

# **"Color Vectorcardiogram" Recorded with a Specially Designed Apparatus for Spatial Representation By Coloring**

*By SHINJI KINOSHITA, M.D., AND TADASHI KOBAYASHI, M.D.*

## **SUMMARY**

Using a vectorcardiogram only in the horizontal plane, spots of the vector loop were colored according to a specially designed apparatus, so that changes in height of the spots could be indicated by differences in those colors. Consequently, the spatial vectorcardiogram was represented by a single, colored graph, i.e. a "color vectorcardiogram." By the use of this graph, an attempt was made to facilitate the understanding of vectorcardiography for common clinicians. The colors corresponding to the heights of the deflections in the Y axis were chosen as follows: in a level of the origin or zero point of the vector loop, yellow; above the origin, reddish colors; and below the origin, bluish colors.

## **Additional Indexing Words:**

Vectorcardiography      Spatial vectorcardiogram

IT IS THE primary purpose of vectorcardiography for all the electrocardiographic leads recorded in a person to be readily appreciated as a single spatial vectorcardiogram. According to the vectorcardiography as now practiced, however, the record in a person consists of three-plane vectorcardiograms. We think this may explain why vectorcardiography is difficult for some clinicians to understand. Although there have been several attempts to visualize directly the spatial vectorcardiogram,<sup>1, 2</sup> it seems to us that these cannot solve this problem because of difficulty in keeping a graphic record.

In the present study, a vector loop was observed only in the horizontal plane. By means of a specially designed apparatus for coloring of spots of the vector loop, variations

in height (that is, the degree of superior and inferior deviations of the spots) were indicated by differences in those colors. The spatial vectorcardiogram, accordingly, was represented by a single, colored plane vectorcardiogram. By employing this colored graph (the "color vectorcardiogram"), an attempt was made to clarify vectorcardiography for clinicians.

## **Method**

An apparatus for recording the "color vectorcardiogram" was specially designed by us. A detailed method for using this apparatus was reported in our previous paper.<sup>3</sup> An outline of the apparatus is illustrated in figures 1 and 2.

At first, by monochromatic light spots, a vector loop of the horizontal plane was described on a fluorescent screen of the oscilloscope, as shown in figure 1. Then, using a lens, the images of these light spots were focused on a filter for coloring. Finally, the spots of the vector loop were photographed through this filter. Thus, a colored graph, i.e. a "color vectorcardiogram," was recorded. Using a galvanometer connected to both leads of the X and Y axes, as shown in figure 2, the position of the filter was varied from instant to instant so as to change the color of the spot only corresponding to the voltage of the deflection in the Y axis.

From the Second Department of Medicine and the Clinical Laboratory, Hokkaido University School of Medicine, Sapporo, Japan.

Address for reprints: Shinji Kinoshita, M.D., the Second Department of Medicine, Hokkaido University School of Medicine, Sapporo, Japan.

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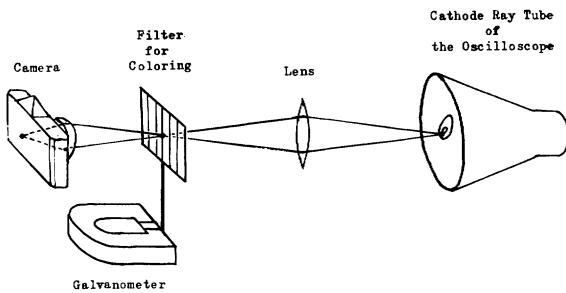


Figure 1

*Schematic representation of the apparatus for recording the "color vectorcardiogram."<sup>1</sup> The type of cathode-ray tube is 3KP4 or 3KP7. The lens of 130-mm focus is placed in the middle between the fluorescent screen and the filter for coloring. The distance from the screen to the filter (520 mm) is equal to four times the focal length of the lens. The image of the vector loop on the filter, accordingly, is the same in length as the vector loop on the fluorescent screen. The filter is 34 mm in width and 23 mm in height. Colors, each of which is 2 mm in width, are arranged side by side on the filter.*

The colors corresponding to the heights of the deflections in the Y axis were chosen usually as shown in figure 3: in a level of the origin or zero point of the vector loop, yellow; above the origin, 0.8 and 0.4 mv, red and orange, respectively; and below the origin, 0.4, 0.8, 1.2, and 1.6 mv, yellow-green, green, green-blue, and blue, respectively. Wherever the deflection in the Y axis was higher than 1.2 mv above the origin, white was chosen; and wherever deeper than 2.0 mv below the origin, blue-purple.

### Results

Figure 4 shows a "color vectorcardiogram" in the horizontal plane, which was recorded with the above-mentioned apparatus. The deflection of the Y axis is shown in figure 3.

At first, the QRS loop shown in figure 4 starts from the origin (yellow) and goes downward through yellow-green (-0.4 mv in height) and green (-0.8 mv) to a depth of green-blue (-1.2 mv). Then, the loop goes upward through green (-0.8 mv) and yellow-green (-0.4 mv) to the same level as the origin (yellow). Furthermore, the loop continues to go upward through orange (+0.4 mv) to a height of red (+0.8 mv.). Finally, the loop again goes downward from this point, and, passing through orange (+0.4 mv), returns to the origin (yellow). The T

loop is almost all yellow. This shows that the T loop is nearly horizontal in the same level as the origin.

### Discussion

Vectorcardiography, though giving us better information in many respects, is used far less commonly than ordinary electrocardiography. We think this may be due to the fact that the use of three-plane vectorcardiograms, as now practiced, makes it difficult to understand this method. In this study, spots of the vector loop in the horizontal plane were colored so that changes in height of the spots might be shown. Consequently, the spatial vectorcardiogram was represented by a single, colored graph. By the use of this graph, an attempt was made to facilitate the vectorcardiographic interpretation for clinicians.

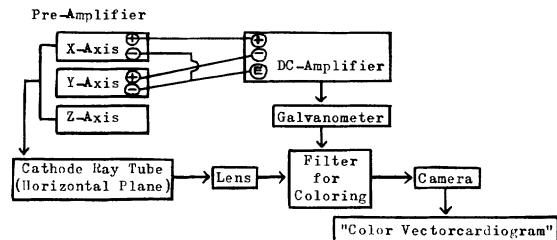


Figure 2

*Schematic representation of the apparatus for recording the "color vectorcardiogram."<sup>2</sup> The apparatus for moving the filter consists of the following instruments, which are constructed by Nihon Kohden Company, Tokyo, Japan: (1) a vectorcardiograph (MVC-3OR) and pre-amplifiers (RB-2), which are installed in a multipurpose polygraph (RM-150); (2) a DC-amplifier (AD2-22); and (3) an ink-writing oscillograph (II-40-B) of the moving-coil type. The frequency-response curve of this system excluding the filter is flat within 10 to 50 cycles per second (Hz), and drops at 100 and 150 Hz, respectively, to 85 and 70% of this level. When the filter is included in this system instead of the pen of the oscillograph, the frequency response is also shown as about the same curve. The filter, weighing 0.6 g, is identical in weight to the pen. Calibration of the X axis on the filter is made equal to that on the fluorescent screen. Calibration of the Y axis on the filter is usually such that 1.0 mv is equivalent to 5 mm. By means of these procedures, the position of the filter is varied from instant to instant, so that the color of the spot of the vector loop is not affected by the voltage of the deflection in the X axis, but is changed only because of the voltage in the Y axis.*

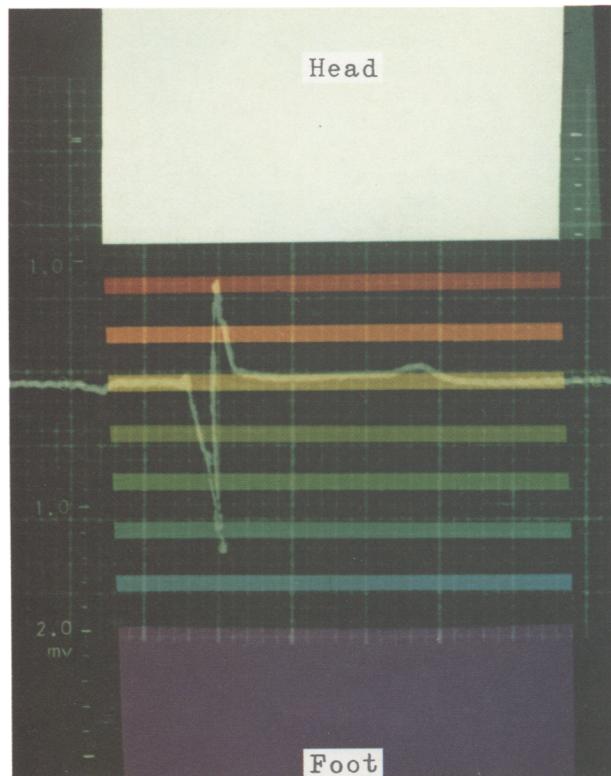


Figure 3

Colors correspond to the heights of the deflections in the Y axis.

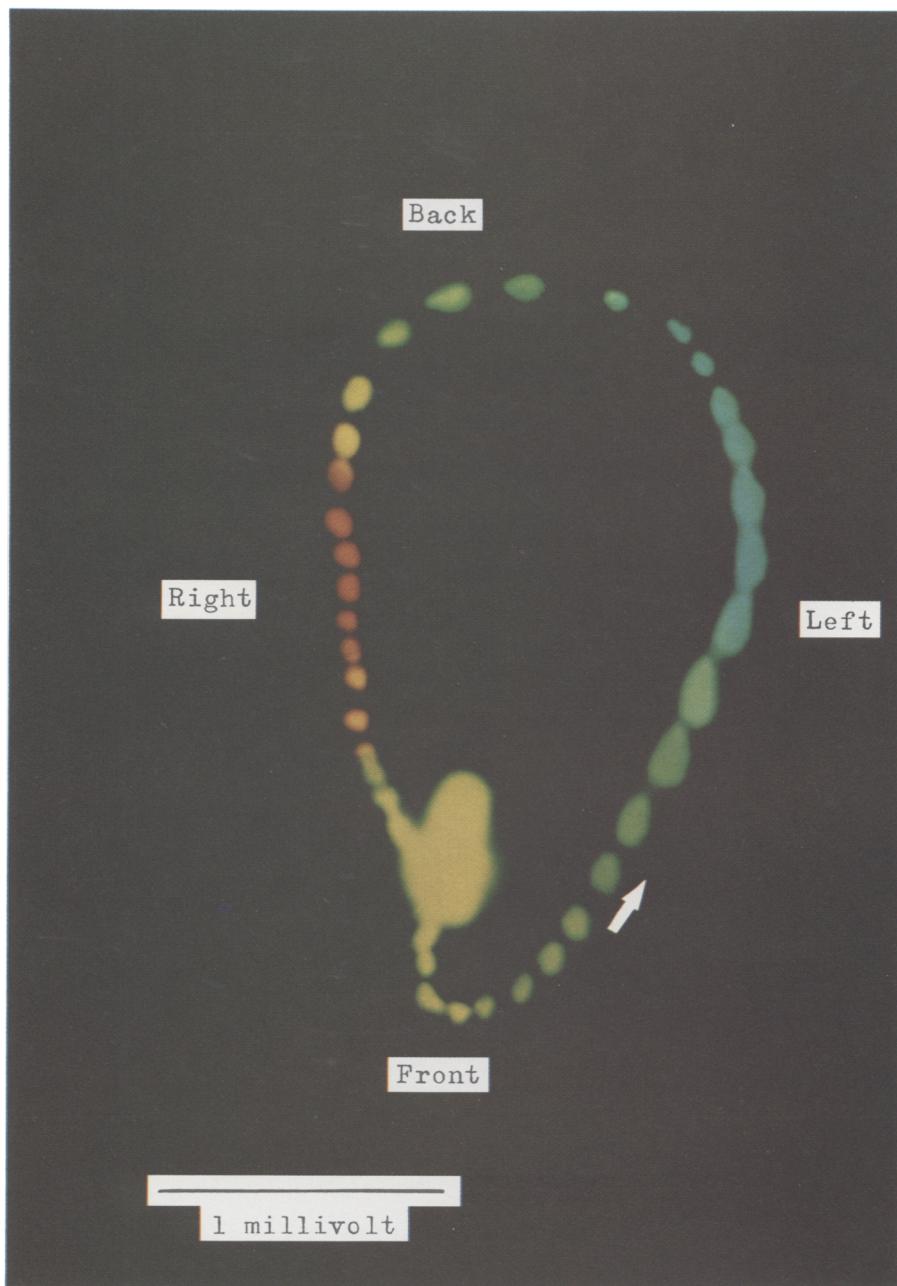


Figure 4

A "color vectorcardiogram" in the horizontal plane. The deflection in the Y axis is shown in figure 3. Each interval between spots represents 2 msec.

It is known that, when the vectorcardiogram is observed in a single plane, the greatest accuracy in interpretation is attained by using the horizontal plane.<sup>4</sup> In order to obtain the "color vectorcardiogram," therefore, a vector loop in the horizontal plane was usually employed. In cases in which the amplitude of the deflection in the Y axis was unusually large or unusually small, the sensitivity to the voltage in the Y axis was respectively decreased or increased to such an extent that differences in color of the spots could be readily appreciated.

We think that the use of these procedures, as compared with the use of three-plane vectorcardiograms, can remove the above-mentioned complication in the graphic inter-

pretation, without greatly diminishing the accuracy.

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#### Correction

Moffitt EA, Molnar GD, McGoan DC: *Circulation* 44: 237, 1971. Legends for figures 2 and 4 are reversed.