IRRADIATION OF THE LACRIMAL GLAND FOR THE TREATMENT OF RECURRENT EROSION

BY Lorand V. Johnson, M.D.

At the 1944 Meeting of the American Ophthalmological Society, Dr. Paul Chandler presented a paper entitled "Recurrent Erosion of the Cornea." Dr. Chandler discussed the possible application of the deturgescence research by Cogan and Kinsey and the relationship of hypotonicity of the tears to vesicle formation under the corneal epithelium. Dr. Chandler stated, "As pointed out by Cogan corneal edema from any cause is worse after sleep, presumably owing to the lessened osmotic tension of the tears overlying the cornea, when there is no surface evaporation. Patients with corneal edema frequently volunteer that their vision is worse after weeping, and this is again probably due to lowered osmotic tension of the tears in contact with the cornea. One of my patients, suffering from recurrent erosion of the microform following a minor injury, stated that an attack was invariably precipitated by weeping. Another patient had two attacks during the day, each time immediately after bathing in a fresh water pool. Any corneal edema can be made worse by bathing the eye with a hypotonic solution." For therapy, Dr. Chandler recommended the use of a bland ointment to establish an oily film in the precorneal mucous layer and to prevent hypotonic tears from contact with the corneal epithelium during sleep.

The purpose of this presentation is to add my endorsement to this hypotonic tear concept of recurrent erosion vesicle formation and to report my observations with an additional method of preventing hypotonic tear contact with the epithelium of the cornea. The depression of the serous component of tears by irradiation of the lacrimal gland for another condition (bullous keratopathy associated with endothelial dystrophy) suggested that it might be possible to depress slightly the serous component of the tears of patients having recurrent erosion, to prevent the formation of night-time vesicles in this condi-

Irradiation of the Lacrimal Gland

Irradiation of the lacrimal gland has, almost without exception, prevented the continuance of recurrent erosion.

CLINICAL OBSERVATIONS

In 1953, an industrial chemist was referred to my office who had two years previously been exposed to concentrated fumes of octylphenol, a very powerful irritative lacrimal stimulant. During these two years constant epiphora and symptoms from macro-type recurrent erosion of the left eye had been so severe that he had been unemployable. Many suggested therapeutic agents, including corneal stripping, had previously been employed without benefit or relief from symptoms. The left lacrimal gland was given 500 r of irradiation. Within two weeks after irradiation the eye was comfortable, and the chemist was able to return to his work. In 1954 this chemist returned to the office and stated that re-exposure to octylphenol fumes had resulted in similar symptoms to the right eye, but that the previously involved left eye had remained comfortable. Examination revealed recurrent erosion of the severe macro-type in the right eye. There were no symptoms or signs of recurrence in the previously severely involved left eye. Irradiation was given to the right lacrimal gland to depress the serous component of tears, with relief of symptoms and of the recurrent erosion vesicles of the cornea, and this chemist has not had further recurrences even though occasionally exposed to the same octylphenol fumes.

Since 1954, 18 other patients with severe and prolonged symptoms have obtained irradiation of the lacrimal gland, given by a roentgenologist, with recurrences in but one patient. This particular abrasion had been received during removal of a contact lens worn for aphakia, and there was relief of symptoms and signs while the patient was wearing his cataract glasses, but even a second treatment did not provide sufficient comfort to enable him to use the contact lens without recurrence of recurrent erosion symptoms. Two patients were comfortable except for recurrences when swimming in a fresh water pool. Two patients, in whom symptoms had been precipitated by contact lens abrasions, were able to wear contact lenses following a single treatment to the lacrimal gland of 500 r of X-ray. Two patients experienced recurrent symptoms after prolonged crying. One patient experienced one recurrence while applying oil paint to the wall of his home. One patient notices a slight blur of the treated eye after slicing onions.
Twelve of the 19 patients have had relief of symptoms for more than two years. There has been no observable or visual complication from the therapy. The technique used by the roentgenologist will be described later.

**DISCUSSION**

Cogan and Kinsey,\(^2\) during their study on deturgescence of the cornea, reported that when a solution, hypotonic to the cornea, is in contact with the cornea, the epithelium acts as an osmotic membrane, the fluid passing through the epithelium to remain as vesicles under the epithelium. This fluid cannot be transferred farther because the stroma does not serve as an osmotic membrane. Hypertonic tears or solution will reverse the flow of fluid, evacuating the vesicles. It is probable that evaporation (which is less on humid days) plays an important part in maintaining hypertonicity of the precorneal mucous film to the cornea.

The closed lids, during sleep, prevent evaporation from the exposed interpalpebral area of the globe. During sleep, the influence of Bell’s phenomenon in elevating the cornea, should provide that the tears emitting from the lacrimal ducts should immediately come in contact with the cornea and that the circulation flow of tears then traverse the conjunctiva, for such mixing or diffusion as may occur, during passage toward the lacrimal punctum. Lack of a “mixing effect” in the absence of blinking would be most apparent during sleep. During sleep, there is an increase in some systemic secretory functions, such as the gastric hydrocholoric acid and sweat, and a decrease in the formation of saliva and urine. It is possible that there is a diurnal variation in the electrolyte secretory activity of the endothelium or in the tonicity of tears. An influence by enzymes or hormones, such as antidiuretic factor, steroids, or steroid inhibitors may be present.

It is well known that in recurrent erosion vesicles do not form during the day when evaporation does concentrate the tears. I have confirmed a presumptive diagnosis of recurrent erosion by instillation of distilled water onto a cornea, the lids having been parted by a speculum to prevent mixing of the distilled water with the conjunctival mucous film. We have, therefore, some evidence that hypotonic solution will raise vesicles under the epithelium of a susceptible cornea. It is easily demonstrated that the hygroscopic effect of glycerine will empty the vesicles. It is not clear why a small percentage of the abraded corneas develop recurrent erosion, or why other individuals will develop recurrent erosion as a result of severe and continued lacrimation such
Irradiation of the Lacrimal Gland

as may be stimulated by noxious chemicals and tear gas. It might be that continuing reflex epiphora in some way alters the secretory mechanism so that tears of lower tonicity result.

The textbook, The Pharmacological Basis of Therapeutics by Goodman and Gilman, gives many references to abnormalities of secretion, generally relating to acetylcholine, but I find no reference in the literature to any permanent secretory effect resulting from prolonged reflex stimulation. Possible influences could be hypertrophy, alteration in secretory potential sensitization to acetylcholine, or supersensitivity of the membrane permeability of the effector cell.

**TECHNIQUE OF IRRADIATION OF THE LACRIMAL GLAND**

A single dose of 500 r has been administered to most of these patients with 200 K.V. therapy filtered with 0.5 cm. copper plus 1.0 mm. aluminum, giving a half-value layer of 1.0 mm. copper. A skin target distance of 44 cm. was obtained by shortening the 2-cm. size extension of an Odman cone. A brass tip was fitted over the end of the cone and compressed to form a kidney-shaped aperture about 20 × 8 mm. in size. Two patients have recently received single doses of 600 r (air dose). A new “lacrimal gland cone” has been developed and will soon be available from the Picker Xray Corporation. Adapters will be available to permit usage of the cone with the General Electric deep therapy and also the Odman cone apparatus.

The small amount of 500 r which apparently suffices to sufficiently depress the serous component of tears at night for the relief of recurrent erosion, may be compared to the relatively large amount, 3,000 r, which is required to sufficiently destroy the lacrimal gland so that daytime dilution of the precorneal mucous film with the serous component of tears will prevent bullous keratopathy for such conditions as endothelial dystrophy.

**SUMMARY**

It is postulated that a functional sensitization of the lacrimal gland occurs, as a result of long-standing reflex epiphora following the abrasion, and that relatively hypotonic tears continue to be secreted during the duration of symptoms from recurrent erosion. The exceedingly small amount of irradiation required to effect clinical relief from further symptoms would indicate that the parasympathetically controlled secretion of the serous component of tears is easily depressed.
REFERENCES


DISCUSSION

DR. A. EDWARD MAUMENEE. All of us are aware of Dr. Johnson’s prolonged interest in the influence of tear secretion on corneal edema and corneal swelling. His use of X-ray to the lacrimal gland to prevent bullous keratopathy and to influence recurrent erosion of the cornea extends back to 1953, so that his follow-up on these patients is excellent.

I have not used X-ray therapy for treatment in reducing tear secretion; but from using X-ray or radiation of one sort or another on the eye for many other conditions, I have become rather disenchanted with this form of therapy in all cases where other forms of therapy could be used. I think many radiologists also feel that if other forms of therapy can be used, this should be used for other benign conditions. I wonder what will happen to some of these patients, for instance, when they reach 60 and 70 years of age. Will there be a continued change in the lacrimal gland which will cause these patients to have keratitis sicca? It will be fortunate indeed if the X-ray can reduce the secretion just the exact amount you wish it to.

I don’t know the cause of recurrent erosion of the corneal epithelium, but we do know that removal of the epithelium by curettement frequently relieves these patients’ symptoms and they don’t have recurrences, at least for a great number of years. This is such a simple procedure that I wonder if Dr. Johnson has tried this technique on patients before using irradiation of the lacrimal gland.

I have not treated recurrent erosion by means other than curettement and the use of steroid therapy, but I have used retrobulbar alcohol injections, using 1 c.c. of novocaine, leaving the needle in place and then injecting 1 c.c. of 90 percent alcohol retrobulbarly. Four patients who had chronic irritation of the eyes were reported on in 1949, and since that time we have had approximately fifty patients in our clinic and in my private service who have had eyes with vision, on whom we have used this technique, and we have yet to see a permanent loss in vision or visual field from retrobulbar injection of alcohol.

I would like to show a couple of slides to illustrate three cases on whom this technique was used. This was a girl, 8 years of age, who had had a cap
pistol backfire and had a slight powder burn of the cornea in one eye three years previously. She developed extreme epiphora. This cornea became quite edematous, with a pigskin appearance, and vascularized. From the excessive epiphora she then developed corneal edema in the second eye. I did a retrobulbar alcohol injection under general anesthesia on one eye, which relieved the symptoms slightly, but because of the continued irritation in the other eye the condition continued. In the second procedure retrobulbar alcohol injections were done, and this relieved her epiphora because of the irritation being produced by the hypertonic tears causing the cornea to be edematous—or at least I assume this was the mechanism—and for the period of three years that I was able to follow her she had no recurrence of her irritation. She had developed an exotropia during this time.

This slide shows another condition of elementary keratitis that occurred following cataract extraction in a patient. Repeated removal of his corneal epithelium and use of both topical and systemic steroids failed to cure this patient’s symptoms. Retrobulbar alcohol injections in the eye stopped the pain, and the trouble disappeared.

This is a patient with superficial punctate keratitis. Removal of the corneal epithelium and prolonged use of both topical and systemic steroids did not relieve his symptoms. After retrobulbar alcohol injections the irritation in his eyes was relieved. In a two-year follow-up he has had no recurrence of his superficial punctate keratitis.

Finally, since Dr. Johnson has mentioned the use of X-ray to the lacrimal gland for bullous keratopathy, it is my feeling that these patients can be relieved of their pain so completely with the thin conjunctival flap of Gundersen that this is really a more benign procedure than is irradiation of the lacrimal gland.

I think this is a very interesting presentation by Dr. Johnson, and a real contribution; but I wonder if we shouldn’t reserve irradiation until we have tried all other forms of therapy in these cases.

Dr. Johnson. I wish to thank Dr. Maumenee for his discussion.

Therapeutic results from procedures vary greatly. I have never felt that I helped any patient by stripping off the epithelium. I believe it to be unphysiologic, because stripping of the epithelium simply adds another trauma to cause further dilution of tears by reflex epiphora. Stripping of the epithelium does not in any way alter the secretory activity of the endothelium in extruding salt or water, whichever the mechanism may be.

The concept that I have in treating corneal edema, bullous keratopathy, or vesicle formation is that if we are unable to alter the extrusion of salt by the endothelium, the least we can do is to prevent a hypotonic tear from coming into contact with this hypertonic stroma. The philosophy of preventing the dilution of the precorneal mucous film with reflex-stimulated tears is of that nature. If we had no tears to dilute this film, evaporation would slightly increase the salt content of the precorneal mucous film so the vesicles would
not form, or so that the osmosis would be reversed and fluid might go even from the stroma out into the precorneal mucous film. I have not had success with stripping of the cornea.

The applicator has an opening beyond the globe so that there is no scatter of X-ray toward the globe. I believe I would prefer that to an alcohol injection of my orbit, especially for the symptoms of recurrent erosion, or where we are simply trying to get the patient able again to wear his contact lens.

The conjunctiva flap of Gundersen is very efficacious in relieving the symptoms of pain from a cornea severely afflicted with bullous keratopathy. It certainly does not improve the visual acuity. While foreign to this paper, I have had many patients with endothelial dystrophy, with as much as 20/70 handicap to their visual acuity who have returned to 20/20 after X-ray of the lacrimal gland.