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ANATOMY AND CLINICAL IMPORTANCE OF THE TRIANGLE OF KOCH

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Abstract

The triangle of Koch occupies the atrial component of the muscular AV septum. The tissue of AV node and the "slow" and "fast" pathway of the AVNRT are incorporated in the triangle, which makes this area clinicaly important.

The aim of this study was to present the morphology and clinical importance of the triangle of Koch. The study consists of two parts: basic and clinical. In the basic part, 100 human hearts fixed in formaldehyde were examined using common anatomical and histological methods. The numerical features of the triangle of Koch were measured in two different ways. In the clinical part of the study, the analysis was made on 100 patients who were tested and treated in the Electrophysiological laboratory of the Institute for Heart Diseases in Skopje. Using the data of patients weight and height, the numerical features of the triangle were calculated. The results obtained were statistically analysed.

The first type of measuring, in the basic part of the study, gave the following mean values of the length of the sides of the triangle of Koch: side a (a1) 26.1 ± 3.1 mm, side b (b1) 20.8 ± 3.6 mm and side c (c1) 24.5 ± 2.5 mm. The mean value of the area of the triangle (P1) was 256.2 ± 67.6 mm^2. According to the second type of measuring the following numerical features of the triangle were obtained: side a (a2) 20.8 ± 2.5 mm, side b (b2) 13.9 ± 2.8 mm and side c (c2) 19.8 ± 2.4 mm. The mean value of the area of the triangle (P2) was 139.47 ± 37.28 mm^2. In the clinical part of the study, mean value of the length of the side a (a3) was 28.5 ± 2.7 mm, side b (b3) 12.9 ± 1.2 mm and side c (c3) 21.1 ± 2.7 mm. The mean value of the area of the triangle (P3) was 116.6 ± 12.3 mm^2.

Knowledge of the variations of numerical features of the triangle of Koch is fundamental for successful catheter placement in electrophysiological studies and radiofrequent catheter ablations.

Key words: triangle of Koch, anatomy, atrioventricular node, numerical data, statistical data, electrophysiology

Introduction

The application of contemporary ablation techniques for treatment of atrioventricular nodal reentry tachycardia (AVNRT) renews the interest for the morphological features of the triangle of Koch. This triangular area occupies the atrial part of the muscular septum, a sloping area that attains its AV location because of the major differences in the levels of attachment of the leaflets of the tricuspid and mitral valves on either side of the septum [1, 2]. For the first time it was described by Koch in 1909, with the heart being seen within body in the anatomic position. The sides of the triangle are the tendon of Todaro (side a) and the attachment of the septal leflet of the tricuspid valve (side c) that converge at its apex, and the base (side b) is formed by the orifice of the coronary sinus. The tissue of AV node and the "slow" and "fast" pathway of the AVNRT are incorporated in the triangle, which dimensions vary among the patients [3, 4].

The **aim** of this study was to present the morphology and clinical importance of the triangle of Koch, and to compare the data obtained directly by postmortal measurements and indirectly using mathematical formulas.

Material and methods

The study consisted of two parts (basic and clinical) and it included two inipendent groups.

The first group comprised 100 human hearts got after autopsies of patients older than 18 years, died from noncardiac reasons. The hearts were removed intact and fixed in 10% formaldehyde, for at least 72 hours. The right atrium was opened through an incision between the superior and inferior caval venous orificies, and then by extending an incision perpendicular to the first, along the lateral wall of the atrium into the right appendage.

The lenghts of the sides of the triangle of Koch (marked as a, b and c) were measured with caliper, using two different types of measuring, which are schematicaly presented in Figs. 1 and 2.

First type of measurement:

Side a (a1) is the length of the tendon of Todaro; side b (b1) - the base of the triangle- is the distance from the tendon of Todaro to the septal leaflet of the tricuspid valve (at the right angle to the leaflet) passing through the coronary sinus ostium (OSC); side c (c1) is the distance from the insertion of side b to the central fibrous body (CF), along the septal leaflet of the valve.

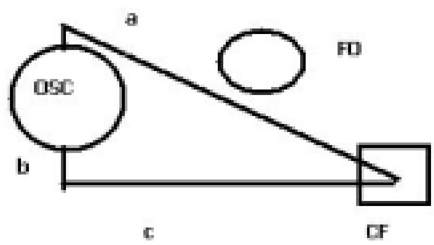

Fig. 1. First type of measurement

Second type of measurement:
Side a (a2) is the length of the Todaro from the central fibrous body to the nearest point of the valve of the coronary sinus ostium (OSC); side b (b2) - the base- is the distance from the anulus of the septal leaflet of the tricuspid valve to the nearest point of the valve of the coronary sinus ostium; side c (c2) is the distance between the attachment of side b to the central fibrous body (CF).

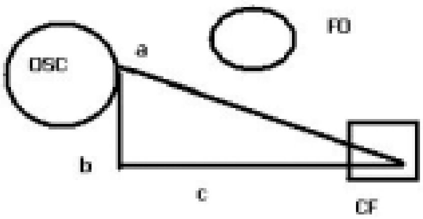

Fig. 2. Second type of measurement

The second group consisted of 100 patients, tested, examined and treated in the Electrophysiological laboratory of the Institute for Heart Diseases of Medical Faculty in Skopje. Numerical values of the triangle of Koch were calculated from the data for the height and weight of the patients, using the following formulas: a = 3.1± 13.7 (BSA); b= 1.8± 6 (BSA); c= 1.7± 13.7 (BSA); p= 2.56 ± 61.5 (BSA) [5]. The surface area of the body (BSA) was calculated according to Mosteller's formula [6]:

$$BSA\ (m^2) = \frac{([height\ (cm) \times weight\ (kg)]/3600}{2}$$

Values were expressed as mean ± standard deviation, minimum and maximum value and difference between two means (p). The following statistical methods were used: t-test, Mann-Whitney U test and Pearson's coefficient of correlation (r).

Results

The first type of post mortal measurements, in the basic part of the study, gave the following mean values of the length of the sides of the triangle of Koch: side a (a1) 26.1 ± 3.1 mm, side b (b1) 20.8 ± 3.6 mm and side c (c1) 24.5 ± 2.5 mm. The mean value of the area of the triangle (P1) was 256.2 ± 67.6 mm^2. The second type of measurements, the following numerical features of the triangle were obtained: side a (a2) 20.8 ± 2.5 mm, side b (b2) 13.9 ± 2.8 mm and side c (c2) 19.8 ± 2.4 mm. The mean value of the area of the triangle (P2) was 139.47 ± 37.28 mm^2. Testing of the differences between the mean values obtained by using these two different types of measuring showed statistically significant differences ($p < 0.01$).

In the clinical part of the study, mean value of the length of the side a (a3) was 28.5 ± 2.7 mm, side b (b3) 12.9 ± 1.2 mm and side c (c3) 21.1 ± 2.7 mm. The mean value of the area of the triangle (P3) was 116.6 ± 12.3 mm^2.

Testing of the correlations between the analyzed parameters showed a direct positive correlation between the height (r = 0.55), weight (r = 0.98) and body area (r = 0.99) of the patients with the length of the sides of the triangle and its area.

Testing of the significance of differences of parameters analyzed in both parts of the study showed a statistically significant difference ($p<0.01$) between the mean values of the lengths and the area of the triangle of Koch, obtained by the two types of measuring in the basic part of the study, and those in the clinical part of the study.

Significance of differences of the values between the parameters analyzed with the second type of measuring in the basic part of the study and those in the clinical part of the study was clinically insignificant.

Discussion

The clinical importance of the triangle of Koch is due to its functional connection with AV node [7, 8, 9]. The anatomical borders of the triangle are easy perceptible, because they are formed by well defined elements, although some authors still make questions about the permanence of the tendon of Todaro [10].

According to our measurements the area of the triangle of Koch greatly varies among the patients. These results are in agreement with those obtained by most authors that analyzed this area [11]. Contrary to these findings, studies published by Mc Guire et al described the triangle of Koch as an area with uniform size. The distance between the tricuspid anulus and the nearest edge of the coronary sinus (mean height) was 13 ± 3 mm and the distance from the central fibrous body to the nearest edge of the coronary sinus (mean length) was 17± 3mm [3, 11]. The mean height of the triangle measured in postmortem hearts was slightly greater than measured at arrhythmia surgery (15±4 mm). In the clinical part of our study, the dimensions of the triangle of Koch were determined indirectly using the data for the height and weight of the patients. Considering the fact that AV node tissue is located at the apex of the triangle, approximately 1 cm anterior of the coronary sinus valve [3], clinicians are interested in a part of the triangle that is smaller than the anatomic one. The sides of the triangle can be determined by measuring of distances as we did in the second type of measurements in the basic part of the study. The dimensions obtained in this way correspond with those obtained by Mc Guire [11].

We measured the dimensions in the postmortem hearts in two different ways. As we expected, the values obtained with the measurements of the anatomical boundaries of the triangle of Koch were significantly different from those obtained with the other types of measurements, but very similar to that published by other authors [1, 3, 7, 11, 12]. However, the difference between the results of the second type of measurements and the values determined by using the formula were not significant (the mean value of the area of the triangle (P2) was 139.47 ± 37.28 mm^2 vs 116.6 ± 12.3 mm^2; $p>0.05$). We concluded that the formula used for determination of the area of the triangle of Koch refers to the part of the triangle that is smaller than the expected anatomic borders and corresponds with our second type of measurements.

In conclusion, the dimensions of the triangle of Koch vary among patients. The knowledge of the variations of its numerical features is fundamental for successful catheter placement in electrophysiological studies and radiofrequent catheter ablations.

References

1. Sanchez-Quintana D et al. Architecture of the Atrial Musculature In and Around the Triangle of Koch: Its Potential relevance to Atrioventricular Nodal Reentry. J of Cardiovasc Electrophysiol 1997; 8(12): 1396-407.
2. Bharati S. Chapter 20 Pathology of the Conduction System in Cardiovascular pathology. Churchill Livingstone 2001; 607-626.
3. Ueng KC et al. Dimensions and Related Anatomical Distances of Koch‘s Triangle in Patients with Atrioventricular Nodal Reentrant Tachycardia. J Cardiovasc Electrophysiol 1996; 7: 1017-23.
4. Sanchez-Quintana et al. The Terminal Crest: Morphological Features Relevant to Electrophysiology. Heart 2002; 88:406-411.
5. Blawfox AD. Catheter Ablation of Tachyarrythmias in Small Children. Indian Pacing Electrophisiol J 2005; 5 (1): 51-62.
6. Mosteller RD. Simplified Calculation of Body Surface Area. N Engl J Med 1987 Oct 22;317 (17):1098
7. Zhivadinovik J. doktorska disertacija
8. Rakovec P, Gjorgov N. Atrioventricular Conduction Disturbances as Complications Following Catheter Ablation of Supraventricular Tachycardias. Ital Heart J 2004; 5(1): 18-22.
9. Inoue S, Becker AE. Koch‘s Triangle Sized Up. PACE 1998; 21(8) 1553-8.
10. Ho SY, Anderson RH. How Constant is Tendon of Todaro. J Cardiovasc Electrophysiol 2000; 11(1) 83-9.
11. McGuire MA. et al. Dimensions of the Triangle of Koch in Humans. The American Journal of Cardiology 1992 ;Vol. 70, No.7 : 829-830
12. Zhivadinovik J, Lazarova, Gjorgov N. Dimensions of the triangle of Koch. Bratisl Lek Listy. 2006; 107 (4):107-9.