The Significance of a Wide TsE Loop

By Te-Chuan Chou, M.D., Robert A. Helm, M.D., and Ralph Lach, M.D.

With the technical assistance of Mr. Robert Schwemberger

In recent years there has been increasing interest in the clinical application of spatial vectorcardiography. Some comparative studies have indicated that the vectorcardiogram may be significantly superior to the conventional scalar electrocardiogram in the diagnosis of myocardial infarction and ventricular hypertrophy. The Frank lead system has many theoretical advantages over the older vectorcardiographic recording systems and has also been claimed to be superior to the older systems for clinical application. The growing number of vectorcardiographic studies with use of the Frank reference frame tends to indicate its acceptance as an improved, although by no means ideal, system.

Investigations in clinical vectorcardiography have primarily been directed to the study of the QRS loop. Very little information can be obtained from the current literature concerning the T loop, especially with regard to its configuration. The purpose of the present investigation is to study with the Frank system: the normal configuration of the TsE loop,* particularly with regard to its length and width ratio; the pathologic entities associated with abnormally wide TsE loops; and the comparative value of vectorcardiography in the study of the process of repolarization, especially as to whether it will supply additional information not easily obtained from the conventional scalar electrocardiogram.

Materials and Method

The electrocardiograms and vectorcardiograms of 130 normal adults were recorded. The age of the individuals ranged from 20 to 59 years. With the exception of four women all of the subjects were men. They included medical students, house officers, and members of the local police and fire departments. The criteria for normalcy included the following: absence of history suggestive of cardiovascular, pulmonary, or renal disease; physical examinations revealing no cardiovascular abnormality; a normal chest x-ray; and a normal electrocardiogram. The electrocardiograms were taken with a Sanborn direct-writing recorder and the 12 leads were taken immediately either before or after the recording of the corresponding vectorcardiograms. All vectorcardiograms were recorded with the Frank system of electrode placement. The chest electrodes were placed at the level of the intersection of the fifth intercostal space with the sternum. Recordings were made with the subjects in the supine position. Transverse, right sagittal, and frontal planes were taken in succession. (The right sagittal plane was selected in preference to the left sagittal plane for the reason given previously by one of the authors.) A Sanborn amplifier model 185 with an attached Frank lead selector and a Sanborn Viosocope model 569A were used. The vectorcardiograms were photographed through a DuMont oscillograph-camera with Polaroid film. In most instances, additional spot films were taken in which the T loops were magnified so that the details of the T loops could be seen and analyzed. The loops were interrupted every 2.5 milliseconds producing four “tear drops” in each 0.01-second interval. The larger end of the “tear drop” represented the front end. Helm’s system of notation was used.

Measurements were made of the maximal length and width of the T loops in all three planes. The distance from the beginning of the T loop to the most remote point of the loop was considered to be the maximal length (or the length of maximal T vector). Lines perpendicular to the maximal T vector were drawn. The study of the T loop was extended to the study of the T loop and the QRS loop.

* Throughout the paper, TsE loop indicates the spatial T vector loop, T loop refers to the plane projection of the TsE loop.

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Statement of the problem.

The T loop (or loop configuration) is an important component of the electrocardiogram and has been widely studied in recent years.

Several studies have been made to determine the normal composition of the T loop configuration. In addition, at least two studies have been made to establish criteria for pathologic T loop criteria.

Objectives of the study.

The present study is aimed at determining the normal T loop configuration, and at establishing criteria for normal T loop configuration for the purposes of diagnosis.

Method of study.

The T loop configuration was determined in the following manner:

1. The T loop configuration was determined in 130 normal adults.
2. The T loop configuration was determined by means of a vectorcardiographic system.
3. The T loop configuration was determined by means of a vectorcardiographic system.
4. The T loop configuration was determined by means of a vectorcardiographic system.
5. The T loop configuration was determined by means of a vectorcardiographic system.

Results of the study.

The results of the study are as follows:

1. The T loop configuration is normal in all the normal adults.
2. The T loop configuration is normal in all the normal adults.
3. The T loop configuration is normal in all the normal adults.
4. The T loop configuration is normal in all the normal adults.
5. The T loop configuration is normal in all the normal adults.

Conclusion.

The T loop configuration is normal in all the normal adults.

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SIGNIFICANCE OF WIDE TsE LOOP

length of the maximal T vector was used as the maximal width of the loop (fig. 1). The magnitude of the maximal T vector was expressed in millivolts. For the sake of convenience the same millivolt scale was used to indicate the width. Obviously, it does not have the same meaning, since the width of the loop cannot be expressed in millivolts. The ratio between the largest maximal T vector among the three planes and the largest maximal width of the T loop in the three planes (L/W ratio) was used to indicate the width of the TsE loop. For example (fig. 1), if the measurements of the T loop were as follows—maximal T vector: transverse plane 0.34, right sagittal plane 0.4, frontal plane 0.44; maximal T loop width: transverse plane 0.08, right sagittal plane 0.05, frontal plane 0.02—the L/W ratio would be 0.44/0.08 or 5.5:1. (Since the denominator of the fraction will always be adjusted to one, the numerator only will be used in the remainder of the paper to simplify the expression for the L/W ratio.)

The normal limits for the L/W ratio of the TsE loop were determined by the formula recommended by Simonson 10 using 97.5 and 2.5 percentiles of the values from the 130 normal subjects as the upper and lower limits, respectively.

The vectorcardiograms and electrocardiograms of 500 consecutive adult patients (age 20 years or older) known or suspected to have heart disease were reviewed. The recordings were obtained by the same procedure as described above. Those patients whose vectorcardiograms presented a L/W ratio of the TsE loop beyond the normal limits as defined from the study of the normal population were selected for analysis. Cases with a large S-T vector were excluded because it is possible that the widening of the TsE loop was actually secondary to the large S-T vector.

The electrocardiographic diagnoses of the 500

Figure 1

Normal vectorcardiogram in a 30-year-old physician. The diagram illustrates the method of determination of L/W ratio of the TsE loop.

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cases were noted. In cases associated with an abnormally wide TsE loop in the vectorcardiogram, special attention was paid to the presence or absence of normality of the T wave of the electrocardiogram. The clinical diagnosis of each case was recorded as was the presence or absence of digitalis therapy.

Results

The normal TsE loop was approximately elliptical in shape. It was usually elongated and sometimes linear in configuration. The efferent limb was always inscribed more slowly than the afferent limb. Its long axis was usually directed anteriorly, inferiorly, and to the left. Its direction of inscription was usually the same as that of the QRS loop. This finding was particularly striking in the transverse and the right sagittal planes. Among the 130 normal subjects, 122 had counterclockwise inscription in the transverse plane, and 125 had clockwise inscription in the right sagittal plane. There were six subjects whose T loops were linear in either or both planes so that the direction of inscription could not be determined. There were four cases in which the direction of inscription of the T loops was opposite to that of the QRS loops in either or both planes. However, the T loops were again very narrow in these four cases. There were no instances in these two planes in which the T loop was not very narrow and yet had a direction of inscription opposite to that of the QRS loop. However, this was not always true in the frontal plane in which the directions of inscription of the QRS and T loops were occasionally but not frequently different.

The normal maximal T vectors in the three planes ranged from 0.2 to 1.0 millivolt with a mean value of 0.53 millivolt. The maximal T-loop width ranged from 0 to 0.22 with a mean value of 0.09. There were 10 cases in which the T loops were so narrow that their width could not be measured. The maximal length and maximal width ratio (L/W ratio) varied from 2.3 to infinity with 81.5 percent of the subjects having a value of 3 or greater. The 97.5-percentile upper limit and 2.5-percentile lower limit for the L/W ratio as determined by the formula recommended by Simonson were infinity and 2.66, respectively. Thus any TsE loop with a L/W ratio of 2.6 or less was considered to be abnormally wide.

<table>
<thead>
<tr>
<th>Clinical diagnosis</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery disease</td>
<td>33</td>
</tr>
<tr>
<td>Hypertensive cardiovascular disease</td>
<td>16</td>
</tr>
<tr>
<td>Rheumatic heart disease</td>
<td>13</td>
</tr>
<tr>
<td>Syphilitic heart disease</td>
<td>4</td>
</tr>
<tr>
<td>Pulmonary emphysema with or without cor pulmonale</td>
<td>3</td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td></td>
</tr>
<tr>
<td>Atrial septal defect</td>
<td>3</td>
</tr>
<tr>
<td>Pulmonary stenosis</td>
<td>2</td>
</tr>
<tr>
<td>Eisenmenger's syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Ebstein disease</td>
<td>1</td>
</tr>
<tr>
<td>Coronary A-V fistula</td>
<td>1</td>
</tr>
<tr>
<td>Aortic stenosis, etiology uncertain</td>
<td>1</td>
</tr>
<tr>
<td>Aortic insufficiency, etiology uncertain</td>
<td>1</td>
</tr>
<tr>
<td>Primary myocardial disease</td>
<td>1</td>
</tr>
<tr>
<td>Dermatomyositis with cardiac involvement</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1</td>
</tr>
<tr>
<td>Anemia</td>
<td>1</td>
</tr>
<tr>
<td>Heart disease of unknown etiology</td>
<td>1</td>
</tr>
<tr>
<td>No demonstrable heart disease</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>85</strong></td>
</tr>
</tbody>
</table>
Among the 500 consecutive vectorcardiograms taken in patients known or suspected to have cardiac abnormalities, there were 85 cases (17 per cent) with a L/W ratio of 2.6 or less. Two patients had ratios from 0.9 to 0.9; 42 patients had ratios from 1.0 to 1.9; and 41, from 2.0 to 2.6. The average maximal T-vector magnitude was 0.30 millivolt with a

Table 2

Analysis of the Electrocardiographic Diagnoses in the 500 Consecutive Patients Reviewed Including the 85 Cases with Abnormally Wide TsE Loops

<table>
<thead>
<tr>
<th>Electrocardiographic diagnosis</th>
<th>No. of cases among the entire group*</th>
<th>No. of cases in the group with wide T loop*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left ventricular hypertrophy</td>
<td>131</td>
<td>35 (26.7%)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>138</td>
<td>24 (17.4%)</td>
</tr>
<tr>
<td>Right ventricular hypertrophy</td>
<td>63</td>
<td>10 (15.9%)</td>
</tr>
<tr>
<td>Right bundle-branch block</td>
<td>84</td>
<td>9 (10.7%)</td>
</tr>
<tr>
<td>Normal</td>
<td>34</td>
<td>6 (17.6%)</td>
</tr>
<tr>
<td>Nonspecific T-wave abnormalities</td>
<td>71</td>
<td>5 (7.0%)</td>
</tr>
<tr>
<td>Left bundle-branch block</td>
<td>32</td>
<td>4 (12.5%)</td>
</tr>
<tr>
<td>Abnormal left axis deviation</td>
<td>49</td>
<td>4 (8.2%)</td>
</tr>
<tr>
<td>Intraventricular conduction defect</td>
<td>5</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Myocardial ischemia</td>
<td>4</td>
<td>1 (25%)</td>
</tr>
<tr>
<td>Right ventricular strain</td>
<td>2</td>
<td>1 (50%)</td>
</tr>
</tbody>
</table>

* The total number in each group is more than 500 and 85, respectively, because many cases have multiple diagnoses.

Table 3

Clinical and Electrocardiographic Diagnoses of the 15 Patients with Abnormally Wide TsE Loops but Normal T Waves

<table>
<thead>
<tr>
<th>Cases</th>
<th>Clinical diagnosis</th>
<th>Electrocardiographic diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cor. art. dis.</td>
<td>Normal (previous ECG showed RBBB)</td>
</tr>
<tr>
<td>2</td>
<td>Cor. art. dis.</td>
<td>Normal (previous ECG showed myocardial ischemia)</td>
</tr>
<tr>
<td>3</td>
<td>Arteriosclerosis</td>
<td>Left atrial enlargement (previous ECG showed LVH by voltage criteria)</td>
</tr>
<tr>
<td></td>
<td>Hypertension</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Probable RHB with MI</td>
<td>Normal</td>
</tr>
<tr>
<td>5</td>
<td>HCVD</td>
<td>Normal</td>
</tr>
<tr>
<td>6</td>
<td>No demonstrable heart disease</td>
<td>Normal</td>
</tr>
<tr>
<td>7, 8</td>
<td>HCVD</td>
<td>LVH by voltage criteria</td>
</tr>
<tr>
<td>9, 10</td>
<td>Cor. art. dis.</td>
<td>Anteroseptal myocardial infarction</td>
</tr>
<tr>
<td>11</td>
<td>Cor. art. dis.</td>
<td>Inferior myocardial infarction</td>
</tr>
<tr>
<td>12</td>
<td>Cor. art. dis.?</td>
<td>LVH by voltage criteria</td>
</tr>
<tr>
<td>13</td>
<td>Syphilitic aortitis</td>
<td>LVH by voltage criteria</td>
</tr>
<tr>
<td>14</td>
<td>Aortic insufficiency</td>
<td>RSR' in V1</td>
</tr>
<tr>
<td>15</td>
<td>Eisenmenger syndrome</td>
<td>RVH</td>
</tr>
</tbody>
</table>

Cor. art. dis., coronary artery disease; RHD, rheumatic heart disease; MI, mitral insufficiency; HCVD, hypertensive cardiovascular disease; RBBB, right bundle-branch block; LVH, left ventricular hypertrophy; RVH, right ventricular hypertrophy.
The clinical diagnoses of these 85 patients are listed in table 1. It is apparent that an abnormally wide TsE loop may be found in a wide variety of acquired and congenital heart diseases. In 84 patients the presence of cardiac pathology was reasonably established. The only exception was a 68-year-old man with minimal pulmonary tuberculosis and gouty arthritis. Thirty-three of the patients were receiving digitalis; 42 were not, and the information was not available in 10 patients.

The electrocardiographic diagnoses in the 500 consecutive patients, including those with an abnormally wide TsE loop, are categorized in table 2. Although an abnormally wide TsE loop was most frequently associated with left ventricular hypertrophy or myocardial infarction, it was also seen in many other pathologic entities. An example of a wide TsE loop in myocardial infarction is illustrated in figure 2.

Fifteen patients whose vectorcardiograms showed an abnormally wide TsE loop had normal T waves in their electrocardiograms according to current criteria. The directions and magnitudes of the maximal T vectors and the directions of inscription of the T loops were also normal. The low L/W ratio represented the only abnormality concerning the event of repolarization. Because they are of special interest, their clinical and electro-
cardiographic diagnoses are listed individually in Table 3. There were six cases in which both the QRS complexes and T waves were normal. The other nine patients had definite QRS abnormalities but their T waves were normal. In five of the six patients with normal electrocardiograms, the presence of cardiac pathology was suggested by other factors, including previous electrocardiograms. The exception was the 68-year-old man mentioned previously. Thirteen of the 15 patients were not receiving digitalis at the time of the recording.

The following is an example to demonstrate the presence of an abnormally wide TsE loop even though the electrocardiogram showed no T-wave abnormality in a patient who had definite heart disease.

Figure 3

Evolution of an anterior wall myocardial infarction in a 50-year-old man. (a) Subacute stage (4-16-1958). (b) Five years after the acute episode (6-28-1963), the T wave in the electrocardiogram has returned to normal polarity and configuration; however, the TsE loop remains abnormally wide.
J.R. (case 10, table 3), a 50-year-old man, had an acute anteroseptal myocardial infarction on March 24, 1958. The diagnosis was well documented by typical symptoms, enzyme elevations, and serial electrocardiograms, one of which is shown in figure 3. After recovering from the acute episode the patient was followed regularly in the Cardiac Clinic of the Cincinnati General Hospital. He remained asymptomatic. Serial electrocardiograms showed gradual improvement of the T-wave abnormality. Although the evidence for an old anteroseptal myocardial infarction was still present with a Q wave in leads V₁ through V₄, an electrocardiogram taken on June 28, 1963, revealed that the T wave could now be considered to be within normal limits in all leads. Vectorcardiogram taken at the same time, however, showed an abnormally wide TsE loop with a L/W ratio of 2.3, even though the direction and magnitude of the maximal T vector and the direction of inscription of the T loop were normal.

Discussion

It is well known that the vectorcardiogram often provides additional information about the process of ventricular depolarization by the demonstration of different configurations of the QRS loops while their corresponding QRS complexes in the scalar electrocardiogram appear similar. For example, patients with right ventricular hypertrophy or right bundle-branch block as well as normal individuals may all present an RSR' pattern in lead V₁ in the conventional electrocardiogram whereas their QRS loop configurations sometimes differ quite distinctively. It is only logical to expect that such an advantage may also exist for the process of repolarization. This belief prompted us to the pursuit of the present investigation.

Karni first suggested the examination of the configuration of the T loop as a new method of analyzing T-loop abnormalities. Examples were given in which widening of the T loop was associated with myocardial lesions. Sano and associates reported an increased incidence of "circular" T-vector loops in elderly patients with hypercholesteremia. Using the Frank lead system for recording the vectorcardiogram, they classified the T loop as "circular" when the ratio between its long axis and its short axis was smaller than 1:0.3, "narrow" when the ratio was greater. The reason for the selection of the dividing ratio was not given and eight of their 31 young normal individuals had "circular" T loops according to the criteria. The long and short axes used for the calculation of the ratio presumably referred to those in the same plane projection. Wajszczuk and Burch used a similar ratio (3.5:1) as the dividing line, even though their vectorcardiograms were recorded with Wilson's tetrahedron lead system. They noticed an increased incidence of "circular" T loops in patients with tetralogy of Fallot and atrial septal defect.

Ideally, the determination of the maximal length to maximal width ratio of the TsE loop should be based upon the measurements from the spatial loop itself instead of those of its plane projections. However, construction of a wire model of the spatial loop is too time consuming for routine practice. Derivation of the measurements from the usual records of plane projections by mathematical calculation would also be a very complicated procedure. Schmitt in 1947 designed a lead resolver with which a spatial loop could be rotated and projected onto any desired plane. Milnor and Pipberger and Carter have used such an instrument, or a modification of it, in the analysis of QRS: loops. It is quite conceivable that the same technic could be used with advantage in the analysis of TsE loops. The loop could be rotated and the desired plane projection obtained in which the loop has the largest length and width (i.e., equal to the maximal length and width of the spatial loop itself). Since such a technic has thus far not been widely used, the interpretation of the clinical vectorcardiogram must depend on data readily available from the the three plane projections generally recorded. However, a ratio calculated from the length and width in the same plane is often unreliable. For instance, an elongated loop viewed from the direction of its long axis may appear to be short and widened. Since the largest maximal T vector among the three planes would be the one nearest in
magnitude to the maximal spatial T vector and the largest maximal width among the three planes nearest to the maximal width of the TsE loop, we think that the ratio calculated from these two values could avoid most of the error and give a closer approximation to the true length to width ratio of the spatial T loop.

We elected to use the formula recommended by Simonson for the determination of the 97.5-percentile upper limit and 2.5-percentile lower limit because the formula applies equally well for data that do not have a binomial distribution, such being the case for the L/W ratio in our group of normal subjects. Since the upper and lower limits determined by this method were infinity and 2.66, respectively, the decision to call any L/W ratio of 2.6 or less abnormal seemed justifiable, with only 2.5 per cent of the otherwise normal population falling into this group. The fact that 17 per cent of the 500 patients suspected or known to have heart disease had a ratio of 2.6 or less further supports the validity of this criterion.

Upon comparing the mean values of the maximal length and width of the normal with those of the abnormally wide TsE loops it can readily be seen that the widening of the TsE loop is the result of both a decrease in length and an increase in width instead of only relative shortening of the maximal T-vector length. The mean values for the maximal TsE-loop length and width were 0.53 and 0.09, respectively, for the normal group and 0.30 and 0.16 for those with abnormally wide TsE loops.

An abnormally wide TsE loop was seen most frequently in coronary artery, hypertensive cardiovascular, and rheumatic heart diseases. It was also present in other types of heart disease. Since its relative frequency among the various diseases parallels closely the prevalence of the diseases themselves, it is quite reasonable to assume that an abnormally wide TsE loop is not specifically related to or more frequently seen in any particular disease entity. However, analysis of the electrocardiographic diagnoses reveals that there seems to be an increase in the incidence of wide TsE loop in ventricular hypertrophy and myocardial infarction. Nevertheless, the finding is by no means specific for either of these conditions.

Of special interest and significance is the group of 15 patients with abnormally wide TsE loops whose electrocardiograms showed no T-wave abnormality. The magnitudes and directions of the maximal vectors of the T loops were also within normal limits. The presence of organic cardiac disease was obvious in the group in which there was QRS complex abnormality in the electrocardiogram even though the T wave was normal. In all of these patients, additional confirmatory evidence of organic heart disease was available also. In the group with completely normal electrocardiograms the presence of organic heart disease could also be reasonably assumed in all except one (table 3). Case 1 (table 3) is a patient who had coronary artery disease with angina pectoris. Even though the electrocardiogram at the time when the vectorcardiogram was taken was normal, many of his previous tracings showed right bundle-branch block. Case 2 had a typical history of angina pectoris. The diagnosis of coronary artery disease was further supported by evidence of myocardial ischemia in his previous electrocardiograms. Case 3 had cerebral thrombosis and hypertension. Previous electrocardiograms met the voltage criteria for the diagnosis of left ventricular hypertrophy even though left atrial enlargement was the only abnormality seen in his latest tracing. Case 4 had a history of rheumatic fever and a grade-II pansystolic murmur at the apex. Case 5 had severe hypertension and slight cardiomegaly by x-ray examination. Thus in these five cases, the abnormally wide TsE loop served as the only evidence of abnormality in the electrical event of the heart. In the other 10 cases with abnormal QRS but normal T wave, the vectorcardiogram offered additional evidence of abnormality even though the information was only supplementary and in itself not essential for the diagnoses. However, they did illus-
trate that vectorcardiography can reveal an abnormality in the process of repolarization in the presence of definite cardiac pathology while its counterpart in the electrocardiogram appears to be normal.

The widening of the TsE loop is obviously not related to digitalis since only two of the 15 patients were receiving the drug.

In regard to the pathophysiology of abnormally wide TsE loops, Karni suggested that the presence of a myocardial lesion disturbed the equilibrium of repolarization. Component vectors, not manifested in normal cases, seemed to influence the new resultant vectors of vector integrations. We believe that this explanation is probably applicable in a majority of instances. However, since an abnormally wide TsE loop is observed in many different pathologic entities it is very likely that there are other factors responsible. The rather narrow configuration of the normal TsE loop reflects the fact that the instantaneous resultant vectors are similar in their directions. The direction of each resultant instantaneous T vector could be changed by either modification of the sequence of propagation of the repolarization process or a change in the amount of contribution from various component vectors. Thus, in myocardial infarction the divergence of the instantaneous resultant T vectors with the result of a wide TsE loop could be the result of either decreased contribution from the necrotic area or a change in the sequence of repolarization because of the presence of an infarct. The latter mechanism could also be expressed as “repolarization conduction defect.” Both mechanisms are not dissimilar to those responsible for the disfigurement of the QRS complex or vector loop. In ventricular hypertrophy, the alteration of the magnitudes of the component vectors are probably respon-

**Figure 4**

Comparison of the scalar derivatives of a normal (a) and an abnormally wide (b) T loop in the transverse plane. The loops are projected on leads x and z. Note the asynchronism of the peaks of the T waves in the two leads when the T loop is wide.

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Sensible for the change while in bundle-branch block the deformity is most likely due to conduction disturbances secondary to alteration of the conduction pathway of the depolarization process.

In an attempt to identify the change in the T wave of the electrocardiogram that corresponds to abnormal widening of the TsE loop, the scalar derivatives of a normal and an abnormally wide TsE loop are compared as illustrated in figure 4. The directions and magnitudes of the maximal T vectors of the two loops are the same and there is very little difference in the configurations of the corresponding T waves in the two leads x and z on which the projections are made. However, when the time intervals between the beginning and the peak of each T wave are measured, the T waves in leads x and z reach their peaks simultaneously when the T loop is narrow, but asynchronously when the loop is wide. Since the leads of the routine electrocardiogram are almost invariably recorded consecutively rather than simultaneously at the present time, such asynchronism cannot be demonstrated and the electrocardiogram is consequently interpreted as normal if no other abnormality is present. Furthermore, since most routine electrocardiograms are taken with a paper speed of only 25 or 50 mm. per second, asynchronism would be difficult to demonstrate even if leads were recorded simultaneously with an electrocardiograph having two or more channels.

**Summary and Conclusion**

The TsE loops of 130 normal adults were analyzed with reference to their maximal length and width ratio (L/W ratio). Ninety-seven and one-half per cent (97.5 per cent) of the group has a ratio of 2.66:1 or greater. A TsE loop with a L/W ratio of 2.6:1 or less was considered to be abnormally wide.

Among 500 consecutive vectorcardiograms taken in patients known or suspected to have heart disease, 85 (17 per cent) had an abnormally wide TsE loop. Abnormally wide TsE loops are associated with a wide variety of heart diseases and electrocardiographic abnormalities. The incidence of abnormally wide TsE loops is comparatively higher in myocardial infarction and ventricular hypertrophy.

In 15 patients, 14 of whom have demonstrable organic heart diseases, the vectorcardiograms showed abnormally wide TsE loops although there were no apparent abnormalities in the T waves of their electrocardiograms by current standards.

Pathophysiology of the wide TsE loop is discussed and an attempt is made to correlate the widening of TsE loop with the changes expected in its scalar counterpart.

It is concluded that the vectorcardiogram may reveal an abnormality of the process of repolarization that is not readily apparent in the scalar electrocardiogram. Analysis of the length-to-width ratio of the TsE loop may offer useful information.

**Acknowledgment**

We wish to thank Dr. Paul Stein for his assistance during the early phase of the study. We also wish to thank Dr. John McSweeney and Dr. Richard Wurzelbacher for their cooperation in obtaining normal subjects.

**References**


Artificial Compartments

Each science confines itself to a fragment of the evidence and weaves its theories in terms of notions suggested by that fragment. Such a procedure is necessary by reason of the limitations of human ability. But its danger should always be kept in mind. For example, the increasing departmentalization of universities during the last hundred years, however necessary for administrative purposes, tends to trivialize the mentality of the teaching profession.—ALFRED NORTH WHITEHEAD, Nature and Life (University of Chicago Press, 1934).
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