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REVIEW

Anthropological Approach of the Proximal Tooth Area: A Systematic Review

Yosra Tabchi, Rajae El Haddaoui, Assmae Bahoum, Fatima Zaoui
Department of Dentofacial Orthopaedics, Consultation and Dental Care Center,
Faculty of dentistry, Mohammed V University, Rabat, Morocco.

ABSTRACT
An analysis of dental anthropological literature dealing with the dental wear of prehistoric men, reveals that little information about interproximal dental attrition and its evolution with the modern man is available. This observation marked anthropologists and dentists for long. The objective of this review is to determine the origin of the interproximal contact region of the tooth. In other words, which interproximal contact was first to appear in human dentitions? Is it the interproximal contact point or the contact surface?
An electronic search was performed in four databases: PUBMED, SCOPUS, Cochrane Database, and EBSCO. Our search was limited to articles in English. We included in our research dental and anthropological studies concerning *Homo sapiens* and excluded all the other species such as *Homo Habilis*, *Homo Erectus*, *Homo Rhudolfensis*, and *Homo Neandertalensis*. Attritional occlusion and flattened proximal facets are considered some of the main characteristics of the masticatory system of nonindustrialized men. Theories and dental researches tried to explain the proliferation of malocclusion and severe tooth crowding in modern society.
The study of dental wear is a path of research that highlights the evolution of the manducatory system and thus, it influences the choice of treatment in our practices.

KEYWORDS: Tooth Wear; Occlusion; Dental Anatomy; Systematic Reviews and Evidence- Based Medicine.

Correspondence: Dr Yosra Tabchi. Department of Dentofacial Orthopaedics, Consultation and Dental Care Center, Faculty of dentistry, Mohammed V University of Rabat, Avenue Allal El Fassi, Mohammed Jazouli Street, Al Irfane -BP 6212, Rabat, Morocco. Email Address: tabchiyosra@gmail.com

INTRODUCTION

The proximal contact between adjacent teeth represents an essential key in maintaining the stability and the balance of the dental arch. It has been defined in 1985, as "the area of proximal contour height on the mesial or distal surface of a tooth that touches its adjacent tooth in the same arch" [1]. Its formation takes place during the supragingival eruption of the tooth. Thus, it is present from the eruption of the crown, even before it enters in occlusion.
Under non-pathological conditions, the proximal contact point is affected over time by the interproximal attrition phenomenon. It occurs mainly as a result of the differential movement of adjacent teeth during mastication [2], transforming the proximal contact point into a flattened surface, joining two adjacent teeth called contact area or surface [3]. The laxity of the periodontal ligament allows these small relative displacements of the tooth, relative to its neighbor and explains the wear that appears on the interproximal dental surface. This wear is compensated by the reaction of the alveolar bone and the cementum which, by affixing/resorption phenomena, maintain contact between the adjacent teeth [4].
Furthermore, interproximal attrition is associated with different factors such as crowding, periodontal disease and angulation of roots.
All of our anatomical and physiological knowledge related to the proximal contact point shown above comes

from the contemporary literature of the 19th and 20th centuries. However, the phenomenon of interproximal attrition is former than that; it is considered as a characteristic of the dentition in prehistoric human populations [5]. Nowadays, it affects much less contemporary industrialized populations than those of the past [6].

In anthropology, the study of dental wear can be a real record of past activities. On one hand, it provides a better understanding of food and habits. On the other hand, anthropologists consider dental wear as a selective force in the evolution of human dentition (by the anatomy, morphology and properties of dental tissue structures) [7,8].

Our aim through this work is to reflect on our previously acquired data, from an anthropological approach and this, to trace the evolution and determine the nature of this interproximal region:

Has the evolution of the contact point to a contact surface existed since ancient geological eras? Or did the notion of the contact point only appear with the modern man? In other words, is the contact surface, whether it is a consequence of interproximal wear or not, a characteristic of the teeth of prehistoric populations?

MATERIALS AND METHODS:

Search strategy : The literature searches involved PUBMED, SCOPUS, Cochrane Database of Systemic Reviews and EBSCO:

In PUBMED, we mainly used keywords found in the Medical Subject Headings (MESH) joined by "and" forming different research equations:

« interproximal » AND « area » AND « tooth » AND « *Homo sapiens* ».

« contact » AND « point » AND « tooth » AND « *Homo sapiens* ».

« contact » AND « surface » AND « tooth » AND « *Homo sapiens* ».

« tooth wear » AND « *Homo sapiens* ».

« tooth attrition » AND « *Homo sapiens* ».

Other combined key terms were used in the following databases SCOPUS, Cochrane Database of Systemic Reviews and EBSCO: the keywords of "anthropology", "*Homo sapiens*" and "tooth description" have been combined respectively with the terms of "contact point", "contact surface", "interproximal wear" and "interproximal attrition". Only articles in English were selected and no date or type of the articles was placed at first. Our search strategy is summarized in Fig.1 using the inclusion and exclusion criteria shown in Table 1.

RESULTS

A total of 397 articles were identified from the database searches, 06 articles met our inclusion criteria and were included in the systematic review.

All the studies consulted have consistently associated the interproximal contact area as a consequence of interproximal wear in prehistoric man, but no study has reported that the evolution of the proximal region started from a contact point.

In contrast, studies on the evolution of the dentitions of ancient and contemporary humans have emphasized a reduction of interproximal wear rate that may have affected our dentitions, leading to the emergence of the proximal contact point in the modern populations.[10-12]

DISCUSSION

Interproximal wear refers to the attrition that occurs between adjacent teeth, transforming the interproximal contact point observed in the young adult dentition to an interproximal wear area [4]. Unlike the occlusal wear that is mainly linked to the forces of mastication and the abrasive content of food consumed, interproximal wear is directly associated with the mechanics of mastication [9,15].

It is the result of an interplay of combined motion: a lateral motion perpendicular to the line between the contact point of adjacent teeth, it results from mastication and a mesial force vector, that produces the tightness of the interproximal contact [4]. The magnitude of the interstitial wear depends on the strength of the mesial force vector [2]. The mesial component of the occlusal force is related to mesial titling of the dental crowns, root angulation, and the direction of jaw movements during mastication [4, 14]. Experimental evidence demonstrates increased mesial tilt during the reapplication of biting force leads to an increase in the mesial component of the occlusal force [16].

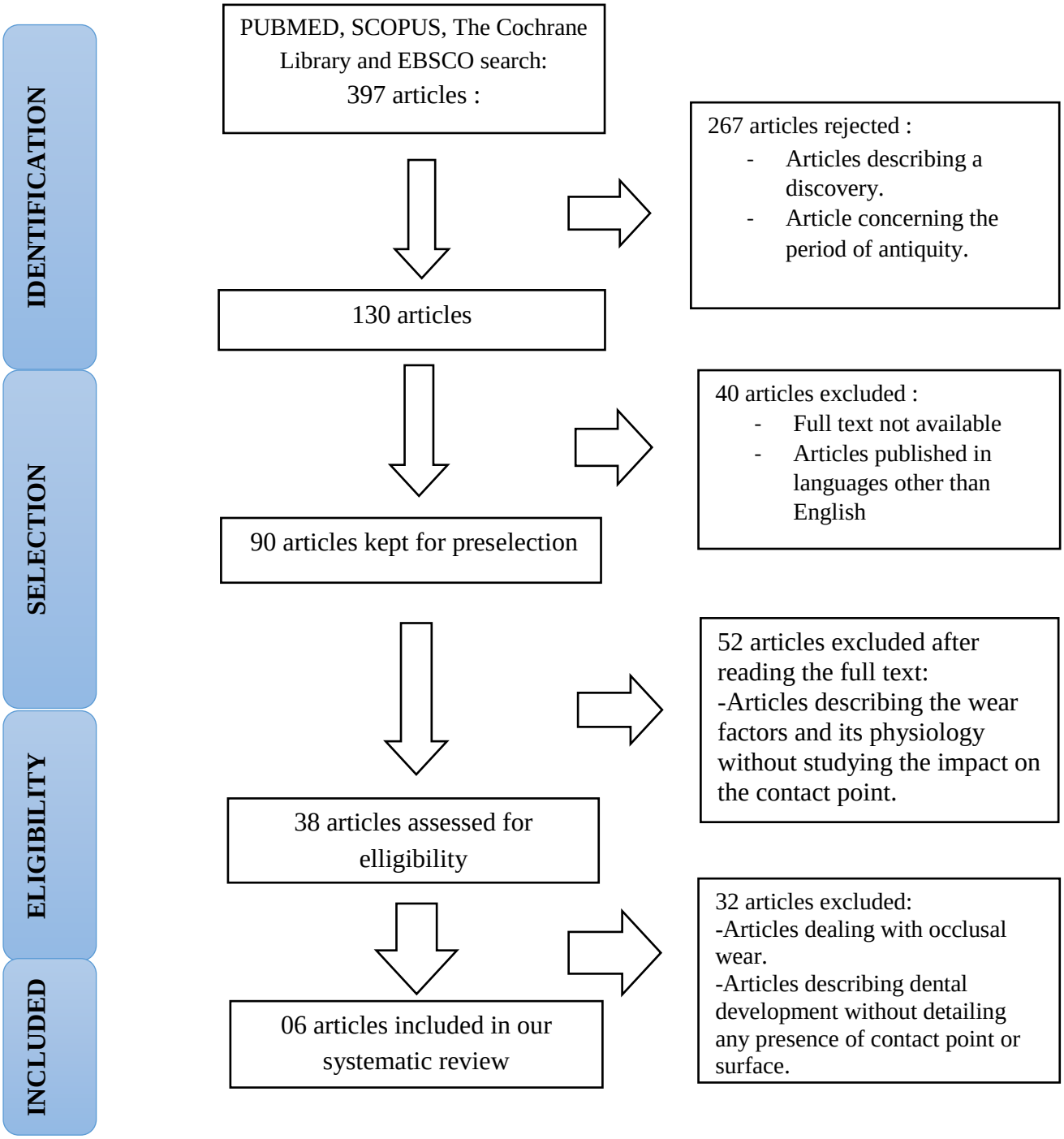
Often the mesial interproximal surface of a tooth wears faster than the distal surface of the adjacent tooth, resulting in the development of mesial concavities. These tend to be more evident in dentitions with advanced wear [4]. In anthropology and archeology, tooth crowns are the most abundant remains in the fossil excavations because of the hardness and resistance of the enamel. As a result, interproximal wear facets are considered a valuable source of information in the study of human evolution as they reflect the magnitude and pattern of the masticatory forces [14, 17, 18].

Although in anthropology, less interest was given to the interproximal contact surface and its evolution, the majority of the articles consulted were mainly concerned with occlusal wear, as it seems more obvious to anthropologists because it reaches most easily observable surfaces. It is usually illustrated by the exposure of the dentinal surfaces at different stages or the alteration of the morphology of the cuspid reliefs.

Proximal contact in *Homo sapiens*:

Indeed, extensive interproximal wear is observed in the dentition of a wide variety of *Homo sapiens* who exhibited advanced proximal contact areas [9, 12, 14]:

In their study on the QESEM Cave teeth (400 000-200 000 years ago), SARIG and al. identified proximal wear facets in seven out of nine permanent teeth, except the third molars and the upper lateral incisor whose distal surface was broken. They calculated the relative wear facet size (RWF ratio) to evaluate the proximal wear facet, they found that the sample of teeth revealed larger wear facets: the RWF ratio for Qesem P4 (distal facet) was 46.74%, implying that the facet occupied almost half of the proximal wall area. [14]



Fg.1: Flowchart of the study selection process.

Table 1: Inclusion and exclusion criteria

Inclusion criteria	- Searches tracing the evolution of the proximal region of the tooth by studying the interproximal wear. - Articles in English. - Studies concerning *Homo sapiens*.
Exclusion criteria	- Searches and articles focusing more on the occlusal wear and its evolution. - Analytical studies measuring the fossil teeth without any detailing of the evolution of this proximal region. - Anthropological articles that describe dental fossils discovered during excavations without any detailing the contact point and its evolution. - Studies concerning species other than those of the *Homo sapiens family: Homo Habilis, Homo Erectus, Homo Rhudolfensis et Homo Neandertalensis.*

TABLE 2: Summary of included articles

	AIM	MATERIALS AND METHODS	RESULTS
Hinton R.J (1982). [9]	Presents data on interproximal and occlusal tooth wear among different human groups.	*The samples included are human skeletal remains representing three major chronological periods in Tennessee Valley prehistory: The Archaic (6000-500 BC[1]), the Woodland (700- 1150 AD[2]) and the Mississipian sample (1300- 1550 AD[2]), *In each individual, breadth of interproximal wear facets were recorded, between the second premolar and first molar and between the first and second molars.	Interproximal wear facets were present in all the dental samples included, with appreciable group differences: the interproximal wear is mainly related to the differences in masticatory forces among these groups, their diet, the root angulation and the temporomandibular joint dimensions.
NeiburgerE.J (2002). [10]	Presents a historic definition of normal occlusion and evidence based-recommendations established by our evolutionary history.	*Analysis of several evolutionary theories and dental research to explain the evolution of man's occlusion. *Comparing the occlusions of prehistoric and modern man.	In ancient times, the earliest Homo had a flat occlusion, with worn nearly flat interproximal tooth surfaces. Tooth crowding was rare, the interproximal contact "point" was quickly worn down. Returning patients to a modified flat occlusion should be considered to decrease traumatic occlusion, third molar impactions and orthodontic crowding observed nowadays.
Kaifu Y. and al.(2003). [11]	Highlight the significance of the concept of "attritional occlusion" in the permanent dentition	Synthesis of the available literature and the contribution of BEGG's theory to explain the changes in human dentition and occlusion from an evolutionary perspective.	Attritional occlusion displayed, in the dentitions of prehistoric humans is considered as a product of evolutionary adaptation, characterized by compensatory mechanisms: mesial drift, continuous eruption and lingual tipping of the anterior teeth. The reduction in tooth wear is preventing contemporary people from accomplishing attritional occlusion. However, it fails to explain the increase of malocclusion in modern times.
Rose J.C and Roblee R.D (2009). [12]	A better understanding of the causes for the increase of dental crowding and malocclusions in modern society, and its support for the development of orthodontic therapies.	Analysis of dental data from the Amarna Project excavations (1353 BC-1333 BC[1]) located in the Egyptian desert along the Nile River.	Most modern malocclusions are caused by a disparity between jaw size and total tooth-arch length. Such malocclusions are rare in the Amarna sample mainly due to interstitial wear. The alveolar bone deficiency could be considered as a leading cause of dental crowding and malocclusion.
Kaidonis J.A and coll. (2014). [13]	Display the aspects of dental occlusion and the continual physiological changes occurring over time.	Analysis of dental and physical anthropological literature to clarify the changes in the occlusion and dental anatomy of human populations.	The modern human populations living in industrialized environments display unworn dental occlusions that can be considered to be 'neotenous'; that is, only seen in infants, juveniles and young adults. Interproximal wear is obvious in worn dentitions of Paleolithic populations, it does also exist in contemporary populations, but it often goes unnoticed.
Sarig R.and coll. (2016). [14]	Analysis of the various types of dental wear patterns of the Middle - Lower Paleolithic Qesem Cave teeth (400 000- 200 000 years ago).	*Excavation at the Qesem cave delivered 13 human teeth (4 deciduous and 9 permanent). *Proximal surfaces were examined using a binocular microscope; wear facet size, proximal wall area and the relative wear facet size (RWF) were measured.	Proximal facets could be identified in seven out of nine permanent teeth from Qesem Cave. Evaluation of the RWF in the Qesem sample revealed larger wear facets and a considerably severe proximal wear when compared to modern teeth with a similar stage of occlusal wear.

In another study, HINTON focused more on the extensive variation in the amount of the interproximal wear between populations, where he took human skeletal remains for three different chronological periods: The Archaic (6000-500 BC[1]), the Woodland (700-1150 AD[2]) and the Mississipian sample (1300-1550 AD[2]), to encompass the transition from a hunting lifestyle to primary dependence on agriculture. He found that the interproximal wear facets were larger in human groups whose mode of subsistence was focused on hunting and gathering. Therefore, the Archaic sample displays a significantly greater amount of interproximal wear than do the Woodland and Mississipian samples at the same levels of occlusal wear. [9]

These results shown above are consistent with some anthropological investigations found in the literature, where the interdental contact surfaces are a characteristic of the prehistoric man:

WOLPOFF M.H and al. evaluated the interproximal wear of human teeth belonging to the Upper Paleolithic period (59 000-40 000 BP[3]) found in VINDIJA cave in YUGOSLAVIA. All the teeth studied displayed interproximal contact surfaces of different dimensions, where the largest interproximal wear facet was found in the molars. [19]

The evolution of the interproximal contact region:

The human dental and masticatory system is considered a dynamic unit as it is routinely exposed over time to different factors that resulted in many adaptive processes. Therefore, interproximal contacts between adjacent teeth should not be considered a static condition but rather a dynamic process that anthropologists consider quite physiological. [20]

It is well-known that the severity of wear was reduced after the Agricultural revolution, accompanied by the development of technology and industry. This finding has been highlighted in several articles:

KAIFU Y. and al. in his articles mentioned that interproximal wear was very severe in the dentitions of prehistoric humans compared with contemporary populations. The dentitions of prehistoric hunter-gatherers are characterized by an extensive interproximal wear compared to the early agriculturists [6, 11]. This observation is in accordance with HINTON's work when he compared the dentition of the Archaic and the Mississipian sample [9] and SARIG and al.'s paper when they compared the RWF ratio of the Qesem sample with the RWF of the modern man [14]. Meanwhile, KAIDONIS and al. in his work added that interproximal wear reduces, from Paleolithic populations whom interproximal surfaces were very obvious to nowadays, where it often goes unnoticed [13].

To resume, all this research shown above agreed, that there is a reduction of interproximal wear rate from prehistoric man characterized by interproximal contact facet to modern man. However, among these studies, none has mentioned, the term "contact point", as a characteristic of modern man.

Within the framework of the evolution of human occlusion, NEIBURGER highlighted the dynamic changes in the proximal contact region. He stated that human teeth erupted into a cuspal occlusion, where we would find pointed interproximal contacts of teeth, and quickly these contacts were worn into flat plane occlusion; where the interproximal areas are so worn, that teeth contact each other on a broad surface area. He also added that today, in industrialized societies, we are witnessing the return of the cuspal occlusion mainly due to the lack of wear [10].

Reduction in interproximal wear and malocclusion:

The major effect of interproximal wear is to shorten the mesiodistal length of each affected tooth. Simultaneous mesial drift maintains the interproximal contacts, thereby reducing the arch length. This reduction in tooth size, which often amounts to 1-1.5cm per arch, provide added arch space for the eruption of most third molars, reducing the incidence of impactions [5, 8, 21].

Extensive interproximal wear and reduction in dental arch length are observed in the dentitions of a wide variety of *Homo species* [4]. Compared to the dentitions of modern humans, characterized by a reduction or absence of interproximal wear, we note an increase in the frequency of dental crowding and malocclusion. [10, 11, 12].

ROSE and ROBLEE in their archaeological dig found that the AMARNA mandible and maxilla remains (1353-1333 BC[1]), displays no malocclusion but a very extensive tooth wear with a well-aligned teeth [12].

Orthodontic textbooks attribute malocclusion to specific causes, such as growth disturbances, developmental anomalies, genetic influences, and behaviors (thumb sucking and tongue thrusting).

To understand the causes of malocclusion, NEIBURGER in his research, stated that tooth crowding is rare in worn plane occlusion, mainly due to the wear of the unstable "contact point" seen in cuspal occlusion. He also added that in modern's man occlusion, the rounded interproximal contacts contribute to tooth slippage, leading to crowding and tooth misalignments. [10]

This statement is consistent with BEGG's work on the concept of "attritional occlusion". Edward Angle's idea that malocclusion was a disease of modern society was exploited by BEGG. He studied the teeth and jaws of modern and prehistoric Native Australians. He found that interproximal wear enables all the teeth to fit within the jaw. BEGG's theory has provided one of the supporting arguments for why premolars may be extracted for orthodontic reasons in modern populations. He then concluded that «without interproximal wear, individuals with a preponderance of tooth substance over bone substance would develop malocclusion, while people with attrition would not». BEGG regarded attritional occlusion as the "anatomically and functionally correct occlusion" of humans and "non-attritional occlusion" as an erroneous concept. [5, 12]

In contrast, CORRUCINI in his study labeled malocclusion as a disease of civilization. He indicated that reduction in interproximal wear was not the primary cause of severe malocclusion, but rather the reduced chewing stress in childhood produced jaws that were too small for the teeth. In other words, the jaws did not develop to a sufficient size to hold all the teeth and thus

malocclusion became common [23]. This research is consistent with ROSE and ROBLEE's work, stating that the cause of dental crowding and malocclusion is mainly related to alveolar bone discrepancies [12].

While according to KAIFU, the interproximal wear does not explain every change between ancient and contemporary human dentitions, it's a completely dynamic system that evolves [11].

Many articles proposed treatment model for contemporary dentistry to enlarge the interproximal interface: BEGG and KESLING proposed the use of chewing gum containing carborundum dust to simulate prehistoric wear [3]. Nowadays, interproximal reduction (stripping) techniques were introduced to correct arch length deficiency by establishing large interproximal wear facets [24].

Interproximal wear and exogenous factors:

With the advent of farming and agriculture, the physical anthropological literature records variation in human dentition, in particular reduction in the size of teeth and dental arches. This variation reflects human adaptations to its environment [13].

HINTON ROBERT J states that the study of interproximal wear provides insight into the masticatory function and food preparation. He concluded that the difference in the interproximal wear facet is primarily related to food preparation, which was minimal to non-existent in the Archaic sample and become indispensable in the Woodland and Mississippi. This method of preparation made most foods soft. Besides, the Archaic sample characterized by their greatest interproximal wear facet showed the largest dimensions of the temporomandibular joints mainly due to the high masticatory forces [9].

Also, SARIG R. and coll. claim that the proximal attrition is mainly associated with mastication, the forces exerted by the posterior teeth and angulation of the dental roots. They add that that interproximal attrition is indirectly related to the consistency of food because there is no direct contact between the food and the interproximal area of the tooth. Rather, the intensity of the forces exerted on the food, depending on its consistency, will determine the amount of interproximal attrition [14].

As explained earlier, the refinement of food over the last few centuries appears to have contributed to a decrease in the intensity of interproximal wear. The earliest *Homo species* had to chew their food much longer and with more masticatory forces. The low nutritional value of their subsistence required them to eat greater quantities than today, which means prolonged chewing. [3, 4].

CONCLUSION

The anthropological approach of interproximal wear introduces a broader view of the evolution of occlusion in human populations, allowing us to question some of our current dental concepts.

Interproximal wear is commonly an age-related process, the size and the distribution of interproximal contact surfaces varies within and between past and present human populations, for a variety of reasons related to changes in eating habits, lifestyle and environment.

According to our systematic review, prehistoric man had a more pronounced phenomenon of interproximal wear, which explains the presence of larger interproximal contact surfaces compared to modern man, whose interproximal wear is minimal or even absent.

Although reduction of wear may have affected our dentitions in many ways as discussed above, anthropologists believe that the increase in dental crowding and malocclusion occurred with the transition from a primitive to a modern diet and lifestyle.

From an evolutionary perspective, in contemporary dentistry the use of interproximal reduction techniques such as stripping allows us to enlarge the proximal "contact point" and reproduce proximal contact surfaces, that could be considered as a treatment alternative in some cases, to correct arch length deficiency in orthodontics.

The available evidence is still insufficient to draw an indisputable picture of the nature of the proximal region of prehistoric man and its evolution in modern man. Further studies must be done to provide well-founded conclusions.

ABBREVIATIONS

BC[1]: Before Christ

AD[2]: Anno Domini (the year Christ was born) [25].

BP[3]: Before present [26]

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The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript and provided approval for this final revised version.

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