



Cemental Annulation as an aid to age estimation in Forensic Odontology

Susmita Saxena¹, Jitin Kharbanda², Nithya S³

¹ Director Professor, Department of Oral & Maxillofacial Pathology, ESIC Dental College and Hospital, Rohini, Delhi.

² Professor, Department of Oral & Maxillofacial Pathology, ESIC Dental College and Hospital, Rohini, Delhi..

³ Assistant Professor, Department of Oral & Maxillofacial Pathology, ESIC Dental College and Hospital, Rohini, Delhi.

Introduction

Cementum deposition continues throughout the life of an individual. In humans, a positive association between cemental annulations (incremental lines) and age estimation has been reported by Stott et al¹. Cementum has been shown to triple in thickness between the ages of 20 and 60 years. The thickness varies, with the maximum at the apex and the minimum near the cemento-enamel junction. While being acellular in the coronal portion of the root, the cementum in the apical half is both acellular and cellular.² The cementum consists primarily of uncalcified dense bundles of collagen fibrils. These bundles later become mineralized by hydroxyapatite crystals, whose varying orientations may be responsible for the optical effect of alternating dark and light layers³. Cementum is laid down in incremental layers on the tooth roots, leading to formation of concentric lines or incremental lines of Salter which can be corresponding to years. Each pair of lines parallels to one year of life and it establishes a biological record that is helpful in age estimation.⁴ Dark and bright lines, visible in a bright field microscope presumably correlate with variable orientation and different mineralization of the collagen fibres (assumed orientation of the Sharpey fibres in the course of one year). Bright bands appear to develop in winter, dark lines in the summer season.^{5,6} A changeover of the bands happens in March/April and September/October.⁵ Some researchers refer to opaque lines as “winter lines” and “rest lines” and to both acellular and cellular translucent lines as “growth lines” or “summer lines”.

Methodology

Freshly extracted teeth are collected, washed in water and stored in 10% buffered Formalin. Teeth that are extracted due to periodontal, caries, orthodontic or prosthetic reasons are taken for study purpose. Longitudinal or cross sections are taken which may be sectioned by hard tissue microtome or ground sections prepared after sectioning with micromotor or lathe. The mid-root region of the tooth is preferred for the study irrespective of the acellular or cellular type of cementum. Sections are immersed in Xylene

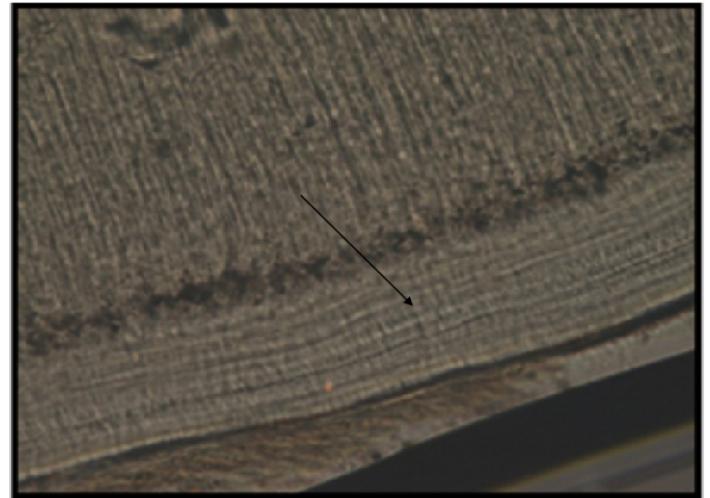


Figure 1: Ground section of tooth showing concentric cemental lines in acellular cementum⁷

for clearing for 48 hours and mounted on slides using DPX mountant and cover slip. The slides are then viewed under light microscope—under 4X and 10X magnification and specific areas are photographed and images transferred from the microscope to a computer monitor. Counting is done with the help of image analysis software. Each dark band followed by light band forms one annulation which are traced and counted by cyto-morphometric method.

Estimated age = No. of incremental lines (n) + Eruption age of tooth (t)

Studies have shown that the cemental annulations are more clearly visible under the phase-contrast microscope as compared to polarizing microscopy and light

Address for Correspondence:

Dr Susmita Saxena

Director Professor,

Department of Oral & Maxillofacial Pathology,
ESIC Dental College and Hospital, Rohini, Delhi

Email: sanjeev.susmita@gmail.com

How to cite this article: S Susmita Saxena, Jitin Kharbanda, Nithya S. Cemental Annulation as an aid to age estimation in Forensic Odontology. J Indo Pacific Acad Forensic Odontology. 2024 Jul-Dec; 13 (2): 30-31.



microscopy.^{2,8,9}

Recent Advances

Technological advancements have affected almost every field of science, including forensic odontology. A wide array of methods for dental age estimation are available ranging from simple visualization to newer sophisticated molecular and genetic techniques. The idea of counting cemental annulations was first done on ground sections of the teeth observed under light microscopy. With advances in microscopic techniques, polarized and phase-contrast microscopy were applied along with digital image analysis software.¹⁰

Quantitative evaluation using Auto-TCA software- Manual line counting, however, is time consuming, potentially subjective and the number of individual counts is insufficient for statistical evaluations. A custom-made Auto TCA software is introduced by Czermak et al⁵ that, "allows automated evaluation of TCA images using Fourier analysis and algorithms for image analysis and pattern. It involves "line-by-line" scanning and the counting of Gray scale peaks within a selected region of interest (ROI). Each scanning process of a particular ROI yields up to 400 counts, thus minimizing the potential error induced by manual line counting".⁵

Award Information- Developing and Validating Standards for Dental Cementum Age-at-Death and Season-of-Death Estimation by the University of Texas Rio Grande Valley. This funding was initiated in 2023 to finance a project on cementochronology or age estimation. "While cementochronology has shown promising results, the process of histological examination remains skill-based, subjective, and prone to intra-and inter- observer error, making standardization necessary to meet medico-legal requirements." This project aims to develop objective, quantitative, and user-friendly AI-based methods, that merge histological analysis and machine learning algorithms to significantly improve age-estimation in forensic sciences. Artificial intelligence modelling and machine learning algorithms will further refine age and season of death estimates. Further information can be found on the website (www.cementochronology.com)

Conclusion

Tooth Cementum annulation (TCA) has great potential but it is, as all anthropological techniques, a tool to be used along with the others in a multi-approach method and not rely upon it solely. We search for that one technique that

answers all of our questions in solving forensic mysteries though we should understand the limitations of each existing technique in drawing the final biological profile. We need to make use of all methods along with developing newer techniques to gather missing information for solving the forensic questions.¹¹

References

1. Stott GG, Sis RF, Levy BM. Cemental annulation as an age criterion in forensic dentistry. *J Dent Res.* 1982;61:814–7.
2. Pundir S, Saxena S, Aggarwal P. Estimation of age based on tooth cementum annulations using three different microscopic methods. *J Forensic Dent Sci.* 2009;1:82–7.
3. Backofen UW, Gampe J, Vaupel JW. Tooth cementum annulations for age estimation: Results from a large known age validation study. *Am J Phys Anthropol.* 2004;123:119–29.
4. Bose S, et al. Age estimation by cemental annulations (A short study). *J Adv Zool.* 2024;45(6):201–8.
5. Czermak A, Czermak A, Ernst H, Grupe G. A new method for the automated age-at-death evaluation by tooth-cementum annulation (TCA). *Anthropol Anz.* 2006;64(1):25–40.
6. Lieberman DE. The biological basis for seasonal increments in dental cementum and their application to archaeological research. *J Archaeol Sci.* 1994;21(4):525–39.
7. Kaur IP, et al. Efficacy of age estimation in forensic dentistry using cemental annulations as a criteria. *J Forensic Dent Sci.* 2009;1:88–92.
8. Aggarwal P, Saxena S, Bansal P. Incremental lines in root cementum of human teeth: An approach to their role in age estimation using polarizing microscopy. *Indian J Dent Res.* 2008;19:326–30.
9. Kaur P, Ashtekar M, Singh J, Arora KS, Bhalla G. Estimation of age based on tooth cementum annulations: A comparative study using light, polarized, and phase contrast microscopy. *J Forensic Dent Sci.* 2015;7:215–21.
10. Phulari RGS, Dave EJ. Evolution of dental age estimation methods in adults over the years from occlusal wear to more sophisticated recent techniques. *Egypt J Forensic Sci.* 2021;11:36.
11. Perrone V, Gocha TP, Randolph-Quinney P, Procopio N. Tooth cementum annulation: A literature review. *Forensic Sci.* 2022;2(3):516–50.