

# Tooth Extraction in Antiquity

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## Abstract

Tooth extraction was probably the first dental treatment in human history, therefore a tooth forceps usually stood out as its symbol. The procedure in these early years was not easy and it posed many risks. Those extracting the teeth prepared several medicaments in order to remove them without pain or to minimize effort. In the ancient medical literature, there are a plethora of references to medicaments that were used for extracting the teeth, and although it seemed like an appealing idea, it did not offer much in painless practice. Only in cases where the pain was unbearable and any effort to relief the process with drugs failed, only then was the tooth forceps used. Just a few forceps have survived in Europe, due to the deterioration of their material used for their construction. The study of instruments that were unearthed came to the conclusion that these surgical instruments which were used not only for tooth extraction but also, for the extraction of arrows and bone fragments. However, those instruments were not anatomically

designed to adapt to the cervix of the tooth. At the same time, the steps of the extraction procedure resembled those used today. At first a sharp surgical instrument was used to separate the tooth from the soft gum tissue. Then, the tooth was grabbed with the forceps and were used in rocking movements. When the tooth was loose enough, they pulled it out using their fingers. In case that this was not possible, the final step for the extraction was done with forceps. Only doctors, usually surgeons, used the forceps. There are also references for root forceps. In Greece, three forceps have been excavated until now. The oldest is dated to the 5th century B.C.

## Introduction

Dentistry was identified in ancient times, at least informally, by a simple instrument, a kind of lever, which is used until today for tooth extraction and was known (for thousands of years), in Greek as *ὀδοντάγγρα* (= forceps for drawing teeth). A dental forceps is a special kind of lever that is modified in such a way that it holds the tooth during extraction, as the etymology of the lemma manifests. The term

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ὀδοντάγρα (Odontagra) is derived from the ancient Greek words ὀδοῦς (=tooth) and ἄγρα (= hunting, arresting). The composition of words ὀδόντος + ἄγρα identifies the name of these “medical tweezers” based upon their intended use - tooth extraction.

Besides the word ὀδοντάγρα, the term ὀδονταγωγόν is also used to describe the same instrument. It describes the medical tool that ἄγει, i.e. pulls the tooth in a certain direction. Although this term survives until today in modern Greek language, it is not mentioned in the ancient Greek literature. Furthermore, it cannot be found in any lexicographic work of antiquity. For example, the entry ὀδονταγωγόν is not found in *The Onomastikon* of Julius Pollux (fl. 2<sup>nd</sup> cen. A.D.), where he describes the medical instruments<sup>1</sup> used by the physicians in early 2<sup>nd</sup> century A.D. The first report of the term ὀδονταγωγόν is recorded by Caelius Aurelianus<sup>2</sup> (fl. 5<sup>th</sup> cen. BC) in the treatise *De morbis acutis et chronicis*, which is the Latin translation of the ancient Greek medical treatise *Περὶ τῶν ὀξέων καὶ χρονίων παθῶν* (*On Acute Chronic Diseases*) of Soranus of Ephesus. The paradox is that Soranus of Ephesus in the survived extracts from his works, exclusively uses the term ὀδοντάγρα, which imparts similar use with ὀστάγρα, forceps for extracting splinters of bone<sup>3</sup>.

The remarkable survival of both terms until today has special semantic value as the dental profession was identified, even after the appearance of Pierre Fauchard, by its main dental practice i.e. by tooth forceps and tooth extraction. Tooth forceps in the passage of years has established itself as an informal symbol of dentists. Saint Apollonia, the Alexandrian Christian martyr of the 3<sup>rd</sup> century A.D., who, in the Western world, is considered patroness of dentists as well as of patients who suffer from their teeth is always depicted holding in her right hand forceps grabbing a tooth.

It remains unknown when tooth forceps were coined as a medical device for extracting teeth. Clearly, the inspiration should have been the formation of “tweezers” between the thumb and the forefinger, during tooth extraction with fingers. It is an ancient technique for tooth extraction which is confirmed as a practice in representations of vessels, like the one excavated in a Scythian Tomb in Kul-Oba, Crimea, southern Russia, dating from the



Book of Hours, Cambridge, Fitzwilliam Museum, 119,15th c., fol. 212r

4<sup>th</sup> century B.C. Today, it is kept in the Hermitage Museum at St. Petersburg, Russia.

However, as it is expected, the invention of forceps is attributed to the deity Asclepius. According to Marcus Tullius Cicero (106 BC – 43 BC) in his treatise *De natura deorum* (*On the Nature of the Gods*), and also as mentioned later by the Byzantine dignitary Joannes Laurentius Lydus (490 A.D. – 578 A.D.) in the treatise *Περὶ τῶν μηνῶν* (*On months*), the inventor of dental forceps is Asclepius the third<sup>4</sup>, who lived, as estimated<sup>5</sup>, on the 13<sup>th</sup> century B.C. He was the son of Arsinoe, the local deity of the Peloponnese, daughter of Lefkippos the King of Messinia and mother of Asclepius by Apollo. However, the two authors display a different genealogy stating the couple Arsippos – Arsinoe instead of Apollo – Arsinoe. This story relates to the



### Medical views on tooth extraction

It is widespread, in both ancient Greek and Latin medical literature, that the use of forceps for tooth extraction should be reasonable and constitutes the ultimate means of treatment of dental pain. The cause of the reluctance was the fact that there lay the risk of patient's death that was associated with the tooth extraction surgery. Great doctors like Herophilos and Heraclides Tarantinos had reported cases of deaths of patients after tooth extraction using forceps<sup>9</sup>.

In the same direction are the perceptions of Erasistratos who uses the divine element to prove that extractions of the teeth should be carried out with forceps made from lead. As a construction material, lead shows little resistance strains, thus great strength cannot be applied on the tooth and hence cannot extract other teeth but only those which are ready to fall out or are mobile. Erasistratus argues, that a lead pair of dental forceps was in a prominent position in the Temple of Apollo at Delphi, in order to substantiate his view that only teeth which require removal with nothing more than simple pulling with lead forceps had to be extracted. However, despite the tightly restricted use of forceps, even those of lead ones, the physician Erasistratus leaves the doctor the freedom to remove the aching tooth in case that it is hurting the healthy teeth<sup>10</sup>. Similar views are delivered in Latin medical works, as for example by Caelius Aurelianus who in his work *On Acute Chronich Diseases* reveals that in his time there were doctors who hesitated to remove teeth even if there was a particularly acute pain and every other treatment had already failed<sup>11</sup>. Aulus Cornelios Celsus (fl. 1 AD) in his treatise *De medicina*, which contains the fullest description of both the tooth extraction process as well as possible complications that may occur, is cautious in using forceps. His perceptions are the same as those of other doctors. He considers that a tooth extraction should be carried out in two cases: a) when the classic pharmaceutical preparations for the treatment of dental pain fail and any other treatment regimen may not bring relief for the patient<sup>12</sup> and b) in children during the eruption of the permanent dentition when a primary tooth has



Detail of a Scythian vase, Guerini V. 1909, pg. 47 fig.7

second burial site of Asklepios in Arcadia and is found in later writers connecting only the name of Arsinoe to the myth of Asclepius<sup>6</sup>. Perhaps, there is a confusion between a local hero who acted in 1200 B.C. and the God<sup>7</sup>. From one side, the unknown Arsippos appears as the father of Asclepius the third while from the other side, as record by Joannes Lydus, his tomb is in Arcadia and astronomers argue that he is the Ophiuchus [the constellation of the serpent], located above the Scorpio<sup>8</sup>. In any case, it seems that it is another usual episode where the actual event of the invention of a medical device is lost in the mists of time and is ultimately mythologized. The mythical dimension should be attributed, to a considerable extent, to the general perception of complications because of the use of forceps, avoiding thus the extraction of teeth using that instrument.

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not fallen out while the eruption of corresponding permanent tooth has already started<sup>13</sup>.

Scribonius Largus (fl. 1st cent. A.D.) in his pharmaceutical treatise *Compositiones Medicamentorum* (Prescriptions of Drugs) devotes a notably large chapter titled *Ad dentium dolorem* in pharmaceutical formulations associated with diseases of the mouth and the teeth. In this chapter, Scribonius Largus seemed to disagree with the view of some doctors of his time that the treatment for toothache is the extraction with forceps but claims that many other things have seem to be beneficial. He believes that there are substances with pharmacological action which relieve the dental pain to such a degree that is no longer necessary to extract the tooth. These drugs are used in washes, chewing, fumigation or they are just applied in the aching area<sup>14</sup>.

Unfortunately, there are no references to Diocles of Karystos on perceptions for tooth extraction. The view of A. Soulé<sup>15</sup> that Diocles followed the Hippocratic practice and was opposed to tooth extractions preferring pharmacotherapies is not documented by Diocles extant work. Diocles' surviving drug recipes refer exclusively to the treatment of dental pain<sup>16</sup> and contain no ingredients like cedar gum and saffron, as incorrectly logs Soulé.

### Tooth extraction with fingers

In case the conservative treatment failed to control the dental problem then therapeutic techniques were preferred that could contribute to the removal of the tooth by hand rather than with dental forceps. The extraction by fingers was a very common practice throughout human history and survives until today, even in the Western world, in the case of deciduous teeth.

Especially in countries like China and Japan, there are reports that this practice was used with skills for thousands of years. In ancient China, according to descriptions, the removal of a tooth was performed with the index finger and the thumb of the hand (right or left) depending on the side that the tooth to be extracted was located. The extraction by fingers was performed by experienced “dentists”, who were trained for 5 to 6 years, for several hours a day, in a carpentry workshop removing nails

from boards. Over time, the education became increasingly rigorous and demanding, extracting larger nails at first from simple boards, then more reinforced boards and finally nails from extremely durable tables. At the end of the apprenticeship, the candidate had to be able to extract iron nails and this constituted the necessary certification to gain the title of “dentist<sup>17</sup>”.

In western dental tradition we do not find such form of specialization. However, it is a prime example of ancient concepts around the globe on the bias and avoidance of the use of odontogras for tooth extraction. In return, a large volume of complex pharmaceutical formulations was developed with the purpose to make easy the extraction of teeth.

### Pharmaceutical tooth extraction

The first recordings of medicines for the purpose of extracting teeth are found in Pedanius Dioscorides (fl. 1st cen. AD). In his work *Περὶ ὕλης ἰατρικῆς* (On Medical Material), for example, he refers to ἀμόργη (amorgi), a common sediment from compressed olives. Amorgi is boiled with juice of unripe grapes until the texture resembles the honey one, then it is brushed around the worn teeth. After that it is possible to remove them<sup>18</sup>. The same happens if the Stinger of the Marine Turtle Dove, which Celsus<sup>19</sup> calls *Pastinaca*, is used. This is the common stingray (*Dasyatis pastinaca*). According to Dioscorides the Stinger soothes the dental pain because it splints the tooth, and this falls out<sup>20</sup>.

In Dioscorides unguine treatise<sup>21</sup> *Περὶ ἀπλῶν φαρμάκων* or *Περὶ εὐπορίστων* (On Remedies Easy to Prepare), a pharmaceuticals recipe is also recorded in which various substances are described that enable you to pull the tooth painlessly, if you have previously detached from gums all round (ἀρεῖς δὲ ἀπόνως, ἂν περιχαράξας). This could be achieved if, for example, the affected tooth is surrounded with brimstone, pyrethrum or other substances of vegetable origin<sup>22</sup>.

The same exactly recipe is reported by Galen<sup>23</sup> and, also, by Aëtius of Amida<sup>24</sup> (fl. mid-5th century to the mid-6th century). However, given the fact, that both of them were imperial doctors

they had at their disposal all of the saved (at the era they acted) pharmacy literature and consequently, in their works, they write down a large number of older drug recipes which they regarded as reliable, i.e., they had the ability to extract teeth without pain (*ἀπόνως*) and without using dental forceps. It is obvious that from the days of Dioscorides in the 1st century A.D. until at least the age of Paul of Aegina who acted in the 7th century A.D., a rich pharmacological tradition existed which provided the necessary knowledge to extract teeth with the use of the fingers, without pain and without using odontagras [dental forceps].

Typical is the case of the milky sap (the latex) of Euphorbia Peplus (Petty Spurge or Milkweed). Galen says it is a very good medicament for removing the tooth without pain<sup>25</sup>. It is noteworthy that the same milky sap is recommended both by Oribasius of Pergamon<sup>26</sup> (325-403 AD) and by Paul of Aegina<sup>27</sup> (625 – 690 AD), written in a manner almost identical. The two Byzantine doctors mixed the sap with flour, which seems to act more like excipient while the active ingredient is still *Petty Spurge*. Then the two ingredients are kneaded, and the dough obtained was placed circumferentially around the tooth, while the process was completed by placing Ivy leaves onto the dough. After an hour the dough and the leaves were removed and finally the tooth falls out without pain and without the use of forceps. Similarly, in the pseudo-Galenic treatise *Περὶ εὐπορίστων* (On Remedies Easy to Prepare) a significant number of complex pharmaceutical preparations is recorded, which are entitled according to the purpose for which they are prepared. There are recipes for *χωρὶς σιδήρου ἀπόνως ἄραι ὀδόντας*<sup>28</sup> (*pull the teeth painlessly without forceps*), *ὥστε αὐτόματον ἐκεπεσεῖν*<sup>29</sup> (*as to fall out automatically*), *ἀπόνως ἄραι ὀδόντας*<sup>30</sup> (*painlessly pull out teeth*), *ὥστε τοῖς δακτύλοις αἴρειν*<sup>31</sup> (*as to pull with fingers*). That is, medicaments designated to painless tooth extraction without using dental forceps which are called iron after the material of manufacturing, which is no longer the lead as it is confessed.

The way and style of the writing of the pseudo-Galenic treatise *Περὶ εὐπορίστων* (On remedies easy to prepare) deviates from the teachings of Galen. However, the philological research has managed to

clarify that even if the author was other than Galen, however he was someone contemporary to him<sup>32</sup>. So, we are able to know that in the middle of the 2nd century B.C. physicians were showing a clear aversion to tooth extraction with forceps.

This perception does not alter in the subsequent years. Typical is the case of Aetius of Amida who records an extensive collection of medicinal prescriptions with the title *Ὀδόντα ἄραι χωρὶς σιδήρου*<sup>33</sup> (*pull the tooth without forceps*). Aetius essentially recompiles pharmaceutical knowledge about tooth extraction without using iron, i.e. without forceps until the middle of the 6th century A.D. This painstaking effort is intended exclusively to the “elimination” of the tooth, indeed, in such a way as to *ἐκπεσεῖται αὐτομάτως* (automatically fall out).

This practice has withstood time, throughout Middle Ages, even after Guy de Chauliac rejected it, challenging directly the effectiveness of *εκρίζωτικῶν φαρμάκων*<sup>34</sup> (rooter out medicines). Although they promised a lot, they offered in essence very little to the patient for the treatment of toothache and they were clearly ineffective in tooth extraction. For example, when in dough is added lizard blood and they are molded together, it is for sure that the tooth is not going to be extracted without forceps as boasts the author of pseudo-galenic treatise *De remediis parabilibus* (On Remedies Easy to Prepare)<sup>35</sup>.

It is remarkable, however, that while it was the main practice for tooth extraction, it has not been evolved at all since the time of Galen. There has been observed the existence of a series of complex prescription medicines containing minerals such as sulfur, hydrogen sulfide, or herbal essences such as spurge (Euphorbia Peplus), or galbanum (Ferula Galbaniflua) which allegedly worked as dental rooters out. It is clear that the development and composition of such medicaments ceases in the time of Galen. Already, Galen himself just reproduces recipes with the same content, from previous pharmacologists, as for example Dioscorides, Archigenes and others, without being very keen to develop new ones.

This practice continues during the next centuries with unabated intensity. The discovery of new medicines that will offer relief in dental pain ceases. The practitioners are limited to simply



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copying drugs that contribute to tooth extraction from older pharmacological treatises. In the works of both Oribasius and Paul of Aegina only a few such recipes have survived. Aetius, in the 6th century A.D., copies word by word recipes for rooter out drugs as they are listed by Galen in the 2nd century A.D., with absolutely no evaluation of their effectiveness. Generally, Aetius shows special interest in reproducing rooters out of teeth pharmaceutical recipes from Apollonios Mys (fl. c. 30 BC), Dioscorides and Galen.

Characteristic is the almost verbatim transfer by Aetius of a recipe from the work of Galen *Περὶ συνθέσεως φαρμάκων τῶν κατὰ τόπους* (On the Composition of Drugs according to Places) of compound drugs used for extracting teeth.

Galen writes:

*εἰ δὲ μηδ' οὕτως ὑπακούει καὶ δόξειεν ἀρθῆναι τὸν ὀδόντα, ἀπόνως ἀρθεῖν φαρμάκω συμφωνοῦντι λίαν τῷδε. πύρεθρον δριμυτάτῳ ὄξει ἐφ' ἡμέρας μ'. ταριχεύσας τρίψον καὶ ἀπόθου. ἐπὶ δὲ τῆς χρείας τοὺς λοιποὺς κηρώσας καὶ ἀσφαλίσάμενος αὐτόν τε τὸν ἀλοῦντα περικαθάρας περίπλασον τῷ φαρμάκῳ, εἶτα διαστήσας ὥραν ἔκλυσον τοῖς δακτύλοις ἢ γραφείῳ ἀνάλαβε, ἢ σῶρι μετ' ὄξους δριμυτάτου ἐπὶ πολλὰς ἡμέρας κατάπλασσε, καὶ ἐκπεσεῖται<sup>36</sup>.*

While approximately 400 years later Aetius of Amida adopts in his work the teaching of Galen on tooth extraction without forceps, word by word, and says:

*Ὀδόντα ἄραι χωρὶς σιδήρου. εἰ δὲ δόξειεν ἀρθῆναι τὸν ὀδόντα, ἀπόνως ἂν ἀρθεῖν φαρμάκω συμφωνοῦντι λίαν τῷδε· πύρεθρον δριμυτάτῳ ὄξει ταριχεύσας ἡμέρας μ' τρίψον καὶ ἀπόθου· ἐπὶ δὲ τῆς χρείας τοὺς λοιποὺς κηρωτῆ ἀσφαλίσάμενος, αὐτόν τὸν ἀλοῦντα περικαθάρας περίπλασσε τῷ φαρμάκῳ, εἶτα διαστήσας ὥραν ἔκλυσον τοῖς δακτύλοις ἢ γραφείῳ ἀνάλαβε. Ἄλλο. σῶρι μετ' ὄξους δριμυτάτου ἐπὶ ἡμέρας ἱκανὰς ἐν ἡλίῳ θερινῷ λεάνας καὶ ξηράνας κατάπλασσε προπερικαθάρας καὶ ἐκπεσεῖται<sup>37</sup>.*

It is a common belief among scholars that the medicine of late Antiquity and early middle Ages, either declined or at best stagnated<sup>38</sup>. This phenomenon accentuated after Galen of Pergamum, who is the most important medical physiognomy of late Antiquity, compared only to Hippocrates. Through Galenism, his doctrines in medicine dominated for more than 1000 years<sup>39</sup>. Similar is the route followed by dentistry, as it was practiced along with medicine. This decline is characterized by a sterile clinging to the past along with extensive reproduction of medical pundits of ancient Greek literature, lack of originality and inventiveness.

### Tooth extraction with forceps

In case the attempts to extract teeth using drugs failed, the use of forceps was the only alternative. The first report<sup>40</sup> on the tooth extraction with the use of forceps is found in the Hippocratic Collection and particularly in the treatise *Περὶ ἰητροῦ* (On the Physician). This is a particularly confusing view; despite the given suspension that existed around the use of forceps, the Hippocratic author considered the whole process simple. Namely, the extraction of teeth using forceps is treated as a routine affair, which can be performed not only by students, but also by anyone (τὸν τυχόντα).

*Τὰ μὲν οὖν κατ' ἰητρεῖον ἀναγκαῖα ὄργανα, καὶ περὶ ἃ δεῖ τεχνικὸν εἶναι τὸν μανθάνοντα, ταῦτ' ἐστίν· ὀδοντάγρησι γὰρ καὶ σταφυλάγρησι χρῆσθαι τὸν τυχόντα ἐστίν· ἀπλή γὰρ ἢ χρῆσις αὐτῶν εἶναι δοκεῖ<sup>41</sup>.*

Ἱπποκράτους *Περὶ ἰητροῦ* (VI.212,18-21 L)

[These are the necessary tools in the clinic, with which the student can practice. As for the tooth forceps and the stafylagra (forceps for taking hold of the uvula), anybody can use them, because it is clear that their use is simple.]

Hippocrates, *On the Physician* (VI.212,18-21 L)

Although the view expressed is that the use of tooth forceps is almost random<sup>42</sup>, the treatise *On the Physician* belongs to the category of surgical works of the Hippocratic collection

and the writing style shows that it is aimed to someone who is already a doctor. The author's way of expression denotes that the treatise is designed to give some rules of ethics which should characterize the doctor in appearance, behavior, and particularly in the practice of the vocation. Clearly, the Hippocratic doctor, who wrote that treatise bore in mind that the reader would be a person already familiar with surgery and surgical tools, and consequently with dental forceps. As prof. Dean-Jones L. notes, it is a graduate project "written for a friend of the author, a teacher who was looking for advice on selecting and training medical students"<sup>43</sup>. So, if we accept that this is a medical work which is not intended for someone who is a beginner in medical education knows medicine and is knowledgeable in surgery, i.e. that the tooth extraction with forceps can be regarded as a routine affair for him, becomes more understandable.

On the other side, the Hippocratic author of the treatise *Περὶ Παθῶν* (On Affections) adopts the widespread perception that the corroded and mobile teeth should be removed when displaying non-manageable pain. However, in the case that they are neither damaged nor mobile although they ache, he suggests desiccation by burning<sup>44</sup>. The burning process on broken and aching teeth was applied by Galen with calcination of a special surgical tool, called *καυτήριον* (kautirion-burner) (branding iron), and its application on the suffering tooth<sup>45</sup>. The burning of the teeth must have been a fairly common practice, as Galen copies the specific technic for the treatment of dental pain from Archigenis.

As Galen of Pergamum states, the use of forceps should be confined only to the necessary cases, because he prefers the technique of pharmacological tooth removal. Tooth forceps is mentioned entirely coincidentally and are rather indifferently<sup>46</sup>.

In Western medical tradition, the most interesting descriptions of tooth extraction are found in Celsus and Paul of Aegina. On the contrary, Galen describes this process with just a phrase, without giving any value: *τοὺς δὲ*

*ὀδόντας ἔξαιροῦμεν περιχαράσσοντες*<sup>47</sup> (*we remove the teeth, detaching from gums all round*). The presentation of the extraction process in Celsus treatise *De medicina* is by far the most detailed in description and undeniably the best that has been delivered to us. Nevertheless, both descriptions exhibit the technique which is generally applied until today<sup>48</sup>.

So, according to Celsus when it was decided for a tooth to be removed, in a first step the tooth was separated from the soft tissue of the gums that surround it<sup>49,50</sup>, in order to free it, so it would be easier to pull it out. This procedure needs using sharp surgical instruments which have the capability of delamination of periodontal connective tissue. According to the author of the pseudo-Galenic treatise *Περὶ ἐνπορίστων* (On Remedies Easy to Prepare), this surgical instrument was called *περιχαράκτῆριον*<sup>51</sup> (luxator: instrument for detaching the gums before drawing teeth) and was used to cut around the gums not only in case of tooth extraction either with forceps or with fingers, but also in other cases of placement of medicaments in the gums around the tooth.

Then, the tooth, to be extracted, must "be moved" to loosen even more. There is consensus on this. Celsus says that after you cut the gums around the tooth, then you will need to "move it" (*tum is concutiendus est*)<sup>52</sup>. Similarly, Paul of Aegina believes that initially one should cut around the tooth until the alveoli and then pull it out, after we have moved it abruptly for a short period of time<sup>53</sup>. We should assume that these "concussive" displacement movements were done with the fingers rather than with tooth forceps or some other surgical instrument<sup>54</sup>.

When the tooth is loose sufficiently, then it should be pulled out with fingers, if possible. Only as the last resort one should use forceps. This advice comes from Celsus who insists on the use of forceps only as a last resort: *Tum, si fieri potest, manu; si minus, forcipe, dens excipiendus est*<sup>55</sup>.

At this point, it should be noted that Celsus uses the term *forcipe* (forceps), which shows that there was not a special term for tooth forceps in Latin and he gives a general description. Yet, it is

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a proof that in the first centuries after Christ, the Latin dental terminology was frustratingly limited, covering only basic concepts, unlike the rich Greek one<sup>56</sup>.

In the case of extracting a tooth that is decayed and presents a significant degree of corrosion, there is a serious risk to break it during the process of extraction because of the pressure applied by the tooth forceps. To avoid breakage, filling of the cavity is proposed, either with thin filaments or with soft lead<sup>57,58</sup>. The fact that filling of the cavity was required in order to remove a decayed tooth is an additional indication of the non-anatomical design of ancient tooth forceps<sup>59</sup>.

The tooth was removed by pulling it and applying force in the direction of its axis, from the alveolus to the exterior of the mouth. After the extraction, Paul of Aegina suggests the rinsing with wine or οξύκρατο (oxykrato: sour wine mixed with water) until full recovery<sup>60</sup>. Finally, if during the extraction of the tooth, one or more roots remained then they should be removed with special forceps, for which Celsus uses the Greek terminology ριζάγρες<sup>61</sup> (rizagres: root forceps).

### Tooth forceps: references and Findings

Thus far, it is obvious that important questions arise regarding the use and functionality of tooth forceps, and about the existence of forceps able to extract teeth. It is characteristic that at the beginning of the previous century, J. S. Milne doubts and says: “There is no ancient forceps, although some have looked upon the Pompeian forceps as tooth forceps<sup>62</sup>”.

Since the first decade of the 20<sup>th</sup> century until today, archaeologists brought to light a small but satisfactory sample of surgical instruments dating mainly to Roman times onwards. Alongside the study and research of ancient medical instruments flourished since the last quarter of the previous century until our days and was able to clarify several issues about them.

At first, their existence is undeniable through a plethora of references in medical treatises of ancient Greek literature. Even in the treatise Mechanical, which is included in the Aristotelian collection, we find an exact definition of tooth forceps. This treatise is a collection of problems and



Map of the areas in which dental forceps were found, dating back to the period of the Roman Empire.

their solutions in engineering matters, which has been wrongly attributed to Aristotle. There is little doubt, however, that the author knew in depth the central core of the Aristotelian tradition.

The Aristotelian author of the study of tooth forceps as a problem of engineering gives us, perhaps unwittingly, useful information not only for the accurate presentation of the perceptions of the 4<sup>th</sup> century B.C., when it is speculated that it was written, but also presents the main issue of functionality and potential manufacturing problems:

21. Διὰ τί οἱ ἰατροὶ ῥᾶον ἐξαιροῦσι τοὺς ὀδόντας προσλαμβάνοντες βάρος τὴν ὀδοντάγραν ἢ τῇ χειρὶ μόνῃ ψιλῇ; πότερον διὰ τὸ μᾶλλον ἐξολισθαίνειν διὰ τῆς χειρὸς τὸν ὀδόντα ἢ ἐκ τῆς ὀδοντάγρας; ἢ μᾶλλον ὀλισθαίνει τῆς χειρὸς ὁ σίδηρος, καὶ οὐ περιλαμβάνει αὐτὸν κύκλῳ· μαλθακὴ γὰρ οὐσα ἢ σὰρξ τῶν δακτύλων καὶ προσμένει μᾶλλον καὶ περιαρμόττει. ἀλλ' ὅτι ἢ ὀδοντάγρα δύο μοχλοὶ εἰσὶν ἀντικείμενοι, ἐν τὸ ὑπομόχλιον ἔχοντες τὴν σύναψιν τῆς θερμαστρίδος· τοῦ ῥᾶον οὖν κινῆσαι χρῶνται τῷ ὀργάνῳ πρὸς τὴν ἐξαίρεσιν. ἔστω γὰρ τῆς ὀδοντάγρας τὸ μὲν ἕτερον ἄκρον ἐφ' ᾧ τὸ Α, τὸ δὲ ἕτερον, τὸ Β, ὃ ἐξαιρεῖ· ὃ δὲ μοχλὸς ἐφ' ᾧ ΑΔΖ, ὃ δὲ ἄλλος μοχλὸς ἐφ' ᾧ ΒΓΕ, ὑπομόχλιον δὲ τὸ ΓΘΔ· ὃ δὲ ὀδὸν ἐφ' οὗ Ι σύναψις· ὃ δὲ τὸ βάρος· ἐκατέρῳ οὖν τῶν ΒΖ



καὶ ἄμα λαβὼν κινεῖ. ὅταν δὲ κινήσῃ, ἐξεῖλε  
ῥᾶον τῆ χειρὶ ἢ τῶ ὀργάνῳ.

Αριστοτέλους, Μηχανικά 854a 16-31

21. *Why doctors extract teeth more easily taking additional weight, the tooth forceps, than with empty hand [from tools]? Is it because the tooth glides easier by hand than by forceps? Or does the iron glide more than the hand and does not encircle the tooth, as the flesh of fingers is soft, clinging and adapts more. But because the tooth forceps are two levers against who have a fulcrum, the procurement of point tweezers. In order to move the tooth more easily, they use the tool for the extraction. Let's call A the one end of a tooth forceps, and the other end which makes the extraction B. Let the one lever be the AΔZ, the other the ο BΓΕ, and ΓΘΔ the fulcrum. The tooth, which is the weight, is I in the conjunction. Holding and pulling at the same time, both with B and Z. Once it is moved, it can be extracted easier by hand than by tool.*

Aristotle, Mechanics 854a 16-31

Analyzing further the description of tooth forceps, in the relevant passage of Mechanics, tooth forceps is a kind of tweezers consisting of two rigid sections connected to a hinge. In the hinge, there is a shaft that holds firmly the two arms, which are now divided into short and long arms. The short arms rotate around the axis under the influence of two competing forces that the doctor puts on long arms. Depending on the intensity of the competitive forces, the small arms apply corresponding forces on the crown of the tooth. Via appropriate “shaking” movements, the tooth is extracted.



Roman dental forceps found in 1894 in ancient Roman Castle at Saalburg, Hamburg (Guerini V., 1909 page 114, figure 33).

Finally, the loosened tooth will be removed, not by forceps, but by fingers since these have better adaptation to the crown of the tooth. It is obvious that the Aristotelian author gives us a very interesting piece of information: the ancient forceps presented spot contact, unlike the modern one that is clearly more anatomical, presenting surface contact of the short arms to the tooth surface.

We also reach this conclusion studying the tooth forceps that have been discovered so far<sup>63</sup>. It is obvious that, at least up to the Byzantine period, tooth forceps showed construction flaws, particularly in the short arms, as they were not specialized to tooth extraction.

According to the perceptions of the Peripatetic school, tooth forceps is a tool used by doctors (*ιατροί*) to extract teeth easier than with the fingers of the hand. The extraction is done not by some skilled dentist but by a doctor. Herodotus, about 100 years before *Mechanics* was written, refers to the practice of dentistry as a separate specialty in Egypt<sup>64,65</sup>. However, the dental profession throughout antiquity up to the Byzantine period does not exist. It is clear, that tooth extractions as well as the treatment of dental and oral problems were exclusive prerogative of doctors.

In literary texts we find references on the use of forceps by doctors, as for example in *Ἠθικά* (Morals) of Plutarch, and in particular *Περὶ εὐθυμίας* (On Tranquility of Mind), where the author explicitly refers to the forceps-doctor relationship. According to Plutarch, the physician during tooth extraction process using forceps should be bland and induce pleasant mood rather than the opposite<sup>66</sup>.

The study of medical treatises that refer to tooth forceps, makes it more than obvious that their use covered a wide range of extractions, which included not only teeth but also bone fragments, arrowheads etc. As a term it occurs very often along with similar medical tools designed to extract either tooth roots or bones or arrow heads. As already mentioned, Soranus of Ephesus identically uses tooth forceps or bone forceps for smashing ossicles (smashing the ossicles using tooth forceps or bone forceps)<sup>67</sup>.

In a similar way, Paul of Aegina uses tooth forceps as the bone forceps a) for crushing the skull<sup>68</sup> and b) to remove bones<sup>69</sup>. Also, tooth forceps are

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used as the root forceps not only for removing tooth roots as would be expected, but also for extraction of: i) peaks in which the spindle deprecated<sup>70</sup> and ii) stone or lead martial pellets<sup>71</sup>.

The use of tooth forceps in a variety of surgical procedures which do not relate solely to the teeth shows that its shape was not specially adapted to “grip” the crown of the tooth. Its construction shows a surgical instrument for a broader use, which is for catching and removing foreign materials and broken bones off the human body.

Another piece of information provided by the treatise *Mechanics* is the use of the terms “tooth forceps” and “iron”. This identification indicates that the material used for the construction of tooth forceps is iron. As already mentioned, these terms are used as identical by Galen who acted in the 2nd century A.D. and in Aëtius of Amida, a most famous physician of the 6th century A.D.

Galen, in a pharmaceutical recipe that deals with tooth extraction without forceps having the title without iron painless remove the teeth (*χωρίς σιδήρου ἀπόνως ἄραι ὀδόντας*), identifies the constructive metal that is iron with the tool itself<sup>72</sup>. Similarly, Aetius delivers all the techniques for tooth extraction using only drugs, without using forceps, in a treatise with the title *Ὀδόντα ἄραι χωρίς σιδήρου* (*remove tooth without iron*). In this case, also, iron is identified to tooth forceps<sup>73</sup>.

So, there is a constant medical tradition, which displays iron and not the lead as a construction material. Iron was processed using charcoal and minerals in high concentration during melting so that the final product shows steel quality. Instead the use of lead was extremely limited because it presented high flexibility.

Caelius Aurelianus reports on Erasistratos' observation that in Delphi (but not in an Asclepeion) a leaden tooth forceps was exhibited in a prominent position, aiming to show that only mobile teeth which are ripe to be swept away without too much effort should be extracted. That is a matter of concern. Even for the status of the 3rd century BC, the exhibition of a particular type of medical instrument, and more precisely, a surgical tool in a sacred place is not a serious argument about the necessity of exclusive use in specific treatment cases.

The surgical instruments that have been discovered so far are made mainly of copper or copper alloys. However, there are tools that are made entirely of iron, such as tooth forceps and lancet blades<sup>74,75</sup>.

The construction material of the medical tools was a big issue and ancient physicians gave serious thought to it. Oreibasios informs us that copper and iron were the basic materials of medical instruments. These two minerals represented the preferences of doctors, resulting in two different supporting groups. The main argument of the supporters of copper was the fact that the bronze tools were smoother and shiny, while harder to get rusty. Instead they believed that the iron tools were rough and tarnished easily. As it regards the supporters of iron medical instruments, they argued the hardness and stability of this metal. Oreibasios tends to support the category of iron with the observation that they should be lubricated continuously to avoid tarnish<sup>76</sup>.

Also, information about manufacturing surgical instruments – rare in *Corpus Galenicum* – are included in the treatise of Galen *Περὶ Ἀλυσίας* (*On the Avoidance of Distress*), that was discovered unexpectedly on 2010, in Vlatadon Monastery manuscript No 14. Galen reveals that he himself designed the surgical instruments and made the wax models which were then casted by craftsmen on his account. We see, then, the deep interest of doctors about the shape and the material of their tools.

τὰ μὲν εἰς τὰς ἰατρικὰς ἐπιτήδεια χρεῖας <ᾱ> μὲν οὖν ἔφην ἀπολέσας, ἄλλα κτήσασθαι ἔτι ἐλπίζει<ν>, τὰ δὲ ὑπ' ἐμοῦ [χρήματα] προσευρημένα [τῶν ἀρμένων], ὧν τὰ ὑποδείγματα πλάτ<τ>ων αὐτὸς ἐκ κηροῦ τοῖς χαλκεῦσιν ἐδίδουν, ὡς οὐκ ἔτ' οἶον τε σχεῖν ἄνευ χρόνου πο<λ>λοῦ καὶ ἀσχολίας μεγάλης<sup>77</sup>.

Γαληνοῦ, Περὶ Ἀλυσίας (3,9-14)

All these that I need for (practicing) medicine which I lost, but I hope I will get them again, these instruments that I had invented, designing the wax models myself and giving them to the blacksmiths, that it was no longer possible to have them without dedicating a lot of time and hard work.

Galen, *On the Avoidance of Distress* (3,9-14)

Regarding the craftsmen who manufactured medical tools such as forceps, one should consider that they were competent enough, as this kind of tools requires considerable skill, delicacy and perfection of construction. Probably, they were themselves artisans who manufactured several other art objects as well.

Finally, the hitherto discovered forceps, particularly those discovered in Greece, don't show evidence of decorative coatings with noble metals. That was a habit that is mentioned by Lucian of Samosata (c. 125 – 180 ad) but doesn't seem to be confirmed. However, interestingly he criticized the habit of some doctors to confuse low level of knowledge with highly intricate decorated medical tools, used to impress the patient. Lucian recommended that one should visit someone physician, whose tools although rusted are well sharpened<sup>78</sup>.

### **Dental Forceps Discovered in Greece**

Until today, three dental forceps have been discovered in Kallion, Dion and Pydna. This number is very likely not to reflect reality. According to the excavators, the forceps in Pydna, as archaeological finding, it is rare but not uncommon. The Pydna findings remain still unpublished. However, it should be noted that for the purposes of this research project, the cooperation and contribution of all relevant archaeological institutions and archaeologists were more than touching, though the archaeological findings are yet unpublished.

The reason behind the scarcity of excavated forceps is their construction material which is mainly iron. Iron is corroded and destroyed easily over time. It is no coincidence that there are no reports of the discovery of any forceps from the classical era or the Hellenistic period throughout Europe, except in Pydna. All the other forceps surviving until today date to the Roman era and after that. Therefore it should be considered as erroneous the view of M. Ring<sup>79</sup> that in many excavations in Greece dental forceps made of iron have been discovered as he was not aware of the existence of those that have been discovered so far and such generalizations are not permitted.

At the same time, we should expect new discoveries at the cradle of medicine where the first

steps of rational dentistry are made. It is more than likely that the Greek Earth keeps many surprises.

Finally, it should be noted that all the three forceps were not found as a separate medical tool, but as part of a collection of medical instruments. This is not surprising as in Greece there is no evidence for the practice of dentistry as an independent art as in Rome and Egypt. On the contrary, in antiquity it was a customary phenomenon doctors who were specialized in bone surgery to perform dental procedures. Furthermore, teeth were considered as bones.

### **The tooth forceps of Kallion**

The best-preserved tooth forceps which has been discovered in Greece comes from the excavations of Kallion and is dated to the 3rd century A.D. Archaeological research, carried out in 1970 under the supervision of archaeologist B. Petrakos, unearthed public buildings, residences and tombs of Roman and late-Roman years, as well as an early Christian basilica church with mosaic floors. In a hilltop, a tomb with arched roof survived that is certified as Macedonian type, whose construction should be estimated either in 317 BC when the Macedonians conquered Aetolia or in the 210 BC when they occupied the area for a second time. The tomb was robbed in subsequent years but was used again as the last residence of a physician during the Roman imperial period. Among the offerings which accompanied the dead, there were found a collection of surgical instruments along with coins, the vast majority of which is dated in 266/267 A.D. when Gallienus was Emperor of Rome (253-268 AD)<sup>80</sup>. The findings belong to the Museum Collection of Lidoriki and are kept temporarily in the Archaeological Museum of Amfissa.

The medical collection of Kallion consists of eight surgical tools which are preserved in quite good condition. The collection includes a pair of tooth forceps, two needles, two knives and three chisels.

Our interest is focused on the rare finding of forceps which did not receive the necessary attention when they were discovered. Then they were poorly recorded as scissors. It is made of iron and consists of two handles which are fitted with a



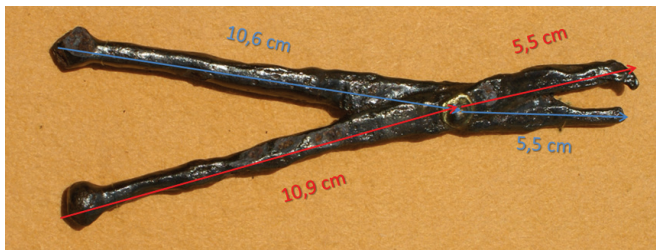
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brass joint. In the present condition the joint is not functioning, due to oxidation, and the small parts of the head (beaks) cannot come close together. These two handles are slightly uneven because the long parts display a difference of 3 mm in length (10.6 and 10.9 cm respectively). Instead, the parts of the head show the same length at 5.5 cm. Thus, the total length of the forceps is approximately 16 centimeters. This size is reasonable and does not refrain from the size of modern tools.

Due to the deterioration of the construction material the endpoints of the head cannot be evaluated, although they seem to be curvy. Finally, the slight bending of the head arms, shortly after the joint, is interesting as it gives greater functionality for dental use.



The iron dental forceps of Kallion. Note the bending of the beaks just next to the hinge which provide better access for dental use.



Measurements of the Kallion dental forceps.



Measurements of the beaks (Kallion dental forceps).

## The tooth forceps of Dion

This tooth forceps dates to the 3rd century A.D. Bibliographic data are extremely limited and the study of this case is difficult. It was discovered in Dion which is located south of Katerini, on the northeastern outskirts of Olympus in Pieria. Dion is one of the most famous Macedonian cities having particular strategic but also religious significance. The strategic importance lies in the fact that it stands at the entrance of Macedonia from Thessaly. At the same time Dion was the Holy City where the Macedonians worshipped the Olympian gods and particularly Jupiter.

The tooth forceps were discovered in the embankment of the House of Euvoulos in the Northwest sector of the market square of Dion. The House of Euvoulos, is a conventional name of the older area of the lane of Road A of Dion. It was discovered along with a small number of medical instruments in a space which was probably a manufacturing laboratory. Today all the medical instruments unearthed from that area are kept in the Archaeological Museum of Dion. The tooth forceps have the catalog entry number M.Δ. 1267.



It belongs to the classical typology of Roman tooth forceps in respect to the morphology of the arms and the spherical endings. According to the excavator archaeologist it dates back to the 3rd century A.D. It is made of iron and has a total length of 18.7 cm. It is intensely oxidized and weathered, compared with the forceps of Kallion which dates approximately the same period. Finally, the short arms (beaks) of Dion forceps have curved serifs that come close while the long arms have approximately spherical endings<sup>81</sup>.

### The tooth forceps of Pydna

Ancient Pydna is in Northern Pieria. It is a city, which played an important role in the history of Macedonia because of its port and its strategic location. In the mid-4th century B.C., Philip II occupies Pydna. His wife Olympiad fled to Pydna in 317/316 and there she was executed by Kassandros.

At the southern Cemetery of Pydna a unique and undisturbed grave was found which belonged to a physician. The deceased was placed on a wooden bed and among other offerings a gold Stater Phillipos II, a bronze coin Alexander III, as well as a set of medical instruments and among them a pair of tooth forceps were found. De facto it is the most important ancient tooth forceps of special historical value as it is the oldest which has been discovered in Europe.



The medical instruments found in Pydna. First from the left, the oldest forceps in Europe.

The tooth forceps of Pydna is made of iron with short and long arms strongly oxidized and corroded. The short arms (beaks), based on the available images, are straight without any distinguishing features. The long arms end in hooks, both focused in the same direction. Because of the corrosion it is in the open position. The angles formed strongly indicate that the beaks were able to come close. This tooth forceps do not display similarities with Diocles' *κναθίσκος* (spoon-shaped probe) as described by Celsus. That probe was used solely to extract deep and wedged darts. So, its morphology resembled a gripper which consisted of two spoons that bore a hole within which the arrow was arrested<sup>82</sup>.

It should be stressed out that the burial of the doctor happened during the reign of Alexander the Great as estimated according to the offerings. Dr. Besios, the excavator archaeologist, believes this set of medical instruments is unique. It is the oldest Macedonian doctor's grave dating to the second half of the 4th century B.C.<sup>83</sup>.

### The tooth forceps of Athens

Maybe, the most famous tooth forceps of antiquity are the ones of Athens. It is exhibited in the National Archaeological Museum of Athens, but it does not meet the conditions to qualify as a tooth or tooth roots extraction tool. Dating of it is impossible as it comes from a private collection. The observation of L. Dude that it is a medical instrument of alexandrine period is unfounded as it relies on the work *Geschichte der Zahnheilkunde* of Sudhoff, though a careful study of this work does not reveal such information<sup>84</sup>.



Collection of the medical instruments in Athens Archaeological Museum

In the Museum's showcase the exhibit L332 is referred to as tooth forceps or root forceps in Greek and curiously only as "forceps" in the English translation. Unfortunately, the available data is not adequate, neither for dating it nor, even more, for the documentation of its use and hence the name of the exhibit as tooth forceps.

Guerini publishes a picture of this medical tool in his work *History of Dentistry* in 1909. Uncritically, he accepts that it is a tooth forceps.

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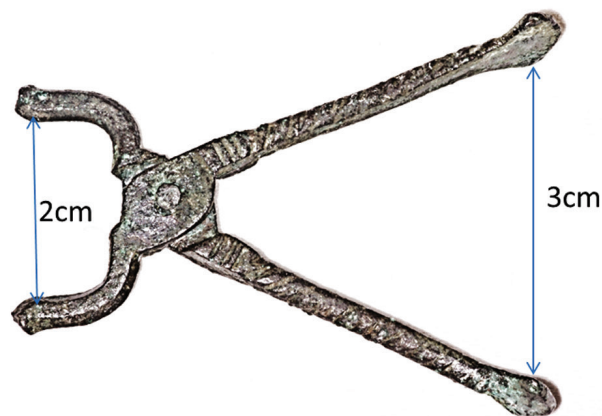
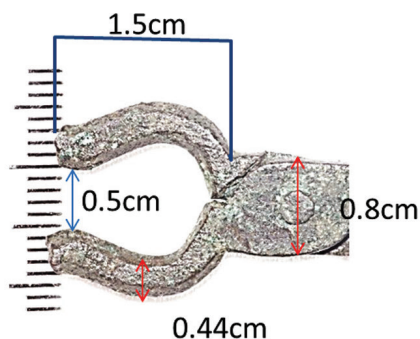
Medical instrument A 332 presented as tooth forceps.

There is no analysis in the text or any documentation of how the author came to this conclusion. Simply, the image caption says that it is a very ancient tooth forceps and nothing more<sup>85</sup>.

Later, in 1921, Sudhoff reproduces the same information that this is tooth forceps, in his work *Geschichte der Zahnheilkunde*<sup>86</sup>. In fact, the reproduction is done in completely identical manner: an image of “forceps” that it is located in the Archaeological Museum of Athens. The most bizarre and inexplicable fact is how Guerini in 1909 and then Sudhoff in 1921 apparently visiting the Museum of Athens (evidenced by the different shots



The most famous ancient tooth forceps is not a tooth forceps.



Detailed measurements of the A 332 medical instrument of the Athens archaeological museum are not in support of the characterization as tooth forceps or root forceps.

of the same medical tool) indicate the medical tool as the tooth forceps, while the official designation of the Museum is unclear after denoted as the tooth forceps or root forceps. The classification is incomplete as tooth forceps and root forceps have different design and use.

The construction material is a copper alloy. The overall length is just 6.8 cm, while the small



arms have a length of 2 cm from the joint. The opening of the head when the strands are in the closest position is 0.5 cm. Because of too small size we should exclude its use as forceps and even more as root forceps, a point on which, Dube also agrees<sup>87</sup>. It is doubtful whether it can be used for the capture and removal of any tooth or tooth root. Probably it should be considered to have exactly the opposite function as a spreader.

### Conclusions

Tooth extraction was the main oral surgical operation in antiquity. Tooth forceps were used as a last mean to treat toothache.

A remarkable pharmacological tradition had been developed for the treatment of oral diseases. It reached the zenith during the 1<sup>st</sup> and 2<sup>nd</sup> century of the Christian era. Medicaments were evolved in such a degree that they were so effective that teeth were extracted with the fingers without using any instrument. Dental forceps, besides their use for tooth extraction, were also used to remove bones fragments or other foreign objects from the human body.

As forceps were used for general purposes, they were not developed in such a degree that they could adapt very well to the tooth crevice. The adaptation was only on point but not on surface area like the contemporary anatomical forceps. Tooth extraction was performed by doctors; there is not enough evidence on specialized dental practitioners except for the cities of Alexandria and Rome.

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