The role of orthodontics in children identification: a case report of two victims of mass disaster

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ABSTRACT

Introduction: Human Identification based on dental evidence cannot be accomplished if antemortem dental records are unavailable or of poor quality. The involvement of the orthodontist in mass disaster victim identification processes may be crucial in relation to the amount and quality of the records which can be obtained before, during, and following the treatment.

Aim: The aim of the study is the description of the contribution of the findings drawn from orthodontic records to the identification of victims of mass disasters who had received an orthodontic treatment, through the presentation of two cases. The first case involves the identification of a child victim of a plane crash and the second case involves the identification of two identical twin girls who died in a fire. In both cases, the identification was based on the findings obtained from the ante-mortem records provided by the orthodontist.

Conclusions: The orthodontists apply customized orthodontic appliances and keep a comprehensive file of images, casts, radiographs, and other records in their practice. As a result, they can make a substantial contribution to the identification of young people or even adult victims of mass disasters in any case in which the authorities make a request.

INTRODUCTION

In recent decades mass disasters became a common global issue of concern. A mass disaster or a mass fatality incident, is an event in which there is a critical relationship between the number of casualties and resources, both human and material, available at the occurrence site, usually unpredictable and abrupt.[1] Environmental (such as tornadoes, hurricanes, earthquakes), transportation, industrial events, or terrorist acts, might all result in mass fatalities .[2]

Depending on the location of the occurrence and the country/ countries of origin of the victims, the disaster might be characterized as local, national, or international.[2-4] Mass catastrophes can also be classified as "closed" (an aircraft-related accident) or "open" (an earthquake), based on whether the number of victims and those involved are known details.[2, 5-7]

Human identification is the process to recognize an individual as a unique being. Forensic odontology is the branch of dentistry applied in criminal and civil law cases. The participation of forensic odontology in the human identification

process is fundamental when human remains are found, since the dental arches have particularities that make such a process possible.[8] According to the International Criminal Police Organization (Interpol), given the individuality of the teeth and other anatomical structures of the dentomaxillofacial region, forensic odontology is one of the three primary human identifiers. These are classified as primary or secondary according to their ability to achieve an accurate identification. Primary methods include dental analysis, fingerprinting, and DNA analysis. Considering the accuracy and reliability provided to the process, these are the methods of choice in cases of human identification ('https://www.interpol.int/en/How-we-work/Forensics/Disaster-Victim-Identification-DVI'), equally reliable, trustworthy.[9,10] The dental evidence is reliable thanks to the uniqueness and stability of the dental tissues and treatments and includes dental records, study models, photographs, X-rays.[11-13]

However, for a successful comparison process of ante-mortem and post-mortem dental evidence, it is imperative to overcome several difficulties.[14] The most frequent challenge is when incomplete, ambiguous, or incorrectly documented ante-mortem dental records are avalilable.[14] Other obstacles that may influence the identification procedures are the administrative and collaborative issues with foreign authorities about the collection of the ante-mortem data.[15]

Although the DNA evidence is a powerful tool in identification cases and especially in mass disasters victims identification, there are various limitations to be considered.[16]

Orthodontics is the dental speciality in charge of establishing a functional and aesthetic harmony to the face. Since the treatment lasts a long time and its planning is complicated, the orthodontist takes several records in the pre-treatment, treatment and post treatment phese. Mostly the records consist of patient's history, dental models, extra oral and intraoral photographs, and X-rays (at least an Orthopantomogram and a lateral Cephalogram). All these data taken from the orthodontic records can help in the identification of a patient.[17] Dental evidence is a reliable tool thank to the uniqueness and stability of the dental tissues and treatments.[11]

Two mass disaster cases are presented in this study; the first case can be characterized as closed and international and the second case as open and national. The cases show the valuable contribution of orthodontics in the identification of children when casualties of mass fatality events.

CASE I

On August 14, 2005, a Boeing 737-300 plane crashed in a mountainous area of Attica, Greece. The plane took-off from Larnaca airport with final destination Prague, Czech Republic, and stop over in Athens airport, Greece. While approaching Athens airport the plane lost communication with the air traffic control center and soon crashed. All the people on board, 115 passengers (adults and children) and 6 crew members, lost their lives.

Depending on each victim's individual situation, all primary human identification techniques (fingerprinting, DNA, and dental evidence) were used since it was impossible to identify the victims visually. Whenever possible, multiple identification techniques were used in each case.

Post-mortem data:

Both jaws were available for examination. Post-mortem dental examination and charting were completed. The child was undergoing orthodontic treatment, as evidenced by the post-mortem data of his corpse, which demonstrated that fixed orthodontic appliances had been fitted in his maxilla.

In particular, the first upper premolars were missing bilaterally, the first upper permanent molars had orthodontic stainless-steel rings (bands), in which a trans-palatal arch was fixed. Both the upper permanent canines, lateral and central incisors had been erupted and had metallic brackets, with hooks on the canines. Also, the second permanent molars were erupted bilaterally (Fig.1).

In the mandible, the first premolars were missing bilaterally, the first permanent molars had orthodontic rings and all the rest of the permanent teeth had brackets. Moreover, the second permanent molars were erupted bilaterally. Supplementary to the clinical examination, post-mortem photographs were taken (Fig.1). Age estimation based on tooth eruption was between 12.5 and 16.5.

Ante-mortem data:

Among the victims' postmortem dental records obtained by the police there was the orthodontic

record of a male child. The record included notes, a panoramic radiograph taken before the orthodontic treatment,1 extraoral photograph, 3 intraoral photographs, and a set of orthodontic models (Fig. 2,3,4,5). The ante-mortem data were collected and charted. The study of the ante-mortem records revealed that the boy had orthodontic stainless-steel rings (bands) in his maxillary first molars in which a trans-palatal arch was fixed, all teeth (from # 15 to # 25) had metallic brackets with hooks on the canines.

Comparison of post-mortem and ante-mortem dental evidence.

The little youngster was positively recognized based on the similarities found from the analysis of the dental records' ante-mortem and post-mortem data. Specifically, there was no difference between the extracted teeth found in the ante-mortem and post-mortem dental records. In both the antemortem and postmortem reports, the fixed trans-palatal arch was precisely the same. And both the dental records, antemortem and postmortem, showed the metal brackets with hooks on the canines.

Figure 1. Post-mortem photographs from both jaws which were available for examination. a) A stainless steel trans-palatal arch was fixed on the palate. b) Fixed orthodontic appliances were placed on the maxilla, first premolars bilaterally were not present, first permanent molars had orthodontic stainless-steel rings (bands). Both permanent canines, lateral and central incisors had erupted and had metallic brackets, with hooks on the canines. c) Right lateral view of the maxilla and mandible, d) Left lateral view of the maxilla and mandible, second permanent molars had erupted bilaterally.

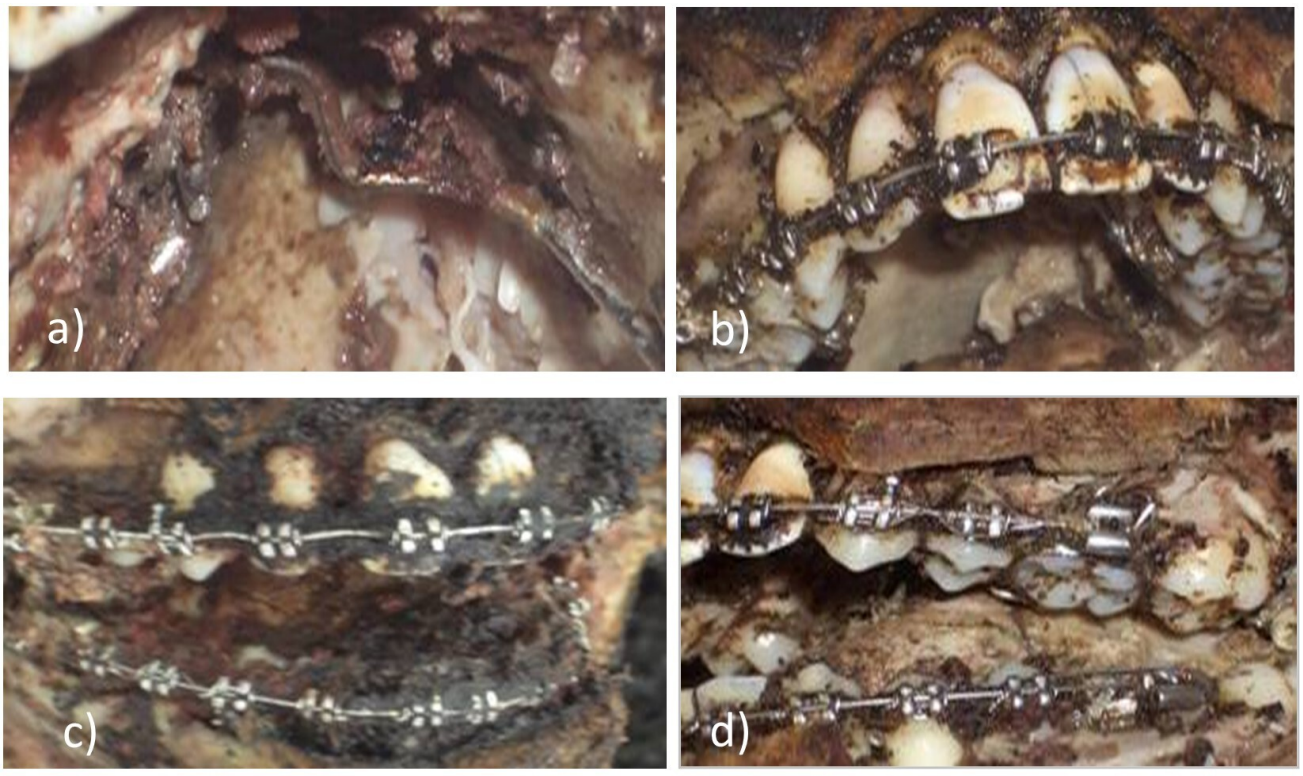

Figure 2. A panoramic radiograph taken by the orthodontist before the orthodontic treatment started

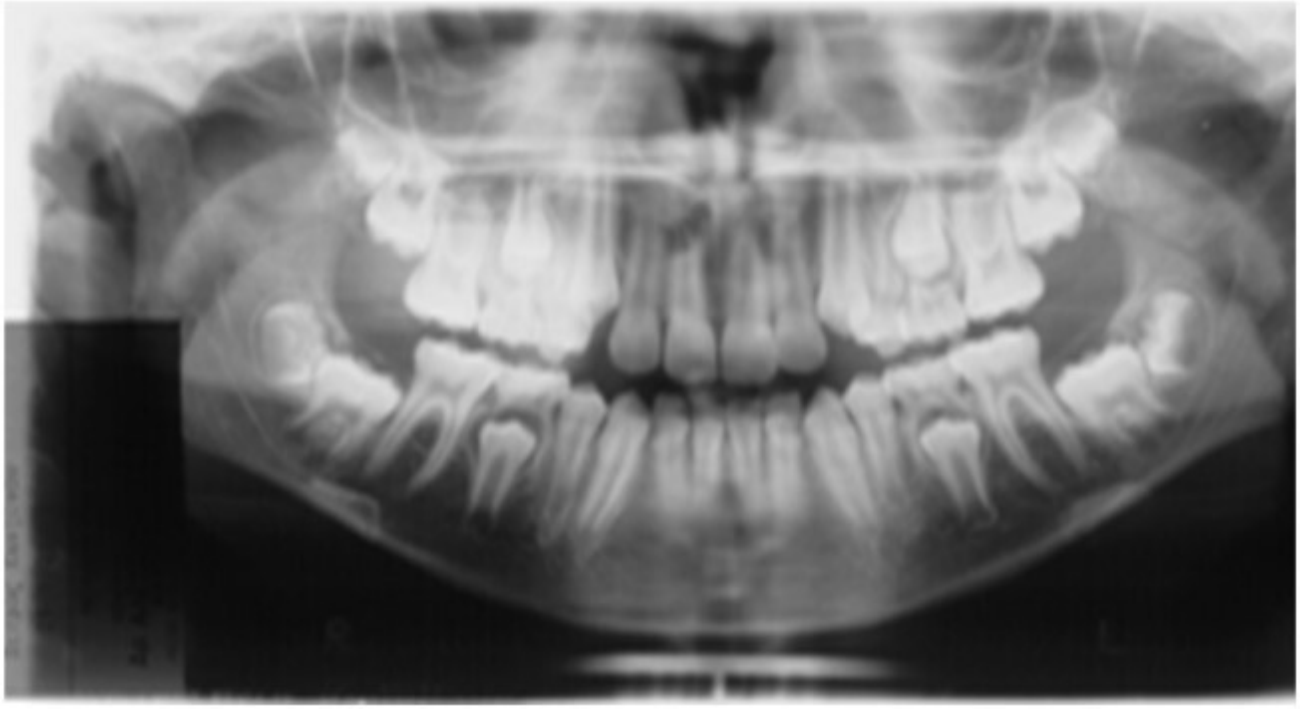

Figure 3. Extraoral photograph taken by the orthodontist. Face frontal lips relaxed

Figure 4. Intra-oral photographs taken by the orthodontist before treatment. a) Frontal in occlusion. b) Upper occlusal a stainless steel trans-palatal arch fixed on the palate. c) Lower occlusal

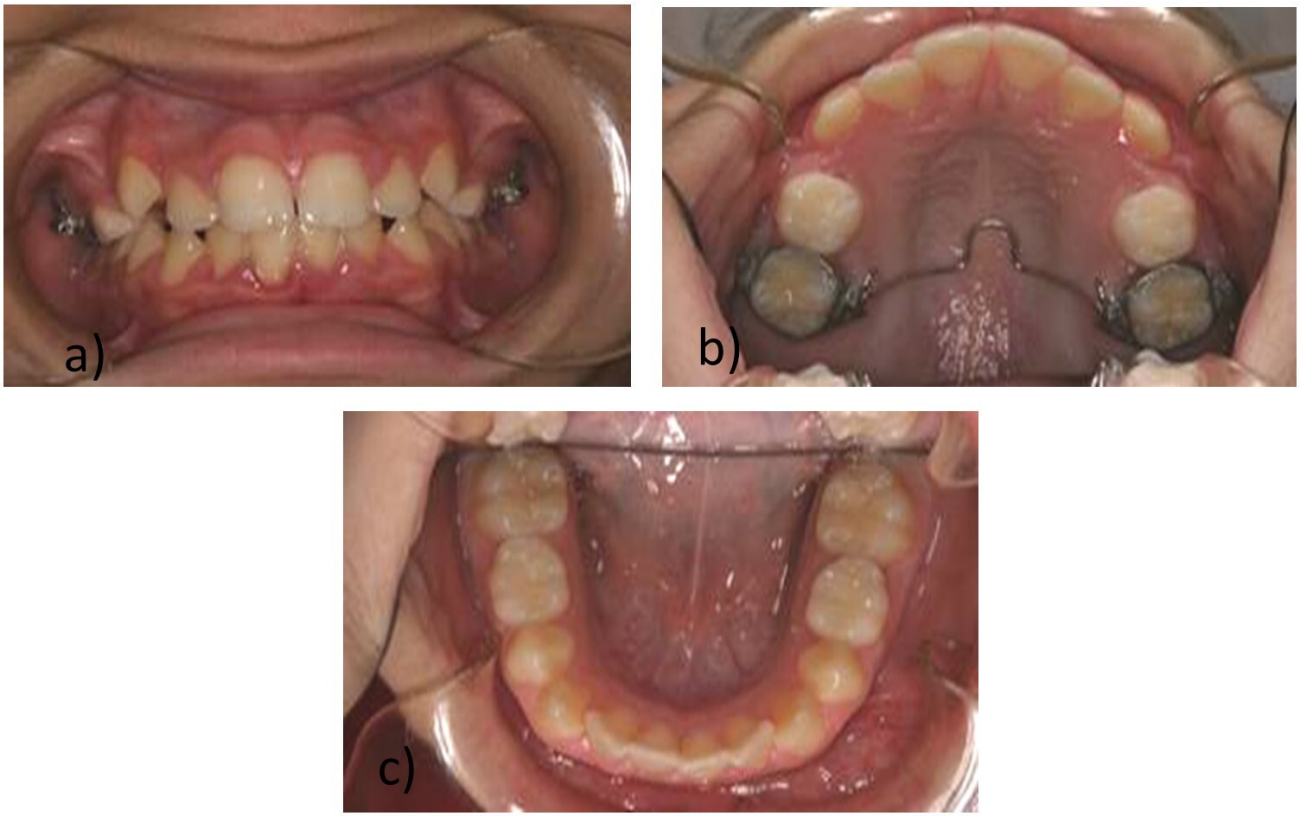

Figure 5. Orthodontic plaster models

CASE II

Two homozygous twin girls were among the 102 people that died in a fire which broke out in a village in Attica in July 2018. Visual identification was impossible. Moreover, the identification of the children's corpses could not be based on the DNA analysis process since the individuals were homozygous twins and shared exactly the same DNA.Therefore, the only suitable process to establish the identity of the victims was the evaluation of dental evidence.

Post-mortem data:

The maxilla and the mandible were available for post-mortem examination in both cases. The children were both in the phase of mixed dentition (Fig. 6).

In the maxilla of both children, the first permanent molars were erupted bilaterally, first premolars were erupted bilaterally, both upper incisors were erupted, as well as the second deciduous molars bilaterally.
The different finding among the post-mortem dental findings of the children was that in the maxilla of one of them, the left central and lateral incisors had erupted labially, while the right lateral incisor had not been erupted yet since it seemed that there was not enough space for its eruption. On the contrary, the maxillary teeth of the second child had been erupted normally (Fig. 6). The dentition of both children did not present any kind of dental intervention.

Ante-mortem data.
The information the family members gave the police authorities indicated that the youngsters had attended a private orthodontist office recently. The orthodontist had the initial models. We obtained the orthodontic models by the orthodontist once the police found him.
The study of the two orthodontic plaster models that belonged to the homozygous twin girls revealed that both children did not present any kind of dental intervention in their teeth. However, we found differences in the arrangement of the anterior maxillary teeth. According to the first plaster model, the left central and lateral incisors had erupted labially, while the right lateral incisor had not yet been erupted since there was not enough space for its eruption (Fig 7 and Fig. 8). On the contrary, the maxillary teeth of the second child's orthodontic plaster model seemed to have been erupted normally (Fig. 9).

Comparison of post-mortem and ante-mortem dental evidence
It was possible to identify the homozygous twins based on the maxillary tooth eruption pattern, which was documented post-mortem and with the comparison of the ante-mortem dental plaster models (Fig.8 and Fig. 10). One orthodontic plaster model's eruption pattern matched the eruption pattern of the first girl's left central and lateral incisors in the maxilla. One other consistent finding between the postmortem and ante mortem dental records was the right lateral incisor not yet erupted due to limited space. The second homozygous twin girl's maxillary incisors had all erupted.

Figure 6. Post-mortem dental records included photographs of the maxillae and mandibles of both children's corpses, that were taken during the post-mortem examination. Both children were in the phase of mixed dentition. Photographs a, and b belonged to one child. Photographs c and d belonged to the other

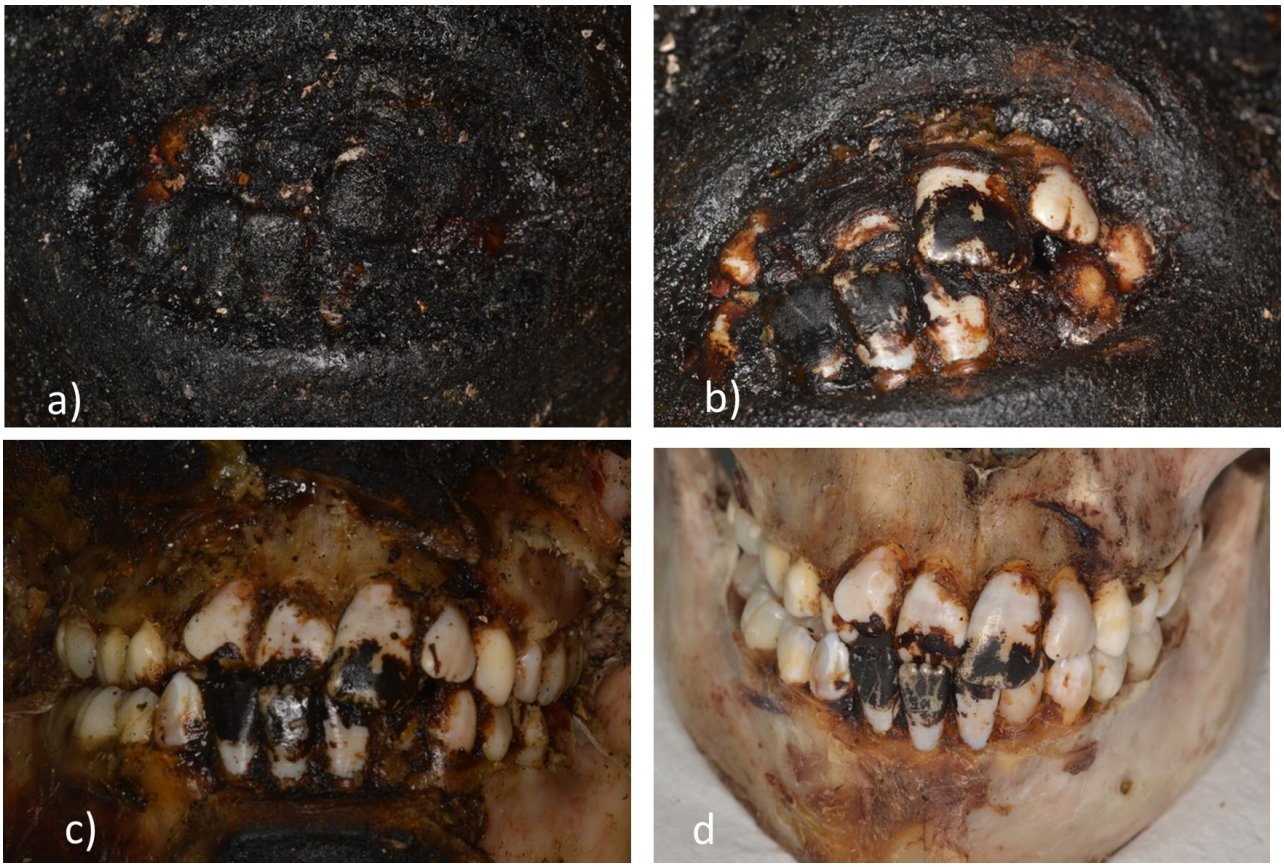

Figure 7. Ante-mortem dental records included plaster models (a and b) taken by the orthodontist for one of the homozygous twin girls. The left central and lateral incisors in the maxilla had erupted labially, while the right lateral incisor had not yet erupted, since there was insufficient space available for its eruption

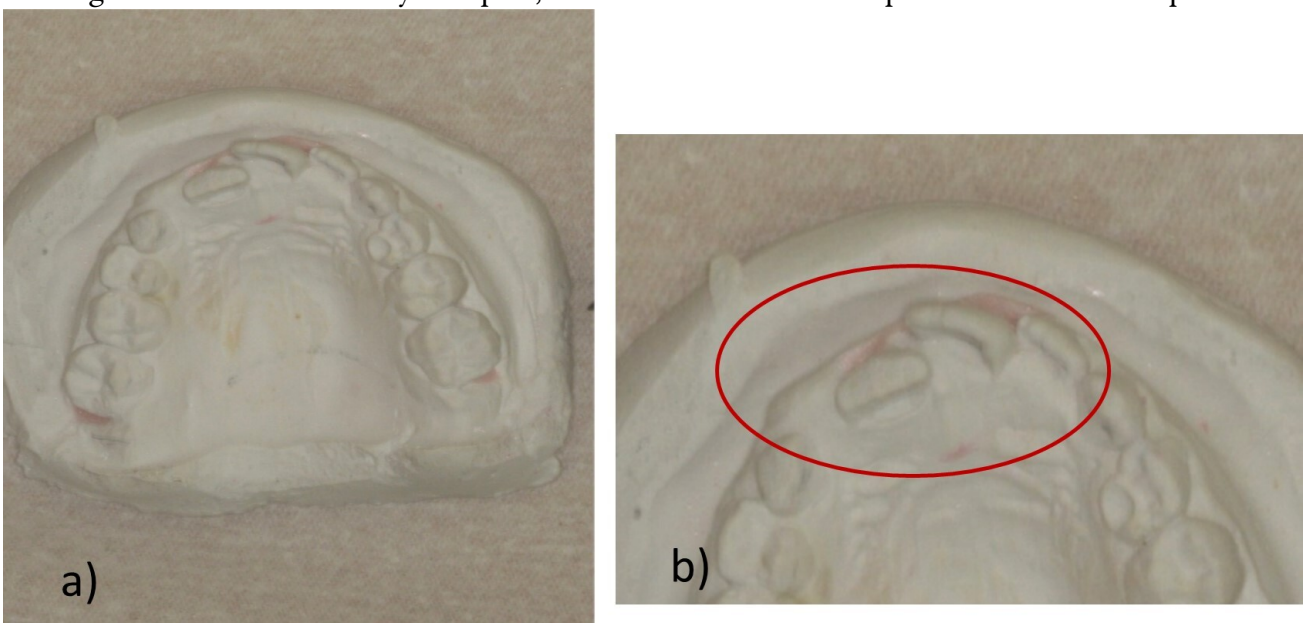

Figure 8. a) Plaster model of the maxilla of one child taken by the orthodontist, ante-mortem records, in the maxilla the left central and lateral incisors had erupted labially, while the right lateral incisor had not been erupted yet since it seems that there was not enough space for its eruption. b) Post-mortem dental records of the same child

Figure 9. Ante-mortem dental records for the second of the homozygous twin girls from the orthodontist included plaster models (a and b). As can be observed, the maxillary incisors had erupted

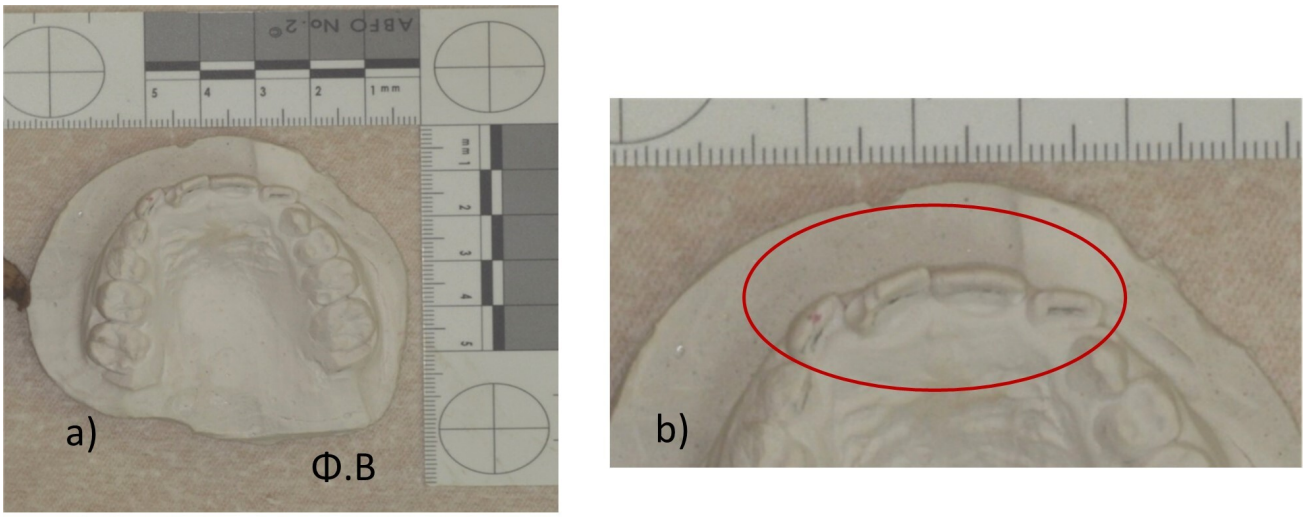

Figure 10. a) Post-mortem dental records of the second homozygous twin girl. b) Plaster model of the maxilla of the same child taken by the orthodontist, in ante-mortem records, the maxillary teeth of the second homozygous twin girl had erupted

DISCUSSION

The orthodontist, from the very first days of his post graduate training, is used to take routinely a set of diagnostic records pre-treatment, during it and at its end. These records are essential for planning and carrying out the appropriate therapies. Written information, dental radiographs, photographs, plaster casts, digital impressions, and any other document included in a patient's dental record are the evidence the orthodontist relies on to make initial diagnoses, assess prognoses and progress of the treatment outcome.[18] These include case history recording, a full set of intra and extra oral photographs, with complete clinical and a thorough medical

examination. Moreover, the orthodontist has extensive knowledge about the various aspects of teeth position, craniofacial growth, age assessment and can deal with the skeletal and dental remains. A well-detailed, accurate, and updated dental record is an indicator of the excellence of the orthodontic services provided. Excellent documentation is directly related to the orthodontist's clinical competence and contributes to the increase of his prestige and trustworthiness. General dentists are more likely to keep incomplete, insufficient, and out-of-date records.[19]

Furthermore, orthodontic appliances are generally manufactured of commercially pure titanium, titanium-aluminum-vanadium alloys, or nickel, molybdenum, copper, and stainless-steel elements. The metals and alloys mentioned above have unique physical and mechanical properties, as well as corrosion resistance.[20-23] Fixed as well as removable orthodontic appliances are valuable dental identification tools due to the aforementioned properties of the orthodontic materials and their resistance to extremely unfriendly circumstances.[24-26] Therefore, all the data an orthodontist collects can be a significant source of information in cases where identification with soft tissue is impossible due to the putrefaction of the bodies.

Creating and maintaining detailed, accurate updated and well organized dental records is essential for a variety of reasons.[27-29] Concerning forensic odontology, detailed and accurate dental records, may help not only with the identification of unidentified corpses or human remains by comparing antemortem and post-mortem dental evidence, but also to the reconstruction of an individual's biological profile and additionally with the resolve of other criminal and civil law cases.[22,30]

The unavailability of dental records or the availability of insufficient dental records are major concerns which complicates the identification procedures in isolated cases and in mass disasters. In this case scenario the collection of all available ante mortem medical data of missing people such as radiographic images out of the dentomaxillofacial area could be considered an useful identification tool.[31] Furthermore, when there is an extreme lack of antemortem medical records, the analysis of images from other sources (like social media) might be suitable for human identification.[32]

In order to use dental records for mass disaster human identification, a number of requirements should be satisfied: trained personnel must collect and evaluate pre- and post-mortem dental records; a uniform dental notation and coding system should be adopted; the necessary equipment must be available; and the personnel must submit to media pressure. Human remains must be adequately stored and recorded in order to safeguard the dentomaxillofacial evidence. The process for identifying teeth should adhere to quality control guidelines. Since various DNA tests that require specific expertise are available, the DNA analysis should be used when dental evidence or fingerprint analysis are inconclusive.[15,16]

Given the complexities of orthodontic cases and long-term treatment plans, orthodontists should always update the patient records on a regular basis. As a consequence, orthodontic records are valuable in forensic cases.[27-29]

The success of an identification process based on forensic dental evidence depends on the availability, accuracy and good quality of the ante-mortem and post-mortem dental records.[20] Due to their excellent quality, orthodontic dental records are extremely valuable tools and when they are available the human identification procedures are greatly facilitated.[33,34]

The present study highlights the contribution of orthodontics to establish the identity of mass catastrophes victims. In the two cases presented the identification was based exclusively on the excellent quality and accuracy of the orthodontic records. The contribution of orthodontics records was even more prominent for the case of the identical twins where all the other primary forensic methods (DNA and finger prints) failed to reach a definite result.

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