

## Letter to the Editor

## The remains of Adolf Hitler: A biomedical analysis and definitive identification



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The biomedical analysis of Adolf Hitler's alleged remains in Moscow, Russia, is a scientific and historical fantasy since the death of the dictator in Berlin on April 30, 1945 (Appendix 1). In this context, for the first time since 1946, the Russian Secret Services (FSB and GARF) gave us full access to the remains in order to make an independent scientific analysis. In March and July 2017, two campaigns of anthropological examination were carried out: direct and under binocular lenses osteological/morphological investigation, followed by minimal sampling for SEM examination and elemental analyses (Appendix 2).

First fragment is a piece of skull vault of  $10.7 \times 12$  cm, corresponding to the upper part of the occipital bone next to the lambdoid suture with the posterior part of both the parietal bones (Appendix, Fig. S1): the left one is almost complete, but the right one is conserved on a maximum width of almost 3 cm, with partial destruction of the superficial part of the cranial vault (delamination). An unilateral parietal foramen is present on the right side. The parts of the sagittal and lambdoid sutures, which were still preserved, are ectocranially closing and in stage 3 according to the stages presented by Meindl and Lovejoy [1], compatible with an age-at-death between 45 and 75-years-old. The poor bone representation makes it difficult to present a more precise age estimate, and observe any sex characteristic features (modification of cranial vault thickness by severe heating, no conservation of the nuchal crest of the occipital bone). A hole is present on the left parietal (6.0 mm diameter, circular regular aspect, on the internal side, and  $11 \times 16$  mm, star-shaped, on the external side), flared outwards, with seven radiating fractures extended in all directions (26 mm of maximum length), of which two extend to the lambdoid suture; no gunpowder residue is visible. Such morphological characteristics correspond to an external beveling of a cranial projectile exit wound (gunshot) on fresh bone, and therefore in peri-mortem interval (i.e. compatible with a direct cause of death). Blackish traces of charred bones are also visible at the periphery of the skull fragment, mainly on the left parietal and on the occipital over the external occipital protuberance, with a crumpled appearance of the entire periphery of the bone. Another hole, of post-mortem type, is present in the left posterior parietal topography, irregular, poorly patinated, coarsely lenticular (maximum of 23 mm wide), next to the lambdoid suture. Irregular scattered brown deposits are present on both sides of the skull

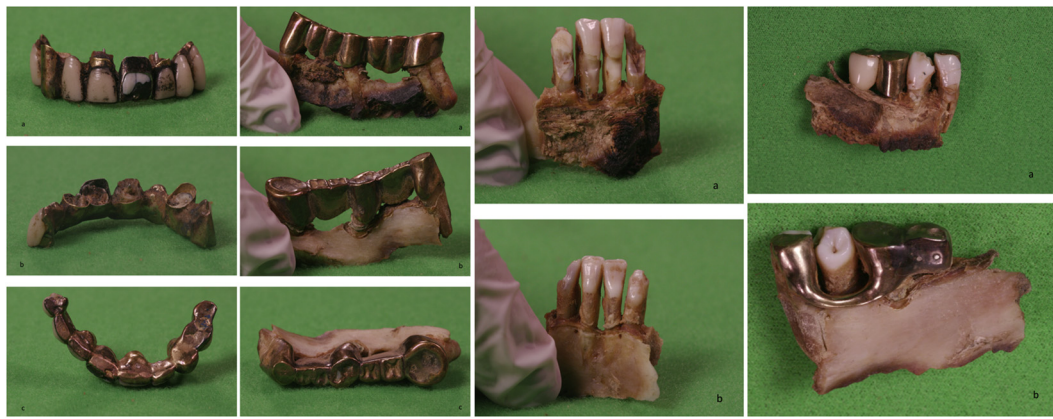
fragments, comparable with that of soil from buried bones (soil staining) [2].

We also examined one fragment of an upper jaw, measuring  $42 \times 8$  mm, characterized by (Fig. 1 extreme-left) a nine-unit maxillary bridge in yellow metal (gold?) culminating with the right second premolar (15), and three fragments of a lower jaw, measuring  $48 \times 20$  mm (Fig. 1 center-left),  $30 \times 32$  mm (Fig. 1 center-right), and  $40 \times 27$  mm (Fig. 1 extreme-right), characterized by other prosthesis, bone resorption and tooth erosion in the incisor region (Appendix 3).

Binocular lenses put to light the following elements: on all the prosthetic structures, there are numerous micro- and macro-scratches, and metallic micro-trauma characteristic of a prolonged use (Appendix, Fig. S2a), traces of severe wear on all conserved dental surfaces (Appendix, Fig. S2b), diffuse deposits of dental calculus of greenish color (mainly at the enamel-cement junction, and in intra-gingival topography, both on the lingual and buccal surfaces) (Appendix, Fig. S2c). Very thin blue deposits (1 to 3 mm of maximal length) are present on the occlusal surface of upper and lower metal prosthesis, but also on ceramic surfaces, at the level of posterior tooth (premolars and molars) (Appendix, Fig. S2d). Heterogeneous crystalline deposits of sandy appearance are observed in the inter-dental and juxta-prosthetic furrows, but also within empty metal prosthesis, on all the jaw segments (Appendix, Fig. S2e). Remains of organic tissues (muscles) are clearly visible in periphery of the cremated zones (Appendix, Fig. S2f).

SEM analyses of dental calculus fragments put to light many vegetal structures incrustated within the matrix (Appendix, Fig. S3a), associated with crystalline and lamellar structures (Appendix, Fig. S3b). No muscular segment (compatible with meat) was identified after careful examination of the whole surfaces and sections. Isolated irregular structures ( $3.8$  to  $5.3 \mu\text{m}$ ) have been identified, incrustated within the dental calculus matrix, characterized by the presence of nickel associated to the previous elements (consecutive to the fragmentation of dental prosthesis? or other origin?) (Appendix, Fig. S3c). Elemental analysis of the matrix put to light a classical composition made of aluminum silicate (Al, O, C) mixed with traces of sodium (Na), magnesium (Mg), phosphorus (P), sulfur (S), potassium (K) and zinc (Zn) (Appendix, Fig. S4); no heavy metal trace has been detected, such as mercury (Hg), lead (Pb) or arsenic (As).

Previous identification of Nazi leaders and relatives have been published in the biomedical literature [3–5], but it has to be said that



**Fig. 1.** Extreme-left: Jugal (a), inferior (b) and occlusal (c) aspects of the nine-unit maxillary bridge. Centre-left: Jugal (a), lingual (b) and occlusal (c) aspects of the first maxillary fragment. Centre-right: Jugal (a) and lingual (b) aspects of the second maxillary fragment. Extreme-right: Jugal (a) and lingual (b) aspects of the third maxillary fragment.

all the published studies dealing with the authenticity of the remains of Adolf Hitler were carried out without any direct access to the remains, i.e. skull and jaws (Appendix 4). We then confronted our new data with all published ones (both biomedical articles and archives dealing with the anatomy/cause of death/autopsy report/cremated remains observations/testimonies).

Regarding the age at death of the individual, the examination of all the 1944 X-ray plates, clearly shows a wide opened sagittal suture (Appendix, Fig. S5): this confirms the fact that the lambdoid suture may have been comparatively wide at the same moment and the year after, compatible with what is observed on the skull fragment, confirming that « specific cranial suture closure patterns have been shown to correlate rather poorly with chronological age » [6].

A synthesis on both the dentist interrogatories and the X-ray plates examination is that: at the moment of his death, Hitler had only four remaining teeth (all four mandibular incisors: 31, 32, 41, 42) not involved in either bridging a gap or supporting a bridge between adjacent teeth, but characterized by a huge bone resorption (parodontopathy); the maxillary left lateral incisor (22) and right central incisor (11) are completely opaque without any metallic post, clearly indicating a dental crown restoration (Richmond or Dowel crown or Stift-Zahn); the presence of a partially metallic crown (« window-crown ») at the level of the left central maxillary incisor (21); a very special (i.e. specific to this patient's anatomy) metallic bar has been created extending laterally from the right mandibular canine (43), bypassing the first inferior premolar (44) and connecting with a metallic crown on the second inferior premolar (45). Remaining clinical crowns involved the following teeth: 11, 13, 21, and 22. Full remaining teeth (bit prepared by the dental practitioner) are: 45, 33, 35 and 38. The tooth 43 is partially conserved (clinic crown and root), and the tooth 44 is intact but bypassed by the bizarre metallic bar previously described. It is important to see that these data fit perfectly with the soviet autopsy report and with our direct observations. We were able to confirm that what is conserved in the Russian archives (teeth and associated material) cannot be a fake, as all signs and elements of past vitality, use and physiological alterations are clearly visible on all biological and prosthetic elements: dental calculus, micro-wear, micro-scratches, micro-break, etc.

The absence of muscular structures within the dental calculus fragments has to be confronted to the fact that Adolf Hitler is said to have been vegetarian (even if only two fragments were examined, and not the totality of the dental calculus deposits).

The presence of lamellar structures (compatible with argil) may be related to the fact that Adolf Hitler had chronic gastric pain (gastritis or ulcer?) and took alginate and biliary salts (according to the list of medics given by the archives) [7–9].

The absence of antimony, lead and barium at the surface of dental calculus deposits could be understood as an argument against the hypothesis of an intra-buccal firearm wound at the moment of the suicide of Adolf Hitler; could this element may indirectly confirm the hypothesis of a non-oral entry orifice for this final firearm wound (right temporal, right frontal or posterior sub-mandibular region)?

Lastly, considering the tiny blue deposits diffusely found on both metal prosthesis and enamel surfaces, various hypothesis may be proposed, without any certitude due to the absence of any elemental analysis on such formations: chemical reaction between cyanide poisoning and metal alloy (gold/platinum/iron) [10] of the dental prosthesis at the moment of death? During the cremation process? During the inhumation period? Further elemental analyses on such blue deposits may be necessary in order to determine more precisely their origin and track any relationship with the ingestion of cyanide at the moment of death.

The results of the anthropological analysis show that the remains found in 1945 and 1946 (skull fragment and dental pieces) may come from the same individual. The morphology of the skull is compatible with that of an adult individual, without any possibility of a more precise diagnosis (including sex and age at death); a peri-mortem exit bullet hole exist at the level of the left parietal bone, compatible with a direct cause of death. Regarding the jaws elements (bone, teeth and prosthesis), confrontation with the official autopsy data from the Russian archives, and the official radiographs of Adolf Hitler from the US archives, together with additional historical data from both sides, provides sufficient pieces of evidence in the definitive identification of the remains of the former Nazi leader Adolf Hitler. Further DNA analyses may be useful in order to conclude on the homogeneity between the skull and jaw remains.

### Compliance with ethical standards

#### Funding

None.

#### Conflict of interest

All authors declare that they have no conflict of interest relative to the subject of this article.

#### Ethical approval (humans)

This article does not contain any studies with human participants or animals performed by any of the authors.

**Informed consent**

Non applicable.

**Appendix A. Supplementary data**

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ejim.2018.05.014>.

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