A Preliminary Investigation of Lead Poisoning in a Napoleonic Era Naval Cemetery in Antigua, W.I.

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Abstract

Lead poisoning has been suggested as being partially responsible for the 'demise' of the British military in the West Indies during the colonial era. Lead was pervasive in the colonial environment, being employed in items such as eating and cooking utensils, water catchments and alcohol distillation equipment. This preliminary study represents the first attempt to determine whether this suggestion has any validity. A bone sample taken from an individual excavated from a cemetery associated with a Royal Naval Hospital cemetery (c. 1793-1822 C.E.) in Antigua was used for initial testing. A control sample from an individual from a pre-contact site provided baseline/control data. Lead levels and distribution in the samples were mapped by synchrotron microprobe X-ray fluorescence (XRF) at the Stanford Synchrotron Radiation Lightsource (SSRL). Preliminary results revealed that the precontact sample had little to no detectable lead, while that from the historic period did indeed contain lead. Further, within the historic sample, discreet biological structures were found to contain a high level of lead relative to the surrounding bone. This result strongly suggests a biogenic rather than diagenetic origin for the heavy metal. This study marks the first successful application of this technology to archaeological bone samples from this region, and represents an exciting new potential tool for bioarchaeology.

Introduction

Lead poisoning is thought to have had a significant impact on the health and well being of colonial era populations of the West Indies. European nations that had colonies in the West Indies maintained a military presence in the region to protect their assets. Due to their possession of several islands with relatively protected bays, only the British maintained a year round military presence in the region. Lead poisoning has been suggested as being partially responsible for the high morbidity and mortality rates of the British military in the West Indies (Buckley 1978; Curtin 1989). The 'West India dry belly-ache' or 'dry gripes' was a notorious malady of the West Indian islands. The primary symptoms being extreme fatigue, apathy and severe abdominal cramping without associated dysentery. Palsy often appeared in the latter stages of the ailment (Sheridan 1985; Wedeen 1984). It was listed by an early seventeenth century naval surgeon as the third most prevalent disease of the West Indies after yellow fever and dysentery (Turnbull 1806:179). Turnbull likened the symptoms of this 'West India dry belly-ache' to that of 'Devonshire belly-cholic' which was recognized by medical practitioners of the time as being due to lead poisoning. Given its symptoms, this 'West Indian colic' was also quite possibly caused by lead poisoning (Howard 2000; Lessler 1988; Wedeen 1981).

The only prior study of lead poisoning in a colonial era cemetery in the Caribbean found high levels of lead in the skeletal remains of enslaved labourers from a Barbados plantation (Corruccini et al 1987; Handler et al. 1986). The high levels of lead were attributed to the consumption of rum distilled with lead-soldered stills and inhalation of lead fumes during the sugar manufacturing process. The lead level of these Barbadian enslaved labourers was found to be much higher than those found in the remains of enslaved labourers from contemporaneous sites in the American South and closer to those of the plantocracy from these American sites (Corruccini et al. 1987). The disparity in the lead levels between Barbadian and American enslaved labourers was likely due to occupational differences, with the former group working in sugar and distillation facilities after the sugar cane harvest.

The population of interest in this study is the interred from the only known non-segregated cemetery from the colonial period of the West Indies. This cemetery was associated with a Royal Naval Hospital (c. 1793 to 1822 C.E.) and was the burial place of lower ranking naval personnel and enslaved labourers owned by the Navy that died at the hospital (Varney 2003). The latter were referred to as the "King's Negroes" and were of higher ranking than

plantation-based enslaved labourers. Their ranking allowed them access to a greater range of resources and activities (Varney 2011). The "King's Negroes" provided the bulk of the skilled labour force at the Naval Dockyard at English Harbour, which provided facilities for the sheltering and refitting of naval vessels throughout the year (Nicholson 2002).
Based on the brief historical sketch given above and the previous work by Corruccini et al. (1987) and Handler et al. (1986), it was hypothesized that the colonial era population of Antigua should have some degree of lead poisoning, and the level of that poisoning was expected to vary by socio-economic class and occupation. As such, the goal of this study was to conduct a preliminary investigation of lead exposure in human bone samples from the previously excavated Royal Naval Hospital cemetery at English Harbour, Antigua using synchrotron based techniques. Previous studies of lead poisoning such as the aforementioned work by Corruccini et al. (1987) and Handler (1986) were limited to measuring bulk lifetime lead exposure via conventional analytical means (atomic absorption spectrometry) and the elimination of post-mortem origins for the lead remained uncertain. In contrast, the present study sought to map the distribution of the lead within the microstructure of the bone, thereby demonstrating absorption of the toxic element during life rather than from the burial environment.

Methods and Materials

A cortical bone sample from the fibula shaft of one individual from the Royal Naval Hospital cemetery site (burial 13; PAH 83) was selected for analysis. The skeletal material from this site was well preserved on both a gross and molecular level (Varney 2003). Osteological analysis revealed that this individual was a male of African ancestry aged 45-49 years old at death. Given this demographic profile and his burial in this cemetery, it is very likely that he was one of the aforementioned "King's Negroes" who worked at the nearby dockyard (Varney 2011; Varney and Nicholson 2001).

A second cortical long bone (ulna) sample taken from a pre-contact burial served as a control and provided baseline data. This sample dates to long before the industrial age (900-1200 C.E.) and there is no evidence of lead usage in the region prior to European colonization.

Thin sections of bone were prepared with a Buehler® IsoMet® Low Speed Saw with a diamond wheel (Norton Company). After an approximately 300 micron bone section was removed, the fragment was ground to a thickness of approximately 100 microns with 2000 Grit 3M sandpaper. The ground sections were placed on Thermanox™ metal free coverslips and examined by light microscopy. Digital images of the histological structure were created using a PAXcam® high-resolution digital microscope camera (PAXcam, Villa, IL) at 10x magnification. A two dimensional spatial map of lead associated with the bone thin section was generated using synchrotron microprobe x-ray fluorescence (XRF) at the Stanford Synchrotron Radiation Lightsource (SSRL). The experiment was performed using a monochromatic beam with an incident x-ray energy of 5-30 keV, and both a beam spot-size and step size of the image of 10 μm. Open source (ImageJ; http://rsbweb.nih.gov/ij/) software was utilized to convert the raw data into an image. Further details on these methods can be found in Swanston et al. (2012).

Results and Discussion

The preliminary data resulting from the application of synchrotron based techniques are very promising and confirmed expectations based on the archaeological context of the samples. As hypothesized, the pre-contact age sample had little to no detectable level of lead. In contrast, lead was detected in the historic era sample. Further, as shown in Figure 1, the lead was found to be located within a secondary osteon, which is a discrete microstructure of bone formed during regular bone tissue maintenance or turnover. This finding in a relatively new structure indicates that it contained higher levels of lead than the surrounding older bone. This finding is compelling evidence that the source of the lead for this individual was not from the post-mortem environment but rather due to absorption during the individual's lifetime.

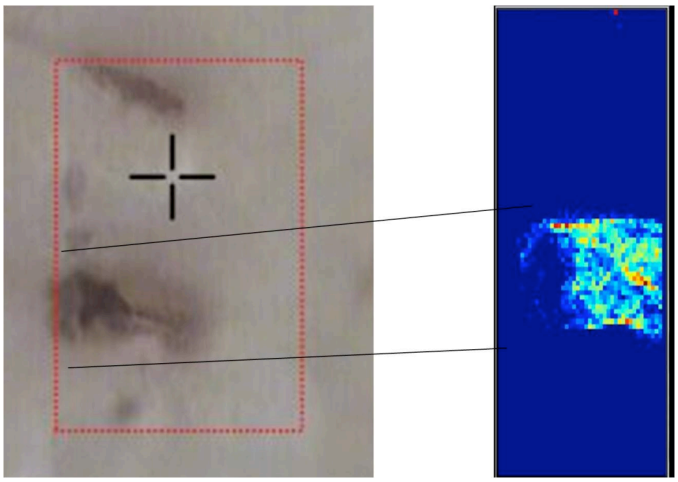

Figure 1. Optical (left) and XRF Microprobe images of a secondary osteon in the historic bone sample showing the 'labeling' of lead distribution.

As noted in the introduction to this paper, lead was abundant in the colonial environment. The dockyard, like all of Antigua, was dependent upon rainwater catchment as its main source of water. Components of these catchment systems such as pipes, down spouting, and tanks were often made from, or lined with, lead. Rum, produced from sugar cane locally on islands in the West Indies, was a common beverage. Both the collection of the cane juice and the distillation of rum involved equipment that was often lined or entirely made of lead (Handler et al. 1986; Martin 1785:22). The Navy provisioned its personnel with food and a daily allotment of rum which was usually mixed with water to make grog. In addition to their official rum allotment, there were other sources of rum that were actively sought out (Howard 2000). "New rum or low wine" which was the product of the initial distillation in the rum making process was readily available and affordable. It was observed to have particularly noxious effects upon consumption (Handler et al. 1986; Hunter 1796). Lead-contaminated water and certainly rum were likely sources of lead exposure for all naval personnel. This would have been in addition to other sources of lead that were common to in the colonial era such as eating and cooking utensils, paint, and fumes from its use in manufacturing and processing.

Conclusions

The application of synchrotron techniques in a preliminary investigation of lead content of human bone from archaeological contexts has yielded promising results. Not only has lead been detected in the historic sample, but an examination of the spatial distribution of the lead has also been possible. The lead has been mapped in an osteon rather than the periosteal surface of the bone, which strongly suggests absorption of lead during life rather than in the post-mortem environment.

Given the archaeological context for the individual from whom the samples came, the most likely sources of lead were ingestion of contaminated food and/or drink, as well as adsorption from environmental sources. Since lead was pervasive in colonial Antigua life, it is probable that the lead was obtained from a combination of such sources. Even relatively low levels of lead exposure can have a significant impact on health and quality of life. Mild poisoning is most often expressed in headaches, absence of appetite and energy, loss of sensation in extremities, and gastrointestinal tract unset (Handler et al. 1986; Prendergast 1910; Wedeen 1984).

Refinement of methods and further study of individuals from the Naval Hospital cemetery is underway (Swanston et al. 2012). There is potential for lead exposure to vary between slave and non-slave segments of naval personnel, which may give us greater insight into the lives of a distinctive group of slaves that contributed greatly to the Dockyard at English Harbour and had a unique role in Antiguan history. Future plans are to broaden the study beyond this cemetery to further explore the social determinants of lead exposure in the colonial era.

This preliminary study marks the first successful application of synchrotron-based techniques for the detection of lead in archaeological bone from this region. The promise of these techniques has been further demonstrated by Swanston, et al. (2012). The attraction of these techniques extends beyond their utility in detecting lead exposure in past populations due to the relatively non-destructive nature of the analyses which allows for further study.

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