# UNIVERSITY of HOUSTON COLLEGE of OPTOMETRY

# Limbal anatomy – a consideration for the scleral lens practitioner.

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# Introduction

- The limbus is an important area anatomically, physiologically, and clinically.
- Functions: Nourish peripheral cornea, provide outflow for aqueous, and assist in corneal epithelial regeneration (1).
- Scientific literature offers little information on a precise definition of its structures and dimensions (Figure 1; Table 1).
- Recent technological and surgical advancements in the fields of contact lenses and cataract and glaucoma surgeries have created the need for a hetter understanding

Corneo-limbal Dimensions according to General Ocular Anatomy Texts					
ıl Diameter H			Limits/Defi	nitions of Limbus	Relationship between Canal of Schlemm ar Trabecular Meshwork
10.6 mm av	average of quoted references	1 mm	N/A	N/A	Micrograph: Canal of Schlemm seems to expand entire width of the meshwork and stops just sho the anterior chamber angle and ciliary muscle
10.6 mm no	not described 1	1 mm	termination of Bowman's layer and Descemet's	surface of the eye about 1.5 mm posterior to the first	Diagram*: Closer to scleral spur, and expanding halfway between trabecular meshwork Micrograph: closer to termination of PLL and expanding 3/4 width of trabecular meshwork
10.6 mm no	not described r	not stated	N/A	N/A	Diagram*: The canal of Schlemm extends to ha the meshwork and about midway between the spur
10.6 mm no	ot described :		Anterior: Line joining the termination of Bowman's layer to the termination of Bowman's layer (indicated in biomicroscopy by the internal limit of the marginal arcade of corneal vessels)		Micrograph: Canal of Schlemm spans about hal TM (closer to the termination of Descemet's membrane). Diagram*: Canal of Schlemm is located halfway meshwork (closer to scleral spur) and spans ab 1/4th of the meshwork.
10.6 mm no	not described 1	1.5 –2.0 mm	Anterior: Defined by Schwalbe's line	Posterior: Trabecular meshwork (specifics not mentioned)	Diagram*: Both diagrams show that the canal of Schlemm are located just superior to the scler and span not even 1/4 of the meshwork
10.6 mm no	not described 1		Anterior: Marked by a line drawn through the terminations of Bowman's layer and Descemet's membrane	Posterior: Shown as a line drawn from the apex of the chamber angle to the region of transition between limbal and bulbar conjunctivae.	Diagram*: Canal of Schlemm spans about half meshwork and begins closer to the scleral spu apex of the anterior chamber angle
10.6 mm no	iot described	not stated			Micrograph: Canal of schlemm also appears to the entire width of the trabecular meshwork
.mm H	IVID 1	1.5 – 2 mm	Anterior: Plane connecting the termination of Bowman's layer and Descemet's Membrane	Posterior: Plane perpendicular to the surface of the globe passing through the posterior edge of the scleral spur	Diagram*: Schelmm's canal expands about ha trabecular meshwork and extends into the cil muscle.
10.6 mm no	not described r		termination of Bowman's layer and Descemet's	portion of the ciliary muscle through the posterior	Diagram*/Micrograph: Both the diagram and micrograph show that the canal of Schlemm s thorughout the entire trabecular meshwork
10.6 mm no	not described 1		Anterior: The peripheral termination of the ALL demaractes anteriorly the histological limit of the cornea	Posterior: The extreme periphery of the PLL forms a circum-corneal ring to demarcate the peripheral limit of the cornea psoteriorly.	Micrograph: Canal of Schlemm seems to exparentire width of the trabecular meshwork
110. 110. 110.	2.6 mm a  2.6 mm n  4 m  4 m  4 m  4 m  4 m  4 m  4 m	Diameter How Measured?  average of quoted references  average of q	average of quoted references 1 mm  1.6 mm not described 1 mm  1.6 mm not described not stated  1.5 x 2 mm  1.5 x 2 mm  1.5 mm not described 1.5 mm  1.	Diameter How Measured? Width(1)  1.6 mm average of quoted references 1 mm N/A  1.6 mm not described 1 mm Anterior: Plane joining the peripheral termination of Bowman's layer and Descemet's membrane  1.5 x 2 mm Anterior: Line joining the termination of Bowman's layer (indicated in biomicroscopy by the internal limit of the marginal arcade of corneal vessels)  1.5 mm not described 1.5 mm Anterior: Defined by Schwalbe's line  1.5 mm Anterior: Marked by a line drawn through the terminations of Bowman's layer and Descemet's membrane  1.5 mm N/A  1.5 mm Anterior: Plane connecting the termination of Bowman's layer and Descemet's membrane  1.5 mm N/A  Anterior: Plane poining the peripheral termination of Bowman's layer and Descemet's membrane  Anterior: Plane joining the peripheral termination of Bowman's layer and Descemet's membrane  Anterior: Plane joining the peripheral termination of the AllL	Diameter How Measured? Width(1)  1.6 mm average of quoted references 1 mm N/A  Anterior: Plane joining the peripheral termination of Bowman's layer and Descemet's membrane  1.6 mm not described 1 mm tot described not stated N/A  Anterior: Line joining the termination of Bowman's layer and Descemet's plane, passing through the scleral spur  Anterior: Line joining the termination of Bowman's layer to the termination of Bowman's layer to the termination of Bowman's layer and Descemet's indicated in biomicroscopy by the internal limit of the marginal arcade of corneal vessels)  Anterior: Defined by Schwalbe's line Posterior: Less clearly defined by a line perpendicular to the surface, passing through the scleral spur  Anterior: Marked by a line drawn through the termination of Bowman's layer and Descemet's membrane  Anterior: Marked by a line drawn through the terminations of Bowman's layer and Descemet's membrane  Anterior: Plane connecting the termination of Bowman's layer and Descemet's membrane  Anterior: Plane connecting the termination of Bowman's layer and Descemet's membrane  Anterior: Plane connecting the termination of Bowman's layer and Descemet's Membrane  Anterior: Plane joining the peripheral termination of the AllL Posterior: The extreme periphery of the PLL forms a

# Purpose

The purpose of this study was to define the limbus morphologically, to develop a methodology to accurately measure the width of the limbus, and to determine the relationships between the limbal components.

#### Methods

- Whole human eyes (n=3) obtained from a US eye bank were dissected along the equatorial meridian (Figure 2)
- After placement in a 2.5% glutaraldehyde fixative within 48 hours of death, smaller pieces of tissue suitable for electron microscopy were prepared following an established histological protocol.
- Scanning electron microscopy (SEM), transmission electron microscopy (TEM), light microscopy (LM), and serial block face (TESCAN) microscopy were used to identify and measure the limits of the limbus using ImageJ software.

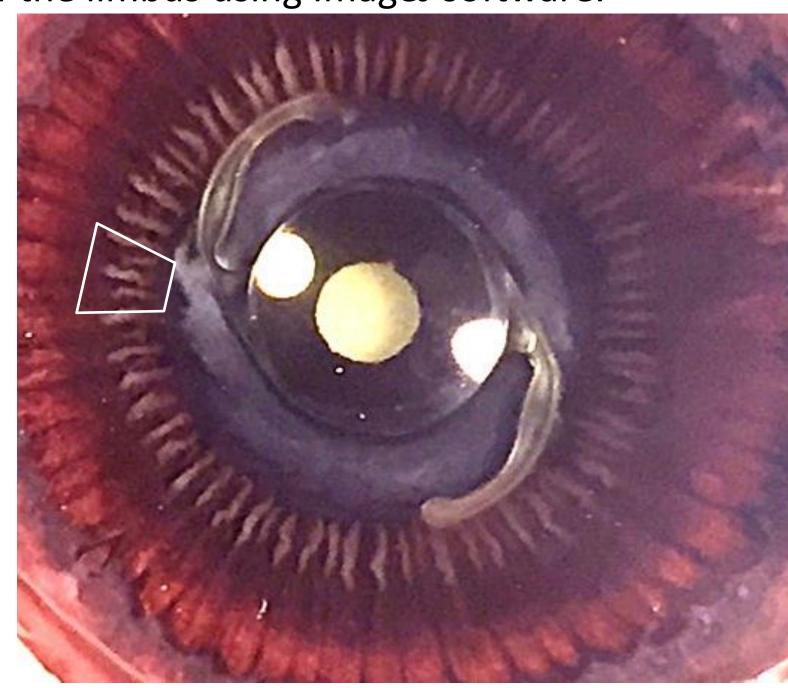
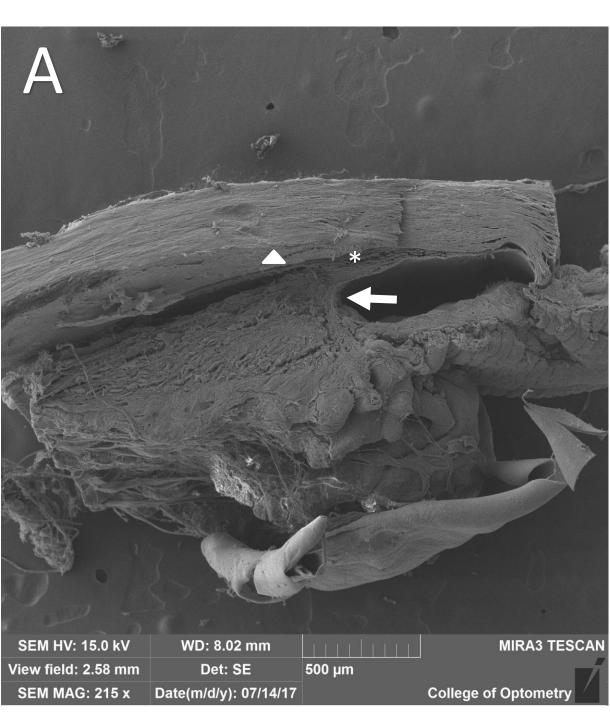


Figure 2. Posterior view of the anterior segment dissected from an 84 year old woman.

The pie-shaped outline indicates from where samples of tissue with intact uveal and outer coats were collected. This illustration also visualizes the perfect implantation of an IOL (Alcon SN60WF).

#### Results

- Limbal dimensions are not exactly the same when measured along the anterior and posterior surfaces.
- The scleral spur is truly a part of the scleral anatomy, although it maintains a close relationship with the limbal trabeculae.
- Imaging indicated that the angle recess is strictly a uveal feature and should not be a reference point for the peripheral extreme of limbus



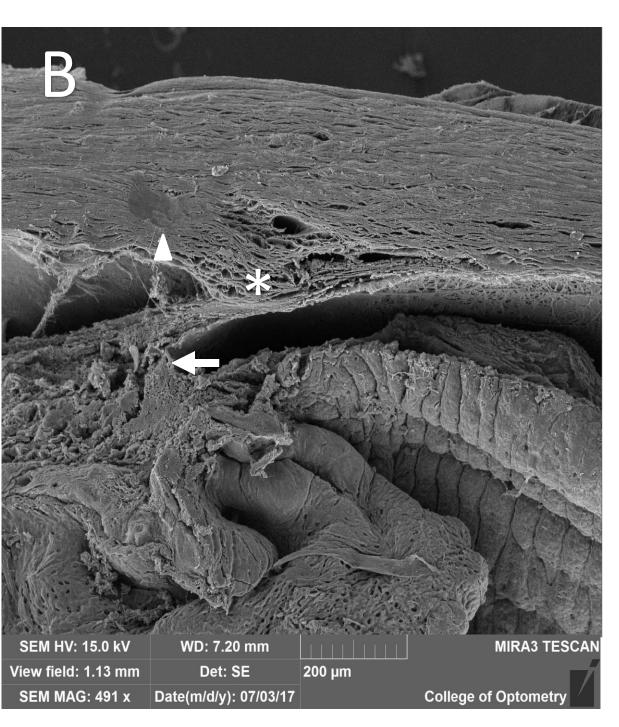


Figure 3. SEM of filtration angle (A low magnification, B high magnification).

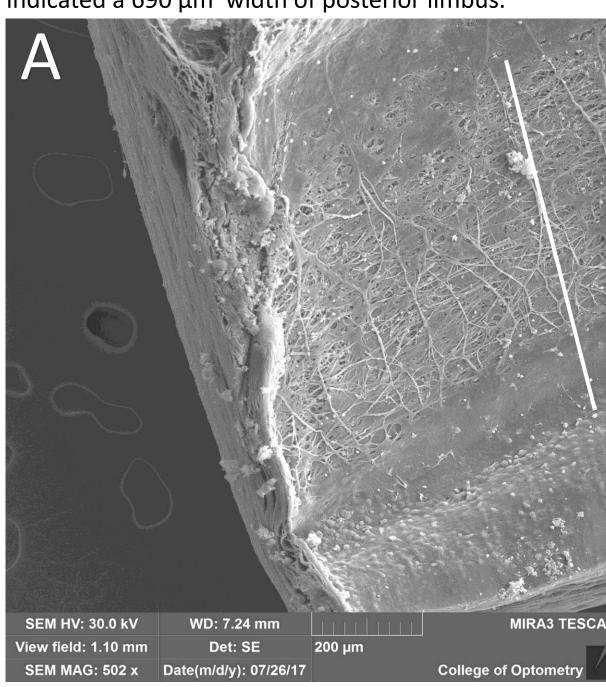
1) Scleral spur – triangle

Trabecular meshes – asterisk

Angle recess - arrow



Figure 4. TESCAN of filtration angle ImageJ software measurement from the peripheral wall of canal of Schlemm to the transition zone of posterior limiting lamina (PLL) into trabecular meshes indicated a 690 µm width of posterior limbus.



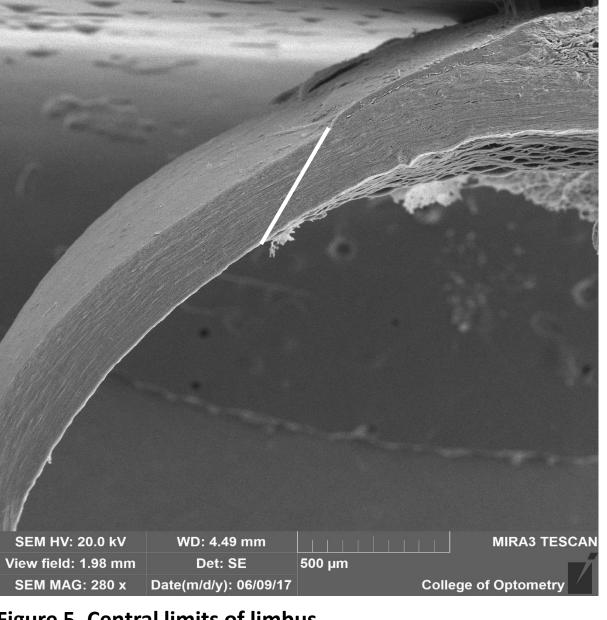


Figure 5. Central limits of limbus. The peripheral terminations of the corneal anterior limiting lamina (ALL) and PLL are connected with a line marking cornea (C) to the left and limbus (L) to the right. SEM.

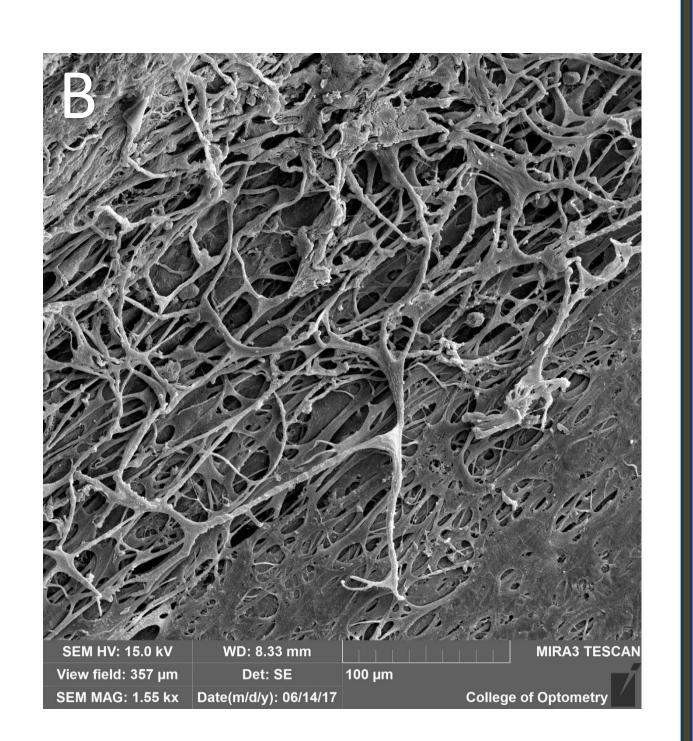


Figure 6. Near full width of trabecular meshwork (A low magnification, B high magnification). The uveal and corneo-scleral meshwork can be distinguished by their chord-like and sheet-like appearances respectively. SEM. ImageJ software revealed that this width was 695 µm

## Discussion and Conclusions

- The Hogan, Alvarado, and Wedell (1971) diagram (Figure 1) and its reproductions (3-10), on which we have based much of our understanding of the region, have inaccuracies.
  - Typically, the canal of Schlemm is wrongly illustrated to occupy a smaller part of the superior and lateral extreme of the trabecular meshes. However, its lumen size has been shown to vary between specimens and is IOP dependent (11). Our observations indicated that it occupies a larger area of the external face of trabeculum than previously suggested.
  - The scleral spur is part of the outer coat and is peripheral to limbus.
  - Angle recess is part of the uveal coat and separate from the trabecular meshes
- The termination of the ALL and PLL are reasonable anatomical reference points for the anterior extremes of limbus, as has been shown in previous literature (3).
- Peripheral limbal extremes are more ambiguous and proved to be more difficult to define
- Corneo-limbal diagonal dimensions are not likely to be the same for measurements along the anterior and posterior surfaces.
- Future measurements of limbus should not include scleral spur and angle
- In scleral lens practice and glaucoma/cataract surgeries, this crucial area has a great need for further research into its structural arrangement and dimensions.

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