

Diphtheria: Gravity of the Disease and Electrocardiographic Changes

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The reduction in the incidence, gravity and mortality of diphtheria during the last 30 years is generally attributed to the widespread adoption of preventive vaccination [10, 14, 18, 21, 24]. Still, some authors [8, 20] observed often fatal cases of malignant diphtheria among inoculated patients, and the appearance of the malignant form is considered [7] to be independent of the population's general immunity. There is, according to TESCOLA [23], no quantitative or qualitative difference between the illness of inoculated and uninoculated individuals. While admitting that the disappearance of diphtheria from Denmark has been due to preventive inoculation, MADSEN and MADSEN [17] think that the invasion of a malignant strain might still release an epidemic. A school epidemic of malignant diphtheria, described by GROARKE et al. [12], points to such a possibility.

The simple fact of having been inoculated does not, in itself, indicate the degree of immunity. To be able to compare inoculated and not inoculated persons, it is necessary to know the mode, number and times of inoculations, the general condition of

the patients and their complete history. The usefulness of inoculations is borne out by the fact that the 1945–1946 epidemic in Hungary did not affect children who had been compulsorily inoculated since 1938 [14]. Fig. 1 illustrates the incidence and mortality of diphtheria patients in our hospital in the course of 60 years.

The number and gravity of cardiac complications seem to facilitate the diagnosis of malignancy. The fact that the clinical and electrocardiographic manifestations of diphtherial cardiac lesions nowadays are mostly transient and moderate is attributed to the effect of preventive inoculations [12, 16, 18, 22].

According to our survey [9], in 1953 of 126 diphtheria patients treated in the course of 2 years, 26 had cardiac complications. Though all had been inoculated, details of the inoculation (time, number, doses) were unknown. Complications were mild, although the initial clinical symptoms pointed to malignancy in 5 cases. Cardiac disturbances occurred in the early phase of the disease. In 18 cases the ECG revealed tachy-

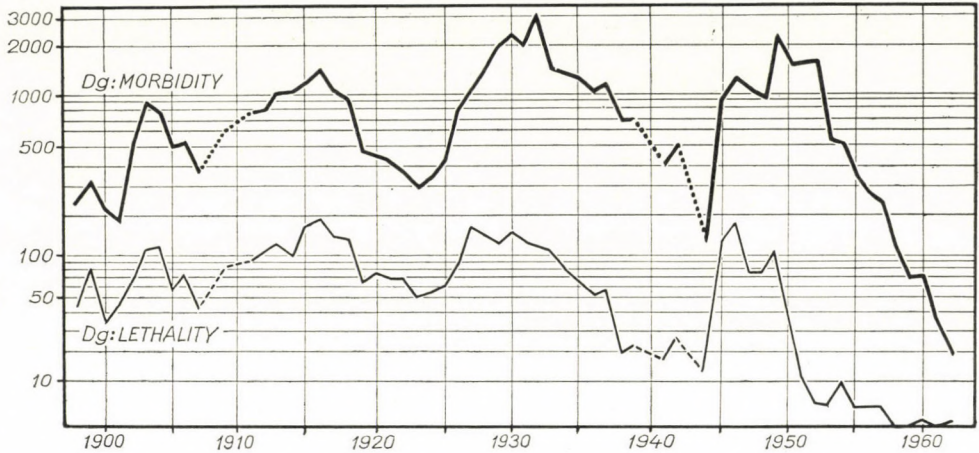


FIG. 1. Incidence and mortality of diphtheria in the László Hospital, in the course of 60 years. Logarithmic scale. Dotted line means lack of data

cardia, abnormal impulse formation, depressed S—T intervals, pathologic T_1 and T_2 waves, abnormal axis deviation.

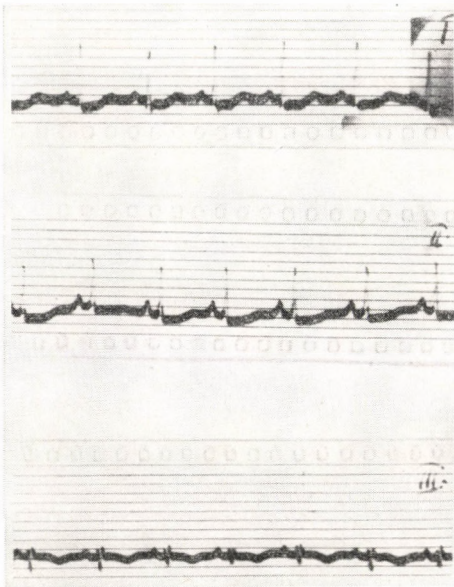


FIG. 2. Zs. K., 3 years of age. ECG on 6th day of faucial diphtheria. Frequency 110/min. Depressed S— T_{1-2} , flat T_1 , isoelectric T_2 . Time mark, 0.1 sec.

Figs. 2 and 3 present the ECG of a mild, Figs. 4 and 5 those of a moderately serious, case of early diphtherial carditis. Both children had been inoculated. No grave lesions developed and both patients recovered. Figs. 6 and 7 show the tracings of a 31 year old male patient who had not been inoculated and then died of malignant faucial diphtheria. A right bundle-branch block was observed in this case.

Diagnosis may be confused by false diphtheria due to streptococcal or staphylococcal infections [6]. In connection with a school epidemic involving 126 cases of faucial diphtheria, OTTO [20] found 50 cases of mixed superinfection.

NYERGES et al. determined the antitoxin titre in the blood of 200 children susceptible of diphtheria [19]. The diagnosis was based on the clinical picture, the bacteriological finding and the result of serological tests. Patients with an antitoxin titre be-

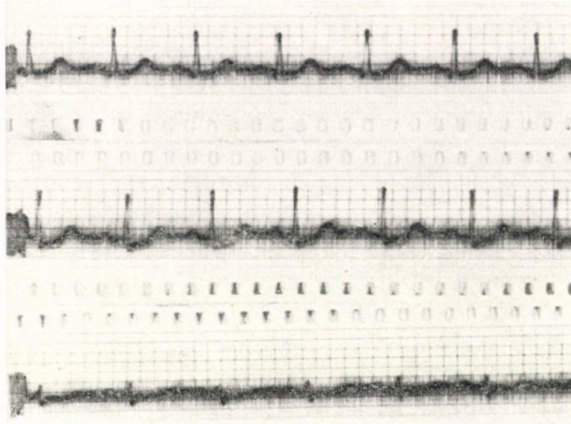


FIG. 3. Same patient. Normalized ECG on 13th day of faucial diphtheria. Time mark, 0.1 sec.

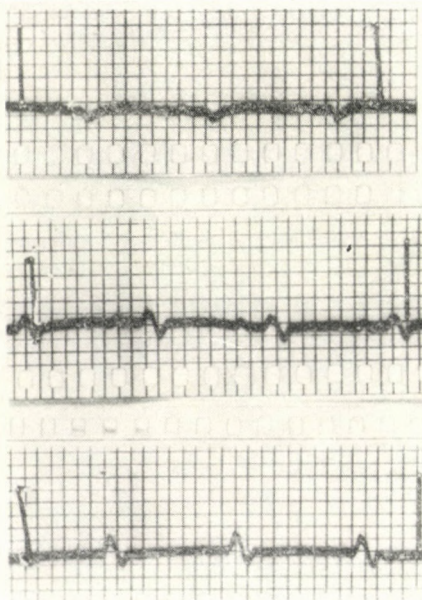


FIG. 4. Zs. F., 20 months of age. ECG on 8th day of faucial diphtheria. Frequency, 100/min. Intraventricular disturbance of impulse conduction. Low voltage. Isoelectric T in all 3 leads. Disturbed repolarization. Time mark, 0.1 sec.

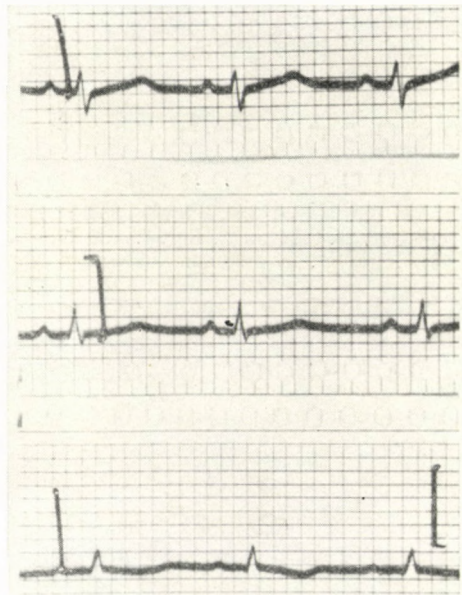


FIG. 5. Same patient. Normalized ECG on 20th day after admission. Time mark, 0.05 sec.

tween 0.2 and 0.4 I. U./ml were regarded as protected immunologically. A rise in the titre was considered to indicate diphtherial infection. Clinically

typical, bacteriologically positive cases, further atypical cases where the antitoxin titre had risen, were considered to be diphtheria.

In view of the above we have attempted to study the connexion between the gravity of diphtheria and the cardiac changes.

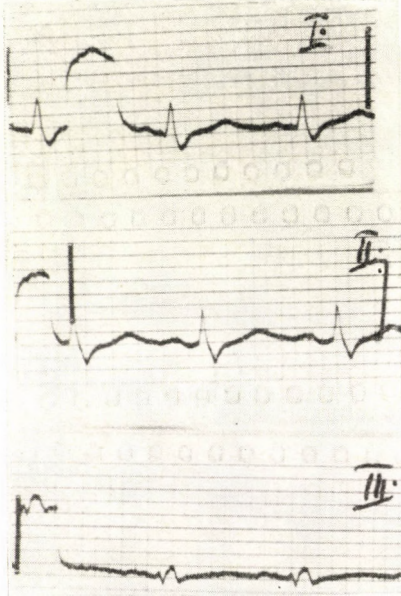


FIG. 6. Gy. K., male, 31 years of age. ECG record on 2nd day of malignant diphtheria. Pathologic intraventricular impulse conduction, Wilson-type block. Frequency, 110/min. Time mark, 0.05 sec.

MATERIAL AND METHOD

The examinations were made on 200 patients admitted with the suspicion of diphtheria. A total of 484 ECG tracing were made of these children during and after their stay in the hospital. It had been agreed not to inform the cardiologist of the serological findings until the termination of the serial ECG recordings, in order not to influence their evaluation. All patients but one had had preventive inoculation against diphtheria. The degree of immunity was determined on the evidence of the antitoxin titre after admission. It was on the basis of the clinical pattern, the bacteriological results and serological findings that ECG changes of diphtherial origin were distinguished

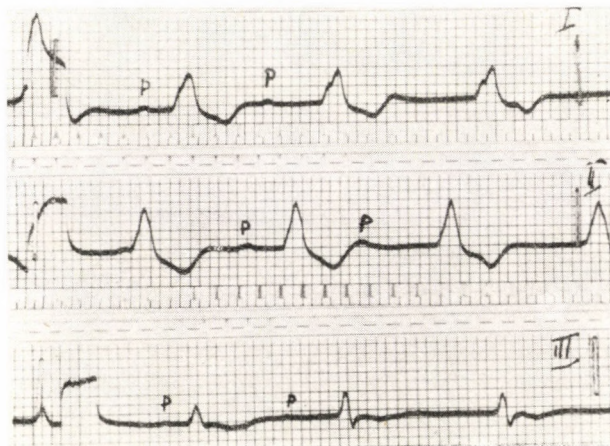


FIG. 7. Same patient. ECG on 5th day. Polytopic ventricular extrasystolia and atrioventricular dissociation. Time mark, 0.05 sec.

from those of different aetiology. The material was divided into three groups.

I. Cases with the clinical manifestation of faucial diphtheria

- a) bacteriologically positive,
- b) bacteriologically negative.

II. Cases with islet-like non-typical membrane on the tonsils

- a) bacteriologically negative,
- b) bacteriologically positive.

III. Cases appearing clinically as follicular tonsillitis

- a) bacteriologically positive,
- b) bacteriologically negative.

RESULTS

ad Ia). There were 7 patients in this group. The initial antitoxic titre was below the limit of protection in all of them. The ECG showed changes in 4 cases.

Case 1. M. L., female, 13 years of age. The patient had probably not been inoculated. She displayed the clinical symptoms of malignancy. Circulatory disturbances due to early cardiac lesion, together with the seriously toxic condition, led to death within 3 days. Figs. 8 and 9 show the ECG, indicating disturbed impulse formation and conduction, similar to the pattern known from the pre-inoculation era.

Case 2. B. F., male, 9 years of age. The ECG, presented in Figs. 10 and 11, pointed to early and late cardiopathy of diphtherial origin. Depressed S—T intervals and flat T_{1-2} appeared on the 4th and 10th day of the disease. The T_1 then became flat, T_{2-3} negative, and the Q—T interval longer by the 23rd day. The only remaining sign after 2 months was a protracted S—T interval.

Case 3. K. V., female, 5 years of age. Transitory unifocal ventricular extrasys-

tolia in the early phase of the disease, in conjunction with the clinical, bacteriological and serological findings, pointed to, and was regarded as a symptom of carditis.

Case 4. E. K., female, 5 years of age. Transitory repolarization disturbance in the second week of the disease was attributed to diphtherial infection.

ad Ib). This group comprised 23 patients.

Case 5. Gy. S., male, 13 years of age. A repolarization disturbance was observed on the 3rd day. The serological result was not considered reliable because of preceding serotherapy. Clinical symptoms and the ECG pointed to diphtheria.

ad IIa). The number of patients in this group totalled 52. In the only doubtless case of diphtheria the ECG was normal, in spite of a low initial antitoxin titre.

ad IIb). There were 4 such cases, 2 of which (both with low initial antitoxin titre) were diagnosed as diphtheria. One of them was.

Case 6. I. R., male, 10 years of age, whose ECG revealed a flat T_1 in the 2nd week. This was interpreted as a sign of mild cardiopathy of diphtherial origin.

ad IIIa). Out of a total of 31 cases, the serological result pointed to diphtheria in 9 only.

Cases 7 and 8. É. F., female, 7 years of age; V. R., male, 8 years of age. During the first days of their disease a transient repolarization disturbance occurred; it was interpreted as a sign of slight toxic damage of diphtherial origin.

ad IIIb). This group contained 83 children. Abnormal ECGs in 9 cases were not attributed to diphtherial infection.

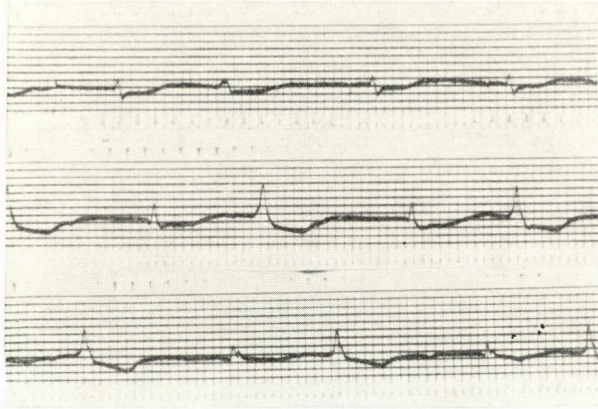


FIG. 8. M. L., 13 years of age. ECG on 2nd day of malignant faucial diphtheria. No sinus rhythm. Ventricular extrasystolia. Time mark, 0.05 sec.

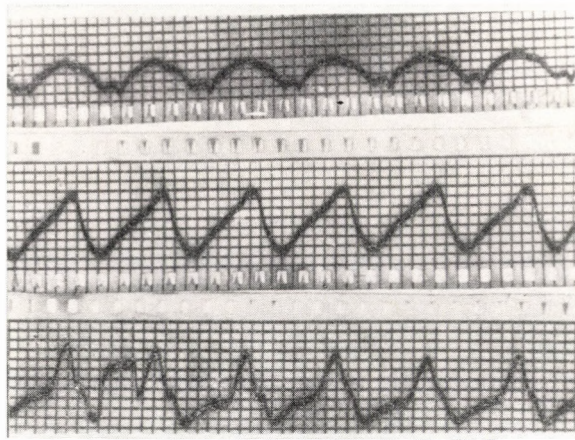


FIG. 9. Same patient. Terminal monophasic curve. Ventricular flutter

Of the children whose disease was not due to diphtherial infection but in whom the ECG revealed changes, 2 suffered from infectious mononucleosis, 5 suffered from haemolytic streptococcus and one of a staphylococcus aureus infection. In 7 cases the aetiology could not be determined. In one child the changes were due to a congenital defect. In the absence of other

clinical symptoms, the irregular electric axis was not considered pathologic in 7 cases [13].

DISCUSSION

Diphtherial diffuse myocarditis accompanied by disturbances of impulse formation and conduction [4, 11, 21]

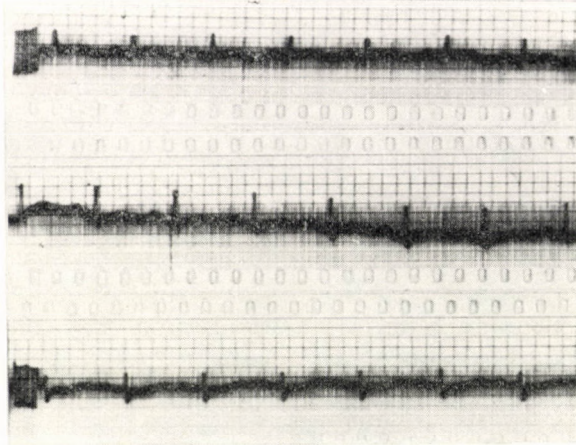


FIG. 10. B. F., 9 years of age. ECG on 4th day of faucial diphtheria. Frequency, 105/min. Repolarization disturbance. Time mark, 0.1 sec.

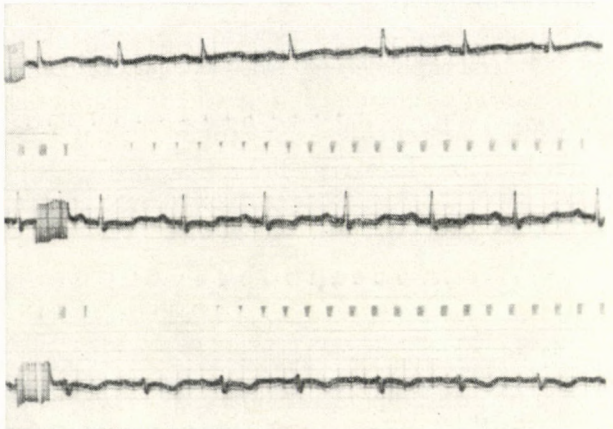


FIG. 11. Same patient. ECG on 23rd day of illness. Dome-shaped S—T₂₋₃, flat pos. T₁, negative T₂. Frequency, 110/min. Time mark, 0.1 sec.

has become rare in the last 30 years, since the introduction of active immunization. It is generally recognized that the low incidence of diphtherial cardiopathy is due to the mild course of the disease in inoculated individuals. An irregular ECG tracing does not, in itself, justify conclusions concerning pathogenesis; it reveals only the extent and location of myocardial destruction [3, 5]. The question,

whether a cardiac complication is due to diphtherial infection, some other infection, or superinfection, cannot be determined from the ECG. It is only on the evidence of the initial antitoxin titre that the cardiac lesions and/or the ECG changes revealed in immunized and unimmunized patients can be compared.

There were 7 clinically typical and bacteriologically positive cases of

diphtheria among the 200 patients. The initial antitoxin titre of these 7 patients was so low that they had to be regarded as unprotected immunologically. In 4 of them, serious disorders of impulse formation and conduction, suggestive of patterns known from the preinoculation era, were observed and an uninoculated patient died of malignant diphtheria.

In 8 cases diphtheria was diagnosed, although the clinical symptoms were not typical. Transient changes in the S—T interval and T_{1-2} were revealed in 4 of these cases. The initial antitoxic titre in this group was higher than in the above grave cases.

Of the 15 cases of faucial diphtheria the ECG pointed to diffuse myocardial lesion in 3 cases, while transient disorders of S—T and T were observed in 4 cases.

SUMMARY

The ECG has been recorded serially in 200 patients admitted with the suspicion of diphtheria. Serious changes on the ECG were present in 8 cases. In one patient who had received no preventive inoculation, a grave disturbance of impulse formation and conduction was observed and the patient died from malignant diphtheria. In another case a reversible toxic, diffuse cardiac lesion was observed both in the early and the later phase of the disease. Transient, slight changes limited to the S—T intervals and the T_{1-2} were encountered in 6 cases. All grave pathologic changes occurred in patients displaying a low initial antitoxin titre. Cardiac disturbances in patients with adequate amounts of antibody were slight and transient.

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