

Dental conditions of Egyptian heads: radiological and direct examination

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Abstract

A study was carried out the dental conditions of 72 mummified heads of ancient Egypt preserved by the Department of Anthropological Sciences of the University of Turin.

From the research, made by means of radiological exams, it emerged that young people have excellent dental arches, while people of over 30 years of age show poor dental conditions in that they suffered from caries, abscesses and apical osteolysis caused by the complications of occlusal wear.

Such considerable wear is attributed to hard food, often polluted by abrasive particles, and to the long time needed for daily chewing. The hypothesis of extended chewing is also supported by the wear of the interproximal contacts and by the remodelling of the mandibular condyles.

Introduction

The aim of this research is to study, by means of direct examination and X-rays, the main defects in the dental arches of an ancient population.

It is known that the incidence of caries, periodontal disease and occlusal wear differs in accordance with variations of environment and diet. The non-refined and low-calory food consumed by ancient populations required lengthy mastication which in time wore away the dental crowns. Thus penetrant wear is the most frequent oral pathology in these populations.

Material and methods

The 72 heads examined are part of a huge anthropological collection known as "G. Marro", preserved in the Museum of Anthropology of the University of Turin. The complete osteological collection consists of about a 650 complete

skeletons, 1300 heads, 20 complete mummies and 72 mummified heads, the latter being the subject of this study. The material comes from several excavations made by Ernesto Schiaparelli between 1903 and 1912 at the dynastic necropolis of Asyut and Gebelein.

The major part of the collection, though retaining traces of embalming is now devoid of bands, and has been the subject of several paleopathological and bio-anthropological studies. The complete mummies and part of the 72 mummified heads, inaccessible to direct examination because they are still fully covered in bands, need to be handled with great care and have only recently been subjected to radiological and tomographical examination.

Because of their practices related to the cult of the dead and the preservation of corpses, the ancient Egyptians are paradigmatic in the study of dental and bone anatomy and paleopathology (Brothwell, 1963), since the embalming process fixed even the minutes details. Furthermore, they were a people whose way of life and eating habits were homogeneous, and who lived in an era in which migration and genetic interference was modest.

Of the 72 mummified heads which are the subject of this study, 39 are still fully banded and were subjected to X-ray examination, 5 lacked both maxillae and were thus excluded from the study, while 28 heads with maxillae not covered by bands were examined directly and the observations recorded in files. Records were made of the number of teeth still present, teeth lost *infra vitam*, teeth lost *post mortem*, anomalies in the number or the position, caries, periapical osteolysis, periodontal bone lesions and occlusal wear.

The samples examined are thought to have come from high-ranking families or, in any event, families that were willing to pay for a thorough embalming rite: Herodotus describes different embalming methods in relation to the price families were willing to pay. This is demonstrated by the abundance of bands, the fine linen impregnated with essences, often smoothly finished and modelled with wax and resins, the heavy impregnation of dentin and bone, the presence of gold on the facial mask, the presence of jewels, an abundance of bitumen, the filling of cavities, nostrils and orbits with resin-soaked linen to prevent the nose and eyelids from becoming sunken, and the preservation of hair (Rabino Massa, 1976).

Both sexes are equally represented. As far as age is concerned, the individuals have been divided into five groups according to a criterion designed to derive specific information.

- 4 infants aged 6, 8, 11 and 12 respectively;
- 6 individuals aged 16 to 20;
- 16 individuals aged 20 to 30;
- 24 individuals aged 30 to 40;
- 17 individuals over 40 years of age.

The equipment used for the X-ray examinations was an analogic Siemens Orthopantomograph 5 and X-omat Kodac dental films developed in accordance with the manufacturer's instructions.

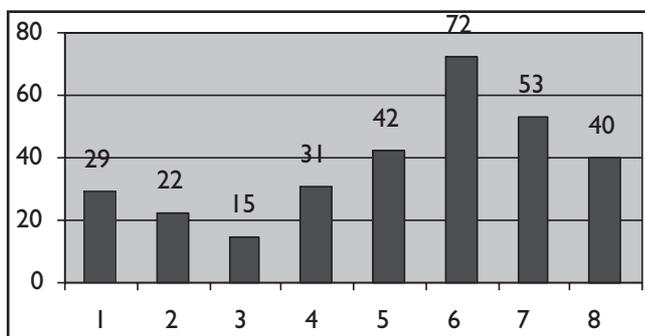
Results and discussion

The teeth still present are 1379, those lost *infra vitam* 294 (Tab. 1). The total number of teeth that one would expect to find on examining 67 individuals has to be reduced in consideration of the absence of ten jaws and one half jaw with part of the maxilla, ageneses of third molars and the *post mortem* loss of 199 teeth. The teeth lost *post mortem*, generally incisors and monoradiculars can be easily identified by the presence of deep empty sockets with clean edges devoid of marginal or apical lesions.

Position anomalies and dental-alveolar discrepancies Young individuals have complete dental arches, with aligned teeth and no remarkable anomalies. Primary teeth are undamaged by caries and hold the place for permanent teeth. Vigorous mastication has resulted in the maxillae developing to the dimensions required to easily accommodate the third molar. Therefore, near-perfect arches are common in young people and adults up to the age of thirty.

Position anomalies concern only the lower front teeth and are all of a slight degree. Eight cases of slight crowding were found: in two cases malposition concerned a single tooth.

The most unfortunate individual of the group is "M42", 25



Tab. 1 - Molars, especially the first ones, are the first which are lost *infra vitam*.

years of age, because of a slight crowding of the lower front teeth, due to the persistence of the third upper-left primary tooth and the mesial migration of the third lower-right molar with slight interdicular bone resorption. The individual's upper incisors were broken *post mortem*.

However, the turbinates and the ethmoid bone are undamaged.

Anomalies in number

The most frequent anomaly encountered is third molar agenesis. In recording ageneses, only complete dental arches of young individuals were considered, in order to exclude remote tooth loss with successive reossification of the socket. The absence of occlusal wear in the antagonist tooth was also helpful in the diagnosis. It was possible to conclude with certainty that in twelve individuals there was a congenital absence of twenty third molars, which in percentage terms comes to 18% of the heads examined. This incidence is surprisingly high if we consider that in present-day day populations, according to the estimates of several Authors, it is between 12% and 17%.

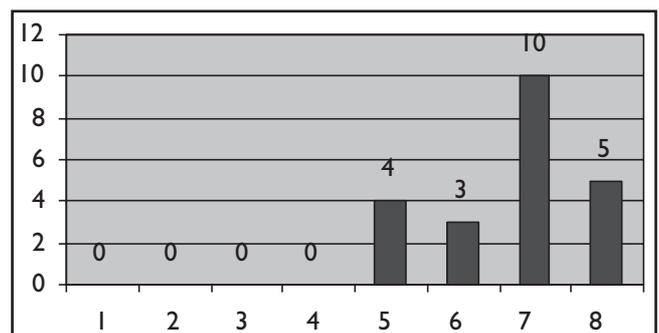
Six heads lack one molar, five lack two molars and one individual alone, identified as "Medio Regno B", lacks three molars.

In "M18", aged 12, there is agenesis of a third molar (28) and three premolars (15, 25, 35), although for the latter there remains some difficulty in interpretation.

In "M56", aged 18, agenesis of the lateral incisor is uncertain due to the presence of a palatal crack that may be interpreted as a residual of the alveolar cavity of a primary or permanent tooth.

Caries

In the 1379 teeth 49 caries were found, of which 22 are non-penetrant (Tab. 2), and 27 are penetrant. This amounts to 3,6%, in keeping with typical frequencies in ancient populations. Nevertheless it is a slightly higher percentage than that found in coeval Egyptian people of a lower rank, in which incidence of caries is between 2,7 and 3,4%. This increase is no doubt due to the more refined diet of the upper classes, or to a diet richer in honey, dates and raisins. In almost all cases, the caries started in the interproximal radicular part of the tooth, below the anatomical neck of the tooth. This is a common site of caries resulting from the depositing of food aided by fractures of the enamel edge made thin by occlusal wear or by the diasthema which occurs when the wear goes above the equatorial line of the tooth. Clearly, occlusal caries (Black class I), though



Tab.2 - 22 penetrant caries only interests posterior teeth.

possible, usually did not have time to develop since they were soon removed and polished by occlusal wear.

Occlusal wear

In the ancient Egyptians, as in all ancient populations, caries and periodontal disease usually occurred less often; on the other hand occlusal wear was the main cause of pain and dental loss (Puech et al, 1983).

The dental arches of 11-year-old and 20-year-old individuals provide the opportunity to evaluate the speed

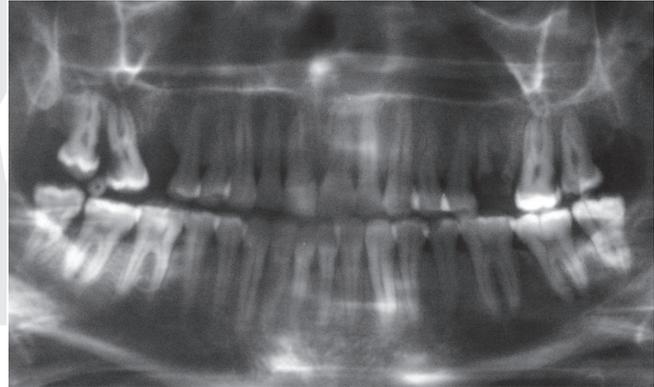
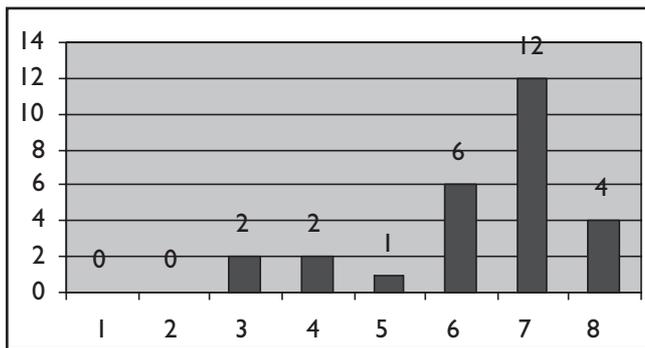


Fig. 1 - Head M6 911: young subject between aged 25 to 30. Aligned teeth. Penetrant caries at the distal neck of 17 and 27. Residual root of 26. There are 4 third molars.

The unknown object, circular and with a central hole, situated between the right upper molars, could be first molar palatal root, lost post mortem, whose socket seems empty.

Moderate occlusal wear, well represented on the first molars. Good periodontal conditions. Ethmoid and turbinates destroyed.

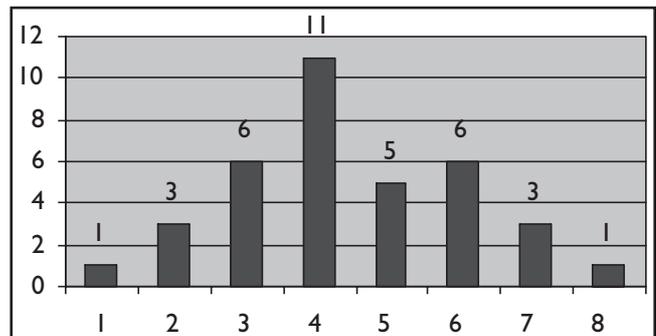


Tab.3 - 27 teeth show penetrant caries.

of occlusal wear. For that purpose, measurements were taken of the vertical reduction of certain key teeth of which we can estimate with reasonable accuracy the period of permanence in the oral cavity. For instance, the second primary molar erupts in the last quarter of the second year and falls physiologically at the age of 11. Therefore it is has been subjected to stress for nine years. The first permanent molar, which erupts at 6 years of age, will have chewed for fourteen years by the time of the eruption of the third molar (Wheeler, 1974). This criterion, already used in a previous study carried out on 381 Egyptians, made it possible to calculate a vertical loss of 1 mm every five years (Peluso, 1980).

If the progression of the occlusal wear is relatively slow, the pulp has time to recede and lay down a new layer of dentin. In fact, it is common to find roots devoid of crowns but with radicular channels perfectly sealed by a thin layer of newly-formed dentin of about 1 mm in thickness (Fig. 1). In some less favourable cases, the penetration of bacteria within the pulp chamber starts from the fifth mm of wear. Probably in these cases the speed of wear has been higher than the formation of new dentin, or hard food has created cracks in newly-formed dentin generated rapidly by a pulp with undermined defensive capacity. A total of 34 cases of penetrant wear were found (Tab. 4); the first teeth to be lost are usually the first molars as a result of higher temporal and mechanical stress, then the first premolars, the second premolars and the lateral superior incisors (Molnar, 1972).

The roots of the teeth affected by penetrant wear are still used for chewing and can be recognised by the clean central hole surrounded by a perfectly polished surface. In the individuals examined radiologically, they are



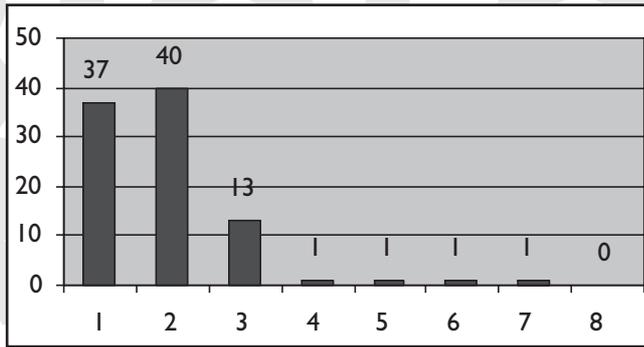
Tab.4 - 34 teeth show apical lesions due to penetrant wear.

distinguished by the absence of caries in roots surrounded by a bone resorption area.

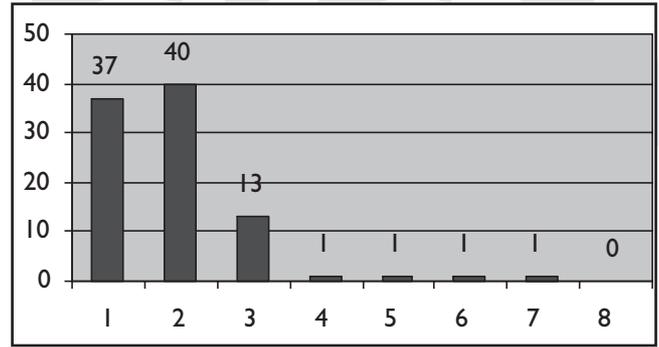
Periapical osteolysis

Radiological and direct examination came up with about sixty apical and periapical lesions of inflammatory origin around the roots of teeth affected by penetrant caries (27 teeth) and penetrant wear (34 teeth), as well as forty osteolytic areas corresponding to recent root loss. The teeth most affected are the first molar, followed by the second, the first premolar, the second and the third molar (Tab. 5).

The lesions detected by X-ray examination range from initial demineralisation to a marked decalcification characterised by an irregular supportive structure, right up to the formation of large osteolytic areas, especially where there are several abscesses in the same arch (Thoma et al, 1960). Direct observation of craniums showed that all the apical osteolyses communicate spontaneously with the oral cavity through an oval opening in the thin buccal wall. In the case of upper molars, the communication may even be palatal, in correspondence to the roots of the same.



Tab.5 - 99 apical lesions with bone resorption are found in correspondence with infected teeth or recent root loss.



Tab.6 - Incisors almost represents the total amount of post mortem broken teeth.

Proximal wear

Proximal wear takes place at the same rate as the wear of occlusal surfaces, due to the mobility of teeth within their sockets and in relation to each other. Points of contact are transformed into larger and larger contact areas, and this extension is directly proportional to the number of masticatory actions.

At first, back teeth move mesially, to prevent diasthema and keep teeth close together. However, this migration ceases at a certain point to maintain an ideal distance between roots, since about 2mm of interradicular bone is required to keep the interdental papilla and periodontal region healthy).

Calculus and periodontal disease

Calculus deposits are limited to the cervical part of the crowns, under the equatorial line; that is, they are found apically in relation to the functional surfaces perfectly cleaned by chewing.

The favourite sites are the lower lingual area and to a modest degree the upper buccal area.

The calculus deposit appears as a cervical band that thickens apically and identifies the clinical neck, while coinciding coronally with the equatorial line of the tooth. No subgingival calculus deposits were found.

Horizontal and vertical resorption of the alveolar bone is limited to a few elderly individuals. Root extrusion is accentuated in teeth deprived of their antagonist.

Teeth broken post mortem

Twelve heads without bands were found to have incisors and canines broken after death and several empty sockets. 13 individuals with broken incisors were also found among those examined radiologically. In total, 94 teeth were considered to have been broken *post mortem* (Tab. 6). With regard to the unbanded heads, *post mortem* tooth loss could have occurred as a result of damage suffered by the finds at the time of excavation and recovery, or during the decapitation of mummies carried out for unknown reasons. However, for the heads still wrapped in bands, tooth loss, whether resulting from breakage or removal,

was undoubtedly the work of embalmers who forcibly opened the mouth and kept it open by means of a jaw separator. The treatment to which the mouth was subjected was intended to restore to the deceased person the functions of feeding and communicating with the gods. The cleansing of the mouth was often accompanied by the destruction of the turbinates and the ethmoid bone in order to extract the brain (Grilletto, 1988).

Both these practises were carried out on high-ranking individuals whose families could afford to pay for them. Nevertheless 10 heads out of the 28 devoid of bands have undamaged ethmoids and turbinates, and also incisors that are in tact (except for "M42"). These heads were probably subjected to partial rites compared to the standard procedures of the time, or perhaps at that period in time different procedures had been adopted.

Despite a few instances of uncertainty in the interpretation of the X-rays, it may be stated that approximately half of the individuals present destruction of the turbinates: in four cases just the right-hand ones and in one case just the left-hand ones.

Conclusions

It is clear from the data collected that occlusal wear and to a minor degree caries are the principal causes of oral pathology in the sample of ancient Egyptians studied. Macroscopic examination of the osteological collection does not enable us to determine what kind of food caused a crown reduction of 1 mm every five years. Historical sources and the food left in the tombs of dignitaries can give us an indication of the diet of ancient Egyptians. The main source of nourishment consisted of cereals (spelt and barley) which, during milling, could become contaminated with particles of silica left by the stones used for grinding. For the average Egyptian the cheapest source of protein was fish, but farm produce and game were also consumed. Honey was particularly appreciated (Donadoni Roveri, 1987). It was considered precious, and for this reason was consumed mostly by the upper classes. It was eaten as it was, or used as a sweetener in pastry, together with dates and raisins. The overall examination of the adults enables us to observe that dental conditions remained excellent up to the age of 30. During the following ten years, conditions



Fig. 2 - Head M64: subject of 40 years of age, with open mouth (26mm), excellent embalming, presence of neck and cervical vertebrae. 31 teeth are present, except right upper first molar. Occlusal wear consumed the crowns over the anatomical neck; a thin enamel is still visible on the third molars walls. Penetrant wear at 24-34-35-36-45 with periodontal space opened and enlargement of the apical part of the roots. Interproximal penetrant caries of 47 and 46 associated with periapical osteolysis and bone setum destruction between the roots of 47. Moderate orizontal resorption at both maxillae. Condyles aspect with no remarkable anomalies.

deteriorated rapidly in accordance with a succession of pathological events leading to an edentulous state in the oldest individuals.

This progression can be summarised as follows:

- wear of first molars as far as the neck and fracture of mesial wall enamel;
- depositing of food in the interproximal fissure (Fig. 2);
- secondary caries at the neck of first premolars and first and second molars;
- loss of first molars;
- mesial inclination of second molars and diasthema between second and third molars;
- further interproximal caries of remaining molars;
- acceleration in wear of front teeth.

Hard, semi-refined, low-calory food, while having on the one hand the disadvantage of requiring lengthy mastication, on the other hand carries out the beneficial action of cleansing the parietal surfaces of the teeth and stimulating the development of maxillary bones. In the Egyptians, as in other ancient populations, third molars have sufficient space to erupt, and there are no malocclusions or dental crowding such as to require orthodontic treatment. Malocclusion is defined by Hunt (1961) as "a disease of civilized man", meaning that it is encountered mainly in urbanised populations. Many anthropological studies (Campbell, 1925 on Australian aborigines; Price 1936 on Eskimos) quote examples of technologically non-advanced populations with near-perfect oral cavities (Lombard and Bailit, 1972). In order to explain the very significant differences in incidences of dental crowding and tooth malposition, many factors have been referred to, and several theories elaborated. These can be divided into two main groups: the first, supported by orthodontists, is based on genetical interpretation; the second, embraced by most anthropologists, places the accent on the role of the



Fig. 3 - M55, age of 35, sex M. Enamel borders fracture, mesially the first molars, causes food deposits with consequent cervical caries.



Fig. 4 - M68. Due to occlusal wear there are no crown in the anterior teeth. Right lateral incisor shows an open pulp chamber and apical osteolysis. Root canal of the left lateral incisor is still closed by a secondary dentin layeri.

environment and the consistency of the food (Corruccini et al, 1987). According to the latter, malocclusion occurs because of the absence of bio-mechanical stimulation during growth, with a consequent discrepancy between underdeveloped maxillary bones and the genetically predetermined dimensions of teeth.

The study of the teeth of populations whose diet is primitive leads to the conclusion - confirmed moreover on several occasions (Vaugh, 1937; Klatsky, 1948) - that a diet of hard, non-refined, sugar-free food, requires lengthy and vigorous mastication which, during growth, brings about a chain of positive effects: enhanced maxillary growth and greater space for third molars; vigorous mechanical cleansing with a consequent reduction. of caries in primary molars (caries are in fact totally absent in the heads of children in the "Marro" collection) which are preserved until the physiological renewal of dentition; finally, complete arches with aligned teeth.

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