

## **Diphtheritic paralysis / by J.D. Rolleston.**

### **Contributors**

Rolleston, John Davy, 1873-1946.  
Royal College of Surgeons of England

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## DIPHTHERITIC PARALYSIS

BY J. D. ROLLESTON, M.D.,

Assistant Medical Officer, Grove Hospital, London, England.



During the last ten years I have been in the habit of keeping notes of all the cases of diphtheria that have been under my care, so that I have now the records of 2,300 completed cases. Observations on the occurrence of paralysis among my cases have been published by me from time to time,\* but, as it is now nearly four years since the figures of my last series consisting of 1,500 cases appeared, the following remarks may be of interest:

A comparison of the following figures with those given in my earlier papers will show that as a result of the observations having been carried out by a single individual, there is not the wide discrepancy between the results obtained which is likely to take place in a collective investigation.

The opportunities for observing the onset of paralysis were exceptionally favorable, as no children admitted with diphtheria were discharged before the end of the sixth week. It is most exceptional for paralysis to develop after that date, except in cases which have shown previous signs of nervous involvement.

*Frequency.*—Of the 2,300 cases, 477, or 20.7 per cent., showed some form of paralysis; 184 were severe and 85 were fatal. In each series of 100 the percentage of paralysis cases was never less than 10 or more than 31.

The much lower figures of other observers, *e.g.*, 11 per cent., noted by Sanné among 1,382 cases of diphtheria, and 9 per cent. by the collective investigation of the American Pediatric Society, are possibly due to several mild forms of palsy, especially nasal voice or cycloplegia having been overlooked.

*Character of Initial Attack.*—It has been my invariable practice, directly the throat has become free of membrane, to classify the case in one of six classes, the names of which are given in the following table. By this method one is enabled to determine the relation of the initial angina to the frequency and severity of the subsequent paralysis. The table clearly shows

\* *Practitioner*, 1904, Vol. LXXIII., p. 614, and 1909, Vol. LXXXII., p. 110; *Review of Neurology*, 1906, Vol. IV., p. 608; *Lancet*, 1906, Vol. II., p. 322, and 1908, Vol. II., p. 261.



that there exists a close relation between the acute attack and the subsequent paralysis. Statements to the contrary have chiefly been made by neurologists who have not had the opportunity of observing the initial attack:—

TABLE I. SHOWING RELATION OF PARALYSIS TO CHARACTER OF INITIAL ATTACK.

A. Faucial cases, with or without nasal and laryngeal involvement.

Character of initial attack.		Paralysis cases of all kinds.		Percent- age.	Severe paralysis cases.	Percent- age.
Class I.	Very severe . . . .	216 cases	153	70.8	104	48.1
" II.	Severe . . . . .	415 "	193	46.5	65	33.6
" III.	Moderately severe	169 "	39	23.6	3	1.7
" IV.	Moderate . . . . .	498 "	68	13.6	9	1.8
" V.	Mild . . . . .	890 "	23	2.5	0	0
" VI.	Very mild . . . . .	62 "	0	0	0	0
		2,250	476		181	

B. Nasal cases only.	Severe . . . . .	1	} No paralysis
	Moderate ..	6	
	Mild . . . . .	20	
	Very mild ..	3	1 case

C. Laryngeal cases only.	Severe . . . . .	11	} No paralysis
	Moderate ..	8	
	Mild . . . . .	1	

50

Of the 216 very severe cases 50 died of toxemia before any paralysis developed, so that all but 13 of the survivors had some paralysis. It may also be noted that 107 cases of that most malignant form of the disease known as hemorrhagic diphtheria, with the exception of the toxemic cases just mentioned, all had paralyzes of a severe kind.

Paralysis was found to be much more frequent and severe in cases in which the nostrils were involved as well as the throat than in those in which the fauces alone were affected. Thus,



among 570 faucial and nasal cases there were 240 paralysis cases, or 42.1 per cent., 133 of which were severe, as compared with 237 paralysis cases, or 14.1 per cent., 51 of which were severe, among 1,680 of faucial diphtheria, including laryngeal cases but excluding those with nasal involvement. On the other hand, only one of the purely nasal cases which was admitted on the fifth day of the disease with a slight nasal discharge, which cleared up without antitoxin, developed paralysis—a cycloplegia of three weeks' duration. No paralyzes followed any of the 20 purely laryngeal cases.

Paralysis following purely cutaneous diphtheria has been recorded, but no such case has come under my notice. Not only is actual paralysis more common after severe than after mild diphtheria, but affection of the tendon jerks and the presence of Babinski's sign is more common in severe than in mild attacks, as is shown in Table II.

The superficial reflexes are only lost in cases of generalized paralysis.

TABLE II. RELATION OF AFFECTION OF TENDON JERKS AND OF BABINSKI'S SIGN TO CHARACTER OF INITIAL ATTACK.

	Knee-jerks lost.	Tendo-Achillis jerks lost.	Babinski's sign.
Classes I., II., III. . .	34.4	27.3	27.9
Class IV. . . . .	11.1	7.6	14.0
Classes V. and VI. . .	7.2	3.3	9.3

*Paralysis after Relapses and Second Attacks of Diphtheria.*—By a "relapse" is meant the reappearance of the disease after recovery from the initial attack but before discharge of the patient from hospital. The term "second attack" is applied to cases in which the two diseases did not occur during a single period of detention in hospital. Of the 2,300, 31, or 1.3 per cent., had relapses, which were separated from the initial angina by periods varying from three to fourteen weeks. Two of the 31 had palatal and ocular palsies after the first attack, but none showed any paralysis after the relapse. This absence of any paralysis is an evidence of the invariably mild character of relapses, which is due in part to the disease being cut short by the prompt administration of antitoxin, and in part to the immunity conferred by the primary attack not being completely exhausted.



Fifty, or 2.1 per cent., had second attacks, which were separated from the primary by intervals varying from three months to fourteen years. In 21 the first attack had occurred in the Grove Hospital, so that their records were available. One of the cases had paralysis during the first attack and 3 had paralysis after their second illness who had previously escaped any nervous sequelæ. In only 1 case, which I have recorded elsewhere,\* were both attacks followed by paralysis.

*Relation of Age to Paralysis.*—Table III. shows that, contrary to the teaching of Landouzy, whose table of age periods is adopted here for the purpose of contrast, paralysis is more frequent in children than in adults, the great majority occurring between two and six years of age.

TABLE III. SHOWING RELATION OF AGE TO PARALYSIS.

Age .....	0-2	2-6	6-10	10-18	18-20	20-30	30-40	40-50	50-60
Number of patients ..	106	1,066	679	278	18	95	42	12	4
Number of paralysis cases .....	19	239	160	49	0	8	2	0	0
Percentage of paralysis cases .....	17.9	22.4	23.5	17.6	0	8.4	4.7	0	0

During the first year of life diphtheria is comparatively uncommon, being represented in the present series by only 18 cases, two of which had paralysis, in each case precocious palatal and cardiac paralysis. Only 10 cases, or 5.8 per cent., 2 of which were severe, occurred after eighteen years, although 171 of the patients were above that age, the oldest case being that of a woman of thirty-five who had ciliary palsy of twenty-six days' duration.

The rarity of serious paralysis in adult life is further shown by the following figures. Of the 80 cases of cardiac paralysis the oldest patient was thirteen years. Of the 36 cases of pharyngeal palsy the oldest patient was fourteen years. Of the 36 cases of paraplegia only two were over eight, one aged fourteen and one aged twenty-nine years. Of 16 cases of paralysis of the diaphragm the oldest patient was aged eight years. Precocious paralysis of the palate, which is much more persistent than par-

\* *Journal of Nervous and Mental Diseases*, 1910, Vol. XXXVII., p. 164.



alysis developing later, occurred in 139 cases, but only one patient, aged twenty-nine, was above fifteen years. Lastly it may be noted that of the 73 recorded cases of post-diphtheritic hemiplegia the oldest patient was seventeen years.

Not only actual paralysis, but abolition of the tendon jerks, also is commoner in children than in adults. Thus among 1,550 cases of diphtheria in which the knee and ankle jerks were examined, the knee jerks were lost in 267 and the ankle jerks in 196, but only four of these cases occurred in patients over fourteen years, although 149 of the 1,550 were above that age.

I have recently shown\* that Babinski's sign may be found in a considerable percentage (19.6 per cent.) of all cases of diphtheria during the acute stage, being probably due to a transitory perturbation of the pyramidal system by the circulating toxins. This sign though not confined to infants and liable to be met with up to adult life shows a marked decrease in frequency and duration after the eighth year.

*Relation of Paralysis to Antitoxin.*—The following table confirms my previous observations on the prophylactic value of the serum treatment of diphtheria. Whereas in pre-antitoxin times early treatment had no power to cut short the disease or to prevent paralysis, early injection of antitoxin undoubtedly jugulates the disease and tends to diminish the occurrence of subsequent complications.

TABLE IV. SHOWING RELATION OF PARALYSIS TO DAY OF DISEASE ON WHICH ANTITOXIN WAS INJECTED.

Day of disease.	Total number of cases injected.	Paralysis cases.	Percentage.	Severe forms only.	Percentage.
1st day	83	3	3.6	0	0
2d "	461	65	14.09	18	3.9
3d "	541	116	21.4	41	7.5
4th "	460	124	26.9	46	10.0
5th "	304	80	26.3	41	13.4
6th "	166	45	27.1	21	12.6
7th " and later.	215	40	18.6	17	7.9
	2,230	273		184	

\* *Review of Neurology and Psychiatry*, 1910, Vol. VIII., p. 404.



Among 70 cases which did not receive antitoxin only 4 in whom no membrane was present on admission developed paralysis, in each case of a mild character.

On the other hand the value of antitoxin in late cases is shown by the following figures: 396 or 12.8 per cent. were admitted after the fifth day of disease. With the exception of 21 very mild cases, all in whom membrane was present received antitoxin. Of the 396, 36 died, a mortality of 9.09 per cent. As in the pre-antitoxin days the mortality never sank below 23 per cent. and often rose to 50 per cent. or higher, the advantage of even late injection is obvious.

TABLE V. SHOWING DATE OF ONSET AND FREQUENCY OF EACH FORM OF PARALYSIS.

	Palatal.	Ciliary.	Squint.	Cardiac.	Labial.	Para- plegia.	Pharyn- geal.	Dia- phramatic.
1st week	29	0	0	31	0		0	0
2d "	109	0	0	49	0		0	0
3d "	67	8	10	0	0		0	0
4th "	40	87	9	0	1		1	1
5th "	32	91	12	0	8		4	1
6th "	40	34	11	0	17		14	4
7th "	14	12	19	0	13		15	3
8th "	0	4	19	0	10		2	7
	331	236	80	80	49	36	36	16
Percentage								
frequency	14.3	10.2	3.4	3.4	2.1	1.1	1.1	0.6

The only palsies which occur during the first fortnight of the disease are cardiac and palatal paralysis. The term cardiac paralysis though convenient is by no means a suitable term, for in several of the so-called cases of cardiac paralysis there has been an absence of nerve lesions. Experimental work on animals and sphygmomanometric observations on man have shown that vaso-motor paralysis is a more accurate designation, the heart failure being secondary to the vaso-motor affection.

In the present paper the term cardiac paralysis is applied to a syndrome arising after the throat has become clean and consisting in alteration of the normal heart sounds, low blood pressure, enlargement of the liver, oliguria, sometimes anuria, retch-



ing and vomiting. Death is preceded by an algid state sometimes lasting many days, in which no radial pulse can be felt. The term cardiac paralysis has been restricted to the fatal cases, although recovery may take place and the heart may resume its normal condition without any residues being left. In rare cases, however, cardiac thrombosis may give rise to cerebral embolism, manifested by hemiplegia\* or to embolism of the extremities leading to gangrene,† examples of which I have recorded elsewhere. Recent work has shown that the cardiac lesion may be of the nature of heart-block. A case of auricular fibrillation has also been recorded by Price and Mackenzie.

Disturbance of the heart's action may occur at any period of convalescence from diphtheria, but no cases of so-called cardiac paralysis in this series proved fatal in which the symptoms had not developed before the end of the second week. I would here repeat, what I have stated on previous occasions, that I have never met with a case of sudden unexpected death in convalescence from diphtheria.

Closely analogous to the early cardiac paralysis is the so-called precocious paralysis of the palate,‡ revealed by a nasal voice and less frequently by regurgitation of fluids through the nose, which occurs in the first fortnight of the disease. Like cardiac paralysis it is almost invariably associated with malignant forms of diphtheria, as is shown by the high mortality, association of other grave symptoms during the acute stage, and subsequently by more frequent development of paralysis in cases in which it occurs.

Histological investigations by Hochhaus, Deguy and others have proved the condition to be due to an interstitial myositis.

The extensive superficial necrosis which occurs in the severe forms of diphtheria accounts for the unusually long duration of this variety of palatal paralysis.

In the present series ocular paralysis never occurred before the third week and only exceptionally before the fourth. As a rule cycloplegia preceded squint. In most cases paralysis of accommodation exists alone without coincident paralysis of the sphincter pupillæ. Squint which in most cases was an internal strabismus usually occurred later and was much less frequent than paralysis of accommodation.

\* *Review of Neurology*, 1905, Vol. III., p. 722.

† *British Journal of Children's Diseases*, 1910, Vol. VII., p. 529.

‡ *Review of Neurology*, 1906, Vol. IV., p. 608.



After the first fortnight no serious palsy as a rule need be feared before the fifth week. It is at this time and still more frequently in the sixth and seventh weeks that the generalized form of paralysis is liable to develop, including paralysis of the pharynx and diaphragm. Vasomotor changes, such as diffuse and transient erythema, urticaria, dermatographism and hyperidrosis are frequently associated with the generalized paralysis.

Palsies of the facial muscles or of the lip muscles alone, vesical and rectal troubles, may also occur at this period. Disturbance of sensation does not usually occur till late, but the detection of its impairment in young children is impossible.

It is interesting to note that though the knee and ankle jerks may be lost at an early stage, it is not until the condition of generalized paralysis is reached that the superficial reflexes are abolished. Their loss is much less frequent than that of the tendon reflexes and of much shorter duration.

*Duration of Paralysis.*—With the exception of the cases of early onset in which the nasal voice may last for two months or even more, paralysis of the palate rarely lasts longer than three weeks. The average duration in the precocious cases was 41.19 days, the longest period being eighty-five days. In the cases in which the palate was affected after the end of the second week the average duration was 17.4 days.

The duration of ocular palsy is about three weeks. Among 210 cases of ciliary palsy in which the duration could be fixed, the average period was 21.1 days, the longest noted being forty-six days. In 62 cases of squint the average duration was 18.4 days, the longest period being forty-three days. It is fortunate that the most serious forms of late paralysis, viz., paralysis of the pharynx and diaphragm should be not only much less frequent but also of much shorter duration than the other varieties of post-diphtheritic paralysis. The average duration of complete paralysis of the pharynx necessitating artificial feeding by nasal or rectal tube was 11.4 days, the longest period being twenty-two days. Diaphragmatic paralysis is of even shorter duration, the average period being 7.8 days. Complete loss of motor power in the lower limbs rarely lasted more than ten days in any of the present series. The average duration was 9.6 days.

About a dozen cases of chronic diphtheritic paralysis have been recorded, but I have never met with an example.

*Mortality.*—The following figures show the place occupied



by paralysis as a cause of death in diphtheria. Of the 2,300 cases 171 died—a mortality of 7.4 per cent. On subtracting 33 cases which died within twenty-four hours of admission the deaths are reduced to 138—a mortality of 6.0 per cent.; 54 died of toxemia within the first few days of disease before paralysis, apart from precocious palatal palsy, had had time to develop. Nineteen deaths were due to extension of the membrane to the larynx in 127 tracheotomy cases. Broncho-pneumonia apart from tracheotomy caused 10 deaths. Intercurrent diseases, viz., 2 cases of scarlet fever and 1 of congenital syphilis were responsible for three deaths. The remaining eighty-five deaths were due to paralysis, but in only five did the paralysis start after the end of the second week, death in these 5 cases being due to paralysis of the diaphragm. In the rest (eighty) death was due to cardiac paralysis, the first signs of which had arisen before the beginning of the third week.

*Prognosis.*—The outlook in diphtheritic paralysis may be said to depend upon the age of the patient, the date of onset, and the situation of the paralysis. The older then the patient, the better the prognosis. Cardiac pharyngeal and diaphragmatic palsies are the only forms which need cause anxiety. It has already been shown that no fatal case was met with above the age of thirteen and that no case of paralysis of the pharynx was met with over fourteen or of the diaphragm over eight years.

Paralysis of the palate occurring during the first fortnight is not only likely to be more persistent than the ordinary form but also not unfrequently heralds fatal cardiac paralysis. The evil significance of precocious paralysis of the palate is shown by a mortality of 35.2 per cent. among 141 cases in whom it was found, as compared with a mortality of 1.5 per cent. among 190 cases in which the palsy first occurred after the end of the first fortnight. Closely associated with the so-called cardiac paralysis is a progressive enlargement of the liver partly due to congestion and partly to fatty degeneration. The following figures illustrate its untoward significance. Out of 111 cases in this series who showed any signs of liver enlargement seventy-one died—a mortality of 63.9 per cent. as compared with a mortality of 6.7 per cent. (130 deaths) among 1,920 cases of diphtheria in whom a routine examination of the liver was made.

On the other hand the occurrence of a well-marked serum reaction occurring at the usual period after injection is of very



favorable omen, it being most exceptional for those cases to die from cardiac paralysis in whom an urticarial eruption has been well developed.

I have shown elsewhere\* that sphygmomanometry in diphtheria though of considerable theoretical interest and of some value in conjunction with other prognostic signs is by no means indispensable in forming the prognosis. It is interesting to note, however, that while early cardiac paralysis is accompanied by a progressive fall of blood pressure, any change in the blood pressure in late paralysis is in an upward direction, thus suggesting an irritative condition of the vasomotor center in the medulla in which the other nerves are undergoing a varying degree of paralysis. Cardiac disturbance arising after the end of the first fortnight of diphtheria is not uncommon but in none of the present cases was death due to cardiac paralysis in which the heart had remained normal until the beginning of the third week.

The prognosis of pharyngeal palsy depends upon the ability of the patient to support artificial feeding, the extent of involvement of the other muscles, especially the diaphragm, and the condition of the lungs. When once the power to swallow is regained progress as a rule is remarkably rapid.

*Treatment.*—In addition to the early use of antitoxin which as shown above is the best means of preventing paralysis, rest in bed in the recumbent position for a period varying with the severity of the initial angina should be enforced. In mild cases the patient may be allowed to sit up by the end of the third week and two days later to leave his bed. In severe cases it is advisable not to let the patient sit up before the end of the sixth week and only then if no paralysis has developed. If by the end of the seventh week there be no other paralysis but that indicated by a nasal voice, defective accommodation or an irregular heart, the patient need not be kept in bed.

The transitory character and incomplete development of the most frequent diphtheritic palsies, viz., palatal paralysis and cycloplegia, renders any special treatment unnecessary, and it is highly improbable that any treatment can curtail their duration. On the other hand, in cardiac paralysis, and paralysis of the pharynx and diaphragm active measures are required. In all severe cases the prophylactic administration of adrenalin is of service either by mouth or subcutaneously to forestall or combat

\* *British Journal of Children's Diseases*, 1911, Vol. VIII., p. 433.



the suprarenal insufficiency which plays so large a part in cardiac paralysis.

Vomiting should be met by the prohibition of food by mouth and the substitution of nutrient enemata containing Pot. brom. gr. xxx and Tinct. bellad. m. xx in alternate feeds. The dangers associated with nasal feeding in pharyngeal paralysis owing to the anesthesia of the larynx and the risk of deglutition bronchopneumonia make it advisable to substitute rectal feeding, which may be adopted all the more readily as the paralysis does not as a rule last longer than a fortnight. During this period injection of strychnine and the addition of belladonna to the nutrients are indicated.

The loss of motor power in the lower limbs which is most likely to be met with in cases convalescent from pharyngeal palsy is not usually of long duration. The psychical element which is present even in young children needs to be taken into consideration. Fear of falling tends to increase their unwillingness to move and requires vigorous counter suggestion. It will usually be found that by encouragement and support remarkable progress will soon be made. Except in cases of hemiplegia, electricity and massage are rarely required.



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