CHRONOLOGY OF THE SPHENOIDAL SINUS AND ITS VALUE IN DIAGNOSIS

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From a practical point of view it is evident that neither radiologists nor clinicians have yet succeeded in interpreting correctly all the details useful for diagnosis obtained by means of cranial radiographs. As regards the lateral projection, which no doubt is the most instructive, we usually pay attention to the gross abnormalities of the cranial walls, to the marked modifications in the sella turcica, and to the presence of large nuclei of calcification only. These disturbances, in spite of the fact that they are extremely important, are not always interpreted accurately. In addition to these there are other disturbances, a great number probably, which are not recorded with precision owing to lack of experience. It is worth while remembering that we all have had a wide experience of radiographs of the thorax for nearly fifty years, but there are many things in them of which we at present know nothing. If all the details that have been misinterpreted in this period were collected the resulting article would teach us many things. Among these details are the hilar shadow and the right significance of the images of the aorta; also, other details that pathologists have either overlooked or misinterpreted for a long time in spite of their serious significance—namely, shadows denoting bronchial cancer, etc. As regards the cranium, the problem becomes much more serious, and the interpretation of each detail can be attained only by comparing many thousands of radiographs, contrasted with clinical examinations, and verified anatomically, surgically, or by means of necropsy. It has been said that a radiograph is something like a post-mortem examination of a living organism, but this is not true. We all could quote many cases of radiographic images that seemed to be unmistakable and were then contradicted by the results obtained by surgical operation or by dissection.

With regard to encephalic radiography we have endeavoured to collect a large number of normal images of both sexes at various ages, including those patients with relatively slight affections which usually do not call for a radiograph of the cranium even in those modern clinics in which all the patients or presumptive patients are systematically subjected to a check-up, so fashionable at the present. Our collection amounts to nearly 8,000 classified radiographs of the heads of normal subjects or of patients suffering from simple headaches, current endocrine disturbances, neuroses or psychoses of various types, etc. Of this vast collection we shall report the useful conclusions in due course. In this paper we shall tackle the chronological development of the sphenoidal sinus and its significance in diagnosis.

A large number of data, classical or recent, on the development of the sinuses are recorded in medical literature (Maresh, 1940). We here refer especially to our own experience.

Frontal Sinuses and the Anterior Pituitary Hormones

The pathologist and, of course, the endocrinologist usually, and almost exclusively, pay attention to the development of the frontal sinuses when observing an encephalic radiograph. The image of these sinuses reveals above all a fact that was well studied by the early anatomists—namely, the enormous individual variety and, apparently without any pathological signification, great variations in the size and shape of the frontal sinuses. But, apart from these individual variations, it is beyond doubt that the development of the frontal sinuses is an indicator of the activity of the growth-controlling hormones of the anterior pituitary lobe. When this hormone is produced in excess the whole skeleton grows intensely and the cranial sinuses develop beyond the normal limits. If this overactivity occurs after growth has ceased a dysharmonic overgrowth of the skeleton occurs in which the well-known characteristics of acromegaly are present.

We are not going to discuss here whether the excess of pituitary somatotrophic hormone by itself is able to give rise to this extravagant morphology or is associated with other hormonal influences. The fact remains that skeletal deformities occur, that these deformities affect the skull especially, and that the increase of the frontal sinuses, seen on simple clinical examination and confirmed by radiography, ranks first among such deformities. Generally speaking, the relationship between pituitary overactivity and size of the frontal sinuses is so exact that the degree of their increase is a fairly accurate index of the severity of hyperpituitarism. It has long been known that, even when dilatation of the sella turcica is not present, acromegaly may be radiographically diagnosed on account of the hypertrophy of the sinuses.

On the other hand, in cases in which the insufficiency of the anterior pituitary lobe occurs before puberty, congenitally, or in the earlier stages of infantile growth, the growth-stimulating hormone deficiency results not only in underdevelopment of the body but in characteristic modifications in the skull. The insufficient development of the frontal sinuses is then especially noticeable. The severe cases of dwarfism, pituitary infantilism, or mongolism are marked by complete absence of the frontal sinus.

Significance of Sphenoidal Sinus Development

Far less importance is attached to the development of the sphenoidal sinus. It is, however, significant and, in our opinion, more important than the development of the frontal sinus. Firstly, because the relationship between the development of the sphenoidal sinus and the functional capacity of the anterior pituitary lobe is more strictly accurate than when the frontal sinus is considered instead. Secondly, because the individual non-pathological variations of the sinuses are less marked in the sphenoidal sinus than in the frontal.

In a course of medical lectures on growth diseases, one of us (Marañón, 1937) pointed out the absence of sphenoidal sinuses, at ages in which they have normally attained full development, as a sign typical of dwarfism or pituitary infantilism. It was also pointed out that the sella turcica, whatever its size, lies, even in old age, in a dense sphenoidal body deprived of sinuses. In the uniform structure of the body the radiograph reveals the clear-cut outline of the sella turcica similar to a hole made by boring. In another paper, published in 1953, we described as "solid sphenoid" this image typical of pituitary dwarfism or infantilism and of many cases of children with myxoedema of precise pituitary origin, not of primary myxoedema. In recent medical literature we have come across a description of this anatomical detail by Gilbert-Deyfus and co-workers (1950), who observed this image in cases of infantile myxoedema (probably, in our opinion, in those of pituitary origin). This lack of sinus development, especially of the sphenoidal sinus, was also pointed out by Pende and Pende (1951) in cases of mongolism in a remarkable work on this disease in which, as is known, the hypopituitary factor doubtlessly takes part.

Findings from our Series of Radiographs

The frequency of these findings urged us to further studies: based on our material, in order to define distinctly the diagnosis arising out of normal or pathological development of the sphenoidal sinus. The general conclusions reached in this investigation—carried out in 365 normal children of both sexes, of average height and weight for their age, aged between 3 and 19 years, in addition to a much larger number of radiographs of children suffering from various pathological conditions—were reported by one of us (Marañón, 1937). With the new details collected throughout the past years we have come to the following conclusions.

(a) The dimensions and shape of the sphenoidal sinus are subject to wide individual variations. These are, however,

less marked than those of the frontal sinus, as already pointed out. Taking into account these variations of the organism, inevitable when judging any functional or anatomical fact, study of the sphenoidal sinus provides a good index of the development of the sphenoid, and also of the development of the hypothalamo-pituitary compound.

(b) The chronology of development of the sphenoidal sinus is graphically represented in the

Chronology of development of the sphenoidal sinus from 3 to 16 years (Marañón and Galvez).

accompanying Diagram, plotted by means of the study and determination of the mean values of the copies of all the radiographic images obtained.

(c) The sphenoidal sinus is first visible at a fairly constant age, ranging between 3 and 3½ years. At first it is just a small vesicle of indistinct limits situated far ahead of the sella turcica. The development of the sinus in subsequent years is rather uniform in dimensions and shape until the eighth year, as is shown in the diagram. The limits of the sinus are clearly distinct at about 8 years of age. The walls are precise and the cancellous tissue is reabsorbed. At this age the posterior limit of the sinusal cavity stands near the anterior contour of the sella turcica. From this age onward the sinus keeps on developing in size and shape, and the individual variations increase. The development may stop before the sinus has reached the sella turcica, or else the sinus will excavate a hole under the sella. At 16 its posterior, definitive limit reaches the plane of the posterior limit of the sella turcica. Normally the sphenoidal sinus does not increase after 16 years of age.

(d) In conditions of pituitary insufficiency, congenital or acquired early in life, the development of the sphenoidal sinus is hindered in variable degree. This underdevelopment is seen in pituitary dwarfism and infantilism, in myxoedema of pituitary origin, and in mongolism. The sphenoid is frequently solid in growth disturbances associated with embryopathies of different type—namely, achondroplasty and other conditions. In cases of underdevelopment associated with disorders not directly connected with the pituitary gland, like rickets and other deficiency conditions, the development of the sphenoidal sinus is the average for the age.

(e) The degree of underdevelopment of the sphenoidal sinus is, roughly speaking, parallel with the degree of the

hypothalamo-pituitary insufficiency. It constitutes, therefore, one of the indices of this hypofunction, especially in cases of pituitary dwarfism and infantilism. The underdevelopment of the child, determined by comparing his cranial radiograph with our diagram, expresses, in cases of infantilism and dwarfism, the degree of inhibition of the general development in years. This determination corresponds exactly enough to that based on the comparison of the radiographs of wrist or knee with the classical graphs of development of epiphyseal growth cartilages and ossification centres of the peripheral skeleton. In cases of pituitary myxoedema the underdevelopment of the peripheral skeleton (wrist, knee) is usually more pronounced than that of the sphenoidal sinus. In mongolism, the underdevelopment of the sphenoidal sinus, very important on account of its frequency of occurrence, is not usually connected, according to our own experience, with the degree of the condition.

(f) The underdevelopment of the sphenoidal sinus is not exactly parallel with the underdevelopment of the other sinuses. There may be, for instance, a marked underdevelopment of the sphenoidal sinus with slight underdevelopment or even normal development of the frontal sinus. And, more often, an underdevelopment of the sphenoidal sinus may be associated with a marked mastoid pneumatization.

(g) The underdevelopment of the sphenoidal sinus is usually associated with other deformities of the skull such as variations in the size and shape of the sella turcica—extremely hypoplastic, or enlarged owing either to congenital hypofunctional tumours (cranio-pharyngiomas) or to conditions marked by internal hydrocephalus. This type of hydrocephalus is extremely frequent in mongolism, as was pointed out by Pende and confirmed by ourselves. The occipito-sphenoidal synchondrosis often becomes wider.

(h) In cases of constitutional or pathological (acromegalic) pituitary hyperfunction the sphenoidal sinus develops intensely, generally simultaneously with the other cranial sinuses.

The final conclusion is that the detailed study of the sphenoidal sinus is absolutely necessary when examining a pathological cranium, and especially in cases of growth disturbances.

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Group 2

- No. 248. Transthoracic Partial Gastrectomy. Colour, silent, 38 mins. 1946.
CS-42. Operative Treatment for Hirschsprung's Disease. Colour, sound, 15 mins. 1950.
CS-335. Resection of Right Colon for Carcinoma. Colour, sound, 13 mins. 1950.
No. 64. Complete Exenteration of the Pelvis. Colour, silent, 37 mins. 1950.
CS-518. Carcinoma of the Thyroid. Colour, sound, 30 mins. 1951.

Group 3

- CS-15. Surgical Management of Primary Hyperthyroidism. Colour, sound, 20 mins. 1950.
No. 318. Thyroidectomy for Papillary Carcinoma of Thyroid. Colour, silent, 17 mins. 1950.
CS-343. Portacaval Shunt. Colour, sound, 20 mins. 1951.
CS-442. Hypertension due to Pheochromocytoma. Colour, sound, 13 mins. 1950.