

Orthodontics in antiquity: myth or reality

R. J. Forshaw¹

In brief

Reviews the origins and history of orthodontic treatment in antiquity.

Examines the evidence put forward by some authors to suggest that ancient orthodontic appliances were in use some 2,500 years ago.

Concludes that abnormalities of tooth position were recognised in antiquity but only very basic treatment was provided.

Malocclusion, although a common finding in today's world, appears to have been less frequent in antiquity. There are references to overcrowding, delayed exfoliation of deciduous teeth and basic orthodontic treatment in the writings of classical authors such as Hippocrates, Celsus and Galen. However, early authentic archaeological finds of dental appliances are extremely rare. Considerable attention has focussed on gold banded devices excavated from ancient Etruscan sites in central Italy which have been dated to around the seventh to the fourth centuries BC, with a number of authors suggesting an orthodontic function for these appliances. This paper reviews the evidence for the possible treatment of malocclusions in antiquity and concludes that the use of orthodontic appliances to facilitate tooth movement is not supported by the available evidence.

Introduction

Malocclusion, and dental crowding in particular, is today a fairly frequent anomaly with estimates of population prevalence ranging between 30–60%,^{1–4} although certain American studies report frequencies even higher at 70–80%.^{5,6} From antiquity, well preserved skulls are rare and so evidence for this condition is not readily available. However, Weinberger⁷ indicated that Neanderthal man of 50,000–60,000 years ago had abnormalities in position and irregularities of the teeth, as well as supernumerary, retained, unerupted and impacted teeth. Similarly, Begg⁸ commented on the low incidence of tooth irregularity and crowding in prehistoric man. Andrik⁹ considered that in the Palaeolithic period dental crowding was a rare condition and in a study of a Bronze Age population he noted a prevalence of 1%. Sarig *et al.*¹⁰ investigated a malocclusion in a well preserved Middle Palaeolithic skull (Qafzeh 9).

Coruccini and Pacciani¹¹ correlate this increased incidence of malocclusion in modern populations with a change from an ancient to a modern diet. They suggest that malocclusion arises from a lack of chewing stress associated with the modern processed diet. This lack of functional stimulation has reduced jaw growth and increased the incidence of occlusal variation.

Textual sources

In the modern world orthodontic treatment is sophisticated and fairly readily available, but what treatment if any was available to our distant ancestors? There is certain evidence to suggest that consideration was given to the eruption of the permanent teeth and their positioning in the dental arch. In addition, some rudimentary treatment was provided for malocclusions.

The earliest recorded commentary on dental crowding is that of Hippocrates (c. 460–370 BC), one of the outstanding figures in the history of medicine. Hippocrates established a school for physicians on the island of Cos and taught rational medicine based on accumulated knowledge. From this school originated the *Hippocratic Corpus*, a collection of approximately 60 manuscripts, some of whom were authored by Hippocrates, but many by his associates and contemporary scholars in later years.^{12,13}

In these medical texts there is not one particular chapter relating to teeth, but there are a number of references to teeth and the tissues of the jaw. Within a case history relating to epidemic diseases, a tooth numbering system is described which in principle is similar to the one in use today (*Epidemics IV* 19. 5, translated Smith).¹⁴ In the book *Fleshes* (12–13, translated Potter)¹⁵ there is a discussion on the formation of teeth as well as the eruption and exfoliation of deciduous teeth and replacement by their permanent successors. Whilst in *Epidemics* (VI I, 2–3, translated Smith)¹⁴ there is this first description of a malocclusion:

‘Among those individuals whose heads are long-shaped, some have thick necks, strong members and bones; others have strongly arched palates; thus teeth are disposed to irregularity, crowding one on the other...’

Perhaps the earliest reference to basic orthodontic treatment is to be found in *De Medicina*, a first century AD medical treatise by Aulus Cornelius Celsus (c. 25 BC – AD 50), a Roman encyclopaedist and influential medical author. He recommends the extraction of a deciduous tooth when its permanent successor is erupting before normal exfoliation:

‘In children too if a second tooth is growing up before the first one has fallen out, the tooth which ought to come out must be freed all round and extracted; the tooth which has grown up in

¹Research Associate, KNH Centre for Biomedical Egyptology, Faculty of Life Sciences, The University of Manchester/ Dental Surgeon
Correspondence to: Roger Forshaw
Email: Roger.Forshaw@manchester.ac.uk

Refereed Paper. Accepted 20 June 2016
DOI: 10.1038/sj.bdj.2016.564
©British Dental Journal 2016; 221: 137–140



Fig. 1 Portrait of Galen, bust by J. Faber, after a drawing by P. P. Rubens, from an antique marble bust. Reproduced from the Wellcome Library, London, licenced under CC-BY 4.0 licence

place of the former one is to be pressed upwards with a finger every day until it has reached its proper height. And whenever after extraction, a root has been left behind, this too must be at once removed by the forceps made for the purpose which the Greeks call *rhizagra*' (*Celsus VII, 12, 1 F*, translated Spencer).¹⁶

Galen of Pergamon, (c. AD 130 – 210) a prominent Greek physician, writer and philosopher, became a celebrated physician in the Roman Empire and his theories dominated Western medical thinking for centuries after his death (Fig. 1). Galen discussed dentistry primarily in his pharmacological works and he suggested that teeth protruding from the normal row should be carefully shortened, using a small iron file, a method that remained in practice until modern times. Galen recommended that if this procedure was painful then it should be spread over several sittings (*Galen De Comp. Medicam. sec. loc. 5, 5, XII*, translated Kühn).¹⁷

There are many other textual references to teeth in antiquity such as in the Ebers, Kahun, Berlin, Hearst and Edwin Smith medical papyri of the ancient Egyptians, the earliest of these dating to around 1800 BC.¹⁸ Cuneiform tablets from ancient Assyria dated to about 1000 BC, but purported to be copies of older works, discuss teeth and dental care.¹⁹ There are references to teeth and dental problems in both the Bible and the Talamud.²⁰ In addition, other ancient philosophers and writers such as Aristotle, Claudius Scribonius Largus, Pliny the Elder and Marcus Valerius Martialis (Martial) included references to teeth and

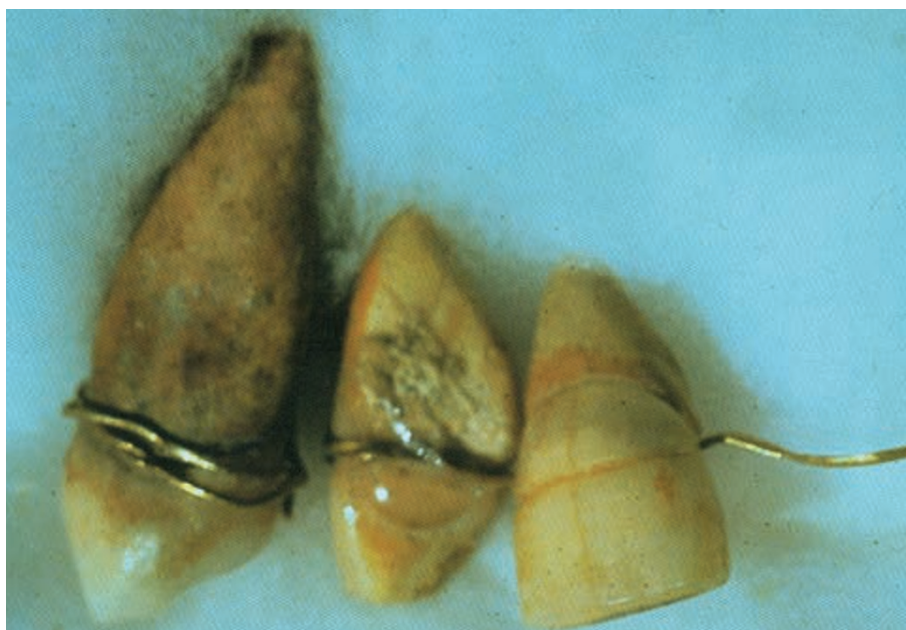


Fig. 2 'El-Quatta bridge' Courtesy of ©Egyptian Museum, Cairo

dental problems within their treatises. The use of gold associated with the prosthetic replacement of teeth is discussed in some of these ancient texts, but little in the way of malocclusion or any form of basic orthodontic treatment is referred to.

Archaeological specimens

Other than textual sources is there any evidence of actual surviving orthodontic appliances from antiquity? A few ancient Egyptian and Phoenician wire prostheses are known but these appear to be aimed at tooth replacement. A typical example of such an appliance was excavated from el-Quatta, in Egypt and has been dated to about 2,500 BC.

'El-Quatta bridge'

The device consists of a maxillary right canine around which a double strand of thin gold wire had been encircled finishing in a knot on its distal surface (Fig. 2). Separate from this are a central and lateral incisor connected to each other with similar gold wire, but at one time thought to have been attached to the right canine by a hook in the wire. The central incisor has a hole drilled in a mesial distal direction as well as a labial groove on the crown in order to accommodate the gold wire passing through and around the clinical crown. The lateral incisor also has gold wire wrapped around it, which rested in a prepared labial groove whilst the roots of both teeth have been artificially polished.²¹ Different

interpretations^{12,22,23} have been offered as to the function of this appliance but some type of rudimentary attempt at tooth replacement is probable. It is likely that the canine is the right abutment of a four-unit bridge with the central and lateral incisor being the pontics, and a missing left central incisor the left abutment.

Etruscan appliances

However, much interest has centred on ancient dental appliances that have been excavated from Etruscan sites in central Italy. Approximately twenty such devices can be recognised in the archaeological record, some dating back to as early as the seventh century BC. They are all considered to be of a high technical standard and an extensive collection of literature discussing them has emerged since 1885 when many of them were first discovered. These appliances are all fashioned from flat gold bands, and are either used to hold a prosthetic tooth in place or in a number of cases consist of simple bands which may have served to stabilise teeth which have become mobile, either as a result of periodontal disease or a traumatic episode.²⁴ A number of authors such as Coruccini and Pacciani,¹¹ Capasso and Di Tota,²⁵ Wahl,²⁶ and Proffit, Fields and Sarver²⁷ have speculated that some of these devices were primitive orthodontic appliances, although such comments are often based on information from secondary sources. This suggested orthodontic function has been referred to in the more popular press, and information pertaining to it is available on the World Wide

Web. However, is there a sound basis upon which to make these hypotheses?

Considerable research has been conducted into this topic and there is extensive literature describing and analysing this material.^{24,28–31} It is perhaps from these in-depth analyses that a clearer picture begins to emerge of the possible function of these appliances. However, a number of problems, particularly associated with the early descriptions of the devices, have led individual examples ‘multiplying’ in the literature and false prostheses being created through poor or erroneous observations often via inadequately searched sources.^{24,31,32} There are conflicting opinions in some of these reports and only minimal information supplied for some examples. Another difficulty is that soon after the discovery of these appliances in the later nineteenth century; copies of varying quality were constructed for display in dental hospitals and museums, some of which were later described as if they were originals, further confusing an already complicated picture.^{32,33} In addition, despite the considerable interest in this topic, archaeological data relating to most of these prostheses is surprisingly limited. It would also appear that few if any of the Etruscan appliances have been preserved together with the skull to which they originally belonged.

In general, the appliances are described as coming in a variety of shapes and sizes but all involve a long oval band, made from a strip of gold with joints created by ‘cold’ welding (hammering the surfaces together to create a direct bond). The purity of gold used in these appliances has been demonstrated in the ‘Bracciano’ appliance by Teshner-Nicola *et al.*³⁴ who analysed the metal content and determined it to be 97% pure gold. At nearly 24 carats, with



Fig. 3 Poggio Gaiella gold appliance. The gold banded appliance(s) is not original to this skull (adapted from Vogel G, Gambacorta G. *Storia della odontoiatria*. Milan: Ars Medica Antiqua 1985)

few impurities, the appliance would be relatively soft; similarly, other Etruscan appliances are judged to be of similar purity.

‘Poggio Gaiella appliance’

An example of such an Etruscan appliance, dating to approximately the fourth century BC, has been recovered from Poggio Gaiella in Italy³⁵ (Fig. 3). A number of publications refer to or describe this appliance with the most recent being that of Becker³⁶ who conducted a detailed examination and published his findings in 1996. He described the device as a single complex gold band now broken in two pieces and, again, not original to the mandible in which it is presently displayed. The banding has an average width of 3 mm, with a thickness averaging 0.14 mm and extends from the mandibular left first premolar to the mandibular right second premolar, with the left lateral incisor missing in the display mandible. It is suggested that the function of the appliance would have been to stabilise teeth which had become mobile as a result of trauma or periodontal disease, although this is difficult to confirm as the original teeth and their supporting bone have not survived. However, there is ancient textual evidence of such a function as Hippocrates (*Joints* 32. 4, translated Withington)³⁷ noted that teeth displaced or loosened through an injury to the jaw could be supported by gold or thread until they were re-established or firmly fixed in place:

‘If the teeth at the point of injury are displaced or loosened, fasten them to one another, when the bone is adjusted, not merely the two, but several, preferably with a gold wire, but failing that, with thread, till consolidation takes place.’

A similar reference to this function can be found in *Celsus* (VII, 12, translated Spencer).¹⁶ Casotti^{29,38} speculated that the two bands of this appliance had once been wired together and served as an orthodontic appliance aimed at approximating teeth, although there is no evidence of any such remaining accessory wiring.

Discussion and conclusion

Whilst the Egyptian and Phoenician devices serve to replace missing teeth, could any of these ancient Etruscan appliances have achieved an orthodontic function? One important factor is that the malleable very thin gold metal of these appliances would have been unlikely to be capable of producing sufficient force necessary to facilitate tooth movement. There is no evidence either in the ancient literature or by

examination of any of the surviving appliances for the suggestion that catgut or secondary metal components, which have now been lost, were used to facilitate tooth movement.^{11,26,39} Many of these authors who suggested this did not directly examine the appliances but relied on secondary reports and images.^{24,31}

Additionally, the ancient texts refer to cosmetic devices and to appliances that were used to stabilise mobile teeth (as described above), however, there is no reference in this literature to an orthodontic function for any of these devices. Interestingly, indications are that these Etruscan appliances were only worn by women, who are recognised as holding a relatively high status in their society, suggesting that cosmetic concerns and display of gold were considered important.^{40,41} There is no evidence for the use of these appliances by juveniles as perhaps might be anticipated if orthodontic treatment was a consideration.

A review of the evidence relating to all these ancient appliances together with an understanding of the aims and procedures of current orthodontic treatment indicates these devices did not perform an orthodontic function. It would appear that in antiquity, although abnormalities of tooth position were recognised and some very basic treatment provided, the suggestion that orthodontic appliances were used to correct malocclusions is contraindicated by the available evidence.

In the centuries following the demise of these ancient civilisations there is little evidence in the textual and archaeological record of any further devices that could be considered capable of correcting malocclusions. It is perhaps not until 1728 AD that true orthodontic treatment became available when French dentist Pierre Fauchard published a two volume manual entitled *The Surgeon Dentist: A Treatise on the Teeth*⁴² which included an entire section allocated to describing and treating malocclusions.

1. Šidlauskas A, Lopatienė K. The prevalence of malocclusion among 7–15 year-old Lithuanian schoolchildren. *Medicina (Kaunas)* 2009; **45**: 147–152.
2. Tausche E, Luck O, Harzer W. Prevalence of malocclusions in the early mixed dentition and orthodontic treatment need. *Eur J Orthod* 2004; **26**: 237–244.
3. Lew K K, Foong W C, Loh E. Malocclusion prevalence in an ethnic Chinese population. *Aust Dent J* 1993; **38**: 442–449.
4. Thilander B, Myrberg N. The prevalence of malocclusion in Swedish schoolchildren. *Scand J Dent Res* 1973; **81**: 12–21.
5. Little R M. The Irregularity Index: A quantitative score of mandibular anterior alignment. *Am J Orthod* 1975; **68**: 554–563.
6. Proffit W R, Fields Jr H W, Moray L J. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. *Int J Adult Orthodon Orthognath Surg* 1998; **13**: 97–106.

7. Weinberger B W. Historical résumé of the evolution and growth of orthodontia. *J Am Dent Assoc* 1934; **21**: 2001–2021.
8. Begg P R. Stone age man's dentition. *Am J Orthod Orofac Orthop* 1954; **40**: 517–531.
9. Andrik P. Die Entwicklung der Bißanomalien vom Neolithikum bis zur Gegenwart. *J Orofac Orthop* 1963; **24**: 12–21.
10. Sarig R, Slon V, Abbas J *et al*. Malocclusion in early anatomically modern human: A reflection on the etiology of modern dental misalignment. *PLoS ONE* 2013; **8**: e80771.
11. Coruccini R S, Pacciani E. 'Orthodontistry' and dental occlusion in Etruscans. *Angle Orthod* 1989; **59**: 61–64.
12. Hoffmann-Axthelm W. *History of Dentistry*. Chicago, Illinois: Quintessence Publishing, 1981.
13. Nutton V. *Ancient Medicine*. Abingdon, Oxon: Routledge, 2004.
14. Hippocrates and Smith W D. *Hippocrates Vol. VII*. 10 vols. Loeb Classical Library. Cambridge, MA: Harvard University Press, 1994.
15. Hippocrates and Potter P. *Hippocrates Vol. VIII*. 10 vols. Loeb Classical Library. Cambridge, MA: Harvard University Press, 1995.
16. Celsus, Aulus Cornelius and Spencer W G. *De Medicina*. 3 vols. Loeb Classical Library, 3. Cambridge, MA: Harvard University Press, 1938.
17. Galen and Kühn C G. De Compositione Medicamentorum Secundum Locum. In Kühn C G (ed) *Claudii Galeni Opera Omnia*. p 872. Leipzig: C. Knobloch, 1821–1833.
18. Forshaw R J. Dental health and disease in ancient Egypt. *Br Dent J* 2009; **206**: 421–424.
19. Paulissian R. Dental Care in Ancient Assyria and Babylonia. *JAAS* 1993; **8**: 96–116.
20. Asbell M B. Practice of dentistry among the ancient Hebrews: A contribution to the history of dentistry. *J Am Dent Assoc* 1941; **28**: 1098–1107.
21. Iskander Z, Harris J E, Farid S. Further evidence of dental prosthesis in ancient Egypt. *Ann Serv Antiq Egypte* 1979; **63**: 103–13.
22. Forshaw R J. The practice of dentistry in ancient Egypt. *Br Dent J* 2009; **206**: 481–486.
23. Ring M E. *Dentistry: An Illustrated History*. New York: Harry N. Abrahams, 1985.
24. Becker M J. Early dental appliances in the Eastern Mediterranean. *Berytus* 1995–6; **42**: 71–102.
25. Capasso L, Di Totà G. Etruscan teeth and odontology. *Dental Anthropol News* 1993; **8**: 4–7.
26. Wahl N. Orthodontics in 3 millennia. Chapter 1: Antiquity to the mid-19th century. *Am J Orthod Dentofacial Orthop* 2005; **127**: 255–259.
27. Proffit W R, Fields H W, Sarver D M. *Contemporary Orthodontics*. 5th ed. St. Louis: Elsevier Mosby, 2013.
28. Clawson D. Phoenician Dental Art. *Berytus* 1934; **1**: 23–31.
29. Casotti L. *L'Odontotecnica degli Etruschi. Rivista Italiana di Stomatologia*. 1947; **2**: 661–678.
30. Emptoz F. *La Prothèse Dentaire dans la Civilisation Etrusque*. Archéologie et Médecine: VII Rencontre Internationales d'Archéologie et d'Histoire (Antibes 1986). pp 545–560. Editions A.P.D.C.A.: Juan-les-Pins, 1987.
31. Bliquez L. Prosthetics in classical antiquity: Greek, Etruscan, and Roman prosthetics. In Haase W (ed) *Aufstieg und Niedergang der Römischen Welt Teil II: Principat* 1996; **37**: 2640–2676.
32. Waarsenburg D J. Auro dentes luncti. An inquiry into the study of the Etruscan dental prosthesis. In Gnade M (ed) *Stips Votiva, Festschrift für C M Stibbe*. pp 241–247. Amsterdam: Allard Pierson Museum of the University of Amsterdam, 1990.
33. Guerini V. *History of Dentistry: From the Most Ancient Times until the End of the Eighteenth Century*. Philadelphia and New York: Lea and Febiger, 1909.
34. Teschler-Nicola M, Kneissel M, Brandstätter F, Prossinger H. A recently discovered Etruscan dental bridgework. In Alt K W, Rösing F W, Teschler-Nicola M (ed) *Dental Anthropology Fundamentals, Limits and Prospects*. pp 57–68. Vienna and New York: Springer, 1988.
35. Menconi A, Fornaciari G. L'odontoiatria etrusca. In Vogel G, Gambacorta (ed) *Storia della Odontoiatria*. pp 88–97. Milan: Ars medica Antiqua, 1985.
36. Becker M J. An unusual Etruscan gold dental appliance from Poggio Gaiella, Italy. *Dent Anthropol News* 1996; **10**: 10–16.
37. Hippocrates and Withington E. *Hippocrates Volume III*. 10 vols. Loeb Classical Library; Cambridge, MA: Harvard University Press, 1928.
38. Casotti L. Vetulonia Etrusca e stomatologia. *Rivista Italiana di Stomatologia*. 1957; **12**: 96–112.
39. Capasso L. *L'Origine delle Malattie*. Chieti: Marino Solfanelli, 1985.
40. Rösing F W, Paul G, Schmitenhaus S. Sexing skeletons by tooth size. In Radlanski R J, Renz H (ed) *Proceedings of the 10th International Symposium on Dental Morphology*. pp 373–376. Berlin: 'M' Marketing Services, Christine und Michael Brünne, 1995.
41. Becker M J. Reconstructing the Lives of South Etruscan Women. In Rautman A E (ed) *Reading the Body; Representations and Remains in the Archaeological Record*. pp 55–67. Philadelphia: University of Pennsylvania Press, 2000.
42. Pierre Fauchard. *The Surgeon Dentist: A Treatise on the Teeth* The reference is (Paris, 1728).

Corrigendum

Practice article (*BDJ* 2012; **220**: 623–625)

Denosumab: a case of MRONJ with resolution

In the above practice article, the contributing author's name was spelt incorrectly. It was listed as 'H. Paterson' but should have been 'H. Patterson'. The authors apologise for the error.