Advancements and Challenges Forensic Odontology and Anthropology: Applications for Identification in Saudi Arabia

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Abstract

The evolution of forensic science has witnessed significant progress in dental identification techniques, originating from prehistoric eras but gaining prominence in the late 19th century. During the 1960s, forensic odontology experienced renewed interest, extending its relevance beyond dentistry to law enforcement agencies. This resurgence coincided with the emergence of forensic anthropology, vital in employing skeletal analysis to reconstruct the biological profiles of unidentified individuals. Collaborative efforts of forensic dentistry and anthropology have notably enhanced the accuracy and scope of forensic investigations, especially in cases involving incomplete or decomposed remains.

In the Kingdom of Saudi Arabia, despite cultural challenges, the significance of multidisciplinary collaboration to assist the law enforcement agencies cannot be overstated. As forensic science advances, the integration of dental and skeletal analyses remains crucial for effective case resolution. Forensic odontology and anthropology jointly contribute to identifying individuals in mass disasters and criminal cases through dental record and skeletal remains analysis. Both disciplines boast rich historical backgrounds, dating back to ancient civilizations. Limited practices and training in Saudi Arabia pose obstacles for forensic investigations, although there is evident public acceptance regarding the importance of maintaining dental records and recognizing skeletal analysis significance. Therefore, establishing a national registry for dental and skeletal data, coupled with comprehensive training programs, is recommended for dentistry and anthropology students at all academic levels.

Keywords: Forensic Science, Identification, Forensic Odontology, Forensic Anthropology, Skeletal Analysis.

Highlights

- Forensic odontology and anthropology collaboratively contribute to identifying individuals in mass disasters and criminal cases through the analysis of dental records and skeletal remains.
- Both forensic odontology and anthropology have rich historical background, with evidence of their practices dating back to ancient civilizations.
- Despite their importance, forensic odontology and anthropology practices and training are limited in Saudi Arabia, presenting obstacles for forensic investigations.
- There is noticeable public acceptance in Saudi Arabia regarding the importance of maintaining dental records and recognizing the significance of skeletal analysis in forensic investigations.

- We recommend establishing a national registry for dental records and skeletal data, accompanied by comprehensive training programs for dentistry and anthropology students at both undergraduate and postgraduate levels.

Introduction

The utilization of dental methods for identification has been evident throughout history, dating back to prehistoric times. Interest in forensics dentistry experienced a notable upsurge in the latter half of the 19th century, becoming a topic of discussion in dental journals of the era. Furthermore, the 1960s witnessed a resurgence of interest in "forensic odontology" extending beyond the realm of dentistry to garner attention from law enforcement agencies as well (Avon, 2004). Additionally, forensic anthropology, a pivotal discipline within forensic science, employs skeletal analysis to assist in the identification of human remains. By scrutinizing skeletal characteristics such as age, sex, ancestry, and indications of trauma or pathology, forensic anthropologists play a vital role in reconstructing the biological profile of unidentified individuals.

This interdisciplinary approach, amalgamating the expertise of forensic dentistry and anthropology, significantly arguments the accuracy and comprehensiveness of forensic investigations, particularly in cases involving incomplete or decomposed remains (Miller, 2024). Moreover, it aids in overcoming cultural obstacles that practitioners may face within societies like Saudi Arabia (Alfaize, 2015).

1. The Significance and Scope of Forensic Odontology

"Forensic odontology involves the correct collection, management, interpretation, evaluation, and presentation of dental evidence for criminal or civil legal proceedings: a combination of various aspects of the dental, scientific, and legal professions" (Rai & Kaur, 2013). Forensics odontology (FO) is considered now to be a specialty among forensics sciences. As forensics odontology's main aspect of importance is the ability to identify human remains when traditional means fail through postmortem dental records

or establish a connection to an individual with antemortem dental records (Ata-Ali & Ata-Ali, 2014; Krishan et al., 2015). Furthermore, the interdisciplinary nature of forensic odontology underscores its multifaceted approach to forensic investigations. By integrating expertise from the realms of dentistry, science, and law, forensic odontology ensures a comprehensive and meticulous analysis of dental evidence (Pereira & Santos, 2013). This collaborative effort not only enhances the accuracy of identifications but also strengthens the credibility of forensic findings presented in legal proceedings.
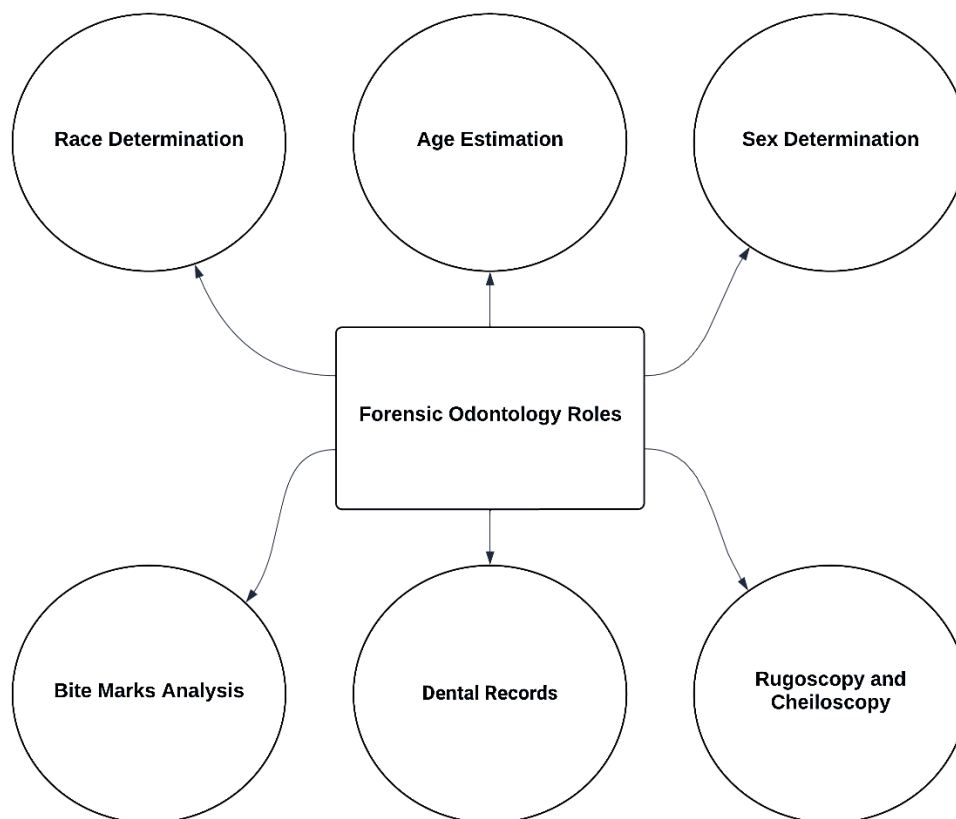

Figure 1: Roles of Forensic Odontology according to the literature.

In addition to its role in identification, forensic odontology plays a vital role in evaluating evidence of dental trauma or pathology (Adserias-Garriga, 2019). Through detailed examination and analysis, forensic odontologists can provide crucial insights into the circumstances surrounding an individual's death or injury. Such information can be pivotal in reconstruing events and establishing the cause and manner of death in forensic investigations. Transitioning to the discussion on dental records, it is essential to recognize that forensic odontology's ability to evaluate evidence of dental trauma or pathology relies heavily on the meticulous examination and comparison of dental records. Transitioning to discuss the significance of forensic odontology, it becomes evident that this interdisciplinary approach not only enhance accuracy and comprehensiveness but also address cultural challenges that forensic practitioners encounter, underscoring its critical role in forensic investigations.

1.1 The Role of Dental Records in Forensic Odontology

There are two types of dental records: antemortem records obtained before death and postmortem records taken after death (Thampan et al., 2018). The dental dentition is one of the hardest structures in the human body that can survive trauma, fires, and decomposition. The different combination of teeth's shapes and forms as well as the different patterns of missing, filled and restored teeth, provides a unique dentition in each individual that allow for accurate identification through comparison of the antemortem and postmortem records in the cases disasters and crimes (Adams, 2003). Dental records serve as indispensable tools in forensic odontology, providing a wealth of information that aids in the identification of individuals in both natural disasters and criminal incidents. Antemortem records, gathered prior to an individual's death, offer a comprehensive overview of their dental history, including details such as dental treatments, surgeries, and anomalies. These records serve as a baseline for comparison with postmortem records, enabling forensic odontologists to establish a positive identification with a high degree of certainty (Chiam et al., 2021).

Postmortem dental records, on the other hand, are obtained after an individual's death and typically involve the examination and documentation of dental features and characteristics (Jensen et al., 2020). Despite the challenges posed by trauma, fires, or decomposition, the dental dentition remains remarkably resilient, often retaining unique features that facilitate identification. The distinct combination of tooth shapes, patterns of missing or restored teeth, and other dental anomalies create a dental profile that is singular to each individual. Transitioning to the discussion on age estimation methods, it's important to recognize the foundational role of postmortem dental records in facilitating this process.

1.2 The Role of Dental Age Estimation in Forensic Investigations

Various methods exist for destemming a person's chronological age, with dental examination playing a crucial role (Galea-Holhoș et al., 2023). By analyzing the number and arrangement of teeth in the oral cavity, along with employing radiographic techniques to estimate mineralization stages, forensic experts can achieve a more precise age estimation that trough methods like bone mineralization assessment alone (Krishan et al., 2015). These dental age estimation methods hold significant value, especially in cases where skeletal remains are incomplete or inaccessible. Their reliability and accuracy make them indispensable tools in forensic investigations for age determination, emphasizing their critical role in such contexts.

Moreover, the use of dental age estimation methods extends beyond mere identification purposes. In forensic investigations involving unknown individuals, particularly in cases of mass disasters or criminal incidents, accurate age determination can provide crucial insights into the timeline of events, the demographics of victims, and even potential suspects. Additionally, in legal proceedings such as establishing the age of individuals involved in criminal activities or determining eligibility for legal rights and responsibilities, precise age estimation an have far-reaching implications.

Furthermore, the interdisciplinary nature of forensic odontology, encompassing aspects of dentistry, anthropology, and forensic science, allows for a holistic approach to age estimation. By integrating expertise from multiple disciplines, forensic odontologists can enhance the accuracy and reliability of age determination, ensuring that forensic investigations are conducted with the highest standards of scientific rigor and precision. Thus, the significance of dental age estimation methods in forensic contexts cannot be overstated, as they serve as invaluable tools for elucidating crucial details in the pursuit of justice. Transitioning to the discussion on sex determination, it's essential to recognize the pivotal role that forensic odontology plays in providing insights inti the biological profile of individuals beyond age estimation.

1.3 The Role of Odontometrics in Sex Determination in Forensic Odontology

While sex determination utilizing dentition using the Odontometrics does not yield concrete results, when combined with other data obtained through forensic science methods, forensic using the Odontometrics method can provide clues to sex with an accuracy rate of approximately 72% (Işcan & Kedici, 2003; Krishan et al., 2015). Despite its limitations, odotometric analysis remains a valuable tool in forensic odontology, offering significant insights into sex determination when integrated with complementary forensic data.

Expanding on this, it's important to recognize that sex determination in forensic odontology often requires a multidisciplinary approach. By combining dental analysis with other forensic techniques such as DNA analysis, anthropological examination, and radiographic imaging forensic experts can enhance the accuracy and reliability of sex determination (Maulani & Auerkari, 2020). This collaborative approach ensures that forensic investigations benefit from a comprehensive analysis of all available evidence, resulting in more robust conclusions regarding sex determination. Therefore, while odontometric analysis may not provide definitive results on its own, its integration with complementary forensic data enhances its utility and effectiveness in forensic

investigations (Grewal et al., 2017). Transitioning to the discussion on bite marks, it's important to explore another aspect of forensic odontology that plays a significant role in criminal investigations.

1.4 The Significance Bite Marks Analysis in Forensic Odontology

The analysis of bite marks represents one of the most common forms of forensic odontology evidence presented in criminal courts. Defined as "patterned injury on the skin or other surface caused by the biting surfaces of human or animal teeth with a minimum amount of force". A dental analysis of a bite mark left in a criminal scene can be analysis to identify the involved individuals. The theory is a bite mark can be distinct and unique enough to differentiate between one person and another by a trained forensic odontologists (Rai & Kaur, 2012). Moreover, the analysis of bite marks not only aids in identifying suspects but can also provide crucial evidence in linking perpetrators to crime scenes (Araújo et al., 2021), thereby playing a pivotal role in criminal investigations.

Expanding on this, it's important to recognize the multifaceted nature of bite mark analysis in forensic investigations. Beyond identification and linking suspects to crime scenes, bite mark analysis can also provide valuable insights into the circumstances surrounding a crime (Benevento et al., 2021). The location, depth, and pattern of bite marks can offer clues about the dynamics of an altercation or struggle, shedding light on critical aspects of a criminal case.

Moreover, advancements in forensic odontology, such as the use of digital imaging and bite mark comparison software, have further enhanced the accuracy and reliability of bite mark analysis. These technological innovations enable forensic experts to conduct more precise and detailed analyses, leading to more robust forensic findings. Transitioning to the discussion on rugooscopy and cheiloscopy, it's essential to explore additional forensic odontology techniques that contribute to the comprehensive analysis of evidence in criminal investigations.

1.5 Rugoscopy and Cheiloscopy

The implementation of rugoscopy and cheiloscopy represents significant advancements in forensic odontology techniques used for identification purposes (Rajendran et al., 2022; Sharma et al., 2020). Rugoscopy involves the analysis of the palatal rugae located on the anterior portion of the palate, while cheiloscopy focuses on the analysis of the depressions and elevations of the characteristic patterns on the lips that form lip prints. These techniques are comparable to fingerprints in their uniqueness and ability to identify individuals based on distinct patterns.

Similar to fingerprints, each palatal ruga and lip print is unique to its possessor (Ata-Ali & Ata-Ali, 2014). Providing forensic invaginators with valuable identifying characteristics. This uniqueness not only allows for individual identification but also enhances the accuracy and reliability of forensic analyses. By utilizing rugoscopy and cheiloscopy alongside other forensic methods, investigators can achieve more robust identification results, bolstering the integrity of forensic investigations.

Furthermore, the incorporation of rugoscopy and cheiloscopy into forensic odontology expands the range of tools available to forensic investigators. In cases where traditional methods such as fingerprints may not be feasible or sufficient, rugoscopy and cheiloscopy offer alternative avenues for identification. Their use provides forensic experts with additional forensic evidence to corroborate findings and strengthen forensic analyses, ultimately aiding in the resolution of criminal cases. Transitioning to the discussion on race determination, it's crucial to explore another aspect of forensic odontology that contributes to the comprehensive analysis of biological profiles in criminal investigations.

1.6 Race Determination

Determining the race of an individual is a challenging endeavor, but dental dental anthropology provides valuable insights in this regard. Genetic and hereditarian indicators that are prevalent in specific racial groups can be discerned through the shape and form

of their dentition (Yaacob et al., 1996). Therefore, by examining distinctive dental traits, dental anthropology enables forensic investigators to conclude the racial affinity of an unknown body.

In forensic investigations, dental anthropology serves as a crucial adjunct, contributing to the determination of racial affinity (Clemmonsa, 2022). By integrating dental anthropology with other forensic disciplines such as DNA analysis and skeletal examination, forensic experts can enhance the accuracy and comprehensiveness of racial identification in forensic cases. This multidisciplinary approach allows for a more thorough analysis or biological profiles, thereby strengthening the forensic investigations process. Through the synthesis of dental anthropology with cutting-edge forensic techniques investigators can achieve a nuanced understanding of an individual's racial background. This collaborative methodology not only enriches forensic analyses but also bolsters the reliability of conclusions drawn in criminal investigations. Transitioning to the discussion on Disaster Victim Identification (DVI) applications of forensic odontology, it's essential to explore another critical aspect of its role in forensic investigations.

2. Forensic Odontology and Disaster Victim Identification Applications

Forensic odontology identification methods are an integral part of victims' identifications in disaster victim identification (DVI) and criminal investigations (Wood & Gardner, 2023). In cases where the victims were severely burned or disfigured. Traditional means of forensic identification may not be enough for victim or assailant identification. Only by using antemortem dental records usually stored in some form of registry and comparing them to the postmortem records that the forensic odontologist can identify the victims where all other traditional methods have failed (Naiman et al., 2007). And this type of identification has been deployed throughout different instances in history.

One instance was the Asian Tsunami of 2004 that resulted in 200,000 casualties in 10 countries. Dentistry alone using DVI was able to identify 85% of the cases with antemortem dental records (De Valck, 2006). In 1995, 46 war victims' bodies were discovered in Petrinja in Croatia. A forensic odonto-stomatologist performed the identification process and helped identify 27 victims (59%) with 16% identified through dental records (Brkic et al., 1997).

In Spain's major highway accident in 1996 resulting in 28 victims, 57% of the victims were identified with dental records (Valenzuela et al., 2000). In a systematic review on the role of FO during major mass disaster, 20 included disasters leading to the death of 23654 victims. 3025 (14.70%) were identified with FO and 1094 victims (5.31%) were identified with FO in combination with other methods (Prajapati et al., 2018). The Michigan Dental Association Forensic Dental Identification Team (MDA-FDIT) was established in 1987 and has since responded to three major incidents in a total of 193 victims. 163 of these victims were identified with dental findings (Fixott et al., 2001).

These examples underscore the critical role in forensic odontology in disaster victim identification, where traditional methods may fall short due to the severity of injuries or lack distinguishing features. The systematic review highlights the widespread applicability of forensic odontology across various mass disaster scenarios, demonstrating its effectiveness in providing closure to families and loves ones. Additionally, the establishment of specialize teams, such as Michigan Dental Association Forensic Dental Identification Team, further emphasizes the dedication and expertise of forensic odontologists in facilitating the identification process during times of crisis.

3. Applications and Prevalence of Forensic Odontology in Saudi Arabia

In the Kingdom of Saudi Arabia, the presence of some form of forensic odontology official body or certified training in forensic dentistry does not seem to exist. Despite the presence of forensic odontology cases.

As detailed in a study conducted by King Saud University in 2017. Stating that out of 51 participants, only one dentist has some type of forensic odontology registration. 42 participants with a medical background, of which 39 have medical forensic training. Focusing on forensic odontology, only 11 participants have had some sort of forensic odontology training. Additionally, the study shows that there are individuals who worked on forensic odontology cases with no forensic odontology training. 37 on age estimation, 27 on bite mark analysis and 36 on human identification cases. The study concludes that there is no official forensic odontology guidelines or systems in Saudi Arabia (Alqahtani et al., 2017).

In another study conducted by King Saud University in 2014, assessing the awareness and training of dentists in forensic odontology. Out of 248 dentists, 44% reported maintaining dental records forever, while 25.8% reported maintaining records for a certain period of time. Shockingly, 42.9% reported not receiving records any FO instructions as undergraduates, and 95% did not obtain any post-graduate FO training (Al Sheddi & Al Asiri, 2015).

Another Saudi study published in 2022 regarding the awareness of cheiloscopy had determined that out of 320 dental professionals, cheiloscopy was only known to 36.6% of them and 63.4% did not know of its existence. Summarizing that there is a lack of awareness, understanding and knowledge of cheiloscopy among Saudi dental professionals (Abdul et al., 2022a).

International Journal for Scientific Research (IJSR)

المجلة الدولية للبحوث العلمية

IJSR

Vol. (3), No. (5)

May 2024

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Umm Al-Qura University in 2021 performed a questionnaire on 784 participants gauging the knowledge of the public on FO during COVID-19. The study's knowledge score was 9.35 out of 21 with a standard deviation of 4.68. Stating that 74.62% of the participants were willing to register in a national dental registry if one was to be established in Saudi Arabia (Aboalshamat et al., 2021) .

A further study in Saudi Arabia on the awareness of FO using surveys revealed that out of 812 participants, 67.5% were ready to register in a future national dental registry (Salam et al., 2020).

Following these findings, it becomes evident that there is a significant gap in the presence of official forensic odontology bodies or certified training programs within the Kingdom of Saudi Arabia, despite the occurrence of forensic odontology cases. The studies conducted by King Saudi University shed light on the limited awareness and training among dental professionals in forensic odontology practices, highlighting the need for standardized guidelines and educational initiatives in this field. Additionally, the public's willingness to participate in a national dental registry underscores the importance of establishing comprehensive forensic odontology frameworks to enhance forensic practices and ensure effective victim identification processes within the country. After highlighting the readiness of a significant portion of the surveyed population in Saudi Arabia to participate in a future national dental registry, the focus now shifts to examining the pivotal role of forensic anthropology within the realm of forensic sciences in the region.

4. The Role of Forensic Odontology and Anthropology in Human Identification: Applications for Saudi Arabia

Before delving into the contributions of forensic anthropology, it is crucial to provide a brief background on this specialized field within the broader discipline of anthropology. Forensic anthropology is primarily practiced and well-established in the United States

(Campanacho et al., 2021), where forensic anthropologists undergo comprehensive training to investigate, uncover, and examine human remains within a medicolegal framework (Passalacqua et al., 2021). This specialized branch of anthropology plays a critical role in forensic investigations by applying scientific methods to analyze skeletal remains and provide valuable insights into the identity, circumstances, and cause of death of individuals. In this context, forensic anthropologists play a crucial role in aiding medicolegal professionals by creating a biological profile, which encompasses predictions for characteristics like sex, age, population affinity and stature, facilitating the identification of unidentified human skeletal remains.

However, challenges arise due to the absence of standardized methods and agreement among anthropologists regarding age estimation. This study aims to pinpoint age-reporting methods that offer precise and dependable adult age-at-death estimates, considering diverse factors such as the entire sample, age range, and sex. Six age estimation techniques were evaluated on 58 adult subjects, alongside an experience-based approach. Findings indicate that the most accurate and reliable age-reporting strategy varies based on the specific criteria used to evaluate the sample. Although no single method emerged as consistently superior across all categories, the experience-based approach proved effective across all groups (Bailey & Vidoli, 2023).

Transitioning from the discussion of the findings on age-reporting strategies, we now shift our focus to a related study that delves into the efficacy of various methods for human identification. Thus, forensic odontology and anthropology play pivotal roles in identifying individuals in various scenarios, including mass disasters and criminal cases involving limited human remains or samples. These disciplines assist in determining age, sex, stature, and race through methods such as analyzing photographs, bite marks, lip prints, palatal rugae, radiographs, and dental DNA identification with access to antemortem records. In this review, we explore the available techniques for human identification. Cone-beam computed tomography of the skull has shown superiority over

traditional methods, allowing for detailed examination of dental features, occlusion, palatal rugae, soft tissue thickness, and other distinctive characteristics of both facial skeletal and soft tissues (Jayakrishnan et al., 2021).

Moving from the discussion of the importance of forensic odontology and anthropology in human identification, particularly in cases involving limited remains or samples, we now shift our lens to their significance in the context of Saudi Arabia. Given the divers population and unique cultural and religious considerations in Saudi Arabia, the applications of these disciplines take an added importance in forensic investigations. In a country where traditional identification methods may face challenges due to cultural practices or limited resources, the utilization of advanced techniques such as cone-beam computed tomography (CBCT) of the skull becomes invaluable (Issrani et al., 2022; Özeren Keşkek et al., 2024). These methods not only enhance the accuracy and reliability of identifications but also contribute to the resolution of cases involving missing persons, mass disasters, and criminal incidents. Therefore, understanding and incorporating the latest advancements in forensic odontology and anthropology are crucial for effective forensic investigations and the administrations of justice in Saudi Arabia, where traditional identification methods may face challenges due to cultural practices or limited resources. While these advanced are widely recognized, their application in forensic dentistry or forensic anthropology may be limited. However, the integration of new technologies such as micro-computed tomography in dentistry (Zainuddin et al., 2023) and the potential utilization of Artificial Intelligence (AI) under the guidance of dentists and other experts hold promise for further enhancing forensic investigation capabilities in the near future.

5. Culturally Sensitive Forensic Investigations in Saudi Arabia: Cultural Integration

In Saudi Arabia, cultural sensitivity plays pivotal role in ensuring that forensic practitioners effectively navigate cultural nuances and uphold ethical standards while integrating the latest advancement in forensic odontology and anthropology. Hence, focusing on cultural sensitivity and how to address it within forensic investigations in Saudi Arabia is crucial. Here's how we can approach this:

1. **Respect for Religious Practices:** Recognize the importance of respecting religious practices, such as burial customs and rituals, which may impact the handling and examination of human remains. Forensic practitioners should work closely with local religious authorities and community leaders to ensure that investigative producers align with cultural sensitives and religious beliefs (Glorney et al., 2019).

2. **Communication and Engagement:** Foster open communication and engagement with communities and families affected by forensic investigations. Establishing trust (Wojcik et al., 2006) and rapport is essential for obtaining consent for forensic procedures and mitigating potential concerns or objections related to cultural and religious beliefs.

3. **Cultural Competency Training:** Provide cultural competency training for forensic professionals to enhance their understanding of Saudi Arabian culture, traditions, and societal norms. This training should cover topics such as etiquette, language, religious practices, and customs related to death and burial (Barber Rioja & Rosenfeld, 2018).

4. **Collaboration with Local Experts:** Collaborate with local experts, including anthropologists, archaeologists, religious scholars, and community leaders, who possess intimate knowledge of Saudi Arabian culture and can provide valuable insights into cultural considerations relevant to forensic investigations.

International Journal for Scientific Research (IJSR)

Vol. (3), No. (5)

IJSR

May 2024

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5. **Adaptation of Procedures:** Adopt forensic procedures and protocols to accommodate cultural sensitives and preferences. For example, when collecting ante-mortem data or conducting post-mortem examinations, consider the preferences of the deceased individual's family regarding the handling of remains and the release of information.

6. **Sensitivity in Reporting and Documentation:** Exercise sensitivity in reporting and documenting forensic findings, particularly when communicating with families or presenting evidence in legal proceedings. Use language that is respectful and culturally appropriate and consider the emotional impact of forensic conclusions on affected individuals and communities.

By prioritizing cultural sensitivity and implanting strategies to address cultural considerations within forensic investigations, Saudi Arabia can ensure that forensic practices are conducted ethically, respectfully, and in alignment with cultural values and beliefs. This approach not only fosters trust and cooperation within communities but also enhances the effectiveness and integrity of forensic investigations in the country.

Discussion

The comprehensive exploration of forensic odontology and anthropology presented in this paper underscores their critical roles in forensic investigations, both globally and within the specific context of Saudi Arabia. These disciplines, with their interdisciplinary nature, offer invaluable insights into human identification, age estimation, sex determination, and other vital aspects crucial for resolving criminal cases and disaster victim identification (DVI).

Significance of Forensic Odontology and Anthropology

Forensic odontology, as elucidated in this study, plays a pivotal role in victim identification, particularly in cases where traditional methods may falter due to severe trauma or decomposition. By leveraging antemortem and postmortem dental records,

forensic odontologists can successfully identify individuals, providing closure to families and aiding in legal proceedings. Moreover, the documented cases of disaster victim identification underscore the widespread applicability and effectiveness of forensic odontology in mass causality incidents.

Similarly, forensic anthropology emerges an indispensable discipline in forensic investigations, offering expertise in analyzing skeletal remains to determine biological profiles. Through meticulous examination forensic anthropologists can ascertain critical details such as sex, age, and ancestry, contributing significantly to victim identification efforts. The integration of advanced techniques, such as cone-beam computed tomography, further enhances the accuracy and reliability of these disciplines, particularly in scenarios involving limited remains or samples.

Challenges and Opportunities in Saudi Arabia

The discussion on forensic odontology and anthropology in Saudi Arabia highlights notable gaps and challenges within the forensic landscape of the country. Despite the presence of forensic odontology cases, the absence of official bodies or certified training programs raises concerns regarding the standardization and quality of forensic practices. The limited awareness and training among dental professionals (Abdul et al., 2022b) underscore the urgent need for educational initiatives and standardized guidelines to bridge these gaps. Moreover, the findings regarding public awareness and willingness to participate in a national dental registry reflect a growing recognition of the importance of forensic odontology in Saudi Arabia. This presents an opportunity for stakeholders to collaborate in establishing comprehensive forensic frameworks and enhancing forensic practices within the country.

Cultural Sensitivity in Forensic Investigations

The section addressing cultural sensitivity within forensic investigations in Saudi Arabia provides valuable insights into navigating cultural nuances and upholding ethical

standards. By respecting religious practices, fostering open communication, and providing cultural competency training, forensic practitioners can effectively navigate cultural sensitivities and enhance community engagement. Collaboration with local experts and adaptation of procedures further contribute to fostering trust and cooperation within communities, ultimately enhancing the integrity of forensic investigations.

Future Directions and Implications

Looking ahead, the integration of advanced technologies, such as micro-computed tomography and artificial intelligence, holds promise for further enhancing forensic investigation capabilities in Saudi Arabia. Moreover, efforts to establish official forensic odontology bodies and training programs are crucial for standardizing practices and ensuring the quality of forensic services in the country.

Ultimately, the comprehensive exploration of forensic odontology and anthropology, coupled with insights into cultural sensitivity within forensic investigations, provides a foundation for advancing forensic practices in Saudi Arabia. By addressing current challenges, embracing emerging technologies, and prioritizing cultural sensitivity, Saudi Arabia can bolster its forensic capabilities and make meaningful contributions.

Conclusion

In conclusion, the utilization of dental methods for identification boasts a rich history, dating back to prehistoric times. The latter half of the 19th century witnessed a surge in interest in forensic dentistry, with its integration into forensic science marked by its appearance in dental journals. The 1960s marked a pivotal moment with the renewed interest in "*forensic odontology,*" gaining recognition not only within dentistry but also among law enforcement agencies.

Additionally, forensic anthropology emerged as a vital discipline within forensic science, serving to complement the biological profile of unidentified individuals. Through a multidisciplinary approach that combines the expertise of forensic dentistry and

anthropology, forensic investigations are significantly enhanced in accuracy and comprehensiveness, particularly in challenges cases involving incomplete or decomposed remains.

Furthermore, this interdisciplinary approach facilitates the navigation of cultural obstacles encountered within societies such as Saudi Arabia. As forensic science continues to evolve, the integration of dental and skeletal analyses will remain indispensable tools.

Conflict of Interest

The authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship, or publication of this paper.

References

- Abdul, N. S., Alotaibi, S. Z., Almughalliq, F. A., Alamri, M. D., Alshahrani, R. A., & Almujalli, A. I. (2022a). A Questionnaire-Based Study to Assess Knowledge and Awareness Regarding Cheiloscopy as a Forensic Odontology Diagnostic Tool Among Dental Professionals. *Cureus*. https://doi.org/10.7759/cureus.31188
- Abdul, N. S., Alotaibi, S. Z., Almughalliq, F. A., Alamri, M. D., Alshahrani, R. A., & Almujalli, A. I. (2022b). A Questionnaire-based study to assess knowledge and awareness regarding cheiloscopy as a forensic odontology diagnostic tool among dental professionals. *Cureus*, *14*(11).
- Aboalshamat, K. T., Alghamdi, D. S., Almaqboul, F. A., Almarhabi, D. A., Aleissa, H., Alattas, T., Aqely, A. A., & Albishry, R. N. (2021). Knowledge and Attitudes of the Public in Saudi Arabia about Forensic Odontology during COVID-19. *Journal of Research in Medical and Dental Science*, *9*(9), 107–115.
- Adams, B. (2003). Establishing Personal Identification Based on Specific Patterns of Missing, Filled, and Unrestored Teeth. *Journal of Forensic Sciences*, *48*(3), 1–10. https://doi.org/10.1520/JFS2002226

- Adserias-Garriga, J. (2019). A review of forensic analysis of dental and maxillofacial skeletal trauma. *Forensic Science International*, *299*, 80–88.

- Al Sheddi, M., & Al Asiri, A. (2015). Awareness of the scope and practice of forensic dentistry among dental practitioners. *Australian Journal of Forensic Sciences*, *47*(2), 194–199. https://doi.org/10.1080/00450618.2014.925975

- Alfaize, N. A. (2015). *The impact of culture and religion on digital forensics: The study of the role of digital evidence in the legal process in Saudi Arabia*.

- Alqahtani, S., AlShahrani, Y., & AlQahtani, A. (2017). REALITY OF FORENSIC ODONTOLOGY IN SAUDI ARABIA. *Revista Brasileira de Odontologia Legal*, 12–21. https://doi.org/10.21117/rbol.v4i2.106

- Araújo, D. O., de Gois Santos, A. L., Pinheiro, J. C., Gomes, A. M. D., de Melo, F. M. V. A., da Silva, G. G., Leite, R. B., & others. (2021). Scientific evidence of forensic dentistry related to techniques of human identification by bite marks. *Revista Da AcBO-ISSN 2316-7262*, *10*(1).

- Ata-Ali, J., & Ata-Ali, F. (2014). Forensic dentistry in human identification: A review of the literature. *Journal of Clinical and Experimental Dentistry*, *6*(2), e162–e167. https://doi.org/10.4317/jced.51387

- Avon, S. L. (2004). Forensic odontology: The roles and responsibilities of the dentist. *Journal-Canadian Dental Association*, *70*(7), 453–458.

- Bailey, C., & Vidoli, G. (2023). Age-at-Death Estimation: Accuracy and Reliability of Common Age-Reporting Strategies in Forensic Anthropology. *Forensic Sciences*, *3*(1), 179–191.

- Barber Rioja, V., & Rosenfeld, B. (2018). Addressing linguistic and cultural differences in the forensic interview. *International Journal of Forensic Mental Health*, *17*(4), 377–386.

- Benevento, M., Trotta, S., Iarussi, F., Caterino, C., Jarussi, V., & Solarino, B. (2021). Multidisciplinary analysis of bite marks in a fatal human dog attack: A case report. *Legal Medicine*, *48*, 101816.

- Brkic, H., Strinovic, D., Slaus, M., Skavic, J., Zecevic, D., & Milicevic, M. (1997). Dental identification of war victims from Petrinja in Croatia. *International Journal of Legal Medicine*, *110*(2), 47–51. https://doi.org/10.1007/s004140050029

- Campanacho, V., Alves Cardoso, F., & Ubelaker, D. H. (2021). Documented skeletal collections and their importance in forensic anthropology in the United States. *Forensic Sciences*, *1*(3), 228–239.

- Chiam, S.-L., Higgins, D., Colyvas, K., Page, M., & Taylor, J. (2021). Interpretation, confidence and application of the standardised terms: Identified, probable, possible, exclude and insufficient in forensic odontology identification. *Science & Justice*, *61*(4), 426–434.

- Clemmonsa, C. M. (2022). The Morphology of Intersectionality Discordance between Ancestry Estimates and Social Identifiers.. *Forensic Anthropology (University of Florida)*, *5*(2).

- De Valck, E. (2006). Major incident response: Collecting ante-mortem data. *Forensic Science International*, *159 Suppl 1*, S15-19. https://doi.org/10.1016/j.forsciint.2006.02.004

- Fixott, R. H., Arendt, D., Chrz, B., Filippi, J., McGivney, J., & Warnick, A. (2001). ROLE OF THE DENTAL TEAM IN MASS FATALITY INCIDENTS*. *Dental Clinics of North America*, *45*(2), 271–292. https://doi.org/10.1016/S0011-8532(22)01762-1

- Galea-Holhoș, L. B., Delcea, C., Siserman, C. V., & Ciocan, V. (2023). Age estimation of human remains using the dental system: A review. *Annals of Dental Specialty*, *11*(3–2023), 14–18.

- Glorney, E., Raymont, S., Lawson, A., & Allen, J. (2019). Religion, spirituality and personal recovery among forensic patients. *Journal of Forensic Practice*, *21*(3), 190–200.

- Grewal, D. S., Khangura, R. K., Sircar, K., Tyagi, K. K., Kaur, G., & David, S. (2017). Morphometric analysis of odontometric parameters for gender determination. *Journal of Clinical and Diagnostic Research: JCDR*, *11*(8), ZC09.

- Işcan, M. Y., & Kedici, P. S. (2003). Sexual variation in bucco-lingual dimensions in Turkish dentition. *Forensic Science International*, *137*(2–3), 160–164. https://doi.org/10.1016/s0379-0738(03)00349-9

- Issrani, R., Prabhu, N., Sghaireen, M. G., Ganji, K. K., Alqahtani, A. M. A., ALJamaan, T. S., Alanazi, A. M., Alanazi, S. H., Alam, M. K., & Munisekhar, M. S. (2022). Cone-beam computed tomography: A new tool on the horizon for forensic dentistry. *International Journal of Environmental Research and Public Health*, *19*(9), 5352.

- Jayakrishnan, J. M., Reddy, J., & Kumar, R. V. (2021). Role of forensic odontology and anthropology in the identification of human remains. *Journal of Oral and Maxillofacial Pathology: JOMFP*, *25*(3), 543.

- Jensen, N. D., Ulloa, P. C., Arge, S., Bindslev, D. A., & Lynnerup, N. (2020). Odontological identification dental charts based upon postmortem computed tomography compared to dental

charts based upon postmortem clinical examinations. *Forensic Science, Medicine and Pathology*, *16*(2), 272–280.

- Krishan, K., Kanchan, T., & Garg, A. K. (2015). Dental Evidence in Forensic Identification – An Overview, Methodology and Present Status. *The Open Dentistry Journal*, *9*(1), 250–256. https://doi.org/10.2174/1874210601509010250

- Maulani, C., & Auerkari, E. I. (2020). Molecular analysis for sex determination in forensic dentistry: A systematic review. *Egyptian Journal of Forensic Sciences*, *10*, 1–9.

- Miller, R. G. (2024). Forensic odontology in disaster victim identification. *Journal of Forensic Sciences*.

- Naiman, M., Larsen, A. K., & Valentin, P. R. (2007). The role of the dentist at crime scenes. *Dental Clinics of North America*, *51*(4), 837–856, vii. https://doi.org/10.1016/j.cden.2007.06.004

- Özeren Keşkek, C., Yılancı, H. Ö., & Akçiçek, G. (2024). Sex estimation by volumetric evaluation of the maxillary canine using cone-beam computed tomographic images. *BMC Oral Health*, *24*(1), 1–8.

- Passalacqua, N. V., Pilloud, M. A., & Congram, D. (2021). Forensic anthropology as a discipline. *Biology*, *10*(8), 691.

- Pereira, C. P., & Santos, J. C. (2013). How to do identify single cases according to the quality assurance from IOFOS. The positive identification of an unidentified body by dental parameters: A case of homicide. *Journal of Forensic and Legal Medicine*, *20*(3), 169–173.

- Prajapati, G., Sarode, S. C., Sarode, G. S., Shelke, P., Awan, K. H., & Patil, S. (2018). Role of forensic odontology in the identification of victims of major mass disasters across the world: A systematic review. *PLOS ONE*, *13*(6), e0199791. https://doi.org/10.1371/journal.pone.0199791

- Rai, B., & Kaur, J. (2012). *Evidence-based forensic dentistry*. Springer Science & Business Media.

- Rai, B., & Kaur, J. (2013). *Evidence-Based Forensic Dentistry*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-28994-1

- Rajendran, D., Mahabob, N., Lakshmi, S. J., Hari, P. A., Raja, T. A., & others. (2022). "Cheiloscopy & Rugoscopy"–In Sex & Racial Identification. *NeuroQuantology*, *20*(6), 2904.

- Salam, M., Al-Rawashdeh, N., & Almutairi, A. F. (2020). Public awareness of forensic odontology and willingness to enroll in a prospective dental registry: A survey conducted in Saudi Arabia. *The Saudi Dental Journal*, *32*(1), 21–28. https://doi.org/10.1016/j.sdentj.2019.05.008

- Sharma, T., Chaitan, S., Somayaji, N. S., Mahajan, B., Rajguru, J. P., Hajibabaei, S., & Hegde, S. (2020). The medicolegal importance of establishing human identity by using dactyloscopy and rugoscopy: A comparative study. *Journal of Family Medicine and Primary Care*, *9*(7), 3236–3241.

- Thampan, N., Janani, R., Ramya, R., Bharanidharan, R., Kumar, A. R., & Rajkumar, K. (2018). Antemortem dental records versus individual identification. *Journal of Forensic Dental Sciences*, *10*(3), 158.

- Valenzuela, A., Martin-de las Heras, S., Marques, T., Exposito, N., & Bohoyo, J. M. (2000). The application of dental methods of identification to human burn victims in a mass disaster. *International Journal of Legal Medicine*, *113*(4), 236–239. https://doi.org/10.1007/s004149900099

- Wojcik, M., Venter, H., Eloff, J., & Olivier, M. (2006). Applying machine trust models to forensic investigations. *Advances in Digital Forensics II: IFIP International Conference on Digital Forensics, National Center for Forensic Science, Orlando, Florida, January 29–February 1, 2006*, 55–65.

- Wood, R. E., & Gardner, T. (2023). Forensic odontology in DVI—A path forward. *Journal of Forensic Sciences*.

- Yaacob, H., Nambiar, P., & Naidu, M. D. (1996). Racial characteristics of human teeth with special emphasis on the Mongoloid dentition. *The Malaysian Journal of Pathology*, *18*(1), 1–7.

- Zainuddin, M. Z., Mohamad, N. S., Su Keng, T., & Mohd Yusof, M. Y. P. (2023). The applications of MicroCT in studying age-related tooth morphological change and dental age estimation: A scoping review. *Journal of Forensic Sciences*, *68*(6), 2048–2056.