# COMPARATIVE ASSESSMENT RESULTS OF SOME SURFACE DETERMINATION METHODS IN VECTORCARDOGRAPHY

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In a number of cardiopathies, such as initial or combined hypertrophy of the chambers, some forms of microinfarctions and heart blocks, the vectorcardiographic data prove to be more clearcut and explicit in comparison with electrocardiographic data (1, 2, 4). In the above mentioned cases one of the criteria is the magnitude of the QRS surface. We made it our aim to study comparatively several different methods of VCG loop surface determination, introducing certain modifications with a view to a greater precison and promptness.

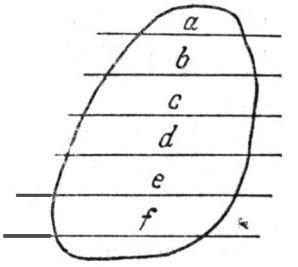


Fig. 1.

1. Mathematical-millimeter method. By importance it ranks first. No special equipment is required, it is readily adopted and executed, comparatively exact and rapid. These qualities render it feasible for practical and research aims. To our knowledge, hitherto the method has not been applied in surface of VCG loop determinations.

Waxed ECG paper, tyre Multicard or Hellige, at 1 mm and 0.5 cm intervals of the mesh, is used. The recorded VCG loop contours are plotted on the underlying ECG paper. Along the edge of a separate sheath of paper, the first (a) and the last (f) segment from the 0.5 cm mesh, enclosed in the surface of the delineated loop (Fig. 1), are plotted one next to the other, and their total length is measured. Then, the rest of the segments (b, c, d, e) from the 0.5 cm mesh, inclosed in the loop, are plotted one by the other along the edge of the paper sheath, and their total length is measured once again. Using a magnifying glass, the squares and square parts between the loop contour and the first (a) and last (f) segments of the 0.5 cm mesh within the loop figure are counted. Next, the VCG loop surface (S) is calculated, using the formula:

$$S = \frac{\frac{a+f}{2}+b+c+d+e}{2} + \text{the sum of millimetered squares } (mm^2)$$

The whole process lasts 1 minute and 37 seondis in the average per loop. To provide for greater precision, surface determinations are made in the same fashion in horizontal direction, and the arithmetical mean is calculated from the horizontal and vertical direction data. The geometrical figures serve as a control. The error is 1 per cent average, i. e. as much as the accepted error of the eye.

2. W e i g h i n g m e t h o d. A pair of laboratory scales are used, e. g. ADV-200 Gosmetr — USSR, with average error amounting to 0.0003 per 1 g weight. It was found out that ECG waxed paper, type Multicard-3, or Hellige for 3 channels, is the most suitable for the purpose. In the different lots of paper reams, the weight of 1 $cm^2$ ranged from 0.010 to 0.0016 g. Because of the small weight 2 $mm^2$=0.00058 g was the least possible reading. The variation coefficient V from a set of equal loops is 1.8 per cent, with error $m_v$= 0.43. The precision of the method is superior over that of the other methods. The time required for surface determination of a single loop is 5' 40'' in the average; obviously, it is a matter of a labour-consuming procedure since it requires careful tracing out of the loop on ECG paper, its cutting and weighing.

3. P l a n i m e t r i c m e t h o d. This is the procedure most frequently employed for surface determination in VCG (4, 5, 6). We worked according to the method adopted in geodesy (3). The mean duration of examination amounts to 2' 21'' per figure. In the course of investigation, it is mandatory to observe a number of rules in order to preclude errors, as follows:

1. It is necessary to set the instrument with levers in perpendicular position.

2. The position of the planimeter with respect to the VCG loop under study should allow for a wider motion range of the planimetric ring. The longitudinal axis of the VCG loop should be parallel to the vertical arm of the planimeter. The movement is verified in advance.

3. Each surface is measured 2—4 times at opposite positions of the planimeter with a view to level errors. This is accomplished through its placement, first on the left side (above), and thereafter — on the right side (below). Of all available planimeters, the most reliable results were attained with PL 1 and REISS. Upon comparing the results of measurement of geometrically regular surfaces, the following data were received:

Table 1

| Surfaces | Planimeters | |
|---|---|---|
| | PL 1 | REISS |
| Small (1—4.5 $cm^2$) | V=37%, $m_V$=8.20 | V=85%, $m_V$=25.9 |
| Large (15—50 $cm^2$) | V=29%, $m_V$=11.99 | V=29%, $m_V$=9.4 |

Obviously, insofar as small surfaces are concerned the data obtained show higher precision whenever PL 1 planimeter is used, whereas for the larger areas it is preferable to use the planimeter, type REISS. Most frequently, measurements are made of small surfaces where the readings are usually connected with errors. We employ planimeter, type PL1.

After comparing the mean error of the mathematical-millimeter method (average 1 per cent) with that of the planimetric method (2 per cent), the greater advantage of the former becomes evident.

4. V i s u a l i n t e r p o l a t i o n m e t h o d. It is inferior in terms of precision to the mathematical-millimeter mathod. Nevertheless, having in mind that the VCG method is labour-consuming, for practical purposes some

calculations could be made with approximation which is sufficient for the assessment of measurements.

The contours of the loop we are interested in is copied on the waxed ECG paper (for instance Multicard 3 or Hellige 3-or 6-channel). Surface readings are made by outlining with pencil whole squares of 1 $cm^2$ and 0.25 $cm^2$, and counting them. The parts of 0.25 $cm^2$ are approximately equalized to 1/4, 1/3 and 3/4 $cm^2$, and added. When greater experience and skill is attained, the error is smaller than that when a planimeter is used.

5. Squared paper method. Tracing on ECG paper of the above mentioned type is resorted to. The whole 1 $cm^2$ and 0.25 $cm^2$ squares are counted, and to them the 1, 1/2, 3/4 and 1/4 $mm^2$ squares, counted with magnifying glass, are added.

The method is labour-consuming. Errors are possible even when re-counting is carried out by the same investigator, and that is why it ranks after the mathematical-millimeter method. The difference per figure when counting is performed by the same investigator amounts to 0.02—0.16 $cm^2$, at 3—9 minutes duration.

It may be used in practice whenever it is a matter of figures measuring from 0.5 to 1 $cm^2$, where the other methods entail greater errors because of the small area surface.

6. Photometric method. The VCG loop is copied with India ink on solid paper, and the area outlined is cut. Uniform light is let through, and is measured with a luxometer.

It was established that light interferes in case of loops with many bends, and that is why the method is considered as inaccurate and unsuitable.

In conclusion, we recommend to perform surface determinations of VCG loops according to the following scheme:

1. For practical purposes — the visual interpolation method.
2. For research purposes — the mathematical-millimeter method.
3. For surfaces smaller than 1 $cm^2$ — the squared paper method.

In research studies, the weighing and planimetric methods could be employed making use of a PL 1 planimeter.

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## РЕЗУЛЬТАТЫ СРАВНИТЕЛЬНОЙ ОЦЕНКИ НЕКОТОРЫХ МЕТОДОВ ПО ОПРЕДЕЛЕНИЮ ПЛОЩАДЕЙ В ВЕКТОРКАРДИОГРАФИИ

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РЕЗЮМЕ

Сопоставляется несколько методов анализа ВКГ-площадей по точности и необходимому времени на исследование с учетом их места для практической и научной цели. Указывается на возможность использования стандартной бумаги для весового метода, в результат чего он приобретает определенное значение, в чем и состоит его вклад.

Разрабатывается модификация «математическо-миллиметрового метода». Для практической цели предлагается новая разработка — метод визуального интерполирования.