Review Article

Indian Journal of Forensic Odontology
Volume 12 Number 1, January - June 2019
DOI: http://dx.doi.org/10.21088/ijfo.0974.505X.12119.3

Tooth Cementum Annulations in Age Estimation

Karthik M Krishna[1], Rahat Saleem[2]

[1]Professor [2]Postgraduate Student, Department of Periodontology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, Uttar Pradesh 244001, India.

How to cite this article:
Karthik M Krishna and Rahat Saleem. Tooth Cementum Annulations in Age Estimation. 2019;12(1):15-17

Abstract

Estimation of age based on study of tooth structures is a widely followed approach in forensics owing to the ability of these hard tissues to withstand changes over long periods. Several aspects can be evaluated for age estimation including degree of attrition, root transparency, secondary dentin deposition, root resorption, cementum apposition, etc. Cemental apposition occurs throughout life by deposition of alternating layers of varying mineralization known as tooth cementum annulations (TCA). Counting of cementum annulations is gaining more acceptance as compared to other methods in that it is least influenced by external factors. This article focuses on this particular aspect of age estimation.

Keywords: Age Estimation, Tooth Cementum Annulations, Incremental Lines, Forensic Odontology

Introduction

Accuracy of age-of-death estimation remains a perennial challenge in forensic science even to this day. Although acceptable results are attained with existing methods in younger individuals, there is a decline with increasing age. Utilization of dental and skeletal models is limited due to influence of variables such as level of physical activity, environmental exposures and pathologies.

To overcome these limitations, increasing interest is being shown in the deposition pattern of cementum, a stable tissue without the remodeling tendency of other hard structures such as bone. Cementum is formed throughout life in the form of a periodical rhythm based on variations in mineral crystal deposition seen on microscopic examination as alternating dark and bright bands in acellular extrinsic fiber cementum known as tooth cementum annulations (TCA). Each dark band and the adjacent light band are together counted as one chronological year [1].

Several studies have been done to establish whether analysis of TCA can be used to estimate age and season of death with increased accuracy.

Animal Studies

The use of differential tooth growth as a technique for age determination was first attempted in marine mammals [2,3]. Stoneberg and Jonkel microscopically examined TCAs in decalcified, sectioned, and stained teeth of three wild known-age black bears and determined that they can be used for age estimation [4].

In a study by Miller, the ages of barren-ground caribou by examination of histological preparations of dental cementum were estimated. He suggested that the time for both decalcification and staining was very critical and varied considerably among individual teeth. Cemental annuli in sagittal tooth sections were considerably more distinct and easier to read than cross sections and the chronological sequence of the layering of two types of cementum allowed the use of the technique with a high degree of confidence [5].

Corresponding Author: Karthik M Krishna, Professor, Department of Periodontology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, Uttar Pradesh 244001, India.

E-mail: karthikmunagala@gmail.com

Received on 24.04.2019, **Accepted on** 08.06.2019

Calvert and Ramsay estimated the ages of polar bears of known age through counts of cementum growth layer groups in vestigial premolar teeth with a high degree of accuracy within 1 year of the correct age [6].

Human Studies

Zander and Hurzeler were the first to discover a linear relationship between the growth of cementum and chronological age based on examination of single-rooted teeth. They also observed a 3-fold increase in cemental thickness in older teeth with the highest values in the apical region [7].

Stott et al. in 1982 were the first to publish a study on the use of cementum layer counting for age estimation in humans. In their study on human cadavers they observed that counting TCAs in undecalcified, stained tooth sections provided a close estimate of actual age [8]. These findings were further corroborated by later studies on human teeth [9,10].

Wittwer-Backofen and Buba established the technique and protocols that are now widely used in TCA estimation [11]. Wedel in 2007 evaluated the seasonal apposition of cementum and its layered appearance and found that a marked transition between translucent (growth) and opaque (dormant) lines. Moreover, a significant relationship between the band width and growth season was stated [12].

The type of sectioning can influence the accuracy of age estimation. Avadhani A, et al. observed that transverse ground sections of teeth give a better result than longitudinal ground sections [13]. A more recent study, however, stated that although counting in transverse sections was easier, longitudinal sections were more appropriate as matching with actual age was better with the latter [14].

The method of microscopic examination may also have a bearing on the accuracy of TCA counting. Studies comparingthree different methods (light, phase contrast and polarized microscopy) observed a strong positive correlation between the estimated age and actual age on using phase-contrast microscopy [15,16].

On the flip side, few studies did not reveal a significant relationship between chronological age and the count of TCAs in that they found an increasing underestimation with advancing age [17,18]. Miller *et al.* in 1988 worked with thick resin sections, a factor that might have impeded a proper observation of tooth cementum annulations [18]. Another study observed that periodontitis affected teeth give an underestimation of age [19]. However, a later study debunked these findings, suggesting that chronic and severe rhino-maxillary infection and periodontitis had no implications on accuracy of TCA estimation and suggested its use in pathological conditions associated with gross morphological changes in the skeleton that could impact the effectiveness of traditional methods [20].

Recently, non-destructive TCA counting was attempted using synchrotron X-ray microtomographyin individuals <50 years from a known-age archeological sample. A moderately strong positive linear relationship was observed between real and estimated ages. This method could serve as a promising alternative to the current destructive methods, particularly useful in cases where preservation of dental remains is crucial [21].

Limitations of TCA

Despite the advantages of TCA in age estimation several hurdles may restrict its adaptation as a more favorable over other techniques. Being a histological technique it may not attain widespread acceptance among forensic specialists, especially those who are unfamiliar with this field. The learning curve for untrained individuals could be long and exhaustive notwithstanding the requirement of a cost-intensive lab set-up.

Conclusion

Most studies published till date have conveyed a positive picture for the use of TCA in age estimation. The consistency and predictability of incremental line pattern is unmatched by other dental or skeletal methods. Introduction of newer non-destructive methods will help in enhancing this method's role in forensic dentistry.

References

1. Tencate A. The estimation of age of skeletal remains from color of roots of teeth. J Can Dent Assoc. 1977;2:83-6.
2. Scheffer VB. Growth layer on the teeth of Pinnipedia as an indication of age. Science. 1950;112 (2907):309-11.
3. Laws RM. A new method of age determination for mammals. Nature. 1952;169(4310):972-73.
4. Stoneberg RP, Jonkel CJ. Age determination of black bears by cementum layers. Journal of Wildlife

Management. 1966;30:411.

5. Miller FL. Age determination of caribou by annulations in dental cementum. The Journal of Wildlife Management. 1974;38:47-53.
6. Calvert W, Ramsay MA. Evaluation of age determination of polar bears by counts of cementum growth layer group, a selection of papers from the tenth international conference on bear research and management, Fairbanks, Alaska. 1995 Sep;10:449-53.
7. Zander HA, Hurzeler B. Continuous cementum apposition. J Dent Res. 1958;37:1035-44.
8. Stott GG, Sis RF, Levy BM. Cemental annulation as an age criterion in forensic dentistry. J Dent Res 1982;61:814-17.
9. Condon K, Charles DK, Cheverud JM, Buikstra JE. Cementum annulation and age determination in Homo sapiens. II. Estimates and accuracy. Am J Phys Anthropol. 1986;71:321-30.
10. Wittwer-Backofen U, Gampe J, Vaupel JW. Tooth cementum annulation for age estimation: results from a large known-age validation study. Am J PhysAnthropol. 2004;123:119-29.
11. Wittwer-Backofen U, Buba H. Age estimation by tooth cementum annulation: perspective of a new validation study. In: Hoppa RD, Vaupel JW, (eds.), Paleodemography, age distributions from skeletal samples. Cambridge: Cambridge University Press, England, UK. 2002.pp.107-128.
12. Wedel VL. Determination of season at death using dental cementum increment analysis. J Forensic Sci 2007;52:1334-37.
13. Avadhani A, Tupkari J, Khambaty A, Sardar M. Cementum annulations and age determination. J Forensic Dent Sci. 2009;1:73-76.
14. Mallar KB, Girish HC, Murgod S, Kumar BY. Age estimation using annulations in root cementum of human teeth: A comparison between longitudinal and cross sections. J Oral Maxillofac Pathol. 2015;19(3):396-404.
15. Pundir S, Saxena S, Aggrawal P. Estimation of age based on tooth cementum annulations using three different microscopic methods. J Forensic Dent Sci. 2009;1:82-87.
16. Kaur P, Astekar 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.
17. Lipsinic FE, Paunovich DG, Houston DG, Robinson SF. Correlation of age and incrementallines in the cementum of human teeth. J Forensic Sci. 1986;31: 982-89.
18. Miller CF, Dove SB, Cottone JA. Failure of use of cemental annulations in teeth to determine the age of humans. J Forensic Sci. 1988;33:137-43.
19. Dias PEM, Beaini TL, Melani RFH. Age estimation from dental cementum incremental lines and periodontal disease. J Forensic Odontostomatol. 2010;28:13-21.
20. Bertrand B, Robbins Schug G, Polet C, Naji S, Colard T. Age-at-death estimation of pathological individuals: A complementary approach using teeth cementum annulations. Int J Paleopathol. 2016;15:120-127.
21. Le Cabec A, Tang NK, Ruano Rubio V, Hillson S. Nondestructive adult age at death estimation: Visualizing cementum annulations in a known age historical human assemblage using synchrotron X-ray microtomography. Am J PhysAnthropol. 2019;168:25-44.