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The impact of periodontal disease on cementochronology age estimation

Amélie de Broucker[a,c,*], Thomas Colard[a,b,c], Guillaume Penel[a,c], Joël Blondiaux[d], Stephan Naji[e,f]

[a] Université de Lille F-59000 Lille, France
[b] Forensic Taphonomy Unit, Anthropology Department, UDSL, F-59000 Lille, France
[c] EA 4490 PMOI, IFR 114 IMPRT, F-59000 Lille, France
[d] Centre d'Etudes Paléopathologiques du Nord, 36 rue Jules Ferry 59127, Walincourt-Selvigny, France
[e] CNRS, UMR 7264 CEPAM, Nice, France
[f] CNRS, UMI 3199 CIRHUS, NY, USA

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ABSTRACT

Estimating an individual's age at death is essential for post-mortem identification, paleopathology and paleodemography. With substantial development over the past 10 years in cementochronology analyses, some concerns have arisen that oral pathological conditions may artificially reduce or increase cementum apposition.

The objective of this study was to observed the impact of periodontal disease on acellular cementum and on the reliability of cementochronology to test its accuracy for estimating individual age at death. The study included 41 teeth presenting different degrees of bone destruction, extracted from 18 individuals affected by untreated periodontal disease.

The results demonstrated that the degree of alveolysis had only limited effects on the counting of cementum annulations in the middle ($r_p = 0.92$, $p < 0.01$ between estimated and civil age) and the cervical ($r_p = 0.85$, $p < 0.01$) thirds of the root, whereas in the apical third, the increments were affected considerably. This cementum reactive process compensates for bone destruction and loss of the attachment apparatus. These data suggest that cementum could continue to grow at a slower rate despite bone destruction due to periodontal disease. Cementochronology can thus be applied to teeth with a damaged periodontium by sectioning the middle third of the root.

1. Introduction

Estimating an individual's age at death is important when performing post-mortem identification for forensic anthropology, paleopathology and paleodemography. Experts in biological anthropology have applied various skeletal macroscopic techniques, such as the use of the pubic symphysis (Brooks and Suchey, 1990; Katz and Suchey, 1986) or the auricular surface (Lovejoy et al., 1977), cranial sutures (Masset, 1989), as well as dental macroscopic methods (Gustafson et al., 1969; Lamendin et al., 1992) to estimate age at death. However, none of these methods are very reliable for they have rarely obtained correlation coefficients greater than 0.8 (Bocquet-Appel and Masset, 1982; Bocquet-Appel, 2008; Hillson, 1996; Kemkes-Grottenthaler, 2002; Rösing and Kvaal, 1998; Séguy and Buchet, 2011; Séguy et al., 2013; Wittwer-Backofen et al., 2008). In contrast, cementochronology (or the cementum annulations method) is the most reliable method published to date (Blondiaux et al., 2006; Meinl et al., 2008; Wittwer-Backofen et al., 2004). Cementum can be divided into cellular and acellular cementum, based on the presence or absence of cementocytes (Yamamoto et al., 2009). Cementochronology is based on histological analysis of the acellular cementum type, which has the particularity to have a slow and continuous growth in seasonal, paired incremental layers. These layers are visible under direct unpolarized light as alternating bright and dark increments. This particular histological characteristic, which has been observed in more than 72 species of mammals (Geusa et al., 1999; Grue and Jensen, 1979; Klevezal, 1996; Rendu, 2007), has not yet been fully explained, although numerous hypotheses have been proposed in the

* Corresponding author at: Faculté de Chirurgie Dentaire, Place de Verdun, 59000 Lille, France.
E-mail address: ameliedebroucker@hotmail.fr (A.d. Broucker).

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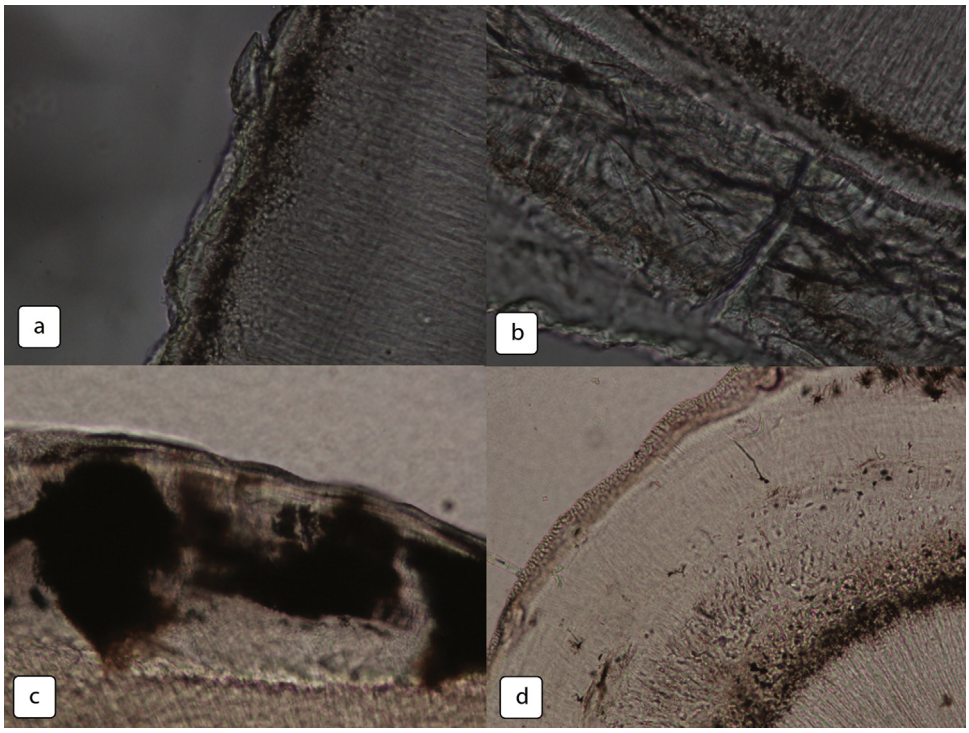

Fig. 1. Photos of excluded cementum sections (A) destruction of cementum (B) broken and split up cementum (C) presence of taphonomic black areas (D) hypercementosis.

literature (Lieberman, 1994, 1993; Renz and Radlanski, 2006; Schroeder, 1986; Spinage, 1973; Wedel, 2007; Wittwer-Backofen et al., 2004; Yamamoto et al., 2010). The general consensus is that the acellular cementum banding is due to either its mineral density or to differences in crystal orientation (Bosshardt and Schroeder, 1996). This particular phenomenon of rhythmic growth has allowed for the development of an age-at-death estimation technique, obtained by the addition of the number of paired (light + dark) acellular cementum increments to the age of eruption of the studied tooth.

With substantial development of efforts to estimate age at death based upon cementochronology over the past decade (Maat et al., 2006; Lippitsch and Grupe, 2007; Grosskopf and McGlynn, 2011; Wittwer-Backofen, 2012; Gauthier and Schutkowski, 2013; Gocha and Schutkowski, 2013), a certain number of questions have arisen regarding the types of dental samples to analyze. Although some studies have not reported any influence of oral pathological conditions on cementum annulation counts (Wittwer-Backofen et al., 2004), other researchers have expressed concerns over the potential influence of pathology on cementum (Kagerer and Grupe, 2001). In particular, there are certain oral pathological conditions that can provoke modifications of the cementum, such as a reduction of the cementum surface or anarchic growth.

Periodontal disease, particularly periodontitis, is a mixed bacterial infection that results in the destruction of dental support tissues. Approximately 10% of the contemporary population is affected by severe periodontal disease, with a prevalence that can vary according to sex, environment or origin (genetic, cultural or socioeconomic differences) (Pihlstrom et al., 2005). Indeed, access to healthcare, a balanced diet in vitamins, education and regular oral hygiene decreases the risks of development of the disease. In contrast, the prevalence of moderate to severe periodontitis in past populations is around 5%, highlighting the potential importance of risk factors such as smoking and diabetes in determining susceptibility to periodontal disease in modern populations (Raitapuro-Murray et al., 2014).

The specific objective of this study was to study the impact of periodontal disease on a cellular cementum, to evaluate its impact on the reliability of cementochronology, and to provide improved age-at-death estimations when applied to teeth with periodontal damage.

2. Materials and methods

The subjects of this study were adults recruited at the Dental Service of Lille University's Hospital in France after explicit consent regarding the protocol. Each subject was affected with untreated periodontitis, and initial treatment included extraction of one or several teeth. Eighteen individuals, four women and 14 men, were included in the study. The mean age at the time of the extraction (used as a proxy for age at death) was 55.2 years of age (range: 34–78 years). Teeth included in the study had to present a degree of bone destruction (alveolysis), estimated with radiographs.

Table 1
Sample distribution of extracted teeth by alveolysis degree.

	Total	Alveolysis degree		
		Group A cervical third	Group B middle third	Group C apical third
N. teeth extracted	41	17	13	11
N. teeth retained	35	17	10	8

Sample distribution of extracted teeth by alveolysis degree.

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