Use of imaging tests in forensic dentistry for the identification of corpses – Integrative Review

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Abstract. Carrying out the identification of a corpse is necessary within the scope of justice and to complete the cycle of life, together with family members and society. This identification through skeletonized, charred or decomposing bodies is a work that requires knowledge on the part of professionals and techniques that help in its recognition. Forensic dentistry is an area that evaluates and performs *post-mortem* (PM) exams, including imaging, being classified as intra and extraoral that can help in the identification of the individual. Comparison of images obtained in PM examinations with *ante-mortem* (AM) radiographs is a reliable and sensitive method, provided that the images are not distorted. The objective of the present study is to evaluate the possibility of identifying cadavers in the context of forensic dentistry through the aid of radiographic examinations of the oral cavity. The PICO strategy was used to formulate the question, and the search was performed in the following databases: Embase, Medline, Cochrane Library, Virtual Health Library and Google Scholar, between the years 2011 to 2021, 457 were found. articles, among these, 24 met the eligibility criteria and were included in the study. Intra and extraoral radiographs such as periapical, bite-wing, panoramic, and computed tomography are performed both AM and PM and when compared to identify a corpse, they have positive results and can be useful in the identification process.

Keywords. Forensic dentistry, dental radiology and diagnostic odontology.

1. Introduction

Identification - the scientific method used to establish identity through comparison with references that are already known - of human beings goes beyond clarifying who that individual was who was found dead. It is a demand that reflects on society and especially on the legality of justice. The area of forensic dentistry is understood as a primary method for identifying the corpse, analyzing through the dental arch of the individual which represents the uniqueness of each one, helping in the identification, it is a comparative method, that is, it is necessary to have dental data that may enable the comparative analysis of AM ante-mortem) and PM (post-mortem). Recognizing a corpse is to give an identity, as well as in the law, to fulfill the rights of that person and for the family to continue and have its moment of mourning.[2,9]

When a corpse is found in a charred, skeletonized state or in the event of mass disasters, an

anthropological assessment is necessary, which tries to estimate: age, sex, height and weight. Because teeth are formed by enamel, a highly mineralized tissue, they tend to resist adverse conditions, being preserved for a long time for possible investigation, through medical records and radiographs leading to processes of human identification and estimation of dental age.[2, 6]

With regard to the dentition of the human being, as well as the fingerprints, they are singular. Two individuals have indistinguishable teeth in terms of shape, configuration, or, anatomy.[4]

It is possible to carry out the applicability of images for research in forensic dentistry by comparing AM dental records, considered a first record, being before the individual's death, such as medical records and in it image exams and the PM that comes as a second record , classified after death, which include radiographic examinations of the patient, provided that objective data are provided and that they are actually available, being a reliable method for identifying the corpse to initiate investigations.[3,7,13,20]

Comparing radiographs and having the knowledge to interpret them, leading to the identification of the individual is of paramount importance, as it is also necessary to know about advances and techniques in forensic radiology linked to dentistry[5]. Bearing in mind the scope and importance of this area of dentistry, the objective of this work is to carry out an integrative review to evaluate the possibility of using dental radiographs in the identification of individuals in the scope of forensic dentistry.

2. Research Methods

This study is an integrative literature review, carried out between June and October 2021.

To carry out the work, the following steps were followed: 1st Elaboration of the problem; 2nd Literature search through data collection; 3rd Data analysis and finally, 4th Interpretation of results[1].

To help with the review, the question asked was: can radiographic examinations of the oral cavity identify cadavers? In formulating the question, the PICO strategy was used, shown in Table 01.

Table 01 - Formulation of the research question according to the strategy PICO

P (Population)	Cadavers
I (Intervention)	Radiographic examinations performed in dentistry
C (Comparison)	No comparison
O (Outcomes)	Forensic identification

As for the identification and selection of articles, for this phase, a search was made through publications in the databases: Embase, Medline, Cochrane Library, Virtual Health Library (VHL) and Google Scholar. To carry out this search, the descriptors that corresponded were: "Forensic Dentistry", "Dental radiology" and "Diagnostic odontology", indexed in Medical Subject Headings (MeSH).

Articles published in the last ten years (2011 to 2021), in Portuguese and English, available in full, were included. Exclusion criteria were: letters to the editor, theses, dissertations, reports, narrative reviews, duplicate articles, and that did not address the subject or did not answer the question of this review.

3. Results

After data collection, 457 articles were found, of which 396 were excluded for not meeting the inclusion criteria. Of these, 89 were theses, 53 were duplicates, 48 did not address dentistry, 68 did not answer the question that guided the research, 61 did not correlate the subject, 29 were letters to the editor, 17 were narrative reviews and 31 were reports. Thus, 61 articles were pre-selected. After reading the abstract, methodology and results, 37 did not have imaging exams in the area of dentistry for forensic identification as resolvable, leaving 22 articles and 2 books for review.

The table 02 presents the list of articles that were included in this research.

Table 02 – List of articles that were included in this article.

Author/ Date/Country	Methods	Conclusion
Santos et al. (2015) BrasiL	Cross-sectional observational study	It was possible to identify the sex of cadavers through dental radiographs.
Wood et al. (2021) Canada	Cross-sectional observational study	Identification of some individuals was possible by the CBCT examination of face performed in PM.
Lenka et al. (2019) India	Literature review	Methods used to identify corpses in forensic dentistry are valid for recognizing the individual.
Sivaneri et al. (2018) EUA	Observational study	Dental students were able to correlate the radiography of a cadaver's tooth by heat with its previous radiograph.
Obafunwa et al. (2014) Nigeria	Analytical study	With the help of forensic dentistry, 97% of corpses from a tsunami were identified.
Newcomb et	Cross-	New device to

Author (Year) Country	Study type	Findings
al. (2016) USA	sectional observational study	perform periapical radiographs did not show differences in comparison with existing positioners on the market for cadaver radiographs.
Biancalana et al. (2015) Brazil	Literature review	Forensic dentistry has its contribution to the INTERPOL protocols. With the oral examination, added to the image, it is possible to identify cadavers.
Montenegro et al (2012) Brazil	Case report	Comparing dental radiographic examinations, it was possible to identify an exhumed body.
Forrest et al. (2012) Australia	Observational study	Image exams are objective records with characteristics of an individual and when used comparing AM and PM radiographs lead to identification.
Eliášová et al. (2017) Czech Republic	Literature Review	The CT scan gave PM details of the cadavers. He compared the images and identified the cadavers.
Ramos et al. (2021) Brazil	Literature Review	For identification cadaver be effective, it is necessary for the dentist to fill in and keep the records, as in disasters this information is necessary.
Bhullar et al. (2014) India	Cross-sectional observational study	The discipline of forensic dentistry in graduation is necessary, for knowledge and training of students.
Du et al. (2020) China	Randomized cross-sectional study	Verification of maxillofacial identifiers on panoramic radiographs is useful for identifying individuals.
Bhateja et al. (2015) India	Retrospective observational study	In 300 panoramic radiographs, there was a 99.9% chance of identifying individuals.
Jensen et al. (2019) Denmark	Retrospective study	Even with artifacts, being a limitation of the examination, it has been proposed that post-mortem CT helps in the identification of cadavers.
Trochesset et al. (2014) USA	Cross-sectional study	Through CBCT it is possible to capture images and present them in 2D to perform a closer comparison of the AM image.
Paris et al. (2020) Brazil	Literature review	Forensic facial reconstruction with CT has been useful, especially when there is no data to perform AM/PM comparisons.
Curi et al. (2017) Brazil	Retrospective analytical observational study	Comparing AM/PM images via overlay with CT scanning is an effective method, enabling identification.
Nuzzolese et al. (2012) Italy	Case Series	The cases were recorded using a portable X-ray, which made radiography possible, as the bodies were already in advanced decomposition.
Beaini et al. (2014) Brazil	Cross-sectional study	New device tested to perform panoramic radiographs on skulls. It is useful to assist in taking radiographs, reducing error bias.
Gadelha et al. (2019) Brazil	Descriptive and analytical cross-sectional study	Measurements of pulp chambers estimating age via CBCT were valid and the teeth most suitable for measurement were the upper incisors, as they are single-rooted, with greater pulp volume.
Peyneau et al. (2020) Brazil	Literature review	The CBCT exam useful when it is necessary to estimate the individual's age. It is through it that the measurement of the volume of the pulp chamber can be used

CBCT = cone beam computed tomography;
PM = post mortem; INTERPOL = Internacional Criminal Police Organization; AM = ante mortem; CT =

computed tomography; 2D = two dimensions.

4. Discussion

The investigation of a death always begins with a history of the circumstances and people involved. In disaster situations, bones, skeletonized or charred corpses, it is not possible to identify the individual. In these cases, the radiographic characteristics of the mandible, maxilla and teeth can lead to identification, according to Bhullar et al[14] through the images, a case can be finalized, giving the identification to someone. This, according to the author, is one of the most successful methods.

Identifying corpses through dental radiographs via comparison, is an effective and fast method, aims to compare dental details of the individual's AM and PM records. For the parameters of the radiographs to be extracted for image comparison, it is necessary that the PM records are similar to the AM, as they deliver a more reliable final image. However, it may be subject to error, since PM radiographs may be distorted, as the angulations or PM positioning may not be the same as for AM. [6,13,22]. Curi et al[19] uses CBCT in the comparative method, by obtaining a new image with the overlapping of the AM and PM radiographs, bringing a much lower chance of technical error, which may be minimal, since a software performs the PM image, being an application more reliable for comparison.

In most cases, carrying out the identification is not easy, demanding difficulties for the forensic dentistry team. The biggest one is getting the AM data and information. According to Biancalana et al8, considering qualities such as low cost and individuality, it is a disadvantage not to obtain dental records, leading to the impossibility or reduction of the chances of identification. Forrest[12] explains that if you have the AM records to carry out the comparison, the best thing to do is wait for the PM records corresponding to what was delivered to the team to be carried out. As there is this wait, the best thing to do is to scan the images to facilitate the comparison and exchange of information, since they will be in a database[19].

It is known that with the advancement of technology, it is necessary to update the various areas of health. Forensic dentistry was no different. CT is an option, however, when used for dental evaluation, it has limitations: resolution, artifacts and time. When CT is associated with CBCT software, it shows improvement, but it is still not ideal. As a result, introducing CBCT in this area has brought benefits and practicality in aiding the examination, as Wood et al[3], show in their research that it is a modality that saves time, the images can be manipulated in relation to contrast, density and can be exported to another program for obtaining a reconstruction of the panoramic radiograph using software. Eliášová et al[13] also showed that it is an important exam in criminalistic practice and in fatal accidents. CBCT is an image that offers less artifact and a quick reconstruction, in addition to generating a virtual 3D model, but there may be errors in the digital radiography by the software for not capturing the image correctly. The authors agree with the ease of handling the images, as they can be enlarged, superimposed and compared when in digital mode.

Even with new technologies, the lack of training interferes with the need to evaluate the images to identify the individual. Sivaneri et al[5], reports that there is a gap in the quality of professionals in carrying out comparisons of AM and PM radiographs, since the gap begins in graduation, since the discipline in dental expertise is not inserted. It is important to understand that the ability to compare the radiograph is included in the identification process in the techniques of dental expertise.

Forrest[12], brings in his research that it would not be possible to carry out the identification of cadavers establishing dental patterns, as individuals can have the same tooth restored, and similar images. However, Bhateja et al[16] managed to find and classify 9 dental patterns in panoramic radiographs, even in individuals who did not have restorations, making comparisons not only with restored teeth, but also by morphology, position and presence of supernumerary teeth. Panoramic radiographs were used in this case, obtaining a 99.9% chance of identifying the cadaver, corroborating the study by Du et al[15], who divided it into 4 groups of identifiers, namely: tooth morphology, dental treatment, pathology, and alterations in the jaws, with the use also of panoramic radiographs, being classified as useful in the identification of individuals.

Beaini et al[23], presents the notoriety of the improvement of oral health in the population with the promotion and prevention by professionals and greater access to care by patients, thus reducing the number of restorations among young adults. This improvement in oral health may lead to a decrease in the chance of finding restored and missing teeth in imaging exams. However, Lenka et al4, exemplifies that even when the cadaver does not present restorative treatment in its teeth or even missing teeth, the PM radiographic examination is still extremely important and presents different structures such as bone morphology, including trabeculae. Forrest[12] also adds that dental morphology can be evaluated, which can be compared with the AM exam in each cadaver. For edentulous individuals, image comparison is also performed, but it is decided to compare more skull structures and bone trabeculae.

5. Conclusion

All radiographs are necessary and important in the

process of trying to identify a cadaver, with the advancement of technology new possibilities can be obtained to assist in the identification of the cadaver through software and digitized images. The intra- and extra-oral radiographic examinations carried out by dentists in the AM, added to the examinations carried out by forensic odontologists in the PM, contribute to identifying the corpses, thus the area of dentistry is extremely important in forensic practice.

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