MORPHOLOGICAL STUDY

Dimensions of the Triangle of Koch

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Abstract

Dimensions of the triangle of Koch varied among the patients. The aim of this study was to present the dimensions of the triangle, and to compare the data obtained directly by post mortal measurement, using two different methods, and indirectly using mathematic formulas. The examination was performed in two independent groups consisting of 50 specimens each. Results showed that the mean value of area of the triangle of Koch obtained by the first type of post mortal measurement was significantly different from the mean value obtained using mathematic formulas (261.65±52.30 mm² vs 116.74±13.20 mm²; p=0.00; p<0.05). But the mean value of the second type of the measurement was very similar to the mathematically obtained data (126.33±23.71 mm² vs 116.74±13.20 mm²; p=0.278; p>0.05) *(Fig. 1, Ref. 10)*.

Key words: triangle of Koch, statistics & numerical data, heart conduction system, catheter ablation.

The triangle of Koch occupies the atrial component of the muscular septum, a sloping area that attains its AV location because of the major differencies in the levels of attachment of the leaflets of the tricuspid and mitral valves on either side of the septum (1, 2). The tissue of the AV node and the "slow" and "fast" pathway of the Atrioventricular Nodal Reentry Tachycardia (AVNRT) are incorporated in the triangle, dimensions of which widely vary among the patients (2, 3, 4).

The knowledge of the dimensions and the anatomic landmarks of the triangle of Koch can simplify the performance of the radio-frequency catheter ablation techniques and reduce the risk of complete AV block (3, 4).

The aim of this study was to present the dimensions of the triangle of Koch, and to compare the data obtained directly by post mortal measurements and indirectly using mathematics formulas.

Material and methods

The examination included two independent groups; each of them consisted of 50 specimens.

The first group contains 50 human hearts obtained after autopsies of patients older than 18 years, died from noncardiac reasons. The hearts were removed intact, together with the proximal parts of the great arteries and veins, and fixed in 10 % formaldehyde, for at least 72 hours.

The lengths of the sides of the triangle of Koch (marked as a, b and c) were measured using two different types of measuring, which are schematically presented on Figure 1.

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 dimension 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; side c (c1) is the distance from the insertion of side b to the central fibrous body, along the septal leaflet of the valve.

Second type of measurement:

Side a (a2) is the length of the tendon of Todaro from the central fibrous body to the nearest point of the valve of the coronary sinus; side b (b2) – the base of the triangle – is the distance from the annulus of the septal leaflet of the tricuspid valve to the nearest point of the valve of the coronary sinus; side c (c2) is the distance between the attachment of side b to the central fibrous body.

The second group consisted of 50 patients examined, tested and treated in the Electrophysiological laboratory at the Institute for heart diseases of Medical Faculty in Skopje. Numerical val-

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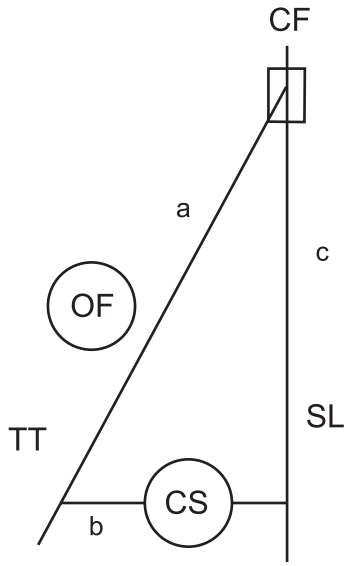

Fig. 1a. First type of measurement.
a, b, c – sides of the triangle of Koch. CF: central fibrous body, CS: coronary sinus, SL: septal leaflet of the tricuspid valve, OF: oval fossa, TT: tendon of Todaro.

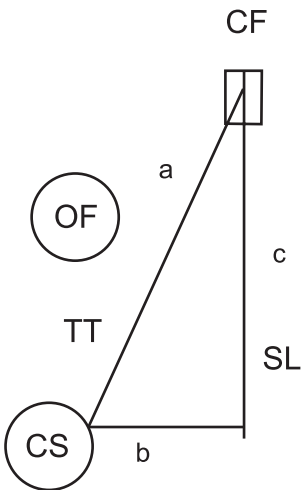

Fig. 1b. Second type of measurement.
a, b, c – sides of the triangle of Koch. CF: central fibrous body, CS: coronary sinus, SL: septal leaflet of the tricuspid valve, OF: oval fossa, TT: tendon of Todaro.

ues of the triangle of Koch were calculated from the data for the height and weight of the patient, using the following formulas: a=3.1±13.7(BSA); b=1.8±6 (BSA); c=1.7±13.7 (BSA) and p=2.56±61.5 (BSA) (5). The surface area of the body (BSA) is calculated according to the Mosteller formula (6):

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

Values are expressed as mean±standard deviation, minimum and maximum value and difference between two means (p), (normal distribution).

Results

The post mortal measurements of the 50 heart specimens from the first group of patients with average age of 57±16.89 (min 20; max 88) years, revealed the following results:

According to the first type of measurement the mean value of the area of the triangle of Koch (P1) was 261.65±52.30 mm^2 (min 160.00; max 375.00), the length of side a (a1) was 24.14±14.53 mm (min 18; max 29), side b (b1) was 20,12±2,42 mm (min 15; max 25) and side c (c1) was 25.80±2.83 mm (min 20; max 31).

According to the second type of measurement the mean value of the area of the triangle of Koch (P2) was 126.33±23.71 mm^2 (min 85.00; max 195.00), the length of side a (a2) was 19.88±14.53 mm (min 13; max 23), side b (b2) was 12.06±1.73 mm (min 10; max 17) and side c (c2) was 20.96±2.76 mm (min 17; max 26).

Patients included in to the second group were in the average age of 47.10±14.31 years (min 17; max 26). The mean height was 166.65±65 cm (min 150; max 184) and the mean weight was 75.10±15.78 kg (min 50; max 133). Using these data for the height and the weight of the patients we calculated the following values:

the mean value of the area of the triangle of Koch (P3) was 116.74±13.20 mm^2 (min 93.38; max 161.15), the length of side a (a3) was 28.53±2.94 mm (min 23,33; max 38,43), side b (b3) was 12.94±1.23 mm (min 10.66; max 17.27) and side c (c3) was 28.51±10.52 mm (min 21.93; max 100.00).

Comparing the values of the area of the triangle of Koch, obtained with different types of measurement, a non-significant difference between P2 and P3 ($p=0.278$; $p>0.05$) and significant difference between P1 and P3 ($p=0.00$; $p<0.05$) were observed.

Discussion

It was Koch (1909) who first described the landmarks of the triangle of Koch, with the heart as seen within the body viewed in the anatomic position (1). The sides of the triangle are the tendon of Todaro and the attachment of the septal leaflet of the tricuspid valve that converge at its apex. The orifice of the coronary sinus forms the base. According to our measurements the area of the triangle of Koch greatly varies among the patients that correspond with the resultsobtained by most of the authors who analyzed this area (7, 8). Contrary, in the studies published by Mc Guire et al the triangle of Koch is described as area with uniform size, and measured in postmortem hearts, the mean height (distance from the tricuspid annulus to the nearest edge of the

coronary sinus) was 13±3 mm and mean length (the distance from the central fibrous body to the nearest edge of the coronary sinus) was 17±3 mm (4, 9, 10). The mean height of the triangle measured in postmortem hearts was slightly greater than that measured at arrhythmia surgery (15±4 mm). Electrophysiological laboratory at the Institute for heart disease in Skopje, R. Macedonia since 1993 successfully performs the procedure of catheter ablation in the treatment of atrioventricular nodal reentry tachycardia (AVNRT). The dimensions of the triangle of Koch are determined indirectly using the data for the height and weight of the patients. Considering that the tissue of AV node is located at the apex of the triangle approximately 1 cm anterior of the coronary sinus valve (4), 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 the length of the tendon of Todaro from the central fibrous body to the nearest point of the valve of the coronary sinus (side a); the distance from the annulus of the septal leaflet of the tricuspid valve to the nearest point of the valve of the coronary sinus (the base of the triangle — side b); and the distance between the attachment of the side b to the central fibrous body (side c). The dimensions obtained in this way correspond with those obtained by Mc Guire (9).

We measured the dimensions in postmortem hearts in two different ways. Comparing the results we found out, as we expected, that the values obtained with the measurement of the anatomical boundaries of the triangle of Koch are significantly different from those obtained with the other types of measurement, but very similar to that published by other authors (1, 3, 7, 8). But, the difference between the results of the second type of measurement and the values determined using formula was not significant (mean value of the area of the triangle was 126,33±23.71 mm^2 vs 116.74±13.20 mm^2; $p>0.05$). So we concluded that the formula used for the determination of the area of the triangle refers to the part of the triangle that is smaller than the excepted anatomic borders and corresponds with our second type of the measurement.

References

1. Sanchez-Quintana et al. Architecture of the atrial musculature in and around the triangle of Koch: Its potential relevance to atrioventricular nodal reentry. J Cardiovasc Electrophysiol 1997; 8 (12): 1396—1407.

2. Bharati S. Chapter 20 Pathology of the conduction system. 607—626. In: Silver, Gotlieb, Schoen (Eds.). Cardiovascular pathology. Churchill Livingstone 2001.

3. Ueng KC et al. Dimension and related anatomical distance of Koch's triangle. J Cardiovasc Electrophysiol 1996; 7 (11): 1017—1023.

4. Gjorgov N, Reiser W, Lazarov. Catheter ablation of the slow pathway in the treatment of atrioventricular nodal reentry tachycardia. J Macedon Med Ass 1994; 48 (5—6): 151—157.

5. Blawfox AD. Catheter ablation of tachyarrythmias in small children. Indian Pacing Electrophysiol J 2005; 5 (1): 51—62.

6. Mosteller RD. Simplified calculation of body surface area. New Engl J Med 1987; 317 (17): 1098.

7. Inoue S, Becker AE. Koch's triangle sized up; anatomical landmarks in perspective. PACE 1998; 21 (8): 1553—1558.

8. Ho SY, Anderson RH. How constant anatomically is the tendon of Todaro as a marke. J Cardiovasc Electrophysiol 2000; 11 (1): 83—89.

9. McGuire MA et al. Dimensions of the triangle of Koch in humans. Amer J Cardiol 1992; 70 (7): 829—830.

10. Rakovec P, Gjorgov N. Atrioventricular conduction disturbances as complications following catheter ablation of supraventricular tachycardias. Ital Heart J 2004; 5 (1): 18–22.

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