
Ancient "Dental Implants": A Recently Proposed Example from France Evaluated with Other Spurious Examples

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The recent announcement of the discovery of a first or second century AD Roman example of a dental implant appears to fall into a category of spurious claims regarding ancient dentistry. Several earlier claims of the discovery of impressive examples of ancient dentistry are reviewed, followed by a discussion of the recent discovery from France. This survey of all of these claims regarding finds of ancient dental implants, plus data from the modern and rapidly evolving field of implant dentistry, suggests that these "ancient implants" are the product of the imaginations of 20th-century archaeologists.

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Recently, a French team identified an artifact from a Gallo-Roman necropolis at Chantambre (Essonne, France) as a Roman period dental implant fashioned from wrought iron.¹ This claim can be discounted by evaluating it in the context of modern implant dentistry and by comparing it with what is known of actual ancient dental appliances.²

The abilities of the ancient Etruscans to fabricate complex dental prostheses from gold continues to impress modern practitioners and contemporary users of sophisticated pontics. The Etruscans produced the first pontics, using simple gold bands, as early as 630 BC and perhaps earlier. A separate tradition of dental prostheses, with wires made of either gold or silver, evolved in the eastern Mediterranean around 400 BC.^{3,4} The total corpus of documented appliances from both traditions now includes 26 examples.

In addition to these known examples of true Etruscan dental prostheses, various modern copies of these ancient devices have been made since the 1880s. Although most are rather poor replicas, these copies and sometimes photographs of them are often mistaken for originals by unwary researchers. More problematic are the numerous unverifiable "examples" of ancient pontics, crowns, and implants.

Ancient Roman literature includes many references to gold dental prostheses,^{3,5,6} but their structure and specific functions cannot be determined from these texts. The first documented archaeological discovery of an Etruscan gold dental prosthesis dates from the end of the 18th century.⁷ This verification of the ancient texts, along with subsequent finds, spawned numerous reports of "discoveries" of other dental prostheses, most of which cannot be confirmed. For example, spurious reports of ancient Egyptian pontics became so common that Van Marter^{8,9} spent considerable time fruitlessly attempting to trace them, even though Mummery¹⁰ had already effectively discounted all previous claims. Invariably these early reports from Egypt were found to refer to amulets, rather than dental prostheses.¹¹ Nevertheless, poor scholarship and the gullibility of authors over the decades has

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filled the literature with fanciful accounts. Weinberger's excellent review dismisses most of these tales, but in the process he manages to generate other mythical examples.^{12,13}

Over the past 125 years, many fanciful reports relating to all types of ancient dental prostheses have been written. The vast literature on ancient dentistry^{6,14} includes a small subset of claims regarding supposed ancient dental implants, from which Crubézy and his colleagues correctly note that no case ever has been confirmed.¹ Claims regarding the use of a bronze wire for an ancient Nabatean root canal¹⁵⁻¹⁷ or for Etruscan orthodonture,¹⁸ plus a long list of other supposed ancient alterations of human teeth, similarly have been revealed as spurious.¹⁹ These spurious dental restorations, supposed ancient dental crowns, and various other "examples" of ancient dentistry recently have been traced to their sources as an adjunct to the production of an accurate corpus of known appliances. While most of these spurious examples appear only in secondary literature, a few had become accepted by scholars well versed in ancient dentistry.²⁰ In most cases, these examples are the result of wishful thinking combined with poor referencing of earlier secondary sources. Ignorance of the technology involved in the fabrication of dental prostheses plus a lack of scholarly communication appear to have allowed the creation of various "examples" by archaeologists. Bliquez resolved a great number of these problems in a recent landmark publication.²¹

A list of commonly noted "examples" of ancient prostheses that can be demonstrated to be fictitious is presented here for the consideration of specialists in modern dental implantology and prosthetics. Following is a discussion of the data relating to the most recent claim of the discovery of an ancient dental implant.

"Examples" of Ancient Prostheses

The "Dental Bridge" in the "Skull of Pliny." For many years a skull with a nonmatching mandible has been displayed in the Museo Storico dell'Arte Sanitaria of the Accademia di Storia dell'Arte Sanitaria in Rome. These human remains are claimed to have been found during excavations at Boscotrecasa, Pompeii, in the late 19th century. This period of excavation at Pompeii revealed many burials, and the bones from these early excavations were either discarded or reburied. In a section of Matrone's excavation report²² is a photograph of a skull (lacking the face) and a mandible, both said to have belonged to Pliny the Elder.

Whether these are the same bones now in the museum remains uncertain. Waarsenburg contends that at a later date the excavator at Boscotrecasa was asked if the body of Pliny was among the bodies recovered.²³ A skull and a mandible were produced and identified as belonging to Pliny the Elder,²⁴ who had died in the eruption of Vesuvius in 72 AD.²⁵

Subsequently, Baglioni suggested that the mandible associated with this skull had been fitted with a dental prosthesis.²⁶ Fortunately, this fable rarely has been repeated except by Sgarbi.²⁷ Waarsenburg, who traced the origins of the fable of this skull,²³ took me to the Museo dell'Arte Sanitaria in Rome to examine the mandible for evidence of the prosthesis "seen" by Baglioni.²⁶ No evidence of any dental restoration, artificial drilling, or filling can be found in this mandible, but Waarsenburg's manuscript repeating this myth had already gone to press.²³

Baglioni also claimed to see evidence for oral surgery on this mandible. Such fantasies are neither new nor uncommon.²⁸ Weinberger reviewed several of these "studies" of supposed "ancient" oral surgery in a historical survey that Baglioni does not appear to have seen.¹² While tooth extraction and rudimentary dental surgery may have been performed prior to 1000 BC, there is no evidence that dental prostheses were made before 630 BC or that they were fashioned in Egypt or even present there until after 400 BC.

Baglioni's "Bridge." In addition to the dental work that Baglioni imagined to have seen in the "skull of Pliny," Baglioni also claims great antiquity for a gold dental plate with a set of 12 sockets purported to hold teeth.²⁶ He said that this "plate" came from the region around Rome and that in 1952 it was in private hands. This supposed example, now missing or unknown,²⁹ is illustrated by Bobbio, who notes that the object (or the photograph) actually was in the collection of Prof. S. Baglioni in Rome.³⁰ Bobbio dates this piece from the Roman imperial period, but this clearly is an error.

Given the fabrication involved in Baglioni's description of the "skull of Pliny," one may discount this reference to "ancient" dentistry. This item may be an example of dentistry dating from after 1700 AD, the so-called "golden" age of dental prostheses. Waarsenburg's initial acceptance of Baglioni's statement regarding this plate led him to include this spurious "denture" in his inventory. Thus 2 "appliances" were added to the literature by a process similar to that which Waarsenburg himself describes.¹³

Cali's Various Creations. In a report by Cali, 3 spurious examples are discussed³¹: (1) Thebes (a mummy?): circa 1880 by Professor Sanders; (2) Meyer Museum, London: the maxilla from a mummy; and (3) the Vatican Museum piece. Cali's specimen from the Museo di Papa Luigi is the same as the piece that he believed was from the Museo di Antichità nella Villa di Papa Giulio III. Cali believes they are 2 separate pieces, as does Weinberger,¹² who attributes one to the Etruscans and the other to the Romans.¹³

Platschick's Piece from "Populonia." Waarsenburg points out that Ghinst took the Valsiarosa gold prosthesis, one of the Etruscan pieces that had been poorly documented, "moved" it to a maxillary position, and claimed that it came from fourth-century BC Populonia.^{13,21,32}

Marzabotto (near Bologna, Italy). Waarsenburg (personal communication) suggests that Count Pompeo Aria apparently provided Dunn with all of the following "information" concerning this spurious prosthesis.³³ Count Aria apparently had in his possession a gold pendant in the form of a human incisor.³³ Platschick describes this object as a deciduous tooth mounted in gold, with a ring for suspension.³⁴ As noted in other cases, Platschick was not always overly concerned with careful description and analysis.

Count Aria alleged that he had had a skull in which there was an artificial tooth attached with a gold wire. This skull was sent with other Etruscan objects to a foreign scientific society, but it was never returned to Count Aria.³³ Although 1894 is remarkably close to the time that Guerini is believed to have made copies of the Italian dental prostheses, the probability that such an artifact or collection of artifacts claimed by Count Aria would not be recovered by the owner is seen as quite low. Dunn also indicated that he owned a skull and mandible in which was located a complex gold band.³³ This prosthesis, and possibly the skull in which it is now exhibited, actually came from Poggio Gaiella, and Dunn subsequently donated it to the Museo Archeologico Etrusco in Florence.

The Vetulonia Dental "Crowns" (Florence). These human molars, now in the collections of the Etruscan Archaeological Museum, Florence, are perhaps the most frequently cited "examples" of ancient artificial dentistry.²¹ A partial listing of early references to these "crowns" includes publications by Dunn³³ and Falchi.³⁵⁻³⁷ These 11 natural human dental enamel crowns come from 4 different tombs, and thus at least 4 different people are represented. All have been stained dark green from contact with the copper salts that form on copper

or bronze artifacts buried in the tombs. The most likely source of these copper salts is corroding coins that were placed in the mouths of the deceased.

These human teeth, from which the roots had deteriorated while they were in the tombs, were recovered by Falchi from the Vetulonia necropolis area northeast of Monte di Colonna. Levi provides information on the site location,³⁸ and Casotti offers related details.³⁹ Falchi describes the burial contexts and offers a plan of the excavated area as well as a detailed plan of the specific location from which some of these teeth were recovered.³⁵ Objects from the excavation are also illustrated in Falchi's report. The report also illustrates, at full scale, 2 teeth that look like those of a small dog.³⁶ The band of metal depicted as binding these teeth may reflect their use as a charm. The crowns of 4 human teeth are also illustrated with their roots reconstructed. The graves at Vetulonia from which 3 of the "human" teeth derive may actually have held material from a necklace, since Falchi notes that near the teeth, and carefully laid out, were 2 necklaces: one of small glass and amber spheres and another of bronze rings and small tubular beads.³⁶ This limited clue suggests that the human teeth from at least one of the graves were in proximity to the bronze rings found on a necklace, which may have been the source of the discoloration noted.

Casotti, citing 2 of Falchi's publications, reviews the archaeological data regarding these 11 crowns that originated from at least 4 different burial sites at Vetulonia.^{35,36,39} Casotti's discussion and illustration are important and provide many references to others who have published information about or related to these human teeth.³⁹ Bobbio, taking his data from Casotti, discusses these stained teeth, noting the various interpretations of them as either human crowns or, incorrectly, as early artificial dental crowns.³⁰

Platschick correctly observes that the roots and dentin of these human teeth had rotted away in the tombs, leaving only the enamel crowns.³⁴ Platschick also correctly notes that the color is the result of being in contact with bronze.³⁴ Other scholars, including Guerini, were not so observant and erroneously identified these teeth as being artificially cast gold "crowns" or part of dental prostheses.²⁰ Dunn had referred to them only as "crowns" but implied that they were artificially fabricated and meant to be attached to natural teeth like modern dental crowns.³³

Brown, as well as Weinberger, clearly recognizes that these teeth were not fashioned from gold, but that they are simply the stained enamel crowns of

human teeth.^{40,41} Nevertheless, the existence of this imaginary “appliance” remains embedded in the popular literature and is cited occasionally by scholars. Boissier is among the early authors mistaking these teeth for artificial crowns.^{42,43} Tabanelli, citing Platschick’s poor description, repeats the error of calling these teeth a dental prosthesis.⁴⁴ Even Emptoz, unfortunately, applies this information to one of his “examples.”⁴⁵ Ghinst seems to be referring to these teeth in his suggestion that a dental prosthesis was discovered in the ancient Etruscan city of Chiusi.³² Waarsenburg (personal communication) provides useful data on one of the Etruscan dental prostheses and also on these Vetulonian teeth that are so often confused with it.

As Bliquez points out, the metallic appearance of these dental crowns confused Guerini and many other observers.²¹ Such stained bones and teeth are common in ancient tombs,^{46–48} and the process of roots and dentin dissolving while leaving the enamel caps intact also is common at archaeological sites. Brown indicates that cast gold tooth “caps” (crowns) are not documented before about 1593 AD, and even this citation is questionable.⁴⁰

The Purland “Egyptian” Example. Purland claimed to have had in his possession a “pivot” tooth from the “head of a mummy in the collection of a lamented friend.”⁴⁹ A “pivot” tooth in 19th-century English dentistry was a false crown affixed to a natural root by means of a gold post or “pivot.” The date and origin of such an example must be considered unreliable, as Brown clearly indicates.⁴⁰ The nature of the object that Purland was identifying as a false tooth remains unknown.

Purland was one of the many 19th-century authors who repeated the myth that Belzoni had found false teeth and teeth “stopped” (filled) with gold in the mouths of Egyptian mummies.⁴⁹ Purland correctly noted, however, that examples of Etruscan gold dental prostheses were then in the collection of Joseph Mayer. The pair that Mayer had acquired were subsequently donated to the National Museum in Liverpool, England. Purland also indicated that additional Etruscan prostheses were then in collections in Berlin and Paris. These other “examples” may refer to gold items associated with mummies, although a true Etruscan dental prosthesis is now located in Berlin and several modern copies of it are in Paris.

Purland’s claims regarding the existence of ancient Egyptian examples of dental prostheses were unfortunately cited by several authors, including Perine, Casotti, and later Michelsoni.^{25,50,51} Ancient Egyptian false teeth are among

the most frequently cited “examples” of early dentistry that have no basis in fact.

Other Spurious Ancient Egyptian Examples Supposedly Dating from Before the Hellenistic Period (Pre-400 BC). As noted previously, a vast literature exists claiming that “ancient” Egyptians used dental prostheses. Textual evidence does suggest that the Egyptians were pulling teeth and practicing complex oral medicine as early as 2900 BC and probably earlier.⁵⁰ However, no evidence for dental prostheses before 600 BC—or even later—can be documented. Most commonly mistaken for Egyptian prostheses are votive objects and other types of charms that were commonly placed in the mouths of Egyptian mummies.⁵²

No sooner than Quenouille had published a well-reasoned paper that effectively discounted the possibility that these votives were anything else,⁵³ Trillou published a vague compendium in which he assembled the spurious and indirect “evidence” in an attempt to prove that early examples of dental prostheses existed in ancient Egypt.⁵⁴ Trillou appears to have taken his conclusions from an earlier French publication in which the popular fantasies involving several of these votives appeared.⁵⁵ Although it is quite clear that no dental prostheses were fabricated in ancient Egypt prior to the sixth century BC, readers should consult Bardinet’s summary of the direct evidence discounting these many spurious claims regarding Egyptian “examples.”⁵⁶

Saint Benedict’s Dentures. The founder of the Benedictine order, who died in 543 AD, is often claimed to have worn dentures or dental prostheses. Brown examined the skull and found no evidence for this myth,⁴⁰ which has parallels with the legends surrounding the teeth in the “Skull of Pliny.”

The Nabatean “Wire Implant” Described by Zias. A skull of a human male found in a mass grave from the northern Negev, dated to circa 200 BC, was found to have “a bronze wire approximately 2.5 mm in length firmly implanted in the canal” of a maxillary right lateral incisor.^{15–17} Zias and Numeroff suggest that the “pin” had been deliberately placed after artificially expanding the chamber; in effect a primitive root canal operation, or an attempt to “prevent ‘tooth worms’.” They also suggest that this may have been a pin to hold an artificial tooth in place, or that something had been done (drilling), perhaps to provide a drain for a large palatal cyst that they identify as being at the root of the tooth.

All of these suppositions regarding a wire “implant” are equally unlikely, given what is known about the state of dental medicine and

technology in that region of the world at that time. None of the theories regarding wire “inserts” have been confirmed using scanning electron microscopy or other techniques that might confirm the speculation. Equally unlikely is the placement of a bronze pin, or even a gold pin, for any of the purposes suggested by Zias. There may be a remote possibility that a false crown was mounted on this tooth, but this idea also is unlikely, given the time period.

I would suggest that this “implant” may be the result of the tip of a bronze probe breaking off inside the tooth during an examination involving symptoms caused by a cyst. Powers very clearly points out the errors in evaluation and speculation in Zias and Numeroff’s proposition.^{6,57} Powers also notes the existence of another similar example from Lackish, described below.

The “Filled Tooth” from Lackish, Palestine. Powers notes that an example of a “filled” tooth similar to that from Nabatea was recovered from an Iron Age site at Lackish in what was then Palestine.^{57,58} This earlier find was reported by Risdon in 1939.⁵⁹ Risdon concluded that this example was not the product of any dental intervention, but that it was the result of an accident. In effect, the Lackish example parallels that reported by Zias from Nabatea. The discovery of 2 examples may be considered as suspicious and possibly reflecting a cultural behavior, of which we remain unaware. The probability that these were deliberate dental activities remains very remote.

The Danish “Pearl” Insert. Another example of accidental placement of a foreign object into a tooth that has been reported as a possible example of ancient “dentistry” is a “bead” (or “pearl”) that was found “fixed into a caries cavity” in a tooth derived from a medieval site in Denmark.⁶⁰⁻⁶³ Subsequently, Bennike quotes Møller-Christensen as reporting this medieval “implant” from the Aebelholt monastery as being a “pearl” deliberately placed in a tooth.⁶² One may infer that this “pearl,” like the bronze wire inserts noted earlier, found its way into this context by accident, as no dental treatment appears to have been intended in this situation.

A “Stone Implant” from the Kalabak Necropolis, Near Klozomenai, Turkey. Atilla⁶⁴ reported the discovery of a piece of stone, which he perceived to be in the size and general shape of a tooth, that was found in a limestone sarcophagus with a limestone lid in the Kalabak necropolis, situated to the east of the ancient Ionian city of Klozomenai on the Aegean coast (to the west of modern Izmir).¹⁹ The report, and the comparanda noted, are not

clearly presented by Atilla, who cites only secondary literature in support of his interpretation of this object as a dental implant. However, his evidence will be summarized here to evaluate these data in light of the documented examples of dental prostheses.

The problematic context of the Kalabak “implant” begins with its discovery in 1981 inside a limestone sarcophagus that had been looted from the Kalabak necropolis. Recovered from inside were “some bones, teeth, and a toothlike structure carved out of stone ... with a gold hair-spiral as a burial offering.”⁶⁴ Later in his text, Atilla notes that this “object, which was found among broken bones, did not resemble a piece of an ornament.” No location for any of the artifacts within this tomb have been provided.

Atilla suggests that the plundering of the tomb disturbed the “tooth” from the “upper right canine” position of its owner. How this conclusion was reached remains unclear, since no list of human teeth found in the tomb is given, nor is there evidence of which portions of the face survived. The mandible is noted only to indicate that molar eruption suggests an age of 14 to 16 years at death. The presence of a hair ornament led him to suggest that the deceased was a woman.

The date of this looted sarcophagus is given as 550 BC, but this is based only on its placement over a cremation burial, which had associated offerings dated “to the first half of the sixth century BC. In the Kalabak necropolis, nothing has been found later than mid-sixth century BC.”^{64p54}

Atilla notes that the size of the stone object from Kalabak is “the same” as is generally noted for maxillary canines, but the actual length is suggested to be 29 mm. Its shape and “inclination” lead Atilla to suggest that this item was meant to replace a maxillary right canine. The shape of the stone, which Atilla claims does not exist in nature, also led him to postulate that the “implant” was attached to the adjacent tooth with special wires or devices. An artist’s drawing depicts it as if it were wired between the maxillary right lateral incisor and first premolar.⁶⁴

Petrological studies made in conjunction with Atilla’s research suggest that this stone is composed of layers that have metamorphosed. There is a hematite travertine section and a calcite section, the latter probably representing the pseudocrown. Calcite is noted as having a hardness of 3 on Moh’s scale, which is quite soft and would be unsuitable for any use such as a dental implant. The “crown” measures 6 × 5 × 11 mm, and fractures seen on it under a stereomicroscope are said

to have led to the theory that this object had functioned as a tooth. The neck area of the stone is believed to have "erosion lines resulting from the gold wire or band," and polarizing light microscopy is said to have revealed "gold pieces a few microns in diameter," supposedly traces of a gold fastening.

Reviewing Atilla's presentation yields a very different conclusion. Although a date of circa 600 to 550 BC is well within the period of the earliest confirmed examples of Etruscan dental prostheses, and since one of these Etruscan prostheses was recovered from a Greek site (the Eretria example, from Euboea), finding an example at one of the famous Ionian cities such as Klozomenai would be possible. In addition, the Etruscan examples all were worn by females, strongly suggesting that decoration and vanity were motivating factors in their use. However, none of the documented examples derive from the burial of an adolescent, and none of the other evidence from this tomb at Kalabak appear at all convincing.¹⁹

Atilla's conclusions regarding this object reflect his belief that the stone had been held in place by a gold wire similar to those known from various Phoenician locations. The reported traces of gold at the neck of this object might be taken to indicate that it was bound in a gold device, but gold may actually be part of the mineralogical composition of the stone. None of the adjacent teeth, if any survived, have been tested to support the theory that this stone was bound in place by a gold ligature.

Although this piece of stone is said by Atilla to have been carved, he later says it "did not resemble a piece of an ornament." While Atilla claims that such a stone artifact does not occur in nature, I can attest that such pieces are found by amateur archaeologists and interested geologists with great frequency. This object clearly is a natural stone, differentially eroded but not worked, bearing only a slight resemblance to a tooth.

At 29 mm this stone piece clearly is too long to have served as a false tooth in a prosthesis. Ancient artificial teeth are always limited to the crown portion alone, being suspended in a pontic device by bands, as in the Etruscan designs, or by wires, as in Phoenician examples. The stone of this tooth is also far too soft to have functioned as an artificial tooth. The preferred materials are ivory, human or animal teeth, and very dense woods. The single example of an artificial gold tooth, from Satricum, is also the earliest known dental restoration. Probably problems involved with the soft gold shell, such as that employed in this exam-

ple, rapidly led to the use of more durable materials. Despite Atilla's claim that stone has been used for other dental pontics, no such documented case can be verified.

Most likely this piece of stone was a chance inclusion within this opened sarcophagus, entering either when the tomb was looted or at any other point when the box was open. Also possible is that some ancient person found this interesting stone and carried it as a charm. Amulets and decorations, often worn on gold or silver wires, were commonly made in antiquity from all sorts of natural formations. Fossils were commonly mounted as decorations, as were "fairy darts," the term given to chipped stone arrow points and other tools of the European Mesolithic. Far from being a dental implant, the stone artifact noted by Atilla appears to be one of the large number of spurious objects wishfully suggested as representing these fascinating examples of ancient dental technology.

Misinterpretations of the Vallois Findings. In an archaeological site report from 1971, Vallois notes the presence of a chance association between a bone and an open dental space in what may be a trophy skull from the Capsian (Mesolithic) period.⁶⁵ This very early Algerian context has been noted by several authors as an example of dental implantology, a suggestion that was never made by the excavator.

Crubézy and his colleagues recently cited Vallois as if to imply that the "phalanx" found wedged between 2 natural teeth may have been used as an ancient replacement tooth.¹ The implication that this bone served as an ancient dental implant is patently absurd. However, this presentation leads one to suggest that the use of the word "implant" in English may be taken by French authors as equivalent to a dental pontic or fixed partial prosthesis. This interpretation, however, does not account for the error made by a French team regarding their "discovery" of an ancient dental "implant."

The Recent French Claim

The recent claim by a team of archaeologists in France regarding a possible Gallo-Roman period dental implant in an individual of the first or second century AD from a necropolis at Chantambre in Essonne, France, is merely the most recent of this long list. Crubézy and his colleagues¹ describe a piece of metal that they believe to have served as a dental implant, found in the maxilla of a male over 30 years of age. They conclude that it was fashioned from "wrought iron" or "an iron or

non-alloy steel." They note close apposition within the alveolar socket and a lack of periapical pathology in the bone, and conclude that this "implant" achieved successful osseointegration more than a year before death. I suggest that this is a perfectly normal and healthy tooth stained with iron oxides. This simple explanation would account for the normal relationship between the root and the socket, as well as for other findings of the French team. For example, the radiograph provided as their Fig 1b depicts a perfectly formed tooth with a smooth, intact surface free from pitted or flaked areas that might be expected on a small iron object interred for nearly 2,000 years in less than ideal conditions.

Their argument for the composition of this "object" is contradictory on several points.⁶⁶ First, the object is described as "severely corroded, preventing magnification for the study of the microstructure." While Crubézy and his colleagues suggest that "[T]here is a piece of metal where the right second upper premolar would have been," their statement that "[T]he implant and the socket fit perfectly together and the osseointegration appears viable"^{1p29} again contradicts their observation that the metal "has been severely corroded."¹ Severe corrosion of iron would expand and distort the surface, either fracturing the surrounding bone or at least distorting the interface. The fact that the break seen in the radiograph and noted by Crubézy is clean and was easily rejoined indicates that the material is not "severely corroded" iron, but is probably a natural tooth stained with iron oxides.⁶⁷ The radiograph also reveals an opaque crown area, with shadows grading through the neck into the root area in a manner that demonstrates that the tooth is not a solid piece of metal. Metal inlays or amalgams rarely permit x-ray passage in such differing degrees as that indicated in the authors' illustration. If the "iron" of the tooth had decayed to the point where such shadings would be evident, the perfect margins of the tooth seen in their radiograph would have corroded to the extent that the outline of the "tooth" would have become irregular.

In fact, the radiograph offered by Crubézy et al reveals a perfectly normally shaped tooth, possibly a premolar, that has no indication of surface corrosion.¹ This suggests that the natural tooth in this socket had been deeply impregnated and extensively stained by contact with an oxidized (rusted) iron-rich object, possibly a coin or a coffin nail. This process also would have aided in its preservation. The migration of iron oxides to the surface of

the tooth would account for the finding that the elements found in their testing were iron and oxygen. The authors' ambiguous reference to "x-ray microanalysis (energy dispersive spectroscopy)" of the "central part" may refer either to the interior of the tooth or to the neck of the tooth. This information, "together with scanning electron microscopy of the apical fragment, identify it [the piece of metal] as iron or non-alloy steels."^{1p29}

The excavators at Chantambre provide no reason for the possible extraction or loss of the original tooth that they claim had been replaced. "No microscopic studies of the alveolar bone next to the implant" were conducted.⁶⁸ While the adjacent first premolar is said to be missing, dental caries or surface decay on the mesial surface of the maxillary right first molar might suggest that the "replaced" tooth had decayed and been extracted, leaving a clean socket into which an implant might be placed. Crubézy suggests that the maker of "the implant used the original tooth as a model." Were that tooth intact, it could have been replaced in the socket with a far greater chance of being accepted than any foreign material available to the ancient Romans.

The skull bones from Chantambre have surfaces that appear to have been uniformly altered in color, either by modern conservation or ancient contact with metallic oxides. Had an iron object been in place in the position that the authors assign to it, stains of iron oxide would be evident in the alveolar area immediately surrounding the socket of the maxillary right second premolar. No such localized staining is evident in their report.¹

Also important is the lack of archaeological data regarding finds of iron in this grave or in related tombs from this Gallo-Roman necropolis. The production of a small, finely detailed replica of a human tooth in wrought iron would test the skills of modern workers in this material. The likelihood that the surface of an iron "tooth," were it technologically feasible to produce one, would serve in the delicate capacity of a dental implant accepted by the human body under questionably sterile conditions appears even more remote. The development of sophisticated materials that will not be rejected by the body is a modern phenomenon that simply was beyond the skills of ancient crafters. In addition, no cultural context is provided for the grave, leaving one to puzzle over the social status of the person within either the cemetery or his group. This is an important variable for the interpretation of the probability that an individual might have sought such a complex, expensive dental procedure.

A simple explanation for the x-ray effect and the results of the scanning electron microscopy test is offered here. I believe that the tooth in question is the natural tooth, original to the location cited by the authors. Contact in the grave with the oxides from an iron-rich object stained the tooth, impregnating it with the iron and oxygen indicated as the main elements discovered in the analysis of this tooth. This explains the detailed shape of the tooth, its appearance in the radiograph, and the analytic results reported.

Two general concerns regarding the interpretation of this tooth as an iron implant merit further discussion. First, the likelihood that someone would seek to have a tooth replaced in antiquity is undocumented. The idea appears to be a projection of 20th-century concepts of dentistry back to a population in which the idea of replacing a lost tooth did not exist. Not only is such a cultural activity unattested in any premodern context, but the possibility that success could be achieved in such an unusual procedure is even more remote.

Modern concepts regarding dental health among the upper classes in industrialized populations developed late in the 19th century and are still evolving. Throughout most of western Europe today, concepts of tooth replacements by prostheses or by implants to attain the perfect "Hollywood" smile are popularly derided as American fetishes. Many national dental services do not appear to foster the idea that missing teeth should be replaced, even among those social classes that may be interested in tooth replacements. Thus tooth loss, and in particular the loss of premolars and molars, is not considered by the population at large as a cause for concern or for seeking an expensive replacement procedure. More commonly, dental loss is treated as a normal factor of aging, with concern for replacements being limited to the well-to-do among the most industrialized countries of the world.

In fact, the principal types of ancient dental prostheses fall into only 2 categories. The better known of these are the decorative South Etruscan examples that were specific to Tarquinia and the cities immediately surrounding that ancient center.^{5,19,69,70} These definitely were not a Roman invention, and the only users appear to have been Etruscans or those of Etruscan descent. These decorative prostheses were going out of fashion during the Romanization of Etruria late in the first century BC. The second type of ancient dental devices were the functional Near Eastern wire examples used to stabilize teeth loosened by a blow or other trauma until they could regain their

natural anchorage.⁴ Wire prostheses, developed around 400 BC or some centuries after the earliest Etruscan pontics were made, used a distinctive construction. This functional approach to wiring loose teeth has survived as an aspect of oral medicine into the late 20th century. Of considerable importance is the fact that both types of ancient dental prostheses are mentioned in ancient literature, and are confirmed in unequivocal archaeological examples. The origins of dental implants are entirely modern, being unknown in the ancient medical texts or literature, and with no archaeological examples identified.

Modern Dental Implants

Comparison of this claim for the discovery of an ancient dental implant with the remarkable progress in implant dentistry over the past few decades helps to put the evidence into perspective. As recently as 1969, the successful anchorage of dental implants in dogs was still in the experimental stages.⁷¹ These experiments, under remarkably modern antiseptic conditions unimaginable prior to 1950, also relied on the development of titanium and other high-technology alloys and bonds of incredibly sophisticated composition. These are necessary to provide a surface that can "fool" the human tissues into accepting them. The goal of modern implant research is to secure to the bone a permanently anchored unit that can be used for prosthesis attachment. This can take place when osseointegration has been achieved.

Only 2 decades ago, Brånemark's pioneering team presented the results of their long-term (10-year) studies of dental implants of all types and provided an important review of the literature.⁷² Two years later Schnitman and Shulman edited a landmark volume discussing the benefits and risks involved in attempts to use the most modern of the dental implants then available.⁷³

The types of experimental materials that had been found to allow any success when used for implants multiplied after 1970, as had the special surfaces created for these implants and the forms of the restorations.⁷⁴ The original titanium alloys that were successfully used were joined by implants using vitreous carbon, Vitallium, aluminum oxide, and various combinations coated with either carbon or titanium to enhance acceptance by the bone. These implant materials had paralleled incredible gains in bone joint replacement research. Despite considerable developmental success, by 1986 most researchers still had incomplete agreement regarding "implant success."

Thus, with space-age technology and the most modern antiseptic conditions, a 5-year success rate of 75 to 85% was being proposed as generally acceptable in the profession.^{75,76} The ancient processes of tooth "replacement" used by the Etruscans and Phoenicians^{77,78} were technologically far simpler than these space-age prostheses.

As recently as 1991, various studies presented a number of alternative strategies for achieving osseointegration. Recent longitudinal studies^{79,80} have reviewed the issues that remain problematic in implant dentistry.^{81,82} The key to successful dental implant therapy clearly became focused on the achievement of osseointegration. Recent advances in this area⁸³ have largely solved the last remaining major difficulties confronting this new technology.

The likelihood that the ancient Romans would even have been interested in attempting to fashion dental implants to replace lost teeth is extremely remote. Even had they tried, the probability that they could fashion a small and finely shaped object from rust-prone iron is even more remote. That an iron object would be accepted by human tissue as a dental implant is infinitely less likely. Thus this chain of improbabilities reduces the possibility of the Chantambre object as a dental implant to incredible proportions.

Why the Archaeological Claims?

Although archaeologists have long claimed the discovery of examples of ancient dentistry, in addition to the well-known Etruscan pontics and Near Eastern wire braces, the belief that successful dental implants were made in antiquity is a relatively new dimension. The newness of specific claims to the discovery of ancient dental implants appears to reflect progress made in modern technology rather than the discovery of ancient skills. The suggestion that the ancients were interested in replacing lost teeth using dental implants or otherwise is called into question. The replacement of central incisors following the deliberate removal of the originals was common among the Etruscan elite,^{6,84,85} but these dental splints and complex prostheses served decorative purposes only. All of these objects were fashioned from soft gold, and none can be demonstrated to have created a functional dental replacement.

The conclusions reached by Crubézy and his team are similar to those that had been made for a set of bronze stained human dental crowns from Etruscan Vetulonia. These teeth from Vetulonia had been in contact with bronze or copper objects

within the tomb and had become stained with copper oxides. They have been described by numerous authors as a set of artificial crowns made of bronze. Some scholars believe that these were the products of sophisticated Etruscan dental technology, but these crowns have been revealed to be only stained natural teeth from which the roots had decayed because of conditions specific to Etruscan chamber tombs.¹⁹

The numerous contradictions in the evidence provided by Crubézy and his team; their lack of understanding of ancient dentistry as indicated by their few dated references¹; and the flawed representation of earlier works,⁶⁵ various citation errors, and poor interpretations of the modern literature on dental implants and the known data relating to ancient dentistry all argue against the conclusion that the Chantambre tooth is an iron implant. Wishful thinking in the interpretation of peculiar artifacts recovered through archaeology is insufficient to create an ancient technology that did not exist.

There is good reason to marvel at the massive and apparently complex, but technologically relatively simple, construction projects of the Romans and at their delicate carvings on impressively hard gemstones. The ability of ancient "surgeons" throughout the world to cut pieces from human skulls and to have patients survive is equally amazing. However, believing that they were interested in or capable of creating dental implants requires more evidence than that produced from the Chantambre necropolis.

Conclusions

A total of 26 ancient dental prostheses from throughout the Mediterranean region are now known. All of these fall into 2 distinct categories: Etruscan bands and Near Eastern wires. While other variations may be possible, no conclusive evidence has been found to verify such claims. The known ancient prostheses are technologically simple to produce and are all fashioned to go around or be held in place by healthy teeth. The technology involved is quite distinct from that needed to create a true dental implant.

No evidence has been produced to substantiate claims for stone implants or wire fillings. Objects such as the rust-stained tooth discussed by Crubézy do not satisfy the primary requirements needed to conclude that they might be a true dental implant or even a variation on the known types of ancient dental prostheses.

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