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Contact lens-induced changes in the anterior eye as observed *in vivo* with the confocal microscope

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Abstract

The availability of the confocal microscope over the past decade has allowed clinicians and researchers to refine their understanding of the physiological and pathological basis of the ocular response to contact lens wear, and to discover previously unknown phenomena. Mucin balls, which form in the tear layer in patients wearing silicone hydrogel lenses, can penetrate the full thickness of the epithelium, leading to activation of keratocytes in the underlying anterior stroma. Epithelial cell size increases in response to all forms of lens wear, with lenses of higher oxygen transmissibility (Dk/*t*) interfering least with the normal process of epithelial desquamation. A higher density of Langerhans' cells is observed in the layer of the sub-basal nerve plexus among contact lens wearers, suggesting that contact lens wear may be altering the immune status of the cornea. Dark lines and folds are observed in the oedematous cornea in response to contact lens wear. Mechanical stimulation of the corneal surface, due to the physical presence of a contact lens, and the consequent release of inflammatory mediators, is the likely cause of reduced keratocyte density associated with lens wear. Highly reflective stromal 'microdot deposits' are observed throughout the entire stroma in higher numbers in lens wearers. 'Blebs' in the endothelium have a bright centre surrounded by a dark annular shadow; this appearance is explained with the aid of an optical model. The confocal microscope has considerable clinical utility in diagnosing *Acanthamoeba* and fungal keratitis. At the limbus, contact lenses can induce structural changes such as increases in basal epithelial cell size. An increased number of rolling leucocytes is observed in limbal vessels in response to low Dk/*t* lenses. It is concluded that the confocal microscope has considerable utility in contact lens research and practice.

Keywords: Confocal microscope; Contact lens; Cornea; Keratocytes; Langerhans' cells

Contents

Abbreviations: CM, confocal microscopy; Dk/*t*, oxygen transmissibility; EGF, epidermal growth factor; HGF, hepatocyte growth factor; IL-8, interleukin-8; KD, keratocyte density; LASIK, myopic laser *in situ* keratomileusis; LSCM, laser scanning confocal microscopy; SLB, slit lamp biomicroscopy; SSCM, slit scanning confocal microscopy; TSCM, tandem scanning confocal microscopy

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1. Introduction

Complications of contact lens wear can arise as a result of mechanical insult, hypoxic or hypercapnic stress, immunological reactions to lens deposits or solutions, toxic reactions to solutions, or infection, and can be exacerbated by local ocular problems (e.g. dry eye) or general systemic disorders (e.g. diabetes) (Efron, 2004a). Contact lens practitioners rely upon the optical slit lamp biomicroscope (SLB) for the critical task of examining the anterior ocular structures before, during and after contact lens wear. This instrument is extremely flexible in that it offers a stereoscopic view over a range of magnifications. The cornea can be illuminated with a slit of light that can be tilted and rotated, varied in terms of brightness, width and height, and interposed with coloured and polarizing filters.

A fundamental limitation of the SLB is that the highest practicable magnification possible is around $\times 40$, with a lateral resolution of 30 μm. In certain circumstances, this places a considerable constraint upon clinical decision-making. For example, it is not possible to identify the precise nature of infiltrates in a case of keratitis. The relatively new technique of confocal microscopy (CM) offers clinicians the opportunity to examine the living human cornea at a magnification of around $\times 500$ to $\times 700$. This technique, therefore, enables examination of tissue structures at a cellular level, and in relation to the example given above, extraneous matter such as infectious agents can be identified.