Human corneal endothelium—new insights

In the past it was possible to study the corneal endothelium by flat mounted preparations, special stains, electron microscopy, and other techniques which demanded pathological specimens and might contribute artifacts. Of necessity, the number and scope of such specimens had been extremely limited, and the questions remaining could clearly best be answered by being able to see corneal endothelial cells in living humans. Much indirect evidence had suggested that although the endothelial cells in young rabbits and even monkeys multiply rapidly after injury, and heal in to make an endothelium which is ultimately nearly identical to the pre-injury endothelium, this might not be the case in man. That is, there was a suggestion that the healing process in the adult human was quite different from that of the animal species studied and from the behavior of such tissue in culture, the ability to actually see the cells in adult humans would permit us to draw firm conclusions.

The potential of a breakthrough came in 1968, when David Maurice discovered the use of the specular microscope to view the endothelial cells of the rabbit. Subsequent to that, Laing, 1975, used a dipping cone lens and modified the specular microscope to permit viewing the endothelium of man. This microscope was further improved, modified, and made into a more convenient clinical instrument by Bourne, Enoch, and others at the University of Florida, 1975, and it is now possible to see corneal endothelial cells in situ in adult humans. The amount this has contributed to our knowledge and is contributing is enormous.

Although all data are not complete, it appears that the corneal endothelium of the adult human either does not divide, or divides very little, so that most healing occurs by spreading of the remaining cells. The implications of this are profound. It is clear that as patients grow older, the number of endothelial cells remaining decreases with age. When the cornea is injured, the remaining cells spread out to cover the previously denuded area and the degree of injury can be quantitated by measuring the number of remaining cells per square millimeter of cornea or calculating the cell area. This extremely important development also opens the door to answering a number of vitally important clinical questions. In terms of donor cornea material we can ask whether the cells remaining on corneas preserved longer by the M-K media are comparable to those remaining on refrigerated corneas stored for a shorter time, and find that the answer is yes. We can see the endothelial cells on cryopreserved corneas placed in human eyes as early as 24 hours after keratoplasty and can determine that they clearly survive. We can quantify the possible damage done to the cornea by such procedures as phacoemulsification, intraocular lens insertion, irrigation with vitrectomy solutions, and drugs, and these studies can be done in humans who will receive such procedures for therapeutic purposes and whose natural course is, in fact, that of a normal patient.

New light will be shed on corneal graft reactions and the recovery from them, as well as many of the normal aging processes, such as the development of corneal edema with age as seen in Fuchs' endothelial dystrophy. We can determine if,
in fact, further surgery on an eye with few remaining endothelial cells represents a great hazard in terms of inability of the residual endothelial cells to spread and heal in, and can assess the possibility of thereby creating leakage and corneal edema. It may well be important to examine the endothelial cell density before intraocular surgery to precisely estimate the risk of past surgical edema. In animal eyes McCarey has made time lapse motion pictures of endothelial cells healing and spreading and the possibility of extending this to humans would give us an understanding of the function of this vital layer never before obtainable.

Much needs to be done, and included in this is a more precise correlation of functional activity with morphological changes. In a way, however, the development of this powerful research tool has profound implications for the understanding, and even therapy of human disease.

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