The Modifications of the Electrocardiogram in Chronic Pulmonary Tuberculosis

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The Method

We wish to report on the results of systematic research carried out for a period of over seven years in some 8,000 patients having chronic unilateral or bilateral pulmonary tuberculosis. Some were subjected to surgical treatment including extrapleural A.P. thoracoplasties, partial or total resections, and decortication.

The greater part of the tracings have been frequently repeated, and especially on the occasion of spontaneous modifications or those provoked by treatment, medical or surgical, appearing in the pulmonary picture.

The electrocardiographic observations have been carried out making use of all the derivations of Einthoven (D1, D2, D3) unipolar of the limbs according to Goldberger (aVR, aVL, aVF) and unipolar-precordial according to Wilson (from V1 to V6).

Since some localized lesions are recorded only in a few and particular derivations, barring the effective selectivity of each derivation for the single and partial electric effects which take place in a myocardic sector, we have added the thorax derivations of Condorelli and the right side thorax derivations of Di Maria to the recording of the normal standardized derivations (Figure 1 shows the normal morphology).

The tracings have been kept sufficiently long because several peculiar recordings might appear sporadically or be quite inconstant.

The study of the same tracings under examination, has been carried out considering also separately the alterations which could be attributed to the damage of the specific myocardium and those which could be referred to the contractile myocardium, and the possible alterations of the pericardium as well.

Statistical Results

If we examine the single alterations of the electrocardiogram from a strictly statistical point of view, we may get the following results:

1) The electrocardiographic investigation of 8,000 cases has ascertained in 2,850 cases, equal to 35.62 per cent, the existence of alterations in at least one of the tracings.

2) The alterations of the electroatriogram (morphological alterations of voltage, P of the pulmonary type, P negative in D2 and D3, lengthening and shortening of the section P-Q and level changes of the same section) have been found in 103 cases, equal to 12.76 per cent, if referred to all of the examined cases combined, and equal to 35.94 per cent if referred to the cases with abnormal modifications of the electrocardiogram.

3) Alterations of the electroventriculegram (morphological alterations and atypical of the QRS, so called heart nerve blockage, syndrome of W.P.W. and alterations of section ST and T) have been documented in 1010 cases, equal to 12,625 per cent if referred to all of the studied cases.
TABLE I—ALTERATIONS OF THE ELECTROATRIOGRAM

<table>
<thead>
<tr>
<th>Type of alterations</th>
<th>Absolute number</th>
<th>Percentage on the total of cases (8,000)</th>
<th>Percentage of pathologic cases per cent (2,850 = 35.62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphological alterations and atypical alterations of voltage</td>
<td>675</td>
<td>8.43</td>
<td>23.68</td>
</tr>
<tr>
<td>P of pulmonary type</td>
<td>111</td>
<td>1.38</td>
<td>3.89</td>
</tr>
<tr>
<td>P negative in D2-D3</td>
<td>25</td>
<td>0.38</td>
<td>0.87</td>
</tr>
<tr>
<td>Lengthening of sections P-Q</td>
<td>160</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td>Shortening of section P-Q</td>
<td>40</td>
<td>0.50</td>
<td>1.40</td>
</tr>
<tr>
<td>Level changes section P-Q</td>
<td>20</td>
<td>0.25</td>
<td>0.70</td>
</tr>
<tr>
<td>Total of alterations of the EAG</td>
<td>1,031</td>
<td>12.76</td>
<td>35.94</td>
</tr>
</tbody>
</table>

combined together, and to 35.85 per cent if referred to the cases with abnormal modifications of the electrocardiogram (Table II).

4) Alterations of rhythm (tachycardia and sinus arrhythmia, paroxysmal-tachycardia, atrial and ventricular extrasystoles, flutter and atrial fibrillations) have been ascertained in 605 cases, equal to 7.625 per cent if referred to the total of subjects, and equal to 22.474 per cent if referred to cases with abnormal tracings (Table III).

5) Particular syndromes (myocardic lability, types S1-S2-S3, heart infarcts) have been found in 203 cases, with percentages of 2.54 per cent and 6.90 per cent (Table IV).

6) In 9.75 per cent of cases deviations have been observed to the right side of the electrical axis and in 5 per cent with deviations on the left side.

There are therefore pictures particular and different, sometimes combined, sometimes in succession, and often isolated.

These can be classified as syndromes from the depression of the excit-
TABLE II—ALTERATIONS OF THE ELECTROVENTRICLEGRAM

<table>
<thead>
<tr>
<th>Type of alterations</th>
<th>Absolute number</th>
<th>Percentage on the total of cases (8,000)</th>
<th>Percentage of pathological cases (2,850 = 35.62 per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphological alterations and atypical alterations of the QRS</td>
<td>200</td>
<td>2.50</td>
<td>7</td>
</tr>
<tr>
<td>So called heart nerve block</td>
<td>40</td>
<td>0.50</td>
<td>1.40</td>
</tr>
<tr>
<td>Syndromes of the W.P.W.</td>
<td>10</td>
<td>0.125</td>
<td>0.35</td>
</tr>
<tr>
<td>Alterations section S-T and T</td>
<td>760</td>
<td>9.50</td>
<td>27.10</td>
</tr>
<tr>
<td>Total of alterations of the EVG</td>
<td>1010</td>
<td>12.625</td>
<td>39.85</td>
</tr>
</tbody>
</table>

ability, attributable to sinus deficiencies, to disturbances of the sinus-atrial and in part intraventricular conducibility, and syndromes from the increase of the excitability of the specific myocardium.

More frequently have been observed the respiratory arrhythmia, and the deformation of the atrial morphology which can appear also sporadically without being accompanied by alterations of the rhythm.

The sinus arrhythmia has been almost always observed in association with those electrocardiographic pictures which Di Maria has defined myocardial lability.

Such pictures are characterized by the existence in the same tracing, besides the respiratory arrhythmia, by three phases of the QRS in D2 and D3, with modifications of voltage of the P and possible modifications of PQ time.

Frequently also the damage of the ways designed for the intraventricular transmission of the excitement has appeared and consequently the damage of the contractile myocardium depolarization ways.

But all these electrocardiographic abnormalities are not in any way specific and are similar to those observed during the course of rheumatic fever or other infectious diseases.

Among the syndromes due to the increase of the excitability of specific myocardium, the extrasistoles of either atrial or ventricular origin are noteworthy for their high frequency: however it does not seem that they can be linked with special myocardial conditions connected with a noticeable damage, and certainly their frequency is markedly superior to that which has been ascertained because they have been found only partially

TABLE III—ALTERATIONS OF RHYTHM

<table>
<thead>
<tr>
<th>Type of alterations</th>
<th>Absolute number</th>
<th>Percentage on the total of cases (8,000)</th>
<th>Percentage of pathological cases (2,850 = 35.62 per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus tachycardia</td>
<td>160</td>
<td>2</td>
<td>5.40</td>
</tr>
<tr>
<td>Sinus arrhythmia</td>
<td>360</td>
<td>4.50</td>
<td>12.20</td>
</tr>
<tr>
<td>Atrial and ventricular extrasistoles</td>
<td>80</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td>Flutter and fibrillation</td>
<td>3</td>
<td>0.037</td>
<td>0.105</td>
</tr>
<tr>
<td>Paroxysmal tachycardia</td>
<td>2</td>
<td>0.025</td>
<td>0.070</td>
</tr>
<tr>
<td>Total of alterations</td>
<td>665</td>
<td>7.562</td>
<td>22.475</td>
</tr>
</tbody>
</table>
in an electrocardiographic recording, which is, out of necessity, discontinuous and sporadic.

Very rare are the atrial tachycardia and the paroxysmal tachycardia; only two cases of atrial fibrillation have been found.

In the field of electrocardiographic modifications, because of the contractile myocardium damage, the duration of the electric sistole has not presented noticeable modifications in the majority of cases, and the few variations which have been observed do not permit particular evaluations.

The picture which frequently emerges in the observation of our tracings, is the one which can be called “atrial or ventricular myocardic sufferance.”

This picture refers to the morphological alterations and voltage alterations of the wave P and of the QRS and of the section S-T alterations and of the T which in our casuistics only emerges respectively as the 8.43 per cent, the 2.50 per cent and the 9.50 per cent.

These pictures have been termed “sufferance” instead of “myocardic damage” because quite frequently they have appeared as reversible damages or damages connected to the proximate period shortly after surgery on the thorax.

To these pictures can be associated the so called “myocardic lability” pictures according to Di Maria, which we have already mentioned.

These sufferance represents the biological consequence of the alterations and negative interferences brought on by the “anoxemia-toxemia” components in the field of the enzyme activities and of the physical-chemical changes which start and control the freeing of energy from the substrata and its adequate use for the nutrition and activity of the myocardic fibre.

**SUMMARY**

This preliminary paper contains general observations on the modifications of the electrocardiogram cases of chronic pulmonary tuberculosis.

1) The study has been continued for more than seven years on 8,000 patients. The tracings have often been repeated at intervals and have been recorded, besides the usual standard derivations like the peripheral ones according to Einthoven, the unipolar derivations of the limbs, and the unipolar precordial ones according to Wilson, also with the thoracic derivations of Condorelli and the right hand side thoracic derivations long since proposed by Di Maria.

2) The electrocardiographic research has revealed how of these 8,000 cases at least 2,850 (35.68 per cent), presented alterations in at least one of the tracings, and has allowed the division of their pathological aspects in three main groups selected with a clinical functional intent. It has not been possible to make evident an electrocardiographic pathognomonic picture for chronic pulmonary tuberculosis.

3) The multiplicity of the electrocardiographic pictures is justified by the fact that the factors generating the lesions of the cardio-vascular system in the course of the tuberculous affection, are different. The most important ones among these are represented by toxemia, anoxemia, the possible medical or surgical treatments, and the alteration of the electrolytic and immuno-biological constants of the organism.

**TABLE IV—PARTICULAR SYNDROMES**

<table>
<thead>
<tr>
<th>Type of alterations</th>
<th>Absolute number</th>
<th>Percentage on the total of cases (8,000)</th>
<th>Percentage of pathological cases (2,850 = 35.62 per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardic liability</td>
<td>80</td>
<td>1</td>
<td>2.70</td>
</tr>
<tr>
<td>Pictures of type S1-S2-S3</td>
<td>120</td>
<td>1.50</td>
<td>4.10</td>
</tr>
<tr>
<td>Heart infarct</td>
<td>3</td>
<td>0.037</td>
<td>0.105</td>
</tr>
<tr>
<td>Total of particular syndromes</td>
<td>203</td>
<td>2.54</td>
<td>6.905</td>
</tr>
</tbody>
</table>
MODIFICATIONS OF THE EKG

Notes on the Condorelli and Di Maria methods

The precordial derivations, called "right side thorax derivations" by Di Maria, are obtained in the following way: the first, putting on the right hand margin of the second section, one electrode attached to the lead normally used for the right arm, and on the IV section, always on the same line, a second electrode attached to the lead of the left arm (commutator in D1); the second, putting on the second section the electrode attached to a lead of the right arm and on the left leg the lead normally reserved to this limb (commutator in D2); the third, putting the electrode of the left arm on the right margin of the IV section and leaving the one of the left leg on the original spot (commutator in D3).

The regulating is made with the usual voltage of 1 cm = 1 mV.

The derivations according to Condorelli, which are called "equatorial derivations," are two: 1) the right side equatorial derivation in which the electrode of the left arm is put on the section of the right median axillary line, and the electrode of the right arm on the left sub-clavicular region; 2) the left side equatorial derivation, in which the electrode of the right arm is put on the right sub-clavicular region and the electrode of the left arm is put on the left median axillary line on the VIII section.

RESUMEN

Esta comunicación preliminar contiene las observaciones generales de modificaciones del electrocardiograma en tuberculosis pulmonar.

1. Se ha hecho un estudio continuado durante más de siete años en 8,000 enfermos. Los trazos se han repetido con frecuencia y se han registrado además de las habituales derivaciones como las periféricas de acuerdo con Einthoven, las derivaciones unipolares de las extremidades y las precordiales unipolares de acuerdo con Wilson y también las desviaciones torácicas de Condorelli y las derivaciones del lado derecho hace mucho tiempo propuestas por Di Maria.

2. La investigación electrocardiográfica ha revelado de estos 8,000 casos por lo menos 2,850 (35.66 por ciento) presentaron alteraciones cuando menos en uno de los trazos y esto ha permitido la división de sus aspectos patológicos en tres grupos principales, ciertos clínicos funcionales.

3. No ha sido posible evidenciar un cuadro electrocardiográfico patognomónico de la tuberculosis pulmonar crónica.

4. La multiplicidad de los cuadros electrocardiográficos se justifican porque los factores que generan las lesiones en el aparato cardiovascular en el curso de la afección tuberculosa, son diferentes.

5. Los más importantes entre ellos están representados por la toxemia, anoxemia, los posibles tratamientos médicos y quirúrgicos y las alteraciones de las constantes electrofísicas y inmunobiológicas del organismo.

RESUME

Ce rapport préliminaire contient des observations générales sur les modifications électrocardiographiques que l'on peut noter dans la tuberculose pulmonaire chronique.

1. L'étude a été poursuivie pendant plus de 7 ans sur 8,000 malades. Les tracés ont souvent été répétés à intervalles réguliers, et, outre les dérivations standard habituelles telles que les dérivations périphériques d'Einthoven, les dérivations unipolaires des membres, les dérivations unipolaires précordiales, selon Wilson, ainsi que les dérivations thoraciques de Condorelli, et les dérivations thoraciques du côté droit depuis longtemps proposées par Di Maria ont été également enregistrées.

2. La recherche électrocardiographique a révélé comment, sur 8,000 cas, 2,850 au moins (35,78%) présentaient des altérations dans l'un des tracés au minimum. Leurs aspects pathologiques se divisent en trois groupes principaux, différenciés dans un but fonctionnel clinique. Il n'a pas été possible de mettre en évidence un type électrocardiographique patognomique de la tuberculose pulmonaire chronique.

3. La multiplicité des aspects électrocardiographiques est justifiée par le fait que les facteurs générateurs des lésions du système cardiovascular sont différents dans l'évolution de l'affection tuberculeuse. Les plus importants parmi ceux-ci sont représentés par la toxémie, l'anoxémie, éventuellement les traitements médicaux et chirurgicaux, et l'altération des constantes électrolytiques et immuno-biologiques de l'organisme.

ZUSAMMENFASSUNG

Diese vorläufige Arbeit enthält allgemeine Beobachtungen über die Modifikationen des Elektrokardiogramms bei Fällen von chronischer Lungentuberkulose.


2. Die elektrokardiographische Forschung hat ergeben, dass von diesen 8 000 Fällen mindestens 2 850 (35,68%) Abweichungen in wenigstens einer der Ableitungen aufwiesen und ermöglichte die Aufstellung dieser pathologischen Befunde in 3 Haupt-
gruppen, die im Hinblick auf die klinische Funktion ausgewählt wurden. Es war nicht möglich, ein elektrokardiographisch pathognomonischer Bild zu entwickeln, für chronische Lungentuberkulose. Die Vielfalt der elektrokardiographischen Bilder ist gerechtfertigt aus der Tatsache, dass die Faktoren, die die Veränderungen des kardiovaskulären Systems im Verlauf der tuberkulösen Affektion erzeugen, voneinander abweichen. Die wichtigsten unter ihnen stellen sich dar als Toxaemie, Anoxaemie, die möglichen internen oder chirurgischen Behandlungen und die Veränderungen der elektrolytischen und immunbiologischen Konstanten des Organismus.

BIBLIOGRAPHY