Density, Light Scatter, and Spectral Transmission of a Scarred Human Cornea* **

Lothar Spillmann
Department of Retina Research, Retina Foundation, Boston Massachusetts 02114, U.S.A.

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Summary. Light measurements were made in vitro through a severely scarred human cornea. Results indicate a specular density of 2 log units for the central cornea and of 2.5 to 3 log units for paracentral regions. Forward scatter amounts to 1% between 0° and 3° half angle with a gradual decrease to 0.06% at an angle of 55°. Transmittance for long wavelengths is reduced by 1 log unit, for medium wavelengths by 2 log units, and for short wavelengths by 3 log units. Perception of objects, although severely limited, may be possible in spite of poor image formation.

1. Introduction

Opaque and turbid optic media in otherwise normal eyes severely impair vision, particularly in the presence of dazzle (Wolf and Gardiner, 1965; Miller, Wolf, Geer and Vasallo, 1967; Defter, Wolf and Geer, 1972). This deficit has two causes: loss of direct transmittance through reflection and absorption; and more important, attenuation of retinal contrast gradients by an increase of scatter. In eyes with clear media, 25 to 30% of the total intraocular opalescence originates in the cornea (Vos and Boogaard, 1963; Boynton and Clarke, 1964). As corneal cloudiness increases, scattered light begins to interfere with image formation until contours become undetectable (Coulombre and Coulombre, 1958; Smelser and Ozaniks, 1960; Smith, 1969). Measurements of optical density and of visual acuity indicate that the loss of transparency is primarily accounted for by the epithelium (Potts and Friedman, 1959), with only a minor portion attributable to the stroma (Zucker, 1966). Opposite results obtained by Kinoshita, Manabe and Kikkawa (1965) were explained by the greater amount of small angle scatter in stromal tissue.

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All of these studies were performed in animals, mostly in rabbit, chick and beef eyes. This paper investigates the goniometric light scattering characteristics of a scarred human cornea. In addition, transmission data are presented as a function of wavelength and for different regions of corneal penetration.

2. Material

A dense white cornea with extensive superficial and deep vascularization was used for measurements (Fig. 1). The excised corneal disk had little if any curvature, measured 10.5 mm in diameter and was between 0.6 and 0.7 mm thick. A peripheral annulus of 1.5 to 3 mm in width was covered by the iris pigment. The cornea was an eight-month-old transplant that had become opaque a few weeks after a penetrating keratoplasty was performed. It was obtained from a patient who had been thoroughly examined with psychophysical and electrophysiological tests of vision before undergoing corneal surgery for a second time (Spillmann and Roberge, 1972).

![Fig. 1. Opaque cornea inside the Rose chamber, posterior view. Note increase of density from center to periphery. Dark areas represent iris pigment](image)

3. Apparatus and Procedures

**Optical Density**

A continuous low-angle, helium-neon laser (Spectra Physics 132) with a dominant wavelength of 632.8 nm was used as the light source. Its beam was lined up with the entrance pupil of a fiber optics cable connected to the photomultiplier of an objective photometer (Gamma Scientific 2020). To obtain an aperture that could be filled completely, the tip of the light guide was covered with a pinhole of 1 mm diameter corresponding to two thirds of the width of the undiffused laser beam. The freshly excised cornea was rinsed with saline solution and immersed in silicone oil (viscosity 100 centistokes, refractive index 1.40). The specimen was then placed