

Determination of Season of Death using Dental Cementum Annulations: A study in humans

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ABSTRACT

Aim: To determine the season of death using dental cementum annulations. **Material and Methods:** 20 freshly extracted teeth from the months of July, August, September, October were cut in transverse sections, ground and examined under the 20X magnification polarizing microscope. The light and dark banding patterns were observed and based on the thickness of the last band percentage growth were calculated. **Results:** pvalue was 0.0001, and highly significant with Karl Pearson correlation coefficient found to be 0.9467. **Conclusion:** The study was in consensus with Wedel's in correlating the banding pattern with the season of death/ extraction.

KEYWORDS: Banding pattern, Dental Cementum Annulations, Ground sections, Polarising microscope, Season of Death this research in human.³ Present study was undertaken to verify wedel's observations. The season of extraction was determined and the percentage of growth of these cemental incremental annulations was also calculated.

INTRODUCTION

Identification of individuals in forensics or anthropology, history and archaeology have been for academic interests as well as practical importance. From time immemorial various fields of science have been utilized for the sole purpose of identification of the remains, whether animal or human, normal or fossilized. Researchers have focused on the identification using Osteology, forensic medicine, anthropology etc. Cementochronology, the term used to describe the use of cementum annulations in the estimation of age has been making ways recently. Although dental cementum incremental annulations (DCIA) have been used in zooarcheology since long for the calculation of season of death/ slaughter/ hunting, and to study the migration pattern of cattle from the ancient remains.¹

It has been established, that cementum grows, annually, in pairs, as dark and light bands. The summer growth band appears translucent under the transmitted polarized microscope, while the winter band appears dark opaque. Various hypothesis has been given for the appearance of this banding pattern. These have been classified as primary and secondary causes. The primary causes are variation in relative mineralization and collagen orientation. Secondary causes are nutrition, biochemical forces and hormonal cycles. By studying the last incremental band the season of death of an individual/ remains can be calculated. Studies have shown that by estimating the percentage of growth of the last increment exact month of death can be predicted.²

Wedel studied these bands throughout the year and had pioneered the implementation and forensic utilization of

MATERIAL & METHODS

20 freshly extracted teeth were collected for the months of July, August, September and October. Five teeth were collected for each month and kept in 4% formalin. The inclusion criteria were intact teeth with cement integrity maintained and the exclusion criteria were stumps, grossly decayed teeth, fractured and teeth with any developmental anomaly.

Cross sections were cut using a diamond disc, and the ground sections were prepared using Cumi List no. 108, Silicon Carbide Combination Stone reduced to a thickness of 75 micrometers. Each section was mounted using DPX mounting media and observed under 10X magnification (Olympus ProRes Speed XTcore 3). Multiple images were taken for each section and the images analyzed using Adobe Photoshop Image Analyser. As the samples were from summer to fall, the last incremental band observed was translucent. The width of each translucent band was measured and the average width calculated. Then the percentage of growth of the last translucent band was calculated using the formula :

$X = b/a \times 100$, where,

a = thickness of the translucent bands (average),

b = thickness of the last translucent band,

x = percentage of growth

Statistical analysis was done using SPSS version 22. Karl Pearson correlation coefficient was calculated between

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the number of days into the season and the percentage of growth of the translucent band.

MATERIAL & METHODS

Fig. 1. Bar graph representing the percentage completion of the outermost translucent band in each tooth.

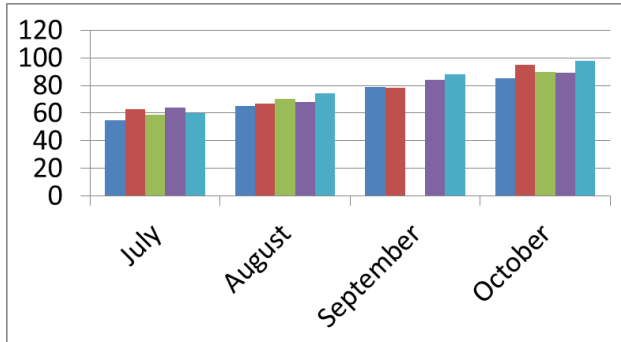


Fig. 1 Bar graph representing the percentage of completion of the outermost translucent band of each of each tooth.



Fig. 2 Line graph depicting the average percentage of completion of translucent band plotted against the respective months.

Fig. 2. Line graph depicts the average percentage of completion of translucent band plotted against the respective months.

As the results show the band width strongly correlates with the progression in months. The p value was 0.0001, which was a highly significant correlation regarding the translucent band width and the growth season. Karl Pearson Correlation coefficient, which provided a linear relationship between the band width and progression into the growth season was found to be 0.9467, which provides support to the potentiality, accuracy and specificity of this study for practical applications.

DISCUSSION

Cementum is protected from the ravagement of the environment as compared to enamel and dentin as it is located safely in the alveolar process. It is deposited throughout the life and tripled in thickness between the ages of 20 to 60 years. Although the number of the incremental lines remain fixed, the characterization that is the width and the degree of mineralization of these incremental lines change. These changes can be either due to the environmental variations or physiological disorders.²

The seasonal rhythms in the cementum annulations, seen as alternating dark and light bands, have been explained using several hypothesis. According to Libermann, these variations can be due to either primary causes or secondary causes.

Primary Causes:

- Variation in relative mineralization
- Variation in collagen orientation

Secondary Causes :

- Nutrition
- Biochemical Forces
- Hormonal Cycles

Seasonal variations can be explained also by the metabolism of parathormone, which not only regulates calcium levels in the blood but also interacts with vitamin D to regulate its uptake. Thus, it is seen that both vitamins and hormones interact mutually to produce a circannual rhythm by a complex mechanism.¹ Authors differ on whether the transparent bands are hypercalcified⁴ or hypocalcified.⁵ The successful use of these studies on archeological as well as modern samples is more deterministic in areas with strong seasonal variations.⁶

This study is more specific and reliable if done on a larger sample and longer duration in India which has different regions with different seasonal variations. Indian study can be a database and standard for the appearance of these banding patterns.

Research has been done using both single as well as multirooted teeth and the differences were insignificant. The results of Witter-Backofen confirms this. Present study utilized only single rooted teeth including incisors, canines and premolars. As stated by Backofen et al, second premolars were not included due to the appearance of irregular cementum bands in them. The middle third represents the best compromise as far as layer width, cellularity and resorption are concerned.⁴ This correlated with our study, as the near cervical region showed enamel instead and in the periapical region the bands were not clear due to the presence of cellular cementum. The sections taken from the junction of cervical third and middle third showed best banding pattern.

As the banding pattern is seasonal and the outermost cementum band indicates the season of death, David B. Landon mentioned the applicability of this type of study in the analysis of seasonality and its potential in determining the season of death in mammals.⁷ The present study was in consensus with that of Wedel, Landon, in depicting the banding pattern according to the season, as well as showing that the percentage of growth of the last cementum band increased in direct proportion to the progress into the season. This differs in its observance as given by Ralston, according to whom there is low reliability of this study due to lack of standardization methods and subjectivity in the identification of outer cementum band.⁸

In accordance with Meckel, further research involving DCA should be done using scanning electron microscope and microradiographic analysis to improve the objectivity and accuracy of the method. In his study, he observed 60% accuracy which was as good as guessing. Although the accuracy is good in young age group, it declines above 50 years of age.⁹

Throughout the world and in India, missing, unidentified remains of humans is a harsh and true reality. While osteological analysis gives a very broad age range, DNA profiling is not possible in all cases due to the cost factor. Limiting the correctly identified individual remains. Although still in its infancy, the prospective use of dental cementum annulations in forensics, mass disasters as well as individual cases¹⁰ shows its, accuracy, efficiency and economic feasibility.

CONCLUSION

Teeth can be said as an undying component of the human remains. They are the toughest and hence survive most harsh of conditions. They are able to decipher the whole life history of the individual. As the study on cementum annulations was basically derived from the pioneering works done in the field of faunal archaeology, this study in humans also substantiates that the determination of season of death is no more a myth, and this is a possibility, within the realms of forensic science.

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