Systematic Review

Evaluating Skeletal Trauma and Forensic Anthropology for Medicolegal Investigations: A Systematic Review

Sachin Kumar Tripathi[1], Sakshi Singh[2], Rajiv Ratan Singh[3], Pradeep kumar Yadav[4]

[1]Scientific Assistant, Toxicology Department of Forensic Medicine & Toxicology, King George's Medical University, Lucknow, Uttar Pradesh, [2]Research Scholar Anthropology, University of Lucknow, Lucknow, [3]Professor (Jr), Department of Emergency Medicine, Dr.RML Institute of Medical Sciences Lucknow, India, Lucknow, India, [4]Assistant Professor, Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute Lucknow.

How to cite this article: Sachin Kumar Tripathi, Sakshi Singh, Rajiv Ratan Singh et al. Evaluating Skeletal Trauma and Forensic Anthropology for Medicolegal Investigations: A Systematic Review. Indian Journal of Forensic Medicine and Toxicology 2023;17(3).

Abstract

Background: Skeletal trauma analysis is crucial in the area of forensic anthropology for locating and analyzing wounds in human remains. For the evaluation and recording of bone injuries, a number of techniques and methods have been developed over the years, including ocular examination and cutting-edge imaging modalities. In order to determine the approaches used in diagnosing bone trauma, the goal of this systematic review is to critically study the body of current research. The goal of this study is to draw attention to the advantages, disadvantages, and recent technological developments of these techniques.

Aim: This study thoroughly examines the examination of skeletal trauma and the function of forensic anthropology in medicolegal cases, finding knowledge gaps and outlining potential directions for future research.

Method: To find relevant studies released within a certain timeframe, a thorough search across the largest scientific databases was carried out. Studies on the assessment of skeletal trauma and the use of forensic anthropology in medicolegal cases were also included. For methodological rigor, quality, and applicability, the chosen papers underwent careful evaluation. According to the particular approaches and procedures used in assessing skeletal trauma and the contributions of forensic anthropology to the field, data were retrieved, synthesized, and classified.

Conclusion: This systematic study examines several approaches for assessing skeletal injuries in medicolegal investigations, stressing their benefits and drawbacks as well as the function of forensic anthropology. For this discipline to improve accuracy and validity, advancements, established standards, and cutting-edge technology are essential.

Key words: anthropological identification, bone fractures, forensic anthropology, medicolegal investigations, forensic evidence etc.

Corresponding Author: Pradeep Kumar Yadav, Assistant Professor, 4th Floor, Academic Block, Department of Forensic Medicine and Toxicology, Dr. Ram Manohar Lohia Institute Lucknow.

E-mail: dctrprdp@gmail.com

Phone: 9410662955

Introduction

Due to its insightful analysis of skeletal injuries, forensic anthropology plays a crucial part in medico legal investigations.[1] Determining the reason and manner of death, recreating the circumstances leading up to the trauma, and presenting evidence for legal procedures all depend on the diagnosis of skeletal trauma. [2] The study of skeletal remains using a variety of tools and procedures falls under the umbrella of forensic anthropology, which enables a thorough knowledge of trauma patterns and their consequences in medico legal settings. [3] Radiologists, forensic anthropologists, forensic pathologists, and other specialists must all work together to evaluate bone trauma. [4] Forensic anthropologists work to correctly record and interpret bone trauma using eye inspection, macroscopic analysis, imaging modalities, and cutting-edge analytical tools. [5] This study seeks to offer an extensive overview of the present state of knowledge in the field of forensic anthropology, identify research gaps, and suggest opportunities for future improvement. [6][7] To do this, a systematic evaluation of the methodologies and procedures used in analyzing skeletal trauma was conducted. [8] In recent years, technical improvements and improved collaboration among specialists from many disciplines have propelled the area of forensic anthropology to considerable advancements. [9] The assessment of bone injuries continues to be mostly dependent on conventional techniques like ocular inspection and macroscopic examination. [10] Visual examination is the process of carefully examining the surfaces of bones for indications of fractures, cuts, abrasions, and other traumatic lesions. [11] The kind and number of skeletal injuries can also be recognized and described via macroscopic examination. [12] While these traditional approaches still offer useful information, they are frequently supplemented with cutting-edge imaging technologies to improve accuracy and precision. [13] Forensic anthropology has been transformed by imaging techniques including X-rays, computed tomography (CT), and magnetic resonance imaging (MRI). [14] X-rays offer comprehensive pictures of the internal bone structures and can help to recognize and classify fractures. [15] The three-dimensional reconstructions provided by CT scans enable more thorough evaluations of bone trauma. [16] Additionally, interior traumas like hemorrhages and organ damage may be seen more clearly thanks to CT scans. [17] Although it is less frequently employed in forensic anthropology, MRI can offer important information on soft tissue injuries and related trauma. [18] Skeletal trauma assessment might be revolutionized by new technologies that have just appeared. Skeletal remains may be accurately represented in virtual form thanks to three-dimensional scanning and modeling techniques like laser scanning and photogrammetry. [19] These digital models allow for manipulation, measurement, and analysis in ways that are not achievable with only physical specimens. [20] This technique makes it easier to recognize minor trauma patterns, helps to recreate the circumstances that led to the trauma, and permits the preservation of evidence while reducing the handling of delicate remains. [21] The field of forensic anthropology now includes analyzing bone trauma, thanks to developments in molecular and biochemical methods. [22] To resolve unsolved cold cases and major catastrophe situations, DNA analysis can be used to identify people and make linkages between remains and missing persons. [23] An individual's geographic origin, food preferences, and migratory patterns can be determined using isotopic analysis, which looks at stable isotopes found in bone and teeth. [24] These details can be utilized to piece together a person's life narrative and aid in finding remains during forensic examinations. [25] Despite improvements in the examination of skeletal injuries, forensic anthropology still faces several problems and restrictions. [26] The interpretation of trauma patterns can be challenging since a variety of variables, including age, sex, bone density, and the presence of underlying diseases, can affect how severe and how quickly skeletal injuries manifest. [27] The evaluation of bone trauma can also be made more difficult by the postmortem period, environmental conditions, and taphonomy processes. [28] Forensic anthropologists' examination of skeletal injuries in medicolegal investigations is a crucial responsibility. This systematic study seeks to give a thorough overview of the procedures and approaches. [29]

Legal Aspect:

In medicolegal investigations, the legal component of appraising bone trauma and forensic anthropology is crucial. The reliability and admissibility of evidence in court are ensured by adhering to scientific standards and legal regulations. [30] Forensic anthropologists are required to adhere to set procedures, record their techniques, and give expert witness testimony. The privacy and security of individual information must be maintained through a chain of custody standards. [31] For correct interpretations and just outcomes in legal situations, elements like as validity, dependability, precision, and ethical norms are crucial. When managing sensitive information, it is vital to adhere to

privacy rules and regulations. [32] The legal considerations cover the safekeeping, accurate documenting, and storage of skeletal remains and related evidence. Respecting these legal requirements encourages openness, defends the rights of everyone concerned, and maintains the fairness of the legal system. [33]

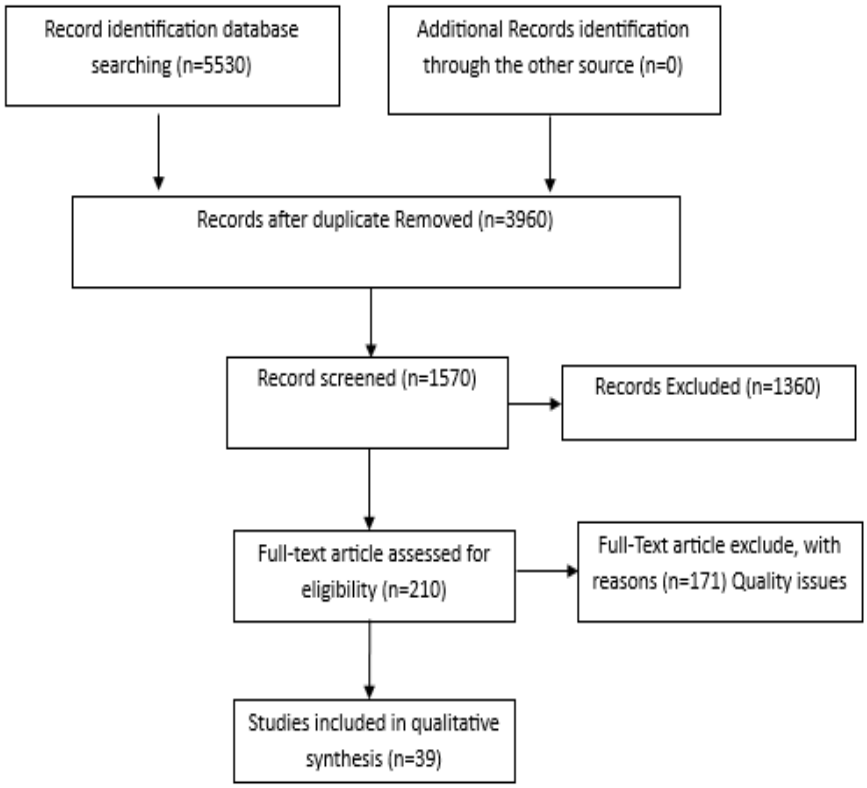
Medicolegal Aspect:

The medico-legal issue arises when examining skeletal trauma and applying forensic anthropological techniques without first establishing the validity and admissibility of the evidence in court. [34] It is essential to follow scientific guidelines and validate the methods employed. The legal context must also be taken into account when interpreting skeletal trauma to correctly determine the cause and manner of death, identify the culprits, and administer justice. [35] To solve the medico-legal issues in this area, meticulous documentation, adherence to strict methods, and persuasive expert evidence are essential. [36]

Methodology

A thorough examination of the literature was done for this investigation utilizing the Bullion Words database. After a search produced 5530 results, 3960 papers were chosen based on their quality and relevancy. A total of 1570 samples were identified after analysis. Samples that were improperly downloaded (210) were excluded. After 1360 full-text papers were evaluated, 31 that met the inclusion requirements were added to the study.

Prisma Flow chart:



Result

The systematic study brought to light the wide range of approaches and tools used in assessing bone trauma for medicolegal inquiries. It shed light on the advantages, drawbacks, and developments of these strategies while highlighting the critical function of forensic anthropology in determining bone trauma. To improve the precision and validity of medicolegal investigations, the evaluation identified research gaps and urged more development and study in the area.

Discussions

In medicolegal investigations, the assessment of bone trauma is extremely important. Skeletal trauma analysis is essential for diagnosing the reason and manner of death, recreating the events leading to death, and supplying evidence in court cases. Fractures, gunshot wounds, stab wounds, and other bone injuries can provide forensic anthropologists and investigators with important clues that help them find the criminals and administer justice. [37] Skeletal trauma is assessed using a variety of techniques for medicolegal investigations. These procedures include visual inspection, radiographic imaging, and sophisticated forensic technologies including computed tomography (CT) scanning and three-dimensional (3D) imaging. While radiographic imaging helps in evaluating internal bone injuries, visual examination enables the detection and study of surface lesions. A thorough evaluation of bone trauma is made possible by cutting-edge methods like CT scanning and 3D imaging, which provide detailed visualization and virtual reconstructions. [38] There are difficulties and restrictions associated with evaluating bone trauma in medicolegal cases. Accurately identifying and evaluating trauma might be made more difficult by postmortem changes such as bone changes and decomposition. Injuries may be difficult to interpret if remnants are fragmented or mixed together. Further obstacles to a thorough assessment of skeletal trauma include the restricted availability of cutting-edge imaging equipment and the absence of standardized trauma assessment methodologies. [39]

Conclusion

The methodologies and approaches used in assessing bone trauma for medicolegal investigations are clarified by this systematic study, which concludes. It highlights the necessity of continual study and development as well as the significance of forensic anthropology in this procedure. Forensic anthropologists can contribute to more accurate evaluations of skeletal injuries and increase the validity and reliability of the evidence used in medicolegal investigations by knowing the strengths, limits, and breakthroughs in this discipline. Standardized procedures, improved methods, and investigation of cutting-edge technology are crucial for developing forensic anthropology in medicolegal situations further.

Future aspect:

The creation of standardized procedures, the development of more accurate methodologies, and the examination of emerging technology are future issues in skeletal trauma and forensic anthropological evaluation for medicolegal investigations. The comprehension of trauma patterns and their interpretation will progress through interdisciplinary research and partnership initiatives. The development and improvement of forensic anthropology in medicolegal investigations will be aided by further innovation and study in these fields.

Conflict of Interest: There is no conflict of interest

Source of funding: None

Ethical Clearance: Not Applicable

References

1. Soler A, Beatrice JS. Expanding the role of forensic anthropology in a humanitarian crisis: An example from the USA-Mexico border. Sociopolitics of migrant death and repatriation: Perspectives from forensic science. 2018:115-28.
2. Kimmerle EH, Baraybar JP. Skeletal trauma: identification of injuries resulting from human rights abuse and armed conflict. CRC press; 2008 Feb 19.
3. Wedel VL, Galloway A. Broken bones: an anthropological analysis of blunt force trauma. Charles C Thomas Publisher; 2013.
4. Cunha E, Cattaneo C. Forensic anthropology and forensic pathology: the state of the art. Forensic Anthropology and medicine: complementary sciences from recovery to cause of death. 2006:39-53.
5. Symes SA, L'Abbé EN, Chapman EN, Wolff I, Dirkmaat DC. Interpreting traumatic injury to bone in medicolegal investigations. A companion to forensic anthropology. 2012 Apr 20:340-89.
6. Dirkmaat DC, Cabo LL, Ousley SD, Symes SA. New perspectives in forensic anthropology. American Journal of Physical Anthropology: The Official Publication of the American Association of Physical Anthropologists. 2008;137(S47):33-52.
7. Yaşar Işcan M. Rise of forensic anthropology. American Journal of Physical Anthropology. 1988;31(S9):203-29.

8. Ferguson E, James D, Madeley L. Factors associated with success in medical school: a systematic review of the literature. BMJ. 2002 Apr 20;324(7343):952-7.
9. Algee-Hewitt BF, Kim J, Hughes CE. Thinking computationally about forensics: Anthropological perspectives on advancements in technologies, data, and algorithms. Human Biology. 2018 Jan 1;90(1):5-10.
10. Eriksson, R.A., Albrektsson, T. and Magnusson, B.J.S.J.O.P., 1984. Assessment of bone viability after heat trauma: a histological, histochemical and vital microscopic study in the rabbit. Scandinavian Journal of Plastic and reconstructive surgery, 18(3), pp.261-268.
11. Stübinger S, Ghanaati S, Saldamli B, Kirkpatrick CJ, Sader R. Er: YAG laser osteotomy: preliminary clinical and histological results of a new technique for contact-free bone surgery. European Surgical Research. 2009;42(3):150-6.
12. Beckwith JB, Palmer NF. Histopathology and prognosis of Wilms tumor Results from the first national wilms' tumor study. Cancer. 1978 May;41(5):1937-48.
13. Horwath JP, Zakharov DN, Mégret R, Stach EA. Understanding important features of deep learning models for segmentation of high-resolution transmission electron microscopy images. npj Computational Materials. 2020 Jul 29;6(1):108.
14. Mamabolo B, Alblas A, Brits D. Modern imaging modalities in forensic anthropology and the potential of low-dose X-rays. Forensic Imaging. 2020 Dec 1;23:200406.
15. Bolliger SA, Thali MJ, Ross S, Buck U, Naether S, Vock P. Virtual autopsy using imaging: bridging radiologic and forensic sciences. A review of the Virtopsy and similar projects. European radiology. 2008 Feb;18:273-82.
16. Kaur J, Chopra R. Three dimensional CT reconstruction for the evaluation and surgical planning of mid face fractures: a 100 case study. Journal of maxillofacial and oral surgery. 2010 Dec;9:323-8.
17. Christe A, Flach P, Ross S, Spendlove D, Bolliger S, Vock P, Thali MJ. Clinical radiology and postmortem imaging (Virtopsy) are not the same: specific and unspecific postmortem signs. Legal medicine. 2010 Sep 1;12(5):215-22.
18. Blau S. How traumatic: a review of the role of the forensic anthropologist in the examination and interpretation of skeletal trauma. Australian journal of forensic sciences. 2017 May 4;49(3):261-80.
19. Urbanová P, Ross AH, Jurda M, Šplíchalová I. The virtual approach to the assessment of skeletal injuries in human skeletal remains of forensic importance. Journal of Forensic and legal medicine. 2017 Jul 1;49:59-75.
20. Abel RL, Parfitt S, Ashton N, Lewis SG, Scott B, Stringer C. Digital preservation and dissemination of ancient lithic technology with modern micro-CT. Computers & Graphics. 2011 Aug 1;35(4):878-84.
21. Anderson RB, Hunt KJ, McCormick JJ. Management of common sports-related injuries about the foot and ankle. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2010 Sep 1;18(9):546-56.
22. Dirkmaat DC, Cabo LL, Ousley SD, Symes SA. New perspectives in forensic anthropology. American Journal of Physical Anthropology: The Official Publication of the American Association of Physical Anthropologists. 2008;137(S47):33-52.
23. Budowle B, Bieber FR, Eisenberg AJ. Forensic aspects of mass disasters: strategic considerations for DNA-based human identification. Legal medicine. 2005 Jul 1;7(4):230-43.
24. Bartelink EJ, Mackinnon AT, Prince-Buitenhuys JR, Tipple BJ, Chesson LA. Stable isotope forensics as an investigative tool in missing person investigations. Handbook of missing persons. 2016:443-62.
25. Dalcher D, Drevin L. Learning from information systems failures by using narrative and ante-narrative methods. South African Computer Journal. 2004 Dec 1;2004(33):88-97.
26. Bidmos MA, Gibbon VE, Strkalj G. Recent advances in sex identification of human skeletal remains in South Africa. South African Journal of Science. 2010 Nov 1;106(11):1-6.
27. Rustagi T, Drazin D, Oner C, York J, Schroeder GD, Vaccaro AR, Oskouian RJ, Chapman JR. Fractures in spinal ankylosing disorders: a narrative review of disease and injury types, treatment techniques, and outcomes. Journal of orthopedic trauma. 2017 Sep 1;31:S57-74.
28. Wieberg DA, Wescott DJ. Estimating the timing of long bone fractures: correlation between the postmortem interval, bone moisture content, and blunt force trauma fracture characteristics. Journal of forensic sciences. 2008 Sep;53(5):1028-34.
29. Kranioti EF. Forensic investigation of cranial injuries due to blunt force trauma: current best practice. Research and Reports in Forensic Medical Science. 2015 Oct 6:25-37.

30. Passalacqua NV, Pilloud MA, Congram D. Forensic anthropology as a discipline. Biology. 2021 Jul 21;10(8):691.

31. Galloway A, Birkby WH, Kahana T, Fulginiti L. Physical anthropology and the law: legal responsibilities of forensic anthropologists. American journal of physical anthropology. 1990;33(S11):39-57.

32. Naglieri JA, Drasgow F, Schmit M, Handler L, Prifitera A, Margolis A, Velasquez R. Psychological testing on the Internet: new problems, old issues. American Psychologist. 2004 Apr;59(3):150.

33. Brown MF. Can culture be copyrighted?. Current anthropology. 1998 Apr;39(2):193-222.

34. Obertová Z, Leipner A, Messina C, Vanzulli A, Fliss B, Cattaneo C, Sconfienza LM. Postmortem imaging of perimortem skeletal trauma. Forensic science is international. 2019 Sep 1;302:109921.

35. Iscan MY, Steyn M. The human skeleton in forensic medicine. Charles C Thomas Publisher; 2013 Sep 1.

36. Indest III GF. Medico-legal issues in detecting and proving the sexual abuse of children. Journal of Sex & Marital Therapy. 1989 Jun 1;15(2):141-60.

37. Judd MA, Redfern R. Trauma. A companion to paleopathology. 2011 Nov 6:357-79.

38. Paszkiel S, Szpulak P. Methods of acquisition, archiving and biomedical data analysis of brain functioning. InBiomedical Engineering and Neuroscience: Proceedings of the 3rd International Scientific Conference on Brain-Computer Interfaces, BCI 2018, March 13-14, Opole, Poland 2018 (pp. 158-171). Springer International Publishing.

39. Velemínská J, Fleischmannová N, Suchá B, Dupej J, Bejdová Š, Kotěrová A, Brůžek J. Age-related differences in cranial sexual dimorphism in contemporary Europe. International Journal of Legal Medicine. 2021 Sep;135:2033-44.s