(c) Local Treatment.

There remain some circles which neither psychotherapy nor constitutional treatment will break. To such the words of Sir Clifford Allbutt apply:

> In neurasthenics a local ill, acting and reacting thus, establishes a short circuit and a vicious circle; and the local ill must be at once readjusted.[19]

Here the physician, while ever bearing in mind the dangers of local treatment, that is, the danger of increasing auto-suggestibility, must be prepared to use every weapon in his armamentarium. Hygienic measures, drugs, surgical appliances and operative interference may all be useful in breaking the circle, so that the perverted forces of Nature can resume their normal course. The improved local condition reacts beneficially on the general neurosis; each factor aids the other. In the words of André-Thomas:

> The local improvement encourages the sufferer and thus acts beneficially on his general health. His *morale* improves and this in turn exercises a favourable reaction on the local disorder. The vicious circle is broken.[20]

CONCLUSION.

It is strange that so little attention has hitherto been directed to this self-perpetuating factor in disease. Primary reactions are the commonplaces of our textbooks. But the reciprocal influence of those reactions on the original disorder is scarcely thought worthy of consideration. And yet this factor is of immeasurable significance in the evolution, progress and termination of disease. There is much need for a textbook of therapeutics based on the principle that the *ars medica* mainly consists in "breaking the circle," and intended to guide the practitioner in his attack on the *locus minoris resistentiae*.

Meanwhile, the philosophic physician who studies the operations of the circle will find his horizon widened and his range of vision extended. His further prospect will assist him in steering his patient safely to the desired haven. True, he will discover that the famous Hippocratic dictum—

νούσων φύσεις ἰητροί *

proves a delusion so far as neurasthenia is concerned. But he can triumphantly reply—

τεχνῇ κρατοῦμεν ὧν φύσει νικώμεθα †

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INTERNAL SECRETIONS AND DENTAL CARIES:

WITH SPECIAL REFERENCE TO THYROID INSUFFICIENCY.

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THE glands whose secretions may possibly influence the resistance of the tissues to caries are the thyroid, the pituitary, and the thymus, and in each case it is deficiency which may be responsible for an increased susceptibility. It is possible that each of these glands pours into the blood stream certain substances which influence lime salt metabolism and utilization, and which might be called "osteogenetic" or "dentogenetic" hormones.

Thyroid Insufficiency.

Of recent years attention has been drawn by Dr. Leonard Williams[1] and others to the fact that calcium utilization in the body is intimately associated with the metabolism of the thyroid gland. It is supposed that the internal secretion of the thyroid acts as a lime salt fixative in the body, and that when it is absent or deficient the formative organs or tissues are unable to utilize, or to hold, the salts present in the blood, and so the bones and teeth do not calcify to the normal extent.

From clinical evidence I am inclined to think that there is an association between that condition seen in children which is now diagnosed as thyroid insufficiency and the presence of dental caries. This, however, is an exceedingly difficult matter to decide definitely, as there are so many concomitant circumstances relating to habits and food which require to be considered and eliminated. Some writers on the subject would obviously go too far in attributing health or disease of the teeth almost entirely to the effect of the thyroid gland. H. E. Waller,[2] for instance, claims that by giving thyroid extract to a child who had very carious deciduous teeth, the condition of the first permanent molar and central incisior teeth was affected, and when they erupted they appeared "to be all that could be desired." Such an argument is, of course, by itself fallacious, but in addition it is necessary to point out that at the age when the thyroid extract was given (6 years) the crowns of the first permanent molars and central incisors were already completely formed. This case would rather go to show that in spite of thyroid deficiency teeth can be well formed.

Effect of Thyroidectomy.

In order to obtain some precise data as to the possible effect on the teeth produced by loss of the internal secretion of the thyroid, thyroidectomy has been performed by the writer on a number of young rabbits. The result of this operation in rodents is admittedly various, some authorities stating that the animals survive, others that the effect is rapidly fatal. My experience supports the latter view; I only succeeded in getting one rabbit to live. The others (four) died within a week. The animal which survived was kept for twelve months and then killed; it throve well and was apparently perfectly healthy; on *post-mortem* examination no trace of thyroid gland was present.

Alimentary Absorption.

In order to ascertain to what extent any deficiency of development might be due to deficient digestion or absorption in the intestines, the amounts of undigested starch and of calcium in the faeces were estimated on several occasions and compared with that of normal animals. It was found that the amount of calcium in the faeces of a thyroidectomized rabbit was slightly in excess of that in the controls, but that starch was much better digested than normally.

The average figures were as follows:

	Calcium Excreted in Faeces. Per cent.	Amount of Starch Undigested. Per cent.
Thyroidectomized animal	... 1.168	..... 18.018
Control	... 0.634	..... 21.83

The amount of starch undigested in the faeces is decidedly low. I have not previously observed it in normal rabbits to be below 20 per cent. under any circumstances. This increased utilization of starch probably accounts for the animals' general fat condition. The loss of calcium is considerably in excess of the normal, and it might be supposed that this would have a prejudicial effect upon the calcium content of the bones and teeth.

Composition of the Teeth after Thyroidectomy.

The teeth were to the naked eye well formed and normal, the only difference being that they were extremely white and quite devoid of that yellow staining and fine black deposit* which is almost universally present in rodents'

* Nature is the healer of diseases.
† Art triumphs where Nature fails.

* This particular form of black stain or deposit is not due to accidental staining by tobacco or foods, but is "biochemical" in origin, being produced either by chromogenic bacteria or from haemoglobin. It is most commonly seen in the cervical region of teeth in children who are immune, or nearly so, and is not improbably allied to the dark coloration which almost invariably accompanies a spontaneous arrest of caries.

and other animals' teeth (and also in many cases on human teeth immune to caries).

The specific gravity of the teeth was estimated by the pycnometer method and compared with that of similar teeth in controls. (I find it is necessary to use similar teeth, since there is quite an appreciable difference between the incisor and molar teeth of the same animals, due most probably to the different proportionate amounts of enamel present in the two kinds of teeth.) In this case the molar teeth were used. The control teeth gave a specific gravity of 2.49, whilst those of the thyroidectomized animal gave a slightly lower figure, 2.46. This difference is not apparently great, but I have previously shown that the enamel of human teeth, demonstrably different in several physical properties, differs only to a similar degree in density.[3]

Analysis of Teeth.

Corresponding with the statement just made, the teeth of the thyroidectomized animal showed on analysis slightly less ash than the controls—namely, 79.16 per cent. and 80 per cent. respectively; that is, the teeth after thyroidectomy contained 0.84 per cent. more organic matter than normal. The calcium in the teeth was estimated, and showed that the ash of the thyroidectomized animal's teeth contained 2.1 per cent. less calcium than that from the controls' teeth.

Effect on Salivary Secretion.

It might be thought on *a priori* grounds that the thyroid and the salivary glands would have something in common. Developmentally they both arise as diverticula from the mouth or oropharynx, and at first the thyroid has also a duct, the thyroglossal, which opens into the mouth (at the foramen caecum), and both may be associated with the utilization of lime salts. It has also been found that in monkeys after thyroidectomy the salivary glands swell up and contain an excess of mucin, but whether this effect is temporary or permanent I am unable to say. The saliva was therefore on seven different occasions obtained from the thyroidectomized and control rabbits by aspiration from the mouth for five minutes after the subcutaneous injection of pilocarpine (1 mg. per kilo).

The following are the results:

	Average Alkalinity of Saliva per c.cm.	Alkalinity Index.*
Thyroidectomy rabbit...	... 0.65	0.336
Controls	... 0.85	0.399

* Total amount of alkalinity per minute.

It is seen, therefore, that apparently thyroidectomy has somewhat reduced the output of alkaline salts from the salivary glands, and also that this is not made up for by any increase in quantity of saliva, as seen by the diminution in the "index." The amount of saliva obtainable per minute, however, was more variable in the thyroidectomized rabbit than in the controls, and was frequently slightly in excess of them. It cannot be claimed, however, that the effect is very considerable either on amount or alkalinity. Of some interest, however, is the calcium secretion of the salivary glands, since it is the metabolism of calcium which the thyroid presumably more directly affects.

Saliva was obtained in a manner similar to that described and estimated volumetrically for calcium. I found that the saliva of the thyroidectomized rabbit contained slightly less calcium than the control, namely:

	Control.	After Thyroidectomy.
Calcium percentage in saliva ...	0.0220 ...	0.0206

That the salivary glands do, however, tend to show a correlated variation with the thyroid gland is supported by the fact that *post mortem* the submaxillary salivary glands were found to be much below the normal in proportion to the weight of the animal; thus the average weight of submaxillary salivary glands in normal full-grown rabbits I have found to be 0.3473 gram per kilo of body weight, whereas in the thyroidectomized rabbit it was only 0.2268 per kilo. The above results may be tabulated as follows:

	Control Animals. Per cent.	Thyroidectomized Animals. Per cent.
Specific gravity of teeth ...	2.49	2.46
Composition of teeth:		
Mineral matter... ...	0.80	79.16
Organic matter... ...	0.20	20.84
Calcium in ash... ...	40.00	37.21
Calcium in dried teeth ...	32.00	29.90
Excretion by faeces:		
Calcium	0.634	1.168
Starch	21.83	18.018
Salivary secretion:		
Alkalinity per c.cm. ...	0.85	0.65
Alkalinity per minute*	0.399	0.336
Calcium	0.0220	0.0206
Weight of salivary glands per kilo of body weight ...	0.3473	0.2263

* In terms of $\frac{N}{50}$ NaOH to methyl orange. For reasons for thus expressing alkalinity, see author's *Prevention of Caries.*

It is doubtful whether a definite conclusion can be drawn from the above investigation, seeing that only one animal was used. Also, of course, the animal showed no signs of myxoedema. It is nevertheless to be observed that the variations in the thyroidectomized animal, although slight, are all in one direction—namely, in that which would lower the resistance of the teeth to disease. This coincides with clinical observations. The result, therefore, goes to support the theory that thyroid insufficiency may favour the occurrence of caries of the teeth.

The Pituitary Gland.

As is well known, the secretion of this gland has an influence upon the morphology of the jaws, excess of secretion leading to increased growth and deposit of bone (= increased local fixation of lime salts), whilst probably a decrease leads to the condition called progeria, in which the jaws remain infantile in character and growth, and local utilization of lime salts is defective. Professor Arthur Keith[4] has suggested that the internal secretion of the pituitary acts as a "sensitizer" between the nerve fibrils and the functioning cells. That is to say, it enables the neurotrophic influence to more readily exert a stimulating effect upon osteoblasts. But why should it be limited to osteoblasts? It is quite possible that ameloblasts may also be similarly affected, and, although I have no evidence for such a suggestion, it is worth inquiry whether pituitary deficiency may not be a contributing cause to the imperfectly "finished" enamel prisms which the writer has shown[5] to be commonly present on the surface of teeth susceptible to caries.*

The Thymus Gland.

This gland, which in human beings is normally only a temporary organ, disappearing after infancy, has also been suggested[6] as playing a part in the etiology of caries. Basch has found that in puppies osseous development is retarded by excision, but I am unable to say whether any effect was observed upon the teeth. If it does play a part it could only be in connexion with the deciduous teeth.

Conclusion.

There is some reason to think that deficiencies of secretions of the thyroid, and perhaps the pituitary and thymus glands, are concerned in the lowering of the resistance of the tissues to dental caries. It is necessary, however, to be careful in generalizing. Because thyroid insufficiency may be a causative factor in certain patients, it does not follow *ipso facto* that it is always a cause of caries. There are very many other factors, physiological and pathological, which must also always be taken into consideration.

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* This imperfect finish (never seen either in "native" or European sclerotic teeth) consists in minute depressions at the ends of the prisms. This defect increases the adherence of foreign matter, and exposes a larger and more vulnerable surface to the action of fermentation acids.