

Dental crown morphology variations
associated with congenital syphilis and
their importance in paleopathological
diagnosis

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Abstract

Background

Standardized methods to diagnose syphilis in skeletal remains have been established, however, they are not efficient due to the lack of a full set of skeletal manifestations in many individuals, and changes similar to syphilis, occurring in other infections. Similar issues arise for congenital syphilis. Dental and skeletal manifestations do not occur in all cases, and dental signs also vary. It is well documented that mercury was used to treat congenital syphilis before 1943, however, the effects of mercuric treatments on dental formation have not been considered as diagnostic signs. Thus, individuals who do not demonstrate typical dental stigmata have been dismissed as possible cases of congenital syphilis. This thesis investigates dental malformations in cases of congenital syphilis to determine the range of possible dental signs of congenital syphilis, and mercuric treatments. Determining the effects of mercuric treatments on tooth crown development would establish a method for a diagnosis of congenital syphilis based on a full range of abnormalities.

Methods

The criteria to determine dental signs of congenital syphilis were based on the standard developed by modern scholars and on own study of 19th century descriptions and illustrations of patients. To determine dental signs of mercuric treatments, descriptions and illustrations of teeth of congenital syphilis patients treated with mercury by 19th century physicians were used. These are the first and only observations made of dental signs attributed to congenital syphilitic treatments.

Dental criteria were applied in a survey of remains of 259 individuals from several skeletal collections: the Wellcome Museum of Anatomy and Pathology, London, St Mary's cemetery, South Australia, Smithsonian Institute, Washington DC, and the Cleveland Museum of Natural History, Cleveland, Ohio. Dental traits attributed to congenital syphilis (Hutchinson's incisor, Moon's, and Fournier's molars, and canines with sharp groove-like hypoplastic defects on the tip) and its treatments were recorded. In cases where it was permitted, levels of mercury were tested for using portable x-ray fluorescence (pXRF). Furthermore, paleopathological cases from the literature with high quality dental images were used. A history of the use of mercury to treat

congenital syphilis and syphilis in the United States and Europe was explored based on government reports and the literature.

Results

Congenital syphilis and mercury affect similar kinds of permanent teeth, (incisors, first molars, and canines) due to tooth development times. However, mercury and congenital syphilis affect odontogenesis and amelogenesis differently resulting in distinct malformations exhibiting individual variation. The range of variation has been established and illustrated. Levels of mercury detected in hard tissues do not prove nor disprove the use of mercury as a form of treatment of congenital syphilis due to mercury turnover in the body.

Conclusion

Variation beyond the classical models of congenital syphilitic teeth occurs. Dental signs produced by mercury should be considered when making a differential diagnosis of congenital syphilis. This is the first study to consider the use of dental signs associated with congenital syphilitic treatments in a paleopathological context which could help elucidate controversial cases of the disease and shed some light on its origins.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of The University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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Research Contribution

Peer-reviewed Publications

Ioannou S., Hunt D., Henneberg M. 2017. Five Cases of Dental Anomalies Attributable to Congenital Syphilis from Early 20th Century American Anatomical Collections. *Dental Anthropology*. 30(1):25-37.

Ioannou S., Henneberg M. 2016. A rare case of congenital syphilis and a supernumerary fourth molar in an early 20th century African American woman. *Dental Anthropology*. 29(1): 41-47.

Ioannou S., Henneberg M., Henneberg R. & Anson T. J. 2015. Diagnosis of mercurial teeth in a possible case of congenital syphilis and tuberculosis in a 19th century child skeleton. *Journal of Anthropology* 2015: 1-11. 10.1155/2015/103842.

Ioannou S., Sassani S., Henneberg M. & Henneberg R. J. 2015. Diagnosing congenital syphilis using Hutchinson's method: Differentiating between syphilitic, mercurial, and syphilitic-mercurial dental defects. *American Journal of Physical Anthropology*. 10.1002/ajpa.22924.

Submitted Publications

Ioannou S., Henneberg M. 2017. Lack of dental signs and bony changes in syphilitic individuals in the Hamann-Todd Skeletal Collection possibly due to effective mercuric treatments. *Anthropological Review*. Article Reference Number: AR_80040417 Submitted 22 July 2017.

Ioannou S., Henneberg RJ., Henneberg M. 2017. Presence of dental signs of the congenital syphilis in Pre-modern specimens. *Archives of Oral Biology*. Article Reference Number: AOB-D-17-00502 Submitted: 29 August 2017.

Keynote Speaker Invitations

Ioannou, S. (2017). Diagnosing congenital syphilis in skeletal remains of the modern era. Villes, sociétés urbaines et syphilis en méditerranée et au-delà (XVI^{ème} - XXI^{ème} Siècles. 25th-27th October, Marseille, France.

Conference Presentations

Ioannou, S, Henneberg, RJ, Henneberg, M. (2017). Hutchinson's dental criteria diagnose congenital syphilis in the pre-Columbian Old World. (**Poster**). American Association of Physical Anthropologists (AAPA), 86th Annual Meeting, 19th-22th April, New Orleans, LA.

Ioannou, S & Henneberg, M. (2016). Dental characteristics of clinically diagnosed cases of congenital syphilis in the United States of America prior to 1910, (**Poster**). American Association of Physical Anthropologists (AAPA), 85th Annual Meeting, 12th-16th April, Atlanta, GA.

Ioannou, S, Henneberg, M, Henneberg, R.J, Anson, T. (2015). Skeletal diagnosis of multiple diseases in an European juvenile (**Podium**). American Association of Physical Anthropologists (AAPA), 84th Annual Meeting, 25th-28th March, St Louis, MO.

Ioannou, S, Henneberg, M. (2015). A case of a supernumerary distomolar tooth in a 19th century African American woman suffering from congenital syphilis, (**Poster**). 12th Annual Conference for the Australian and New Zealand Association of Clinical Anatomists (ANZACA), 9th-11 December, Adelaide, SA.

Ioannou, S, Sassani, S, Henneberg, M, Henneberg, R.J. (2014). Diagnosing congenital syphilis using Hutchinson's method: Syphilitic versus mercurial vs syphilitic-mercurial teeth, (**Podium**). Australasian Society for Human Biology (ASHB), 28th Annual Conference 10th-13th December, Adelaide, SA.

Awards

2017

AAPA Pollitzer Student Travel Award

2016

School of Medicine Research Travel Award

2015

Faculty of Health Sciences Divisional Scholarship

Thesis Style and Layout

This format of this thesis is “Thesis by Publication”. The chapters are in the following order: Chapter 1: Introduction, discusses the general background, aims and importance of this doctoral study. The methodology of each study is discussed in each research article. Chapters 2, 3, 4, 5, 6, and 7 are the results of original research in the form of six research articles, four of which have been published in peer-reviewed journals, and two which have been submitted for publication in peer-reviewed journals. Each result chapter is prefaced with a ‘Statement of Authorship’, which details the contribution of each author. The purpose and objective of each research article is outlined before each article. The layout and format of each research article is in accordance with the journal requirements (i.e. US or British spelling, different reference style etc.), therefore, formatting may vary between articles. Chapter 8 provides an overall summary/discussion, drawing upon the findings of each publication, how the findings have contributed to the current body of work and describes what further investigations could be conducted. Appendices contain data that were collected for research articles.

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List of Abbreviations

Abbreviation	Full Description
AI	<i>Amelogenesis imperfecta</i>
CS	Congenital syphilis
TB	Tuberculosis