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Journal of Historical Archaeology & Anthropological Sciences

Research Article

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Finding of exostoses in the external auditory channel of maritime workers in the port of Arica. Rescue of contemporary historical data

Abstract

Since the beginning of the 20th century, different investigations in human mummies from the fertile coast of northern Chile have reported the appearance of a bone growth indistinctly called osteoma or exostoses in the external auditory channel (EAC) of prehistoric skulls. Subsequent works defined this excrescence as exostoses, based on the radiological study of the tissues and its bilateral appearance due to reactive growth, based on an environmental hypothesis due to continuous exposure to the cold temperatures of the coastal edge mainly due to fishing and underwater diving for survival during prehistory. At the end of the 20th century, we used conventional radiology to study a group of maritime workers from the port of Arica, divers, and fishermen who worked in the same geographical place where exostoses were reported in the EAC of mummies in northern Chile. For the radiological analysis, the number of exostoses and their location were considered, determining the frequencies and subjecting them to statistical tests, comparing them with a control group of people who did not work at sea. This article rescues the unpublished data of this series of cases of contemporary population and provides radiological evidence to compare with the series of data on local prehistoric population. We conclude that the higher frequency of exostoses in the EAC of current divers and fishermen when compared to the control group, as well as its greater bilateral appearance, allow us to support the hypothesis of exposure to the cold of the maritime environment as the cause of this reactive bone growth of the EAC.

Keywords: exostoses, external auditory channel, maritime workers, coastline, contemporary population

Volume 7 Issue 1 - 2022

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Received: March 21, 2022 | **Published:** April 08, 2022

Introduction

Since the last century, the discovery of bony excrescences in the external auditory canal (EAC) of mummies from northern Chile has drawn the attention of physical anthropologists and archaeologists. They were defined by the majority, indistinctly as osteoma or exostoses, being benign tumors whose presence is frequent in EAC.[1,2]

For Raspall and other researchers, it would be a benign osteogenic tumor or osteoma, presented as a large single growth, generally unilateral and preferably located in the osteocartilaginous junction of the EAC.[1–3]

On the other hand, the protuberance defined as exostoses is identified as a bony proliferation of multiple appearance, bilateral and frequently located near the tympanic membrane[3] whose cause would be a reactive process, before the stimulation of an external agent.[3,4]

Research carried out on the fertile coast of the Arica region concludes that the excrescence is an exostoses due to its bilateral characteristics, its location preferably in the tympanosquamous suture, and more frequently in the suture of the posterior wall of the EAC.[5,6]

In the literature, several hypotheses are mentioned that would most likely be responsible for the formation of exostoses in the EAC. For this work, the "environmental hypothesis" is used: the one that indicates as a causal factor triggering exostoses, the prolonged and repeated stimulation of the walls of the EAC by humidity, wind, and cold water in susceptible people. Therefore, it is observed more frequently in people engaged in maritime activities.[7]

This is how this alteration was found in prehistoric mummies, which according to their coastal habitat and the activity of extracting molluscs that are found at average depths of 8 meters, suggest the adequate mastery of diving techniques, non-traditional behavior of man primitive of the South American coasts.[8]

Benign neoplasms

Benign tumors of the external ear are very rare, and those that do occur may be of conjunctival, glandular, or epithelial origin. The most frequent are osteoma and exostoses; these tumors are considered by some authors as hyperplasias and not as neoplasias.[9]

Exostoses

Exostoses are the most frequent bony excrescences. They are located in the internal part of the EAC and are usually multiple and bilateral. They are variable in size and nodular, pedunculated, or flat in shape.[3] They are not considered true tumors; although some authors do,[1] they are considered irregular nodular masses or excrescences of periosteal bone that arise due to irritation or stimulation, forming in layers, which suggests a growth pattern. Regarding their location, they are medial and are most frequently located near the tympanic membrane.

Exostoses has been aetiologically attributed to continuous contact with cold water, generally in those waters where the temperature is below 16ºC. This new bone formation is asymptomatic, except in cases where it traps remains of epithelium and earwax, causing otitis; On the other hand, if they are totally obstructive, they produce conductive hearing loss.

According to studies in prehistoric skulls, this excrescence is located predominantly in the posterior wall of the duct and radiographic analysis is observed to have a wide base and preferably located in the middle third of the EAC, reaching a 50% frequency; At the same time, significant thickening of the walls was found, mainly of the anterior one,[5] which would also correspond to a form of exostoses.[3]

The present investigation reports a local series of previously unpublished data, which maintain their value during the time that has elapsed since their first analysis, having a direct implication in clarifying the origin of the exostoses in the EAC reported in the areas of; physical anthropology, paleopathology, medicine and otorhinolaryngology among others.

Materials and methods

Sample material

The sample under study corresponded to 60 male individuals residing in the city of Arica, chosen randomly, 30 of whom carried out maritime tasks and corresponded to the group under study. Within them got into the survey indistinctly fishermen and support workers at the surface in one subgroup, and divers in the other subgroup. The remaining 30 worked in tasks unrelated to the marine environment and corresponded to the control group. The selected got in this group randomly by their collaboration interest and were students or academics working near the university campus's radiology department.

In this work, only male individuals are included, both in the study group and in the control group, considering that at the date of the study, maritime fishing and diving tasks in this area of Chile were carried out almost exclusively by men.

Method

Each patient underwent two X-rays consisting of Law and Axial focused projections for both ears in each case. Record sheets were prepared in order to collect the personal and work history of each patient. Once the radiographs were obtained, they were analyzed together with a radiologist based on morphological parameters and variables in order to determine the presence of exostoses in the EAC and obtain a diagnosis. For the above, the following were considered: number of exostoses present, unilateral or bilateral excrescence, and duct morphology.

Design of the investigation

The present investigation corresponds to an experimental design of a control group with post-test, where the sample was chosen randomly.

Statistical analysis

Once the data had been collected and the radiographic examinations analyzed, a statistical study was carried out to determine the frequency of exostoses of the EAC in the sample, considering the variables of age in addition to the type of work. As a hypothesis test, the Z distribution was used with an α=0.05 significance to determine statistical differences between the study group and the control group. We used this statistical test due to the low number of participants captured in the study group, which allowed them to occupy a normal distribution when compared to the control group with a similar number of participants.

Limitations

The main difficulty found in the development of the research was the limited time availability of the study group to attend the radiographic examination, which limited the number of cases in the sample. Another limitation during that date was the scarce information regarding the appearance of exostoses in the EAC and its radiological findings in contemporary populations.

Results

The results of the study are presented in the following tables, graphs, and photographs.

Table 1 for the frequencies observed in the study group shows a high percentage of exostoses in individuals who carry out marine work (93.33%), which is distributed mainly among young adult individuals and then decreases with increasing age. However, we cannot affirm that age has a clear relationship with the appearance of exostoses. Two individuals did not present exostoses in the study group. On the other hand, the absence of exostoses among elderly individuals corresponds to the low probability of finding active maritime workers at that age due to the hardship of marine tasks. When reviewing the frequencies of exostoses in the control group, these occur in a lower proportion and are distributed similarly, both in young and older individuals. Considering that the individuals in this control group have not been chronically exposed at work to a cold-humid environment, it is possible that the cases detected in this group have a congenital origin.[4]

In Table 2, we can see that the frequency of exostoses in the group of divers is 100%, distributed mainly between 30 and 53 years, most likely because the diver's productive working life is between these ages. In fact, as age increases, there are practically no individuals who carry out underwater work; the majority adopt surface maritime tasks (both in small and large vessels), which translates into a lower frequency of exostoses in the older age ranges.

Table 1 Frequency of exostoses in the study group versus the control group according to age

Age in years	Frequency in the study group	Percentage (%) in the study group	Frequency in the control group	Percentage (%) in the control group
18 - 29	3	10,71	7	50,00
30 - 41	14	50,00	1	7,14
42 - 53	6	21,43	5	35,72
54 - 65	5	17,86	1	7,14
66 - 77	0	0,00	0	0,00
Total	28		14	

Table 2 Frequency of exostoses in the group of divers versus surface and fishing support personnel according to age

Age in years	Frequency in the group of divers	Percentage (%) in the group of divers	Frequency in the support group	Percentage (%) in the support group
18 - 29	3	17,65	0	0,00
30 - 41	10	58,82	4	36,36
42 - 53	3	17,65	3	27,28
54 - 65	1	5,88	4	36,36
66 - 77	0	0,00	0	0,00
Total	17		11	

On the other hand, for the group of support personnel in surface and fishing operations, the table shows a high frequency of exostoses

(84.62%), which is more evenly distributed among the intermediate ages. Unlike divers, surface seafarers do not develop bony outgrowths as early, perhaps because they are less directly exposed to cold water. In the older age range, no cases of exostoses are observed since these individuals retire from working life in those hard maritime tasks.

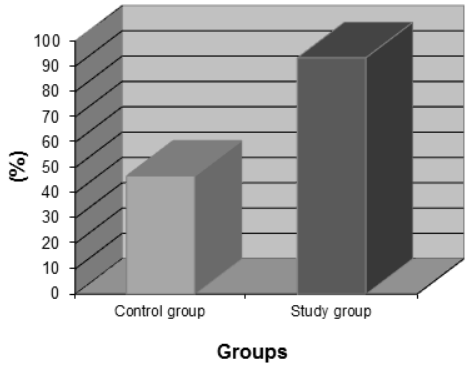
Table 3 shows the morphological characterization of the exostoses found and analyzed by conventional radiology in the study group. In this, a higher percentage of double exostoses is observed in the EAC (53.57%), considering their different degrees of development.

Regarding the number and degree of growth of the excrescence, we can highlight that the single exostoses are mainly incipient bone neoformations; on the other hand, the double exostoses are in their highest percentage of medium and great development.

Table 3 Morphological characterization of the exostoses found in the study group according to number and degree of growth

Types of exostosis	Support and fishing staff	Divers	In the whole study group
Early bone formation	27,28 %	23,53 %	25,00 %
Medium development exostoses	00,00 %	29,41 %	17,86 %
Highly developed exostoses	00,00 %	05,88 %	03,57 %
Incipient double exostoses	09,09 %	05,88 %	07,14 %
Double exostoses of medium development	36,36 %	11,77 %	21,43 %
Largely developed double exostoses	27,27 %	23,53 %	25,00 %

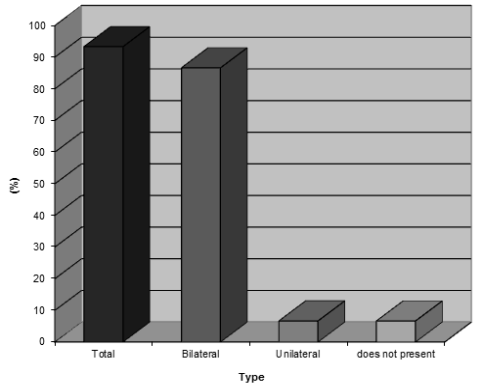
In Graph 1 we can see that the frequency of exostoses in the EAC of the study group is significantly higher than the frequency detected in the control group, at a confidence level of 95% [P(3.8877>1.96)].



Graph 1 Frequency of exostoses in the EAC detected in the study group and control group.

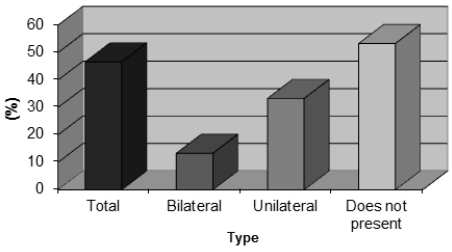
Graph 2 shows that the presence of bilateral exostoses in the EAC is significantly higher than unilateral exostoses and the absence of this new bone formation. On the other hand, the total frequency of exostoses within the study group is statistically significant at a level of 0.05, stating that with 95% confidence in the study group, both bilateral and unilateral EAC exostoses can be found.

Graph 3 presents the frequency of EAC exostoses in the control group. Through the statistical test, we found that even when its total percentage is high, at a level of 0.05 the presence of exostoses observed in the control group is not significantly elevated when compared to the study group [P(-0.647<1.6991)].



Graph 2 Frequency of exostoses according to type in the study group.

Graph 4 shows us the presence of exostoses in both divers and artisanal fishermen. A difference can be seen in the percentage of exostoses, but comparing them using a statistical criterion, they are not significantly different at a level of 0.05 [P(1.0927<1.7056)]; which allows us to point out that the occurrence of exostoses within the study group is apparently similar.



Graph 3 Frequency of exostoses according to type in the control group.

Graph 4 Frequency of exostoses in the EAC detected in divers and support personnel.

Figure 1 Single exostoses of medium development.

Figure 2 Double exostoses of medium development.

Figure 3 Largely developed double exostoses.

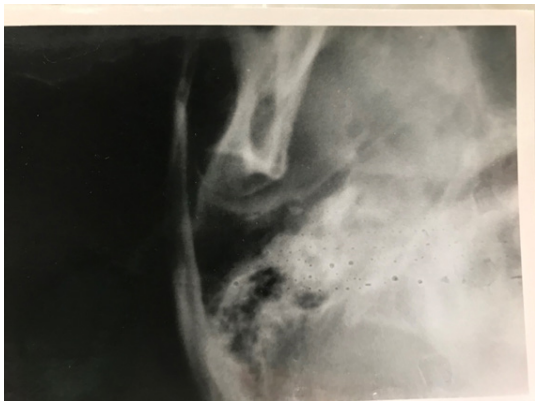


Figure 4 Double exostoses of medium development through axial projection.

Discussion

Once the results of the investigation were exposed, the existence of significant differences in the frequency of exostoses between the study group and the control group was determined. These results support what was concluded by Corrales et al.[5] on the possible relationship between the presence of exostoses and marine activities.

In the control group, the findings of exostoses may correspond to individuals subjected to environmental stress, as a result of the frequent maritime sports activities on this coast, or on the other hand, be the product of a genetic marker,[10] in this case, persistent in the permanent population of the territory of Arica.

Regarding the results obtained in the subgroups of divers and support personnel (surface personnel and fishermen), we observed that the presence of EAC exostoses is generalized; 100% and 84.61%, respectively. This agrees with what was pointed out by Tattersall[11] and cited by Bonavia[12] who indicates that not only those individuals who keep their heads submerged will present exostoses, but also those who carry out tasks on the surface.

Within the study group, the excrescences were mostly bilateral; 86.66%, which can be explained by the continuous exposure of both ears to the humid and cold environment. Regarding the above, there is a historical background of exostoses of the EAC found in mummies from human settlements on the coast of Arica and who had fishing and diving activities in the same territory used by current local divers and fishermen.[8]

Statistical analysis indicates that 50% of exostoses cases in the study group occur between 30 and 41 years of age; now, if we compare the age distribution of exostoses between divers and maritime support personnel, a decrease in cases is observed in divers as age increases, and in the latter, the distribution tends to be regular between 30 and 65 years old. These differences are possibly due to the useful working life of divers, which, in contrast to that of maritime support workers, is shorter and is subject to the state of health of the diver, who may suffer from decompressions, flu-like states, or perforated eardrums.

This is supported by the research of Ponce et al.[10] who posit the influence of the latitudinal location of coastal populations and the rigor of a cold environment in the development of exostosis.

Conclusion

In this work, we report that the finding and development of exostoses in the EAC of divers, surface support personnel and fishermen is significantly higher in the group studied, who are occupationally exposed to the stress of the cold marine environment.

There is a history of exostoses of the EAC found in prehistoric populations of the same territory on the coast of Arica, proposing with great probability an environmental causal factor as individuals are exposed to a cold and humid coastal environment.

The evidence of exostoses found by conventional radiology in both samples from prehistoric and contemporary populations merits further investigations with modern radiology techniques to confirm the reported findings with greater accuracy and detail.

Thanks

To Professor Jorge Corrales Muñoz and his collaborators.

Funding

This article did not receive funding.

Availability of data and material

All data is available within the article.

Authors contribution

All authors contributed to the development of the article

Ethical approval and consent to participate.

The study followed international regulations in accordance with the Declaration of Helsinki. The sample population consented to the taking of radiographs at the time.

Patient consent for publication

Does not apply.

Conflicts of interest

The authors have no conflicts of interest for the development of this article.

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