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By CLARENCE J. BLAKE, M.D.,  
BOSTON.  
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(Reprinted from the AMERICAN JOURNAL OF OTOLOGY, April, 1880.)

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*with the compliments of the author.*

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# ON THE OCCURRENCE OF EXOSTOSES WITHIN THE EXTERNAL AUDITORY CANAL IN PREHISTORIC MAN.<sup>1</sup>

BY CLARENCE J. BLAKE, M.D.,

BOSTON.

## I.

ALTHOUGH the occurrence of these peculiar bony growths as an accompaniment or result of diseases of the external auditory canal and middle ear is well recognized by aural surgeons of the present day, and is treated of in the several text-books on aural surgery, from Toynbee onward, comparatively little mention of the subject is made, for the reason that, practically considered, except in cases where they are excessively developed, they are of but little importance to the surgeon.

This fact will probably account for the small percentage of such cases recorded in the reports of aural clinics, a review of such reports published in Great Britain, on the Continent, and in America giving, on an average, five cases of exostoses recorded in each one thousand cases of aural disease. It is readily understandable that in the tabulation of hospital cases the smaller exostoses covered by the integument lining the canal, and calling forth, by their presence, no decided symptoms, should either escape notice or especial mention, a record being made only of those cases in which the growths especially attracted attention, or in which they were so excessive or so far served to complicate some other existing disease of the ear as to call for surgical interference.

Particular attention has, on the other hand, been called to the fact of the existence of aural exostoses in crania, especially of

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<sup>1</sup> This paper was read by title at the annual meeting of the British Medical Association, Aug. 5, 1879. It is intended to be the first of a series of similar observations.

American origin; and since these growths might be supposed to have some connection with the possible habits or race-character of the peoples in whom they are found, the subject has received a fair share of attention from craniologists. The opportunity afforded for the detection of these growths and the determination of their exact location and true character, after the removal of the overlying soft parts, will serve to account for the greater proportion of these cases observed in the examination of crania from various sources and recorded by various writers, especially within the last fifteen years. Even under these circumstances, the recorded cases of aural exostoses are very few in number, and since these growths have been observed particularly in the crania of American prehistoric races, it is to be hoped that the opportunity afforded by the large collections of such crania now in progress in this country will be availed of for further investigation of this interesting subject.

It is partly with the hope of furthering this interest that the examination of the crania of the mound-builders of Tennessee, which forms the basis of this paper, has been undertaken; and, so far as I am aware, no similar examination of the crania of this race has as yet been made. The crania in question form a part of the large collection of the Peabody Museum of Archæology and Ethnology in Cambridge, and it is proposed to extend the same examination to the crania of other American races in this collection. To the courtesy of Prof. F. W. Putnam, curator of the museum, I am indebted for this opportunity, and also for valuable advice and personal assistance in making the examination and tabulating its results.

Attention was first especially drawn to the presence of exostoses in the external auditory canal in American crania, in 1864, by Prof. Seligmann, who found these growths in five out of six "Titicaca," "Huanka," and "Aymara" crania, and who inclined to the opinion, as quoted by Prof. Welcker in a paper on this subject published in the *Archiv für Ohrenheilkunde* of the same year, that there might be a connection between the occurrence of these growths and the artificial elongation of the crania in question. This view is combated by Prof. Welcker, who found exostoses in two out of nine crania of Marquesas Islanders, forwarded to him

from the collection of Dr. J. Barnard Davis, and also in the skull of a Fox Indian (Mississippi), No. 229 in the Heidelberg collection.

This view, as well as that according to which the peculiar narrowing of the external auditory meatus observable in many Peruvian crania, is the result of the artificial elongation of the head, is also negatived by Prof. Wm. Turner in a recent publication, in which are described exostoses occurring in an artificially deformed Peruvian skull from Pisagua closely resembling the distorted Aymara cranium, also from Pisagua, figured by Dr. Davis in his "Thesaurus Craniorum," and also in the adult skull of a flat-head Chenook Indian, found in the Natural History collection of the Edinburgh Museum of Science and Art.

In concluding his paper, Prof. Turner says: "As these two crania, as well as those examined by Prof. Seligmann, had been much altered in shape by artificial compression, the question naturally arises if the growth of the exostoses had been induced by the pressure to which the bones had been subjected in infancy. There is nothing in the appearance of these two skulls to bear out this supposition. Notwithstanding the deformity of the vault of the cranium and a somewhat backward inclination of the squamous temporal, the zygoma and the parts around the meatus have preserved their normal form. Again, although Prof. Seligmann found exostoses in as many as five out of six artificially deformed crania which came under his notice, I have only seen the above two specimens, while seventeen other artificially deformed crania of North and South American Indians have been examined. At the same time I should say that in at least three of these skulls the auditory meatus (though without any exostoses) was modified in shape from what one usually sees, for, instead of being almost circular at its orifice, it was antero-posteriorly compressed, so that the vertical diameter was markedly greater than the antero-posterior. I am not, however, prepared to ascribe this modification in the form of the orifice of the meatus to the artificial compression, for I have observed in several specimens of Peruvian skulls, which were not artificially deformed, a similar alteration in the form of the external meatus. There would thus appear to be a tendency on the part of the aboriginal inhabitants of the American continent to

possess modifications in the configuration of the external auditory passage."

The opinion here expressed by Prof. Turner led me to add to my examination of the mound-builder crania for exostoses, the measurement of the diameters of the external auditory meatus, and the results obtained, together with more superficial observations made some time previously in a large number of Peruvian crania, fully confirm his opinion. Should similar investigation in other races show as fixed a type of proportion, the dimensions of the orifice of the external auditory canal may advisedly, it would seem to me, be added to the list of acknowledged cranial measurements.

My own attention was first drawn to this subject, in 1874, by Prof. Jeffries Wyman, who submitted for examination six out of three hundred and thirty-four Peruvian crania which had recently come into his possession, in which six crania there existed exostoses in the external auditory canals. A peculiarity of the growths in these six cases was that they were almost uniformly situated at the entrance of the canal, and upon the anterior superior or posterior inferior wall. From the results obtained in the present examination of the mound-builder crania, I am led to believe that the more careful examination of these same Peruvian crania, now in the Peabody Museum, which I hope to make in continuation of this paper, will reveal other cases of exostoses less prominently noticeable. In the six cases in question, the orifice of the meatus, aside from any alteration in shape in consequence of the exostoses, was much narrowed, and in the majority of the three hundred and thirty-four crania the vertical diameter of the meatus much exceeded the antero-posterior diameter.

To furnish the basis for the present paper, of the crania taken from the stone graves—mound-builders—of the Cumberland Valley, Tennessee, obtained for the museum, as the result of the explorations of Prof. Putnam, one hundred and ninety-five were examined, and the measurements of the external auditory meatus made as follows: of the vertical diameter, from the centre of the arch of the superior wall to the inside of the lip of the inferior wall of the canal; of the antero-posterior diameter, from the inside of

the outermost lip of the anterior wall to the opposite point on the posterior or mastoid wall.

Both canals were measured and the average of the two taken for record, except when one canal was abnormally large. In imperfect crania, where the bone had broken away, or had been injured by rodents, these measurements were necessarily omitted or modified; the great care which had been taken in the preservation of these crania, however, rendered this necessary only in five cases, and of the one hundred and ninety crania measured, the average diameters were found to be: vertical diameter, 10.1 millimetres; antero-posterior diameter, 6.3 millimetres.

In thirty-six of the one hundred and ninety-five crania, about 18 per cent., exostoses were found in one or both canals, and the average diameters of the canals, without reference to the narrowing effected by the exostoses, was found, in thirty of the thirty-six, to be: vertical diameter, 10.3 millimetres; antero-posterior diameter, 5.7 millimetres, showing a more decided narrowing of the canal in the cases in which exostoses existed, this being in part accounted for by a general thickening of the anterior and posterior walls of the canal.

For purposes of comparison, measurements were also made on this occasion of the canals in fifty Californian crania, taken from graves in the Islands off Santa Barbara, and the average diameters were found to be: vertical diameter, 11.1 millimetres; antero-posterior diameter, 8.61 millimetres. Of one hundred and eight Californian crania, superficially examined—that is, without exact measurement of the canals—five were found to possess exostoses in one or both canals, and in three of the five a corresponding narrowing of the canal, without reference to the exostoses, was observable.

On reviewing the tabular statement herewith presented, compiled from the more exact examination of the thirty-six mound-builder crania in which exostoses were found, it appears—

1. That exostoses occurred in both canals in twelve out of the thirty-six crania, and of the remainder, in the right canal in nine and in the left canal in fifteen crania.

2. That of all the exostoses detected, fifty-four in number (counting the triple exostosis found in cranium No. 18,503 as one), forty-

two occurred on the posterior and twelve on the anterior wall of the canal.

3. That making the division into "rounded" and "flattened," to distinguish the two forms principally assumed by these growths, twelve belonged to the former and forty-two to the latter class.

The flattened exostoses occurred principally upon the posterior wall of the canal, varied from three to six millimetres in width at the base, and extended inward along the wall of the canal parallel to the long axis of the passage, while the rounded exostoses had their origin, as a rule, from the anterior superior or posterior inferior lip of the anterior inferior wall of the canal. It is this latter form of exostosis in this location, as figured by Welcker in the paper cited, which has principally attracted the attention of craniologists, as may well be the case, since it is the rounded exostosis which is more prominent and which usually attains the greatest size, even completely blocking, in some instances, the entrance of the canal.

The consideration of the etiology of these curious growths with a view to any light which may be thereby thrown upon the habits or development of the extinct races in which they are found, is a most interesting one, but is unfortunately of little service.

Otological authorities of to-day differ as to the possible predisposing causes of such growths, and in the majority of cases coming under clinical observation are enabled to refer them frequently to some source of irritation in an existing disease of the external or middle ear. Toynbee mentions the possibility of their occurring usually in persons of a gouty or rheumatic habit, and Gruber finds a possible explanation in reference to hereditary or acquired syphilis. Neither of these possible explanations is, however, fully supported by the general facts accompanying the occurrence of these growths, and in regard to a connection with specific disease I may say that especial pains were taken to examine these mound-builder crania for evidences of syphilitic disease, either in the form of the more minute cranial lesions or as evidenced by the peculiar "natiform" skull described by M. Parrot in the London *Lancet* of May, 1879. In this connection the examination of the California crania (in which the exostoses occurred in 5 per cent. as compared with 18 per cent. in the mound-builder crania) is also of interest, for no race probably

ever had a better opportunity for developing syphilis than had the California Indians after their contact with the Spaniards.

So far as local irritation may have had to do with the causation of these growths, the fact, already mentioned, that the majority of them occurred upon the posterior wall of the canal, the wall most exposed to violence from without, may possibly be of importance, but there is nothing, so far as I am aware, in the various remains taken from the stone graves pointing to any peculiar custom or ornamentation, which might have had an influence in predisposing to or causing bony growths in the external auditory canal, and moreover, though the occurrence of these exostoses may be apparently more common in New World races, this can by no means be taken as an established fact while comparative data are so meagre as at present. Certainly, according to Welcker and Turner, the growth of these exostoses cannot be regarded as a race-characteristic peculiar to American crania; were this at all possible the comparison of the mound-builder crania with the Peruvian brachycephalic crania in regard to their occurrence would be especially interesting.

That the habits of a people should have an influence on the uniform causation of such growths is hardly possible though certainly conceivable. The discovery of exostoses in the external auditory canals of crania of Hawaiian Islanders, and again in crania from the Bay of Chacota, Peru, by Prof. Wyman, suggested to him the possible influence of the aquatic habits of the people, and this suggestion gave an added interest to the examination of the crania of the mound-builder, a people living far inland, in whom, as has been shown, they equally pertain.

There is one other possible influence which may have a bearing upon the occurrence of these growths, and which is at least worthy of consideration in any future investigations which may be made, and that is, hereditary tendency. Of the more marked cases—that is, cases exhibiting excessive growth without evidence of other aural lesion—I have found, in aural practice, that the majority have occurred in certain families, in the male members of successive generations, the most marked instance, being in the three successive generations of one family in which there is no tendency either to gouty or rheumatic disease.

The mound-builders, as we know, made their settlements in the fertile river-bottoms, clustering together in more or less distinct communities, and of thirty cases of exostoses found in these crania ten came from one distinct locality and six from another.

The facts presented are at least suggestive, and if any reliance can be placed upon them it will be interesting in future investigations to compare, so far as is possible, the carved shells or totems found in the mounds from which the crania were taken.

With the large additions which are now being made with each succeeding year to collections of American crania, the pursuance of examinations as to the occurrence of aural exostoses and the tabulation of dimensions of the external auditory meatus, in addition to other cranial measurements, promises to afford material of interest at least, if not of positive value.

In the following tabular statement the numbers given are those marking each skull in the Peabody Museum collection. For purposes of comparison, note is also made of the cranial type.

#### TABULAR STATEMENT.

##### MOUND-BUILDER CRANIA.

- 18,248. *Brachycephalic*. R. two exostoses, one on the anterior superior wall, 4 mm. wide, 6 mm. long, the other on the posterior inferior wall, in the form of an elongated ridge, extending inward from the outer lip of the canal and 3 mm. in diameter. L. one rounded exostosis on the anterior superior wall 2 mm. in diameter.
- 18,251. *Brachycephalic*. L. on the posterior wall a flattened exostosis, 3 mm. wide, 6 mm. long.
- 18,402. *Brachycephalic*. L. on the posterior wall a flattened exostosis, 4 mm. wide, and 7 mm. long.
- 18,277. *Brachycephalic*. R. on the posterior wall a rounded exostosis, 5 mm. in diameter. L. a similar growth in a corresponding position, 4 mm. in diameter.
- 18,280. *Brachycephalic*. R. on the posterior wall a rounded exostosis, 4 mm. in diameter, and on the anterior superior wall a large flattened exostosis, hardly sufficiently marked in outline to distinguish it as a distinct growth. L. on the anterior wall two rounded exostoses, impinging and together 3 mm. in diameter.
- 18,503. *Brachycephalic*. L. on the posterior wall a triple flattened exostosis, extending inward from the outer lip to a depth of 9 mm.

- 17,314. *Brachycephalic*. R. on both anterior and posterior walls flattened exostoses, 6 mm. and 7 mm. in diameter. L. corresponding exostoses, respectively 5 mm. and 6 mm. in diameter.
- 18 274. *Brachycephalic*. R. on the posterior wall a flattened exostosis, 3 mm. wide and 8 mm. long, the antero-posterior diameter of the canal being only 4 mm. L. antero-posterior diameter of canal 3 mm.; no exostoses.
- 17,279. *Brachycephalic*. L. two exostoses, nearly touching across the canal, that on the anterior wall 2 mm. and that on the posterior wall 3 mm. in diameter. R. flattened exostosis on posterior wall, 4 mm. in diameter; the anterior wall much thickened.
- 17,275. *Brachycephalic*. L. long, flattened exostosis on the posterior wall, 3 mm. in diameter.
- 14,256. *Brachycephalic*. R. on the posterior wall a flattened exostosis, 4 mm. wide and 7 mm. long.
- 18,599. *Orthocephalic*. L. on the posterior wall a flattened exostosis, 4 mm. wide and 7 mm. long, also a small flattened exostosis on the anterior wall.
- 18,620. *Dolichocephalic*. Broad flattened exostoses on both posterior walls.
- 16,006. *Brachycephalic*. Flattened exostoses on both posterior walls.
- 14,273. *Brachycephalic*. R. broad, flattened exostosis on posterior wall.
- 15,218. *Brachycephalic*. Broad, flattened exostoses on both posterior walls.
- 15,910. *Brachycephalic*. R. on the posterior wall a rounded exostosis, 4 × 9 mm. in diameter.
- 15,997. ——— L. on the posterior wall a rounded exostosis, 4 × 8 mm. in diameter.
- 16,003. *Brachycephalic*. R. on the posterior wall a rounded exostosis, 2 mm. in diameter.
- 15,827. *Brachycephalic*. R. the canal nearly closed by a large rounded exostosis, 9 mm. in diameter, springing from the posterior wall. L. a small exostosis on the posterior wall.
- 14,090. *Brachycephalic*. R. on the posterior wall a rounded exostosis, 3 mm. in diameter, also a small exostosis of the same form on the anterior superior wall. L. on the posterior wall a rounded exostosis, 4 mm. in diameter.
- 15,213. *Brachycephalic*. L. on the posterior wall a small rounded exostosis.
- 15,998. *Brachycephalic*. R. on the posterior wall a group of long exostoses, nearly closing the canal, which had an antero-posterior diameter of 6 mm.
- 14,006. *Brachycephalic*. L. on the posterior wall a flattened exostosis, 4 mm. in diameter. R. a corresponding exostosis, 5 mm. in diameter.
- 15,904. ——— L. on the posterior wall a flattened exostosis, 3.5 mm. in diameter.

- 15,913. ——— L. on the posterior wall a flattened exostosis, 4 mm. in diameter.
- 15,829. *Brachycephalic*. R. on the posterior wall a flattened exostosis, 4.5 mm. in diameter.
- 15,219. *Brachycephalic*. L. on both anterior and posterior walls flattened exostoses, 3 mm. in diameter at the base and nearly touching across the canal.
- 15,839. *Brachycephalic*. L. on the posterior wall a rounded exostosis, 2 mm. in diameter.
- 14,096. *Brachycephalic*. R. on the posterior wall a flattened exostosis, 5 mm. in diameter, and on the anterior wall, more deeply seated, two exostoses, respectively 3 mm. and 4 mm. in diameter. L. on the posterior wall a flattened exostosis, 4 mm. in diameter.
- 15,215. ——— L. on the anterior and posterior limits of the inferior wall two small exostoses, a third small exostosis, rounded, on the anterior superior wall. R. a broad exostosis, irregular in shape, and including in its base nearly the whole of the posterior wall.
- 12,018. ——— (Lebanon group). L. large exostosis, 6 mm. in diameter, springing by a broad base from the posterior wall at the entrance of the canal, projecting upward and forward, and touching the superior anterior lip which was somewhat thickened.
- 11,825. ——— (Lebanon group). L. on the posterior wall, just within the outer lip, a peculiar nipple-shaped exostosis, 3 mm. in diameter.
- 12,310. ——— (Lebanon group). R. on the posterior wall a long, flattened exostosis.

## CALIFORNIAN CRANIA.

- 9,166. *Orthocephalic*. R. small, flattened exostoses, on the posterior wall, 3 mm. in diameter, and on the anterior wall, 2 mm. in diameter.
- 9,156. ——— L. on the posterior wall, flattened exostosis, 4.5 mm. in diameter. R. a similar exostosis, 1 mm. in diameter.
- 13,234. *Orthocephalic*. On both posterior walls small, flattened exostoses.
- 13,233. *Dolichocephalic*. L. on the posterior inferior wall a group of three small, rounded exostoses, averaging 1 mm. in diameter, one also on the anterior wall near the tympanic ring, 1 mm. in diameter. R. a small, flattened exostosis, 2 mm. in diameter on the posterior wall, and a corresponding growth on the anterior wall near the outer lip.
- 9,181. *Orthocephalic*. L. on the anterior wall two small, flattened exostoses, a similar growth on the anterior superior wall averaging 2 mm. in diameter.
- 9,189. *Brachycephalic*. L. on the posterior wall, near the outer lip, a small nipple-shaped exostosis, 1 mm. in diameter.



