



## HISTORY OF MEDICINE

## The eye in antiquity

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Interest in diseases of the eyes (which were probably rampant in antiquity) is evident in early medical writings from the Middle East, India and China. Advances in ophthalmology only followed growing understanding of the anatomy of the eye during the Grecian era (5th and 4th centuries BC). The Hippocratic Corpus included the first reasonably accurate description of the structure of the eyeball (based on animal dissection) and the prognostic value of eye symptoms in clinical medicine. Aristotle was probably the first to convincingly describe the optic nerve. Human dissection, initiated by the Alexandrians in Hellenistic times, established the correct structure of the eye and the course of the optic nerves. The anatomical descriptions of Herophilus, in particular, were not improved on for 18 centuries. However, the physiology of vision largely remained a closed book, and the pathology of eye disease was not understood, with consequent haphazard treatment of abnormalities and diseases. Eye surgery for trichiasis, abscesses, growths and small tumours of the eyelids were performed and, during the 1st century AD, successful couching operations for eye cataracts were described. Demosthenes Philateles, Rufus of Ephesus, and Susruta in India made some contributions, and Galen of

Pergamon's consolidation of knowledge remained dogma up to the Renaissance.

### Pre-Grecian era

Early Chinese medicine produced significant advances in ophthalmology.<sup>1</sup> Some historians consider the productive Brahman period in Indian medicine to date back to the 6th century BC, but recent understanding places it in the Christian era. Earliest medical writings of the Vedic era, possibly from the early first millennium BC, include the Athar Veda, which deals with many illnesses, including eye diseases. The Rig Veda mentions artificial limbs, teeth and eyes.<sup>2,3</sup> Mesopotamia had a vague concept of anatomy, but the Ashurbanipal clay tablets mention many eye diseases, and considered the eyes and ears as the seats of attention in the human body. Treatment corresponded with that of Egypt. The Code of Hammurabi (1 950 BC) includes references to nonspecific surgery of the eye.<sup>1,4</sup> In Egypt, eye disease was rampant, and 3 of the 7 medical papyri (Ebers, Carlsberg and London) dealt with the topic. The Ebers papyrus contains more than 100 eye prescriptions, containing *inter alia* salts of copper, antimony and sodium, and organic materials, e.g. crocodile dung (later adopted by the Greeks). Recognised medical conditions included trachoma, trichiasis, dim vision, eye injuries and various infections. There are drawings of the eye and eye socket and, in their extensive classification of 856 bodily *metu* (vessels containing blood but also other fluids, air, spirits and mucus), blood-containing *metu* are identified in the eye (possibly referring partly to the optic nerves). Herodotus (5th century BC) recorded that Egyptian eye doctors were held in high regard, and were consulted by the Persians. In Egyptian mythology, the eye of Horus was torn out by Seth, but magically restored by Thoth, to become a symbol of healing (the *medjat* eye).<sup>4,6</sup> Suggestions that operations such as couching for cataract were performed in Chinese, Babylonian and early Egyptian times, are almost certainly unfounded.<sup>6</sup>

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### Classical Greece

#### Pre-Hippocratic era

The pre-Hippocratic philosopher-physician, Alcmaeon of Croton (5th century BC), was widely regarded as the first to examine and describe the human eye. Since his works no longer exist, all we know is from the writings of subsequent authors. Chalcidius (4th century AD) wrote that Alcmaeon

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(followed by Callisthenes, a pupil of Aristotle, and Herophilus) first dissected the eye, and described the optic nerve and the 4 tunics comprising the walls of the eyeball. It is almost certain that Alcmæon did not dissect human bodies or the eye, but he might have performed a surgical excision of a human or animal eye, and perhaps noticed the optic nerve. He declared that the sense organs are attached to the brain by ducts (*poroi*). According to Theophrastus (4th century BC), Alcmæon asserted that vision is due to a gleaming element in the eye, which contains elements of fire – a blow to the eye caused one to see a flash.<sup>6,7</sup>

Democritus of Abdera (5th century BC) said that the eyeball comprised only 1 tunic.<sup>8</sup>

### Hippocratic era (5th - 4th centuries BC)

The Hippocratic Corpus refers to the eyes in various contexts. Anatomically, it is mentioned as the origin of a fourth pair of blood vessels, which start in the head and eyes and then proceed down the neck to the body, and 2 other sets of superficial blood vessels associated with the eyes.<sup>9</sup> In *Places in Man* 2.3, the eyeball is described as comprising 3 tunics: a thick outer layer ('damage to which causes much distress'), a thinner middle layer which may protrude like a bladder when injured, and the thinnest and third layer, which is very prone to damage. Craik<sup>8</sup> could not find evidence for Galen's claim that Hippocrates (Fig. 1) described 2 tunics. Elsewhere, the pupils and transparent fluid within the eyeball are described. There is mention of blood vessels supplying the eye with moisture from the brain that is essential for vision (which might refer to the optic nerves).<sup>8</sup> In a discourse on genetics, the Corpus incidentally mentions that grey-eyed parents produce grey-eyed children.<sup>9</sup>

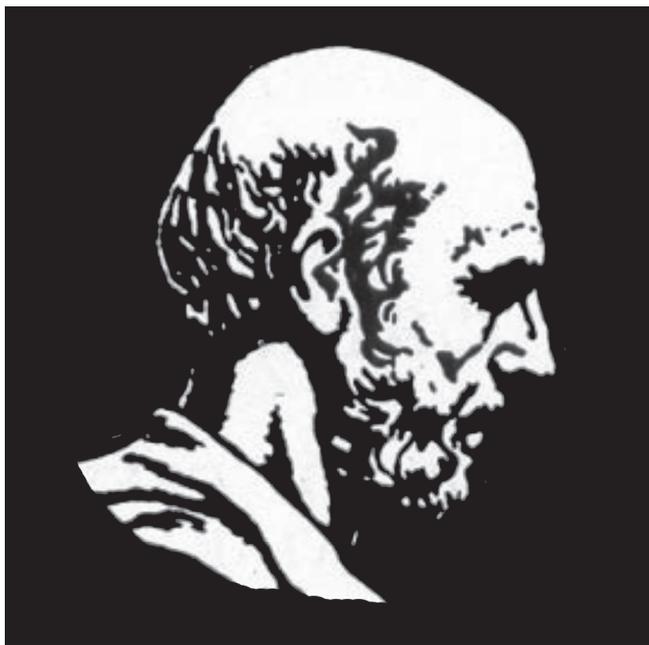


Fig. 1. Hippocrates.

The prognostic value of the eyes in clinical medicine is extensively mentioned. When the eyes, nose and lips are distorted in fever, or the eyes are blind, the prognosis is bad (*Aphorisms* iv.45). If, at the onset of acute disease, the eyes are sunken, it is a bad sign; also if on the third day they wander, weep, squint, avoid glare, are sunken or of different size. Death is imminent if the whites of the eyes are red. If the eyelids are swollen during sleep, or the whites show (and it can be determined that this is not a normal phenomenon and the patient is not taking drugs), the prognosis is bad (*Prognostic* 2). Eyes moving about rapidly in the presence of epigastric pathology, indicates insanity (*Prognostic* 7). In tuberculosis, the eyes normally sparkle (*Epidemics* iii.14), and in epilepsy they are fixed (*Sacred Disease* 10). Squinting eyes in postpartum fever (*Epidemics* III.11) and blood-shot eyes with vomiting are prognostically bad signs (*Aphorisms* vii.3).

Many eye diseases are mentioned. Very painful eyes should be treated with ordinary and vapour baths, drinking wine and certain drugs. Venesection is indicated for persistent pain.<sup>9</sup> Ointments for watery or painful eyes are described. Surgery played a minor role, but treatment for serious infection of the eyeball included incisions and, in critical cases of any eye disease, shaving of the head, incisions of the scalp and cautery. Errors of refraction were not mentioned. Strabismus, described by Hippocrates, was first mentioned in the Ebers papyrus of Egypt.<sup>1,10</sup>

On the basis of animal dissections, Aristotle (Fig. 2) described the optic nerve, considering it to be a duct connecting the eye with the membranes of the brain (Fig. 3).<sup>6</sup> Chalcidius' claim that Callisthenes, disciple of Aristotle, described the eyeball and optic nerve is probably incorrect, as Callisthenes almost certainly did not dissect humans.<sup>6</sup>

### Hellenistic era

Proper understanding of human anatomy and physiology commenced at the Alexandrian school where the human body was first dissected. Herophilus showed a special interest in vision and the eye, contributing a separate treatise, *On Eyes*. Only fragments of his written works survived, and knowledge of his contributions rests largely on quotations from later scholars such as Celsus, Rufus, Anonymous (Pseudo-Rufus), Chalcidius and Galen.<sup>6</sup> The latter mentioned Herophilus' description of the optic nerve, but not the structure of the eyeball. Herophilus apparently described 3 layers to the eyeball: an outer horny layer (comprising the cornea in front and the sclera further back), a second layer, smooth on the outside and rough inside, 'like grape skin' (iris in front, choroid behind) and a 'cobweb-like' inner layer (retina – likened to a casting net (retiform), from which the word retina originated). The thin conjunctiva was not described.<sup>6</sup> The optic nerve was called a *poros* (duct), possibly because of the ophthalmic artery occupying its centre; the origin of the nerve from the floor of the brain (Herophilus' 'centre of intelligence'), its cross-over in the optic chiasma and continuation through the skull to the



Fig. 2. Aristotle.

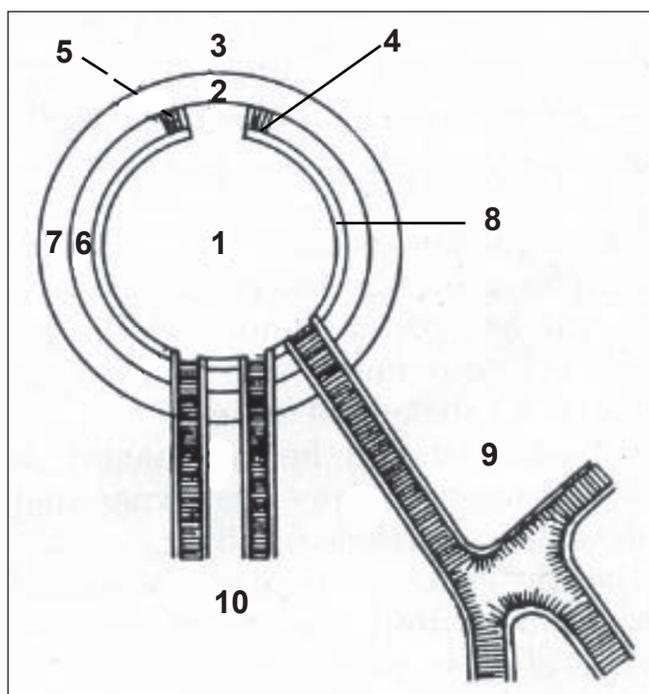


Fig. 3. The eye according to Hippocrates and Aristotle. (1) Fluid. (2) Visual spirit. (3) Pupil. (4) Iris. (5) Cornea. (6) Choroid. (7) Sclera. (8) Arachnoid. (9) Vein to the eye. (10) Optic nerves.

eyeball, was described. It was noted that although the two optic nerves originated in different parts of the brain, the eyes moved in unison. Galen wrote that Eudemus, an associate of Herophilus, also described the optic *poroi* (nerves).<sup>6</sup>

Herophilus prescribed treatments for eye diseases, such as ointments containing *inter alia* crocodile dung, hyena bile and vitriolic copper in honey and goats' milk by mouth, for day blindness.<sup>11</sup> The *Herophilus Ocularius* mentioned by the Roman, Valerius Maximus, was almost certainly by another person.<sup>6</sup> Philoxenes (3rd century BC) had a reputation as an excellent doctor of the eyes, but his writings are lost.<sup>12</sup>

### Roman era (1st century BC - 6th century AD)

Eye diseases were common and an increased awareness of them is recorded. Pliny the Younger, for example, suffered from eye problems. Eye ointments formed a major component of pharmacopoeias, but few could have been effective. The salve of Axius was popular, as was a preparation from the Lycium plant, prescribed by Scribonius Largus and used up to modern times. Sculptures showed eye problems, and still extant are stone and metal votives for eye diseases left in temples by grateful patients. *Collyria* (popular solid ointment preparations with attached stamps, indicating the content and origin) were often centrally prepared and then circulated by *circuitoires* (travelling doctors).<sup>13</sup>

Eye disease was also treated by surgery. Trachoma was endemic; trichiasis was corrected by surgical incisions of the eyelid, and needle cautery. Growths and small tumours in and around the eye were removed, and Celsus (1st century AD) (Fig. 4) gave a detailed description of a cataract operation by couching techniques.<sup>13</sup> Cataract extraction techniques might also have been used.<sup>13</sup> Kirby<sup>12</sup> suggests that Celsus (and subsequently Galen) saw cataract disease not as pathology of the lens, but as opaque aqueous concretions between the lens and iris; this view persisted through the Middle Ages.

Judging from tombstone inscriptions, *medici ocularii* were common, some as young as 19 or even 17 years. The satirical poet, Nichargus, could be severe in his criticism of these doctors, claiming that one Dion not only blinded his patient, Olympias, but even blinded a portrait of him! By the 1st century AD, recruits to the Roman army had to pass an eye test. Typhon (52 AD) failed his test (applied by 3 doctors) because of a cataract.<sup>13</sup>

Demosthenes Philateles (early 1st century AD) was the outstanding ophthalmologist of antiquity. His *Ophthalmicus* remained a standard work up to the 13th century, but no copy remains. He is said to have arranged the contents under headings of anatomy and physiology of the eye, concepts of disease with clinical detail, and therapy (drugs, ointments and surgery). His mention of an operation for cataract was the first in Greek literature, although Celsus first described



Fig. 4. Celsus.

the technique. He discussed the management of more than 40 eye diseases, and was the last recognised member of the Herophilean school, originated by the great Alexandrian, 3 centuries earlier.<sup>6</sup>

Rufus of Ephesus (at the turn of the 1st century AD) also contributed significantly to ophthalmology. His anatomical description of the eye was probably based on Herophilus' findings as well as personal practise of human dissection. Abdullah Abou-Aly<sup>14</sup> stated that Rufus' description of 4 layers to the eyeball corrects Herophilus' claim of only 3 layers. But the eyeball does in fact contain 3 tunics – as a fourth layer, Rufus added the lens. Rufus also refers to the 'perforated body' (probably the iris), the 'glass-like fluid' (vitreous humour), and the 'crystalline humour' within the lens capsule. Anonymous (Pseudo-Rufus) gives a similar anatomical description – and states that the fourth layer (the lens – 'an integument coagulation') should possibly not be called a layer.<sup>6</sup> Rufus' contribution on management of eye diseases was based on ill-understood pathology, and consolidated existing practice without adding significant contributions.<sup>14</sup>

Galen of Pergamon (2nd century AD) acknowledged Herophilus' description of the optic *poroi* (nerves), claiming that they were hollow so as to convey *pneuma* to the eye. He accepted Herophilus' description of the layers of the eye, without acknowledging its origin. Galen was the first to mention dissection of the eye muscles of animals, but did not describe his findings.<sup>15</sup> He believed that the crystalline lens was the essential organ of sight. He did not describe refractive errors of vision.<sup>1,6,12</sup> Galen's clinical ophthalmology was greatly indebted to Demosthenes, like virtually all authors of

the Christian era. As the greatest physician of Roman times, Galen's view on medicine (and ophthalmology) held sway up to the Renaissance. His books on ophthalmology *per se* no longer exist, but he included the subject in many of his other works.<sup>6,12</sup>

The very productive Brahman period of Indian Medicine (based on Vedic writings) occurred in the late 2nd century AD. Charaka was probably a contemporary of Galen, while Vaghbata lived around the 7th century, but they made no significant ophthalmological contributions. Susruta probably lived in the 4th century, was active in the field of surgery and also studied the eye. The Indian Code of Manu prohibited the touching of a corpse, thus making human dissection virtually impossible. Susruta nevertheless managed to study the human body, although knowledge of anatomy was confused. He described many eye diseases, with appropriate treatment, and clearly described a cataract operation by the couching technique. There probably had been communication between Greek and Indian medical scholars from Hellenistic times onward.<sup>2,3</sup>

In the 4th century, several prominent physicians wrote about the eye but produced little new knowledge. Vindicianus from North Africa wrote his *Liber Ophthalmicus* in Latin. It was probably largely a translation of Demosthenes' *Ophthalmicus*.<sup>6</sup> An interesting case description of a patient with excessive lacrimation, elaborated on the treatment of the day.<sup>16</sup> Oribasius based his description of the eye on Herophilus, using his nomenclature for the 'coats' of the eyeball, in *Collectiones Medicae*.<sup>6</sup> Chalcidius erroneously claimed that Alcmaeon and Callisthenes had described the structure of the eye and optic nerve before Herophilus.<sup>6</sup> As late as the 6th century, Aëtius of Amida, a Byzantine court physician, was (after 8 centuries) very likely still quoting directly from Herophilus' *On Eyes*, in accepting his eye ointments containing crocodile dung and hyena bile for blindness. Aëtius compiled one of the best complete ophthalmological treatises of antiquity. Paul of Aegina (7th century), 'last of the Greek eclectics and compilers', wrote an excellent overview of surgical treatment of the eye<sup>1</sup> – by which time the era of Graeco-Roman antiquity was over, and Europe had collapsed into the Dark Ages.

1. Albert DM, Edwards DN. *A History of Ophthalmology*. Cambridge, Mass.: Blackwell Science, 1996: 1-11, 13-28.
2. Major RH. *A History of Medicine*. Springfield, Ill.: Charles C Thomas, 1954: 65-81.
3. Porter R. *The Greatest Benefit to Mankind*. London: Harper Collins, 1997: 136-144.
4. Sigerist HE. *A History of Medicine*. Vol. I. New York: Oxford University Press, 1951: 334-491.
5. Nunn JF. *Ancient Egyptian Medicine*. Norman: University of Oklahoma Press, 2002: 45-57.
6. Von Staden H. *Herophilus*. Cambridge: Cambridge University Press, 1989: 200-255, 570-574.
7. Nutton V. *Ancient Medicine*. London and New York: Routledge, 2004: 31-48.
8. Craik EM. *Hippocrates: Places in Man*. Oxford: Clarendon Press, 1998: 25-39, 105.
9. Hippocrates. *Nature of Man, 11; Airs, Waters and Places, 14; Aphorisms vi. 31*.
10. Hirschberg J. *The History of Ophthalmology*. Bonn: Wagenborgh, 1982: 46-62.
11. Von Staden H. *Herophilus*. Cambridge: Cambridge University Press, 1994: 423-426.
12. Kirby DB. *Surgery of Cataract*. Philadelphia: JB Lippincott, 1950: 3-8.
13. Jackson R. *Doctors and Diseases in the Roman Empire*. Norman: University of Oklahoma Press, 1988: 82-130, 161-164.
14. Abou-Aly AM. *The Medical Writings of Rufus of Ephesus*. PhD thesis, University College, London, 1992: 101-110.
15. Singer C. *Galen on Anatomical Procedures*. Oxford: Oxford University Press, 1999: 104.
16. Vindicianus, *Epistula ad Valentinianum par. 8 - 10*. In: Kollesch J, Nickel D, eds *Marcellus. Uber Heilmittel*. Berlin: Akademie Verlag, 1968.