Slit lamp biomicroscopy

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slit lamp biomicroscope

• combination of a versatile light source with a biomicroscope
• allows study of ocular structures and their relationships in microscopic detail
• (photo documentation)
• developed by Gullstrand 1911
basic components

• slit lamp illuminator
  – precise and widely adjustable light source

• biomicroscope
  – provides a magnified (6x-40x) 3D image
slit lamp biomicroscope
components

illuminator and biomicroscope are

- parfocal
  - i.e. focus on the same plane
- co-pivotal
  - i.e swing on the same axis
- isocentric
  - i.e. centre on the same place
basic components

• slit lamp illuminator
  – adjusts height and width of beam
  – offers various filters (red-free, fluorescein exciter, neutral density)
  – allows horizontal displacement of the slit beam from the vertical position
  – allows vertical displacement of the beam from the isocentric position (decentering)
basic components

• biomicroscope
  – offers variable degrees of magnification
    (x6 to x40)
  – allows adjustment for observer refractive errors and inter-pupillary distance
photo slit lamp biomicroscopy

• several other features required
  – beam splitter
  – diffuse overall illuminator
  – electronic flash
  – camera body
  – eye piece graticule
slit lamp biomicroscopy - principles

• isolation with illumination

• serial viewing of the eye with as many forms of illumination as possible
courtesy of
C Martonyi
forms of illumination

• direct illumination
  – the examining light is directed on the structure to be examined
    • can be focal or diffuse

• retroillumination
  – the structure of interest is illuminated by light reflected from a posterior surface (iris or retina)
    • can be direct or indirect
slit lamp biomicroscopy - principles

- **direct forms of illumination**
  - diffuse beam examination
    - specular reflection
  - focal examination
    - optical sectioning
    - distance estimation
    - tangential exam
    - Tyndall phenomenon
- **indirect forms of illumination**
  - direct retroillumination
    - from the iris
    - from the fundus
  - indirect retroillumination
    - from the iris
    - from the fundus
direct illumination

indirect retroillumination

indirect retroillumination with dark background
courtesy Animal Health Trust
diffuse beam illumination

- advantages
  - many changes best viewed with a broad beam
  - allows a good overview
  - especially important for adnexal and iris examination
diffuse beam illumination

• disadvantages
  – fine detail (especially in transparent media) is lost
  – viewing subtle changes requires:
    • more selective illumination
    • a decrease in the area of simultaneous examination
diffuse beam illumination

- specular reflection
  - the reflected image of the light source itself
  - brightness and intensity depend on the reflectivity of the surface upon which it is seen
  - permits assessment of integrity of the optical surfaces (i.e. corneal epithelium, endothelium, anterior and posterior lens surface)
Zara, CKCS 3 y, corneal ulceration OD

Zara, OD STT 5

Normal dog

Zara, CKCS 3 y, mucoid discharge OS

Zara, OS STT 10
specular reflection of the endothelium

- surfaces of healthy corneal cells are smooth and highly reflective
- but borders are irregular and highlighted by absence of reflection
  - HONEYCOMB APPEARANCE OF HEALTH ENDOTHELIIUM
- pathology of cells results in loss of reflection and dark fill defects

requirement: 25-40x magnification!

http://www.opticianonline.net
direct focal illumination

• tangential illumination with a broad beam
  – with the creation of distinct highlights and shadows, the normally flat appearing surface of the iris becomes vividly three-dimensional
Direct illumination

Direct illumination - tangential

courtesy of C Martonyi
optical sectioning

- slit lamp biomicroscopes can produce an optical section of the transparent tissues of the anterior segment
- achieved by the projection of a narrow and precisely delineated beam of light without illumination of the adjacent areas
wide beam – watch trailing edge
distance estimation

• with the help of a standard relationship between eye, slit lamp and biomicroscope, relative distances between surfaces can easily be appreciated
direct illumination

• pinpoint illumination (Tyndall’s phenomenon)
  – ‘the rendering visible of a transverse beam of light through its being broken up by solid particles suspended in liquid or gas’
  – allows detection / quantitation of aqueous flare
Narrow (short) beam, high intensity, wide angle
indirect forms of illumination

• especially useful for visualizing subtle changes by enhancement of contrast
• slit beam may be de-centered from optical axis
indirect forms of illumination

• proximal illumination
• sclerotic scatter
• retroillumination
  – direct retroillumination from the iris
  – indirect retroillumination from the iris
  – retroillumination from the fundus
  – iris transillumination
indirect forms of illumination

• proximal illumination
  – direction of a moderate slit beam adjacent to an area of interest
  – absorption / scattering of light around / behind the abnormality → enhancement of contrast
indirect forms of illumination

• sclerotic scatter
  – demonstration of subtle corneal abnormalities
  – slit beam is decentred and directed at limbus
  – light is absorbed by the sclera and scattered throughout the cornea by total internal reflection
  – abnormalities become evident through reflection; the normal cornea is not visible
indirect forms of illumination

- retroillumination
  - light reflected from iris or fundus can indirectly illuminate subtle abnormalities anterior to these surfaces
  - the abnormalities appear dark against the bright background created by the reflecting surface
retroillumination

• retroillumination from the fundus
  – requires mydriasis and a narrow beam
  – subtle lesions e.g. cataracts are readily appreciated
retroillumination

- retroillumination from the iris can be:
  - **direct**: the iris immediately posterior to the corneal interest is illuminated
  - **indirect**: slit beam is further decentered - an iris area away from the corneal lesion is illuminated
direct retroillumination

- retroillumination from the iris can be:
  - **direct**: the iris immediately posterior to the corneal interest is illuminated
indirect retroillumination

- retroillumination from the iris can be:
  - **indirect**: slit beam is further decentered - an iris area away from the corneal lesion is illuminated
direct vs indirect retroillumination
direct retro-illumination

indirect retro-illumination

direct illumination

courtesy of C Martonyi
Gelatt

Fig. 10.1.23.
retroillumination

• iris transillumination
  – a narrow short slit is directed at the pupil
    almost coaxial to the biomicroscope
  – reflected light from the fundus will show iris
    transillumination in areas of iris atrophy
type of opacity examined

• opacities in the clear optical media can be characterized as
  – obstructive
  – refractive
  – dispersive
obstructive lesions

- block light on retroillumination (appear black on bright background)
  - for example
    - active corneal blood vessels, corneal pigmentation
    - blood clots in anterior chamber
    - dense cataracts
    - tissue masses
refractive lesions

• allow passage of some light on retroillumination
  – detailed examination through lesion not possible
    for example
    • keratic precipitates, corneal oedema, mild cataract, fibrin, thin scars, cysts
dispersive lesions

- on retroillumination, light passes through lesion but is refracted
  - underlying tissues visible but distorted
  - lesion takes on colour of background
    for example
    - nuclear sclerosis, incipient cataracts, distorted tear film, corneal bullae
Further diagnostic procedures

- in gonioscopy
- for posterior segment examination using a 60 or 90 Diopter lens
- specialized instruments for pachymetry and endothelioscopy
OCT ant segment
## Comparison of Slit Lamp Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Magnification</th>
<th>Slit options (mm width)</th>
<th>Light source</th>
<th>Illumination levels</th>
<th>Light filters</th>
<th>Photo/Video port</th>
<th>Weight</th>
<th>Extras</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kowa SL 15</td>
<td>10x, 16x</td>
<td>0.1, 0.2, 0.8, 1</td>
<td>Halogen</td>
<td>1/16&lt;sup&gt;th&lt;/sup&gt;, ¼, ½, 1</td>
<td>blue, white</td>
<td>Video</td>
<td>0.79kg</td>
<td></td>
</tr>
<tr>
<td>Keeler PSL</td>
<td>10x, 16x</td>
<td>1x1; 0.15, 0.5, 0.8, 1.6, 12.0</td>
<td>Halogen</td>
<td>continuous</td>
<td>red free, blue, neutral density</td>
<td>Video (via I-phone 4)</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>Hawkeye</td>
<td>10x, 16x, 20x</td>
<td>1x1; 0.1, 0.2, 15.0</td>
<td>LED</td>
<td>continuous</td>
<td>Red free blue</td>
<td>Photo and Video (6 MPX integrated digital camera)</td>
<td>1.5 kg (incl camera)</td>
<td>Inbuilt Holder for fundus exam lenses</td>
</tr>
<tr>
<td>Reichert PSL</td>
<td>10x, 16x</td>
<td>0.1 – 1.10; 10.0</td>
<td>LED</td>
<td>red free blue colour temperature conversion</td>
<td></td>
<td></td>
<td>0.68 kg</td>
<td></td>
</tr>
</tbody>
</table>
Kowa SL 15

- 10x and 16x mag
- Blue and white light
- 4 lighting levels
- 0.1, 0.2, 0.8 and full beam
- Supports video adapter
Kowa SL-17

- 10x and 16x mag
- LED light source
- Cont illumination levels
- Standard AAA batteries
  - 140-280 mins power
- 0.1, 0.2, 08. mm slit
- 1, 5 and 12 mm spot size
- Weight 790 g
- Supports video adapter and still shot
- Anti-tip design!
### Keeler PSL

![Image of Keeler PSL Biomicroscope]

<table>
<thead>
<tr>
<th>Biomicroscope</th>
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<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Binocular Hand held</td>
</tr>
<tr>
<td></td>
<td>Biomicroscope Slit Lamp</td>
</tr>
<tr>
<td><strong>Optics</strong></td>
<td>Converging binoculars at 13°</td>
</tr>
<tr>
<td><strong>Magnification</strong></td>
<td>10x and 16x, lever change</td>
</tr>
<tr>
<td><strong>Objective lens working distance @ 10x</strong></td>
<td>16mm</td>
</tr>
</tbody>
</table>

#### Slit wheel

- 1x1
- 0.15
- 0.5
- 0.8
- 1.6
- 12

#### Filter wheel

- Red free
- Blue
- Neutral density (0.8)
- Clear
Hawkeye

- 8x, 12x and 20x magnification
- 0.1, 0.2 and full beam, also 1.0 x1.0 spot for flare
- seamless lighting level adjustment
Hawkeye

Digital instant iconography
Security
Optical quality

Digital instant iconography

- Built on high resolution digital camera: 6.0 megapixels
- Digital 2.5 inch monitor
- DivX® Certified Encoder device
- High speed USB 2.0 connector

- Ideal light
- Image quality
- Practicability and autonomy
Scan optic monocu lar slit lamp

- 6x magnification
- 0.3 mm slit
- 3.0 mm disc
- 5.0 mm square
- Slit angle set to 25% of the corneal surface
Scan optic monocular slit lamp module for Welch Allyn ophthalmoscope

- 6x magnification
- 0.4 mm slit
- 3.0 mm disc
- 5.0 mm square
- slit angle set to 35 degree angle of the corneal surface