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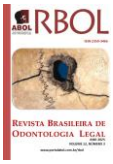

Human identification

HUMAN DECOMPOSED BODY IDENTIFICATION BASED ON PM COMPUTED TOMOGRAPHY OF THE MANDIBLE: CASE REPORT.

Identificação de corpo humano em estado de decomposição com base em tomografia computadorizada post-mortem da mandíbula: relato de caso.

Carolina Lucena Veloso GUSMÃO[1], Tainá Nascimento FALCÃO[1], Milena Norões Viana GADELHA[2], Cristiane Helena da Silva Barbosa FREIRE[2], Bianca Marques SANTIAGO[1,2].

1. Universidade Federal da Paraíba, João Pessoa, Paraíba, Brasil.
2. Núcleo de Medicina e Odontologia Legal da Paraíba, João Pessoa, Paraíba, Brasil

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Contact author:
Carolina Lucena Veloso Gusmão
Rua Olivio Ribeiro Campos, 108, Miramar, João Pessoa, Paraíba, Brazil. Zip Code: 58043230.
E-mail: carolinav42@gmail.com.

ABSTRACT

When conventional identification methods are compromised, the comparative study of dental images proves to be effective in human identification. This study reports a human identification case using the comparison of ante-mortem radiographs with post-mortem mandibular computed tomography. A male body found in an advanced decomposition stage was sent to the Scientific Police Institute of João Pessoa/PB, Brazil. Fingerprinting and facial recognition were not feasible due to the destruction of digital pulps and severe epidermal damage. Therefore, the forensic dentist decided to enucleate the mandible to obtain computed tomography images for comparison with an ante-mortem panoramic radiograph provided by a victim's relative. The images were essential for studying and comparing the anatomy of the mandibular structures, such as the mandibular canal, as well as the positioning and angulation of the dental roots. The comparison between ante-mortem dental radiograph and post-mortem computed tomography revealed sufficient concordant features for a positive identification.

KEYWORDS

Forensic dentistry; Forensic anthropology; Tomography.

INTRODUCTION

Dental professionals play a crucial role in human identification procedures and in preparing reports to assist the justice system[1-3]. Human dentition is unique, with even a single tooth surface containing multiple individualizing characteristics, thereby providing a highly distinctive model when considering all the evidence[4-6].

Moreover, human teeth are situated in a protected area of the body, protected by the oral cavity's humidity. Their structure is also the most resistant to natural elements, such as decomposition and heat. Teeth are primordial in more complex cases of identification forensics in

charred, skeletonized bodies, in an advanced decomposition stage, or fragments, in which fingerprint examination is difficult or even impossible[2,4,7].

The identification process primarily involves comparing *ante-mortem* (AM) records with the observed *post-mortem* (PM) records[5,8]. Therefore, proper preparation and maintenance of dental documentation are extremely important. During dental care, professionals must produce and retain various documents generated from patient care, including odontograms, radiographs, computed tomography (CT) scans, study models, and photographs, collectively forming the dental record[9,10]. CT scans, like radiographs, are valuable for identification purposes and have become increasingly common due to their three-dimensional visualization of anatomical structures.[11-13]. In forensic casework, CT can support AM/PM comparisons using craniofacial structures and can also be post-processed into panoramic-like reconstructions for direct comparison with AM panoramic radiographs[14,15].

This study aims to describe a human identification case of a body in an advanced decomposition stage by comparing the AM record with the post-mortem CT scan of the mandible.

CASE PRESENTATION

In 2020, an unidentified male body in an advanced decomposition stage was found in a river in the city of João Pessoa/PB, Brazil.

The body presented a compromised epidermis, which made it impossible to describe the facial features in detail. The fingerprint identification was not possible as the digital pulps were destroyed. Additionally, there was a loss of integrity in the left earlobe and right auricular pavilion.

Upon intraoral examination, it was found that the individual had poor oral condition, we observed a low number of teeth remaining and some of them were in a severely deteriorated state. The upper left second molar (#27*) and the lower left lateral incisor (#35*) were removed and sent to the DNA Laboratory if identification by genetic matching was necessary (Fig.1).

* Dental notation preconized by FDI.

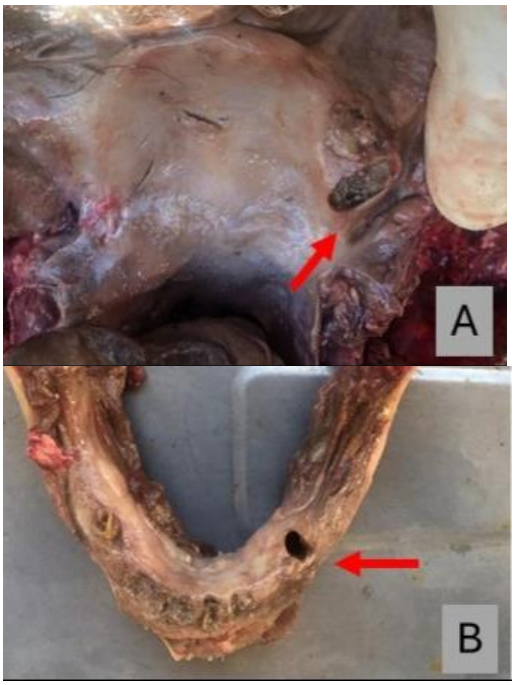

Figure 1: Occlusal images of upper(A) and lower(B) dental arches demonstrating advanced dental deterioration and reduced dentition. Teeth #27 (A) and #35 (B) removed for potential DNA analysis.

During interviews with family members of a presumed victim, they provided a single panoramic radiograph of the jaws as ante-mortem dental documentation for potential comparison (Fig. 2). This *ante-mortem* record included

personal identification details (full name, age, and gender) and the approximate date it was performed, which was approximately one year before the body was found.

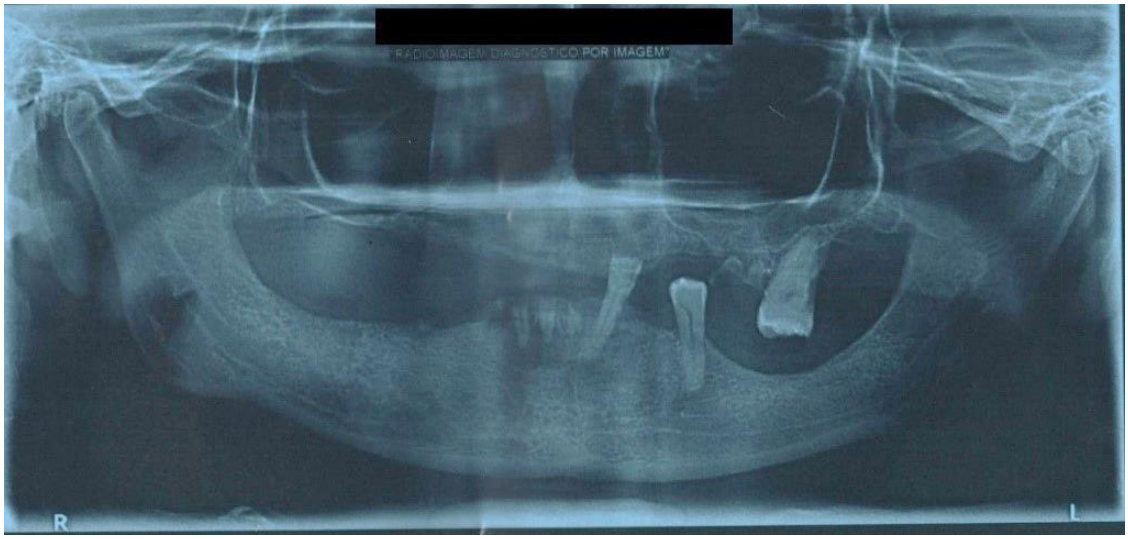

Figure 2: Panoramic radiograph provided by the alleged victim's relatives as an *ante-mortem* dental documentation.

The panoramic radiograph (Fig. 2) displayed the following characteristics in the mandible region: the presence of teeth #31, #32, #35, #41, #42, #43 and #45 with a radiolucent area in the root apex region of teeth #41 and #42; a significant reduction in the height of the alveolar ridge in the left hemi-arch; and distinctive morphological features of the mandibular canal.

To facilitate dental comparison, the forensic dentist decided to enucleate the mandible using the inframandibular technique developed by Keiser-Nielsen (1963)[16] (Fig. 3). The mandible was scanned using the FlatScan® *scanner* at the forensic institution to obtain dental images (Fig. 3). Only the mandible was considered for further imaging, as it still preserved sufficient dental elements for comparison.

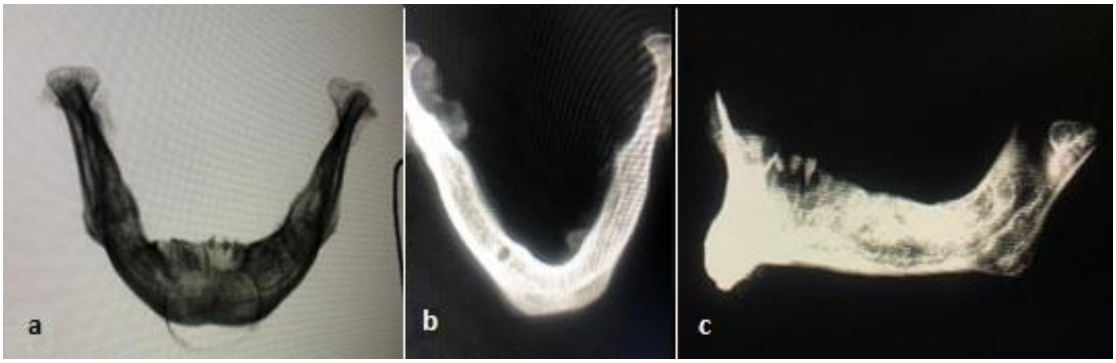

Figure 3: Mandible *post-mortem* images obtained with FlatScann®: A - front view, B - top view, C - right inclined view.

Given the limitations of the images using the FlatScan® *scanner*, private radiology clinics were contacted onde the Institute doesn't have a . on-site CT scanner. One clinic suggested transporting the mandible to perform CT scanning, which allowed for reconstruction of an image comparable to a panoramic radiograph. No images of the maxilla were obtained, because the maxilla had not been enucleated.

A three-dimensional image of the mandible was obtained using the Morita® Veraview X800 F150 2019 and processed in CDT's e-Vol DX software. The *post-mortem* tomographic sections were converted into a two-dimensional linear image that closely resembled the panoramic radiograph using the i-Dixel *software* by Morita® (Fig. 4).

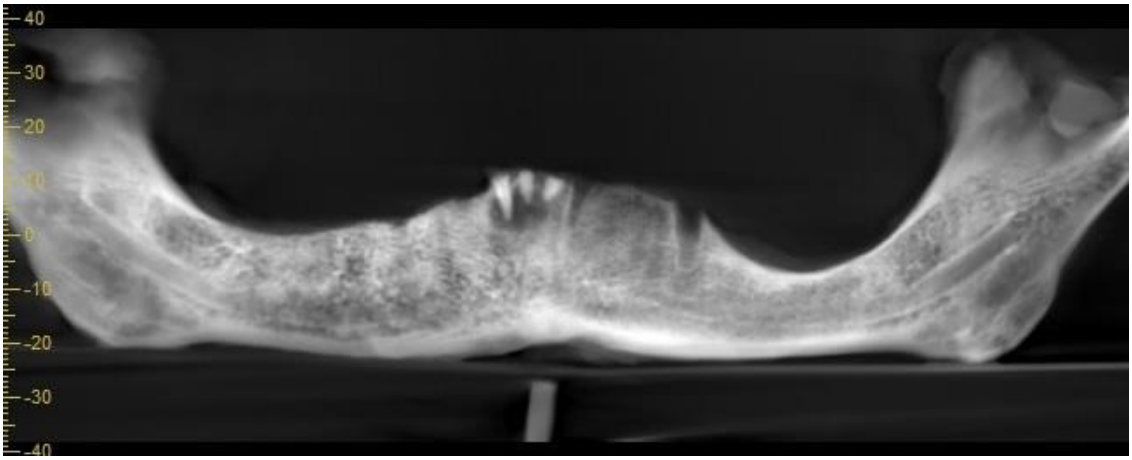

Figure 4: Linear junction of the *post-mortem* tomographic sections to obtain a two-dimensional image close to a panoramic radiography.

This two-dimensional image allowed for a detailed comparison with the *ante-mortem* radiograph provided by the family. Figure 4 illustrated the presence of three roots of mandibular dental elements #31, #41, and #42, with a hypodense, circular-shaped area in the root apex region of teeth #41 and #42. Additionally, it displayed the recent loss of teeth #32, #34, #43 and #45 along with a significant decrease in alveolar ridge height in the left hemi-arch.

Upon comparing the *ante-mortem* (AM) and *post-mortem* (PM) images, the following concordant points were observed: hypodense and radiolucent areas in the root apex region of teeth #41 and #42; and an empty alveolus outline of tooth #35, #43 and #45, which was consistent with the dental element's root on the AM radiograph. Moreover, similarities were noted in the inclination of the remaining tooth roots, the inclination and thickness of the alveolar ridge (Table 1).

For a clearer visualization of the similarity in the inclination of the roots of the dental elements, we conducted a superimposition of the *ante-mortem* panoramic radiograph image (Fig. 2) with the linear junction image of the *post-mortem* tomographic sections (Fig. 4), generating Figure 5. Upon comparing the

superimposed images, no divergences were found that would invalidate the identification process. The coinciding characteristics observed were deemed sufficient to establish a positive identification of the body. Consequently, the body was given to the family without the need for a genetic confrontation exam, which would be more expensive and time-consuming than the identification process conducted through Forensic Dentistry.

Table 1. Comparison of features of the mandible, using the ante-mortem panoramic radiograph provided by the family, obtained in 2019, and the *post-mortem* tomograph performed in 2020.

Tooth*	Panaromic Radiograph (AM)	Intraoral Exam (PM)	Computed Tomography (PM)	Comparison
31	RR Present	RR Present	RR Present	Concordant
32	Present; Distally inclined	RR Present	Absent; Distally inclined alveolus	Explainable Disagreement
33	Old loss	Old loss	Old loss	Concordant
34	Old loss	Old loss	Old loss	Concordant
35	Present; Mesially inclined	Present *Removed for DNA analyses	Absent/Open alveolus; Mesially inclined alveolus	Explainable Disagreement
36	Old loss	Old loss	Old loss	Concordant
37	Old loss	Old loss	Old loss	Concordant
38	Old loss	Old loss	Old loss	Concordant
41	RR Present; Circular radiolucent area	RR Present	RR Present; Circular radiolucent area	Concordant
42	RR Present; Circular radiolucent area	RR Present	RR Present; Circular radiolucent area	Concordant
43	RR Present	RR Present	Absent/Open alveolus	Explainable Disagreement
44	Old loss	Old loss	Old loss	Concordant
45	RR Present	RR Present	Absent/Open alveolus.	Explainable Disagreement
46	Old loss	Old loss	Old loss	Concordant
47	Old loss	Old loss	Old loss	Concordant
48	Old loss	Old loss	Old loss	Concordant
Left hemi-arch alveolar ridge height	Sharp decrease of the alveolar ridge	Sharp decrease of the alveolar ridge	Sharp decrease of the alveolar ridge	Concordant

*Dental notation preconized by FDI. RR: Root Residue.

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DISCUSSION

In this case, the body was found submerged in water in a river, and it was in an advanced stage of decomposition. The macroscopic examination revealed disfiguration of the facial features, loss of the auricular extremities, and destruction of the digital pulps, possibly due to the action of local fauna, as aquatic animals tend to target bodily extremities after death.[17,18] Given these conditions, the forensic expert must select the most appropriate identification method to employ[19,20].

Forensic Dentistry has a significant role in the human identification process, not only in cases of bodies submerged in water but also in other situations where papiloscopy is not feasible, such as advanced decomposition, mass disasters, and carbonization, as dental elements present reliable characteristics for evaluation[2,3,19].

The individuation of human dentition is based on the combination of morphological and positional characteristics from all teeth in a dentition[22]. Dental features contribute significantly to forensic identification, as a single individual's 32 teeth can exhibit around 160 dental surfaces. Moreover, the evaluation of restored, decayed, and lost teeth can yield over 2.5 billion distinguishing features[6]. Combining several dental traits can make identification as individualizing as mitochondrial DNA analysis, and dental confrontation is a swift and cost-effective method, particularly advantageous in mass disaster cases[2,4].

A systematic review published in 2020[11] analyses the forensic odontology with digital technologies, the authors agree that the human dentition is unique because it consist in the combination of decayed, missing and filled teeth[11]. They empathize the important of the dental comparation for individual identification. They also show positive results in use CT for superimposition function in *ante-morten* images taken with different modalities[21,22].

For successful dental confrontation, it is essential for clinical professionals to maintain well-filled and updated medical charts, documenting all relevant procedures performed and including images and exams when possible[10,23,24]. Dentist may prepare and keep patient records up-to-date[25]. However not always we have a complete documentation to perform the forensics, making the forensic process more challenging[19]. In this specific case, only a

single panoramic radiograph was available, but it provided a rich amount of dental and bone information.

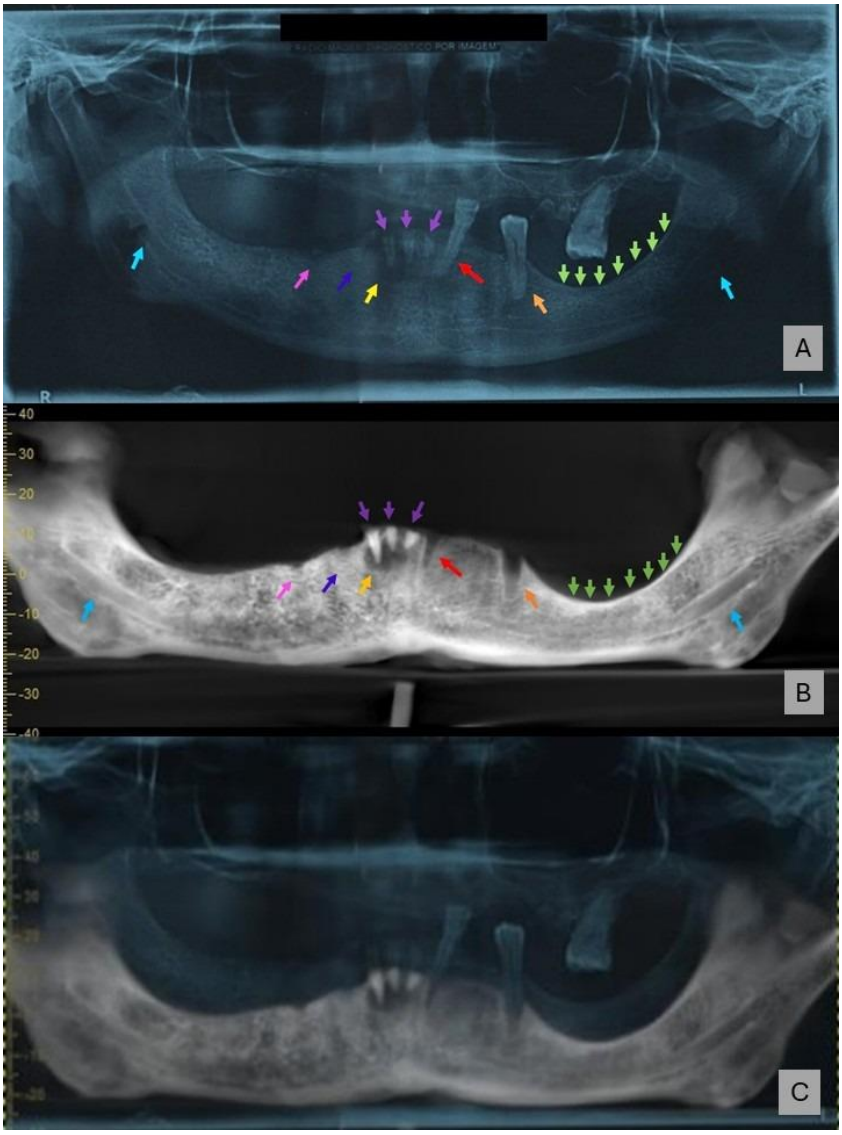

Figure 5: Computerized superimposition (C) of the *ante-mortem* panoramic radiograph images provided by the alleged victim's relatives (A), and the linear junction of the tomographic sections performed *post-mortem* CT scan (B). Inclination of the dental roots (purple arrows); hypodense and radiolucent areas in the root apex region of teeth 41 and 42 (yellow arrow); an empty alveolus outline of tooth 43 (dark blue arrow), 45 (pink arrow), 32 (red arrow) and 35 (orange arrow); inclination and thickness of the alveolar ridge (green arrows) and the shape and morphology of the mandibular canal (light blue arrows).

Although a minimum of 12 convergent points is often advocated for positive forensic dental identification, Silva et al.[26], in their case report discuss the existing controversy regarding the need to establish such a fixed minimum number. They present a forensic odontology identification supported by eight convergent points and emphasize that any quantitative assessment must be applied cautiously and

always alongside a qualitative analysis, giving primary weight to the individualizing value of the evidence.

In our present case, the comparison between the *ante-mortem* panoramic radiograph and the *post-mortem* findings revealed a consistent and characteristic pattern; the observed disagreements were explainable, and there were no disagreement points. Therefore, the quality and specificity of the concordant evidence - rather than a fixed number of points - were sufficient to support the positive identification.

The forensic dentist has the expertise to use necroscopic access routes to visualize dental arches. In this case, the mandible was removed from the body to obtain high-quality images. The adopted dissection technique was the inframandibular technique of Keiser-Nielsen (1963)[16], which enables the disarticulation of the temporomandibular joint through incisions made below the mandible. When necessary, disarticulating the mandible is also feasible[27,28].

The FlatScan® devices are employed in forensic practice for comprehensive body imaging and the detection of firearm projectiles. Efforts to obtain satisfactory dental images using this device were not successful, so a private clinic was contacted and recommended transporting the mandible for CT, which allowed reconstruction compatible with a post-mortem panoramic representation.

Use a CT scan for *pos-mortem* images offered advantages, including easier positioning of the mandible for X-ray incidence and the acquisition of a three-dimensional image, which facilitates the elimination of overlapping structures[11,29]. CT-based reconstruction also allows the generation of images compatible with panoramic radiographs, reinforcing its value in forensic dental identification when conventional radiographic techniques cannot be applied. This was crucial in this case, as the ante-mortem panoramic radiograph was the only available reference, and it was not feasible to perform a post-mortem panoramic radiograph due to positioning limitations of the body. Thus, advances in medical and dental technology are enhancing the capabilities of forensic science, and *post-mortem* CT has demonstrated its potential to become a standard replacement for radiographs[4,12,23,30,31].

Despite the high costs involved in implementing a CT service within the Institute, the benefits can be substantial. It tends to shorten case turnaround time by streamlining post-mortem image acquisition and processing, improving the efficiency of the autopsy[14]. In addition, it may lead to indirect cost savings by decreasing reliance on more expensive and time-consuming complementary examinations, such as DNA analysis[19,33]. In this case, if forensic dental identification had failed, the material would likely have been sent for genetic testing, which is more costly and time-consuming.

In addition to reconstructing the post-mortem image, the comparison benefited from digital alignment and superimposition between the PM reconstruction and the ante-mortem panoramic radiograph[10,29]. This approach facilitates direct point-to-point assessment

and improves visualization of concordant regions, making individualizing features easier to identify. Robinson et al.[10] describe a workflow using transparency (opacity) adjustment and color editing to enhance visualization of matching areas, and similar applications of digital superimposition have been reported to support positive dental identification[32]. Without superimposition, the comparison would likely be less informative, and the radiographic evidence less readily demonstrable[10,29].

CONCLUSION

The comparison of *ante-mortem* (AM) and *post-mortem* (PM) dental records plays a vital role in the forensic investigation process of human identification. In this case, the utilization of *post-mortem* tomography proved to be effective in comparing with the *ante-mortem* panoramic radiograph provided by family members, enabling a positive identification of the body based on the evaluation of bone and dental features. As a result, the case was efficiently solved, underscoring the significance of forensic dentistry in human identification.

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RESUMO

Quando os métodos de identificação convencionais são comprometidos, o estudo comparativo de imagens dentárias demonstra ser eficaz na identificação humana. Este estudo relata um caso de identificação humana utilizando a comparação de radiografia ante-mortem com tomografia computadorizada da mandíbula post-mortem. Um corpo masculino encontrado em estado avançado de decomposição foi encaminhado ao Instituto de Polícia Científica de João Pessoa/PB, Brasil. A identificação por impressões digitais e o reconhecimento facial não foi possível devido à destruição das polpas digitais e aos graves danos epidérmicos. Portanto, o odontolegista decidiu enuclear a mandíbula para obter imagens de tomografia computadorizada para comparação com uma radiografia panorâmica ante-mortem fornecida por um familiar da vítima. As imagens foram essenciais para o estudo e a comparação da anatomia das estruturas mandibulares, como o canal mandibular, bem como o posicionamento e a angulação das raízes dentárias. A comparação entre a radiografia dentária ante-mortem e a tomografia computadorizada post-mortem revelou características concordantes suficientes para uma identificação positiva.

PALAVRAS-CHAVE

Odontologia legal; Antropologia forense; Tomografia.

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