Television slit-lamp biomicroscopy

A. J. BRON, D. V. KAUFMAN, AND D. HARWOOD

From the Eye Hospital, Oxford

SUMMARY The basic requirements for performing television slit-lamp biomicroscopy are outlined, and the methods of demonstrating particular features of ocular anatomy and ocular disease are discussed. The technique has a particular role in teaching in the clinical setting.

Television has been used for many years to document and display ophthalmic procedures and clinical disorders. The modular construction of the Zeiss series of biomicroscopes makes it possible to carry out successful video-photography with the slit-lamp, using the same attachments employed for televising ocular surgery. This creates a most valuable teaching tool with some potential for research use. The following paper details the requirements for successful television slit-lamp biomicroscopy.

Materials and methods

Slit-lamp

A standard Zeiss slit-lamp may be used (Fig. 1) but the results may be affected by differing combinations of accessory equipment.

Video equipment

The basic requirement for simple display work (surveillance) is a television camera and monitor. To record observations a videotape recorder (or VTR) is required. It is not the purpose of this paper to discuss the relative merits of different commercial equipment, since the final choice will depend on factors of cost or the adaptation of existing equipment. The present report rests on experience gained with the Sony camera AUC 3420CE and portable VTR (AU 3420CE) (i.e., the Sony 'Rover' system) and Pye 11 inch (28 cm) precision monitor (842843/01) for black-and-white. For colour a Shibaden camera (HV 1500) × (HV9015) was used with a Hitachi 18 inch (45 cm) colour monitor (CM 181U). The Hitachi colour VCR with the Pal-Secam cartridge system was used (SV 630). Also in the United States the Cicon Camera and Sony Trinitron monitor have proved satisfactory. The slit-lamp and video requirements are summarised in Table 1.

Address for reprints: Mr A. J. Bron, FRCS, The Eye Hospital, Walton Street, Oxford OX2 6AN

TECHNICAL POINTS

Field of view

For general surveillance of the eye in diffuse white light it is important to be able to display the whole of the palpebral aperture without 'scanning' with

Fig. 1 The arrangement of the television slit-lamp biomicroscopy

the slit lamp. This requires that the field of view in the horizontal meridian at the lowest magnification of the slit lamp is at least 3.0 cm. This is also important when examining the tear film using fluorescein in the conjunctival sac, since an excellent opportunity is afforded to watch both the marginal strip of tears and precorneal tear film simultaneously.

The fields of view for varying combinations of the slit lamp, magnification change, and photo-adaptor combinations are given in Table 2.

LIGHT SOURCES

The primary light source (slit source) may be used for surveillance of the eye in diffuse illumination (white light) or for fluorescein work (blue light).

Table 1 *Slit-lamp requirements for television biomicroscopy*

1. Zeiss slit lamp (100/16) or photo slit lamp
2. Objective lens 100 mm 125 mm Photoslit
3. Single beam splitter (70:30)
4. Photo-adaptor 137 mm 107 mm
5. Magnification change Manual Zoom
6. Illumination sources (a) Slit source (primary illuminant). Overload facility of value (b) Additional source (secondary illuminant)
7. Microscope height adjustment (a) Joystick (manual) (b) Column (manual) (c) Motorised
8. Video equipment (a) Camera (b) Monitor (c) VTR

Table 2

Slit lamp		Photo-adaptor number	Smallest horizontal diameter (mm)	Smallest diagonal diameter (mm)	Smallest vertical diameter (mm)
Regular	Manual	137	15	19	11
		107	20	25	15
	Zoom	137	12	15	9
		107	16	20	12
Photoslit	Manual	137	20	23	15
		107	25	29	18
	Zoom	137	16	18	14
		107	13	16	10

Diffuse illumination

The pool of light can be enlarged to cover the whole of the palpebral aperture by placing a standard diffusing filter over the slit source. Alternatively less costly diffusers are easily produced from paper or opalescent plastic sheets cut to size.

Fluorescein work

Exciter filter

It is important to use an interference filter (e.g., Baird Atomic No. 5 Spectrotech SE 40 or Balzar FITC 4) to produce the blue exciter source, since even with such a source the intensity of illumination may be less than optimal. With a blue exciter filter over the 1° source, opened wide, the pool of blue light does not encompass the whole palpebral aperture. It would be useful to enlarge the pool of light, but this problem has not yet been solved with existing equipment. Two solutions have been considered. (a) The pool of light can be enlarged by placing a diverging lens over the 1° light source in addition to the blue filter. However, this so reduces the intensity of illumination that the technique appears to have little application. (b) An alternative technique, which will probably be adopted ultimately, is to place the blue exciter filter over a secondary (e.g., fiberoptic) light source with delivery of the light close to the eye.

Barrier filter

A barrier filter, such as a gelatin absorption filter (e.g., Ilford 110) placed over the objective lens of the slit-lamp is essential for examination of the marginal strip of tears, the preglobar and precorneal tear films, and for negative and positive staining of the cornea (e.g., dry spots and ulcers). A matched interference filter is the ideal to provide maximum illumination, but a suitable absorption filter will do.

A barrier filter is both unnecessary and undesirable for the demonstration of the rings of appplanation during appplanation tonometry. Use of the barrier filter reduces illumination to unsatisfactory levels, and the rings are clearly visible without it.

Secondary light source

A bright secondary illuminant is required, particularly to provide background illumination during slit microscopy. Unfortunately the secondary source of the photoslit lamp is not intense enough. However, it is easy to supply another lamp for this purpose, and a fiberoptic source controlled by a rheostat and located close to the objective lens of the slit lamp proves to be satisfactory.

Televising the slit image

Placing the slit image on the screen is at first disap-

Fig. 2 *Slit picture of the anterior segment*

Fig. 3 *Lower lid margin seen by broad focal illumination*

pointing because of the great contrast between the light on the object of interest, e.g., cornea or lens, and the surrounding structures, which are not illuminated directly. This problem is readily negotiated by adding a secondary fibreoptic source (see above) to provide background illumination. This technique is identical to that required for slit photography using a photoslit-lamp camera (Fig. 2).

Scleral scatter illumination

With the pupil dilated scleral scatter illumination will demonstrate epithelial corneal oedema. The

available intensity from the primary light source is not adequate to do this well, however.

MANOEUVRING THE MICROSCOPE

When recording sequences for clinical documentation it is important to achieve smooth transitions from one mode of examination to another. The observer must retain focus when shifting the microscope to different points of interest in the eye or when changing magnification. The following points may be made:

Horizontal traverse of the microscope is achieved easily and smoothly with the joystick control.

Fig. 4 Perilimbal bulbar conjunctival vessels (diffuse illumination)

Fig. 5 The iris collarette seen by diffuse illumination

Vertical movement may be achieved adequately by manual controls such as the knurled ring on the central column or, better, rotation of the joystick control. Motorised controls with the switch are within easy reach of the hand holding the joystick. The weight of the camera becomes a critical consideration during the 'up' movement and may on occasion demand manual assistance.

The click-stop manual magnification change is satisfactory, but not ideal, since a series of dark periods occur on the screen at each change, which interrupts the continuity of observation. The foot-

operated motorised zoom is ideal for television slit-lamp biomicroscopy because it allows the user to convert a survey picture into a detailed scrutiny at high magnification. Both the motorised zoom and vertical movements permit smooth titling using typescript. This can reduce editing problems at a later date.

APPLICATIONS OF TELEVISION BIOMICROSCOPY
The majority of anterior segment features studied with the slit-lamp are amenable to scrutiny by slit-lamp television biomicroscopy.

Fig. 6 Cortical lens opacities seen in the dilated pupil (photographs taken from 'stop frame' are of lower quality)

Fig. 7 Gonioscopy: a lightly pigmented open angle, with visible iris processes

The lids

The lid margins, including lacrimal puncta and Meibomian orifices, may be demonstrated at high magnification with diffuse or focal illumination (Fig. 3). Expression of Meibomian oil may be shown by catching the specular reflex from the oil dome. The palpebral conjunctival vessels may be shown with diffuse illumination, or at high magnification, with red-free light.

The Globe

The globe vessels are well demonstrated in diffuse

light, and at high magnification red-cell flow may be demonstrated. To show the limbal vessels, i.e., the marginal corneal arcade, retroillumination using the slit source is satisfactory, and a background illuminant should also be used. The contour of the globe can be examined in specular light from the tear film (Fig. 4).

The tear film

With high magnification and reduced intensity of illumination the typical coloured interference pattern produced by the surface Meibomian oil may

Table 3 Video techniques

Technique	Purpose	Primary source	Secondary source	Filter	Magnification	Notes
Survey (diffuse illumination)	General detail	+	-	Diffuser	Any	Low mag. to show whole of palpebral aperture. High mag. for conjunctiva, globe, vessels, Meibomian orifices and specular reflex of tear film
Fine slit (focal)	Thickness of objects in section. Also location of depth of objects in section	+	+ Added fibre-optic or other source	-	Any	(1) Show thickness and shape of cornea (2) Depth of chamber (3) Opacities in cornea and lens (4) Flare and cells in anterior chamber?
Broad slit (focal)	Used with slit angled obliquely to illuminate objects which scatter light	+	+	-		For punctate epithelial keratitis opaque microcysts
Retroillumination (against iris)	Shows objects in silhouette; refractile objects	(Fine or broad slit)	+ (May not be needed for HP)	-	Any	Limbal vessels, e.g., pannus, corneal lesions, e.g., clear microcysts, superficial corneal disorder (SCD)
Retroillumination (against red reflex: slit offset to one side or other to avoid corneal reflex)	As above	+ (Broad slit)	-	-	Any	Ideal to show fine detail of structures in cornea or lens, differing from surrounding structures in refractive index, e.g., microcysts and SCD
Specular reflection	To examine: (a) specular reflex of tear film, e.g., interference pattern (b) Endothelial specular zone (c) Internal specular reflection	+	-	-	Any	Endothelial mosaic is visible at high magnification
Scleral scatter (broad strip at either limbus)	To show light-scattering structures in the cornea, e.g., epithelial oedema	+	-		LP-HP	Best at low power with TV because of low emittance level
Dyes: Fluorescein	(a) Negative staining follicles; fingerprint lines (b) Positive staining punctate epithelial erosion, ulcer (c) Applanation	+ Large pool + Large pool of light +	?+ ? ? -	Blue exciter yellow barrier Blue exciter yellow barrier Blue filter only	LP-HP	HP poor at low light levels

HP = high power. LP = low power

be seen or accentuated by narrowing the palpebral aperture, using specular examination. The marginal strip and tear film debris are also demonstrated.

With the use of fluorescein and the appropriate exciter and barrier filters (see above) the marginal strip, prebulbar, and precorneal tear films are graphically demonstrated, as is the replenishment of the tear film which accompanies each blink. Negative and positive staining can also be shown.

The cornea

Numerous features of corneal disease may be demonstrated by slit, focal, and retroillumination. The fine detail of vesicular epithelial oedema, finger-print lines, and bleb-like dystrophies are well seen by retroillumination against the iris or red reflex. Scars may be shown in slit section and diffuse or focal illumination, while density may be suggested by retroillumination. The latter technique has also

proved ideal for demonstrating corneal vessels and splits in Descemet's membrane in buphthalmos. Scleral scatter will demonstrate epithelial oedema against the dilated pupil. Specular examination is just capable of resolving the cells of the endothelium, but the tear film highlight diminishes the value of using this technique except to demonstrate how it is done. It should be possible in future to limit the occurrence of such 'hot spots' on the screen electronically.

The iris

The architecture of the iris and the mobility of the pupil are shown well by diffuse illumination (Fig. 5).

The lens

With the pupil dilated the detail of a clear lens, including the anterior clear zone, may be shown in slit section. Certain lens opacities may be shown in

focal illumination (Fig. 6) while others are best seen against the red reflex. Still other opacities may be demonstrated as contour changes within the cortex by means of the specular technique.

The vitreous

The normal vitreous architecture is difficult to display, but significant opacities may be shown in focal and retroillumination.

The fundus

With a fundus contact lens in place the disc and its vessels can be shown. Venous pulsation at the disc may be a striking phenomenon. Demonstration of macula and vessels, lesions such as new vessels, and haemorrhage has been achieved but has not been fully satisfactory. Colour is essential here, since colour contrasts are important.

Gonioscopy

The angle structures are well seen, so that television has particular teaching value in this area (Fig. 7).

Some of the greatest problems encountered occur when illumination is moved from a highly reflecting surface such as the sclera to a poorly reflecting surface such as the iris. This may be most marked, for instance, with a dark brown iris. The problem may be overcome at times by using secondary illumination, but at others it may have to be accepted that in a given patient it may not be possible to display adequately a given mode of examination on the television screen.

Discussion

The technique of television biomicroscopy has its greatest use in the teaching of medical students. The teaching of ophthalmology is often condensed and makes severe demands on the keenest of teaching staff. One of the greatest problems relates to the difficulty of making observations accessible to the

student. By using the television slit lamp the teacher cuts down a great deal of the repetition when students are obliged one by one to look down an observer tube. Instead he can point out features which appear on the screen and indeed may make adjustments to the slit lamp while observing the screen himself.

Observations which are usually not easy to demonstrate, such as the applanation rings or the chamber angle, can be discussed with the student group looking at the phenomenon at the same time. The dynamic components of the features examined, such as blinking, blood flow, pupil constriction, pulsation of the applanation rings, and the venous pulse at the disc, all add to the interest generated by the technique. It is clear that the resolution of most television systems is sufficient to demonstrate all the clinical problems normally studied with the biomicroscope. There is, however, room for improvement, and it is likely that selection of low-weight, high-resolution cameras, of low-light-level cameras, the use of image intensifiers, and improved illumination sources will bring about these improvements. A streamlined custom-built television slit lamp, embodying some of the ideal features mentioned above, would also be a welcome addition to the clinical armamentarium.

Other uses and improvement may be foreseen for the future. The use of a 'special effects generator' would allow the combination of clinical observations with temporally related information on the same screen. An example would be to combine the applanation rings with the pressure reading dial during tonometry, or of disc vessel pulsation during ophthalmodynamometry, with a simultaneous reading of force applied to the globe. It must be anticipated that fluorescein angiography of the anterior segment will be feasible by this technique, and that the time after injection could similarly be displayed on the screen.