The practice of dentistry in ancient Egypt

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IN BRIEF

- Provides an insight into the origins of the dental profession and the world's first recorded dentist.
- The dental remedies and treatments of the ancient Egyptian civilisation suggest that the sources of some of the modern therapies lay in the distant past.
- An illustration of how different interpretations of limited archaeological and skeletal evidence can provide contrasting conclusions.

This paper addresses the questions of whether a dental profession existed in ancient Egypt and if it did then considers whether these practitioners were operative dental surgeons as we know them today or whether they were pharmacists. Evidence from hieroglyphic inscriptions, from the dentitions of the surviving mummified and skeletal remains, and from ancient documents and artefacts are examined. The conclusion would suggest that operative dental treatment if it did exist at all was extremely limited. The dental treatment that appears to have been provided was mainly restricted to pharmaceutical preparations that were either applied to the gingival and mucosal tissues or used as mouthwashes, and these at best may only have provided some short term relief. It seems apparent that many ancient Egyptians suffered from widespread and painful dental disease, which the available treatments can have done relatively little to alleviate.

Was there a dedicated dental profession in ancient Egypt? Ever since two teeth connected by gold wire were discovered by the Egyptologist Hermann Junker in an Egyptian tomb in 1914, this topic has been debated by both Egyptologists and dentists alike, and even today the literature would seem to indicate that no clear consensus exists. To consider this question in detail it is probably necessary to examine the available evidence on this subject from resources such as hieroglyphic inscriptions, human remains, various medical papyri, surgical instruments, ancient writings and other miscellaneous source materials.¹

HIEROGLYPHIC INSCRIPTIONS

Translation of hieroglyphic inscriptions found in tombs and monuments throughout Egypt has been able to reveal the occupation of the dead person, which in some cases has pointed to a medical

or dental title. Of the approximately 150 persons who are recorded as being medical personnel in ancient Egypt, only nine are recognised as dentists. They appear to have been hierarchically ordered with two basic categories, 'one who is concerned with teeth' usually regarded as a dentist, and 'one who deals with teeth'. It is not certain how these two titles differ, but possibly they reflect differences in duties and status. In addition there were 'chief of dentists' and perhaps the highest dental position was that of 'chief dentist of the palace'.¹

The earliest recorded dentist not only in Egypt but in the world was Hesyre, who is evidenced from six exquisitely carved wooden panels that were found in his tomb at Saqqara near modern day Cairo, and which are generally considered to be the finest wood artefacts handed down from antiquity (Fig. 1). Hesyre, who lived about 2660 BC, was not only chief of dentists but also chief of physicians as well as holding a number of other religious and secular titles. Other dentists similarly held multiple titles such as Nyanksekhmet who was also a 'chief of physicians' and Khuwy who was not only a dentist, but 'elder of the physicians of the palace' as well as specialising in gastrointestinal

Fig. 1 Hesyre. Excavations at Saqqara – Quibell (1913)

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complaints. Whether these multiple titles indicated that the individual was engaged in several specialities or that the titles were perhaps administrative or ceremonial is unclear, but overall they do suggest a need for dental care.

HUMAN REMAINS

It is in the skeletal and mummified human remains that if any operative dental surgery did occur in ancient Egypt, then it is here that we might expect to find some conclusive confirmation. However, from the tens of thousands of remains that have been examined from the entire 3,000 year period of Dynastic Egypt the evidence is very limited. There are a few instances where a surgical approach for the treatment of dental abscesses is claimed to have been adopted; there are only three cases of possible prosthetic work, and some examples where an extraction may have occurred. Much has been made of these cases with some authors²⁻⁵ claiming, quite categorically in some cases, that this evidence proves the existence of an operative dental profession, but equally so other workers⁶⁻⁸ have doubted this.

Surgical treatment of dental abscesses was first raised by Hooton⁹ in 1917, following his visual and radiographic study of an ancient Egyptian mandible, dating to about 2,500 BC. The teeth of the mandible showed considerable wear, with the lower right first molar having a pulpal exposure and an associated apical infection. Hooton noted two small holes penetrating the outer cortical plate above the mental foramen and in the direction of the anterior root of this tooth. He claimed that due to the upward angulation of the holes, their artificial symmetrical appearance and the apparent thickness of bone they had transversed, the holes were the result of man-made drillings, affected in order to drain the pus from the apical abscess.

Breasted,¹⁰ an Egyptologist later supported this view and suggested that they could have been created by a bronze instrument in a bow drill. Certainly the bow drill was in use in ancient Egypt for carpentry and stone work, as evidenced by various wall paintings in tombs, such as that seen in the 18th Dynasty tomb of Reckmire at Luxor.

Fig. 2 'Giza bridge'. Courtesy of ©Roemer- und Pelizaeus-Museum, Hildesheim

Fig. 3 'el-Quatta Bridge'. Courtesy of ©Egyptian Museum, Cairo

However, Wingate-Todd¹¹ considered that one of Hooton's holes was an accessory mental foramen whilst the other a pathological cavity formed by the abscess. Leek¹² when examining a comparable ancient Egyptian mandible found a similar situation of tooth wear and abscess formation, also having circular holes that were extremely cleanly cut and penetrating through sound tissue. He also noted that the direction of the hole was from behind forward, a direction impossible to perform with a straight drill due to the presence of the intervening soft tissues. Such a hole could only have been drilled with a right angled drill, technology that was

not available in Dynastic Egypt. He concluded that these holes were not drilled in an operative procedure but were the result of a pathological process caused by the dissolution of bone by pus. Additionally, his examinations of large number of skulls revealed that the path an abscess takes varies and the earlier suggestion that an upward direction must implicate a surgical procedure could not be considered valid. Such canals occur frequently, in many different positions and are related to every tooth in the dentition, thus indicating that they could be the result of apical infection.

Other arguments against a surgical interpretation were put forward by

Nickol *et al.*¹³ in which they considered that for such treatment to have occurred, an awareness by the ancient Egyptians of the process and pathological anatomy of apical periodontitis would be required, which would seem unlikely. Also, that perhaps Hooton's conclusion was based on the dental techniques and understanding existing in the early part of the twentieth century. Then it was not uncommon to treat dental abscesses by a similar procedure known as 'apical airing', a practice long since discontinued.

Of the so-called 'prosthetic appliances' that have been documented from ancient Egypt, the best known example consists of a mandibular second molar connected by gold wire to a worn third molar (Fig. 2). It was discovered at Giza, near Cairo in a burial shaft dating to approximately 2,500 BC and importantly not found attached to a skull. The dental report at the time stated that judging by the colour and anatomic form of the teeth they belonged to the same individual. Additionally, as the roots of the third molar were very absorbed, due to a probable inflammatory process, the tooth had become mobile, and so in an attempt to stabilise it, it had been attached to its neighbouring tooth.¹⁴

However, Leek,^{6,15} who later examined the appliance, identified a number of problems with these conclusions. He considered that the considerable tooth wear had produced such a significant change in the morphology of the tooth, that positive identification of the position of the tooth in the dentition or indeed confirmation that the teeth belong to the same individual was not possible. Additionally, as the wear is greater on the third molar compared to the second, then it is unlikely to have come from the same individual as this tooth would have erupted some six years later. He also stated that the 0.35 mm diameter gold tubular wire would unlikely achieve even a short term result due to its insubstantial nature.

Overall the indication would seem to be that the appliance was not present during the lifetime of the individual, and a possible explanation could be that it was inserted into the mummified body in an attempt to make the body

whole for the afterlife, a practice common in ancient Egypt. Alternatively, the teeth could have been worn as an amulet, with the owner perhaps hoping that they would afford some form of power or protection.

A second appliance, similarly dated to about 2,500 BC, was excavated at el-Quatta, near Cairo and again was not found *in situ*, but retrieved from amongst the crushed bones of a skull. It was described as consisting of a maxillary right canine around which a double strand of gold wire had been encircled, finishing in a knot on its distal surface (Fig. 3). Separate from this were 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 had 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 had gold wire wrapped around it, which rested in a prepared labial groove and the roots of both teeth were scraped and polished producing an artificial morphology.³ The suggestion was that the canine was the right abutment of a four unit bridge with the central and lateral incisors being the pontics, and a missing left central incisor the left abutment. Because calculus was found on the lateral incisor and canine, it was claimed that the bridge was worn for a relatively long period of time during life.

A problem with this conclusion is that the roots of both the incisor and the lateral although slightly scraped and polished are not sufficiently gum fitted to function as a conventional bridge. As the figure indicates, pontics of this length would probably cause food trapping and mucosal irritation. Also it is questionable whether the gold connecting wire would have been sturdy enough to stabilise the teeth during the normal rigours of mastication. The presence of calculus on the roots of the teeth could indicate periodontal involvement during life with associated pocketing and gingival recession. A possibility here is that the teeth could have been accidentally dislodged from their sockets during the

mummification process, and then later reattached, or even that they were teeth that had been accidentally lost during life and then were being replaced at this time.

The third and final appliance was excavated from Tura el-Asmant, and was found attached to a skull, the only one from ancient Egypt to be found *in situ*. It was dated to the Greek (Ptolemaic) period of ancient Egypt (332-330 BC), and was described as a bridge whose single pontic was a right maxillary central incisor. It was fixed into place by a silver wire passing through two holes that had been drilled mesio-distally through the crown of the tooth, whilst the exact means of connection to the adjacent teeth is unknown. Radiographs showed no evidence of a radiolucent area above the pontic as well as a much shorter root, suggesting that the tooth had been prepared outside the body before insertion. The recontouring of the labial alveolar bone also pointed to the tooth being placed *in situ* after healing. The direction of the drill hole would probably exclude the possibility of this procedure from being carried out in the mouth.¹⁶ Blustein *et al.*⁴ pointed out that the lower central incisor was positioned more labially than the remaining lower anterior teeth, and this could therefore have resulted in trauma to the upper right central incisor, and thus may have been the reason for its loss.

This then would appear to be a true prosthetic device, and dating to the Ptolemaic period, the earliest one discovered from ancient Egypt. However, the Ptolemaic period was a time of trade and cultural exchange in the Mediterranean and because of the lack of similar finds in Egypt there is also the possibility that either the bridge was found on a foreign traveller or that this particular technique had been imported. Certainly dental work of a similar nature has been discovered in Sidon, Greece and in Etruscan cemeteries.¹⁷

It is not clear if extractions were performed in ancient Egypt since although there is considerable evidence of ante-mortem loss of teeth; many of these teeth appear to have been periodontally involved and may therefore have been removed by simple digital pressure or

displaced naturally. No ancient Egyptian instrument has ever been discovered that could be utilised for the extraction of teeth, nothing like the examples of Greek and Roman extraction forceps that have been unearthed. However, simple elevation of a tooth by means of a primitive metal lever should perhaps not be excluded from consideration, and such a lever may well have been excavated in the past but not identified as such.

However, examinations of skeletal remains have led some workers to conclude that there were cases where extractions had been performed.^{18,19} This judgement was based on a consideration of the amount of space, the inclination of the adjacent teeth, and the contouring of the intervening alveolar bone in areas where there were missing teeth. Nevertheless, there are many examples of periodontally involved teeth which could easily have been removed by finger manipulation or by means of a simple extraction procedure, but have been left *in situ*.⁸ These extractions had they been performed would undoubtedly have resulted in considerable pain relief. Why these simple extractions were not carried out seems rather strange when you consider the sophistication of the ancient Egyptian civilisation and their extensive knowledge of medicine and surgery.

INSTRUMENTS

There are probably no instruments so far excavated which can be definitely considered to have been used for dental purposes, but one difficulty in identification of any such instruments is that they were never engraved with their purpose. An example that has been suggested which may show dental instruments is a large scene inscribed on one of the walls of the temple of Kom-Ombo. Here there is what appears to be a collection of nearly 40 surgical instruments, and although different interpretations have been suggested as to their purpose, it has been pointed out that many of the items shown are contemporary to numerous well authenticated depictions of Roman and Greek surgical instruments.^{20,21} Indeed, it has been suggested that there are representations of dental forceps depicted. However, as Ghalioungui²² points out, the building relates

to the Greco-Roman era (332 BC - 394 AD) and is therefore usually considered to be related to medicine as originating from Alexandria rather than ancient Egyptian medicine.

MEDICAL PAPYRI

The medical papyri are the written records of medical procedures and treatments that have been handed down to us from ancient Egypt, and although they have to be viewed with caution they do provide us with an important source of information as regards dentistry. Of the 12 papyri which can be regarded as medical texts, four (Ebers, Kahun, Berlin and Hearst) include prescriptions for the treatment of dental problems and a fifth papyrus (Edwin Smith) provides instructions for dealing with fractures and dislocations of the mandible and maxillary regions. Only therapeutic remedies are recommended, and importantly there is no reference to any type of prosthetic, surgical or conservative form of treatment. As some of the components of the various prescriptions are unknown to us, and there are translational uncertainties in the identification of others, it is not always possible to judge the effectiveness of a particular pharmaceutical remedy.

Of the approximately 18 cases in the papyri relating to prescriptions for disorders of the teeth and oral cavity, seven are for remedies to prevent tooth loss by packing various materials in paste form around the tooth and the surrounding gums. The theory seems to have been that these would harden and serve as a temporary means of stabilising teeth that were mobile, presumably due to periodontal disease.¹ These seven remedies use words such as 'set in place', 'make strong', 'if it wants to fall to the ground' - all these wordings seem to imply a mobile tooth, and are fairly similar. An example of such a prescription is Papyrus Ebers 739:²³ *'Beginning of the remedies to consolidate a tooth; Flour of emmer seeds; ochre; honey; made into a mass; and the tooth to be fattened therewith'*.

Here the first constituent is emmer wheat, which would seem to have been used non-selectively, whereas ochres are iron oxides which have mild astringent

and antiseptic properties. Ochres were used by the Aborigines and even today are used medicinally by the Andaman tribes who live off the coast of Bengal.²⁴ Honey, which is a binding agent, is used in more Egyptian medicines than any other ingredient and because of its hypertonicity kills micro-organisms by drawing water out of them through osmosis.²⁰ Thus honey would have inhibited bacterial growth and helped reduce inflammation in infected gingival and mucosal areas.

The other prescriptions for the prevention of tooth loss are similar in their supposed mode of action and only differ in the types of material with which the teeth are packed. Examples of these being malachite and terebinth resin, both having antiseptic properties.²⁰ Therefore a number of the components do have some medicinal value and may have temporarily relieved the painful symptoms in addition to splinting the mobile teeth, but for a number of others, their function is unknown. Importantly, only the symptoms of the disease process were being treated and not the source.

The second main group of prescriptions appear to be for treating various ulcers, abscesses or gum infections. An example of such a remedy is Ebers 742:²³ *'Another, for the treatment of a tooth that is eating in the opening of the flesh: cumin; terebinth; carob; to be made into a powder and applied to the teeth'*.

It is not certain what is meant by 'eating in the opening of the flesh' although it is often considered to be a dental abscess.^{1,6} Looking at the components of the prescription, cumin is a carminative and has antiseptic and local anaesthetic properties, whilst terebinth resin as previously mentioned is an antiseptic. Carob is a stabiliser and in addition possesses astringent and demulsifying properties. Consequently, such a material would be soothing and with antiseptic and astringent properties would provide some limited relief. Other constituents used in this type of prescription are sycamore fruit, celery, gum, oil as well as a number of materials yet to be identified.²⁵

Three prescriptions deal with oral pain and among the various components used to treat the condition was willow. Willow bark contains salicin, a chemical similar

to acetylsalicylic acid, therefore having both analgesic and anti-inflammatory effects, although there is some doubt if the ancient Egyptians had discovered the true value of this plant.^{21,26}

The other remaining papyrus of dental interest, the Edwin Smith papyrus, is a well written and sophisticated example of medical literature, being the earliest known treatise dealing with surgery. This papyrus lists 48 mainly trauma cases and amongst them is one in which instructions are given for correcting a dislocated mandible. It shows a clear logical approach differing little from the method that is practiced today and importantly is the earliest description of a surgical procedure still in use.²⁷

'Instructions concerning the dislocation in his mandible: If you examine a man having a dislocation in his mandible [and] you find his mouth open [and] cannot close it for him, you should place your thumbs upon the ends of the two rami in the inside of this mouth [and] your two groups of fingers under his chin, and you should cause them to fall back so that they rest in their place.'

Also of note is that the Edwin Smith papyrus contains the first recorded use of absorbent lint made from vegetable fibre whilst splints and bandages are routinely used. It describes the use of adhesive strips in dealing with wounds, and cases of complex suturing are described in detail. It is clear from this papyrus that surgery was known, understood and practised in ancient Egypt and that some of this knowledge is still in use today.²⁷

Perhaps no discussion of medical and dental practice in ancient Egypt could be complete without considering the part that magic played in the various prescriptions in the papyri. Certainly, the ancient Egyptians were intelligent observers and discovered empirically some effective drugs and rational healing methods, but magic undoubtedly had a part to play. There are cases where the use of ritual and magical spells is suggested as a sole remedy, and in other instances 'magical' and 'rational' treatments are linked, with the two methodologies being complementary to each other.²⁸ It would seem that the majority of the dental prescriptions fitted into the

rational scenario, with many of the components having a recognised pharmacological action. However, for those where the specific component is unknown it is possible that there may have been an associated magical element. Equally so there does not appear to be any obvious reference to recited spells directed for the relief of oral problems.

ANCIENT WRITERS

Many ancient authors such as Homer, Pliny the Elder, and Herodotus described the illustrious position in which Egyptian medicine achieved in the ancient World.¹ In particular Herodotus, a Greek traveller and historian, who visited Egypt in about 440 BC, and later wrote an account of the country and its history, described specialisation in the medical profession:

*'The practice of medicine they split into separate parts, each doctor being responsible for the treatment of only one disease. There are, in consequence, innumerable doctors, some specialising in diseases of the eye, others of the head, others of the teeth, others of the stomach, and so on.'*²⁹

Whilst it may be wrong to interpret this passage with the notion that medical knowledge was so advanced in ancient Egypt that specialisation was necessary, much as occurs today in the modern world, it does nevertheless imply that some form of dental care did exist.

RELIEFS, PAINTINGS AND NON-MEDICAL TEXTS

There seems to be little mention of dental diseases among the various popular literary texts handed down to us from ancient Egypt. Also there seems to be no records of non-attendance from work due to toothache from the many details of absenteeism kept by foreman at various building sites or workers villages.³⁰ There are no depictions of the ancient Egyptians experiencing toothache or receiving dental treatment in the various surviving wall paintings, certainly nothing comparable with the Byzantine and late-medieval illustrations showing teeth being extracted.³¹

However, one Ramesside text, the papyrus Anastasi IV³² refers to a worm as being the cause of toothache. In this

text an Egyptian official describes the suffering of a fellow scribe:

'A mns-scribe is here with me, every muscle of whose face twitches, the wStt-disease has developed in his eye and the fnt-worm into his tooth. I cannot leave him to his fate.'

The worm is also referred to in the medical papyri as a disease agent, although the reference in the Anastasi IV papyrus is the only one suggesting it as being a cause of toothache.¹ However, the idea that a worm was responsible for dental disorders was widespread amongst other ancient cultures, with probably the first documented case being a Sumerian text dating to about 5,000 BC.³³ This belief continued throughout history and even as late as the eighteenth century an ivory carving of a tooth was produced showing inside it a tooth worm.³⁴

FINALLY

In the late 1960s the University of Michigan in co-operation with Alexandria University radiographed the Royal mummies in Cairo Museum. Mummies of several of the pharaohs, notably those of Amenhotep III and Ramesses II, perhaps two of the greatest Pharaohs of ancient Egypt, revealed dentitions showing extremely worn teeth, periapical abscesses and advanced periodontal disease.³⁵ The radiographs showed no evidence of any form of dental treatment, and surely if anyone was to receive oral care it would have been these powerful rulers. Certainly, if they did not then the peasants, the vast majority of society, would unlikely to have done so.

The conclusion seems to be that operative dental treatment if it did exist at all was extremely limited, and any suggestion that the ancient Egyptian dentist operated on patients routinely is not supported by the available evidence. Most of the dental treatment that appears to have been provided was restricted to pharmaceutical preparations that were either applied to the gingival and mucosal tissues or used as mouthwashes. These remedies would not have retarded the progress of the dental disease, and at best may have only provided some short term relief. It seems clear that many ancient Egyptians suffered from widespread and painful dental disease, which

the available treatments can have done relatively little to alleviate.

- Weeks K R. Ancient Egyptian dentistry. In Harris J E, Wente E F (eds). *An X-ray atlas of the royal mummies*. pp 99–121. Chicago & London: University of Chicago Press, 1980.
- Ghalioungui P. Did a dental profession exist in ancient Egypt? *Med Hist* 1971; **15**: 92–94.
- Iskander Z, Harris J E, Farid S. Further evidence of dental prosthesis in ancient Egypt. *Ann Serv Antiq Egypte* 1979; **63**: 93–122.
- Blustein Y, Stern N, Kottek S S. A case of prosthetic dentistry in ancient Egypt. *Bull Hist Dent* 1987; **35**: 120–124.
- Chohayeb A A. The dental heritage of ancient Egypt. *Bull Hist Dent* 1991; **39**: 65–69.
- Leek F F. The practice of dentistry in ancient Egypt. *J Egypt Archaeol* 1967; **53**: 51–58.
- Hoffman-Axthelm W. Is the practice of dentistry in ancient Egypt an archaeological fact? *Bull Hist Dent* 1979; **27**: 71–78.
- Miller J. *An appraisal of the skulls and dentition of ancient Egyptians, highlighting the pathology and speculating on the influence of diet and environment*. Oxford: Archaeopress, 2008.
- Hooton E A. Oral surgery in Egypt during the Old Empire. *Harv Afr Stud* 1917; **1**: 29–32.
- Breasted J H. *The Edwin Smith surgical papyrus*. 2 vols. Chicago: Chicago University Press, 1930.
- Wingate Todd T. Egyptian medicine: a critical survey of recent claims. *Am Anthropol: A New Series* 1921; **23**: 460–470.
- Leek F F. Reputed early Egyptian dental operation, an appraisal. In Brothwell D R (ed). *Diseases in antiquity*. pp 702–705 Springfield: Thomas, 1967.
- Nickol T, Germer R, Lieberenz S, Wilke W. An examination of the dental state of an Egyptian mummy by means of computer tomography: a contribution to dentistry in ancient Egypt. *Bull Hist Dent* 1995; **43**: 105–112.
- Junker H. *Giza I: Die mastabas der IV Dynastie auf des Alten Reiches*. Vienna and Leipzig: Holder-Pichler-Tempsky AG, 1929.
- Leek F F. Did a dental profession exist in ancient Egypt during the 3rd millennium BC? *Med Hist* 1972; **16**: 404–406.
- Iskander Z, Harris J E. A skull with a silver bridge to replace a central incisor. *Ann Serv Antiq Egypte* 1977; **62**: 85–90.
- Thibault A, Thibault M. L'art dentaire dans l'Égypte pharaonique. Available from: <http://www.bium.univ-paris5.fr/sfhad/vol5/art07/corps.htm>. Accessed 16 January, 2008.
- Leek F F. Dental health & disease in ancient Egypt with special reference to the Manchester mummies. In David A R (ed). *Science in Egyptology*. pp 35–42. Manchester: Manchester University Press, 1986.
- Quenouille J J. *La bouche et les dents dans l'antiquité Égyptienne*. Doctorat en chirurgie dentaire thesis, Lyon University, 1975.
- Worth Estes J. *The medical skills of ancient Egypt*. Canton, Massachusetts: Science History Publications, 1993.
- Nunn J F. *Ancient Egyptian medicine*. London: British Museum Press, 1997.
- Ghalioungui P. *The House of Life, Per Ankh: Magic and Medical Science in Ancient Egypt*, 2nd ed, rev. Amsterdam: B M Israel Boekhandel, 1973.
- Wreszinski W. *Der papyrus Ebers*. 1 Teil: Umschrift. Leipzig: Hinrichs, 1912.
- Bhargava N. Ethnobotanical studies of the tribes of Andaman and Nicobar Islands, India. *Econ Bot* 1983; **37**: 110–119.
- Sigerist H E. *A history of medicine*. Oxford: Oxford University Press, 1951.
- Manniche L. *An ancient Egyptian herbal*. London: British museum press, 1989.
- Lipton J S. Oral surgery in ancient Egypt as reflected in the Edwin Smith Papyrus. *Bull Hist Dent* 1982; **30**: 108–114.
- Ritner R K. Magic in medicine. In Redford D B (ed). *The Oxford encyclopedia of ancient Egypt*, vol 2. pp 326–329. Oxford: Oxford University Press, 2001.
- Herodotus. *The histories*. trans. De Sélincourt A. revised ed. London: Penguin, 1972.
- McDowell A.G. *Village life in ancient Egypt*. Oxford: Oxford University Press, 2001.
- Ring M E. *Dentistry an illustrated history*. New York: Harry N. Abrahams, 1985.
- Caminos R A. *Late Egyptian miscellanies*. Brown Egyptological Studies, 1. London: Oxford University Press, 1954.
- Suddick R P, Harris N O. Historical perspectives of oral biology: a Series. *Crit Rev Oral Biol Med* 1990; **1**: 135–151.
- Gerabeck W E. The tooth-worm: historical aspects of a popular medical belief. *Clin Oral Investig* 1999; **3**: 1–6.
- Harris J E, Storey A T, Ponitz, P V. Dental disease in the royal mummies. In Harris J E, Wente E F (eds). *An X-ray atlas of the royal mummies*. pp 328–345. Chicago & London: University of Chicago Press, 1980.