Theme section

Slit lamp Examination Techniques

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Abstract *The slit lamp biomicroscope is the quintessential tool for ophthalmological examination. The instrument has seen technological advancements with improved optics. This review aims to help the reader revise the basics of slit lamp biomicroscopy- the assembly, optics and various examination techniques.*

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Introduction

The slit lamp is a stereoscopic bio-microscopic device that uses a high intensity focussed beam of light which can be varied in size, angle and intensity to permit visualisation of fine anatomical details of ocular adnexa, anterior and posterior segments. Since its invention, it remains the most essential and versatile ophthalmic diagnostic equipment. Accessories extend its use to measuring intraocular pressure (Goldman applanation tonometer), fundus examination (lens biomicroscopy), angle visualization (gonioscopy) and recording (video recording device).

History

Invention credit goes to Alvar Gullstrand (1862-1930), a professor of ophthalmology and physical optics in Stockholm, who built on von Helmholtz optical imaging to device " large reflection free ophthalmoscope" (manufactured by Zeiss optical works), the precursor of modern day slit lamp . Gullstrand was awarded the 1911 Nobel Prize for 'diffraction of light by lenses as applied to eye".

The instrument comprising of corneal microscope and illumination system, underwent many modifications. Initial binocular handheld loupe was replaced by table mounted bi-tubus corneal microscope where light was distributed between two oculars by prisms (Abbe 1881, Koeppe 1922). Corneal microscope was modified to introduce binocular stereoscopic view and erect image, eye pieces adaption for individual inter-pupillary distances and linear movements along three directions, rotational movements in vertical and fronto-horizontal directions by Czapski.

Illumination system from initial Nernst lamp (magnesium oxide usage as an incandescent body) focussed to first to a slit (by condensing system of lenses) and then to eye (hand held lens) was modified by mounting both slit lamp and condensing lens on a single horizontal arm on pivoted table (Henker1916). Unavailability of Nernst lamp after 2nd world war, saw entry of Nitra lamp (spiral filament in nitrogen). Vogt's invented the illumination system with slit diaphragm controlling beam size. Narrowing of slit enabled thin optical sections, conical beams to observe the Tyndall effect.

Coaxial rotation of illumination system and microscope maintaining focus, was invented by Koeppe & Fincham in 1923-24. Con-focality of microscope and illumination system was introduced by indefatigable Hans Goldman in 1930's who also introduced joystick for fine controlled movement Coaxial illumination by use of prisms to deflect beams permitted posterior segment evaluation. Bypassing mechanism of Binstead and Stockwell permitted delinking of microscope and illumination systems, allowing them to move separately enabling sclerotic scatter. The first commercially available slit lamp was manufactured by Haag Streit in 1958

Design

Includes the **Illumination**, **Observation system** and **mechanical system** which keeps the two together and maintains parfocality.

The basic principle is the common focal plane and the common axis of rotation of the microscope and the illumination system. Their alignment is such that the microscope and the light are focussed on the same point.(Figure 1)

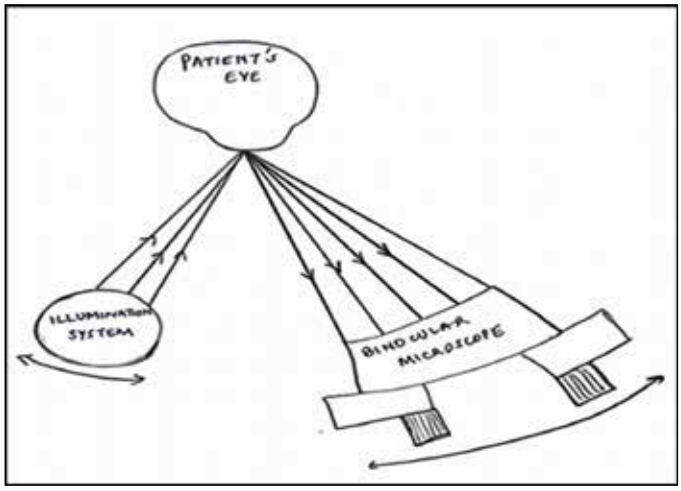

Figure 1: *J. Slit lamp design includes binocular microscope & illumination system*

A. Illumination system

Controls of illumination system are: Slit height variable from 0.2 to 8 mm, Slit width variable from 20 microns to a fully open aperture, variable light intensity (rheostat) to step change or continuous change.

Angle: Variable vertical and horizontal angles.

Filters: Cobalt blue for enhancing fluorescence for corneal staining including contact lens fitting and Goldmann tonometery. *Red free* to enhance view of blood vessels and nerve fibre bundles. *Neutral density* to reduce illumination in photosensitive patients. *Grey filter* reduces maximum illumination for patient comfort. *Yellow filter* (optional) enhances contrast especially with the cobalt blue filter. *Diffuser* is a flip-flop attachment on light source for diffuse illumination.

B. Observation system/ Corneal microscope

A telescopic system with two convex lenses separated by their focal lengths it provides magnified view. A second magnification is achieved using a Galilean type telescope (concave-convex) at the examinee's end to increase image size.

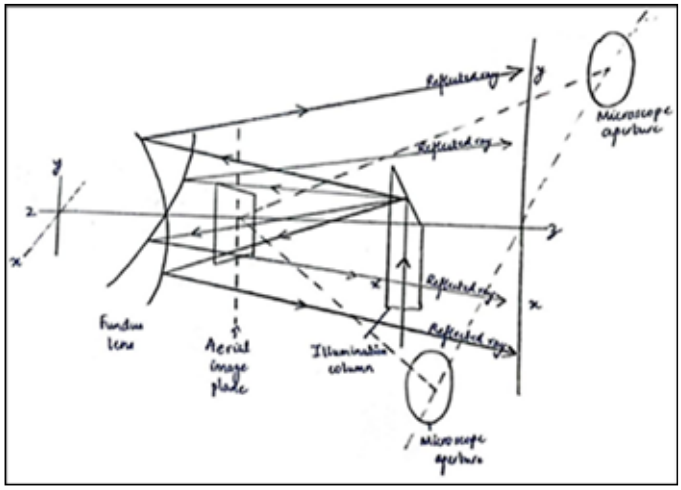

Figure 2: *. Schematic representation of slit lamp apparatus*

Magnification can be altered by two-level Grenough Flip (flip device) and Galilean step (3-5 step magnification by rotatory device).

C. Mechanical system

Integrates illumination and observation systems as well as takes care of patient positioning. Permits simultaneous movement of illumination and observation systems, tilting and alignment for gonioscopy, 3 mirror fundus exam. Dissociation of two permits sclerotic scatter.

The system includes forehead rest, chin rest and adjustment, canthus alignment, head fixation band, patient handlebars, joy stick, table height adjustment, knob for dissociating illumination, and observation system.

Examination technique

The slit lamp examination should be algorithmic to ensure complete and efficient examination. Anterior segment examination strategies: Examination under diffuse illumination, sclerotic scatter, focal examination (direct & indirect), retro-illumination (direct & indirect), zone of specular reflection, oscillating illumination

1. Diffuse illumination: For gross examination of anterior segment, lids, conjunctiva and cornea. A broad beam is shown on the ocular surface by opening the light aperture wide. The lowest magnification is used to view more area – for preliminary examination of ocular structures. In photophobic patients, neutral density filter is used. A beam of light is slightly defocussed near the object of interest so a large area is illuminated.

2. Direct focal illumination: Slit beam is narrowed and vertical height is altered to include specific structure to be viewed. Light is shone obliquely from temporal side and three-dimensional view is obtained by a precise optical section with magnification ranging from 5-25 times. Minute differences in media and opacities are rendered visible. Too long a vertical height would increase light scatter and reduce contrast. Illumination is varied from broad beam (parallelepiped), narrow beam (optical slit), conical or spot (aqueous flare).

3. Indirect lateral illumination: Light is placed on side of lesion to be examined. Parfocality of the observation and illumination system is often needed to be disengaged for optimum observation. Light scattered in neighbourhood of the lesion makes it stand out in softer illumination. Used for examining ghost vessels, corneal nerves, fine corneal opacities, neovascularisation, iris bleeds, sphincter changes etc.

4. Sclerotic scatter: Enables detection and mapping of subtle corneal opacities by using principle of total internal reflection Light normally falling on limbus travels internally and exits at opposite limbus, resulting in a lighted limbal ring and a dark cornea. A corneal opacity halts and scatters light passing through the cornea highlighting its margins.
To remove parfocality of illumination and observation system, the knob at base of illumination system or on the horizontally placed illumination tower is loosened.

5. Retro-illumination: Lesions are examined in background of reflected light form posterior structures like iris or fundus. For optimal image clarity, the illumination and observation systems are made co-axial. Useful for opaque lesions in back of cornea like keratic precipitates and semi translucent lesions such as vacuoles, corneal oedema and iris defects.
Softer indirect retro-illumination is useful for vacuoles and fluid filled cavities which would stand out in the softer surround with a darker centre.

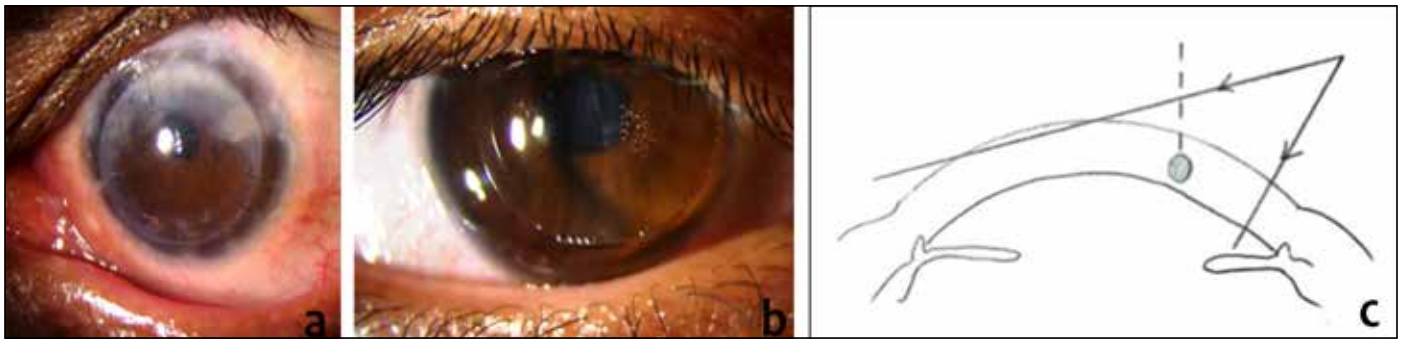

Figure 3: **a, b** *Diffuse illumination.* **c**. *Ray diagram showing a beam of light thrown slightly out of focus across the structure being examined so that a large area is diffusely illuminated*

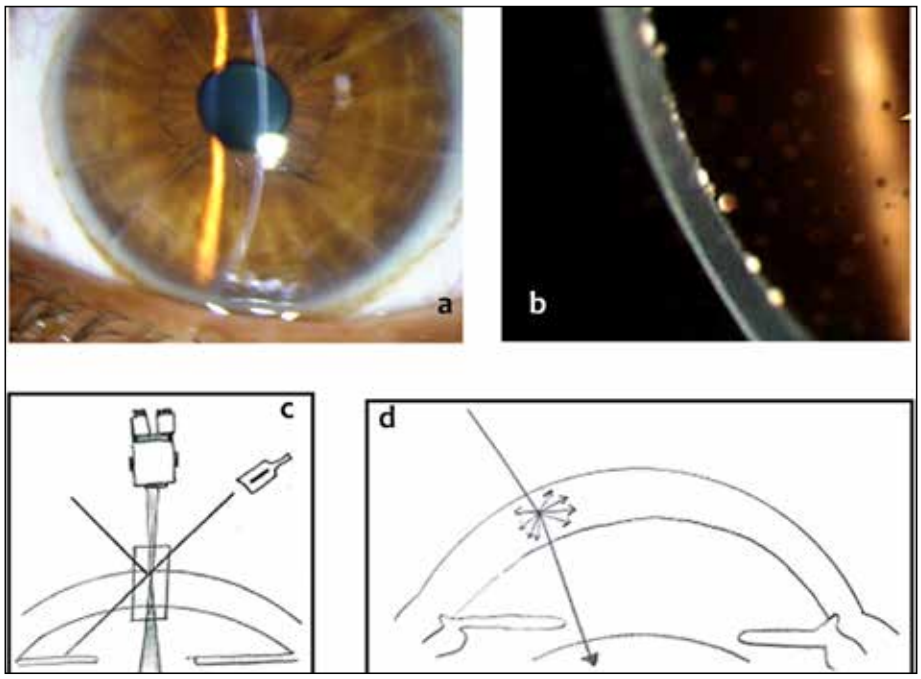

Figure 4: **a, b** *Direct focal examination showing central anterior chamber depth; Keratic precipates.*
c, d. *Ray diagram showing light exactly focused on area to be inspected*

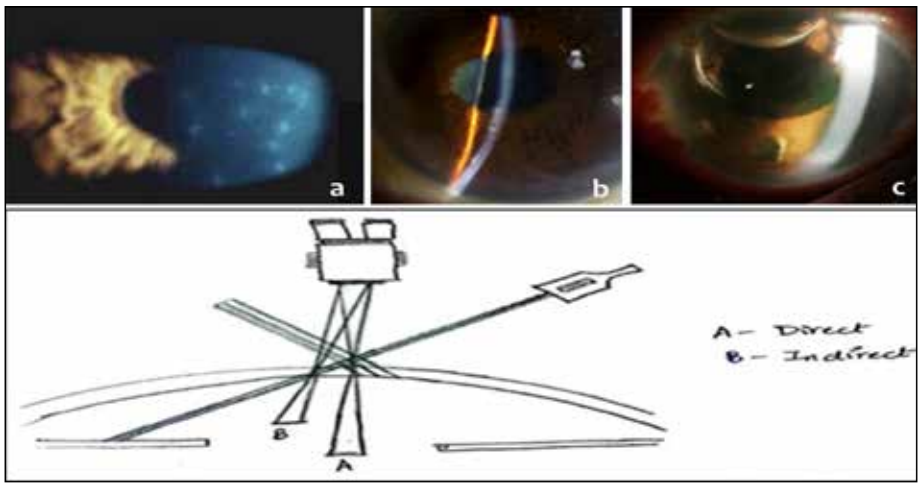

Figure 5: **a, b, c** *Indirect focal examination. Ray diagram showing light being reflected from tissue adjacent to the structure being examined.*

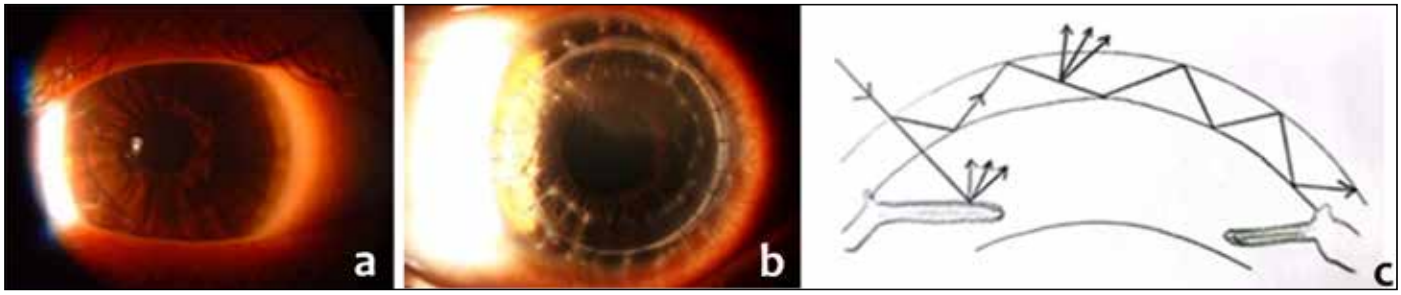

Figure 6: **a, b,** *Sclerotic scatter* **c**. *Ray diagram*
b*(Photograph courtesy Dr. Nikhil Gotmare), (Senior Resident, Cornea Services, Guru Nanak Eye Centre)*

6 Zones of Specular reflection

Specular reflection is an irregular reflection from a very small area of optical discontinuity. A monocular examination technique which high magnification of 25 times or more. Angle between observation and illumination systems is kept at 30 degrees so that the angle i and r are at 15 degrees to each other and catoptric image of light is focussed. The irregularly reflected light delineates areas of surface roughness and is used to examine corneal endothelium, tear film and cells of lens surface.

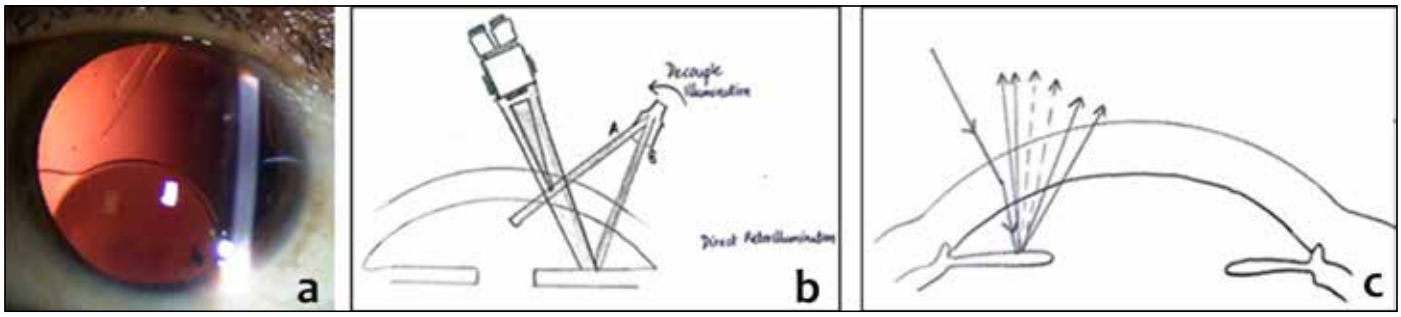

Figure 7: **a.** *Retro illumination showing a dislocated intraocular lens with red fundal glow.* **b,c.** *Ray diagrams showing light reflected off a structure that acts as a mirror.*

8. Examination under oscillating illumination

Area to be examined is studied under alternating direct and indirect illumination, to reveal fine scars. Magnification is kept low and may be increased after localising and mapping the lesion.

Dyes used in slit lamp examination

Various dyes are used in conjunction with diagnostic filters available with the slit lamp for delineating pathological process. They are the following:

a. Fluorescein 1%: Used with cobalt blue filter for diagnosis staining of epithelial defects, erosions, diagnosis of dry eyes (tear fil break up time, meniscus height), filamentary keratitis, aqueous leak (Seidel test), nasolacrimal duct patency (Jones test). Also used for measuring intraocular pressure by applanation tonometry and rigid contact lens fitting (both static and dynamic).

b. Lissamine green 1-2%: It stains the dead, degenerated cells unprotected by mucin or glycocalyx and mucous strands. It is less irritating and toxic than Rose Bengal and is better tolerated by patients. It is the preferred dye in diagnosis of dry eyes especially kerato-conjunctivitis sicca. Used with red-free filter, the transmitted light demarcates the stained areas black. In dry eye patients, it is used to assess lid margins for lid wiper epitheliopathy.

c. Rose Bengal: 1.3 mg impregnated strips that stain devitalised cells and mucous strands. Used to diagnose dry eye syndrome, dysplastic or squamous metaplastic cells of conjunctiva, corneal herpetic disease and meibomian gland disease. It causes stinging and burning sensation on instillation and is known to be ocular toxic.

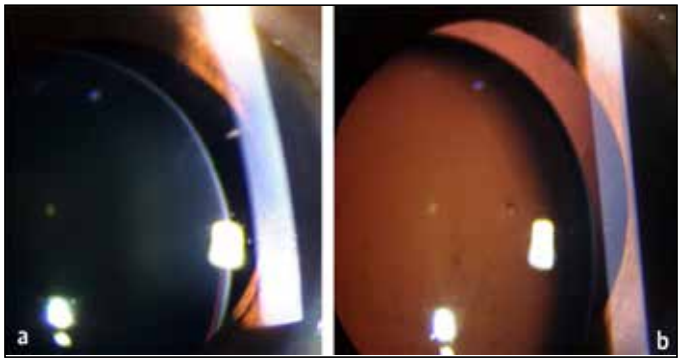

Figure 8: **a** *Indirect lateral illumination of subluxated lens*
b. Retro-illumination *demarcates it clearly and identifies zonular loss*

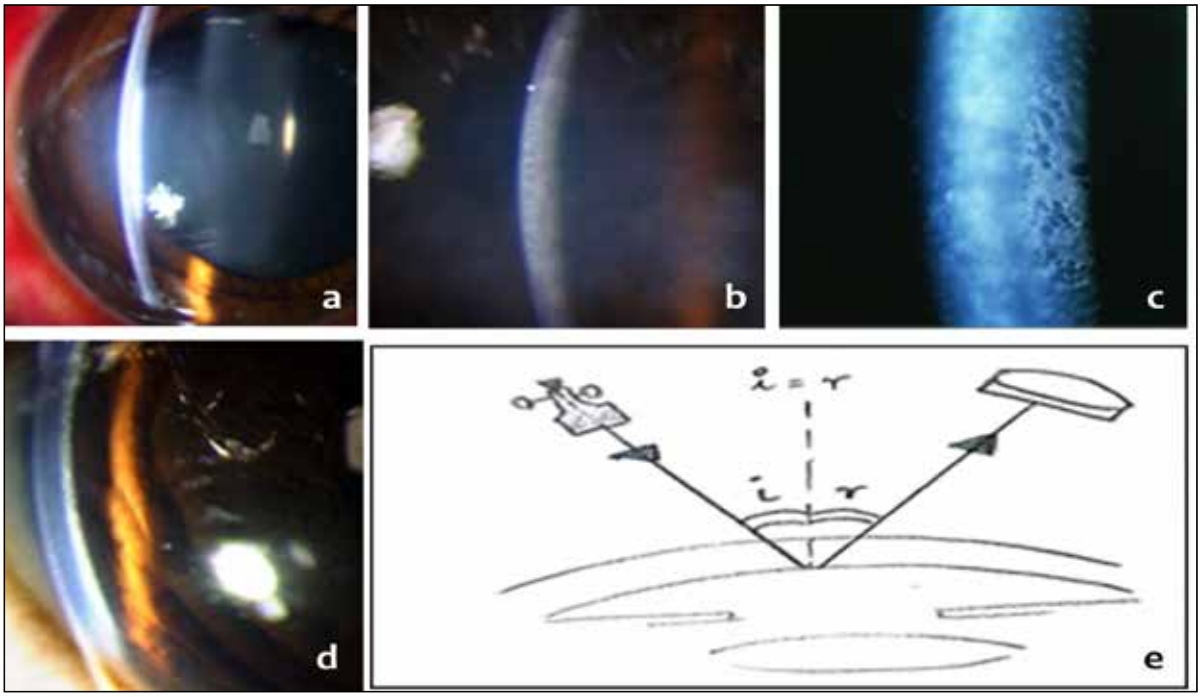

Figure 9: **a, b, c , d** *Zone of specular reflection* **e** *Ray diagram*

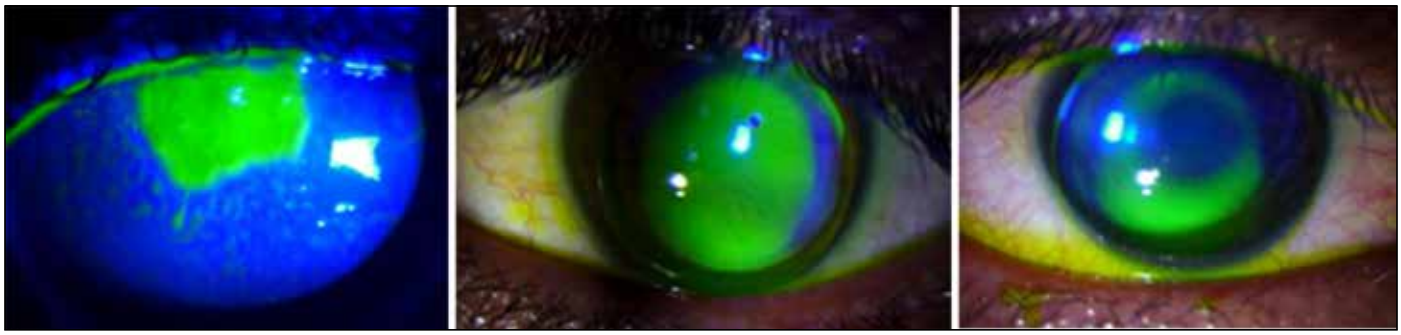

Figure 10: **a.** *Fluorescein staining of epithelial defect in ulcer, steep fit of rigid contact lens , apical touch in keratoconus contact lens fitting*

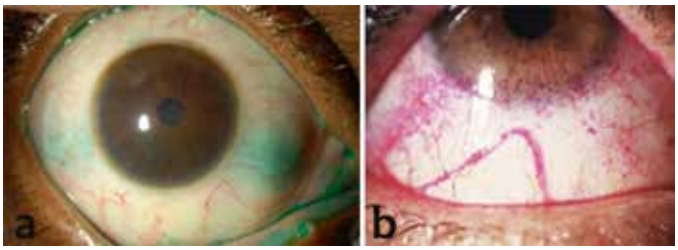

Figure 11: **a** *, Lissamine green in dry eyes (courtesy Dr. Christopher Rapuano)*
b. Rose *Bengal stain (courtesy Nicole C, Dry Eye flash cards. Optometry)*

References

1. Gullstrand A. Demonstration der Nernst-Spaltlampe. 37. Versammlung der Ophthalmologischen Gesellschaft Heidelberg. Wiesbaden: Bergmann; 1911, p. 374–376.
2. Duke Elder S . Textbook of Ophthalmology. Section 3 Diagnostic Methods in Examination of Eye Manchester. London, CV Mosby, 1941, p. 233-290.
3. Berliner ML. Biomicroscopy of the Eye. Slit lamp microscopy of the living eye. New York, Hoeber PB Inc; 1949.
4. Gellrich MM. The Slit Lamp: Applications for Biomicroscopy and Videography. Heidelberg, Springer Berlin , 2013, p 1-74
5. Ledford JK and Sanders VN. The slit lamp primer. The Basic Bookshelf for Eye care Professionals 2nd ed. New Jersey, Slack Incorporated 2006
6. Duke Elder S. Section 3.Examination of eye. Duke Elder. Text Book of Ophthalmology, Manchester MH , St. Louis Mosby 1933 pg 248-255
7. Review of Ophthalmology. Approaches and Methods for Treating Dry Eye 2021 [Internet]. Place unknown; Spiegle L, 2021 September 10. Available from: reviewofophthalmology.com/article/approaches-and-methods-for-treating-dry-eye-2021
8. Etxebarria J. Ocular Surface Dyes. In: Benítez-del-Castillo JM, Díaz-Valle D, Gegúndez-Fernández JA, editors. Ocular Pharmacotherapy. (place unknown) Jaypee Digital; 2017 p. 20-50

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