Original article

Malocclusions in Xia Dynasty in China

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Keywords: *malocclusion; Xia Dynasty skulls; tooth crowding; diastema; individual tooth malposition*

Background The prevalence of malocclusion in modern population is higher than that in the excavated samples from the ancient times. Presently, the prevalence of juvenile malocclusion in the early stage of permanent teeth is as high as 72.92% in China. This study aimed to observe and evaluate the prevalence and severity of malocclusions in a sample of Xia Dynasty in China, and to compare these findings with the modern Chinese population.

Methods The material consisted of 38 male and 18 female protohistoric skulls of Xia Dynasty 4000 years ago. Of 86 dental arches, 29 cases had the jaw relationships. Tooth crowding, diastema, individual tooth malposition and malocclusion were studied.

Results Of the samples, 23.3% showed tooth alignment problems including crowding (8.1%), diastema (9.3%), and individual tooth malposition (5.8%). The prevalence of malocclusion was 27.6%, mainly presented as Angle Class I.

Conclusions It is indicated that over thousands of years from Neolithic Age (6000–7000 years ago) to Xia Dynasty (4000 years ago), the prevalence of malocclusion did not change significantly. The prevalence of malocclusion of Xia Dynasty samples was much lower than that of modern population.

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Malocclusion is defined as any deviation from the normal or ideal relationship of the maxillary and mandibular teeth, as they are brought into functional contact. The prevalence of malocclusion in modern population is about 40%–80%.[1] In China, malocclusion incidence was 67% among Chinese children, which increased from 40% to 67% in the last 40 years.[2] Malocclusion is one of the most common dental diseases in modern society. And emerging and prevailing of such disease has very closely related with the evolution and development of human beings.[3]

Although malocclusion now generally occurs in large portions of the population, this was not always the case. Malocclusions were rare during the Paleolithic period. An increase in malocclusion has been reported since medieval times, after relatively modest changes for 6000 years.[4] Malocclusion incidence seems to have accelerated in modern industrialized societies during the last century. Theories proposed to explain the cause of malocclusion vary widely, embracing concepts such as evolution, heredity and environmental factors.[5]

Studies of occlusion and malocclusion in protohistoric remains not only offer valuable information for ascertaining the roles of distinct environmental and genetic factors in the aetiology of malocclusion but also help in orthodontic treatment planning. In ancient Chinese materials, occlusion and malocclusion on Neolithic skeletal samples excavated in Chinese (6000–7000 years ago) has been investigated, yet no report on malocclusion of Xia Dynasty's skulls (4000 years ago) has been presented.[6]

This study aimed to describe the tooth crowding, diastema, individual tooth malposition and malocclusion of skull samples of Xia Dynasty excavated in Er-li-tou site in Henan Province and You-yao site in Shanxi province, China, and to compare these findings with our previous studies of various historical periods.

METHODS

Some of the materials which were used in the present study were collected at Er-li-tou site located in Henan province, China, by the Institute of Archeology of Chinese Academy of Social Sciences; and some were jointly excavated at You-yao site Shanxi Province, China, by the Research Center of Frontier Archaeology of Jilin University and Archaeology Institute of Shanxi Province, China. All the skull samples from both sites were scientifically identified by radiocarbon dating technology, which were basically dated about 4000 years ago.

The inclusion criteria of the samples were as follows. The samples must have adequate structural preservation so that every measurement could be performed satisfactorily.

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The jaws must match to the skulls properly, the teeth have to cling to alveolar sockets, or the shedding teeth after death should be accurately reset, at least 2/3 teeth remained in the dental arch. Sex and age were determined using the method described previously by Ferembach et al[7] and by the cranial sutures and/or eruption status, tooth form and attrition patterns.[8] A total of 56 skeletal samples excavated in two sites were collected. Among them, 38 were males, and 18 were females, including 894 teeth, 86 dental arch.

The tooth alignment and occlusion were diagnosed as tooth crowding, diastema, individual tooth malposition and malocclusion.

Tooth crowding

Tooth crowding was diagnosed by space analysis using the method described by Proffit.[9] Briefly, space available was measured with a divider dividing the dental arch into 4 straight line segments and summing the length of 4 segments; space required was the sum of the mesiodistal widths of all individual teeth, measured from contact point to contact point. If space required is more than space available, it is tooth crowding.

Diastema

If the amount of space available for the alignment of the teeth is more than the amount of space required to align them properly, space appears due to space excess, which is diastema.

Individual tooth malposition

If space available is equal to space required, but one tooth or some teeth are aligned out of the normal arch line, it was diagnosed as individual tooth malposition.[9]

Malocclusion

The criteria of sample selection for the study of occlusal relation are as follows: the same individual who has the entire or almost entire tooth alignment, upper dental arch matching to its lower arch, and clear molar-biting relationships. Twenty-nine samples with upper and lower jaws which presented interarch relationship were finally selected. Angle classification was used to determine the occlusal relation. Based on the relationship between maxillary first molar and mandibular first molar, we classified the relation into neutral occlusion (Angle Class I), distocclusion (Angle Class II) and mesiocclusion (Angle Class III). Cephalometric roentgenogram for the skulls were taken and analyzed by computerized cephalometric analysis.

RESULTS

Tooth alignments

The findings concerning crowding, diastema and individual tooth maloposition are summarized in Table 1. Among 86 maxillary and mandibular dental arches, 66 were normally aligned (76.7%) (Figure 1A), while 20 were abnormally aligned (23.3%). Of 20 abnormal alignments, crowding (Figure 1B) accounted for 8.1%, dental diastema (Figure 1C) accounted for 9.3% and individual tooth malposition (Figure 1D) accounted for 5.8% (Figure 1).

Table 1. Tooth alignments (*n*, examined from single dental arch) of the skull samples from Xia Dynasty in China

Dental arch	Normal	Abnormal		
		Crowding	Diastema	Tooth individual malposition
Maxillary (*n*=53)	39	3	7	4
Mandibular (*n*=33)	27	4	1	1
Total (*n*=86)	66	7	8	5

Occlusal relation

Among the 29 skull samples from Xia Dynasty in China, occlusal relation (examined from interarch relationship) was as follows: normal, 21 (72.4%); malocclusion angle I, 4 (13.8%); malocclusion angle II, 2 (6.9%), and malocclusion angle III, 2 (6.9%). The prevalence of malocclusion in the skulls of Xia Dynasty was 27.6%. There were 2 cases of Angle Class I malocclusion (Figure 2A, 2B), 1 case of Angle Class II malocclusion division 2 with anterior deep bite (Figure 2C, 2D), and 1 case of

Figure 1. Tooth alignment of the skull samples from Xia Dynasty in China. **1A:** Normal alignment. **1B:** Tooth crowding. **1C:** Diastema. **1D:** Individual tooth malposition.

Figure 2. Malocclusion of the skull samples from Xia Dynasty in China. **2A, 2C, 2E:** Right side. **2B, 2D, 2F:** Left side. **2A, 2B:** Angle Class I malocclusion. **2C, 2D:** Angle Class II division 2 malocclusion with anterior deep bite. **2E, 2F:** Angle Class III malocclusion with the whole arch in cross bite.

Angle Class III malocclusion with the whole arch in cross bite recognized as skeletal Class III (Figure 2E, 2F) which was confirmed by cephalogram.

DISCUSSION

Human beings have experienced evolutional history for millions of years. In the late Paleolithic age dated from 18 000 years ago, malocclusions were first discovered so far from the fossils of Shandingdong man by Jia.[10] The original report writes: "a supernumary tooth between upper right central incisor and lateral incisor causes a relatively big diastema and makes the central incisor stick out". Zeng et al[6] studied the Neolithic skull samples excavated in Baoji-Huaxian site dated 6000–7000 years ago and found that the prevalence of malocclusion calculated by individual sample was 26.30%. Our research focused on skulls of Xia Dynasty dated 4000 years ago and the prevalence of malocclusion at that time was 27.6%. Mao and Yan[11] studied the skulls of Anyang-Yixu dated more than 3000 years ago, and found its prevalence of malocclusion was 28%. And Zhang[12] reported that the prevalence of malocclusion of skulls in Weijin 16 States Age excavated in Liaoning-Beipiao-Lama Cave (dated 1500 years ago) was 42.53%. Among modern population, malocclusion is one of the three most common dental diseases, and the report by Fu et al[2] in 2001 showed that the prevalence of child and juvenile malocclusions at the early stage of permanent teeth in China was 72.92%. Therefore, with the evolution of human beings from millions of years ago, malocclusion emerges from none and grows up from less and mild to more and serious.

In the whole evolutional process from Homo erectus to Man, human beings were gradually transited from crawling to erectly walking and from original "big jaw but small head" to unique cranial-facial shape of "small jaw but big head". Such human species background illustrates that malocclusion specially appears in humans but rarely appears in Pithecanthropes and other mammals.

When entering into the human society, tools and fire made the food much easier to be chewed, that largely reduced the burden on masticatory system. Compared with ancient people, modern humans have underdeveloped jaws, the influence of masticatory stimulation on skeletal structure and its shape has been affirmed.[12] People living in aboriginal conditions (such as Eskimos) often had strong masticatory functions, and most of them had healthy and orderly tooth alignments with the clear proximal and occlusal wears, strong alveolar bones and well-developed jawbones.[13,14] Obviously, if reduction in jaw size is not well matched to the opposite jaw and to the decrease in tooth sizes and numbers, greater prevalence of the commonly existed tooth crowding and mal-alignments among modern people is inevitable.[15]

About 7000 years ago, human beings entered into the Neolithic Age and began to transit their living style from hunting and collecting to residential agricultural life. The ingredients of carbohydrate in diet were increasing and the dental diseases experienced a first rapid bursting in human society. The prevalence of malocclusion then was 26.3%.[6] Comparing with 26.3% in Neolithic Age and 28% in Shang Dynasty, the prevalence of malocclusion in samples from Xia Dynasty shown as 27.6% in our study demonstrated no significant difference. That indicates that over thousands of years from Neolithic Age to Shang Dynasty, people had been living in agricultural-economic society and their lifestyle and diet did not have the qualitative changes, so that the incidence of malocclusion did not change much. Moreover, with the beginning of industrial revolution, the finer food and more sugar used in diet caused a great increase of dental caries, distinct reduction of dental wears and further weakness of masticatory tissues, thus led to a second leap of malocclusion in the human society. In China's modern society, the prevalence of juvenile malocclusion in early permanent dentition is highly as 72.92%.[2]

It is believed that evolutional decrease of jaw size and reduction of tooth wear are the two factors which lead to increase of malocclusion in modern society. Decrease of jaw size causes reduction of space available, while less tooth wear including that on interproximal surfaces results in increase of space required, which make crowding to be much more popular nowadays than that in prehistoric times. Interestingly, Mockers et al[16] investigated dental crowding from the Copper Age (about 2000 B.C.) in France and found different results. They found that all of the mandibles presented incisor crowding with a majority of minimal and moderate irregularities, but in seven cases there were extreme irregularities and two canine impactions were observed. Mockers et al's[16] samples came from the same era as the samples in our study, but from different geographic area and race. In our study, the incidence of crowding was 8.14%. The etiology of malocclusion involves genetic and environmental factors. The conflict findings suggested that crowding may be of a genetic origin besides the jaw and tooth size changes caused by environmental factors (masticatory activity) only. And racial difference can not be excluded.

Although Angle Class I was the most common malocclusion in protohistoric population, we found one typical Angle Class II division 2 case and one typical skeletal Class III case in the skull samples of Xia Dynasty in China. According to the previous discussion, the era of Xia Dynasty is on the way of evolution, if reduction in jaw size is not well matched to the opposite jaw, malocclusion of Class II or Class III problem happens.

The study indicated that over thousands of years from Neolithic Age (6000–7000 years ago) to Xia Dynasty (4000 years ago), the prevalence of malocclusion did not

change significantly. The prevalence of malocclusion of Xia samples was much lower than that of modern population.

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