Comparison within a dental disease (caries) in two historical populations in the Roman southern Spain: Cortijo Nuevo and Cortijo Coracho (3-8th centuries AD)

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Abstract

Two populations excavated in the region of Lucena (Córdoba, Spain) are presented here, in which the presence and frequency of caries has been analyzed in two samples of individuals older than 20 years: a population of Late Roman period, Cortijo Nuevo (3-4th centuries AD), with 9 individuals and 112 dental crowns analyzed; and the Late Antiquity population of Cortijo Coracho (4-8 centuries AD), with 160 individuals and 1681 dental crowns analyzed. It has been possible to determine that there is a tendency towards the appearance of the caries in the posterior teeth of the same ones, mainly in the molars. The analysis performed with the Chi square statistic, in the Cortijo Coracho sample, showed that its presence in the posterior teeth, especially in the molars, is significant. On the other hand, after analyzing various parameters (the frequency of teeth with caries and the Individuals Frequency with caries or IFC), it was possible to determine that the economy of the population of Cortijo Nuevo was based on a mixed diet with non-cariogenic products, where there were abundant non-cereal vegetables and animal proteins from hunting and/or livestock. Similarly, the population of Cortijo Coracho would present an economy based on a cariogenic diet with fermentable, non-protein products, mostly from cereals. These types of diets correspond to the type and frequency of oral lesions caused by caries observed in the samples of teeth analyzed.

Keywords: paleodontology; late antiquity; late Roman empire; dental diseases; caries

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Historical and Archaeological Context

The research that is now presented is based on skeletal remains that are deposited in the funds of the Archaeological and Ethnological Museum of Lucena (Córdoba), coming from a Late Roman necropolis (Cortijo Nuevo: 3-4th centuries AD) and another Late Antiquity necrópolis (Cortijo Coracho: 4-8th centuries AD), following the concept of Late Antiquity defined by Sánchez (1): this author distinguishes the Low-Imperial period or Late Roman (between the third and fifth centuries) of Late Antiquity (from the fifth century, with the arrival of the barbarians, until the 8th century - with the arrival of the Muslims to Hispania -, which corresponded with the end of the late antiquity and early Middle Ages).

The farm called "Cortijo Nuevo" is located in the western part of the municipal area of Lucena (Córdoba), 7 km from the city, on the right bank of the Rigüelo or Lucena river. Inside it two archeological zones with different functions and chronology separated from each other about 900 linear meters: part of an extensive necropolis, and remains of a pottery factory of highimperial Roman period. The necropolis seemed to be associated with the high and low-imperial Roman deposit that exists in the Hill of Villar, on the other side of the road that appears next to the deposit, reason why would have no relation with the potter industrial zone. The documented archaeological remains were interpreted as different negative and positive structures corresponding, in all cases, to the Roman underimperial phase (3rd and 4th centuries AD). The scarcity of material that could be dated to a tomb (that is, the absence of trousseau), in addition to the rite of burial, as well as the orientation, or the appearance of lead sarcophagi, facilitated the determination of the chronology of the necropolis: a Roman subimperial period, perhaps of the 4th centuries AD. The presence of a coin found on the left clavicle of the remains of the individual in tomb 2 (in cut 6), coin of Magnencio (which was coined in AD 351), would confirm it. It is probable that the remains of the individuals who rested there belonged to the settlers and peasants who worked on them, as well as the remains of the owners of the villas and their families, of Spanish-Roman origin (2).

The late antiquity necropolis was discovered in the area called "Cortijo Coracho", located in the vicinity of the municipality of Lucena, in the south of Cordoba, territory belonging to the Autonomous Community of Andalusia. This is related, in turn, to a basilica (3), which possibly had an initial origin as martyrium or memory. In it would be deposited the remains of some saint, or martyr, of the zone; However, it is not ruled out that it was used to evangelize the rural populations of the Roman villages that were close to it (as was the case during other times: 4-5).

It is probable, therefore, that the remains of the individuals who rested there belonged to the settlers and peasants who worked on them, as well as the remains of the owners of the villas and their families, of Spanish-Roman origin (2), as happened in the case of the population of Cortijo Nuevo, already mentioned. However, it is considered that the population buried in the necropolis would correspond in its entirety to an indigenous Spanish-Roman population, although, according to the chronology that is associated with it, it is possible to assume that there might be remains (6-7). The chronology of the necropolis oscillates between 4-8th centuries AD (3). Therefore, following historical reasoning, it is considered that the population buried in the necropolis would correspond, as a whole, with an indigenous Spanish-Roman population: it would be a population assimilable broadly to the human group of Mediterranean typology, according to the definitions of Campillo and Subirà (8). Thus, it would be unlikely that the Visigothic population were buried in the necropolis under investigation. The study carried out by Diéguez Ramírez (9), in his doctoral thesis, is not conclusive in this respect.

Materials and Methods
Sex estimation
The determination of the sex of the sample of adult individuals used in this investigation has

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been carried out by simultaneously analyzing the skull and mandible, as well as the coxales (10-12). When this has not been possible, or no conclusive data have been obtained, the sex has been estimated from the method of Alemán et al. (13), based on discriminant functions on various variables analyzed in long bones (14).

Age estimation

The estimation of the age, in the individuals of the sample of Cortijo Coracho population, over 20 years, has been made analyzing the dental wear of the permanent teeth (Guerasimov, 1955, modified by Zoubov, 1968, both cited in: 15-16), also using the method of Lovejoy et al. (17), for the analysis of the atrial facet of the ilium, when the present bone remains have allowed it.

Oral paleopathology: methodology

Caries has been studied as a type of oral paleopathology, describing it and interpreting and diagnosing it if it has been possible.

Dental caries: the microorganisms that live in the oral cavity constitute the flora of the same, formed not only by bacteria but also by other germs, which can produce diseases in the said cavity according to the circumstances. One of those would be caries. This affects the visible areas of the tooth, outside the gingiva (18), producing a demineralization of the dental tissue that leads to the appearance of a cavity which, if left untreated, would lead to tooth destruction (19). See: 20-23.

At first they are usually shown as matt white spots that become darker without cavitation. Then the loss of minerals, which initially affects the enamel, also occurs in the dentin. This causes it to soften even further, so that the enamel remains like a shell that eventually collapses, causing a cavity to appear (24). Consult Hillson (22).

If a dental probe is used, when its end is retained inside the lesion, it can be affirmed that there is a caries in the tooth (25). Nevertheless, Domínguez (26) indicates that, occasionally, a radiographic study is necessary.

In addition, other problems have to be solved: the existence of sediment on the surfaces of the teeth, or a dark coloration in furrows and pits, among other things, can lead to confusion when diagnosing the presence of caries in the dental pieces.

The methodology employed in the remains from Cortijo Coracho in order to determine the presence or absence of caries was done by a thorough examination and post classification of the dental crowns that clearly displayed the presence or absence of cavities. This was followed by the analysis of those dental samples that supposed a larger challenge: the presence of caries in dental pieces without cavities could also be diagnosed by identifying slight white matte stains on the crown surface that could become darker over time. The latter analysis was carried out through a magnifying glass in order to avoid a potential confusion as a consequence of embedded sediments that could be located on the surfaces of the crowns.

Materials

In the population of Cortijo Nuevo, 24 tombs were found with an overall MNI (Minimum Number of Individuals) of 12: 8 were older than 20 years (4 males, 2 females and 2 individuals with undetermined sex), along with 4 individuals whose sex or age could not be determined due to the poor conditions of their remains. None were less than 20 years old, and only 9 had teeth, with a total of 112 crowns satisfactorily analyzed.

The research in Cortijo Coracho began after the urgent archeological intervention that began in 2003 (27), during the construction of the Córdoba-A-92 / CN 331 motorway from Cordoba to Malaga, at the site called " Finca Coracho ": found remains of a necropolis (with a total of 273 tombs investigated) and a basilica. After the study, a MNI (Minimum Number of Individuals) was counted of 397, of whom 219 were over 20 years old (75 males, 70 females and 74 individuals of unseen sex), 86 were under 20 years old and, in addition, there were a total of 92 individuals in whom it was not possible to determine sex or age (by their

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state): many of them were in reused graves, with several burials. For the anthropological study of the population, the human bone remains that were older than 20 years and that preserved dental pieces have been used as a sample: a total of 160 of the 219 individuals over 20 years of age, since the rest did not presented the same, or could not be determined by the deterioration they presented. A total of 1681 dental crowns were analyzed.

Statistical procedure

The calculation of the "Chi square" statistic, for Cortijo Coracho material, has been done in all cases using the MICROSTA program. When the result obtained is less than 0.0001 (p <0.0001), the observed differences are considered to be significant.

	Frequency of teeth with caries in the late roman population of Cortijo Nuevo (dental crown anaysed= N)											
	Maxilla						*Mandible*					
	Left		*Right*		*All*		*Left*		*Right*		*All*	
	n	*Teeth with caries*	*n*	*Teeth with caries*	*N*	*% Teeth with caries*	*n*	*Teeth with caries*	*n*	*Teeth with caries*	*N*	*% teeth with caries*
I1	2	0	4	0	12	0,00	2	0	2	0	11	0,00
I2	3	0	3	0			3	0	4	0		
C	4	0	2	0	6	0,00	5	0	5	1	10	10,00
P1	1	0	2	0	11	9,09	5	1	5	0	19	5,26
P2	4	1	4	0			3	0	6	0		
M1	5	0	4	2	16	12,50	4	0	7	0	27	0,00
M2	2	0	3	0			5	0	7	0		
M3	0	0	2	0			2	0	2	0		
Total	21	1	24	2	45	6,67	29	1	38	1	67	2,99

Table 1. Frequency of caries by dental type (in maxilla and mandible) in the late roman population of Cortijo Nuevo. Modified from Rihuete (19)

Frequency of teeth with caries in the late roman population of *Cortijo Nuevo (Permanent teeth)*			
Dental Crown analysed		*Teeth with caries*	
Position	**N**	**n**	**%**
Maxilla	45	3	**6,67**
Mandible	67	2	**2,99**
Total	112	5	*4,46*

Table 2. Frequency of caries by dental type (in maxilla and mandible) in the late roman population of Cortijo Nuevo. Modified from Rihuete (19)

Results

Analysis of caries frequency in the investigated sample of Cortijo Nuevo. In reviewing the data (Tables 1 and 2), it is verified that the percentage of teeth with caries is more than double in the maxilla (6.67 %) with respect to

the mandible (2.99 %), being the total value of 4.46 % (Table 2). On the other hand, the percentage of individuals with caries amounts to a total of 33.33 %: this value would be similar to the IFC (Individual Frequency with Caries), defined by Zapata (28-29). In turn, the number

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of caries per individual amounts to almost two (1.67 caries / individual). It is verified how the highest percentage of teeth affected by cariogenic processes corresponds to the premolars, with the molars being the least affected (Table 3), except for the incisors. From all of the above, therefore, it can be deduced that this dental disease affects to a greater extent the posterior teeth of the right hemiarcate of the maxilla.

Dental Pathologies: caries			
Individual analysed (A)	9		
Dental crowns observed (F)	112	% individuals with caries (G/A)	33,33
Individuals with caries (G)	3	% teeth with caries (H/F)	4,46
Teeth with caries (H)	5	Caries per individual (H/G)	1,67
Incisors with caries	0	% incisors with caries	0
Canines with caries	1	% canines with caries	6,25
Premolars with caries	2	% premolars with caries	6,67
Molars with caries	2	% molars with caries	4,65

Table 3. Frequency of caries by dental type in the late roman population of Cortijo Nuevo. Modified from Robledo (43).

Analysis of caries frequency in the investigated sample of Cortijo Coracho. In reviewing the data (Tables 4 and 6), it is verified that the percentage of teeth with caries is very similar in maxillary and mandible, being the total value of 11.24% (Table 6). On the other hand, the percentage of individuals with caries amounts to a total of 51.86%: this value would be similar to the IFC (Individual Frequency with Caries), defined by Zapata (28-29). In turn, the number of caries per individual amounts to more than two (2.28 caries / individual). It is again verified that the highest percentage of teeth affected by cariogenic processes corresponds to molars (perhaps because of their greater participation in the food chewing process), with anterior teeth being the least affected (Table 6). Analyzing the frequency of caries according to position, situation and laterality, it is observed how the frequency in the posterior teeth is greater, as previously determined, while the percentages obtained according to the situation

and laterality result values very close to each other. From all of the above, therefore, it can be deduced that this dental disease affects to a greater extent the posterior teeth of the mandible, especially in the molars of the right hemi-arch.

Study of caries in both populations: chi square analysis. It has been decided not to perform, in the late Roman population of Cortijo Nuevo, the statistical study of Chi square to the observed and expected frequencies of caries lesions in the whole mouth (the null hypothesis to be verified would be that the differences in each case would not be significant), since the observed values of crowns analyzed and teeth with caries are very low.

From here, we have chosen to perform a statistical study that confirmed or not, in the Cortijo Coracho population, the incidence of a greater number of lesions in the posterior teeth of the right hemimandible, especially in the molars, and if this would be significant, applying the statistical method of Chi square to observed and expected frequencies of caries lesions throughout the mouth (the null hypothesis to be checked would be that the differences in each case would not be significant). There were significant differences between the observed and expected frequencies (of a homogeneous distribution) in the total dental groups (Chi square = 46.276, Df = 7, p = 3.714E-7 < 0.0001). Df= Degrees of freedom.

Table 7 shows that the frequency of teeth with caries was higher in the posterior (167/874) than in the previous (22/807): the Chi square value was 111.194 (Df = 1, p = 7.547E-11 < 0.0001). There were no differences between the right and left hemiarcates, regarding the frequency of teeth with caries (Chi square = 1.298; Df = 1; p> 0.0001). Simultaneously, this was the case for maxilla and mandible: the Chi square value was 0.277 (Df = 1, p> 0.0001).

According to Table 7, there is a significant difference between the anterior and posterior teeth, throughout the oral cavity, relative to the higher incidence of caries in the posterior ones. However, there are no significant differences in the frequency of caries with respect to the right

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and left hemiarcades, or with reference to maxillary and mandible. From all this it follows that, fundamentally, the posterior teeth of the

whole oral cavity appear more affected by caries.

	Frequency of teeth with caries in the late antiquity population of *Cortijo Coracho* (dental crowns analysed= N)											
	Maxilla						*Mandible*					
	Left		Right		All		Left		Right		All	
	n	Teeth with caries	n	Teeth with caries	N	% Teeth with caries	n	Teeth with caries	n	Teeth with caries	N	% Teeth with caries
I1	29	1	32	2			35	0	32	2		
I2	40	1	36	2	137	4,38	48	2	47	1	162	3,09
C	61	4	55	3	116	6,03	70	3	65	1	135	2,96
P1	58	8	57	6			70	4	68	4		
P2	44	3	43	3	202	9,90	77	10	68	7	283	8,83
M1	53	8	59	16			77	13	72	12		
M2	38	6	39	8			81	17	76	19	413	19,61
M3	25	1	19	2	233	17,60	51	8	56	12		
Total	348	32	340	42	688	10,76	509	57	484	58	993	11,58

Table 4. Frequency of caries by dental type (in maxilla and mandible) in the late antiquity population of Cortijo Coracho. Modified from Rihuete (19)

Frequency of teeth with caries in the late antiquity population of *Cortijo Coracho (Permanent teeth)*			
Dental Crown analysed		*Teeth with caries*	
Position	N	n	%
Maxilla	688	74	10,76
Mandible	993	115	11,58
Total	1681	189	11,24

Table 5. Frequency of caries by dental type (in maxilla and mandible) in the late antiquity population of Cortijo Coracho. Modified from Rihuete (19)

Dental Pathologies: caries			
Individual analysed (A)	160		
Dental crowns observed (F)	1681	% individuals with caries (G/A)	51,88
Individuals with caries (G)	83	% teeth with caries (H/F)	11,24
Teeth with caries (H)	189	Caries per individual (H/G)	2,28
Incisors with caries	11	% de incisors with caries	3,68
Canines with caries	11	% de canines with caries	4,38
Premolars with caries	45	% de premolars with caries	9,28
Molars with caries	122	% molars with caries	18,89

Table 6. Frequency of caries by dental type in the late antiquity population of Cortijo Coracho. Modified from Robledo (43)

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Diferences between maxilla and mandible regarding pathological teeth						
Oral Cavity	**Chi Square**	**p**	**s.**	**n.s.**	**Maxilla**	**Mandible**
	0,277	0,598	---	n.s.	74/688	115/993
Diferences by laterality (Hemiarchs right and left)						
Oral Cavity	1,298	0,256	---	n.s.	100/824	89/857
Diferences by the position of teeth (anterior and posterior)						
Oral Cavity	111,194	< 0,0001	***	---	22/807	167/874

Table 7. Summary of the statistical study for caries in the Cortijo Coracho population

Archaeological Site	Period	Centuries	Economy	IFC	% Caries in teeth	E(x) (male and female)	Autors
Son Real (Mallorca)	Post- talaiotic	6-4th BC	Mixed	9.43			Pérez-Perez *et al*. (1991). In: Zapata (29)
S'Illot des Porros (Mallorca)	Post- talaiotic	6-2th BC	Mixed	10.46	4.5		Carrasco y Malgosa (37); Rihuete Herrada (19)
Valentia republicana (Valencia)	Hispanic Romans	2-1th BC	Mixed	45.24	5.71	14.06	Polo Cerdá (44)
Valentia imperial (Valencia)	Hispanic Romans	1th BC	Agricultural	19.40	4.71	19.79	Polo Cerdá (44)
Tarraco 2 (Tarragona)	Hispanic Romans	1-3th	¿Agricultural?	57.63	8.72	17.69	Polo Cerdá (44)
Pollentia (Alcudia, Mallorca)	Hispanic Romans	3-5th	Non Agricultural	59.04	10.60	22.87	Lalueza and García (1994). In: Polo Cerdá (44)
Corduba (Córdoba)	Hispanic Romans	3-4th	¿Agricultural?	50.00	9.37	12.75	Polo Cerdá (44)
Cortijo Nuevo (Lucena, Córdoba)	Hispanic Romans	**3-4th**	**Mixed**	**33.33**	**4.46**	**20.42**	Diéguez Ramírez (9); **present study**
Eucaliptal (Huelva)	Hispanic Romans	1-6th	Mixed	56.35			Pecero (1997). In: Zapata (29)
Molineta (Murcia)	Hispanic Romans	4-6th	Mixed	15.46			Zapata (29)
C/ Era (Murcia)	Hispanic Romans	5-6th	Mixed	24.44			Zapata (29)
El Ochavillo (Hornachuelos, Córdoba)	Hispanic Romans	6-7th	Agricultural	57.00	20.7	18.17	Cabrera et al (24)
Cortijo Coracho (Lucena, Córdoba)	Hispanic Romans	**4-8th**	**Agricultural**	**51.86**	**11.24**	**19.02**	Diéguez Ramírez (9); **present study**
Castros Lastra (Álava)	Christian	9th	Agricultural	67.70		nc	de la Rúa *et al*. (1995). In: Zapata (29)
Ronda Sur (Lucena, Córdoba)	Jewish	10-11th	Agricultural	nc	17.3	25.83	De Luca and Viciano (38); Diéguez Ramírez (9)
Monasterio de Suso (San Millán de la Cogolla, La Rioja)	Christian	10-11th	Non Agricultural	35.7		21.6	Botella, Du Souich and Ruiz (1993). In: Du Souich and Jiménez (45)
El Castillo (Palacios de la Sierra, Burgos)	Christian	10-13th	¿Agricultural?	50.0		20.7	Botella, Du Souich and Ruiz (1993). In: Du Souich y Jiménez (45)
Santa María de la Piscina (San Vicente de la Sonsierra, La Rioja)	Christian	10-14th	Non Agricultural	36.4		19.3	Botella, Du Souich and Ruiz (1993). In: Du Souich and Jiménez (45)
San Baudelio de Berlanga (Berlanga de Duero, Soria)	Christian	12th	¿Agricultural?	60.0		13.3	Botella, Du Souich and Ruiz (1993). In: Du Souich and Jiménez (45)
Jewish Necropolis of York (England)	Jewish	12-13th	¿Agricultural?	59.5		17.13	Lilley et al (1994). In: Diéguez Ramírez (9)
Santa Clara de Cullar (Segovia)	Muslims	15th	¿Agricultural?	> 50.0		**26.84**	Montiano Torres (46); **present study**
San Nicolás de Ávila (Ávila)	Muslims	12-16th	Agricultural	83.9	8.0	nc	Montiano Torres (46)

Table 8. Different series of Spanish sites by historical periods, specifying their model of subsistence, their IFC (Individuals Frequency with caries) and frequencies of teeth affected by dental caries. Life expectancies was at 20-21 years [Modified from: Du Souich and Jiménez (45); Zapata (28-29)]

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This statistical study, in contrast to the conclusions drawn after the study of the tables that reflect the percentage of caries present in the teeth of Cortijo Coracho population (Tables 4, 5 and 6), confirms this conclusion: the highest percentage of pathologies due to this disease in the oral cavity, within the population sample of Cortijo Coracho, affects the posterior teeth (especially to the molars, in front of the premolars), although not especially to the molars of the right hemiarch of the mandible, as was shown by the study of the frequencies of teeth with this pathology in the tables already mentioned (Tables 4, 5 and 6).

Discussion

In the case of the sample of the population of Cortijo Nuevo, it can be observed that the maxillary parts present a higher percentage of caries than the dental pieces of the mandible (more than double), especially in the posterior teeth: molars are the more affected (12.50%), compared to the premolars (9.09). Anterior teeth are the ones with the lowest values, except for the canines of the mandible, where they approximate the maxillary premolar values (10%).

In the case of the Late Antiquity population of Cortijo Coracho the anterior teeth (incisors and canines) are those with a lower percentage of caries compared to the posterior teeth (premolars and molars): higher in the maxilla compared to the respective values in the anterior teeth of the mandible. It also occurs in the premolars, as opposed to the molars: the latter have a higher rate of disease in the mandible compared to the molars of the maxilla.

The posterior teeth, especially the molars, present a greater number of cariogenic processes, perhaps due to their greater participation in the process of food chewing (30): the molars have a crown of dimensions greater than the others teeth, which makes the surface on which the microorganisms that cause caries can be larger than in the other teeth (having a larger interproximal surface also facilitates the action of the microorganisms on them). In addition, the existence of furrows and ridges, in greater numbers than in the other teeth, facilitates the retention of food remains, which constitute the broth of the microorganisms. Hence the high incidence of caries in the molars, in relation to other types of teeth.

For Cortijo Nuevo, it can be concluded that the presence of caries is more abundant in the posterior teeth of the right hemiarcate of the maxilla, but the low number of individuals and dental crowns analyzed, as well as the low number of caries that affect the teeth in the maxilla, in the cited sample, makes it not of interest to carry out a statistical study of it. However, in the case of Cortijo Coracho, it is verified how exists a tendency that would confirm the greater presence of this oral pathology in the posterior teeth of the mandible, especially in the right hemiarcated. After applying the Chi square statistic, it is verified how this condition appears in the posterior teeth, and in a significant way. Nevertheless, it is not significant its presence in the mandible nor in both right hemiarcades.

Brothwell (12) confirms this by stating that "molars are often affected more frequently than the anterior teeth". (See: 15). This is also demonstrated by Domínguez (26), who states that the caries frequency is higher in molars, followed by the premolars, due to morphological differences and other factors, such as tooth wear. Similarly, Bonfiglioli et al (31) and Hillson (22) say: for the latter investigator it is clear that the incidence of caries is higher in the posterior and superior teeth, especially in the communities of farmers, being different and less frequent in communities of hunter-gatherers.

In this regard, consult Hillson (32): states in the article that the frequency of caries would be higher in the mandible than in the maxilla (something that does not happen in Cortijo Nuevo). On the other hand Delgado (33), citing Powell (1985), maintains several hypotheses

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concerning the greater presence of dental pathologies, especially caries, in the posterior dentition, due to "endogenous factors such as the complex morphology" of the same (as already mentioned). See: 30.

If we compare data from Cortijo Coracho with those obtained in the investigation of the population of the Roman necropolis in the city of Córdoba, we can observe a higher Individuals Frequency with caries or IFC: 59.04% (compared with 33.33% in Cortijo Nuevo, or 51.86% in Cortijo Coracho's population); It presents a percentage of the number of caries per person of 3.64% (around two for both populations analyzed in this research), according to Cabellos and Garralda (34). On the other hand, a prevalence of 9.37% of teeth with caries in the emergent teeth (lower than the one obtained in Cortijo Coracho, 11.24%, but higher than the respective Cortijo Nuevo, 4.46%), is observed in the Cordoban population, as mentioned in Cabellos and Garralda (34-35).

Wasterlain et al (36), after studying the presence of caries in a recent sample of Portuguese population, affirm that it is higher in molars, intermediate in premolars, and inferior in anterior teeth (incisors and canines), confirming such data also Hillson (32): in the necropolis investigated by said author, caries appears, mainly, in the posterior teeth of the mandible, especially in the molars of the right hemimandible (as it happens in the population of Cortijo Coracho). He argues that caries frequency studies should be performed according to tooth type, sex and age groups, in addition to considering the effects of hypoplasia (22).

Bonfiglioli et al. (31), within the Roman high-imperial population studied by them, verify how the higher frequency of caries appears in the posterior teeth, as Prieto (30) maintains in the Hispano-muslims necropolis of Baza (in the maxilla and in the mandible). Other authors also affirm it of the posterior teeth with respect to the previous ones: Carrasco and Malgosa (37) in a Talayótica Majorcan necropolis, De Luca and Viciano (38) in a medieval sephardic necropolis, or Gutierrez de Calderón (39) in a

necropolis of Toledo (a fact that occurs in the two populations analyzed in the present investigation). This author, citing the theory of Anderson and Popovitch (1977), also cited in Brandi (1992), states that such a fact may be due to "the fact that smaller teeth are more resistant to the initiation of caries" (39).

Comparing the IFC values (Individual Frequency with Caries: Table 8) with other Hispanic necropolis, it is observed that the population studied has high values (51.86%), while Cortijo Nuevo has lower values than the previous one (33.33%): for values greater than 50% in the IFC (Individuals Frequency with caries), in these populations would be considered to the diet as agricultural, where cereals would predominate as food. Based on the value of IFC being higher than 50% (51.86%) concerning the population of Cortijo Coracho, they should have had an agricultural diet, whereas in the case of Cortijo Nuevo, with a IFC value of 33.33%, the result suggests that their individuals had an mixed type of diet, in which vegetables that would not be cereals, hunting and stockbreeding, were decidedly feasible to be combined. However, since the population of Eucaliptal, whose IFC value is higher than 50% (56.35%), presents an economy with a mixed diet, it could be assumed, on the other hand, that the diet of Cortijo Coracho, with such data, would also be mixed.

Turner (1979), during his investigations with regard to the frequency rate of caries on a world-wide sample, proposed the following ranges according the type of their economic strategy: 0.0-5.3% for hunting and livestock; 0.44-10.3% for mixed forms; 2.3-26.9% for agriculture (19). In the Cortijo Coracho necropolis there is a prevalence of teeth with caries of 11.24%, which would exceed the limit associated with a population with mixed economy: it would correspond, therefore, to a type of agricultural economy. In the case of the population of Cortijo Nuevo, attending these values, their diet would be properly mixed, perhaps with a significant component of food from hunting and livestock.

Stable isotope analyzes indicate that the diet was mixed in Italian populations from the 1st to 3rd centuries AD (as it seems to be occurring in the population of Cortijo Nuevo, a period similar to these) and in British populations at the same time, as in Hispania, in the late antiquity: all of it was based mainly on cereals (almost always wheat), for all social classes, accompanied by pulses and vegetables in the privileged classes, together with wine and oil and some dairy (cheese), as Menéndez Bueyes (23, 40). It is probable that, according to Gozalbes (41), this diet was mainly composed of cariogenic products such as legumes (used for cooking, with some oil: chick peas, lentils or beans, for example), vegetables (carrots, radishes, turnip and others), as well as wheat porridge, prior to the acquisition and consumption of bread in Roman territory (obtained from the Greeks during the second century BC), food that was already habitual during the centuries in which the ancient necropolis of Cortijo Coracho was used as cemetery (centuries 4-8th AD). The meat (pork and poultry, in general, although sheep and goats were also consumed) was an expensive and poorly consumed product, like fish, increasing their consumption according to the local resources available and the geographical situation (23, 40), Its consumption (cariostatic product), although normal (like products made from fish, such as minuta, salted fish and fish sauces), was less common for peasants than they lived in the Roman villas (for their high price), especially in the case of slaves (41). Fruits and honey supplemented this diet, providing vitamins to it: "This type of food produced multiple imbalances and malnutrition, even among the privileged classes", so they were frequently suffering from avitaminosis (23, 40).

According to Hillson (42), the influence of a diet rich in carbohydrates, in the cariogenic processes, has been experimentally proven. Such a fact could explain the high prevalence of caries that appeared in the population during the ancient times, although it is also necessary to consider the possible existence of water consumption with a low fluoride content (23).

Conclusions

According to this research, the late Roman and the late antiquity populations studied (Cortijo Nuevo and Cortijo Coracho, respectively) would be composed of Hispano-Roman individuals. Cortijo Nuevo would have a mixed economy, with a diet based on non-cariogenic products in which non-cereal vegetables and animal proteins from hunting and/or livestock, would be abundant; while Cortijo Coracho would maintain a model of agricultural economy in which the diet would mainly include cariogenic (fermentable, non-protein) products: this type of diets corresponds to the type of oral lesions caused by the caries observed in the tooth samples analyzed. From a statistical point of view, in the case of Cortijo Coracho, it can be stated that there is a significant tendency in the sample towards the appearance of the caries in the posterior teeth of the maxilla and mandible.

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