PROBLEMS OF SOFT CONTACT LENSES

AN ESSAY

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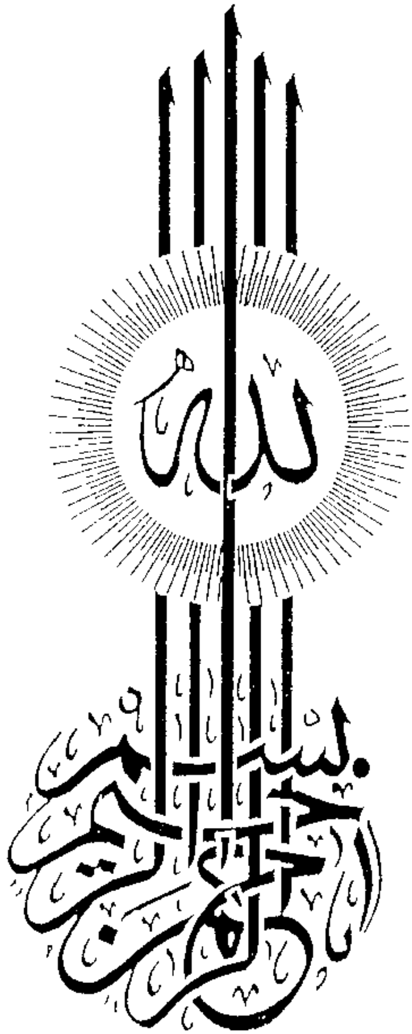
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Chapter 1

INTRODUCTION

In the same year,Kalt was the first to use corneal contact lenses in the treatment of Keratoconus.

In 1933,Dallos made the first contact lens by using prints from the living eye which does not deform after its production (Dawoud,1980).

In 1936,Feinbloom utilized a new synthetic plastic in the fabrication of contact lenses. He manufactured a scleral lens with a central optic portion made of glass, while the surrounding portion was made of a translucent acrylic plastic. At about the same time the Polymethylmethacrylate plastic (P.M.M.A) was introduced in the U.S.A.

In 1938, Muller and Obrig produced the first all plastic scleral contact lens (Lowther,1982).

In Egypt, Taher was the first to introduce and practice the fitting of contact lenses (Dawoud,1980).

In 1947,Norman Bier designed a lens with a minimum clearance corneal fit which increased the wearing time of lenses.

Kevine Touhy(1947) developed the first all plastic corneal contact lenses which were eventually capable of all day wear (Lowther,1982).

In 1960,Witchterle and Lim published an article on the hydrophilic gels Hydroxyethylmethacrylate (H.E.M.A.).

In the same year, Drifus described the use of these materials for contact lenses.

In 1964, HEMA was introduced by the U.S.A., and in 1971, the soft lens HEMA was approved by the U.S. Food and Drug Administration.

The extended wear of contact lenses also received a great deal of attention and experimentation during the late 1970 s. John De Carle of England was the leader in this field with the high water content Permalens. The use of extended wear increased with the development of other high water content and high oxygen permeable materials such as silicone (Lowther, 1982).

It is very important to the contact lens practitioner to have an idea of the basic anatomy, physiology of the cornea and tear film, in order to understand the fitting, adaptation and problems that may occur with contact lens wear.

II- ANATOMY OF THE CORNEA :-

The cornea is a transparent, avascular tissue which forms the anterior refractive surface of the eye, and is of direct concern, since the contact lens rests on this tissue.

Ideally, a contact lens should not change the shape of the cornea or its metabolism, since this can result in discomfort, damage or decreased visual acuity (Bier & Lowther,1979).

The shape of the cornea is important since a contact lens is fitted to this surface.

Viewing the cornea from the front, it has an elliptical shape with a horizontal diameter ranging from 11.0 to 12.5 mm. with an average of 11.7 mm. The vertical diameter is 10.6 mm. When viewed from the back, the cornea is rounded and averages 11.7 mm. (Wolff, 1973).

The average central thickness is 0.52 mm. under 25 years of age and increases to 0.53 mm. over 65 years,however at the periphery it is about 0.67mm.thick.Corneal thickness increases after prolonged eye closure and decreases in myopia over 5 D.

The radius of curvature of the central portion of the cornea ranges from 7.0 to 9.5 mm. The anterior surface is mostly curved centrally and somewhat flattens peripherally (Bier, 1956).

The central part of the cornea often approximates a sphere, and is called the optic cap. The steepest point on the cornea is called the corneal apex. This may be in the center of the cornea or displaced from the center. A displaced apex can result in a poorly centered contact lens, since a lens will usually center on the corneal apex (Lowther,1982).

Microscopic structure of the cornea

The cornea is composed of five basic layers; the epithelium, Bowman's membrane, stroma, Descemet's membrane and endothelium.

The epithelium measures 50 μm (0.05 mm.) and constitutes about 10% of the total corneal thickness. It consists of five layers.

The uppermost two layers are squamous layers. They are non-keratinized, thin flat polyhedral cells which retain their nuclei and other organelles, thus retaining some metabolic activity.

The next layer of the epithelium is a two or three cells thick layer, these cells are termed wing cells. They have many interdigitations and are tightly bound to adjacent cells by desmosomes.

The deepest layer of the epithelium is the basal one, which consists of tightly packed, columnar cells. They contain nuclei and few organelles in the cytoplasm. These cells are the most active cells, which divide actively giving rise to all layers of the epithelium, to reach the surface and slough off in the tear film in about seven days from the time of formation.

The basal cells rest on a very thin basement membrane and are attached to it by half-desmosomes. This membrane contains fine fibrils and mucoproteins and blends into Bowman's layer on which it rests. The basement membrane is generated by the basal cells and when the epithelium is removed, it usually remains in place.

Bowman's membrane is a modification of the anterior stroma. It is relatively thin, 8-14 μn. It consists of ground substance and collagen fibres. It ends at the limbus. If Bowman's membrane is damaged, it will not regenerate and scarring will occur. Nerve fibres penetrate this layer and extend up into the epithelium.

The stroma makes up the major portion of corneal thickness, approximately 90%. It consists of 200-250 lamellae which lie parallel to the corneal surface. Each lamella is made up of small,equally spaced collagen fibrils, with intervening mucopolysaccharides. The main cells of the stroma are fibroblasts, which lie between the lamellae, and make up only 2 to 4% of the stromal substance.

Descemet's membrane is the basement membrane of the endothelial cells and is 10 to 12 μn thick. This membrane is very resistant to damage and is elastic. It regenerates after trauma.

The endothelium is made up of a single layer of cells which have numerous organelles, indicating high metabolic activity (Bier & Lowther, 1979 ;Lowther, 1982).

III-PHYSIOLOGY OF THE CORNEA :-

1. Corneal Metabolism :

For the cornea to retain its normal transparency and thickness, the water content must be maintained at about 78%. This is maintained by the metabolic activity of the cellular layers; the epithelium and endothelium. The endothelium is the layer mostly responsible for corneal clarity (Maurice,1972).

In cases where the endothelium is damaged,there will be severe epithelial as well as stromal swelling due to an excessive amount of water entering from the aqueous humour. On the other hand, if the metabolic activity of the epithelial cells is decreased, there will be swelling of its cells up to 30% with a lesser extent of stromal swelling (Bier & Lowther,1979).

Glucose is the main metabolite used by the epithelium to produce the energy necessary to maintain its activity. It can be supplied via the tears,the limbal vessels and the aqueous humour.

Thoft et al. (1971) reported that the cornea obtains glucose,mainly from the aqueous humour,while the tears and limbal vessels supply a minimal amount.

Under aerobic conditions,glucose is metabolised into carbon dioxide and water with 36 units of energy being produced,while under anaerobic conditions, the end product of metabolism is lactic acid with 2 units of energy. The latter is a very inefficient system, the cells do not recieve enough oxygen to do their work with consequent corneal swelling (Lowther, 1982).

The oxygen needed by the cornea is obtained from the atmosphere via the tear film (Mandell, 1981). When a contact lens is placed on the cornea, oxygen intake from the atmosphere will be reduced. The amount of reduction which will sustain normal corneal metabolism is of concern to the contact lens practitioner. Polse and Mandell (1970) have shown that the minimal critical oxygen tension needed to maintain normally functioning corneal epithelium is 11 to 19 mm. Hg. Below this critical oxygen tension, there will be a shift of the aerobic to anaerobic glycolysis that cannot maintain corneal functions normally over a long period and symptoms of corneal hypoxia develop (Runge & Friedrich,1979).

Ruben (1975) illustrated that there is a wide variation in the individual oxygen requirements of the cornea related to its inborn sensitivity to changes in respiration. This wide variation makes some contact lens patients more prone than othersto corneal oedema from contact lens wear.

Oxygen supply to the cornea is also reduced during sleep or prolonged lid closure since the lids prevent atmospheric oxygen from reaching the eye. However, oxygen is available from the palpebral conjunctival plexus of vessels, at a partial pressure of 55 mm. Hg. which is above the minimum level required(Bier & Lowther, 1979).

For permanent wearing and without contribution of lacrimal pumping underneath the lens periphery,it appears that at least 5 to 6% oxygen transmission through the material is desirable and 8% for absolute safety(Bier & Lowther, 1979).

2. Corneal Temperature:

The corneal temperature is lower than the normal body temperature (37°C) with the corneal apex being the lowest, being about 31.5-35°C. This is due to corneal avascularity and evaporation of tears.

A rise of 10°C may approximately double the corneal metabolic rate. Hill and Leighton (1965) found no increase in corneal temperature with a contact lens in situ under normal open eye conditions. With normal lid closure, it increased by 2.5°C, while with forced lid closure the rise was 3.9°C.

The complaint of hot sensation in contact lens wearers is not correlated to corneal temperature but to a poor fit, which causes a corneal insult resulting in engorgement of the conjunctival vessels.

Heat receptors are absent from the cornea but present in the conjunctiva and lids, and this may give rise to heat sensation (Bier & Lowther, 1979).