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THE ENDOCRINE SYSTEM IN ITS RELATIONSHIP TO DENTAL PROBLEMS*

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IT IS highly probable that all of the dental problems, in so far as they are related to the endocrine system, may fall in either one or the other of two arbitrary groups:

1. Problems due to alterations of growth and metabolism of the jaw bones and teeth.

2. Problems due to alterations in growth, metabolism and nutritional state of the gingiva.

I have no doubt that the endocrine relationship involved in each of these groups would be equally interesting to the dental practitioner, but I shall content myself with an attempt to discuss only the first group with you. If I were going to discuss the second group I would be forced to consider the embryonic and fetal developments as influenced by the thyroid of mother or fetus and as influenced by the pituitary, gonads and the adrenals. Likewise I would need consider the part played by the pituitary, thyroid, adrenal, parathyroid and pancreas in maintaining the resistance and healthy state of the gingiva.

Let us pass immediately to the group for our consideration tonight, i. e. the problems directly related to the jaw bones and teeth. This is largely a problem of mineral metabolism. A glance at the analysis of the mineral composition of the bones and teeth as given by Harrow and Sherwin,¹ Fish² and others suggests that calcium and phosphorus metabolism are of primary importance. Calcium and phosphates constitute approximately ninety per cent of the minerals. If, therefore, this presentation seems too heavy in a discussion of calcium and phosphorus metabolism, my only excuse is that the bones and teeth appear to me to be too heavy in calcium and phosphate.

The parathyroid gland undoubtedly deserves first consideration as a result of its part in influencing calcium and phosphorus metabolism. By way of refreshing your memories concerning the entrance and exit of calcium and phosphorus and its shifting within the body, I have elected to use a schematic representation prepared by Albright.³

The body fluids are in close relationship with all functioning

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structures of the body. They serve both as a transporting agency and as an adjustable medium in which activity of the tissues can be effectively regulated.

Calcium and phosphorus are to be found in the body fluids and soft tissues as well as in the bones and teeth. Their content within the body fluids under normal conditions remain constant. The blood serum calcium of the adult is about 10 milligrams per 100 cc., with a variation of ± 1 milligram and the inorganic phosphorus in the blood 4 milligrams ± 0.5 mg. per 100 cc. The bones play a very important part in maintaining this constancy. They contain the greatest amount of calcium and phosphorus of the body. Under certain conditions they release calcium and phosphorus to the blood and under other conditions they remove it from the blood and store it. There is less convincing evidence that the calcium and phosphorus of the teeth can pass so readily to and from the body fluid. To the contrary, the more convincing evidence tends to support the view that the minerals of the teeth are laid down early in their development and undergo little or no change thereafter.

The gastrointestinal tract and the kidneys also play important roles in connection with the concentration of calcium and phosphorus in the body fluids. The gastrointestinal tract serves as the only initial source of calcium and phosphorus in the body, the amount which enters the body depending upon the amount ingested and the conditions which influence their absorption from the gastrointestinal tract. Once having entered the body fluids they have several exits:

1. They may pass from the fluids into the tissues, especially the bones, and thereby be conserved for future release to the fluids if the need arises.

2. They may pass from the fluids back into the gastrointestinal tract and for the most part be permanently lost to the body.

3. They may pass from the fluids into the renal pelvis and be permanently lost to the body.

4. They may pass from the body fluids into the fetal structures and secretions of the pregnant and post parturient woman.

The parathyroid gland functions in maintaining a balance between the amount of calcium and phosphorus which enters and leaves the bones.

An excessive secretion, under otherwise normal conditions, serves to upset this balance and permit a greater amount of the minerals to leave the bones than is permitted to enter. This may, and does

at times, proceed to the point of softening and even resorption. Such changes involve the alveolar processes of the mandible and maxillae. The dentist knows full well the outcome of such changes in the supporting structures of the teeth.

A diminished or inadequate secretion from the parathyroid gland presents a somewhat variable and oftentimes confusing picture.

The present state of our knowledge points to a diminished renal excretion of phosphorus in hypoparathyroidism and a slightly increased excretion and diminished absorption of both phosphorus and calcium through the gastrointestinal tract. The retained phosphorus is believed to be responsible for the lowering of the serum calcium level. If the calcium supplied orally or intravenously is sufficiently in excess of that necessary to provide an adequate excretion of phosphorus, then the fluid calcium level will rise in spite of the diminished parathyroid secretion. Viewed from this angle it is easy to see how on a low or even normal intake the bones may become depleted of calcium and show osteoporosis on roentgenological examination. If this disturbance of calcium metabolism occurs during the growing period of the teeth, they will be definitely affected. The supporting structures of the teeth will be affected by a disturbance of calcium and phosphorus metabolism at any time during the life of the individual. Numerous cases representative of such bone changes in hyperparathyroidism and in hypoparathyroidism have been reported in the literature.

Barr and Bulger⁴ report the case of a man, aged 57, with a history of muscular weakness, in whom, after the removal of a tooth, a tumor developed at its site. There was also reported a general loosening of the teeth. After operation, this tumor decreased in size and the teeth were more firmly imbedded.

Wilder⁵ reported a patient subject to marked dental caries, who developed a tumor at the base of the lower right bicuspid. This was operated on and microscopically diagnosed a sarcoma. Numerous teeth were removed on account of caries. The patient developed other bone deformities and, five years later, the diagnosis of hyperparathyroidism was established and a tumor found at operation.

Cohen and Kelly⁶ report the case of a woman, aged 48, who had a swelling of the jaw for eight years, and later developed leg pains and renal stones. Further study, followed by the removal of a parathyroid tumor, established the condition as due to hyperthyroidism.

Keynes and Taylor⁷ described the case of a man, aged 25, who for several years had had renal calculi and abdominal pains. For five years he had had diffuse swelling of the right maxillary process. Biopsy revealed an osteoclastoma with multinucleated giant cells. Later investigation showed all of the complaints to be due to hyperparathyroidism, and marked improvement followed the surgical removal of a parathyroid tumor.

Borg⁸, citing these cases in an address before the American Society of Oral Surgeons and Exodontists at St. Paul, Minn., cautions the dentist to suspect hyperparathyroidism in his cases of bony resorption about the roots of the teeth with subsequent loosening and pyorrhea.

It is very doubtful that there are changes actually in the teeth which express themselves clinically after the teeth have been fully formed, but as previously stated such changes are to be expected during the growing period of the teeth.

Schour, Tweedy and McJunkin⁹ report enamel hypoplasia following a single injection of parathyroid extract in five rats. The principal changes in the teeth as a result of parathormone injections, they state, were in the dentin.

(Each animal showed a primary hypocalcified stripe in the dentin that was being calcified during the immediate effect of the first injection and a secondary hypocalcified stripe in the dentin that was being calcified subsequently. The extent of the secondary stripe varied with the number and amount of the injections and the duration of the experiment.)

I interpret this report of Schour and his associates as representing disturbances in mineral metabolism prior to the complete mineralization of the teeth. These workers also observed the usual bone changes in the alveolar processes of their animals.

Albright, Aub and Bauer¹⁰ as a result of a study of seventeen proved cases in their own clinic state that the teeth do not take part in the generalized decalcification. They may fall out because of disease of the jaw, but they themselves remain well calcified.

Roentgenograms showing decalcification of the jaws with the teeth well calcified support their view that the teeth are not a reserve source of calcium.

There is much evidence in support of the statement that the teeth are affected during the growth period by disturbances of calcium and phosphorus metabolism. Changes associated with rickets and with tetany have frequently been observed. Falta¹¹(a) and Schelling¹², using the work of Erdheim, Fleischmann and others as a basis, call attention to the appearance of opaque spots

on the gingival areas of the incisors, defective calcification of the dentin and hypoplasia of the enamel following parathyroidectomy in the rat. Quoting from Falta, "the opaque spots were observed to advance gradually toward the points with the teeth's growth. Either the tooth breaks off at this point or the defect in the enamel heals, leaving behind a shallow groove. The tooth may also break in the alveolus, in which case suppuration of the latter occurs." A few years before Erdheim's work on parathyroidectomized rats Fleischmann pointed out that the defect of the enamel commonly observed in the human was due to tetany and not to rickets as was formerly supposed. It is important to bear in mind that these enamel and dentin defects are due to disturbance of calcium metabolism from any cause and are evidences of upset during the growing period of the teeth.

Pituitary. Our present knowledge gives to the pituitary a key position in the endocrine system and must therefore be reckoned with whenever disturbances of that system are to be analyzed. The anterior lobe of the pituitary produces an active substance which has come to be referred to as the growth hormone. Because of the presence of the growth hormone the bones are strikingly affected.

The bones of the jaw participate along with other bones in overactivity of the anterior pituitary. When the overactivity occurs long before the usual time of closure of the epiphyses, gigantism is the result. Under these circumstances there may or may not be a dental problem. This will be dependent upon the extent to which the teeth share in the excessive growth. If the teeth are stimulated to the same extent as the jaw bones and keep pace with them there may be no abnormal appearances. The teeth, however, do not always keep pace and under such conditions may be improperly spaced. If one of the jaw bones outgrows the other malocclusion and impaired "bite" become the dental problem.

Behrens and Barr¹³ report the case of a boy who at nine years of age was 6 feet 1 inch and weighed 178 pounds. There was some spreading of the upper teeth and complete absence of mandibular prognathism.

Cushing¹⁴ reports a case in which there was maxillary prognathism. Whether or not the quality of the teeth are affected remains to be investigated in more detail.

If the overactivity of the anterior lobe comes late in life, the result is acromegaly with its pronounced growth of the jaw bones.

This excessive growth is not participated in by the teeth and not equally by the maxilla and mandible. As a result there is a spreading apart of the teeth, especially those of the lower jaw—Falta¹¹(b). If the growth of the mandible is in excess of that of the maxilla, there is a protrusion of the lower jaw, or, if the reverse maintains there is maxillary prognathia. Mandibular prognathism is more common in acromegaly. In either mandibular or maxillary protrusion the bite is largely lost and on account of the oblique position of the alveolar process there is malocclusion. Chewing, under the conditions, may become almost impossible.

Hypopituitarism presents many variations in its clinical picture. The dental, as well as other manifestations, seem to depend upon several factors, among which are: (1) the time of onset of the glandular dysfunction; (2) participation of other endocrine glands; (3) extent of regional reaction of body structures; (4) type cells of the pituitary most involved in the secretory disturbance.

In hypopituitarism there is frequently an early eruption but the teeth remain small. The diminished growth of the teeth may be out of proportion to the growth of the jaw bone and hence may be widely spaced. In this respect they are similar to the spacing in acromegaly, but the cause is reversed and the size of the teeth are in marked contrast to their size in gigantism or acromegaly. In other cases the teeth may be regular and evenly placed. In some cases the temporary teeth may be retained longer than normal. This condition has been observed experimentally in animals following extirpation of the pituitary.

Spinney,¹⁵ reporting upon a study of endocrinology and metabolism in relation to orthodontia, concludes that the dental practitioner meets three types of tooth malformations. *In one group* belong those symptoms we have previously described as due to hyperfunction of the pituitary. He describes them as a group in which the teeth are large, well shaped, with more than normal spacing and in which the osseous structure is hyperplastic, due to rapid growth and low mineral content. The teeth are very susceptible to local influence and give rapid response to mechanical stimulation. The dentist has difficulty in fixating the teeth, however, after he has them in alignment. *In a second group* he includes those which he believes to be marked by a congenital overgrowth of the skeletal structure and clinical symptoms of thyroid and pituitary overactivity in the early years, followed by relative inactivity of the thyroid, causing irregularities in the growth processes. *In the third group* he places those showing

symptoms of thyroid and pituitary inactivity. In this group there are patients in whom there is a slow response of the osseous structures to mechanical stimulation, delayed eruption of the permanent teeth, delayed exfoliation of the deciduous teeth, lack of density of the crowns, progressive decay and slow repair.

One should not rule out hypopituitarism because he encounters a tall individual. In early *hyperpituitarism* followed by secondary exhaustion and *hypofunction* the individuals are tall and obese and the teeth are apparently healthy and large, but widely spaced.

Calder,¹⁶ in an analysis of seventy cases of Simond's disease, reports falling of the teeth as one of the characteristics.

It is apparent, then, that the pituitary, as a result of its anterior lobe secretions, whether overactive or underactive, is prone to present dental problems.

While the parathyroid and the pituitary glands may be regarded as of first importance in connection with the changes influencing the bones and teeth, other glands should at least be mentioned in connection with the problems involving disturbances of growth and metabolism of the jaws and teeth. The thyroid, through its direct and indirect influence upon growth and metabolism, has been associated etiologically with dental irregularities.

Hyperthyroidism has been associated with crowding of teeth and delayed eruption. Hutton¹⁷ calls attention to the fact that the thyroid influence begins early in the intra-uterine life and continues until the patient has lost all of his teeth. The teeth may not only be slow in eruption in the child born of a hypothyroid mother, but may appear in the wrong order and be irregularly placed.

Hyperthyroidism in the adult has been reported as associated in many cases with sponginess, bleeding and recession of the gums, pyorrhea, rapid decay of the teeth, falling out of the teeth, late eruption and poor development of the permanent teeth. Engelbach¹⁸ expressed the view that the delayed eruption of the deciduous teeth in hypothyroidism resulted in their retention to a later age than normally. This retention of the deciduous teeth caused the permanent teeth to be pushed out of place and forced to erupt in abnormal positions, with a resultant malocclusion not uncommon in adults suffering from hypothyroidism.

Although dental defects have been reported in some instances as due to hyperthyroidism and its disturbance of calcium metabolism, it can hardly be said at this time that hyperthyroidism per se is responsible for bone and subsequent dental changes. Hanseman and Wilson¹⁹ were unable to confirm the experimental findings of

Aub and Hunter that throxin has a direct catabolic effect on the calcium deposits in the bone. After an analysis of the experimental data on seven patients suffering from hyperthyroidism, they concluded that there was an associated hyperparathyroidism as the direct cause of the excessive mobilization and excretion of calcium and phosphorus.

There is some indication that the gonads may directly or indirectly affect the supporting structures of the teeth or the teeth themselves. Poor teeth with small lateral incisors but outstanding central incisors have been mentioned by Goldzieher²⁰ as a part of the picture of hypogonadal obesity.

One investigator,²¹ in a study of the influence of the endocrine organs on the teeth and jaws, involves nearly all of the endocrine glands. He presents numerous cases with hypo and hyperfunctional conditions of the endocrine glands with accompanying abnormalities of the jaw. From these he concludes that the pineal gland, thymus, thyroid and parathyroids are intimately connected with the development of the crowns of the teeth. The hypophysis and sometimes also the thymus and thyroid influence not only the crown of the tooth but also the period of eruption and the position of the teeth in the jaw. The sex glands and suprarenals also play a part in these processes through interrelations with the above-mentioned glands. On the basis of interrelationships, he may well have included the pancreas. The frequency with which dental defects are observed in association with diabetes mellitus is well known to the internist.

I have by no means completely covered the field of endocrinology in its relationship to dental problems, nor have I exhausted the material of any one phase of the topic. I have, however, presented you a few facts which I hope may serve to impress you further with the need for a very critical study of the dental problems which your patients present.

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