Faculdade de Medicina da Universidade de Coimbra

Mestrado Integrado em Medicina Dentária

Human identification for undocumented situation

- a technical note for a digital approach -

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Coimbra, junho 2023

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1. Abstract

In extreme forensic scenarios, such as mass disasters, the oral cavity can be a valuable source of identification information relevant to legal issues. The human identification scope has explored three-dimensional technology in personal data records. It has been empirically presented, focusing on isolated facial features, neglecting the overall context and real forensic scenarios. The study aims to explore two methodologies, intraoral scanner, and photography, in the scope of the orofacial record in forensic pathology, highlighting their impact on human identification.

A pilot and quasi-experiment study was performed using the intraoral scanner i700 wireless (Medit®, Lusobionic, Portugal) (Seoul, South Korea), Canon 5D-Full Frame equipment (Tokyo, Japan), Medit Scan for Clinics software and Smile Design application. The sample included living individuals (N=10) and forensic cases (N=10). The study was divided into two complementary phases: (i) data collection by two-dimensional and three-dimensional technologies, and (II) visual comparison by superimposition procedures, three-dimensional dental with three-dimensional facial records (3D-3D) and two-dimensional photography with screen-print of three-dimensional facial records (2D-3S). The statistical analysis was performed by descriptive procedure (Likert scale) and the Mann-Whitney test.

The analysis of data collection (n=220 records) by Mann-Whitney test between living individuals and forensic cases identified differences statistically significant in photographic method performance for intraoral mineralized tissues (p=0,004), intraoral soft tissues (p=0,016), and intraoral distortion (p=0,005), and intraoral scan method performance for intraoral extra-devices (p=0,003) and extraoral soft tissues (p=0,005).

The visual comparison (n=40) allowed the superimposition by 3D-3D. The 2D-3S superimposition qualitatively identified the medium third of the face as the corporal area within the anatomical features for the procedure's success.

In conclusion, the present study presented evidence-based data for intraoral scanners and emergent technologies to be explored as precious tools in forensic identification in real-world scenarios.

Keywords: Intraoral Scanner; Human Identification; Forensic Dentistry; Forensic Pathology; Legal Medicine

2. Resumo

Em cenários forenses extremos, tais como os desastres em massa, a cavidade oral pode ser uma valiosa fonte de informações para o processo de identificação, com relevância jurídica. A literatura atual relativa à identificação humana explora o registo de dados pessoais através da tecnologia tridimensional. Foi apresentada de modo empírico, centrando-se em características faciais isoladas, perecendo o seu estudo no contexto geral e cenários forenses reais. O estudo pretende explorar duas metodologias, o scanner intraoral e a fotografia, no âmbito do registo oro-facial em patologia forense, destacando o seu impacto na identificação humana.

Foi realizado um estudo piloto e quasi-experimental utilizando o scanner intraoral i700 wireless (Medit®, Lusobionic, Portugal) (Seul, Coreia do Sul), o equipamento Canon 5D-Full Frame (Tóquio, Japão), o software Medit Scan for Clinics e a aplicação Smile Design. A amostra incluiu indivíduos vivos (N=10) e casos forenses (N=10). O estudo foi dividido em duas fases complementares: (i) recolha de dados através de tecnologias bidimensionais e tridimensionais, e (II) comparação visual através de procedimentos de sobreposição, registos tridimensionais dentários com registos faciais tridimensionais (3D-3D) e fotografia bidimensional com screen-print de registos faciais tridimensionais (2D-3S). A análise estatística foi efetuada através de procedimento descritivo (escala de Likert) e do teste de Mann-Whitney.

A análise da recolha de dados (n=220 registos) pelo teste de Mann-Whitney entre indivíduos vivos e casos forenses identificou diferenças estatisticamente significativas no desempenho do método fotográfico nos tecidos mineralizados intraorais (p=0,004), nos tecidos moles intraorais (p=0,016) e na distorção intraoral (p=0,005), e no desempenho do método de digitalização intraoral para o uso de dispositivos-extra intraorais (p=0,003) e nos tecidos moles extraorais (p=0,005).

A comparação visual (n=40) permitiu a sobreposição por 3D-3D. A sobreposição 2D-3S identificou qualitativamente o terço médio da face como a área corporal dentro das características anatômicas para o sucesso do procedimento.

Em conclusão, o estudo apresentou dados baseados em evidência científica que suportam a continuação da exploração/ investigação dos scanners intraorais e das tecnologias emergentes como ferramentas precisas na identificação forense em cenários reais.

Palavras-chave: Scanner Intra-oral; Identificação Humana; Odontologia Forense; Patologia Forense; Medicina Legal

Abbreviations and acronym list

AM – Antemortem

PM – Postmortem

DNA – Deoxyribonucleic acid

IOS – Intraoral scanner

CBCT – Cone Bean Computer Tomography

INMLCF, I.P. – Instituto Nacional de Medicina Legal e Ciências Forenses

RENNDA – Registo Nacional de Não Dadores

LFD – Laboratory of Forensic Dentistry

2D – Two-dimensional

3D – Three-dimensional

EO – extraoral

IO – intraoral

3S – Screen-print of a three-dimensional record

3. Introduction

Human identification is grounded on the comparison of antemortem (AM) or missing data and postmortem (PM) data or undocumented findings. [1–7] In this process, fingerprint and dental (43-89%) [1] comparison, as well as genotyping (over 99%) [8] are the gold-standing methods due to their accuracy. [5] Both methods require a trustable baseline and preserved material. [1,8,9]

Current methods for human identification primarily involve morphometric or morphological criteria. [8] The morphometric approach involves the measurement of anatomic structures and inter-population groups' mean dimensions variability, mostly using different statistical methods to derive models or equations. [8] Regarding the morphological approach, it relies on the visual assessment and expertise skills of unique anatomic features and traits.

In extreme forensic cases involving burial, chemical attack, incineration, mutilation, submersion, and severe head and neck trauma, fingerprints analysis may be unreliable. Similarly, deoxyribonucleic acid (DNA) analysis for submerged remains depends on various factors such as temperature, duration of submersion, presence of contaminants, and the condition of the remains. However, oral structures can withstand such conditions to some extent, allowing for identification. [1,5,6,9–11]

Dental autopsy being invasive on facial structures [2,12], is the final step in the identification process and is considered the slowest. [1,2,8,9] Dental structures become elective for morphological analysis and genotype profile sampling [1,3,8,9], applying primarily geometric morphometric techniques. [7,8] It relies on the unique characteristics of the dentition and dental restorations, as well as the relative resistance of the mineralised dental tissue and dental restorations. [1,3,11,13] In addition, the palatal rugae are sufficiently unique and relatively stable, specifically the second and third palatal rugae, can also be used as a supplementary data for forensic individual identification. [10,14] In fact, palatal rugae discriminate between identical monozygotic twins, who have identical DNA. [9,10] Postmortem dental profiling plays a crucial role in forensic identification by providing information on the deceased's age, ancestry background, sex, and social-economic status. This data helps narrow down potential matches and facilitates a more focussed search of antemortem findings. [1,3,4,8]

Antemortem data are accessed from clinical dental records [3] following the Data Protection Act 2018, which demands the preservation of dental records. [1,6] Clinical dental records contained valuable information such as radiographies, photographs, dental charting, and dental models. These records include distinctive characteristics such as missing teeth, dental implants, prostheses, dental restorations (fillings), presence of tooth crowding, or unusual arrangements of teeth in a dental arch. [1,6] Clinical dental data can be recorded digitally, in handwritten form, or in two-dimensional dental charts and captured in dental cast models. [1,3] By comparing the antemortem and postmortem dental records, forensic odontologists can positively identify the deceased or provide valuable information to assist in the identification process.

In contemporary dental clinical practice, intraoral scanners (IOS) and cone bean computer tomography (CBCT) have become standard health devices [4,7,9,10,15,16] by offering highly accurate, three-dimensional records of the dental arches and surrounding structures. [4,9,15] Compared with the traditional dental cast methods, IOS reduces the operative time, stress, and discomfort for the patient. [2,10,16–19] Furthermore, it allows easy and quick access to patient information, eliminates impression material or gypsum deformation, reduces storage space, and facilitates communication between peers. [2–4,15–18,20]

IOS can be categorised as contact and laser. [21] Contact IOS explores the object's surface through a probe with a hard-steel or sapphire tip, and a series of internal sensors determine the spatial positions of the probe. On the other hand, the laser IOS projects a light source. It detects its return, capturing the object's geometry by triangulation and capturing the dental arches more rapidly than the contact IOS. [21] Contact IOS is often used in inspection and quality control systems, while laser IOS is typically used in dental clinical practice for scanning dental arches. The scanning software that processes the captured images to generate point clouds reproduces the object’s geometry. These point clouds are then triangulated by the same software, creating a 3D surface model (mesh), producing a virtual alternative to traditional plaster models. [3,18,19,21] A complete IOS 3D model can include other stationary structures besides teeth, allowing the association of high-reliability methods such as rugoscopy for identification purposes. [2,10]

The study aims to present evidence-based data to explore two methodologies, IOS and photography, in the scope of the orofacial record in forensic pathology, highlighting their impact on facial identification and addressing a gap in the literature.

4. Material and Methods

4.1. Sample selection

The study included a sample of oro-pathological exams, conducted at the National Institute of Legal Medicine and Forensic Science (INMLCF, IP), Central Branch, Portugal (Figure 1). The exams were carried out between July of 2022 and June 2023 and encompassed forensic cases involving individuals who were (i) over 18 years old, (ii) in possession of permanent dentition and (iii) following the Portuguese protocol stated as Portuguese's Record of Non-donors (RENNDA) following Portuguese protocol. The exclusion criteria were (i) fragmented and/ or (ii) undocumented corpses, (iii) advanced stage of putrefaction and (iv) edentulous status.

Dental exams in living individuals, (i) over 18 years old (ii) in permanent dentition were performed at the Laboratory of Forensic Dentistry (LFD), Faculty of Medicine, University of Coimbra, Portugal. Dental exams were completed from September 2022 until May 2023. The exclusion criteria were (i) edentulous status and (ii) rehabilitation by removable dental prosthesis. Those who satisfied the eligibility criteria were asked to provide written informed consent before the study commenced (Appendices I. Informed consent).

The study was carried out according to the Declaration of Helsinki and approved by the Ethics Committee CE12/2022 of the INMLCF, I.P. and CE-023/2027 of the LFD.

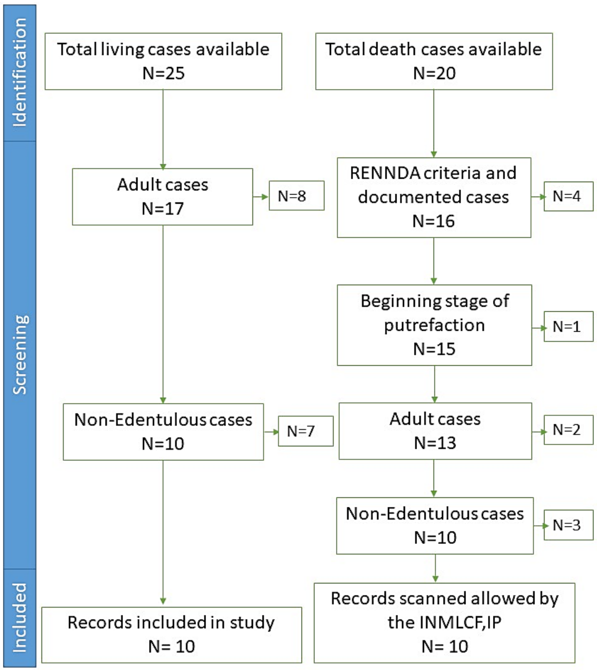


Figure 1 – Sample collection, following inclusion and exclusion criteria.

4.2. Study design

A pilot and quasi-experimental study design was utilised to examine oral records as personal data. The personal data were obtained through two methods: 1) photography and 2) IOS techniques.

The study sample was divided into two complementary phases: (P1) the first phase or Data Collection phase, the record of two-dimensional (2D) and three-dimensional (3D) data, and (P2) the second phase or Visual Comparison phase, the superimposition procedures (Appendices II Figure 1).

The Data Collection or P1, used a Canon EOS 5D Mark-II (Tokyo, Japan) and 28-135 mm Macro 0,5mm/1,6ft lens was used to capture 2D photograph data. Moreover, additional devices were used: mouth retractor (Optragate, Ivoclar®), supplementary lighting (flash), and tripods (monkey tripod, Joby®).

The equipment was selected to photograph extraoral (frontal and lateral) and intraoral (maxillary and mandibular arches and interdental relation) 2D data. In total, seven photographs were taken for each case.

The i700 wireless IOS (Medit ®, Lusobionic, Portugal) (Seoul, South Korea), along with the Medit Scan for Clincs and Smile Design software's, running on a MacBook Air M2 with 24GB of RAM, was used to collect 3D data. The equipment and the application were used to record intraoral (maxillary and mandibular dental arches and interdental relation), and facial 3D data. In total, four scan were taken for each case.

The study focused on the medium and lower third of the face following the anatomic details of Arnett's study (Appendices II Figures 2). [22]

The Visual Comparison or P2, included two superimposition procedures: (i) 3D dental and 3D facial data or 3D-3D superimposition (3D-3D), and (ii) 2D frontal extraoral photography with a screen-print of a 3D facial record (3S) or 2D-3S superimposition (2D-3S).

4.3. Data development and analysis

A team of dentists performed the study, supervised by forensic odontologists from the LFD. With up to 15 years of experience in medico-legal expertise and anatomy education, the research team analysed the data records' consistency. Two researchers assessed and scored each parameter separately, and in case of doubt, a third person was appointed as a decision-maker, and one researcher conducted the superimpositions using the Medit Scan for Clinics under the supervision of the team.

4.3.1. Data collection

The 2D data collection included the settings: ISO 300, a shutter speed of 1/60 and an aperture of f/5,6 for extraoral data, and aperture was adjusted to f/32 for intraoral data. The 2D images were saved as a RAW and JPEG file with a resolution of 300 dpi.

In the 3D data collection was performed into Medit Scan for Clinic software. Intraoral scanning involved starting with the occlusal surface of the left rearmost teeth, followed by scanning the dental arch and the surrounding soft tissues. The interdental relation was recorded based on the natural inter-arcade position in living individuals, and manual alignment using reference points in forensic cases. The facial scan captured the anatomical details of the inter-labial exposure zone, defined in the resting position, which includes the incisor exposure, situated between the lower limit of the upper lip and the upper limit of the lower lip. [22] The scanning process in a circular motion, filling the lower third of the face. Anatomic details were capture from the sub-nasal cutaneous point to the glabella and laterally following the external angle of the eye for the medium facial third.

Data analysis followed the parameters: (i) time elapsed (seconds), (ii) mineralized details (Likert scale), (iii) soft tissue details (Likert scale), (iv) communication (Likert scale), (v) extra devices (Likert scale), and (vi) distortion (Likert scale). Parameters' evaluations were based on a scoring system following a Likert scale (0 to 4), in which higher scores were given for better performance.

A Likert scale for the analysis of mineralized details included a score of 4 points if teeth or both arches were visible; 3 points if teeth were visible in one arch; 2 points if teeth were partially visible in both jaws, 1 point if teeth were partially visible in one jaw and not visible in the other jaw, and 0 points if no elements were visible in both jaws. For soft tissues details included: a score of 4 points was given if soft anatomical details were visible in the correspondent facial third portion; 3 points if all features were visible in the lateral portion (left or right); 2 points if details were partially in the lateral portion; 1 point if details were partially visible in one lateral portion; and 0 points if no elements were visible. The communication score was based on the type and format of data included in the record. A score of 4 points was given if the documents had both 3D and 2D data; 3 points for only 3D data; 2 points for only 2D data with colour information; 1 point for only 2D data without colour information; and 0 points for unformatted data.

The extra-devices score was based on the number and type of devices used. A score of 4 points was given if no extra devices were used; 3 points if mouth retractors were used; 2 points if additional lighting was used; 1 point if both mouth retractors and additional lighting were used; and 0 points if mouth retractors, extra lighting, and a tripod were used. Distortion was scored with 4 points if the records had no distortion (three circles of the ABFO-2 scale were respected); 3 points if the documents needed a dimensional scale for some record details to be assessed (two circles of the ABFO-2 scale were respected); 2 points if a scale was required for some of the details to be evaluated (one circles of the ABFO-2 scale was respected); 1 point if the records showed partial distortion (no circles of the ABFO-2 scale was respected) and 0 points if the records were entirely distorted.

A statistical study was performed by descriptive analysis and the Mann-Whitney test for the data collection phase.

4.3.2. Visual comparison

The 3D-3D superimposition process was performed by Medit Scan for Clinics through alignment tools and resolution's colour scale (Appendices II. Figure 3) for accurate assessment (Appendices II. Figures 4). Coronary details of anterior teeth achieved the alignment for the superimposition between the intraoral and facial scans within a range of 2 to 3 mm of the occlusal limit following Corte-Real and Reesu studies. [23,24] The tooth with the highest resolution was selected to conclude the process, and the highest and lowest scale values were identified for mean value calculation.

The 2D-3S superimposition process was performed by Smile Design application with the uploading of the 2D photograph records and 3S records (Appendices II. Figures 5) and their alignment. The 3D facial was reoriented to align anatomical facial details with the photos achieving the 3D screen-print for accuracy superimposition. The superimposition of 2D-3S was performed through the manual identification of cutaneous biometric points, as facial landmarks, following Gibelli*.* [25] study. The cutaneous landmarks were glabella; right and left exocanthion and endocanthion; right and left nose wing; nasion and sub-nasal; right and left cheilion, upper and lower lip; gnathion and mento (Appendices II. Figures 2).

The 2D-3S superimposition process was detailed in Appendice II. Figures 5, highlighting that the Smile Design application assessed the potential compatibility between these two records as they were overlaid.

5. Results

A total of photos (n= 140) and dental and facial scanners (n=80) corresponded to 10 living individuals (samples L1 to L10) and 10 forensic cases (samples D1 to D10) flowing previous criteria (figure 1). A total of 40 superimpositions corresponded to 3D-3D (n=20) (samples L1 to L10 and D1 to D10) and 2D-3S (n=20) (samples L1 to L10 and D1 to D10).

5.1. Data collection

The photography method was able to record extraoral data for all samples (N = 20). All individual scores were summed up and presented in Table 1. Different devices, mouth retractors, and additional lighting were used (1 score). The recording of intraoral mineralized data in forensic cases was partial, ranging from 2 to 3 scores. Additionally, there was a notable decrease in intraoral distortion and soft data tissue, with scores ranging between 1 and 2.

Table 1 – Descriptive statistics for photography (N=20). Intraoral (IO) and extraoral (EO) parameters (mineralized details, soft tissue details, communication, extra-devices, distortion) ranting using a Likert scale ranging from 0 to 4, and the duration of the photograph procedure was measured in seconds (s).

	Parameters	Mean		Std. Deviation		Minimum		Maximum	
		Life	Death	Life	Death	Life	Death	Life	Death
Intraoral	Mineralized	3,70	2,40	,46	,49	3	2	4	3
	Soft	2,70	1,70	,46	,46	2	1	3	2
	Communication	2,00	2,00	,00	,00	2	2	2	2
	Extra-devices	1,00	1,00	,00	,00	1	1	1	1
	Distortion	3,00	1,40	,00	,49	3	1	3	2
	Duration	300,90	899,40	5,37	5,92	298	889	309	907
Extraoral	Soft	4,00	4,00	,00	,00	4	4	4	4
	Communication	2,00	2,00	,00	,00	2	2	2	2
	Extra-devices	1,00	1,00	,00	,00	1	1	1	1
	Distortion	4,00	3,20	,00	,40	4	3	4	4
	Duration	89,30	301,30	1,73	3,49	86	295	92	308

The i700 wireless scanner was able to record intraoral data for all samples (N = 20). All individual scores were summed up and presented in Table 1.

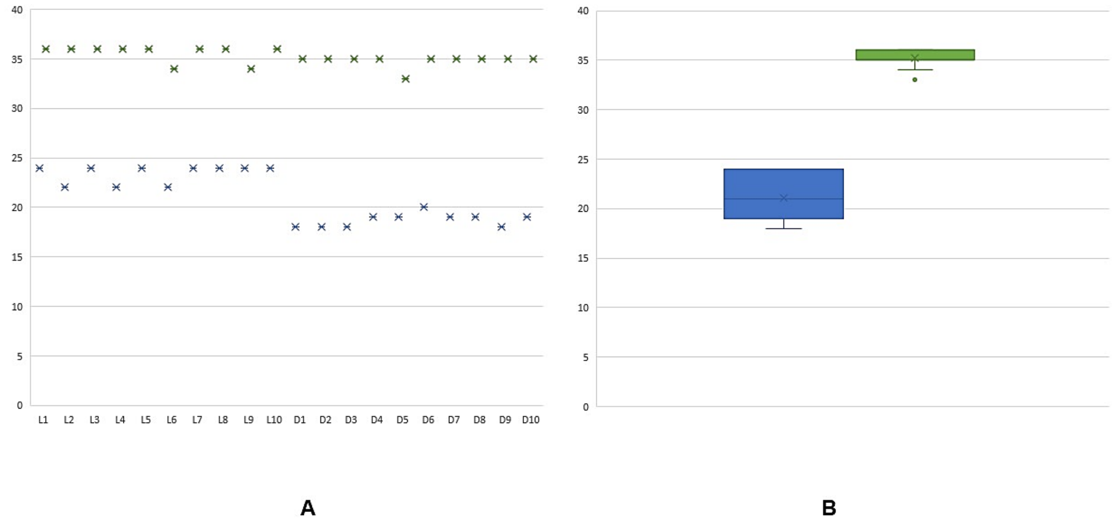
The scanner performed with the lowest results in extraoral view in living individuals. Extraoral data corresponded to the minimum 3 score and maximum 4 scores for the soft tissue and distortion record parameters (Table 2). The scanner performed with high scores in all other parameters, either in living individuals or forensic cases.

Table 2 – Descriptive Statistics for i700 wireless scanner (N=20). Intraoral (IO) and extraoral (EO) parameters (mineralized details, soft tissue details, communication, extra-devices, distortion) ranting using a Likert scale ranging from 0 to 4, and the duration of the IOS procedure was measured in seconds (s).

	Parameters	Mean		Std. Deviation		Minimum		Maximum	
		Life	Death	Life	Death	Life	Death	Life	Death
Intraoral	Mineralized	4,00	3,90	,00	,30	4	3	4	4
	Soft	4,00	3,90	,00	,30	4	3	4	4
	Communication	4,00	4,00	,00	,00	4	4	4	4
	Extra-devices	4,00	3,00	,00	,00	4	3	4	3
	Distortion	4,00	4,00	,00	,00	4	4	4	4
	Duration	720,00	788,10	11,38	8,57	709	775	750	800
Extraoral	Soft	3,80	4,00	,40	,00	3	4	4	4
	Communication	4,00	4,00	,00	,00	4	4	4	4
	Extra-devices	4,00	4,00	,00	,00	4	4	4	4
	Distortion	3,80	4,00	,40	,00	3	4	4	4
	Duration	123,70	86,10	6,29	5,96	115	75	135	93

The descriptive analysis included the summed scores of each parameter which used the Likert scale for all samples (Figures 2).

The lower values corresponded to photographic methods on forensic cases (score 18). All photographic scores were between 18 and 24, being the highest scores in living individuals (Appendices II. Figures 6).



Figures 2 (A and B) – *Scores of the Linkert scale parameters* (A). The summed scores for live individuals (L1 to L10) and forensic cases (D1 to D10) (N=20). (B). Boxplot graphic with score between photographic (blue) and IOS (green) (N=20).

The higher values were found on IOS methods. The lowest score among IOS methods was 34 in living individuals, and the highest score was 36.

The analysis by Mann Whitney test between living individuals and forensic cases identified differences statistically significant in photographic method performance for intraoral mineralized (p=0,004), intraoral soft tissues (p=0,016), and intraoral distortion (p=0,005).

The analysis by Mann Whitney test between living individuals and forensic cases identified differences statistically significant in IOS method performance for intraoral extra devices (p=0,003) and EO soft tissues (p=0,005).

5.2. Visual comparison

5.2.1. 3D-3D superimposition

The Medit software allowed the 3D-3D superimposition process in all samples (N=20) (Appendices II. Figures 7). The findings were summed up and presented in Figure 3 following the resolution score of the software.

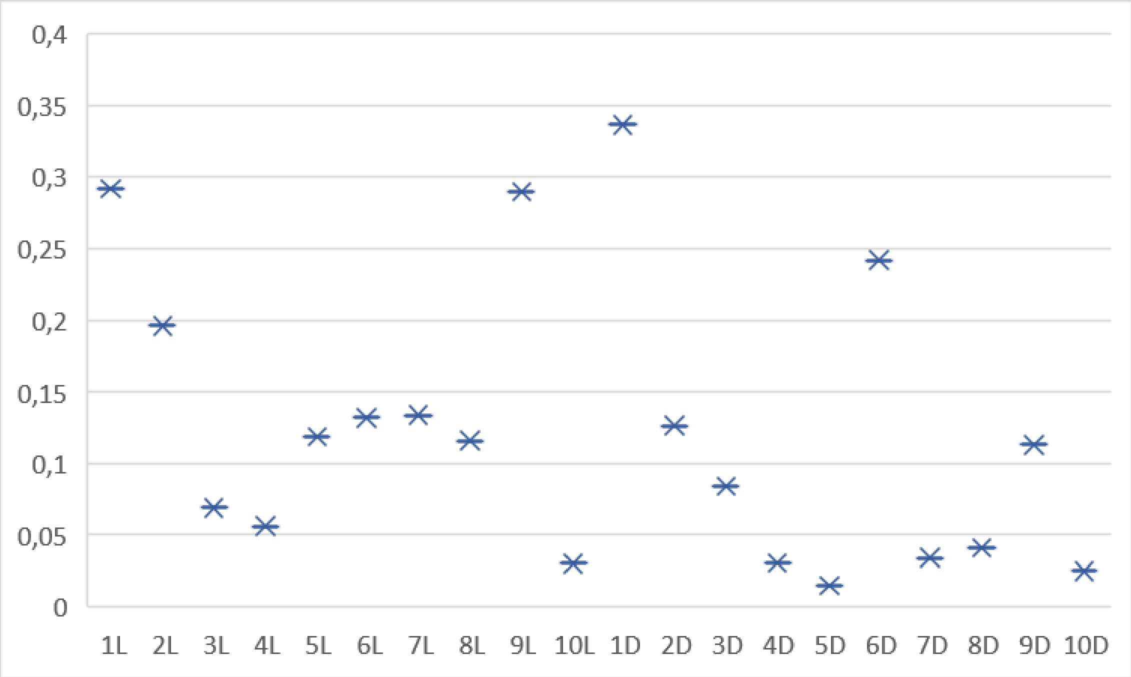


Figure 3 – Descriptive analysis for 3D-3D superimposition results (N=20) for live individuals (L1 to L10) and forensic cases (D1 to D10).

5.2.2. 2D-3S superimposition

The descriptive analysis with the Smile Design application allowed the user to perform a 2D-3S superimpositions process in all samples (N=20) (Appendices II. Figures 8). Cutaneous biometric points were selected following the sequence of positive superimposition (match) in opposite to negative superimposition (no match) (Table 4).

The 2D-3S was successfully superimposed: right and left endocanthion landmarks and their linear measure; right and left nose wing landmarks and their linear measure; glabella and sub-nasal landmarks and their linear measure; and occlusal plane.

Only the exocanthion lines matched between the records without any other landmark alignment. While the cheilion line can ensure a match in living individuals, in forensic cases, no match occurs.

Table 4 – Descriptive analysis for 2D-3D superimposition (N=20). Legend: green (match), red (no-match) and grey (different results depending on the different cohorts).

		Screen-print of 3D facial scan					
		Endocanthion line	Gb-Sn line	Nose wing line	Occlusion plan	Cheilion line	Exocanthion line
2D photograph	Endocanthion line						
	Gb-Sn line						
	Nose wing						
	Occlusion plan						
	Cheilion line						
	Exocanthion line						

The 2D-3S was successfully superimposed following right and left endocanthion landmarks, and its linear measure; right and left nose wing landmarks, and its linear measure; glabella and sub-nasal landmarks, and its linear measure; and occlusal plane.

6. Discussion

This ground-breaking study investigates the application of 3D scanners, specifically IOS, in dental and facial identification within an authentic forensic setting. The research encompasses both living and deceased individuals, aiming to address a significant gap in the existing literature. [2,4,11,23]

The utilisation of IOS technology allows for the capture of intraoral (dental and gingival) features, which can be stored in various file formats and integrated into a unified model referred to as the “virtual patient”. [2,12,18] This emerging technological paradigm significantly enhances functionality and augments accuracy [7,17,18] across a broad spectrum of scenarios. When comparing different facial scanners, it is essential to consider the potential impact of minor variations or slight modifications caused by involuntary facial mimicry resulting from facial muscular contractions. Such variations can lead to false negatives when attempting to match 3D scans from the same individual. [26] Both the clinical and forensic communities have established the precision of 3D recording to analyse anatomical morphology. [4,17,19,27] The reliability and advantages of using IOS technology in forensic applications, as discussed previously, should be considered in conjunction with the challenges and limitations of visual identification and facial scanning scenarios. Facial differences among monozygotic twins were found to be higher compared to superimpositions involving 3D models from the same individual but lower than those obtained by superimposing 3D facial models of unrelated subjects. [28] This highlights the importance of cautious application when visually identifying individuals directly from human remains or facial scanners in mass disasters, as high error rates and environmental conditions can alter appearances. [5] Additionally, the rapid deterioration of the face in such situations further complicates accurate identification. [5] The present study intended to relate different methods of data recording for the same individual instead of analysing data records between different individuals.

The i700 wireless scanner (Medit ®) was selected for this study based on its accuracy demonstrated by Bae EJ et al., which established the suitability of the i500 scanner for forensic applications. [3] The i700 wireless scanner was chosen for its portability, wireless capabilities, and compatibility with software updates, addressing recent needs in oral rehabilitation. These features enable convenient usage and ensure adaptability to evolving technological advancements. [7,17,18] Moreover, the standardised recording of personal data in a universal formal within a global space holds immense significance for effective communication, seamless data sharing, comprehensive analysis, and reliable comparisons. [29]

Trends in reaching a quantitative outcome in facial identification emphasise a comprehensive examination of descriptive analysis of technical parameters to compare the performance of IOS and photography. The geometric relations management with the ABFO scale allowed us to overcome the angular distortion, ensuring the specificity of the lens and perpendicular camera positioning. [11,23] Unlike 3D images, photographic images are 2D projections of 3D objects, resulting in a lower recognition rate and difficulties in comparison when the orientations are not practically identical. [11,30] Challenge the conventional use of photograph as a standard complementary diagnostic examination in oro-pathological exams was focused on its applicability in forensic situations compared with its routine use in clinical practice in dentistry. These two methods were explored in all their functionalities, and findings shed light on the capabilities in a forensic scenario.

Focusing on data collection issues, photographs of living individuals demonstrated high performance and minimal distortion in 2D records, both EO and IO records, enclosing mineralized and soft tissues. However, it is important to note that achieving such precision often requires the use of additional devices. [31] On the other hand, the IOS procedure demonstrated excellent performance in EO and IO records, achieving high accuracy nevertheless adding mouth retractors. Furthermore, IOS distinguished itself by its ability to generate a 3D model. The 3D record improves dynamic visualisation, allowing unlimited static individual profiles. [23,32] In forensic scenarios, photography had higher performance EO than IO records (Table 1). The present of rigor mortis and stiffening of the masticatory muscles posed challenges for accessing and fully capturing IO structures. In contrast, IOS demonstrated faster and higher performance, particularly in IO records, due to its smaller camera size and the absence of additional devices.

However, it is important to consider the limitations of IOS during the advanced stages of putrefaction, where remaining soft tissues undergo degeneration. While the photography method can capture available data, the IOS may face challenges in establishing reference points based on mineralized morphology, limiting the generation of substantial data.

Focusing on superimposition issues, technique engage morpho-anatomical characteristics shape, position, angulation, size, anomalies, alignment, and interrelations. [11,23] For identification purposes, dental and smile features of the lower facial third have been used to highlight the anterior area. [25] Reesu's study empirically used AM data of the lower facial third by frontal photographs, following straight standards, and 3D volumes to determine the anatomical relations in superimposition procedures. [11]

The 3D-3D superimposition through landmark-based or surface-based methods includes manually identifying its references in both models following Stucki and Talaat studies. [15,20] The human error of a manual procedure will pass through the accuracy and expertise in carrying out the procedure, as well as the choice of reference areas and the number of landmarks used significantly influence the outcome of the superimposition. [15,20,32] The Medit for Clinics software validated the manual procedure through a resolution scale (Appendices II. Figure 3) and guided the match to offer increased precision, accuracy, and robustness, with minimal mismatch distances at the arch and tooth levels. [6,8,23] It added that the advantages of using 3D models lies in comparing images at the same orientation and size emphasising the Gibelli's study. [25]

The 2D-3S superimposition through the Smile Design application processed automatically on the dimensional adjustment of both records (Appendices II. Figures 5). In a virtual environment, selecting the pattern for the chosen profile allowed identifying of the same anatomical structures on the photography and screen-print. These records became digital replicas of real-world photographs, facilitating their geometries' analysis, visualisation, and manipulation overcoming the bias in Reesu's study. [11] Additionally, 3D records can have the capability to be seamlessly overlaid with a wide range of AM records, which encompass diverse techniques, an enhanced level of versatility and complexity is achieved. [5,8,23,32]

In this overlapping stage, the importance of the anatomical details of the medium floor of the face was verified in terms of the relationship between the two registers. It was possible to maintain its narrow anatomical overlap by combining the endocanthion, nose wing, glabella and sub-nasal line and the occlusal plane while associating the details of the face's lower third, the overlap's success was compromised.

These results align with works that focus on the need for adjustment in identifying individuals who underwent orthognathic surgery in a treatment plan due to a class III diagnosis. [33] Furthermore, no match was found between the cheilion line. It can be explained by the anormal position of the mandible in forensic cases. Additionally in living individuals exocanthion line no match can be explain by the involuntary movements of the orbicular muscles under the IOS light stimulus.

The use of emergent technologies and recent 2D data (namely social records) were in line with update records needed in real scenarios. Nakamura and Reesu's studies highlighted new changes in the incisal margin, cusps, or tooth alignment over timebases as traumatic facial injuries on the anterior dentition. [7,11] The learning curve associated with using IOS technology becomes crucial to address a potential bias. Despite this, the reliability and precision of IOS, particularly with newer generation models like the I700 wireless, make it a promising tool for forensic applications, capable of detecting sharp edges such as the incisal edge of anterior teeth with high precision. [3,16,17,19] Additionally, IOS offers additional benefits, including minimising distortion and creating a digital archive with proprietary and open-format files, which enables effortless sharing for legal purposes and eliminates the risk of losing essential data. [2,3,18,19] Moreover, the ability to present virtual expert witnesses in court and maintain a chain of evidence, while enabling seamless information exchange between professionals and institutions further enhances the value of utilising scanning technology in complex forensic scenarios. [19]

Overall, a more comprehensive and balanced approach can be taken in forensic applications by considering the challenges and limitations of traditional visual identification and facial scanning methods and recognising the advantages and potential biases associated with using IOS technology.

7. Conclusion

The present study highlights the advantages of using IOS for medicolegal and forensic purposes, specifically in human identification, in comparison to traditional photographic methods. While photography provides a visual record of orofacial structures, it has limitations due to its two-dimensional nature and susceptibility to lighting and other factors.

On the other hand, IOS offers several benefits, including the ability to capture highly detailed 3D models of teeth and oral structures with exceptional reliability, ease to use, and reproducibility. In forensic cases, the time required for an IOS is shorter compared to conventional photography, without requiring additional sources of light or mirror devices.

Other advantages of IOS are the possibility of superimposing 3D records onto both 2D and 3D records. As a result, IOS emerges as a potentially accurate and robust tool with numerous benefits in the forensic scope, enabling efficient real-time communication and comparison between cases.

8. Acknowledgments

As primeiras palavras de agradecimento vão para a minha orientadora, prof. Doutora Ana Teresa Corte-Real, a quem devo apenas gratidão desde o início até ao fim do curso. Obrigada pela orientação, conselhos, apoio, oportunidades e amizadade ao longo do meu percurso académico.

Ao meu co-orientador, Dr.º Tiago Nunes, agradeço por toda a disponibilidade, simpatia, conselhos e dedicação.

Quero agradecer a todos que me ajudaram na realização deste trabalho. Ao Instituto Nacional de Medicina Legal e Ciências Forenses, em especial ao doutor Gonçalo, agradeço a gentileza e disponibilidade. Ao doutor Pedro Almiro, agradeço pela realização da análise estatística.

Agradeço a todos os professores que enriqueceram a minha formação, quer professional quer pessoal, e aos funcionários que me acompanharam diariamente ao longo destes árduos anos, com especial destaque à dona Alda e dona Sónia, muito obrigada pelo carinho e amizade.

Aos meus colegas, amigos, afilhadas, Bea, Leonor, Sara, Mariana, e madrinhas, um eterno obrigado por todos os momentos ao longo destes anos.

Laura, Maria, Rita e Joi obrigada por serem a minha segunda família.

Ao Kamil, que mesmo longe está perto, obrigada por me apoiares e motivares sempre a continuar.

À minha família, Marta, mãe e pai, a quem devo tudo o que sou hoje, obrigada por me oferecem as condições que me permitiram alcançar os meus objetivos.

9. References

[1] Dostalova T, Eliasova H, Seydlova M, Broucek J, Vavrickova L. The application of CamScan 2 in forensic dentistry. J Forensic Leg Med 2012;19:373–80. https://doi.org/10.1016/j.jflm.2012.04.015.

[2] Putrino A, Bruti V, Enrico M, Costantino C, Ersilia B, Gabriella G. Intraoral Scanners in Personal Identification of Corpses: Usefulness and Reliability of 3D Technologies in Modern Forensic Dentistry. Open Dent J 2020;14:255–66. https://doi.org/10.2174/1874210602014010255.

[3] Bae E-J, Woo E-J. Quantitative and qualitative evaluation on the accuracy of three intraoral scanners for human identification in forensic odontology. Anat Cell Biol 2022;55:72–8. https://doi.org/10.5115/acb.21.136.

[4] Santo E, Pinho T, Teixeira A, Perez-Mongiovi D. Use of intraoral three-dimensional images for the identification of dental morphological traits related to ancestry estimation. Journal of Forensic Science and Medicine 2021;7:70. https://doi.org/10.4103/jfsm.jfsm_21_21.

[5] Caplova Z, Obertova Z, Gibelli DM, De Angelis D, Mazzarelli D, Sforza C, et al. Personal Identification of Deceased Persons: An Overview of the Current Methods Based on Physical Appearance. J Forensic Sci 2018;63:662–71. https://doi.org/10.1111/1556-4029.13643.

[6] Abduo J, Bennamoun M. Three-dimensional image registration as a tool for forensic odontology: a preliminary investigation. Am J Forensic Med Pathol 2013;34:260–6. https://doi.org/10.1097/PAF.0b013e31829f6a29.

[7] Nakamura Y, Nakamura M, Kasahara N, Hashimoto M. Personal Identification by Superimposition of Three-dimensional Intraoral Models. Bull Tokyo Dent Coll 2020;61:169–78. https://doi.org/10.2209/tdcpublication.2019-0028.

[8] Mesejo P, Martos R, Ibáñez Ó, Novo J, Ortega M. A Survey on Artificial Intelligence Techniques for Biomedical Image Analysis in Skeleton-Based Forensic Human Identification. Applied Sciences 2020;10:4703. https://doi.org/10.3390/app10144703.

[9] Simon B, Aschheim K, Vág J. The discriminative potential of palatal geometric analysis for sex discrimination and human identification. J Forensic Sci 2022;67:2334–42. https://doi.org/10.1111/1556-4029.15110.

[10] Zhao J, Du S, Liu Y, Saif BS, Hou Y, Guo Y. Evaluation of the stability of the palatal rugae using the three-dimensional superimposition technique following orthodontic treatment. J Dent 2022;119:104055. https://doi.org/10.1016/j.jdent.2022.104055.

[11] Reesu GV, Mânica S, Revie GF, Brown NL, Mossey PA. Forensic dental identification using two-dimensional photographs of a smile and three-dimensional dental models: A 2D-3D superimposition method. Forensic Sci Int 2020;313:110361. https://doi.org/10.1016/j.forsciint.2020.110361.

[12] Roy J, Shahu U, Shirpure P, Soni S, Parekh U, Johnson A. A literature review on dental autopsy an invaluable investigative technique in forensics. Autopsy Case Reports 2021;11:e2021295. https://doi.org/10.4322/acr.2021.295.

[13] Franco A, Willems G, Souza PHC, Bekkering GE, Thevissen P. The uniqueness of the human dentition as forensic evidence: a systematic review on the technological methodology. Int J Legal Med 2015;129:1277–83. https://doi.org/10.1007/s00414-014-1109-7.

[14] Gibelli D, De Angelis D, Pucciarelli V, Riboli F, Ferrario VF, Dolci C, et al. Application of 3D models of palatal rugae to personal identification: hints at identification from 3D-3D superimposition techniques. Int J Legal Med 2018;132:1241–5. https://doi.org/10.1007/s00414-017-1744-x.

[15] Stucki S, Gkantidis N. Assessment of techniques used for superimposition of maxillary and mandibular 3D surface models to evaluate tooth movement: a systematic review. Eur J Orthod 2020;42:559–70. https://doi.org/10.1093/ejo/cjz075.

[16] Róth I, Czigola A, Joós-Kovács GL, Dalos M, Hermann P, Borbély J. Learning curve of digital intraoral scanning – an in vivo study. BMC Oral Health 2020;20:287. https://doi.org/10.1186/s12903-020-01278-1.

[17] Róth I, Czigola A, Fehér D, Vitai V, Joós-Kovács GL, Hermann P, et al. Digital intraoral scanner devices: a validation study based on common evaluation criteria. BMC Oral Health 2022;22:140. https://doi.org/10.1186/s12903-022-02176-4.

[18] Mangano F, Gandolfi A, Luongo G, Logozzo S. Intraoral scanners in dentistry: a review of the current literature. BMC Oral Health 2017;17:149. https://doi.org/10.1186/s12903-017-0442-x.

[19] Vilborn P, Bernitz H. A systematic review of 3D scanners and computer assisted analyzes of bite marks: searching for improved analysis methods during the Covid-19 pandemic. Int J Legal Med 2022;136:209–17. https://doi.org/10.1007/s00414-021-02667-z.

[20] Talaat S, Kaboudan A, Bourauel C, Ragy N, Kula K, Ghoneima A. Validity and reliability of three-dimensional palatal superimposition of digital dental models. Eur J Orthod 2017;39:365–70. https://doi.org/10.1093/ejo/cjx008.

[21] Molina A, Martin-de-las-Heras S. Accuracy of 3D scanners in tooth mark analysis. J Forensic Sci 2015;60 Suppl 1:S222-6. https://doi.org/10.1111/1556-4029.12598.

[22] Arnett GW, Jelic JS, Kim J, Cummings DR, Beress A, Worley CM, et al. Soft tissue cephalometric analysis: diagnosis and treatment planning of dentofacial deformity. American Journal of Orthodontics and Dentofacial Orthopedics 1999;116:239–53. https://doi.org/10.1016/S0889-5406(99)70234-9.

[23] Reesu GV, Brown NL. Application of 3D imaging and selfies in forensic dental identification. J Forensic Leg Med 2022;89:102354. https://doi.org/10.1016/j.jflm.2022.102354.

[24] Corte-Real A, Silva DN, Corte-Real F, Anjos MJ. Bitemarks in foodstuffs – An approach for genetic identification of the bitter. Forensic Sci Int Genet Suppl Ser 2013;4:e340–1. https://doi.org/10.1016/j.fsigss.2013.10.173.

[25] Gibelli D, Palamenghi A, Poppa P, Sforza C, Cattaneo C, De Angelis D. 3D-3D facial registration method applied to personal identification: Does it work with limited

portions of faces? An experiment in ideal conditions. J Forensic Sci 2022;67:1708–14. https://doi.org/10.1111/1556-4029.15021.

[26] Gibelli D, De Angelis D, Poppa P, Sforza C, Cattaneo C. A View to the Future: A Novel Approach for 3D-3D Superimposition and Quantification of Differences for Identification from Next-Generation Video Surveillance Systems. J Forensic Sci 2017;62:457–61. https://doi.org/10.1111/1556-4029.13290.

[27] Soto-Álvarez C, Fonseca GM, Viciano J, Alemán I, Rojas-Torres J, Zúñiga MH, et al. Reliability, reproducibility and validity of the conventional buccolingual and mesiodistal measurements on 3D dental digital models obtained from intra-oral 3D scanner. Arch Oral Biol 2020;109:104575. https://doi.org/10.1016/j.archoralbio.2019.104575.

[28] Gibelli DM, Cappella A, Dolci C, Rosati R, Bedoni M, Sforza C. A Longitudinal 3D Investigation on Facial Similarity among Two Monozygotic Twins in Their First Childhood: An Application of the 3D-3D Facial Superimposition Technique. Children 2022;9:187. https://doi.org/10.3390/children9020187.

[29] Corte-Real A, Nunes T, Santos C, Rupino da Cunha P. Blockchain technology and universal health coverage: Health data space in global migration. J Forensic Leg Med 2022;89:102370. https://doi.org/10.1016/j.jflm.2022.102370.

[30] Mou Q, Ji L, Liu Y, Zhou P, Han M, Zhao J, et al. Three-dimensional superimposition of digital models for individual identification. Forensic Sci Int 2021;318:110597. https://doi.org/10.1016/j.forsciint.2020.110597.

[31] Terry DA, Snow SR, McLaren EA. Contemporary dental photography: selection and application. Compend Contin Educ Dent 2008;29:432–6, 438, 440-2 passim; quiz 450, 462.

[32] Wilkinson C, Lofthouse A. The use of craniofacial superimposition for disaster victim identification. Forensic Sci Int 2015;252:187.e1-187.e6. https://doi.org/10.1016/j.forsciint.2015.03.023.

[33] Corte-Real A. Orofacial Anatomy Discrepancies and Human Identification—An Education Forensic Approach. Anatomia 2022;1:170–6. https://doi.org/10.3390/anatomia1020017.

10. Appendices

I. Informed consent

CONSENTIMENTO INFORMADO

De acordo com a Declaração de Helsínquia da Associação Médica Mundial e suas atualizações:

1. Declaro ter lido este formulário e aceito de forma voluntária participar neste estudo.
2. Fui devidamente informado(a) da natureza, objetivos, riscos, duração provável do estudo, bem como do que é esperado da minha parte.
3. Tive a oportunidade de fazer perguntas sobre o estudo e percebi as respostas e as informações que me foram dadas. A qualquer momento posso fazer mais perguntas ao investigador responsável do estudo.

   Durante o estudo e sempre que quiser, posso receber informação sobre o seu desenvolvimento. O investigador responsável dará toda a informação importante que surja durante o estudo que possa alterar a minha vontade de continuar a participar.
4. Aceito que utilizem a informação relativa à minha história clínica e os meus tratamentos no estrito respeito do segredo médico e anonimato. Os meus dados serão mantidos estritamente confidenciais. Autorizo a consulta dos meus dados apenas por pessoas designadas pelo promotor e por representantes das autoridades reguladoras.
5. Aceito seguir todas as instruções que me forem dadas durante o estudo. Aceito em colaborar com o investigador.
6. Autorizo o uso dos resultados do estudo para fins exclusivamente científicos e, em particular, aceito que esses resultados sejam divulgados às autoridades sanitárias competentes.
7. Aceito que os dados gerados durante o estudo sejam informatizados pelo promotor ou outrem por si designado.

   Eu posso exercer o meu direito de retificação e/ ou oposição.
8. Tenho conhecimento que sou livre de desistir do estudo a qualquer momento, sem ter de justificar a minha decisão e sem comprometer a qualidade dos meus cuidados médicos. Eu tenho conhecimento que o investigador tem o direito de decidir sobre a minha saída prematura do estudo e que me informará da causa da mesma.

9. Fui informado que o estudo pode ser interrompido por decisão do investigador, do promotor ou das autoridades reguladoras.

Nome do Participante: ____

Assinatura: ____

Data: ________/_____/____

Confirmo que expliquei ao participante acima mencionado a natureza e os objetivos do estudo acima mencionado.

Nome do Investigador: ____

Assinatura: ____

Data: ________/_____/____

II. Figures

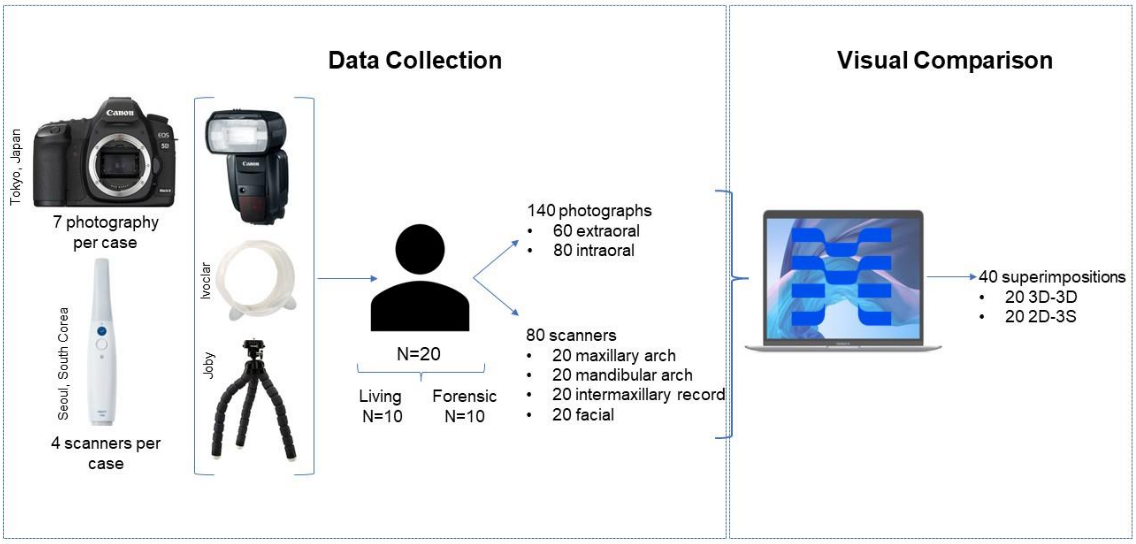
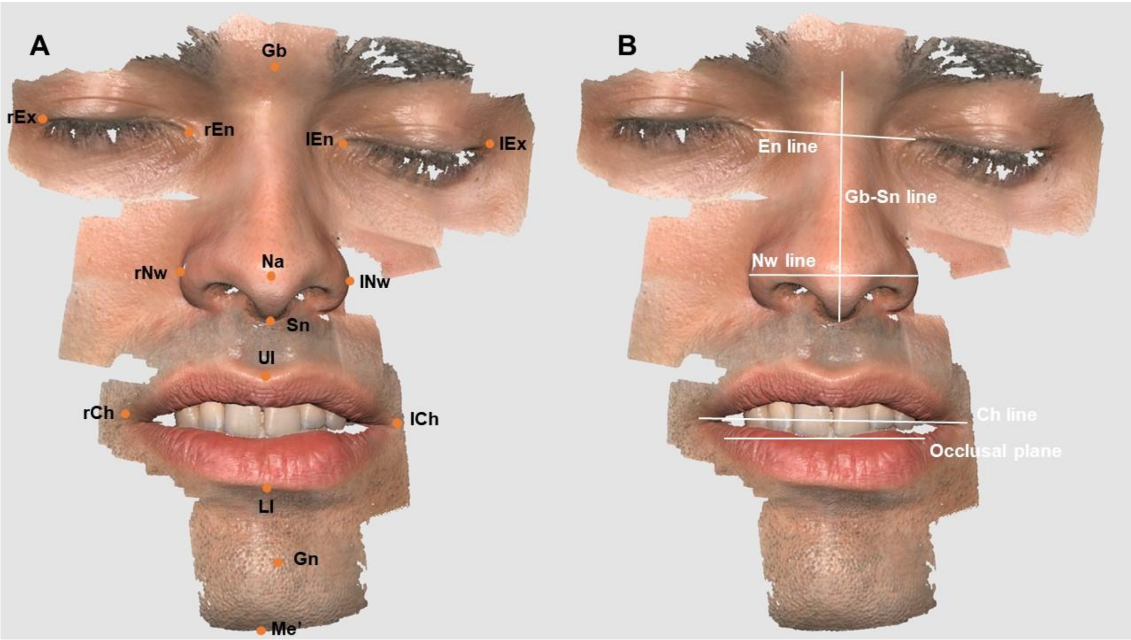


Figure 1: Study design scheme.



Figures 2 (A and B): Facial scan of living individual to illustrate the facial points (A) and lines collected (B). Legend: Gb (glabella); rEx (right exocanthion); lEx (left exocanthion); rEn: (right endocanthion); lEx (left exocanthion); rNw (right nose wing); lNw (left nose wing); Na (nasion); Sn (sub-nasal); rCh (right cheilion); lCh (left cheilion); Sl (superior lip); Il (inferior lip); Gn (gnathion); Me' (cutaneous mento); En line (endocanthion line); Gb-Sn line (glabella and sub-nasal line) ; Nw line (nose wing line); Ch line (cheilion line) and Occlusal plane.

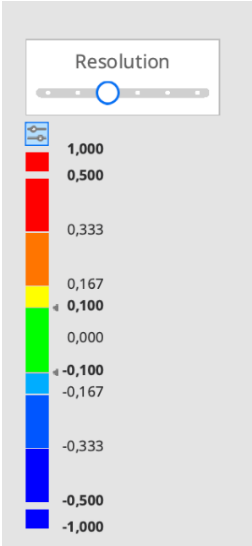
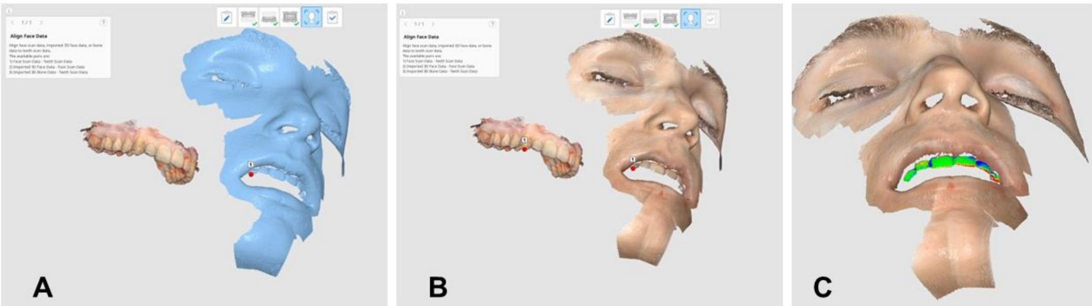
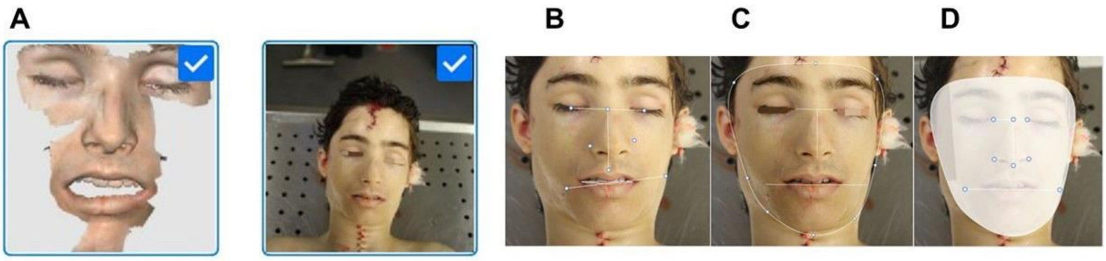


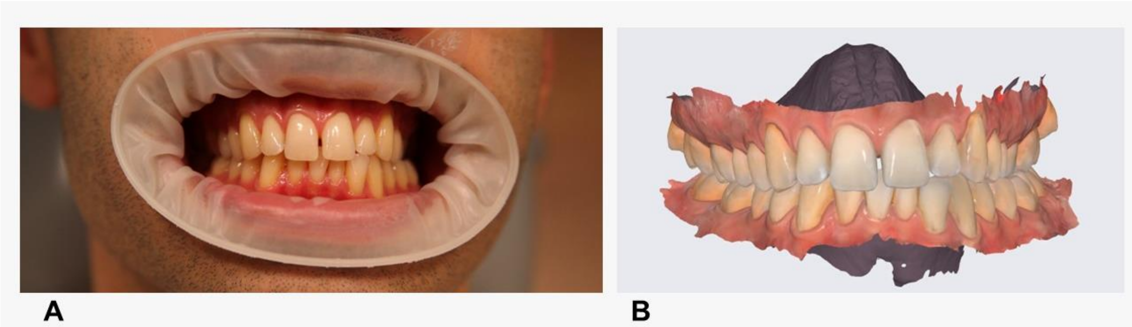
Figure 3: Resolution scale of the Medit Scan for Clinics software.



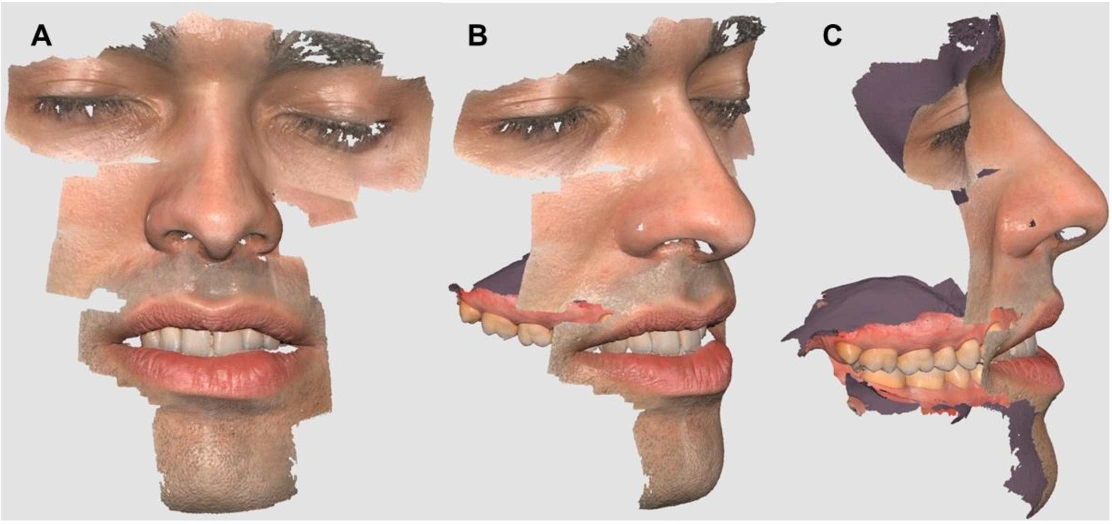
Figures 4 (A, B and C): 3D-3D superimposition sequence. (A) Landmark of the upper right canine (cuspid) in the 3D facial; (B) Landmark of the uuper right canine (cuspid) in the 3D intraoral; and (C) Analysis of the 3D-3D superimposition.



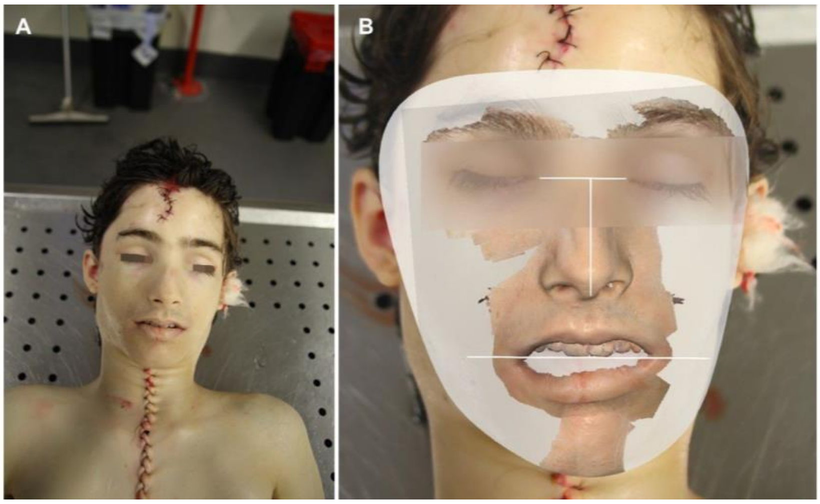
Figures 5 (A, B, C, D and E) – 2D-3S superimposition sequence. (A) Selection and upload of records within Smile Design application; (B) Automatic profile of reference landmarks and their lines; (C) Manual adjustment of landmarks, their lines and study area; and (D) Superimposition of landmarks and their lines.



Figures 6 (A and B) – Personal data in living individual. (A) photograph record; (B) IOS record.



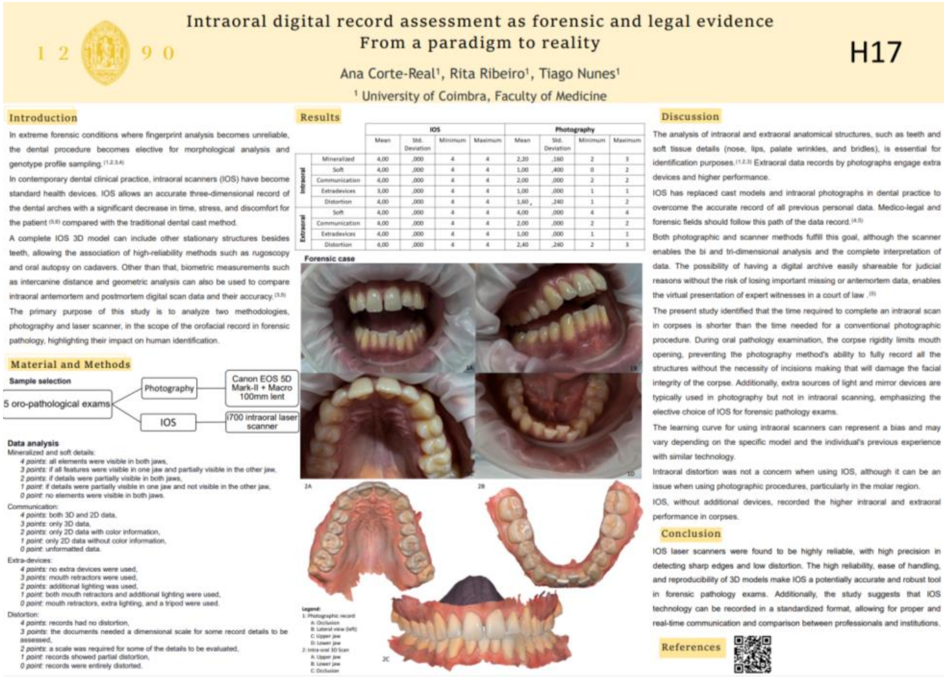
Figures 7 (A, B and C) – Personal data in living individual. (A) Frontal view of facial scan, (B) 45 angle view of the facial and maxillary scan and (C) Lateral view of 3D-3D superimposition.



Figures 8 (A and B) – Personal data in forensic case. (A) Photograph record and (B) Superimposition 2D-3S.

III. List of Posters Communications and publications

Scientific poster was presented at American Academy of Forensic Sciences 75th Anniversary Conference.



AAFS AMERICAN ACADEMY OF FORENSIC SCIENCES Est. 1948

Odontology—2023

H17 Intraoral Digital Record Assessment as Forensic and Legal Evidence: From a Paradigm to Reality

Ana Corte-Real, PhD, Faculty of Medicine at University of Coimbra*, Coimbra, PORTUGAL; Rita Ribeiro, BSH, Faculty of Medicine at University of Coimbra, Coimbra, PORTUGAL; Tiago Nunes, MS, Faculty of Medicine at University of Coimbra, Coimbra, PORTUGAL*

Learning Objective: Comprehensive and accurate methods for intraoral record data should be the alternative to traditional methods of intraoral data, such as stone models. Dental identification is the first choice for human identification, and the methodology applied should be friendly for frequent use. It will allow immediate results and analysis following the quality of the report.

Impact Statement: In extreme forensic scenarios, such as arm conflicts or legal cases, needed long-term storage and real-time sharing of digital record methods are the election.

In extreme forensic scenarios, such as arm conflicts or mass disasters catastrophes, the oral cavity is a database for forensic identification that is associated with legal issues. The registration of dental records is mandatory in several European countries. In modern dental clinical practice, digital scanners have become common health devices to record the individual's dental status.

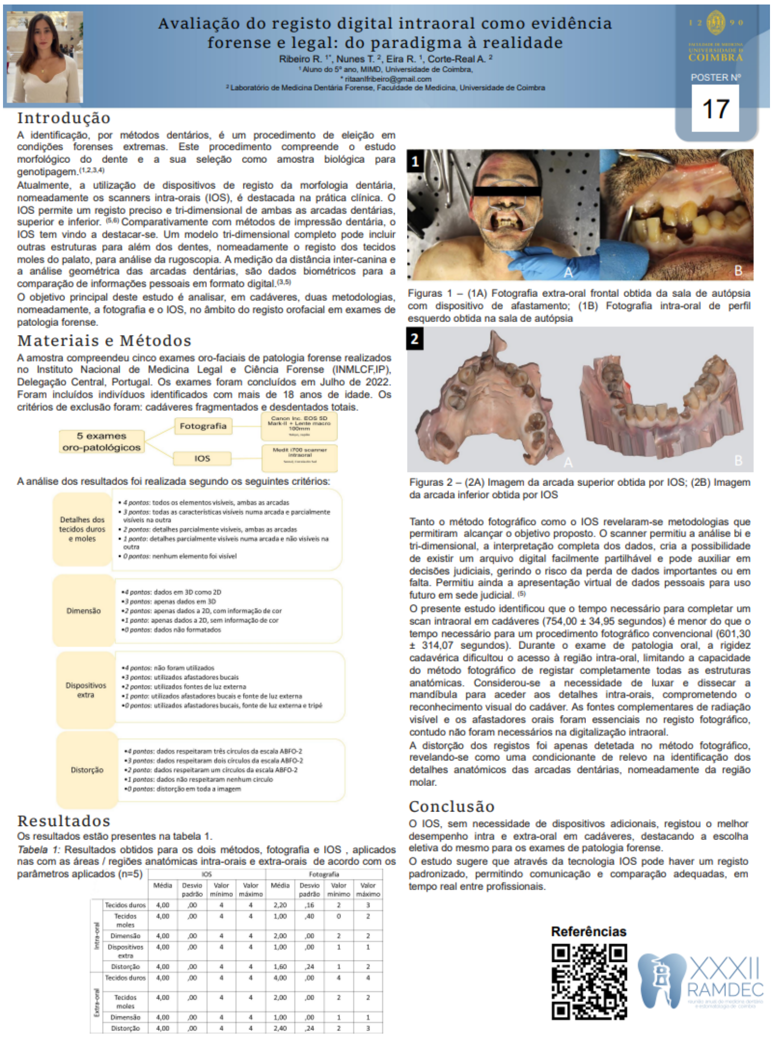
The study intends to present a digital methodology for intraoral digital records in forensic pathology procedures. A quasi-experimental study was performed in the Central Branch of the National Institute of Legal Medicine and Forensic Science, Portugal. The intraoral scanner i7000 (Medit, Lusobionic, Portugal) was selected as a wireless device, and the Canon 5D-Full Frame equipment was used to record intraoral postmortem status. Data were compared according to team expertise (number, time required, and training) and intraoral information (teeth number, morphologic, dimensions, color, and metrics). The two methodologies were compared to establish the one that is more suitable to optimize human identification in corpses.

The scanner allowed two-dimension and three-dimensional reconstruction findings while the photography can only concede two-dimension reconstructions. The intraoral scanner allowed full arcade and inter-arcade registrations when confronted against a limited mouth opening, characteristic of cadaveric rigidity. On the contrary, intraoral photography did not permit the registration of all oral structures. The superimposition of intraoral data for the scanner and the photography were not equal. The scanner displayed high accuracy in position matches between postmortem and antemortem intraoral records of the anatomical structures (up to 90%, $p < 0.01$), whereas the photographic method contained minor information, thus lower efficient matches were obtained. Furthermore, photography requires color and dimension calibration through the mandatory use of scales and color checkers, which the scanner did not require due to hitsis primer calibration prior to its use. In addition, both methods in a digital medium can permanently store data and share it instantly.

The scope of the intraoral scanner expands clinical purposes, allowing the forensic record of oral cavity with morphological details. It can be performed by one expert, recording general and specific anatomical features of the oral cavity. Teeth and soft tissues, namely palatine rugae, were recorded to perform identification, as an adequate and an accurate alternative to traditional records.

Human Identification; Forensic Dentistry; Forensic Pathology

The following scientific poster was presented at XXXII Reunião Anual de Medicina Dentária e Estomatologia de Coimbra.



Avaliação do registo digital intraoral como evidência forense e legal: do paradigma à realidade

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POSTER Nº 17

Introdução

A identificação, por métodos dentários, é um procedimento de eleição em condições forenses extremas. Este procedimento compreende o estudo morfológico do dente e a sua seleção como amostra biológica para genotipagem.(1,2,3,4)

Atualmente, a utilização de dispositivos de registo da morfologia dentária, nomeadamente os scanners intra-orais (IOS), é destacada na prática clínica. O IOS permite um registo preciso e tri-dimensional de ambas as arcadas dentárias, superior e inferior. (5,6) Comparativamente com métodos de impressão dentária, o IOS tem vindo a destacar-se. Um modelo tri-dimensional completo pode incluir outras estruturas para além dos dentes, nomeadamente o registo dos tecidos moles do palato, para análise da rugoscopia. A medição da distância inter-canina e a análise geométrica das arcadas dentárias, são dados biométricos para a comparação de informações pessoais em formato digital.(3,5)

O objetivo principal deste estudo é analisar, em cadáveres, duas metodologias, nomeadamente, a fotografia e o IOS, no âmbito do registo orofacial em exames de patologia forense.

Materiais e Métodos

A amostra compreendeu cinco exames oro-faciais de patologia forense realizados no Instituto Nacional de Medicina Legal e Ciência Forense (INMLCF,IP), Delegação Central, Portugal. Os exames foram concluídos em Julho de 2022. Foram incluídos indivíduos identificados com mais de 18 anos de idade. Os critérios de exclusão foram: cadáveres fragmentados e desdentados totais.

5 exames oro-patológicos → Fotografia → Canon Inc. EOS 5D Mark-II + Lente macro 100mm

5 exames oro-patológicos → IOS → Medit i700 scanner intraoral

A análise dos resultados foi realizada segundo os seguintes critérios:

Detalhes dos tecidos duros e moles
- *4 pontos*: todos os elementos visíveis, ambas as arcadas
- *3 pontos*: todas as características visíveis numa arcada e parcialmente visíveis na outra
- *2 pontos*: detalhes parcialmente visíveis, ambas as arcadas
- *1 ponto*: detalhes parcialmente visíveis numa arcada e não visíveis na outra
- *0 pontos*: nenhum elemento foi visível

Dimensão
- *4 pontos*: dados em 3D como 2D
- *3 pontos*: apenas dados em 3D
- *2 pontos*: apenas dados a 2D, com informação de cor
- *1 ponto*: apenas dados a 2D, sem informação de cor
- *0 pontos*: dados não formatados

Dispositivos extra
- *4 pontos*: não foram utilizados
- *3 pontos*: utilizados afastadores bucais
- *2 pontos*: utilizados fontes de luz externa
- *1 ponto*: utilizados afastadores bucais e fonte de luz externa
- *0 pontos*: utilizados afastadores bucais, fonte de luz externa e tripé

Distorção
- *4 pontos*: dados respeitaram três circulos da escala ABFO-2
- *3 pontos*: dados respeitaram dois circulos da escala ABFO-2
- *2 ponto*: dados respeitaram um circulos da escala ABFO-2
- *1 pontos*: dados não respeitaram nenhum circulo
- *0 pontos*: distorção em toda a imagem

Resultados

Os resultados estão presentes na tabela 1.

Tabela 1: Resultados obtidos para os dois métodos, fotografia e IOS , aplicados nas com as áreas / regiões anatómicas intra-orais e extra-orais de acordo com os parâmetros aplicados (n=5)

		IOS				Fotografia			
		Média	Desvio padrão	Valor mínimo	Valor máximo	Média	Desvio padrão	Valor mínimo	Valor máximo
Intra-oral	Tecidos duros	4,00	,00	4	4	2,20	,16	2	3
	Tecidos moles	4,00	,00	4	4	1,00	,40	0	2
	Dimensão	4,00	,00	4	4	2,00	,00	2	2
	Dispositivos extra	4,00	,00	4	4	1,00	,00	1	1
	Distorção	4,00	,00	4	4	1,60	,24	1	2
Extra-oral	Tecidos duros	4,00	,00	4	4	4,00	,00	4	4
	Tecidos moles	4,00	,00	4	4	2,00	,00	2	2
	Dimensão	4,00	,00	4	4	1,00	,00	1	1
	Distorção	4,00	,00	4	4	2,40	,24	2	3

Figuras 1 – (1A) Fotografia extra-oral frontal obtida da sala de autópsia com dispositivo de afastamento; (1B) Fotografia intra-oral de perfil esquerdo obtida na sala de autópsia

Figuras 2 – (2A) Imagem da arcada superior obtida por IOS; (2B) Imagem da arcada inferior obtida por IOS

Tanto o método fotográfico como o IOS revelaram-se metodologias que permitiram alcançar o objetivo proposto. O scanner permitiu a análise bi e tri-dimensional, a interpretação completa dos dados, cria a possibilidade de existir um arquivo digital facilmente partilhável e pode auxiliar em decisões judiciais, gerindo o risco da perda de dados importantes ou em falta. Permitiu ainda a apresentação virtual de dados pessoais para uso futuro em sede judicial. (5)

O presente estudo identificou que o tempo necessário para completar um scan intraoral em cadáveres (754,00 ± 34,95 segundos) é menor do que o tempo necessário para um procedimento fotográfico convencional (601,30 ± 314,07 segundos). Durante o exame de patologia oral, a rigidez cadavérica dificultou o acesso à região intra-oral, limitando a capacidade do método fotográfico de registar completamente todas as estruturas anatómicas. Considerou-se a necessidade de luxar e dissecar a mandíbula para aceder aos detalhes intra-orais, comprometendo o reconhecimento visual do cadáver. As fontes complementares de radiação visível e os afastadores orais foram essenciais no registo fotográfico, contudo não foram necessários na digitalização intraoral.

A distorção dos registos foi apenas detetada no método fotográfico, revelando-se como uma condicionante de relevo na identificação dos detalhes anatómicos das arcadas dentárias, nomeadamente da região molar.

Conclusão

O IOS, sem necessidade de dispositivos adicionais, registou o melhor desempenho intra e extra-oral em cadáveres, destacando a escolha eletiva do mesmo para os exames de patologia forense.

O estudo sugere que através da tecnologia IOS pode haver um registo padronizado, permitindo comunicação e comparação adequadas, em tempo real entre profissionais.

Referências

XXXII RAMDEC

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SPEMD

DIPLOMA

CERTIFICA-SE QUE

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FORAM AUTORES DO PÓSTER **"AVALIAÇÃO DO REGISTO DIGITAL INTRAORAL COMO EVIDÊNCIA FORENSE E LEGAL: DO PARADIGMA À REALIDADE"**, SUBMETIDO NO ÂMBITO DA CATEGORIA DE INVESTIGAÇÃO À XXXII REUNIÃO ANUAL DE MEDICINA DENTÁRIA E ESTOMATOLOGIA DE COIMBRA, QUE DECORREU NOS DIAS 24 E 25 DE MARÇO DE 2023, NO AUDITÓRIO DA REITORIA DA UNIVERSIDADE DE COIMBRA.

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An article has been submitted in Forensic Sciences Research and is currently under-review.

Action	Manuscript Number	Title	Initial Date Submitted	Status Date	Current Status
Action Links	TFSR-2022-0209	Orofacial assessment as a digital path for forensic and legal evidence-record	Dec 29, 2022	Feb 12, 2023	Under Review
Action Links	TFSR-2022-0193	Oral health professional intervention and child physical abuse - European legal approach	Dec 01, 2022	Jan 03, 2023	Under Review