

## SOME VARIATIONS IN THE ANATOMY OF THE FRONTAL SINUS.\*

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The greater the number of specimens examined the more one is impressed with the wide variation in extent and capacity of the frontal sinus. Among over a hundred human skulls which I have recently examined, the capacity varied from 1.2 cc. to 28.4 cc with all possible intermediate gradations. In this series of one hundred anatomical specimens, the sinus was absent in only one. (Fig. 1.)

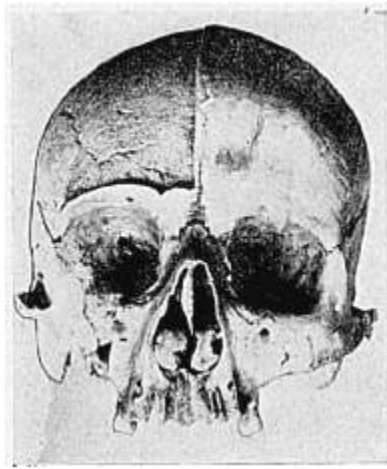


Figure 1.—No frontal sinus. The outer table of the skull has been removed on the right side to show the diploe.—From a specimen in the Wistar Institute, Philadelphia.

Half of this series was secured from the dissecting room of the University of Pennsylvania, and the other half from the excellent collection of skulls at the Wistar Institute. Included among the latter, numbering one hundred and seventy skulls, were specimens from India, Borneo, New Zealand, China, Japan, Africa and Alaska. Most of the museum specimens I was only able to examine by transillumination. As all of this material represents the lowest possible type of skull, it is fair to presume that such variation would be greater in the higher and more intelligent types.

\*Read before the Section on Otology and Laryngology of the College of Physicians of Philadelphia, May 20, 1908.

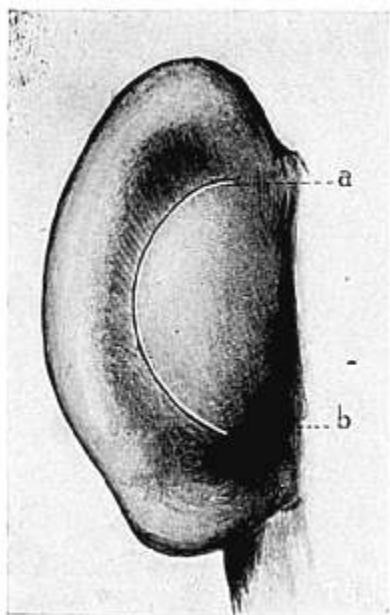


Figure 1.

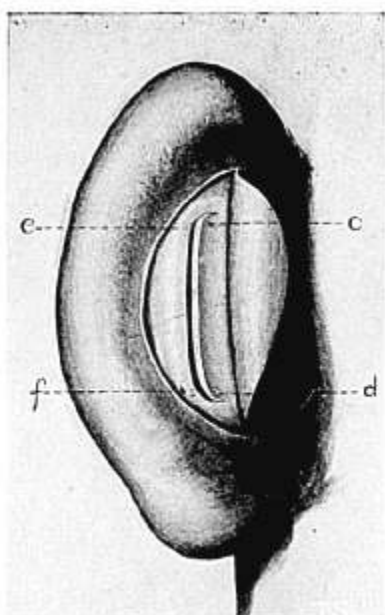


Figure 2.

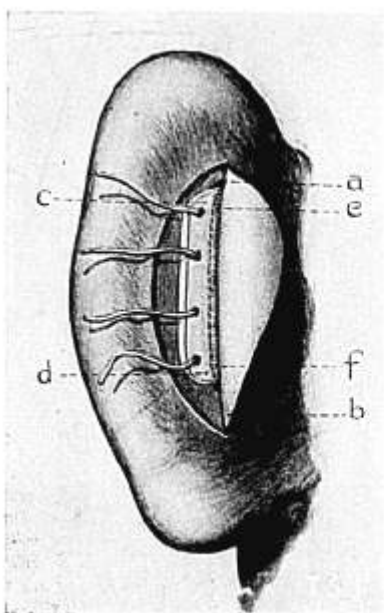


Figure 3.

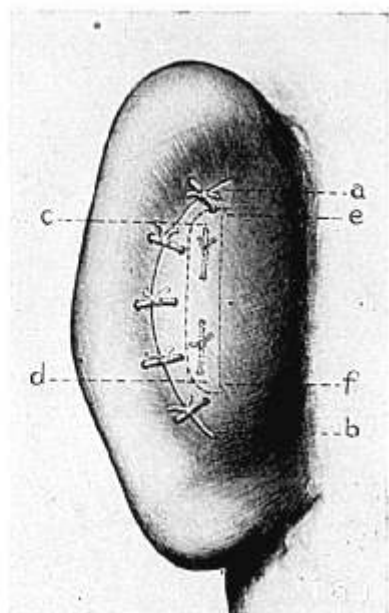


Figure 4.

Plate II.  
Author's Operation for Reducing Macrotia.

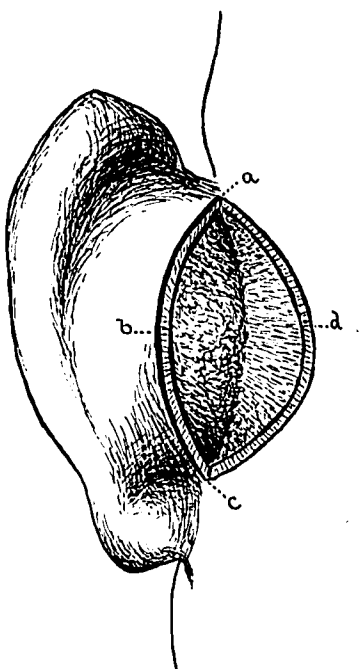


Figure 1.

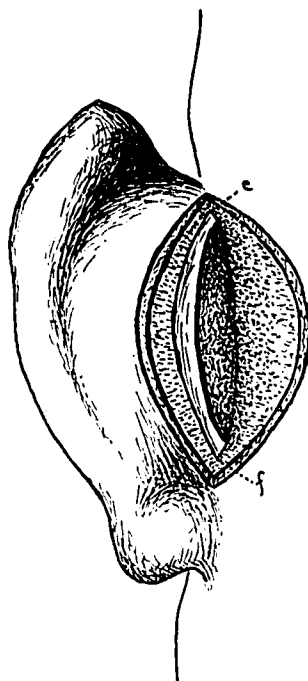


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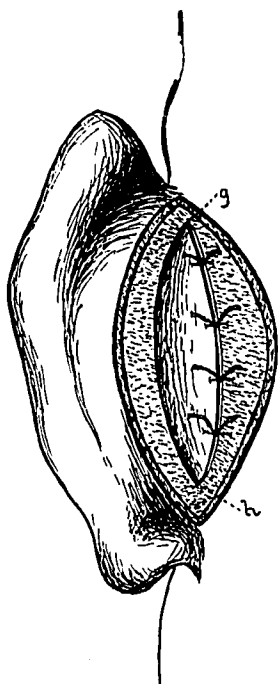


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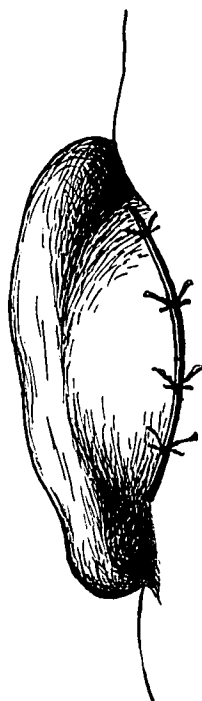


Figure 4.

Plate III.  
Author's Operation for Correction of the Projecting Ear.

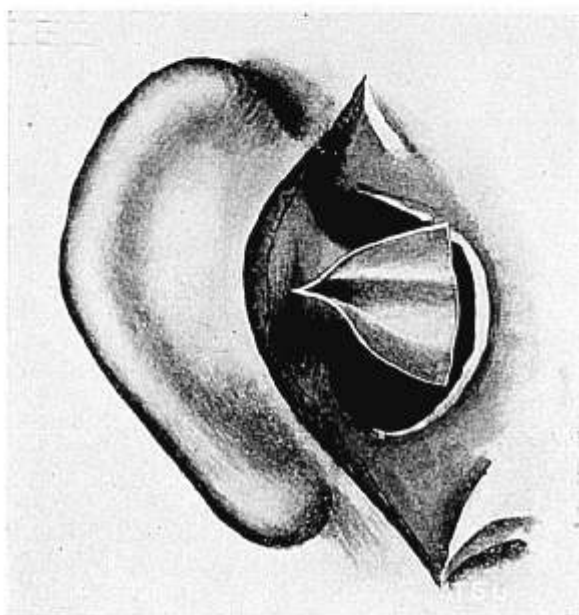
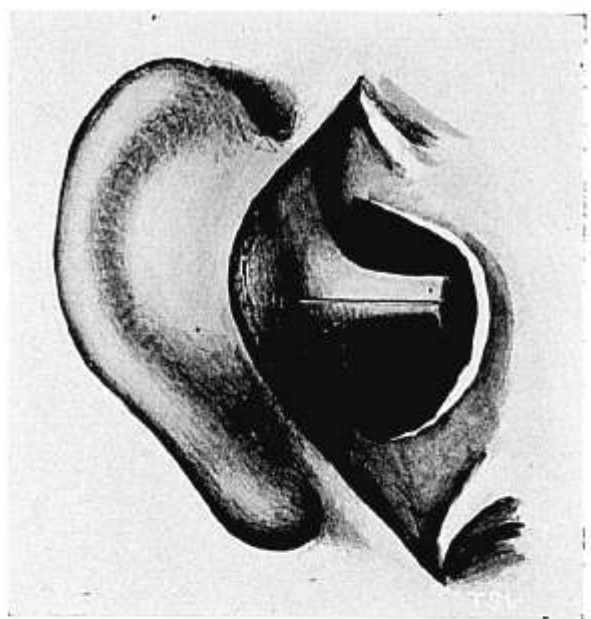


Plate V.  
The Stacked Plastic.

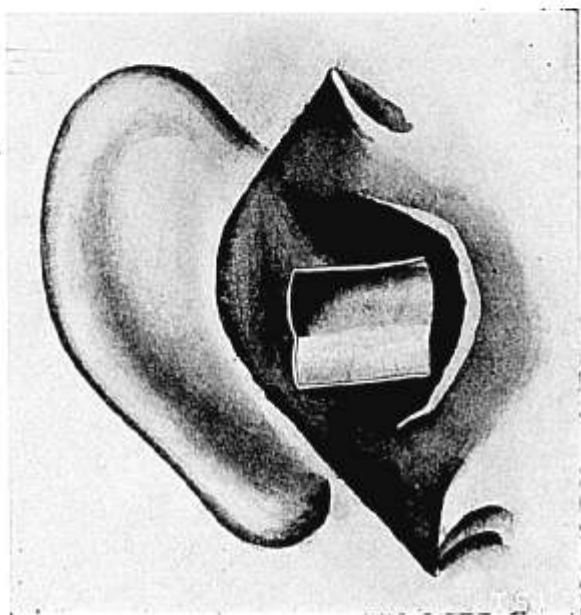
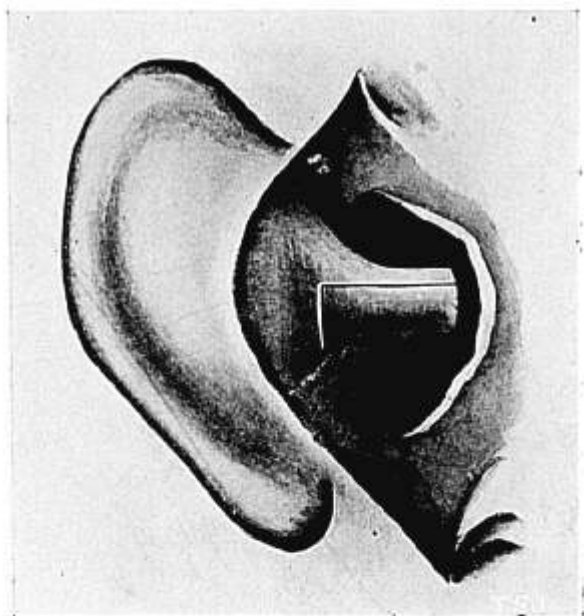


Plate VI.  
The Stacke-Jansen Plastic.

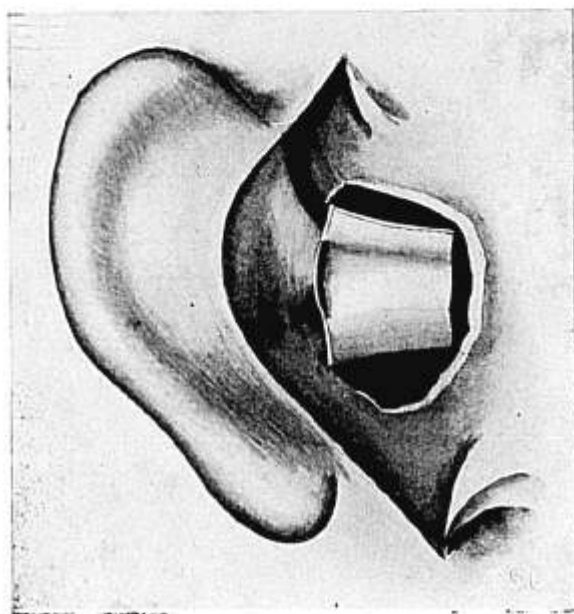
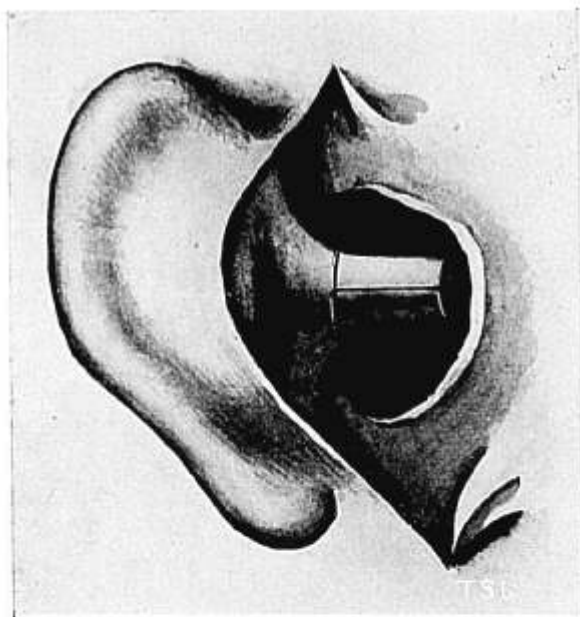


Plate VII.  
The Panse Plastic.

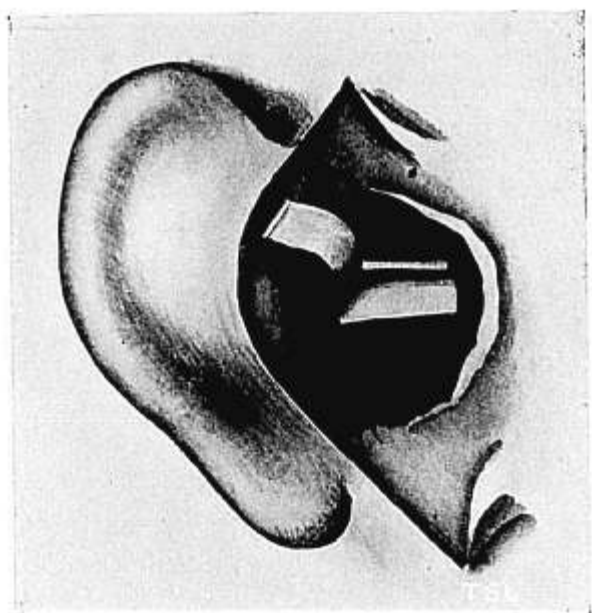
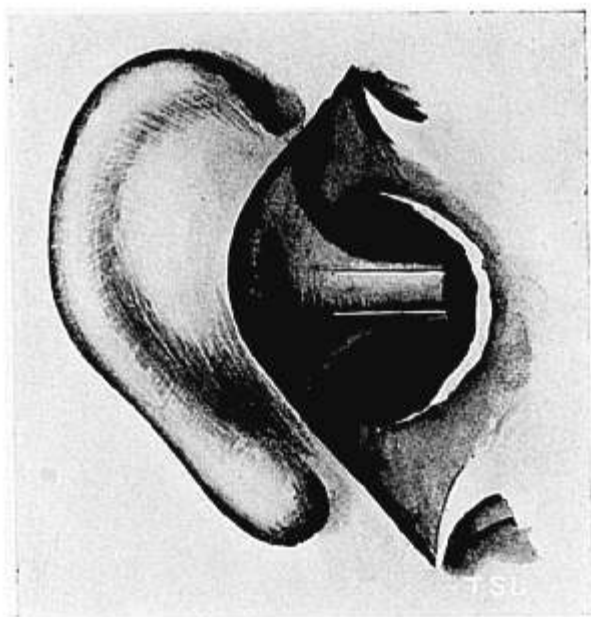


Plate VIII.  
The Korner Flap

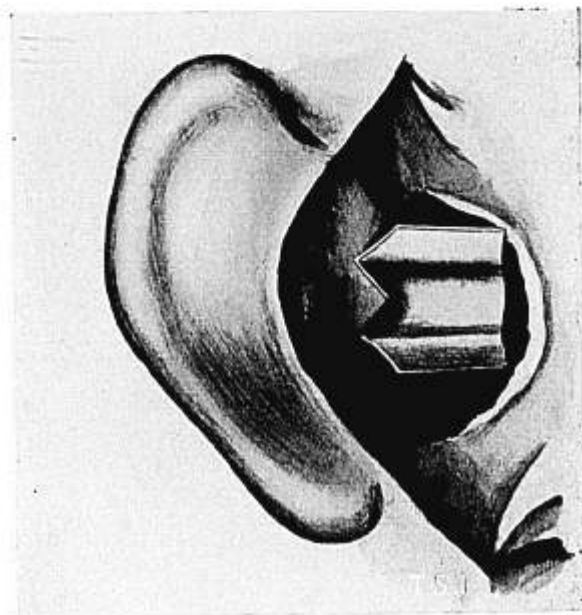
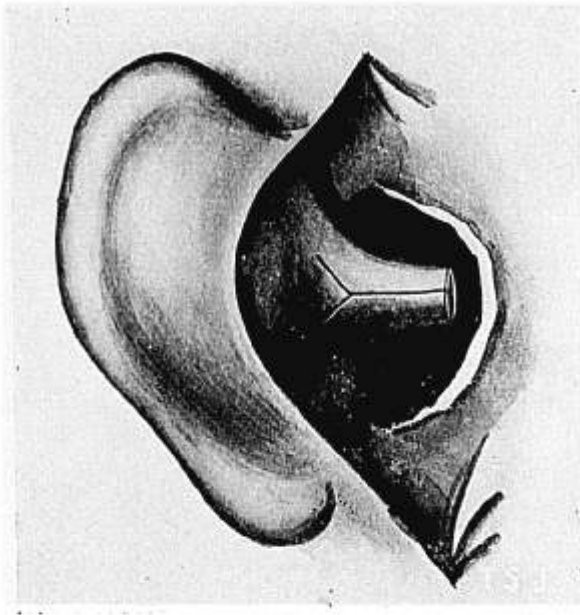


Plate IX.  
The Siebenmann Flap.



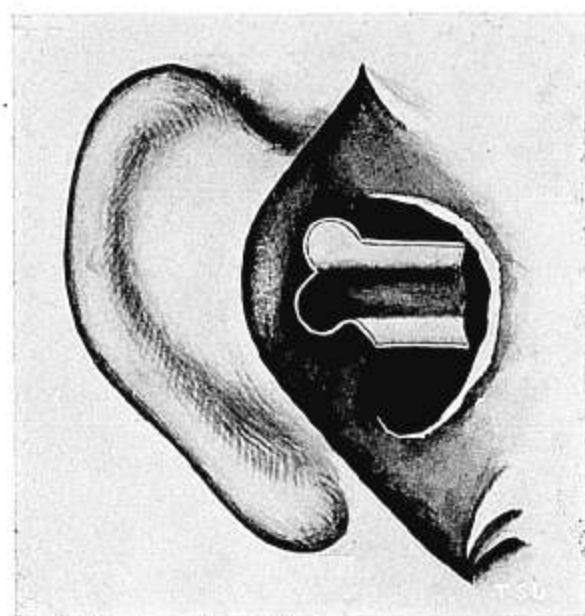
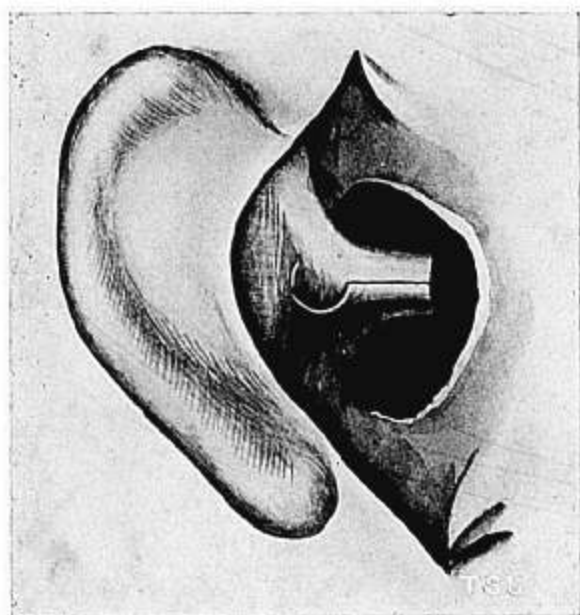


Plate X.  
The Ballance Flap.

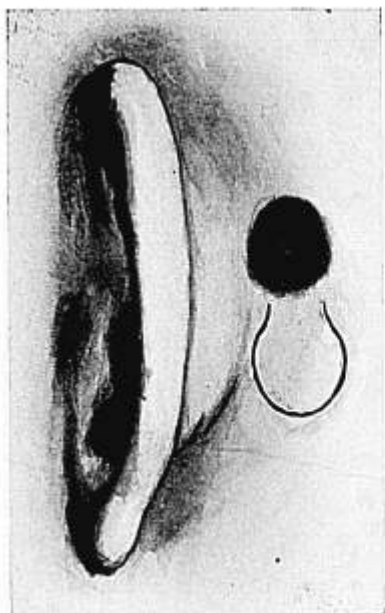


Figure 1.

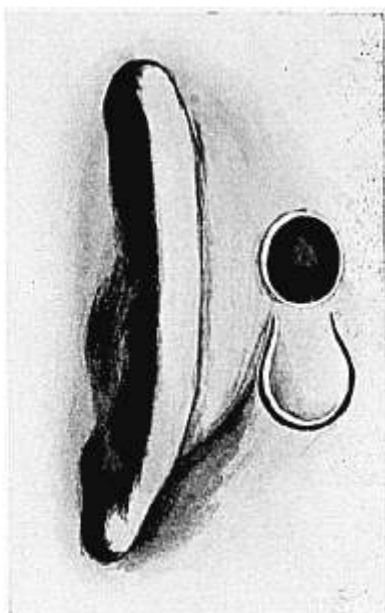


Figure 2.

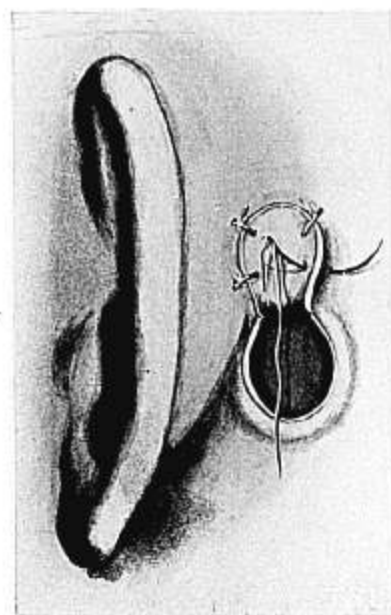


Figure 3.

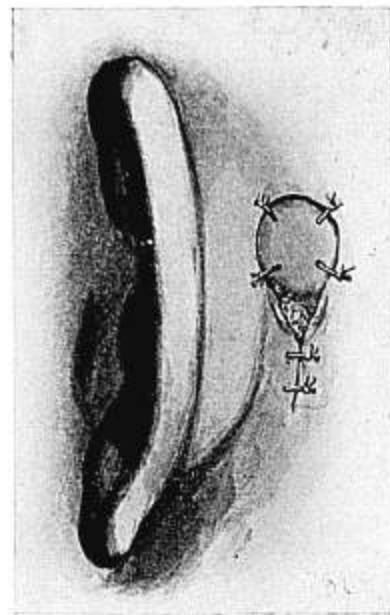


Figure 4.

Plate XI.  
The von Mosetig-Moorhoff Operation.

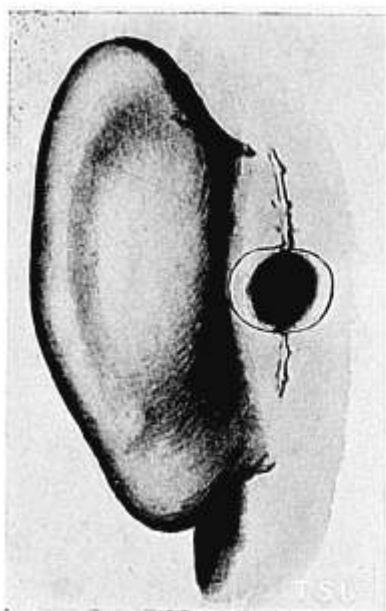


Figure 1.

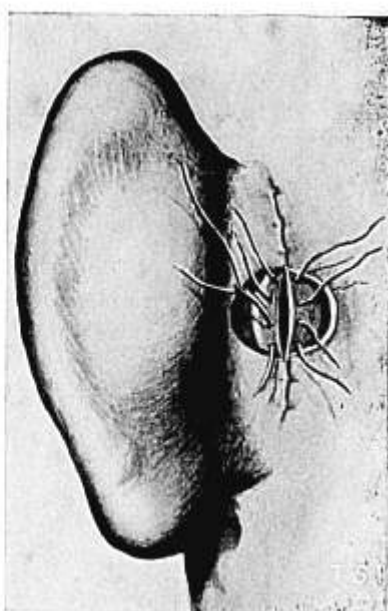


Figure 2.

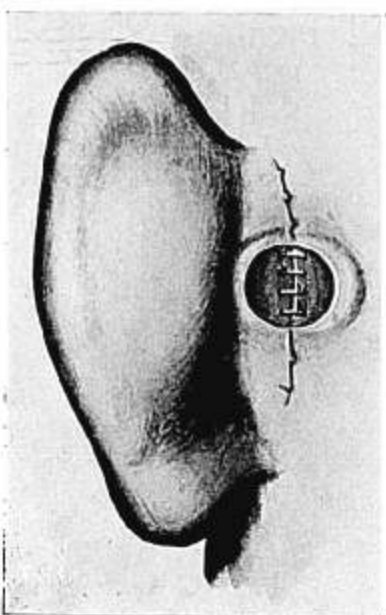


Figure 3.

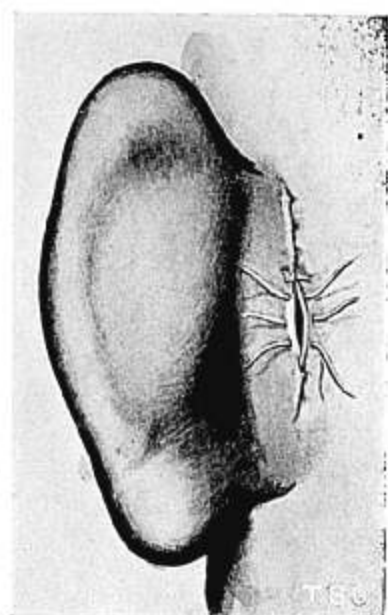


Figure 4.

Plate XII,  
The Trautmann Operation.

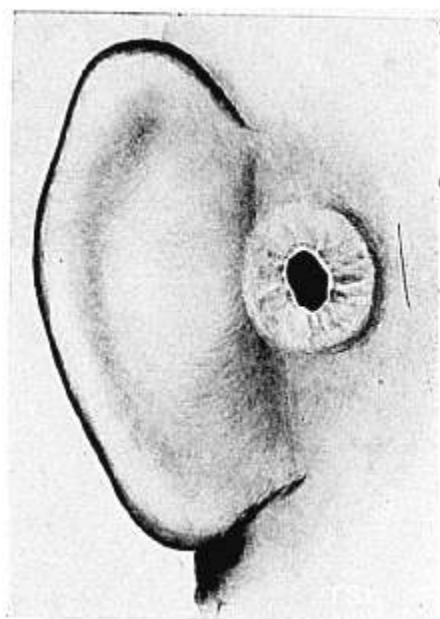


Figure 1.

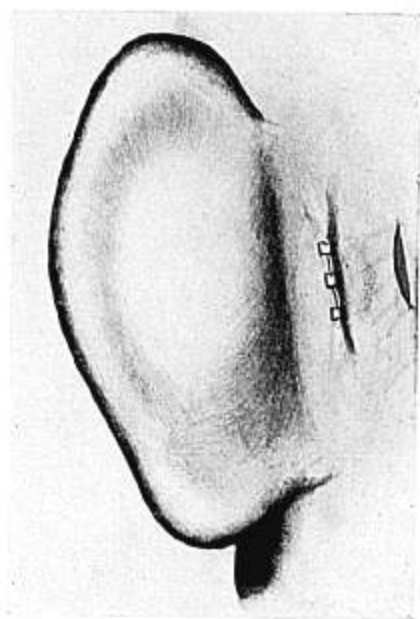


Figure 2.

Plate XIII.

Author's Retro-Auricular Plastic.

According to Holden<sup>1</sup> the points of interest about the frontal sinuses are: "1. That they communicate freely with each nostril through the 'infundibulum,' hence it is possible for foreign bodies to lodge there. 2. As they are lined with a continuation of the nasal mucons membrane we have a ready explanation of the aching pain in the forehead in cases of influenza, or a common cold in the head. 3. In cases of fracture of the base of the skull, involving the walls of the cells, it is possible for fragments of the brain to escape from the nose. 4. If the outer walls of the cells be in-



Figure 2.—Sagittal section of adult frontal bone, with ethmoid attached, to show space between anterior and posterior wall of frontal sinus. —From a specimen in the Wistar Institute, Philadelphia.

jured by violence or disease, the air, in sneezing or coughing, is liable to escape under the skin of the forehead; causing 'surgical emphysema.' 5. They not only contribute to the lightness of the skull, but increase the resonance of the voice. They do not begin to be developed until about the second year, and steadily increase in size afterwards. Even in Europeans their size and extent vary exceedingly. \* \* \* In old persons, as a rule, when the sinuses enlarge, it is by the inner table encroaching on the brain-case. The skull wall follows the shrinking brain."

While a resident at the Episcopal Hospital I saw three cases of fracture of the outer wall of the frontal sinus without injury to the inner and more brittle one. One of these was a boy of four

years; the second case a boy of 14, and the third an adult. All three made an uneventful recovery. Such cases are not infrequent in surgical practice, and illustrate the very considerable space or air cushion, antero-posteriorly, between the two walls of this sinus. (Fig. 2.) As to the age at which the frontal sinus develops, I have only been able to examine half a dozen skulls of children; their ages ranging from two to six years. Of these the specimen I show you (Fig. 3) is presumably that of a child from five to six years old, judging from the condition of the unerupted teeth. This child has a well marked frontal sinus on the right side and also a decided sphenoidal sinus. The other five juvenile specimens showed no frontal sinus at all.

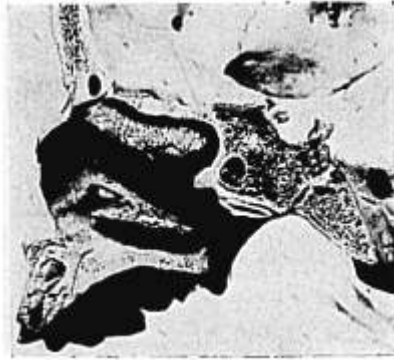


Figure 3.—Sagittal section from a child of five years. Note the frontal sinus, the sphenoidal sinus, the thinning out of the cancellated bone in the sphenoid, and the unerupted canine teeth.

Logan Turner,<sup>2</sup> from an examination of over five hundred skulls, gives the following measurements for a sinus of average size;—height, 31.6 mm. ( $1\frac{1}{4}$  in.); breadth, 25.8 mm. (1 in.); and depth, 18 mm. ( $\frac{3}{4}$  in.). Three diameters were taken for this purpose, namely, the vertical height, from the fronto-nasal aperture vertically upwards; the transverse breadth, from the mesial septum horizontally outwards; and the antero-posterior depth, from the lower end of the fronto-nasal suture backwards along the orbital roof. (Fig. 4.) "In estimating the height of an unopened sinus, however, it will be found that the lower end of the suture between the nasal process of the superior maxilla and the frontal bone sufficiently indicates the position of the ostium frontale." "The ostium frontale is always present. This is readily understood when we remember that the

sinus is developed by an upward extension from the ethmoid labyrinth. As the result of measurements which I have made in a large series of macerated skulls, the opening was found to vary from a mere slit which would not admit the point of a very fine probe, to one measuring 7x8 mm. The average diameters were found to be 4x3 mm."

"The smallest cavity met with (by Logan Turner) measured in height 18 mm. ( $\frac{3}{4}$  in.), in breadth 13 mm. ( $\frac{1}{2}$  in.), and in depth 5 mm." A glance at specimen No. 22 or No. 23 will show that



Figure 4.—Skull No. 9. Outline of a frontal sinus of more than average capacity.

these are much smaller ones. In specimen No. 22 the frontal sinus extended upward and backward half an inch while in specimen No. 23 these measurements were reduced to a quarter of an inch in each direction. Neither of these specimens showed any vertical extension of the sinus above the supra-orbital ridge. The largest sinus (of this same observer) bounded internally by a mesial septum, extended as far outwards as the external angular process of the frontal bone.—Height, 45 mm. ( $1\frac{3}{4}$  in.); breadth, 60 mm. ( $2\frac{1}{2}$  in.); and depth, 25 mm. (1 in.) A sinus with a greater vertical diameter than the above was, however, met with; its cavity ex-

tended upwards in the forehead for two and a half inches. In another skull, again, the sinus extended backwards almost as far as the optic nerve."

Among my specimens, skull No. 5 (Fig. 5) gives some greater measurements than the largest of Turner's. Unfortunately the calvarium of this skull was missing so that the vertical diameter could not be accurately determined. Laterally the measurement is three and an eighth inches; antero-posteriorly, on the right side, one and three quarters inches; while vertically it extends at least two inches upward. Note the extremely thin anterior wall of this sinus on the right side and the poorly developed supra-orbital ridges. In this specimen there is also a gigantic sphenoidal sinus extending outward to the extremities of the greater wings of that

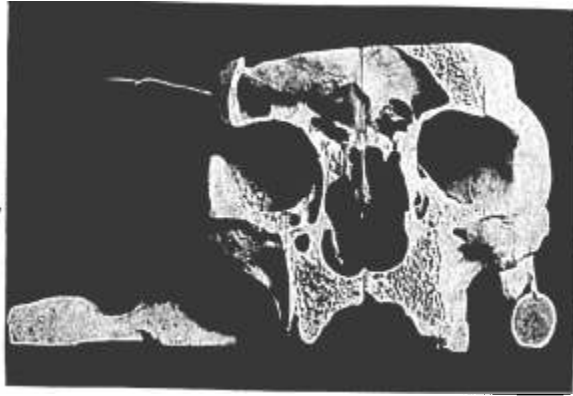


Figure 5.—Skull No. 5, with thin anterior wall to frontal sinuses, extending laterally to the external angular processes of the frontal bone and measuring 50 mm.x37 mm.x50 mm., over right orbit. The combined capacity was 190.3 grams, or 28.4 cc.—From a specimen in the Wistar Institute, Philadelphia.

bone. Unfortunately I have no data concerning this skull. It is merely a dissecting room specimen.

Dr. M. H. Cryer<sup>2</sup> has described a specimen where the sinuses were even larger, and Onodi<sup>4</sup> has an X-ray picture in his book of a frontal sinus which extended vertically 80 mm., or 3 1-5 in. from the supra-orbital ridge to within 4 cm. of the coronal suture. This sinus had the greatest vertical diameter of any I can find reported in the literature of the subject.

In examining the thirty odd specimens I have the pleasure of showing you to-night you will see that there is only a very small sinus on the right side in specimens No. 22 and No. 23. The



actual capacity of the former, measured by pouring in small shot and then weighing it, is 1.2 cc., while the capacity of the sinus in skull No. 5 was 28.4 cc; specimen No. 24 being second best, having a capacity of 16.8 cc. The shot used for this purpose was the smallest I could get, namely No. 12. By determining the equivalent in cc. of each gram of shot it was found that every 6.7 grams of shot were equal to 1 cc. of water. This method of determining the capacity of each sinus renders it an easy matter to make comparisons. Note also the very considerable antero-posterior diameter in specimen No. 24,—three quarters of an inch, and the large ostia. The sphenoidal sinus in this specimen is above the average, with large openings into the superior meatus.

In specimen No. 20 there is a small sinus on the right side and in No. 21 it is only present on the left. No. 25 shows an average sinus with an almost symmetrical septum, No. 26 a well marked horizontal partition as well as a vertical one. No. 27, a fragment, shows an average thin-walled sinus on cross section and the manner in which this air space blends with the ethmoid labyrinth. No. 28 shows a small sinus behind very decided supra-orbital ridges. The ostium on the right is large and patulous while on the left the ostium opens into an anterior ethmoid cell. Specimens No. 29 and 30 show average sinuses behind comparatively smooth foreheads. Thus examples might be multiplied. Almost all of them are asymmetrical.

H. Lambert Lack<sup>5</sup> says that the average depth, behind the supra-orbital margin, is from 4 to 8 mm. This writer quotes Lothrop as finding both sinuses invariably present in the orbital region after an examination of 250 specimens, but in three per cent the vertical portion was absent. "Logan Turner, in 240 European skulls, found one or both sinuses absent in forty-one; that is in 17 per cent. Among these in 7.5 per cent both sinuses were absent and in 9.5 per cent one sinus was absent. Tilley found entire absence of the sinuses twice in 120 skulls, in one case in association with prominent brows. Kicer found both sinuses absent five times and one sinus absent seven times in 195 skulls. Max Scheier found no frontal sinus twice in 100 skulls. On the whole, the sinuses seem to be larger in males than in females and are smaller and more often absent in races with receding foreheads; but the size of the cavity bears no constant relation to the prominence of the supra-orbital ridge. Developmentally, the frontal sinuses are absent at birth and

up till about the sixth year. They apparently begin to develop as a protrusion from the ethmoidal region at about the sixth or seventh year and slowly spreading between the tables of the frontal bone attain their full size and dimensions at or about the age of puberty."

Writer:	Skulls examined.	Sinus absent on both sides.	Sinus absent on one side.	Sinus absent on right.	Sinus absent on left side.
Lothrop .....	250	0	†	....	....
Logan Turner .....	240*	18	23	9	14
Tilley .....	120	2	....	....	....
Kicer .....	195	5	7	....	....
Max Scheler .....	100	2	....	....	....
Tunis .....	100	1	3	1	2
	1005	28	33	10	16

## REFERENCES:

1. HOLDEN: Human Osteology, Seventh Ed., London, page 50.
2. LOGAN TURNER: Accessory Sinuses of the Nose, Edinburgh, 1901.
3. M. H. CRYER: Jour. Amer. Med. Assoc., Vol. XLVIII, pp. 284-289, Jan. 26, 1907.
4. A. ONODI: Die Nebenhöhlen der Nase, Wien, 1905, Tafel 113, Fig. 113.
5. H. LAMBERT LACK: The diseases of the nose and its accessory sinuses, London, 1906, pages 15 to 17.

No. 1426 Pine Street.

\*European Crania. †Vertical portion absent in 3 per cent.

### A Case of Malignant Tumor of the Thyroid Gland. H. C. KLOPPER. *Medical Fortnightly*, September 10, 1908.

This case of malignant growth in the thyroid, a rare occurrence, was presented to the Medical Society of the City Hospital Alumni of St. Louis. The tumor before operation was diagnosed as malignant adenoma, but examination after death threw some doubt upon this.

In the latter part of her illness the patient, a woman of 71, had severe cough and dyspnea, but no pain. Physical examination showed considerable exophthalmos and a cyanotic color of lips, face and hands. The entire body was covered with a profuse, clammy, cold perspiration. There was edema and swelling of both legs above and about the ankles. No operation was attempted.

EATON.