

Filling the Gaps: The History of Dental Pathology and Restoration in 19th-century Washington, DC.

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In order to understand historical dental health and treatment in the 19th century, the remains of several high status individuals from seven burial vaults in Historic Congressional Cemetery were examined. This study is a report on the frequency of dental pathology in this series, as well as the occurrence and type of dental restorations, including their elemental compositions. Interpretation of these data were informed by historic documents related to the dental profession in the 19th century.

Background

Congressional Cemetery in Washington, DC first opened in 1807 to replace an earlier lot which frequently flooded. The cemetery flourished throughout the 19th century, containing the graves and burial vaults of congressmen and other government officials, decorated military personnel, and some of the wealthiest families in Washington. Throughout the 20th century the cemetery fell into disuse, decay, and was often the site of illicit activity. Efforts to restore the cemetery began in 1997 and continue to this day.

As part of these efforts to restore deteriorating and vandalized 19th-century brick burial vaults, the cemetery entered into a research partnership with the National Museum of Natural History. At-risk vaults were selected for repair and Smithsonian scientists worked with cemetery staff to systematically remove the badly deteriorated vault contents, allowing masons access to the crypt for renovation. To date, seven vaults have been repaired and their contents studied.



Figure 1. Exterior of the Causten family vault.



Figure 2. Collapsed shelving and deteriorated coffins inside the Causten family vault.

Materials and Methods

A total of 82 individuals were analyzed. Nearly all were recovered from badly degraded burial containers and in most cases their identity was unknown. Age, sex, and pathology data were recorded and paired with genealogical research in an attempt to identify the unknown individuals. Of the 82 individuals studied, 60 have currently been matched with burial record data and names assigned.

Dental pathology, including the number of teeth lost in life, the frequency of cavities, the incidence of gold or other metal restorations, and the number of individuals with partial/complete dentures was documented for the total series (Table 1). A number of fillings were analyzed using X-ray Fluorescence and Energy Dispersive X-ray Spectroscopy to determine their component materials. Results of these analyses were used to assess differences in material use over time, and differences in restorations relative to age and sex.



Figure 3. Andres Carlos examining a cranium dating to 1851 with a single gold filling.



Figure 4. Nova NanoSEM 600 used in study. Image courtesy of <http://mineralsciences.si.edu/facilities/sem.htm>

Results

When dental pathology is analyzed by sex and age (Table 1), there is a slight difference between males and females, with females showing a higher percentage of antemortem tooth loss, and slightly lower rates of abscesses and decay. Age is a factor in the frequency of these conditions: individuals age 35 years and older generally show more pathology, with the exception of dental caries, which are more common in young adult males. Overall, the study showed that when examined by tooth, the highest degree of dental pathology is seen in maxillary dentition. Carious lesions are observed most frequently in maxillary premolars (59.5%). Maxillary molars exhibit the most antemortem loss (55.9%) and the most abscesses (31%).

Table 1. Dental Cavities, Abscesses, and Antemortem Tooth Loss by Age and Sex.

Age in Years	Male						Female									
	No. of Teeth	No. of Carious Teeth	%	No. of Sockets	No. of Abscesses	%	No. of Teeth Lost Antemortem	%	No. of Teeth	No. of Carious Teeth	%	No. of Sockets	No. of Abscesses	%	No. Teeth Lost Antemortem	%
15-34	120	57	47.5	124	4	3.2	10	8.1	111	20	18	80	4	5	9	11.3
35+	228	87	38.2	404	76	18.8	170	42.1	172	61	35.5	346	56	16.2	152	43.9
Total	348	144	41.4	528	80	15.2	180	34.1	283	81	28.6	426	60	14.1	161	37.8

Table 2. Dental Restorations by Decade

YEARS	NO. OF ADULTS / NO. WITH RESTORATION	% WITH RESTORATION	NO. OF GOLD	NO. OF AMALGAM	DENTURES, BRIDGE, CROWN	TOTAL
1820-1829	1/0	0	0	0	0	0
1830-1839	3/1	33.3	0	0	1	1
1840-1849	3/0	0	0	0	1	1
1850-1859	10/4	40	27	1	0	28
1860-1869	6/3	50	11	5	1	17
1870-1879	10/3	30	25	1	1	27
1880-1889	8/6	75	25	8	1	34
1890-1899	6/5	83.3	13	26	2	41
UNKNOWN	24/1	4.2	3	0	1	4
TOTAL	47/23	48.9	104	41	8	153



Figure 5. The difference in bridges and dentures over time. Partial frontal bridge made of gold and carved porcelain teeth from a male who died in 1841 (top row). Gold plate with molded and painted porcelain block teeth from 19th century, identity unknown (bottom left). Vulcanized rubber and porcelain block teeth dentures belonging to a female who died in 1894 (bottom right).

Table 2 tabularizes observed dental restorations by decade from 1820 to 1899. Note the steady increase with the exception of the 1870s. This may reflect decreased availability and economic hardship following the Civil War.

The historical record (Harris 1893) cites the progression of the discovery and use of materials such as amalgams (metal alloys mixed with mercury,) gold plates, porcelain teeth and vulcanized rubber. This transition is reflected in the Congressional Cemetery series (Figure 5).

Table 3. Dental Restorations by Family Vault

Vault	NO. OF INDIVIDUALS / NO. WITH RESTORATION	% WITH RESTORATION	NO. GOLD FILLINGS	NO. AMALGAM FILLINGS	OTHER RESTORATIONS	TOTAL
CAUSTEN (1835-1899)	19/9	47.4	29	22	0	51
COOMBE (1828-1880S)	12/2	16.7	3	0	1	4
KEYWORTH (1856-1900)	12/5	41.7	2	7	2	11
MACOMBE (1822-1841)	2/1	50	0	0	1	1
RICHARDS (1851-1920)	11/4	36.4	12	6	2	20
WHITE (1834-1921)	21/6	28.6	51	5	1	57
WIRT (1834-1877)	2/1	50	8	1	1	10
TOTAL	79/28	35.4	105	41	8	155

The occurrence of dental restorations by family vault (Table 3) shows that the Causten family received the greatest degree of dental care, with 47.4% of individuals exhibiting some form of dental restoration. The White family has a lower number of individuals with restorations, but the greatest number of gold fillings (57). Data are skewed by specific individuals who received extensive dental care (Figure 6).



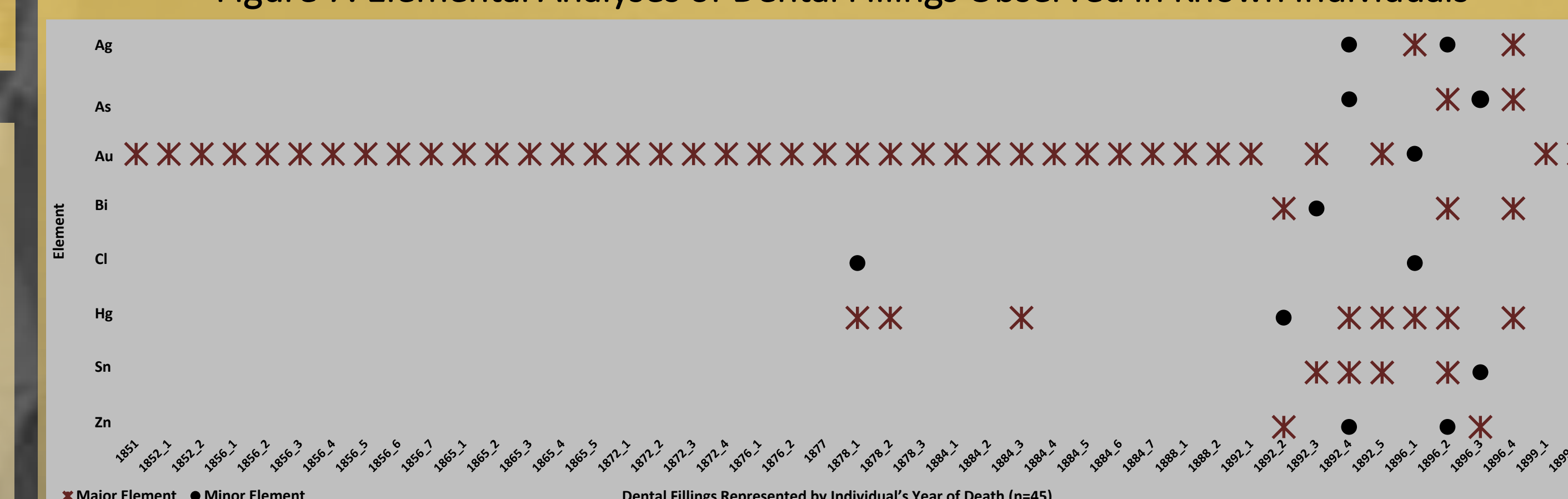
Figures 6. Top: Occlusal view of maxillary dentition showing 6 gold fillings (top). Ten amalgam fillings are visible in the maxillary dentition of another individual (bottom).

Composition

The composition of metal restorations was determined by X-ray Fluorescence or Energy Dispersive X-ray Spectroscopy. Both methods work by bombarding the sample with electromagnetic energy causing the elements to emit secondary x-rays. These x-rays are plotted on a spectrograph, from which the type and relative quantity of elements can be interpreted. Figure 7 identifies combinations of elements used in dental restorations through the last half of the 19th century. Gold is by far the most common, followed by mercury. Smaller amounts of silver, tin, zinc, bismuth, and even arsenic, are noted. All of these components are mentioned in 19th-century documents, although precise details are generally lacking. Professional dental care advanced after 1850 with vigorous dispute as to whether substances other than gold should be used. This period is referred to as the "amalgam war." Members of the dental professional debated whether or not to allow the use of mercury in dental fillings (Harris 1893, Taft 1859).

Unexpectedly, some gold fillings were found to also contain mercury, which was typically reserved for amalgams with "lesser" metals (Taft 1859). Additional analysis is needed to determine if the gold-mercury combinations are true amalgams, or whether the mercury content is due to postmortem contamination.

Figure 7. Elemental Analyses of Dental Fillings Observed in Known Individuals



In addition to providing information on the chemical composition of the fillings, microscopy yielded unexpected insights into the methods of dental restoration. Figure 8 is an image of a gold filling from an individual who died in 1851. There are parallel striations that seem to curl around the surface of the filling. This is indicative of the popular mid-19th-century method of rolling the gold foil into a cylinder before filling the cavity. The image suggests the material is non-adhesive gold foil, frequently used prior to the introduction of adhesive gold in 1858 (Harris 1893).

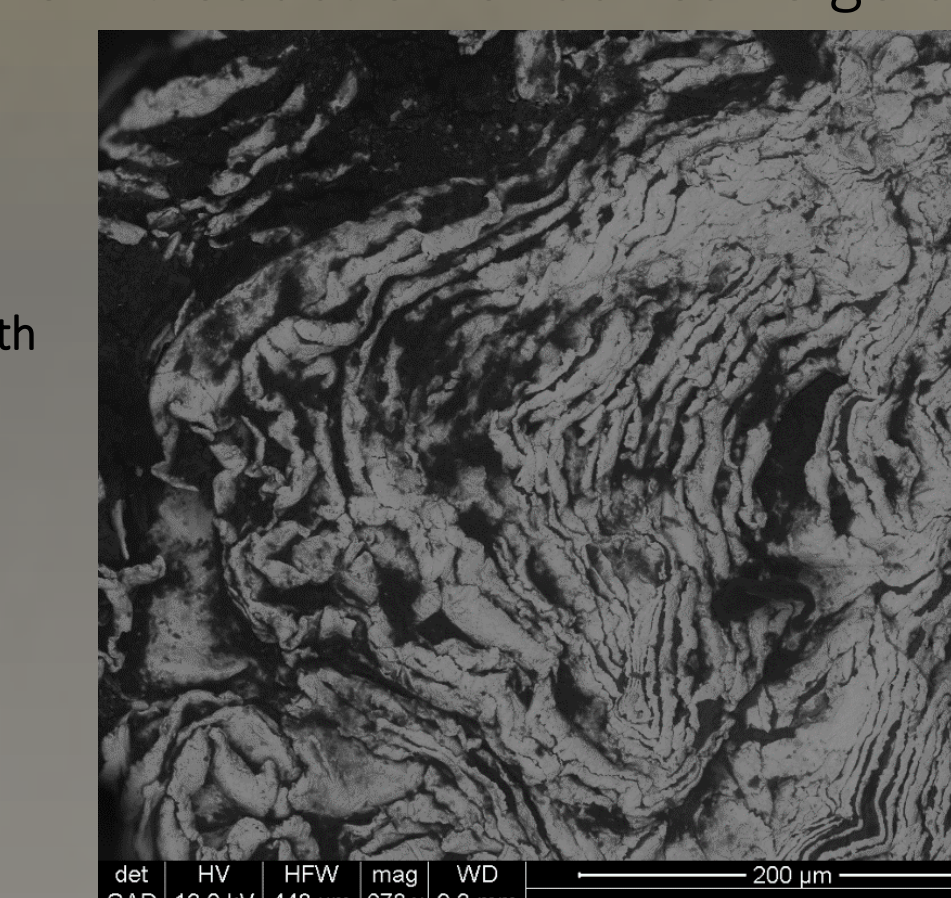


Figure 8. Scanning Electron Microscope image of a rolled gold filling.

Conclusion

Dental disease had a major impact on health in the 19th century. This project assessed the overall dental health of high-status individuals interred at Congressional Cemetery in Washington DC, and focused on restorations. Results show little difference between male and female dental pathology and treatment of these conditions. Elemental analyses of dental restorations reflect a transition in material use during the last half of the century, from gold to amalgam. The results are compelling, but future analyses require expanded sample sizes and integration of individuals from different geographic and socioeconomic backgrounds.

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