined 28 women during an early gestation. We found that the Valsalva maneuver, Propanorm, and the combination of both produced an antianarrhythmic effect via the anterograde and retrograde conduction in reentry. The study is the first to reveal that the Valsalva maneuver influences retrograde conduction in reentry in pregnant patients. We proved that it is necessary to use the Valsalva maneuver to stop paroxysms of orthodromic atrioventricular tachycardia (AVRT) in the first trimester of pregnancy. If the maneuver is ineffective, it is advisable to use Propanorm or the combination of Propanorm with Valsalva manoeuvre.

Keywords: Orthodromic atrioventricular reentrant tachycardia paroxysms; Pregnancy; Valsalva maneuver; Propanorm

Introduction

During the paroxysms of reciprocal atrioventricular orthodromic tachycardia, the circulation of impulse occurs first in the anterograde direction—from the atria to the ventricles via the normal conduction system of the heart—and then it goes retrograde, from ventricles to the atria, in an abnormal way [1-4].

In previous studies [5,6,9], we have found that in women with paroxysms of orthodromic tachycardia (AVRT) in the early stages of gestation, the shortening of the effective refractory period of the atrioventricular node (ERP AV), the upper window and the lower window of tachycardia, the expansion of the zone of tachycardia, and the dispersion of the refractory period of AV connection and a retrograde pathway occur. These electrophysiological (EPh) changes indicate a high arrhythmogenic readiness of the heart.

The purpose was to study electrophysiological indicators of the heart in pregnant women in the first trimester with orthodrome paroxysms of reciprocal atrioventricular tachycardia during the Valsalva test, after a single dose of propafenone and a combination of the Valsalva test with propafenone.

Materials and Methods

A clinical study was conducted in the period from 2013 to 2015 at the SBMH “Clinical Hospital № 6 named after G. A. Zakharyin” in Penza.

We examined 28 pregnant women with paroxysms of AVRT, age from 19 to 32 years (26.5 ± 2.5).

Studies included: clinical survey, assessment of medical history, physical examination, EKG in twelve leads, Holter EKG monitoring, echocardiography, expert ultrasound examination of the fetus, transesophageal electrophysiological study of the heart, blood test for electrolytes (potassium, sodium), and thyroid hormones (T<sub>3</sub>, T<sub>4</sub>, TSH). Variation statistics and correlation analysis were performed using the software package Microsoft Excel 7.0 and Statistica 6.0. For a dynamic control of the results of the studies, Holter monitoring (HM) of EKG and transesophageal electrical stimulation (TEES) were used.

All patients included in the study signed a written consent.

Results and Discussion

Table 1 shows EKG and EPh indicators of the heart during the first Valsalva test, after a single dose of propafenone and a combination of the Valsalva test with propafenone in pregnant women with AVRT in the first trimester.

Data obtained from the study (Table 1) show that during the Valsalva test in patients with AVRT in the first trimester of pregnancy, there is a decrease in heart rate by 18.1% (p < 0.05), the points of Wenckebach by 16.5% (p < 0.05), and the time of discrete conduction by 24.3% (p < 0.01). There is also a reduction in the ratio of St2-R2 max/St1-R1 min by 16.9% (p < 0.05) and St2-R2/ERP of AV node by 29.4% (p < 0.001). The increase in the ERP of AV node was by 20.1% (p < 0.05); the ERP of LA was by 20.3% (p < 0.05). The increase in the upper window of tachycardia by 19.3% (p < 0.05) and the lower window of tachycardia by 31.1% (p < 0.01) has led to the reduction of tachycardia zone by 22.1% (p < 0.01).

In patients with AVRT in the first trimester of pregnancy during the Valsalva test 10, indicators from the main 16 EPh indicators (which were involved in relieving AVRT and maintaining sinus rhythm) have statistically significantly changed (62.5%).

Among the 28 patients with AVRT in the first trimester during a Valsalva test, a relief of the arrhythmia was achieved by blocking in the anterograde direction through the atrioventricular node in 11 women (39.3%); in 3 (10.7%)—in retrograde; in 1 (3.6%)—in anterograde and retrograde; and in 13 (46.4%), a relief failed.

In numerous electrophysiological studies [1,3,7,8] of antiarrhythmic drugs’ action at the cellular level, it is proved that there is no single antiarrhythmic drug that has only one single point of application at the level of the cell membrane. Antiarrhythmic drugs that mainly affect Na channels (propafenone) can simultaneously modify K and Ca-channels [2]. Amiodarone, in addition to the predominant influence on K-channels, also simultaneously modifies...
| EPh indicators of AVRT | Before pregnancy | The first trimester of pregnancy (n = 28) | | | |
|------------------------|-----------------|------------------------------------------|---|---|---|
|                        | Outcome | Valsalva test | Propafenone | Valsalva test | propafenone |
|                        |   | 1 | 2 | 3 | 4 | 5 |
| HR, min | 62.6 ± 3.4 | 74.5 ± 4.7 | 61.0 ± 3.9 | p<sub>1</sub> < 0.05* | 64.8 ± 4.1 | p<sub>1</sub> < 0.05 | 63.7 ± 3.8 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| P, ms | 86.4 ± 5.5 | 89.2 ± 5.4 | 85.3 ± 4.8 | p<sub>1</sub> < 0.05 | 92.5 ± 5.5 | p<sub>1</sub> < 0.05 | 93.6 ± 5.2 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| P-Q, ms | 154.3 ± 9.8 | 155.8 ± 9.7 | 157.6 ± 9.5 | p<sub>1</sub> < 0.05 | 158.2 ± 9.5 | p<sub>1</sub> < 0.05 | 160.3 ± 10.0 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| QRS, ms | 92.5 ± 5.9 | 93.8 ± 5.9 | 95.8 ± 5.6 | p<sub>1</sub> < 0.05 | 96.5 ± 5.8 | p<sub>1</sub> < 0.05 | 97.4 ± 5.4 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| QT, ms | 365.8 ± 23.1 | 360.4 ± 21.9 | 363.8 ± 23.1 | p<sub>1</sub> < 0.05 | 366.8 ± 23.3 | p<sub>1</sub> < 0.05 | 368.6 ± 23.3 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| Corrected time of sinus node function recovery, ms | 324.6 ± 20.8 | 336.4 ± 21.2 | 343.2 ± 21.7 | p<sub>1</sub> < 0.05 | 349.8 ± 22.2 | p<sub>1</sub> < 0.05 | 357.4 ± 22.6 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| Effective refractory period of AV node, ms | 372.3 ± 23.9 | 309.6 ± 20.0 | 371.8 ± 22.6 | p<sub>1</sub> < 0.05 | 378.2 ± 23.1 | p<sub>1</sub> < 0.05 | 374.5 ± 23.6 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| Time of a discrete holding, ms | 58.6 ± 3.5 | 88.2 ± 5.7 | 66.8 ± 4.2 | p<sub>1</sub> < 0.001* | 63.2 ± 4.0 | p<sub>1</sub> < 0.0001* | 3.2 ± 0.1 | p<sub>1</sub> < 0.05* | p<sub>2</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>5</sub> > 0.05 |
| Wenckebach point, pulse/min. | 156.8 ± 9.3 | 158.4 ± 9.9 | 132.3 ± 8.1 | p<sub>1</sub> < 0.05 | 135.5 ± 8.6 | p<sub>1</sub> < 0.05 | 134.8 ± 9.1 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| The top window of tachycardia, ms | 366.8 ± 23.0 | 306.4 ± 19.6 | 365.4 ± 21.7 | p<sub>1</sub> < 0.05* | 367.8 ± 21.9 | p<sub>1</sub> < 0.05 | 371.8 ± 23.5 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| The lower window of tachycardia, ms | 294.7 ± 18.0 | 217.8 ± 13.9 | 285.6 ± 17.6 | p<sub>1</sub> < 0.001* | 283.1 ± 18.1 | p<sub>1</sub> < 0.01 | 292.7 ± 18.2 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| Area of tachycardia, ms | 63.6 ± 4.0 | 96.7 ± 6.1 | 75.3 ± 4.6 | p<sub>1</sub> < 0.001* | 74.7 ± 4.9 | p<sub>1</sub> < 0.01* | 64.2 ± 4.0 | p<sub>1</sub> < 0.05* | p<sub>2</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>5</sub> > 0.05 |
| RR of tachycardia, ms | 372.5 ± 23.5 | 374.8 ± 23.8 | 350.7 ± 22.4 | p<sub>1</sub> < 0.05 | 358.7 ± 22.9 | p<sub>1</sub> < 0.05 | 376.3 ± 23.8 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| VA of tachycardia, ms | 116.2 ± 7.3 | 116.9 ± 7.4 | 115.4 ± 7.2 | p<sub>1</sub> < 0.05 | 118.7 ± 7.6 | p<sub>1</sub> < 0.05 | 119.4 ± 7.6 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
| AV of tachycardia, ms | 253.6 ± 16.3 | 257.4 ± 16.7 | 254.9 ± 16.1 | p<sub>1</sub> < 0.05 | 258.3 ± 16.4 | p<sub>1</sub> < 0.05 | 260.6 ± 16.7 | p<sub>5</sub> > 0.05 | p<sub>4</sub> > 0.05 | p<sub>3</sub> > 0.05 | p<sub>2</sub> > 0.05 | p<sub>1</sub> > 0.05 |
Na and Ca-channels, and meanwhile it has α- and β-blocking action [2]. At the same time, enumerated investigations did not provide tests of the vagus nerve stimulation. As can be seen from the obtained data, vagal tests and antiarrhythmic drugs have multiple points of application [5,6,9]. A relief of the paroxysm through the blockade of anterograde and retrograde pathways proves this.

The side effects of the Valsalva test were observed in 1 (3.6%) patient.

The conducted correlation analysis in the first trimester showed (Figure 1) that between the dynamics of EPh indicators during the Valsalva test and the frequency of spontaneous seizures in a year, there is a strong inverse relationship ($r = -0.9303$, $n = 28$, $p < 0.01$).

After a single dose of propafenone in patients with paroxysms of orthodromic AVRT in the first trimester of pregnancy was revealed a decrease in the discrete holding time by 39.6% ($p < 0.001$), the ratio of St2-R2 max/St1-R1 min by 22.5% ($p < 0.05$), and the ratio of St2-R2/ERP of AV node by 46.9% ($p < 0.001$). It was established that there is an increase in the ERP of AV node by 18.1% ($p < 0.05$) and the ERP of LA by 17.0% ($p < 0.05$). The increase in the upper window of tachycardia by 16.7% ($p < 0.05$) and the lower window of tachycardia by 23.1% ($p < 0.01$) led to the narrowing of tachycardia by 29.5% ($p < 0.01$).

After a single dose of propafenone in patients with paroxysms of orthodromic AVRT in the first trimester of pregnancy among 16 EKG and EPh indicators, 8 of them were statistically significantly changed (50.0%). These 8 indicators were involved in relieving paroxysms of orthodromic AVRT in and maintaining sinus rhythm.

Among the 28 patients with orthodromic AVRT in the first trimester, a relief of arrhythmia with a singular propafenone use has been achieved by the blockade of conduction in 18 women (64.8%) in the anterograde direction via the atrioventricular node; in 5 women (17.9%) in the retrograde direction; in 2 (7.1%)—in the anterograde and retrograde directions; and in 3 (10.7%), the blockade failed. Side effects from a single dose of propafenone were in 2 (7.1%) patients.

### Table 1: Electrophysiological parameters of the heart during the Valsalva test, after a single dose of propafenone and a combination of Valsalva test with propafenone in pregnant women with AVRT in the first trimester (M ± m)

| Effective refractory period of LA, ms | 286.4 ± 18.0 | 209.7 ± 13.3 | 251.7 ± 15.0 | 252.5 ± 15.5 | 279.2 ± 17.7 |
|--------------------------------------|--------------|--------------|--------------|--------------|--------------|
| $p_{1-2}$ < 0.001*                   |              |              |              |              |              |
| St1-R1 min, ms                       | 153.6 ± 9.0  | 138.7 ± 8.5  | 150.1 ± 9.7  | 155.2 ± 9.9  | 170.8 ± 7.8  |
| $p_{1-2}$ > 0.05                     |              |              |              |              |              |
| St2-R2 max, ms                       | 226.7 ± 10.4 | 256.4 ± 15.1 | 230.5 ± 14.6 | 234.2 ± 195.5| 212.6 ± 15.0 |
| $p_{1-2}$ > 0.05                     |              |              |              |              |              |
| St2-R2 growth, ms                    | 36.8 ± 2.4   | 41.5 ± 2.6   | 37.6 ± 2.4   | 36.8 ± 2.1   | 34.6 ± 2.1   |
| $p_{1-2}$ > 0.05                     |              |              |              |              |              |
| St2-R2 max/ St1-R1 min              | 1.5 ± 0.1    | 1.85 ± 0.1   | 1.54 ± 0.10  | 1.51 ± 0.08  | 1.24 ± 0.09  |
| $p_{1-2}$ < 0.005                    |              |              |              |              |              |
| St2-R2/ Effective refractory period of AV node | 0.8 ± 0.05 | 1.19 ± 0.07 | 0.84 ± 0.06 | 0.81 ± 0.05 | 0.62 ± 0.05 |
| $p_{1-2}$ < 0.001*                   |              |              |              |              |              |

* – statistically significant indicators.

The conducted correlation analysis showed (Figure 2) that in women in the first trimester who were taking propafenone had inverse relationships between the EPh indicators responsible for paroxysms of orthodromic AVRT and in maintaining sinus rhythm. In our opinion, the evaluation of influencing the EPh-indicators of orthodromic AVRT in the combination of Valsalva test with propafenone is of particular interest.
24.9% \( (p < 0.01) \). A slight increase in the upper window of tachycardia by 17.6% \( (p < 0.05) \) and a marked increase in the bottom window of tachycardia by 25.6% \( (p < 0.01) \) have led to the reduction of tachycardia zone by 50.6% \( (p < 0.001) \).

In contrast to the Valsalva test alone and propafenone alone, the combined use of the Valsalva test with propafenone caused an increase in St1-R1 min by 18.8% \( (p < 0.01) \), a reduction of the St2-R2 max by 20.6% \( (p < 0.05) \), and St2-R2 increase by 19.5% \( (p < 0.05) \). As can be seen from the obtained data, compared with the single use of propafenone, a combined use of the Valsalva test with propafenone, we can see the additional time reduction of the discrete holding by 18.5% \( (p < 0.05) \), the ratio of St2-R2 max/St1-R1 min by 17.5% \( (p < 0.05) \), and the ratio of St2-R2/ERP of AV node by 23.5% \( (p < 0.05) \).

Among the 16 EPh indicators, 11 statistically significantly have changed (68.8%). Among the 28 patients with orthodromic AVRT in the first trimester as the result of the combined use of the Valsalva test with propafenone, a relief of arrhythmia by blocking a conduction in the anterograde and retrograde; and in 1 (3.6%), the blocking failed. The adverse events in a concomitant use of the Valsalva test with propafenone were observed in 3 patients (10.7%).

The conducted correlation analysis showed (Figure 3) that in the first trimester, the combined use of the Valsalva test with propafenone demonstrates a strong inverse relationship between the EPh indicators responsible for the maintenance of sinus rhythm and the frequency of spontaneous seizures in a year \( (r = -0.8901, n = 28, p < 0.01) \).

It is known that the dynamics of above-mentioned EPh indicators in orthodromic AVRT evidence of the therapeutic and prophylactic efficacy of the Valsalva test and propafenone [4]. Based on the obtained data, it is evident that in patients with paroxysms of orthodromic AVRT in the first trimester of pregnancy, the arrhythmia relief should begin with the Valsalva test, but in the absence of an effect, we can go to the combined use of the Valsalva test with propafenone. It should also be noted that the combined application not only increases the number of analyzed parameters but also potentiates the EPh effect.

Conclusion

In patients with the paroxysms of reciprocal atrioventricular orthodromic tachycardia in the early stages of gestation as a result of the analysis of 16 EPh indicators, it was established that 10 of them (62.5%) have changed significantly during the Valsalva test: after a single dose of propafenone—8 (50.0%); in a combined use of the Valsalva test with propafenone—11 (68.8%). It is revealed that the Valsalva test, propafenone, and the combination of both implement antiarrhythmic effect via the anterograde and retrograde link of circulation of excitation. For the first time, it was established that in pregnant patients, the Valsalva test has an impact on the retrograde part of circulation of excitation. It is established that between the number of EPh indicators involved in the circulation of excitation and the frequency of spontaneous seizures in a year, there is an inverse relationship. It is proved that in the first trimester of pregnancy, it is necessary to achieve a relief of AVRT by the Valsalva test, and in the absence of the effect, by propafenone alone or by the combination of the Valsalva test with propafenone.

References

1. Alekseeva LL (2004) Specific Features of Cardiorespiratory Adaptation in Pregnant Women with Low Obstetric Risk: PhD dissertation in Medicine. Irkutsk, 300 p.
2. Stryuk R, Bakalov SA, Bunin YuA (2013) Diagnosis and treatment of cardiovascular diseases during pregnancy. Russ J Cardiol 102: 40-49.
3. Bernal O, Moro C (2006) Cardiac arrhythmias in women./ Rev Esp Cardiol 59(6): 609-618.
4. Chandrasekhar S, Cook C, Collard C (2009) Cardiac surgery in the parturient. Anesth Analg 108: 777-785.
5. Rakhmatullov FK (2006) Transesophageal Electrical Stimulation of the Heart and Clinical Electrophysiology of Antiarrhythmic Medications: A Monograph. Penza State University Publishing. Penza, 112p.
6. Rakhmatullov FK, Klimova SV, Kuryaeva AM, Dyatlov NE, Zinovyeva EG, et al. (2015) The influence of pregnancy on the frequency of extrasystoles and paroxysms of atrioventricular nodal reentrant tachycardia. University Proceedings. Volga region. Med Sci 2: 103-112.
7. Yu M, Yi K, Zhou L (2015) Pregnancy increases heart rates during paroxysmal supraventricular tachycardia. Can J Cardiol 31: 820-825.

8. Kornacewicz-Jach Z, Peregud-Pogorzelska M (2014) Maternal arrhythmias during pregnancy. Practical review. Przegl Lek 71: 177-181.

9. Dyatlov NE, Rakhmatullov FK, Kuryaeva AM, Burmistrova LF (2016) The relationship between gestation term and the condition of the heart conduction system in symptomatic atrial fibrillation. University proceedings. Volga region. Med Sci 1(37): 54-62.