MODERN OPTICAL METHODS IN THE EXAMINATION OF THE EYE.*

BY

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THE older optical instruments used for examining the eye consisted of the reflecting ophthalmoscope, concave and flat mirrors, condensing lenses, and loupes of various kinds. During the past ten years Czapski's corneal microscope, combined with a somewhat inefficient electric lamp, has been employed to some extent in Continental clinics for the more minute examination of the cornea and the iris. This valuable instrument has up to the present received little attention in England.

Down to a period more or less corresponding to the end of the war our knowledge of the living eye in health and disease depended upon these optical aids. In many cases our interpretation of what we saw was largely a deductive process, and not the actual result of pure vision. Our observations were interpreted by a subsequent microscopic examination, and when the same appearance presented itself again it was explained in the light of previous experience. During the past ten years improved optical appliances have enabled us to examine an eye under vastly increased magnification and to make our diagnosis directly from the appearances without any deductive process.

The ophthalmoscope was first invented by Babbage, an English physicist, in 1847. He gave it to Wharton Jones to try, but unfortunately this ophthalmic surgeon failed to appreciate its value. This is not unnatural, for even the modern instrument is difficult to use. As a result, Helmholtz, who described and used an ophthalmoscope in 1851, has obtained the credit for the invention of the ophthalmoscope. Helmholtz's instrument has been improved to its latest form, the refracting ophthalmoscope.

During the past decade the self-lit electric ophthalmoscope has been developed and we now possess a very satisfactory instrument. The best I have used is that manufactured by Messrs. Curry and Paxton. It has a more powerful light than the majority, and I think that it is whiter in character and contains less red light. With this ophthalmoscope we get more penetration than with the reflecting model. The nerve fibres leaving the optic disc can be made out and followed for some distance over the retina. This naturally causes the edge of the optic disc to look less sharp, and till the observer becomes accustomed to the instrument it is possible to imagine that there is pathological blurring of the disc edges when in reality they are quite normal. Colour values, too, are different, and to some extent a man who for years has used the reflecting ophthalmoscope has to learn over again. It is hardly necessary to emphasize the value of a self-lit ophthalmoscope. Examinations of patients in bed, which with the old instrument took a long time and demanded a darkened room, can now be made with ease in full daylight. I am now able to examine all my patients at the desk, and dismiss many at once instead of keeping them for dark-room examination. This means that not only is much time saved, but that practically all the patients are examined with the ophthalmoscope. In all respects the self-lit ophthalmoscope seems to me to be an improvement upon the old pattern, which I now hardly use and regard as obsolete. For the physician and the general practitioner there cannot be a doubt that the modern apparatus is best; it is easy to use and it is convenient for bedside work. Students, who in time past found ophthalmoscopy most difficult and often failed to master it, are now able to see the fundus at once, and have only to learn to interpret what they see.

The latest development in ophthalmoscopy is the use of the red-free light, a method introduced by Professor Vogt of Zürich. If we look at a tenuous film of blood on the retina against the red background of the fundus, a colour due not to the blood content of the tissues but to the retinal pigment, with light rich in red, it is clear that there will be no contrast and that a thin haemorrhage will be difficult to see. With a red-free light it will show up black, and be quite obvious. The nerve fibres are seen all over the retina, and the yellow coloration of the macula is evident. For some purposes, then, examination with red-free light has advantages. It is necessary to use a micro-arc lamp with a special filter for red rays. The resulting beam of light is green, and is naturally very intense. The examination must be short and is made with the reflecting ophthalmoscope. We are installing a red-free lantern at the Warneford Hospital.

In 1910 Gullstrand invented his reflexless ophthalmoscope. A beam of light furnished by a nitra-lamp is projected into the eye and the illuminated fundus is observed with a telescopic type of eyepiece. A very high magnification can be obtained, and if the binocular eyepiece be used the fundus is seen in relief stereoscopically. A demonstration eyepiece can be added so that the instrument can be used for teaching. The surgeon can look through the telescope and the student through the demonstrating eyepiece. The ability to employ stereoscopic vision is often of great value. The ophthalmoscope is very expensive and is an institution instrument valuable chiefly for teaching.

In 1911 Gullstrand invented the slit-lamp and at once opened a new chapter in ophthalmology. Used in conjunction with Czapski's microscope, this instrument has provided an entirely new field of research—the microscopy of the living eye. The combination of the slit-lamp with the microscope we owe to Henker, and the pioneer clinical work has been ably done by Vogt and Koeppe. The slit-lamp does not in any way replace any of the older instruments and methods; it supplements them all to such an extent that first-class modern ophthalmology cannot be carried out without it. The instruments are made by Zeiss, and although costly are not in any sense dear. The minimum outfit costs £65.

The slit-lamp consists of a system of lenses which projects from a nitra-lamp a ribbon of light that can be accurately focused upon any part of the eye. The light passes through a slit which can be adjusted to supply a ribbon of light of varied width. The lamp is mounted on an arm attached to a table in such wise that the light can be projected from any desired angle. The table has a glass top in which we place the Czapski's microscope. There is a chin and head rest for the patient. The microscope is a binocular with paired objectives and eyepieces and gives stereoscopic vision. The magnification with three objectives and a series of oculars ranges from 9 to 100. The practical magnifications are 9, 25, and 35; 25 is most frequently used. With the higher powers the slightest movement on the part of the patient defeats the observer.

The slit-lamp not only enables us to employ high magnification and new methods of illumination, but it also introduces an entirely new principle—the examination of an optical *section* of the eye as far back as the first third of the vitreous. If a contact glass be placed upon the cornea which abolishes its curvature the retina can be seen, and examined with a linear magnification of 80 (Koeppe). The use of contact glasses must be regarded as research work, and not as a clinical method.

There are four methods of illumination. The light can be focused directly upon the object in the cornea, iris, lens, or vitreous—direct focal illumination. It can be directed upon the iris in such wise that it is reflected back through the cornea, which can then be examined in a negative field—dark background illumination by transmitted light. Similarly the pupillary margin of the iris can be seen by light reflected back from the lens. Another method is to examine directly in the mirror of light seen when the patient looks between the axes of the lamp and microscope. This shows up the corneal endothelium, which is seen as a mosaic of hexagonal cells. The lens shagreen caused by the epithelial cells of the lens is easily seen, and with a high magnification can be resolved up into its constituent cells. Finally, the relucency of the tissues can be used to cause an internal illumination of the structure. As an example, the light is directed upon the sclera close to the limbus and it is internally reflected along the cornea, causing it to light up internally, a phenomenon which Graves calls "sclerotic

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scatter." It is obvious that the smallest opacity or haze will be clearly visible.

When the beam is thrown into the eye obliquely it illuminates a prismatic section of the cornea and of the lens. If the ribbon of light is made very thin this is in effect an optical section. The section of the cornea magnified twenty-five times is two centimetres thick and enables opacities and alterations to be accurately localized. The anterior chamber remains dark unless the aqueous contains particles which can be clearly seen if the light and microscope are accurately focused upon them; they will be noted to move with a streaming motion, caused by the heat eddy in the anterior chamber due to the difference in temperature between the iris and cornea. The motion is accelerated by the heat of the beam of light. Whereas the presence of cellular elements is the first sign of irido-cyclitis the detection of this movement may be of great clinical significance, and may give timely warning of an impending attack of sympathetic ophthalmitis.

The lens seen in optical section shows a series of lamellae, areas of varying refractive index. Vogt divides them into the capsule, the cortex, the senile nucleus, and the embryonic nucleus. The latter corresponds to the lens in later foetal life. The ability to localize opacities in one or other of these layers has a prognostic significance, for a cataract confined to the cortex cannot be congenital, this part of the lens developing after foetal life.

The vitreous shows a framework structure which varies in different individuals; in fact, in many it appears to be optically homogeneous till examined with a slit-lamp furnished with a micro-arc lamp. It is interesting to note that the slit-lamp has shown that persistence of the hyaloid artery in rudimentary form is almost constant and is not the rarity that was supposed.

The clinical value of the slit-lamp is immense, and since I have used one at the Coventry Hospital I feel lost without it. It is obvious that an instrument which enables us to see the blood circulating in the corneal vessels, that shows up cells in the aqueous, and by means of which we can make an accurate localization of objects in the transparent media cannot be neglected much longer. The slit-lamp has for the past three years found a place in every Continental clinic, and at Zürich, under Professor Vogt, it is used for nearly every patient. It turns what at best is good guessing to certainty, and opens the way for intensive research.

The address was illustrated by epidiascope projection from Vogt's *Atlas of Slit-Lamp Microscopy*, and from Koeppe's *Microscopy of the Living Eye*.

THE ACTION OF PHYSOSTIGMINE AND PITUITRIN:

THE ACTION OF THESE DRUGS, ALONE AND COMBINED, UPON THE ISOLATED HUMAN VERMIFORM APPENDIX; THE ADVANTAGES OF THEIR COMBINED USE IN POST-OPERATIVE ILEUS.

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SINCE the early days of abdominal surgery post-operative atony of the intestines or ileus has been a menace to recovery. The signs and symptoms are closely akin to those of acute mechanical intestinal obstruction. The distinction was clearly drawn by Nothnagel,[1] who divided ileus into two classes—

1. Mechanical, from occlusion of the bowel—(*a*) by obstruction from within; (*b*) spasm or constricting disease in its own substance; (*c*) pressure from without, adhesions, tumours, etc.; (*d*) twists, kinks, invaginations, etc.
2. Dynamic ileus, in which there is the syndrome of occlusion, with no closure of the lumen, this occurring when the intestine becomes paralysed.

With the first group this paper is not concerned; there is fortunately no more appreciated fact in modern surgery than that immediate laparotomy is required.

In regard to dynamic ileus Cannon and Murphy[2] have concluded that this condition is caused (1) by inhibitory impulses via the splanchnic nerves; (2) by injury or depression of Auerbach's myenteric plexus; (3) by trauma to the muscle itself. They proved this by the radiographic examination of opaque meals given to cats (*a*) after ether anaesthesia, (*b*) after ether anaesthesia during which the testicles were crushed, (*c*) as in (*b*), the splanchnic nerves having been cut some days before. After (*a*) the meal passed normally; after (*b*) the meal passed hardly at all because the shocked animal sent inhibitory messages along its splanchnic nerves; after (*c*) the meal passed almost normally because messages could not pass along the cut splanchnic nerves.

Further, handling of the intestine caused subsequent delay, presumably causing inhibitory splanchnic messages. To quote from their paper:

"Manipulations of the stomach and intestines, therefore, even gently and under the most favourable circumstances, produced in our experiments much greater effect in the direction of post-operative inactivity than any other of the factors under control during operation. Whether manipulation produces its effects on the mechanisms in the wall of the canal or indirectly through reflex inhibitions from the central nervous system was left undetermined."

Dangers of Ileus.

A slight distension of the intestines with gas is an almost constant occurrence after abdominal operations; it should begin to pass off in twelve to fifteen hours. When true ileus develops distension and discomfort steadily increase. The condition is a vicious circle, for the atony permits both stasis of faecal matter, which in putrefying causes further paralysis of the gut, and formation of gas, which increases the distension.

The dangers are readily apparent. (1) Organisms may penetrate the devitalized viscera and a fatal peritonitis occur. (2) Acute post-operative dilatation of the stomach may cause intractable vomiting and death from inanition and heart failure. (3) Kinking of the distended intestine may change the condition to mechanical intestinal obstruction. (4) Great distension may embarrass the diaphragm and impede the heart action.

More theoretical causes of death are: (*a*) Absorption via the lymphatics of a bacterial toxin found in the putrefying faecal matter (Murphy and Vincent[3]). (*b*) Splanchnic blood stasis, causing anaemia of the vital brain centres. (*c*) Irritation of the nerve endings in the intestinal wall, which causes death by constant reflex stimulation of the central nervous system. (*d*) The more recent work of Whipple and Stone[4] suggests that the toxic symptoms are caused by the absorption by the blood stream of a toxin in the nature of a proteose which is secreted in the affected intestine.

Treatment of Ileus.

It cannot be denied that the present treatment of severe ileus is not all that could be desired; the condition is much feared by surgeons. Methods past and present are:

1. Massage of the abdomen. This is not enjoyed by the patient, nor is it ideal over a large wound.
2. Thrusting a trocar and cannula through the abdominal wall. This temporarily relieves one loop of bowel and infects the abdominal wall. It is not a scientific method.
3. Passage of a lighted taper or the cautery downwards along the colon, in the assumption that the heat would start peristalsis.
4. Temporary colostomy or enterostomy, hoping that if the gas and faecal contents escape peristalsis will be re-established. In practice, however, the loss of tone prohibits the emptying of the intestines.
5. For acute post-operative dilatation of the stomach washing out the stomach is certainly the best treatment. For atony of the intestines a stiff-walled rubber tube may be passed high up in the rectum and left *in situ* for several hours to permit the escape of flatus. High enemata of different kinds—soap, olive oil, turpentine and asafoetida, etc.—are of the utmost value.
6. Drugs acting from within. In ileus carminative and purgative drugs are disappointing.
7. Drugs acting from without.

(*a*) Physostigmine. For many years it has been known that physostigmine (eserine) has the power to augment the movements of the alimentary canal by stimulating the parasympathetic nerve ends. One of the first surgeons to use physostigmine as a remedy for post-operative ileus was Craig.[5] Its value in this connexion was scientifically estimated by Cannon and Murphy,[2] who found, however, that the contractions