*Compensatory Increase in Contractile Tone after
Sympathetic Denervation of the Skeletal
Muscle of the Wing.*

To test the duration of the effect upon the wing of severing the cervical sympathetic trunk caudal to the brachial plexus, the position of the normal and affected wings of some preparations were daily measured. I am indebted to Mr. R. E. Murray, who carried out these daily observations. Fig. 8 is a graphic record of these observations. One observation was made each day on the position of the tips of the wings from the median line was recorded daily. Both graphs show the same features. The contractile tone increases in the affected wing until both wings are approximately equidistant from the median line. This condition is gradually attained and the distances become equal in about sixty days. A similar result is found after removal of the afferent limb of the sympathetic proprioceptive reflex arc.

When this compensation has taken place the effect of cutting the cervical sympathetic is manifested under two conditions; when the bird is kept at rest for a period of approximately fifteen minutes or longer, the droop and abduction of the operated side reappear. Fatigue has a

similar effect. Starting with the elbows and tips of the two wings equidistant from the median line, the left wing and then the right wing were each folded across the back by passive movement fifty times. The difference in the distance of the elbows from the mid-line was then 2.2 cm. and the difference in the distance of the tips from this line was 2.9 cm., due to the droop of the wing on the operated side.

Plastic tone was therefore still absent. It remains to account for the increase in contractile tone. Magnus and de Kleijn have demonstrated that pathways other than the afferent nerves from the muscles themselves affect the tone of skeletal muscle. These accessory influences are the labyrinths and the proprioceptors of the neck muscles. In the resting conditions both these sources of impulses would no longer be effective, and consequently the contractile tone would be lessened, as in the experiment recorded above. It is noteworthy that Langelaan has shown that in frogs removal of

FIG. 8.—One of Mr. R. E. Murray's graphic records to express the compensatory increase in contractile tone in a fowl's wing after sympathetic denervation.

plastic tone from the hind limb leads to domination of the labyrinth of the opposite side. This leads to extension of the normal limb and increased flexion of the limb upon the operated side.

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- ¹⁵ Compare Langelaan, *Brain*, 1915 and 1922. ¹⁶ *Ibid.*, 1915. ¹⁷ *Med. Journ. of Australia*, June 14th, 1924, p. 581.

THE HYPOTONIC (FLABBY) CHILD.

BY

DONALD PATERSON, M.B., M.R.C.P.,

PHYSICIAN FOR DISEASES OF CHILDREN, WESTMINSTER HOSPITAL;
PHYSICIAN TO OUT-PATIENTS, HOSPITAL FOR SICK CHILDREN,
GREAT ORMOND STREET; PHYSICIAN TO THE INFANTS
HOSPITAL, WESTMINSTER.

A CONSIDERABLE proportion of the children seen at the out-patient department of a children's hospital present such indefinite symptoms but such a uniform clinical picture that they were thought to be worth investigating in detail. These children are generally between the ages of 2 and 7 years, and are brought to hospital for such complaints as tiredness, lack of energy, pains in the limbs on continued exercise, knock-knee, flat-feet, or turning in of the toes when walking, and hence may be seen by either the general physician or the orthopaedic surgeon. Sometimes, however, the complaint was merely that the child had no appetite or was pale, and the usual diagnosis was "debility."

On examination of these children the most striking feature is their stance and their extreme lack of muscle tone. This is well shown in the figures. The large "pot" belly with compensating lordosis is the result of the extremely feeble development of the abdominal muscles. Hyper-extensible joints, knock-knee, flat-feet, turned-in toes, and winged scapulae are further expressions of this same lack of tone. The great majority of cases appear well nourished, but the limb muscles are so soft that it is sometimes difficult to judge whether they are really properly developed. It is interesting to note here that the calf and thigh muscles are always better

developed and have better tone than the arm muscles. Many have enlarged tonsils and adenoids, and some have a more generalized lymphoid enlargement.

Cameron¹ recently described a type of case frequently seen at the out-patient departments, which he terms the nervous child. This is not, however, the type of patient which the writer is attempting to describe and elucidate. The child which Cameron describes is as a rule an only child or the youngest child of elderly parents. He is thin, dislikes to hold himself in the upright position, and has what is

described in America as the "fatigue" stance. His day is spent in bursts of activity and periods of collapse. During a period of exhaustion his stance is like those under investigation, but his muscles never at any time show the hypotonia of a flabby child. The metabolism of the "nervous exhaustion" child is as a rule overactive, and what is required for him is mental and physical rest.

With the hope of elucidating the etiology of this clinical syndrome of flabbiness an investigation of a large number of cases was undertaken during the past year at the Hospital for Sick Children, Great Ormond Street. Early in the investigation it was clear that a number of factors were involved, and the following is a review of these factors and of the various theories that have been put forward to account for the condition.

DIET.

Recently Mellanby² has stated that by diet alone in dogs he can produce every degree of muscular weakness and wasting and can cure the same by restriction of cereals and

addition of cod-liver oil. He also claims that the muscular flabbiness of rickets can be cured by the same line of treatment. He believes that the cereals have a neutralizing action on the antirachitic factor, so that on high cereal diets the dose of cod-liver oil must be increased. Vining³ also believes in a dietetic error, probably carbohydrate excess, as one of the causes of the "debilitated state," although he considers the toxic factor to be more important.

An investigation was made of the diets of the children attending the out-patient department, and it was found that as a general rule they were all on the same badly balanced diet, which was too liberal in calories for the output of energy in the day. This diet was ridiculously high in carbohydrate, which was mainly cereal, and low in animal proteins and fats. Although all the children of the poor were on this badly balanced diet they did not all show flabbiness, and some had remarkably good tone. This difference was seen to occur even in the same family. Further, many of these flabby children were treated for months on therapeutic doses of cod-liver oil with no improvement, but at the same time it must be noted that the cereals were not restricted, as such a measure was impracticable when dealing with the out-patient class of patients. It is obvious from the above that other factors besides diet must be concerned in the production of muscular hypotonia.

It is interesting in this connexion to note the reports of Holt and Fales⁴ on children in an institution in New York. These children received a most liberal diet, but one which included a large excess of carbohydrate (over 60 per cent.), and yet they were in most excellent physical condition. Practically the same portion of food was allowed to both the younger and older children, but both increased normally in weight and remained in good health.

CONFINEMENT AND LACK OF EXERCISE.

That rickets, and especially lack of muscle tone, is due to confinement has been the opinion of the Glasgow school for many years. Recently Galbraith⁵ stated that although cod-liver oil caused a deposition of calcium in the bones and healed bony manifestations of rickets, nevertheless the muscular flabbiness remained as ever. He reports rapid cures of flabbiness with massage and exercise.

That actual immobility does not necessarily produce lack of muscle tone is suggested by a study of the results of the open-air treatment of children suffering from tuberculous hips or spines, gross rickets, or congenital malformations. These children during their treatment are confined in splints for long periods, but they are lightly clad and exposed to both moving fresh air and sunshine, and under these conditions retain excellent muscle tone. This can be explained by the work of Leonard Hill⁶ as due to the stimulating effects of sunshine and moving fresh air on metabolism. It is a matter of common observation that normal children with good tone who are confined to bed as a result of some acute illness rapidly become flabby, but after being up soon evince a desire to move about and quickly recover their muscle tone. This is in marked contrast with the true flabby child, who shows no desire for exercise. Undue confinement sometimes occurs even in the homes of the well-to-do, and though the children are taken out of doors they may not get sufficient walking exercise, as they are sometimes kept too much in their perambulators. At the same time these children are receiving an over-liberal diet and are excessively warmly clad.

Inquiries into the histories of the hospital cases showed that many of these flabby children had practically no exercise during the day, only being taken out for about one hour in the morning. The majority were confined to small quarters which were badly lit and badly ventilated. When the children reach the age of 4 or 5 years they are allowed out by themselves and also commence school; at this age the number of hypotonic children rapidly decreases. The superior tone of the calf muscles as compared to the arm muscles also becomes very remarkable at this age, although the same contrast to a lesser degree is seen in younger children. This is obviously due to the fact that the calf muscles are those most exercised. Another interesting point noted was the frequent complaint that the children were always tired and slept much during the day.

From the above facts it would appear that lack of exercise and confinement, though very important factors in the production of hypotonia, will not by themselves produce flabbiness but must be correlated with others in order to have this effect.

TOXIC THEORY.

Vining³ has suggested that toxic absorption from either the throat or bowel plays a most important part in the production of the debilitated state. Wills and Warwick⁶ showed that children with septic tonsils as a rule had excellent muscle tone, but that true hypertrophy of the adenoid tissue of the throat was associated with flabbiness of the muscles. There is no evidence that toxic absorption is taking place from the bowel. The constipation which is present in a number of the cases is rather the result of the atonicity of the abdominal and bowel wall muscles than the cause of this condition. Against the toxic theory is the fact that in tuberculosis, syphilis, and rheumatism, all of which are chronic toxæmias, flabbiness may occur but is certainly not characteristic.

CONSTITUTIONAL DEFECT.

The theory is put forward by Czerny⁷ that there is a type of child who is born with a particular constitution which he calls the "exudative diathesis." In this type the muscles are flabby, the child is inactive, shows general enlargement of the lymph glands, and is prone to infections of the mucous membranes. Whether such a child exists or not it is difficult to say. Certainly every clinician knows that there are infants who from birth are firm, quick in their movements, inclined to be under weight, and difficult to fatten, while other infants are slow in their movements, flabby, sleep a great deal, gain weight easily, and do this on a low calorie intake. In the former the metabolic fires are burning rapidly, while in the latter these fires are burning slowly.

CONCLUSIONS.

1. A consideration of the first two theories—namely, diet and lack of exercise—suggests that factors which tend to depress metabolism produce flabbiness, while factors which tend to stimulate metabolism cure flabbiness.

2. The factors which tend to depress metabolism and produce flabbiness are confinement, and lack of exercise, fresh air, and sunshine; overclothing with consequent heat retention, overfeeding or over-calorying in relation to the child's output of energy in the day; feeding with a diet too high in cereals, too low in animal fat and protein, and defective in vitamins.

3. The factors which tend to stimulate metabolism, and therefore cure flabbiness, are the reduction of the diet and especially of the cereals, retaining in the diet a sufficient amount of animal fat and protein; the administration of cod-liver oil; and stimulation by sunshine, fresh air, exercise, massage, and open-air treatment, with scanty clothing to increase heat loss from the skin.

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BLOOD CALCIUM AND INORGANIC PHOSPHATES IN CHILDREN WITH MARKED LACK OF MUSCLE TONE.

BY

LUCY WILLS, M.B., B.S.LOND.

(From the Biochemical Department, Hospital for Sick Children, Great Ormond Street, and the Pathological Department, Royal Free Hospital.)

It is well recognized that extreme lack of muscle tone is a characteristic accompaniment of bony rickets, and many consider this symptom as definitely part of the rachitic syndrome. This flabbiness is, however, characteristic of a type of child frequently seen in any out-patient department