Incisive Foramen as a Tool for Forensic Identification Using Dental Anatomy: A Comprehensive Review

Dr. Deepak Sharma[1], Dr. Anita Yadav[2], Dr. Rajesh Kumar[3*]

[1]Research Scholar, Forensic Science, School of Science, Sanjeev Agrawal Global Educational (SAGE) University, Bhopal, Madhya Pradesh, India

[2]Associate Professor, Forensic Science, School of Science, Sanjeev Agrawal Global Educational (SAGE) University, Bhopal, Madhya Pradesh, India

[3]Additional Professor, All India Institute of Medical Sciences, Deoghar, Jharkhand, India

[*]Corresponding Author

DOI: https://doi.org/10.51244/IJRSI.2026.1304000033

Received: 04 April 2026; Accepted: 10 April 2026; Published: 27 April 2026

ABSTRACT

Human remains analysis, mass disaster victim identification, and criminal investigations all heavily rely on forensic identification. Because of its distinct form and stability after death, the incisive foramen has become one of the most important anatomical landmarks in dental forensic research. By examining its anatomical structure, diversity, and use in forensic odontology, this paper thoroughly investigates the function of the incisive foramen in forensic identification. This study summarizes current knowledge and explores potential avenues for future research to improve forensic identification techniques using a number of academic articles.

Keywords: Forensic Odontology, Incisive Foramen, Morphology, Anatomy, Post-mortem

INTRODUCTION

Dental structures are used in forensic odontology to identify people, especially when the remains are fractured or decayed. Because of the physical differences between individuals and populations, the incisive foramen—which is situated in the hard palate behind the central incisors—has drawn forensic attention. The anatomical features, importance in forensic investigations, and techniques used for personal identification are all examined in this research.

Within the roof of the oral cavity, in the hard palate, is an anatomical structure known as the incisive foramen. It is situated at the midline, immediately below the central incisor teeth and in front of the intermaxillary suture, which is where the maxilla's palatine processes unite. The oral aperture of the incisive canal that joins the nasal and oral cavities is called the incisive foramen, and it is shielded by the incisive papilla. In the nasal cavity, close to the nasal septum, the canal—which is usually shaped like a "Y" or "V"—ends, creating bilateral nasal foramina around 2 cm beyond the nostrils. Neurovascular structures that connect the nasal and oral canals, such as the larger palatine arteries and the nasalopalatine nerve, a branch of the trigeminal nerve, pass via the incisive foramen.

In dental and maxillofacial operations, the incisive foramen is an essential marker that is used to identify and treat diseases such as congenital anomalies, cleft palate deformities, and nasopalatine cysts. Age, sex, ethnicity, trauma, and tooth loss are among of the variables that might affect its size and form.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

Anatomical Significance of the Incisive Foramen:

A crucial anatomical feature situated just behind the central incisor teeth in the anterior region of the hard palate is the incisive foramen. It is crucial to dental anatomy, surgery, and clinical procedures and acts as the opening of the incisive canals.

Location and Morphology - A passageway for neurovascular systems, the incisive foramen is a component of the nasopalatine canal. Individual distinctiveness is influenced by its size, shape, and positional changes. With a medio-lateral diameter that ranges from 1.40 mm to 5.90 mm, the incisive foramen frequently takes the form of oval, circular, or heart-shaped apertures. The nasopalatine nerve, a branch of the trigeminal nerve, provides sensory innervation to the mucosa of the anterior hard palate. It is located at the midline of the hard palate and is funnel-shaped, covered by the incisive papilla. The foramen leads into the incisive canal, connecting the oral and nasal cavities.

Developmental Aspects - The incisive foramen is a vital part of the maxilla during embryonic development, and its shape is influenced by both genetic and environmental influences. During development, the incisive foramen—a vital anatomical structure—develops at the point where the major and secondary palates fuse. It is an important clinical landmark since it is connected to categories of cleft palates and helps to understand palatal dysmorphogenesis. The incisive foramen's size and shape vary significantly among individuals, typically being oval-shaped with a larger anteroposterior diameter. Canal morphology, including single, double, or triple canals with septa, can impact surgical approaches.

Population and Sex Variations - Several studies have documented the morphological differences of the incisive foramen across populations, genders, and age groups, contributing to its forensic applicability. The incisive foramen is a crucial landmark in cleft lip and palate assessment, serving as a reference point for severity classification. It is also crucial in dental implantology due to its proximity to the central incisors. Enlargement of the foramen can complicate surgical procedures, necessitating preoperative imaging like CBCT to avoid damaging neurovascular structures. The foramen also serves as an injection site for local anesthetics during dental procedures. Enlargement beyond 10mm may indicate pathological conditions, and misinterpretation on radiographs can lead to diagnostic errors.

Forensic Applications of the Incisive Foramen:

An important anatomical marker in the anterior palate is the incisive foramen, sometimes referred to as the anterior palatine foramen or nasopalatine foramen. It connects the nasal and oral canals and acts as a passageway for the sphenopalatine artery and vein as well as the nasopalatine nerve. The incisive foramen has a number of possible uses in forensic science, though its application is still developing:

Radiographic Identification - Radiographic techniques such as CBCT (Cone Beam Computed Tomography) and panoramic radiographs allow forensic experts to analyze the incisive foramen’s shape and dimensions. Because it is close to blood arteries and nerves, the incisive foramen is crucial in oral and maxillofacial surgery. It serves as a marker to prevent harm during operations like tooth extractions and dental implants. The position of the IF medial to the third molar, which is seen in 84–95% of patients, is an anatomical landmark for dental procedures that serves as a reliable guide for nerve blocks and surgical procedures. Because of its stability, it can be used to compare dental radiographs taken before and after death, which is important for identification procedures.

Superimposition and Digital Reconstruction - Advanced imaging techniques enable superimposition of ante-mortem and post-mortem records for positive identification. In order to replicate face features in FFR, the oral cavity—including the structures around the incisive foramen—is essential. Although the incisive foramen is not particularly mentioned as a crucial characteristic in this context, this method uses anatomical features to assist in identifying individuals.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

Incisive Foramen in Age and Sex Estimation - Research has demonstrated that the foramen's dimensions correlate with age and sex, providing an additional tool for forensic profiling. Recent studies suggest that measurements from the incisive foramen can be used to predict gender using cone-beam computed tomography (CBCT) scans. Although not a primary indicator, these measurements can contribute to gender prediction models when combined with other anatomical features. However, their standalone forensic value is limited compared to other skeletal features. The incisive foramen may be used as an additional landmark to identify anatomical features in circumstances where skeletal remains are broken or destroyed. However, traditional forensic anthropology procedures that focus on age or gender estimation tend not to stress it.

Morphometric Identification of Sex includes sex variations in distance from the IF to other palatine foramina are statistically significant. For instance: In males, the average distance between the IF and the greater palatine foramen (GPF) is 39.07±2.23 mm on the left and 39.81±2.37 mm on the right. The average distances for females are 38.57±2.41 mm (left) and 38.62±2.53 mm (right), which is shorter. When paired with other skeletal indicators, these sex-based variances allow forensic specialists to infer biological sex in unidentified remains.

Comparative Analysis with Other Forensic Markers:

Dental Records vs. Incisive Foramen Analysis - A comparative review of dental records, bite marks and incisive foramen analysis in forensic identification. A patient's dental history, including treatments, diagnoses, and care plans, are documented in their dental records, which are crucial documentation. They consist of radiographs, charts, treatment plans, patient data, medical history, and progress notes. Precise dental documentation facilitates future treatment planning, patient safety, and practitioner and patient legal protection. Whereas in dental procedures like local anesthetic administration and surgical operations, incisive foramen examination is an essential step. Using imaging methods like CBCT, it measures things like nasopalatine canal length, labio-palatal and mediolateral diameters, and form variations. Recognizing anatomical features in disorders such as cleft lip and palate and preventing difficulties during dental treatments depend on an understanding of the incisive foramen's anatomy.

Aspect	Dental Records	Incisive Foramen Analysis
Purpose	Comprehensive patient care documentation	Anatomical analysis for surgical and procedural planning
Content	Patient history, treatment plans, radiographs	Dimensions, shape, and location of the incisive foramen
Importance	Continuity of care, legal protection	Avoiding procedural complications, precise anatomical identification

Skull and Palatal Landmarks vs. Incisive Foramen Analysis - The incisive foramen is compared with other cranial landmarks to evaluate its reliability in forensic anthropology. Understanding the anatomy of the nasal and oral cavities requires knowledge of the skull and palatal landmarks. An essential landmark for a number of medical operations is the incisive foramen, which is situated in the front region of the hard palate (Fig.-01). Here, we shall examine the connection between the incisive foramen and palatal and cranial landmarks. The Panatine Bone, which creates the orbits, nasal cavity, and hard palate, is a structure of the skull. The horizontal plates of the palatine bones and the palatine processes of the maxilla combine to form the Hard Palate, which serves as a partition between the nasal and oral chambers. The Greater Palatine Foramen (GPF), which is important for maxillary nerve blocks, is situated posteriorly on the hard palate, frequently close to the third molar. Nerves and arteries are transmitted to the nasal cavity through the Incisive Foramen. Whereas just behind the incisors, at the intersection of the maxilla's two palatine processes, is the incisive foramen. It is located in front of the greater palatine foramen and is essential for dental and nasal cavity operations. In order to better understand the location of the incisive foramen, studies have measured distances from it.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue IV April 2026

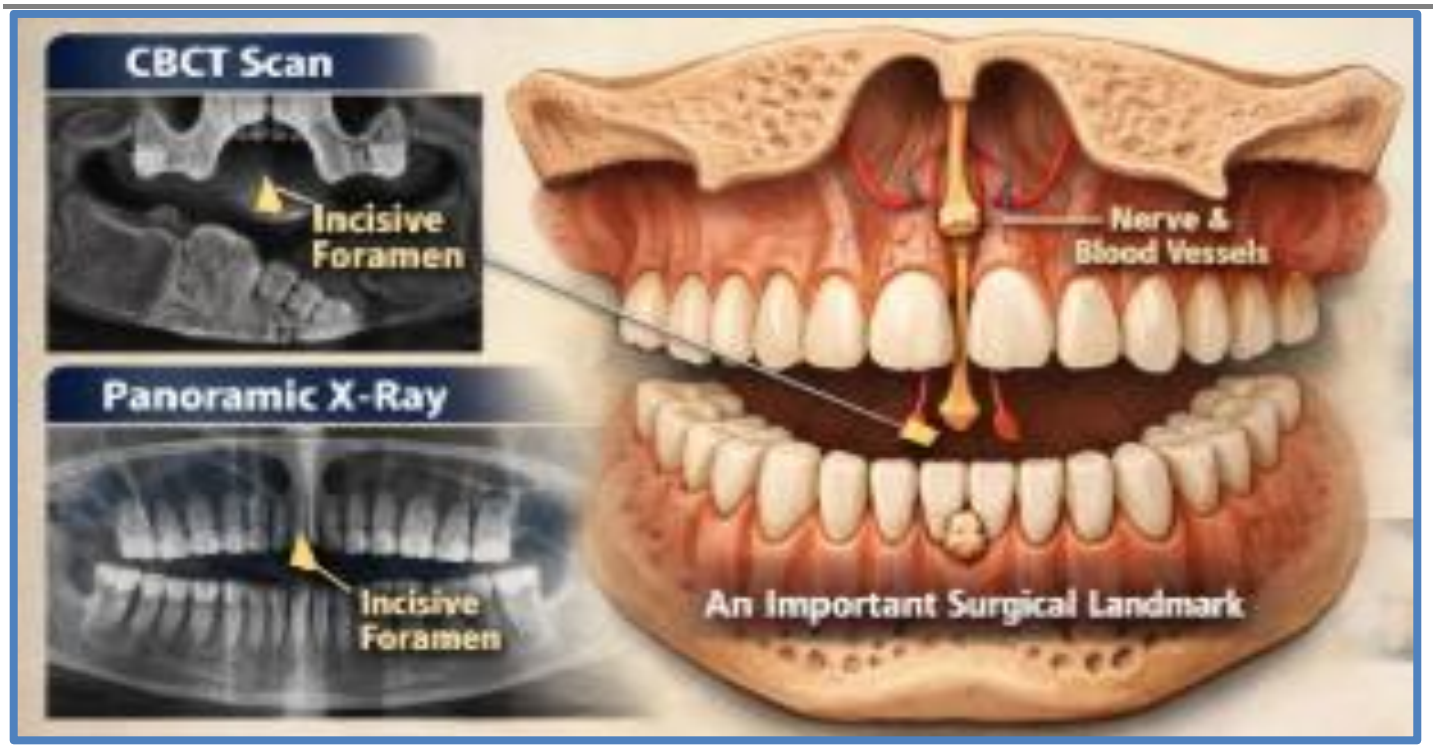

Figure -01 (Landmark of incisive foramen)

Landmark	Location	Clinical Significance
Palatine Bone	Between maxillae and sphenoid	Forms hard palate, nasal cavity, orbits
Hard Palate	Barrier between oral and nasal cavities	Essential for dental procedures, forensic identification
Greater Palatine Foramen	Posterior hard palate, near third molar	Important for maxillary nerve blocks
Incisive Foramen	Anterior hard palate	Transmits nerves and vessels to nasal cavity

Challenges and Limitations:

Despite its forensic potential, variability in morphological documentation, difficulty in post-mortem preservation, and standardization of radiographic protocols pose challenges. The incisive foramen and canal, despite not being a direct challenge in forensic science, exhibit significant anatomical variability that can complicate identification and analysis. Variations in size, shape, and location can make it difficult to establish consistent markers for identification. Traditional imaging techniques like panoramic radiographs (PAN) have limitations in accurately visualizing the incisive canal and foramen, leading to incorrect interpretations in forensic contexts. Cone-beam computed tomography (CBCT) offers more accurate imaging, providing detailed three-dimensional views, which can be beneficial for precise skeletal remains analysis. Forensic implications of these challenges require careful consideration and advanced imaging techniques like CBCT. Research limitations, such as small sample sizes or measurement biases, can affect the reliability of forensic conclusions drawn from studies. Therefore, advanced imaging techniques like CBCT are essential for overcoming these challenges.

Future Perspectives and Research Directions:

Advancements in AI-based forensic imaging, 3D morphometric analysis, and population-specific databases could enhance the reliability of incisive foramen-based identification. The incisive foramen, located in the hard palate, is a crucial part of forensic facial reconstruction due to its anatomical significance and variability. Future research directions include understanding variations in the morphology of the incisive foramen, which can help create more accurate facial reconstructions and aid in identifying individuals by providing unique anatomical markers that can be matched with dental records or other skeletal remains.

Advanced imaging techniques, such as cone-beam computed tomography (CBCT), can be used to study the incisive foramen's morphology. Developing advanced 3D models of the incisive foramen and surrounding structures can improve the accuracy of facial reconstructions and help visualize anatomical details that might be crucial for identification.

Forensic facial reconstruction can be enhanced by integrating data from the incisive foramen with other facial features, such as the nasal cavity, dental structures, and other foramina. Validation studies can help establish the reliability and accuracy of methods incorporating the incisive foramen.

Ethnic and age-related variability can be investigated to provide valuable data for forensic applications, especially in diverse populations. Studying how the incisive foramen changes with age can help estimate the age of unidentified remains, which is crucial in forensic investigations.

Collaboration and standardization between forensic scientists, anatomists, and radiologists can lead to more comprehensive understanding and application of incisive foramen data. Standardizing measurement techniques will facilitate comparison across different studies and enhance the reliability of forensic findings.

CONCLUSION

In conclusion, the incisive foramen serves as a vital anatomical landmark in forensic odontology, offering unique opportunities for human identification in various investigative scenarios. Its distinct morphology and relative stability post-mortem present significant advantages in identifying remains, particularly when other methods may be compromised. Although its potential remains largely underutilized, advancements in imaging technologies, such as cone-beam computed tomography (CBCT), and interdisciplinary collaboration among forensic scientists, anatomists, and radiologists can enhance the efficacy and accuracy of incisive foramen analysis. Emphasizing standardized methodologies in future research will not only improve the reliability of findings but also expand the application of the incisive foramen in forensic contexts. By addressing existing challenges and exploring the anatomical variability across different populations, the incisive foramen can be further integrated into comprehensive forensic identification protocols, thereby bolstering its significance in both individual cases and broader mass disaster victim recovery efforts. Future studies should continue to refine techniques and establish robust databases to maximize the forensic applicability of this critical anatomical feature. The incisive foramen represents a promising but underutilized tool in forensic identification. Standardized methodologies, technological advancements, and interdisciplinary research can improve its forensic applicability.

REFERENCES

1. THUNYACHAROEN, S.; IAMAROON, A. & MAHAKKANUKRAUH, P. Morphometric study of incisive, greater and lesser palatine foramina: A novel point of maxillary nerve block in a Thai population. Int. J. Morphol., 39(4):994-1000, 2021.
2. 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
3. Emam N. M. (2024). Role of Forensic Odontology in Identification of Persons: A Review Article. Cureus, 16(3), e56570. https://doi.org/10.7759/cureus.56570
4. He, P., Caughey, J., Tubbs, R. S., & Iwanaga, J. (2021). Microsurgical Anatomy of the Incisive Canals. The Kurume Medical Journal, 68(2), 115-119.
5. Sarna, K., Estreed, M. A., Sonigra, K. J., Amuti, T., Opondo, F., Kamau, M., & Ngeow, W. C. (2023). Anatomical Patterns of the Nasopalatine Canal and Incisive Foramen in an African Setting: A Cross-Sectional Study. Craniomaxillofacial trauma & reconstruction, 16(3), 222–233. https://doi.org/10.1177/19433875221100943
6. Mudgal P, Rock P, Al Kabbani A, et al. Incisive foramen. Reference article, Radiopaedia.org (Accessed on 06 Apr 2025) https://doi.org/10.53347/rID-28248
7. Brennan, P. A., Mahadevan, V., & Evans, B. T. (Eds.). (2015). Clinical head and neck anatomy for surgeons. CRC Press.

8. Iamandoiu, A. V., Mureşan, A. N., & Rusu, M. C. (2022). Detailed Morphology of the Incisive or Nasopalatine Canal. Anatomia, 1(1), 75-85. https://doi.org/10.3390/anatomia1010008
9. Costa, E. D., de Oliveira Reis, L., Gaêta-Araujo, H., Martins, L. A. C., Oliveira-Santos, C., & Freitas, D. Q. (2021). Comparison of distance of upper central incisor root and incisive canal in different sagittal and vertical skeletal patterns and sex: A retrospective CBCT study. International orthodontics, 19(3), 462–470. https://doi.org/10.1016/j.ortho.2021.07.001
10. Pinto, P. H. V., Ferraz, M. Â. A. L., de Sousa Júnior, S. C., de Pinho Mendes, J., Costa, A. L. F., de Castro Lopes, S. L. P., & Pinto, A. S. B. (2017). Assessment of the opening diameter of the incisive foramen as a parameter for gender and age estimation. Brazilian Dental Science, 20(4), 106-114.
11. Jayakrishnan, J. M., Reddy, J., & Vinod Kumar, R. B. (2021). Role of forensic odontology and anthropology in the identification of human remains. Journal of oral and maxillofacial pathology : JOMFP, 25(3), 543–547. https://doi.org/10.4103/jomfp.jomfp_81_21
12. Mohammed, F., Fairozekhan, A. T., Bhat, S., & Menezes, R. G. (2022). Forensic Odontology. StatPearls.
13. Krishan K, Kanchan T, Garg A. Dental Evidence in Forensic Identification – An Overview, Methodology and Present Status . Open Dentistry J, 2015; 9: . http://dx.doi.org/10.2174/1874210601509010250
14. Lake, S., Iwanaga, J., Kikuta, S., Oskouian, R. J., Loukas, M., & Tubbs, R. S. (2018). The Incisive Canal: A Comprehensive Review. Cureus, 10(7), e3069. https://doi.org/10.7759/cureus.3069
15. Thakur AR, Burde K, Guttal K, Naikmasur VG. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. Imaging Sci Dent. 2013 Dec;43(4):273-281. https://doi.org/10.5624/isd.2013.43.4.273
16. Linjawi, AI; Othman, MA; Dirham, AA; Ghoneim, SH; Aljohani, SR; Dause, RR; Marghalani, HYA. Morphological evaluation of the incisive canal with reference to gender and age: A cone-beam computed tomography study. Nigerian Journal of Clinical Practice 24(11):p 1596-1601, November 2021. | DOI: 10.4103/njcp.njcp_40_21
17. Alhumaidi, A. M., Al Moaleem, M. M., Gadah, T. S., Alahmari, N. M., Al Makramani, B. M., Mattoo, K., & Homeida, H. E. (2025). Nasopalatine canal morphology: CBCT review & nomenclature proposal. Folia Morphologica.
18. Juodzbalys G, Wang HL, Sabalys G. Anatomy of Mandibular Vital Structures. Part II: Mandibular Incisive Canal, Mental Foramen and Associated Neurovascular Bundles in Relation with Dental Implantology. J Oral Maxillofac Res. 2010 Apr 1;1(1):e3. doi:10.5037/jomr.2010.1103. PubMed PMID: 24421959; PubMed Central PMCID: PMC3886037.
19. Senol, Deniz; Secgin, Yusuf1; Harmandaoglu, Oguzhan2; Kaya, Seren3; Duman, Suayip Burak4; Oner, Zülal5. Gender Prediction Using Cone-Beam Computed Tomography Measurements from Foramen Incisivum: Application of Machine Learning Algorithms and Artificial Neural Networks. Journal of the Anatomical Society of India 73(2):p 152-159, Apr–Jun 2024. | DOI: 10.4103/jasi.jasi_129_23
20. Dias, P. E., Miranda, G. E., Beaini, T. L., & Melani, R. F. (2016). Practical Application of Anatomy of the Oral Cavity in Forensic Facial Reconstruction. PloS one, 11(9), e0162732. https://doi.org/10.1371/journal.pone.0162732
21. Alotaibi, M. K., Alansari, M. A., Alqahtani, J. M., Alduhaymi, A. A., Assari, A., & Baseer, M. A. (2018). Evaluation of Greater Palatine Foramen and Incisive Canal Foramen among Saudi Patients using Cone Beam Computed Tomography Scans. Journal of Oral Health & Community Dentistry, 12(2).