Manufacture and use of home made ophthalmoscopes: a 150th anniversary tribute to Helmholtz

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Abstract

Objective To produce a simple, effective, and inexpensive training ophthalmoscope.
Design Case study.
Setting A coffee table in a sitting room and an eye clinic.
Participants 10 friends and relatives, several patients, and a cooperative Persian cat.
Interventions Direct ophthalmoscopy with instrument made with easily available material and tools from art and office equipment shops.
Main outcome measures Efficiency, clarity of view, and price of ophthalmoscope.
Results The instrument was readily made; of the 50 manufactured two thirds gave a good view; and each cost less than £1 to make.
Conclusion The ophthalmoscope is fun to make, works well, and anyone can make one.

Introduction

As a medical student in Lahore, I wished I had my own ophthalmoscope but could not afford one. Now retired after 40 years in the NHS, I decided to try to make one.

The ophthalmoscope was invented in December 1850 by Helmholtz (fig 1).[1–3] He had neither the Leclanché dry cell battery (1867) nor Edison's electric light bulb (1881), yet he succeeded. In his original invention he looked through one side of a glass plate while light was reflected into the subject's eye from the other.

The modern ophthalmoscope is a highly sophisticated but expensive instrument. I reasoned that with modern materials it should be possible to make a simple, efficient, and inexpensive ophthalmoscope that medical students and doctors might make for themselves. A mirror made from reflecting card in one of my grandson's books showed me how I could avoid working with glass.

Fig 1 Hermann von Helmholtz (1821-94), inventor of the ophthalmoscope

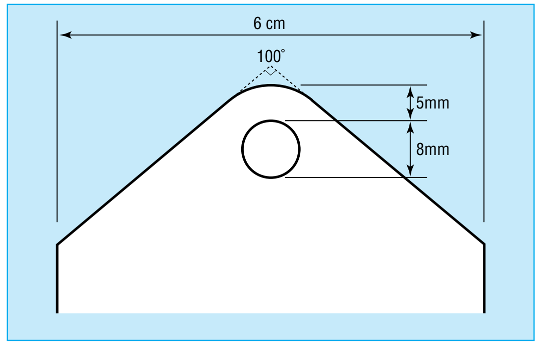

Fig 2 Design for the ophthalmoscope tube

Materials and methods

Materials—Black card of gauge 300 g/m^2, mirror card such as Mirriboard (white card with a reflecting surface on one side), adhesive tape such Sellotape, and a pen torch.

Tools—Scissors, pointed scalpel, ruler, protractor, pencil, and stencil to draw circles.

Manufacture—One end of a 14×6 cm length of black card is shaped as shown in figure 2. The card is rolled lengthways into a tube round the barrel of a pen torch and secured with adhesive tape. Its bevelled upper end is covered with an oval piece of mirror card with a 2.5 mm viewing hole just below its centre, reflecting side down. The edge of the hole, especially anteriorly, is covered by overlapping it with the edge of a 2 mm hole in a disc of black card to prevent glare.

The ophthalmoscope is now ready (fig 3). The pen torch is inserted, and light intensity is adjusted by advancing or withdrawing the torch. The instrument weights 2.6 g without the torch and 32 g with the one I used. Six pen torches (code FFE980, NHS Logistic Authority, April 2000) can be purchased for £4.35 (72.5p each). The other materials used to make one ophthalmoscope cost 2.5p. Outside the NHS pen torches cost £1.91-£3.49.

Results

I made 50 ophthalmoscopes. Two thirds of these gave a good view. I tried the ophthalmoscope on 10 relatives and friends aged 1-72 years and obtained a good view in all but one (small pupils). A consultant ophthalmologist colleague tested it in his clinic and was surprised by the clarity of the view. With him, I saw macular degeneration, retinal haemorrhage, glaucomatous cupping, etc. I then taught two non-medical people how to use it. One, a nurse, described the optic

Fig 3 Front view of ophthalmoscope. Note sight hole seen through light aperture. (Pen torch not shown)

disc as "like a sunset." Finally I saw the optic fundi of my Persian cat, Tabley. I could see the vessels and dark discs clearly against the brilliant tapetal glow of the upper fundi, and I also saw the black pigmented and rather mysterious non-tapetal lower fundi.[4] Tabley showed only curiosity.

Discussion

All countries are struggling to keep up with the soaring costs of their health services and of training medical students and doctors. This includes teaching direct ophthalmoscopy. My ophthalmoscope costs 75p ($1.13).

Charles Babbage, the British mathematician, actually invented the first ophthalmoscope in 1847, but the surgeon friend he gave it to failed to use it, and it was not reported until 1854. Helmholtz is therefore rightly credited with the invention.[5] Modern manufactured ophthalmoscopes are exquisitely intricate instruments: even the less expensive ones cost £80-£130, and their range of lenses and lights are rarely used by the non-specialist. Common problems for the novice learning to operate one include breath holding, difficulty keeping both eyes open to relax the accommodation and avoid strain, blocking the subject's gaze with the head, and difficulty aligning the view with the light beam and the subject's pupils. These difficulties can be largely ironed out by practising with my ophthalmoscope at home. My instrument would allow the beginner to study the normal fundus and appreciate its beauty before moving on to diseased fundi. I could find no reference to a similar instrument.

Of course, the instrument does have flaws. The light beam gives light and dark patches and is not polarised. The field of view is small. The absence of lenses may cause problems in some cases of ametropia, but these may be partially resolved by allowing myopic subjects to keep their glasses on and by asking hypermetropic subjects to try to focus on a near object.[6] However, this simple device should enable the user to achieve considerable skill at direct ophthalmoscopy and to prepare for advanced training. It should be taken everywhere—I carry mine in my top pocket—and it is fun at parties (fig 4).

What is already known on this topic

Most medical students and doctors do not own their own ophthalmoscopes

What this study adds

For less than £1, a home-made training ophthalmoscope can be produced that works well on most people

I thank Mr Bachittar Sandhu, consultant ophthalmologist, for trying the instrument; my family, friends, and cat for allowing me to observe their optic fundi; and Mrs Clair Daniel for typing the paper. I also thank the staff of the Lister Hospital library and the department of medical photography and illustration.

Competing interests: The instrument may be offered for manufacture in a modified form.

1 Duke-Elder WS. *Parson's diseases of the eye.* 12th ed. London: J and A Churchill, 1954:90-1.

Fig 4 A spectrum of training ophthalmoscopes. A black lining is necessary with light-coloured instruments to prevent glow. Note black glare shields

2 Feldman H. Vom Ohrenspiegel zum Augenspiegel und zurück [From otoscopy to ophthalmoscopy and back again]. *Laryngo-Rhino-Otology* 1995;74:707-17.
3 Helmholtz H. Beschreibung eines Augenspiegels zur Untersuchung der Netzhaut im lebenden Auge [Description of an eye mirror for the investigation of the retina of the living eye]. Berlin, 1851. (The original monograph could not be found by the major British libraries as it is extremely rare. Recently a copy was found in the Bascomb Palmer Eye Institute, Miami, Florida. I thank P Kelly and JEE Keunen for locating it and R Hurtes for supplying it.)
4 Jones RG, Bedford P. In: Peiffer RL, Petersen-Jones SM, eds. *Small animal ophthalmology.* 2nd ed. London: WB Saunders, 1997:51.
5 Duke-Elder WS. *Textbook of ophthalmology.* Vol 1, part 2, 2nd impression with corrections. London: Henry Kimpton, 1938:1159-60.
6 Trevor-Roper PD, Curran PV. *The eye and its disorders.* 2nd ed. Oxford: Blackwell Scientific, 1984:225-7.

Commentary: "Here's one I prepared earlier"

Nigel F Hall

At first glance, Roger Armour's instructions for making a direct ophthalmoscope seem to have more in common with one of the model building exercises so beloved of the BBC children's television programme *Blue Peter* than they do with the pages of a scientific journal. Nevertheless, I built an instrument according to his design, and with it I saw the optic discs of my 8 year old daughter in sharp focus.

Despite their appearance and cost, commercially available direct ophthalmoscopes are fundamentally simple. In essence, the instrument's light beam is directed by a mirror along the visual axis between subject and observer. The focusing power of the subject's eye is then used as a magnifying lens, enabling the observer to view the retina at close quarters.[1]

Medical students are expected to become competent at fundus examination with a direct ophthalmoscope, but most don't have their own instrument because of its high cost.[2] To acquire the skill of ophthalmoscopy requires practice. Practice comes with opportunity, and opportunity, I would suggest, comes with ownership of an instrument. At a cost of 75p, Mr Armour's ophthalmoscope is a Christmas cracker.

The challenge now is for an ophthalmologist to come up with a home made sigmoidoscope.

1 Elkington AR, Frank HJ, Greaney MJ. *Clinical optics.* 3rd ed. Oxford: Blackwell Science, 1999.
2 McNaught AI, Pearson RV. Ownership of direct ophthalmoscopes by medical students. *Med Educ* 1992;26:48-50.

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Do animals bite more during a full moon? Retrospective observational analysis

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Abstract

Objective To test the hypothesis that the incidence of animal bites increases at the time of a full moon.
Design Retrospective observational analysis.
Setting Accident and emergency department at a general hospital in an English city.
Subjects 1621 consecutive patients, irrespective of age and sex.
Main outcome measures Number of patients who attended an accident and emergency department during 1997 to 1999 after being bitten by an animal. The number of bites in each day was compared with the lunar phase in each month.
Results The incidence of animal bites rose significantly at the time of a full moon. With the period of the full moon as the reference period, the incidence rate ratio of the bites for all other periods of the lunar cycle was significantly lower ($P < 0.001$).
Conclusions The full moon is associated with a significant increase in animal bites to humans.

Introduction

The word "lunacy" is derived from Luna, the Roman goddess of the moon, and from the belief that the power of the moon can cause disorders of the mind.[1] The effect of the phases of the moon on human nature and behaviour is well documented; some studies show positive aspects of the association and some show negative aspects. Crime, crisis incidence, human aggression, human births, and traffic accidents are all positively correlated with the phases of the moon.[2–6] Some articles have suggested that the full moon has no influence on human insanity, alcohol intake, drug overdose, trauma, or the volume of patients in emergency departments.[7–11]

We are not aware, however, of any correlation between the full moon and injury to humans by animals. In ancient mythology the day of the full moon was a day for driving away misfortune and evil. We aimed to determine if any pattern exists of animal attacks on humans during a full moon.

Materials and methods

We collected data on new patients attending the accident and emergency department at Bradford Royal Infirmary during 1997 to 1999 after being bitten by an animal; the data came from the department's computer database, which records information on all new admissions.

We calculated the total number of patients in each calendar month and then distributed this number according to the days of the lunar months. We then compared the total numbers of patients on each day of

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A table showing the data supporting figure 2 is available on the BMJ's website