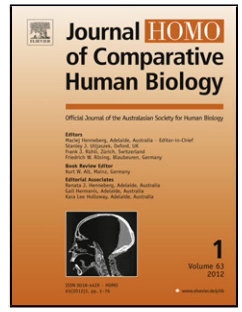
Accepted Manuscript



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PII: S0018-442X(17)30027-6
DOI: http://dx.doi.org/doi:10.1016/j.jchb.2017.05.002
Reference: JCHB 25473

To appear in:

Received date: 13-5-2016
Accepted date: 6-5-2017

Please cite this article as: Fiorin, E., Ibáñez-Gimeno, P., Cadafalch, J., Malgosa, A.,The study of dental occlusion in ancient skeletal remains from Mallorca (Spain): a new approach based on dental clinical practice, *Journal of Comparative Human Biology* (2017), http://dx.doi.org/10.1016/j.jchb.2017.05.002

The study of dental occlusion in ancient skeletal remains from Mallorca (Spain): a new approach based on dental clinical practice

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Received 3 May 2016, accepted 6 May 2017

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Abstract

Occlusal characteristics, fundamental to assess the presence of malocclusion, have been often unexplored in bioarchaeological analyses. This is largely due to the fragmented condition of the skeletal remains. By applying a method that considers dental and maxillary features useful to evaluate occlusion in ancient fragmentary material, the purpose of this work is to define the occlusal features and explore the causes of malocclusion in a medieval population from Mallorca. The findings of this study suggest that normocclusion was present in ca. 60% of the individuals (N=31), and that some characteristics, such as molar relationship, were slightly different from those of modern populations. The analysis of the occlusal features revealed for example that open-bite was absent in 85% of the sample, posterior open-bite was completely absent and overbite and overjet were normal in around 90% of the individuals. Statistically significant correlations between canine and molar relationships and between molar relationship and dental wear of the superior and inferior canines and incisors were observed. In addition, wear could affect the curve of Spee. All these findings strengthen the hypothesis that in ancient times malocclusion was not as generalized as in modern times. Although the factors that lead to malocclusion throughout centuries could have several causes, we suggest that in this population dental wear, which is strongly associated with the diet, was the fundamental causing factor.

Introduction

Dental occlusion is the relationship between both dental arches when the maximum number of contacts between upper and lower teeth is achieved. A correct dental occlusion “refers to how well the teeth are arranged individually and one-to-another within and between the dental arches” (Harris and Corruccini, 2008:1). Conversely, malocclusion is considered a discrepancy between teeth that can modify the maxillary shape, sometimes affecting mastication, diet and health. If these irregularities of the teeth are severe, they should be corrected by orthodontic treatments.

Orthodontic treatments were not common in the past, although evidence of their use dates back to ancient Egypt (Nunn, 2002). Etruscans, for example, employed gold appliance to support inserted teeth, which was useful for improving mastication. However, this bridge work type had mainly an aesthetic rather than a functional purpose (Frati and Giulierini, 2002).

Despite the scarce archaeological and historical evidence of orthodontic treatments, the issue of malocclusion in past populations is still largely unexplored. Moreover, the study of dental occlusion is not frequently included in bioarchaeological analyses due to often fragmented and incomplete skeletal remains, and in particular, the lack of a suitable method for the study of such ancient remains. The analysis of occlusion is generally conducted only when jaws are occluded with condyles placed in their fossae and taking patterns of attrition as a reference for dental position. However, complete skulls from ancient contexts are unusual; in the most habitual scenario, samples suitable for dental occlusion analysis are just a small percentage of the total number of skeletons available. This relates to the vulnerability of bones and the importance of a proper recovery and management of samples, from excavation to laboratory. In several cases the taphonomic process is causative of fragmentation and lack of archaeological skeletal material (Duday, 2006).

The specific aims of this study are: 1) to analyse the occlusal characteristics of a medieval population from Mallorca applying the method for ancient fragmentary material elaborated in the frame of this project (Fiorin et al., 2014); 2) to investigate whether there is an association between the analysed variables and, when possible, to compare them with ancient or modern material; 3) to estimate the prevalence and the severity of malocclusion and to investigate the factors that may have caused it.

Material and methods

The material analysed in this study belongs to the medieval necropolis of Can Reiners (Mallorca, Spain). The skulls were frequently incomplete and fragmented, and thus the material employed for the analysis of occlusion was not numerous (31 of 156 individuals, 19.9%). The samples were chosen according to the state of preservation of the jaws [0](Fig. 1, A). Mandible and maxilla were well preserved in some cases, although in other cases only one fragment or side of the dental arch was present.

INSERT Fig. 1 ABOUT HERE

Methods used by orthodontists to evaluate dental occlusion and adapted for incomplete maxillary remains were employed in this work. The study of dental occlusion in skeletal remains can only be done on "static" occlusion, i.e. study of the jaws with maximum dental contact and maximum inter-cuspidation. The complete description of the methods employed in this work is contained in Fiorin et al. (2014).

Regarding data collection, information was gathered from six main sections: anthropological information, dental features, dental arches features, occlusal features, occlusal plane, and articulation characteristics. Not all features could be recorded for all individuals, and therefore the total number of individuals analyzed was different for each variable.

In the anthropological section, sex and age determination was conducted using classical methods described in Buikstra and Ubelaker (1994) and Krogman and İsçan (1986). Individuals were classified as males, females or undetermined. The undetermined individuals are those without the necessary elements for sex diagnosis. Categories of age at death employed for this study were: young adult (15-20 years old), adult (21-40 years old), and mature (41-60 years old) individuals. Sub-adults (0-14 years old) were disregarded due to the incomplete development of their skeleton and individuals more than 60 years old were not present within the sample. To describe maxillary and dental characteristics, morphological and X-ray examinations were conducted (Fig. 1, B).

Concerning dental features, we described the dental status and possible alterations, such as pathologies, tooth loss, dental wear, and spacing characteristics (diastema and dental crowding). Diastema is the space separating two adjacent teeth. We analysed central diastema, which is the inter-incisal space in the upper arch midline. The dental arch was divided in sextants in order to perform an accurate analysis of central and lateral dental wear. The degree of dental wear was classified into five categories: absence (0), point of enamel wear (1), islands of visible dentine (2), confluence of islands (3), and absence of enamel (4) (Fiorin et al., 2014).

The morphology, symmetry and measurements of the dental arches were evaluated. Sagittal measurements include: 1) maxillary or superior depth, 2) maxillary length, 3) mandible depth, 4) mandible length. Transverse measurements include: 1) superior and inferior intercanine width, 2) superior and inferior intermolar width.

Occlusion was analysed with the inter-maxillary relationship. This includes: 1) overbite, which is the vertical covering of the lower incisors by the upper incisors, 2) open-bite, which is a space between the upper and lower anterior teeth incisal edges when jaws are closed, 3) overjet, which quantifies the distance between the lower incisor buccal surface and the upper incisor incisal edge evaluated parallel to the occlusal plane considering the starting point of the measurement at the superior incisor, 4) anterior cross bite, which is a malocclusion caused by mandible or maxillary bone sagittal displacement, 5) midline displacement, which is the asymmetry between the dental arches in the incisor area, 6) posterior open-bite, which is the presence of a space between upper and lower posterior teeth when jaws are closed, 7) lingual posterior cross bite, which is caused by a transverse malocclusion, where upper molar and premolar buccal cuspids occlude in the lower molar and premolar pits, 8) buccal posterior cross bite, which occurs when upper molar and premolar palatine cuspids contact with lower molar and premolar buccal cuspids, 9) canine relationship, which is the relationship between upper canine cuspid and lower canine and first premolar cuspids -Angle's classification (1899) established that Class I is considered normocclusion (the upper canine cuspid is located between the lower canine and the lower first premolar, when dental arches are occluding), while the other two (Class II and III) are considered as anterior or posterior movement of the mandible-, 10) molar relationship -Class I, or normocclusion, is present when the upper first molar mesiovestibular cuspid occludes in the lower first molar buccal sulcus, Class II is observed when maxillary arch is displaced forward in relation to the mandible, and Class III is present when maxillary bone is displaced backwards (Angle, 1899).

With regard to the occlusal plane, Spee and Wilson curve were evaluated. Spee curve is a line defined by occlusal surfaces of the teeth of the mandibular hemiarch, joining anterior teeth incisal edges with posterior teeth buccal cuspids (Fig. 2, A). Wilson curve is the transverse curvature of the occlusal plane in frontal view (Fig. 2, B).

INSERT Fig. 2 ABOUT HERE

Finally, regarding articulation, pathologies affecting the temporo-mandibular joint (TMJ) were analyzed.

As female sample size is small, both sexes are pooled together in the analysis of data. To test the reliability and repeatability of this analysis, intra- and inter-observer differences were tested for. With that purpose, four examiners analyzed the entire sample twice. For metric and descriptive characteristics, differences among groups were evaluated with Mann-Whitney's test and Kruskal-Wallis's test, as some of them were not normally distributed (Shapiro-Wilk's: $P<0.05$). Bivariate correlations for metric and descriptive variables were assessed using the Spearman's rank correlation coefficient. Association between pairs of descriptive variables was assessed using Fisher's exact test. All statistical analyses were performed with SPSS 15.0 for Windows (2006).

In order to evaluate maxillary occlusion of Can Reiners, ancient and recent populations were used for comparison. Publications using the above mentioned variables in ancient remains are rare because of the methodological difficulties previously explained. The series used for comparison will be cited in each specific analysis.

Results

Anthropological information

Concerning sex, 71% of the individuals were male, 22.6% were female and 6.4 % were undetermined. The sample is composed by 22.6% of young adults, 64.5% of adults and 12.9% of mature adults (Table 1).

INSERT Table 1 ABOUT HERE

Dental features

Among the jaws of the 31 individuals, 93.4% of alveolar cavities and 76.6% of teeth were preserved. *Ante mortem* tooth loss concerned 2.4% of the alveolar cavities and adult and mature individuals of both sexes were involved. Loss affected mostly the maxillary molars (32%) and premolars (41%). Dental decay was present in 8.7% of teeth and affected almost exclusively molars and premolars (97.5%). Rotation and dental movements were present in 1.3% of the total analyzed teeth. Usually these medial movements of teeth have a relationship with *ante mortem* tooth loss. Third molars which are impacted, erupted partially or absent (agenesis) were observed in seven individuals (22.6%). Central diastema was present in six individuals (19%). Its width ranged from a minimum of 3 mm to a maximum of 6 mm. Conversely dental crowding was present in only four individuals (13.3%) and involved the inferior central teeth. Values lower than 3 mm were not considered.

In Can Reiners sample, tooth wear under 20 years old was absent or had only some points of enamel wear. Tooth wear usually increases with age at death, but this was not constant in this study because there were also mature individuals with little tooth wear.

There were differences among groups for tooth wear of upper and lower jaws (Kruskal-Wallis's test: $P<0.05$). Differences between young adult and adult individuals in tooth wear of the superior right dental arch and of the inferior right dental arch were found (Mann-Whitney's test with Bonferroni correction: $P<0.017$ in both cases), with adult individuals presenting higher values (Table 2). Between young adult and mature groups, there were differences in tooth wear of the upper molars and premolars and of the lower right molars and premolars (Mann-Whitney's test with Bonferroni correction: $P<0.017$ in both cases). As expected, all values were higher in the mature group (Table 2). Between adults and matures no significant differences were found (Mann-Whitney's test with Bonferroni's correction: $P>0.017$ in all cases). The association between age and other variables was not significant (Fisher's exact test: $P>0.05$).

INSERT Table 2 ABOUT HERE

Dental arch features

Shape of dental arch was evaluated in 18 maxillae and in 31 mandibles. In the mandibles 74.2% were parabolic in shape, 9.7% oval-shaped and 16.1% square-shaped. In the maxillae, 66.6% were parabolic in shape, 16.7% oval-shaped and 16.7% square-shaped. Generally jaws were nearly symmetrical, but there were three adult individuals with clear asymmetry.

Regarding sagittal and transverse measurements, values in Can Reiners were compared with other ancient and modern populations (Table 3): (i) a prehistoric population from Roaix, located in the south of France (N= 43) (Mockers et al., 2004), (ii) a group of soldiers who died during an epidemic of typhus in 1810 from Sweden (N= 35) (Ingervall et al., 1972), (iii) a modern series from Sweden (N= 312) (Ingervall et al., 1972), (iv) a modern series from Pakistan (N= 100) (Amin et al., 2012) and (v) a modern series of Northern European origin (N= 27) (Harper, 1994). The results showed that the lower intercanine width of our sample is slightly greater than in the prehistoric population of Roaix and similar to the modern European sample. In addition, Can Reiners series has a smaller intercanine width than the modern Pakistani population. In relation to intermolar width, Can Reiners individuals have greater values than the Pakistani population. They are also lower values than in both Swedish samples, although differences are only significant for lower intermolar width. Regarding upper and lower length, our sample has higher values than the other samples, except for the lower length of the Swedish modern sample, which is similar.

INSERT Table 3 ABOUT HERE

Occlusal features

Overbite was considered normal in the 89.5% of recordable cases. Only one case, an undetermined young adult, had more than 2/3 of dental crown of lower teeth covered (9 mm). Similarly, open-bite was absent in 84.2% and present in 15.8% of the cases. Regarding overjet, 94.4% of values were up to 4 mm and 5.6% of values were between 4 and 8 mm. Anterior cross bite was absent in 90.5% and it was present in 9.1% of the individuals, affecting just one tooth. The midline displacement and the posterior open-bite were absent. Lingual posterior cross bite on the right side was present in 8%. On the left side, it was present in 7%. Buccal posterior cross bite, on the right dental arch, was absent whereas in the left side it was present only in one case.

Regarding canine relationship (Angle, 1899), we observed that on the right dental arch (N= 18), 66.7% were Class I, 11.1% were Class II, 22.2% were Class III. On the left dental arch (N= 22), 59.1% were Class I, 22.7% were Class II and 18.2% were Class III.

The analysis of molar relationship (Angle, 1899) for the right dental arch (N= 24) showed Class I in 62.5% of the cases, Class II in 4.2% and Class III in 33.3%. On the left side (N=26), Class I was present in 61.5% of the arches, Class II in 19.2% and Class III in 19.2%.

Table 4 shows a comparison of molar relationship between Can Reiners and other populations: (i) individuals from Gallic and Gallo-Roman population from North France (N=52) (Benauwt, 1974), (ii) medieval samples from Southeast France (N= 58) (Guichard et al., 2001), (iii) a present-day group from Southeast France (N= 82) (Guichard et al., 2001), and (iv) a modern group of Swedes (N=137) (Seipel, 1946). Comparing these groups, it is clearly visible that the “normal” trend is Class I occlusion. The highest values are those of Can Reiners and of the modern Swedes. Class III has greater percentages in ancient samples than in the modern Swedish group and in the present-day French sample (except for the left side of our sample). Frequency of Class II of Can Reiners (left dental arch) is higher than in Gallic and Gallo Roman samples and similar to the Southheast medieval and modern Swedish groups. Interestingly, in modern populations the values of Class II are in general higher than those of Class III, whereas in ancient samples the opposite occurs. In Can Reiners, if we observe the left dental arch for Class III and the left dental arch for Class II, the two values are similar.

INSERT Table 4 ABOUT HERE

Occlusal plane

Spee curve was normal in 90.3% and inverted in 9.7% of the mandibles. Wilson curve was normal in 9.6% of the mandibles, flat in 45.2%, and inverted in 45.2%.

Articulation

Pathologies affecting the temporo-mandibular joint (TMJ) were analyzed. The mandibular condyles were absent in many individuals (45.2% on right side, 32.3% on left side). Only two individuals exhibited signs of pathologies.

Association between variables

A strong correlation was observed among all sextants for their tooth wear (N= 31; R^2 ranging between 0.44 and 0.84; $P<0.05$). A strong correlation was also observed between superior intercanine width and inferior intercanine width (N= 18; R^2= 0.76; $P<0.05$) and between superior intercanine width and inferior intermolar width (N= 18; R^2= 0.47; $P<0.05$).

Association between nominal and other variables (Fisher's exact test: $P<0.05$) was observed between the Spee curve and dental wear, between molar relationship and dental wear and between molar and canine relationship. In general terms, the increase of dental wear is linked to the inversion of the Spee curve. When dental wear is not heavy (from grade 0 to 3), Spee curve tends to be normal. This interrelation is observed between Spee curve and dental wear of the inferior canines and incisors, of the inferior left molars and premolars, of the superior right and left molars and premolars (Fig. 3).

Right molar relationship has a statistically significant association with superior canine and incisor dental wear, and left molar relationship with superior and inferior canine and incisor dental wear (Fisher's exact test: $P<0.05$). Class I, or normocclusion is present until dental wear grade 2 and 3. When dental wear has a value of 4, only classes II and III are present (Fig. 4). The last two Fisher’s exact tests with statistical significance ($P<0.05$) show that right molar and right canine relationship, and left molar and left canine relationship, present similar categories in each individual (Table 5).

INSERT Fig. 3, Fig. 4, AND Table 5 ABOUT HERE

Discussion

The analysis of the 31 individuals from the medieval necropolis of Can Reiners showed that pathologies such as dental decay and tooth loss were not frequent and affected only adult and mature individuals, premolars and molars being the teeth most commonly affected. Change of molar or canine relationship could be caused by the inclination of a tooth subsequent to loss of the adjacent tooth during life, which was not observed in the sample. In addition, impacted, partially erupted or absent (agenesis) third molars were not associated with other occlusal or spacing features.

Statistical analyses revealed that dental wear increases with age at death, but no statistical differences in dental wear between adults and matures were observed. Differences among age groups in spacing characteristics, dental arches features and TMJ pathologies variables were not statistically significant. Nevertheless, the results may be influenced by the low number of mature individuals, which is in any case a reflection of the high mortality at young ages in this population, as evidenced not only by the study of the sample (Fiorin, 2015), but also by the epigraphic records of the Balearic Islands (Marimon Ribas, 2009-2010).

In clinics, sagittal and transverse measurements are important for diagnosis and treatment planning and can provide information on dentition development. For instance, the maxillary intercanine relation is an influential factor in the development of a posterior crossbite (Lindsten et al., 2002). In a study carried out in Pakistani patients without orthodontic treatment (Amin et al., 2012), increase of intercanine width was associated to an increase of intermolar width (between upper intercanine and intermolar: R^2= 0.35; and between lower intercanine and intermolar: R^2= 0.33). In the same study, a lack of correlation was observed between upper intercanine and upper arch length, as well as between the former and lower arch length. A high correlation was observed between upper and lower arch length (R^2=0.61). In Can Reiners sample, as expected, there is a correlation between the sizes of the maxillaries: the superior intercanine width is correlated with the inferior intercanine width and the inferior intermolar width. Therefore, the increase of superior length values is linked to an increase of inferior length values. Furthermore, our data showed that the increase of arch's depth is related to an increase of the length.

Transverse and sagittal measurements are usually dependent on each other (Lindsten et al., 2002). Nevertheless, in Can Reiners no correlation was observed between the arch width and the arch depth measurements. Comparing our measurements with other samples, sagittal length was generally greater in Can Reiners. All measurements taken together are consistent with the sharper maxillaries (small intercanine and large intermolar dimensions) in European faces that in Pakistanis. These findings agree with the ethnic characteristics of European and Asian people (St Hoyme and İsçan, 1989). On the other hand, the data of ancient remains indicate longer maxilla than in recent remains, in agreement with an evolutionary tendency towards reducing human maxillae and prognathism (Daegling, 2010; Emes et al., 2011).

Degree and position of dental wear affects the form of occlusion and consequently the curve of Spee. The curve of Spee influences oral health because it has a biomechanical function during food processing, as it increases the crush-shear ratio between the posterior teeth and the efficiency of occlusal forces during mastication. Even though leveling of the Spee curve is an everyday occurrence in orthodontic practice, little research has been done to assess the relationship between Spee curve and multiple factors that could influence its depth. Batham et al. (2013) observed that the depth of the curve of Spee is greatly influenced by sagittal maxillomandibular discrepancies, overbite, overjet and the inclination of mandibular first molar. Baydas et al. (2004) observed a statistically significant correlation between the depth of curve of Spee and overjet and overbite. By contrast, the sample of Can Reiners does not show correlation among these variables, maybe due to sample size and the low frequency of these pathologies. Few studies are devoted to the Spee curve analysis in ancient remains. Sengupta et al. (1999) examined the effect of dental wear on the curve of Spee in an archaeological sample with a high rate of dental wear. Their data suggested that there is no straightforward relationship between the Spee curve and occlusal wear. Conversely, the Can Reiners findings show a significant association between Spee curve and dental wear, involving in particular premolars and molars, and also the inferior canines and incisors. This association is not present in the modern sample due to the absence, even among mature individuals, of a heavy dental wear.

Several previous studies indicate that prevalence of malocclusion in modern populations is higher than in ancient samples (Baydas et al., 2004; Evensen and Øgaard, 2007; Sengupta et al., 1999). Actually, our sample reflects this tendency especially in variables such as spacing characteristics and some occlusal features such as overjet, overbite and open-bite. Concerning molar relationship (Angle classification), this tendency is not so simple. A review of the literature has revealed that normocclusion is the general trend in different historical periods (Benauwt, 1974; Guichard et al., 2001; Seipel, 1946). However, in the modern populations the values of Class II increase at the expense of Class III. By contrast, in our sample these percentages in the left dental arch are similar whereas in the right side the values of Class III are as high as in the other ancient samples. This is probably due to the underrated values of Class II of the right dental arch.

The statistically significant correlation found between molar relationship and superior and inferior canines and incisors dental wear is an important finding. Dental wear, which is strongly associated with diet, could be the influencing factor for the onset of molar malocclusion in the Can Reiners sample. Considering that dental wear increases with age and it is influenced by the type of diet or habits (such as the use of the teeth as a tool), it may be speculated that malocclusion (defined by Angle classes) has an environmental origin.

In previous studies few aspects of the occlusion were analyzed. In general, space issues related to tooth size or dental crowding have been the most commonly explored. The implementation of a method with orthodontic characteristics adapted for skeletal remains remarkably increased the amount of information concerning the occlusion features in archaeological material.

The poor state of preservation that ancient remains generally show and the need of more studies on occlusal characteristics have led to an incomplete frame regarding dental occlusion from a historical perspective. In this context, the analysis of Can Reiners provides new insight into the evolution of the jaw and teeth. Further analyses would be helpful to clarify the relationship between occlusal features and the factors that influence them.

Acknowledgements

The authors thank Dolores Ceperuelo, Eduardo Chimenos and María José Adserias for helping them with the analysis of occlusion conducted on the skeletal remains. They also would like to thank the anonymous reviewers for their helpful and constructive comments which contributed to improve the final version of this article.

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Legends for Figures

Fig. 1. Remains of a young female (CR 191.1) with well-preserved pair of jaws in "static" occlusion (A), and an x-ray which shows state of formation of the third molar of the same individual (B)

Fig. 2. Spee curve (A) and Wilson curve (B)

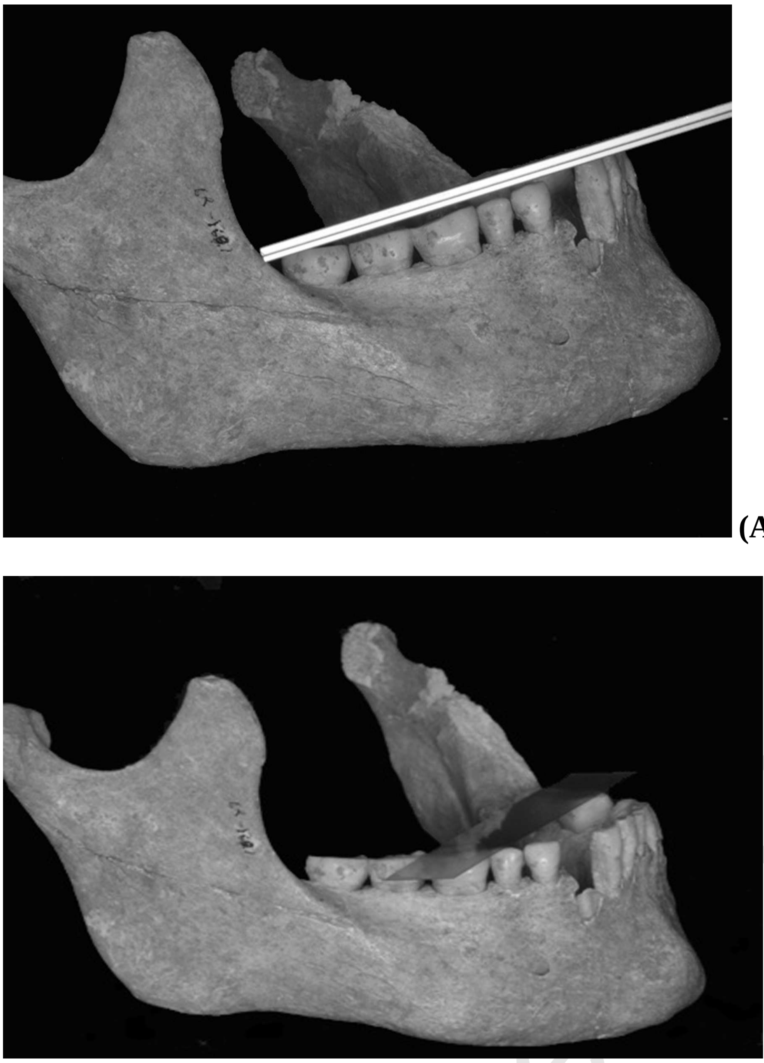
Fig. 3. Frequency of normal (black) or inverted (grey) Spee curve for each dental wear grade in different sextants. Dental wear grades: 0= absence, 1= point of enamel wear, 2= islands of visible dentine, 3= confluence of islands, 4= absence of enamel

Fig. 4. Frequency of right and left molar relationship (Angle's classes) for each degree of inferior and superior canines and incisors dental wear. Dental wear grades: 0= absence, 1= point of enamel wear, 2= islands of visible dentine, 3= confluence of islands, 4= absence of enamel

Fig. 1.

(A)

(B)

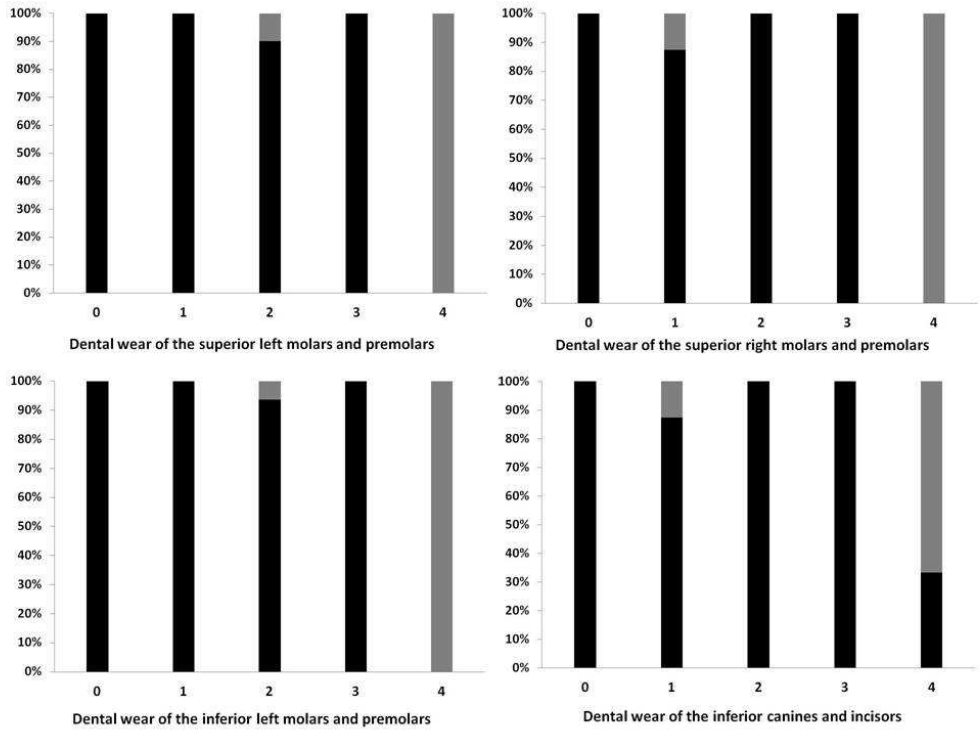


(A)

(B)

Fig. 2

Fig. 3.


100%
90%
80%
70%
60%
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40%
30%
20%
10%
0%
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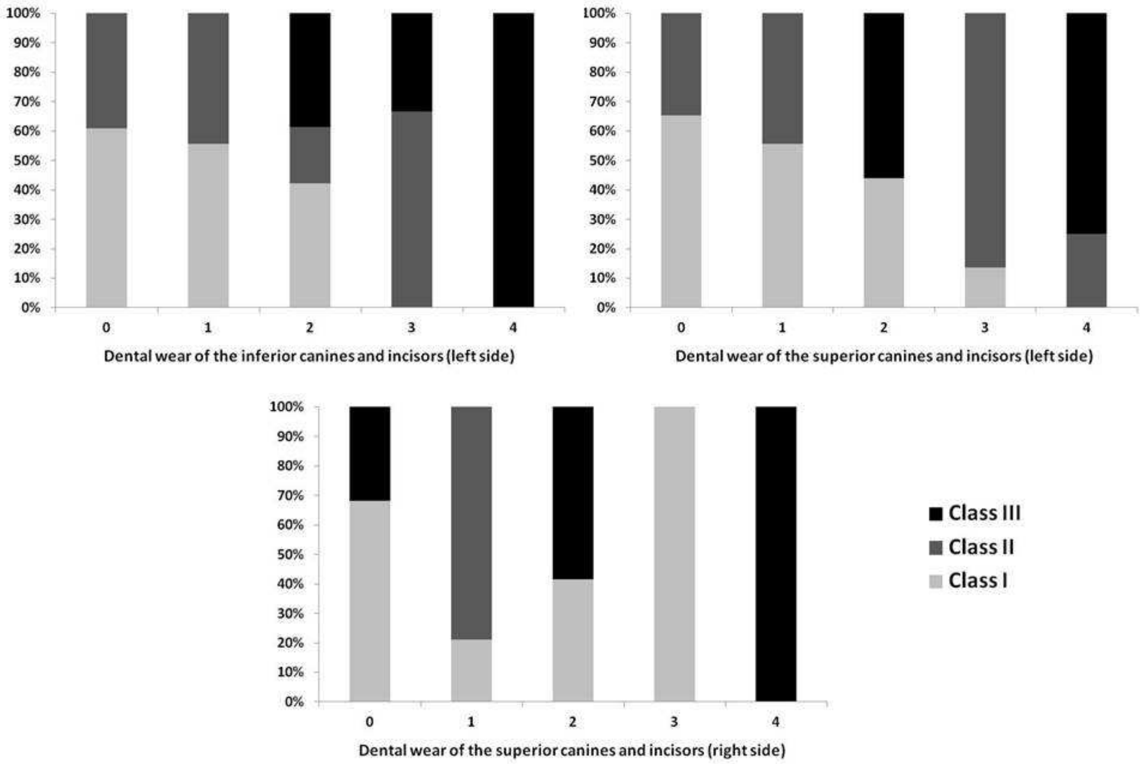
1
2
3
4
Dental wear of the superior left molars and premolars
Dental wear of the superior right molars and premolars
Dental wear of the inferior left molars and premolars
Dental wear of the inferior canines and incisors

Fig. 4.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Dental wear of the inferior canines and incisors (left side)
Dental wear of the superior canines and incisors (left side)
Dental wear of the superior canines and incisors (right side)
Class III
Class II
Class I

Table 1. Sex and age at death of the individuals of Can Reiners site used for dental occlusion analysis

Sex	Young adult	Adult	Mature	Total
Male	3	15	4	22
Female	2	5	0	7
Undetermined	2	0	0	2
Total	7	20	4	31

Table 2. Mean, standard deviation (SD), and median of the tooth wear divided for sextants by age group

Sextant	Age group	Mean	SD	Median
Superior right molars and premolars	Young adult	0.29	0.76	0.00
	Adult	1.70	1.08	1.50
	Mature	2.50	1.00	2.00
Superior canines and incisors	Young adult	0.43	0.79	0.00
	Adult	2.15	1.50	2.00
	Mature	2.75	1.50	3.00
Superior left molars and premolars	Young adult	0.43	0.53	0.00
	Adult	1.45	1.15	1.50
	Mature	2.50	1.00	2.00
Inferior right molars and premolars	Young adult	0.57	0.78	0.00
	Adult	1.90	0.78	1.50
	Mature	2.50	1.00	2.00
Inferior canines and incisors	Young adult	0.43	0.78	0.00
	Adult	1.90	1.02	2.00
	Mature	2.50	1.30	2.50
Inferior left molars and premolars	Young adult	0.71	0.95	0.00
	Adult	1.80	0.95	2.00
	Mature	2.50	1.00	2.00

Table 3. Mean and standard deviation (SD) for transverse and sagittal measurements of Can Reiners compared with ancient and modern samples

	Ancient populations (before XX century)						Modern populations (After XX century)					
	Can Reiners		(Mockers et al. 2004)		(Ingervall et al.1972)		(Ingervall et al.1972)		(Amin et al. 2012)		(Harper 1994)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
UIC	32.1	3.1							34.6*	2.6		
LIC	25.5	2.5	24.6	1.9					26.7*	2.5	25.4	1.9
UIM	47.3	4.0			48.9	3.0	47.4	3.4	44.6*	2.8		
LIM	46.1	2.3			50.8*	3.1	48.8*	2.5	41.2*	3.8		
UL	35.4	2.6			29.1*	2.8	32.4*	2.8	27.8*	3.9		
LL	29.1	3.4			26.0*	1.8	29.9	2.8	23.1*	2.5		

Legend: UIC= upper intercanine, LIC= lower intercanine, UIM= upper intermolar, LIM= lower intermolar, UL= upper length, LL= lower length. Asterisks indicate statistically significant differences with Can Reiners (Student's t-test: $p<0.05$)

Table 4. Distribution of molar relationship (Angle classification) in Can Reiners and other populations

Population	Class I		Class II		Class III		Total
	N	%	N	%	N	%	N
Can Reiners right dental arch	15	62.5	1	4.2	8	33.3	24
Can Reiners left dental arch	16	61.5	5	19.2	5	19.2	26
Gallic/Gallo Roman (Benauwt 1974)	30	57.0	7	13.4	15	28.8	52
Southeast France (medieval) (Guichard *et al.* 2001)	25	43.1	11	18.9	22	38.0	58
Southeast France (present-day) (Guichard *et al.* 2001)	37	45.0	28	34.0	17	21.0	82
Modern Swedes (Seipel 1946)	102	74.15	27	20.10	8	5.75	137

Table 5. Association between canine and molar relationship

			Right canine relationship			Total
			0	1	2	
Right molar relationship	0	N	10	0	0	10
		%	100%	.0%	.0%	100.0%
	2	N	0	2	4	6
		%	.0%	50.0%	50.0%	100.0%
Total		N	10	2	4	16
		%	62.5%	12.5%	25.5%	100.0%

			Left canine relationship			Total
			0	1	2	
Left molar relationship	0	N	11	1	0	12
		%	91.7%	8.3%	.0%	100.0%
	1	N	1	4	0	5
		%	20.0%	80.0%	.0%	100.0%
	2	N	0	0	3	3
		%	.0%	.0%	100.0%	100.0%
Total		N	12	5	3	20
		%	60.0%	25.0%	15.0%	100.0%

Legend: Right and left canine relationship: 0= Class I, 1= Class II, 2= Class III. Right and left molar relationship: 0= Class I, 1= Class II, 2= Class III