ACUTE KERATOCONUS*

BY *Frederick C. Blodi,* M.D., AND *Alson E. Braley,* M.D.

ACUTE KERATOCONUS IS AN EXACERBATION in the usually slowly progressing course of this corneal dystrophy. Its clinical picture and treatment have recently been summarized.[1] The sudden deterioration of vision, the marked corneal edema, and the greatly aggravated bulging of the corneal stroma are hallmarks of this phase. It has been known for many years that keratoconus occurs frequently in patients who suffer from Down's syndrome[2] or are otherwise mentally retarded.[3] Only recently has it been pointed out that in this group the acute stage is a frequent complication.[4]

The cause of the acute episode is a sudden rupture of Descemet's membrane. This has occasionally been observed clinically after the cornea had again become clear and it is a rather consistent finding in the few buttons which have come to histologic examination[5-7] and in the globes enucleated with this condition.[8]

Treatment may be either conservative or surgical. In many cases a pressure dressing will suffice. The edema will disappear in time and the resulting scar can be taken care of when the condition has quieted down. On the other hand, with the improvement of technique and equipment, penetrating keratoplasty may be performed in the acute stage and some authors regard this operation as the treatment of choice.[7]

CASE REPORTS

CASE 1

This 14-year-old girl was known to have had keratoconus for at least four years. Two years before admission she was fitted with contact glasses. With these her vision had been satisfactory.

When first seen in our hospital she complained about a sudden loss of vision in her left eye which had occurred two weeks before her visit. The left eye was painful and the contact lens could no longer be worn. When

*From the Department of Ophthalmology, College of Medicine, University of Iowa.

TR. AM. OPHTH. SOC., vol. 65, 1967

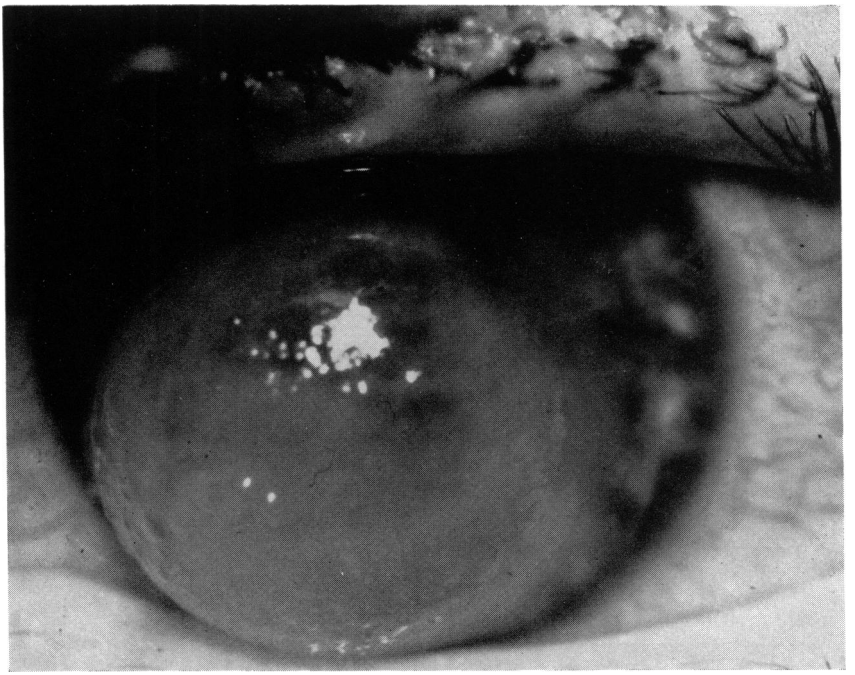

FIGURE 1. CASE 1.
Left eye on admission.

she was admitted the right eye showed a marked keratoconus with a visual acuity of 6/6 with the contact lens. The left cornea was nearly completely opaque and severely edematous. Several bullae were visible on the surface. The cone was bulging forward to such an extent that the lids could not be closed over it (Figure 1). Vision was reduced to light perception with good projection. In every other respect the young girl was of normal development and average intelligence. Because of the pain and the severe protrusion of the cornea it was decided to operate in the acute stage.

A penetrating keratoplasty was performed on November 7, 1964 (by F.C.B.). A 9-mm. button was used (Figure 2). The immediate postoperative course was uneventful but four months later a typical homograft reaction occurred. The cornea cleared with intensive steroid treatment and eight months after the operation vision in this eye was 6/6 with a contact lens. The cornea remained crystal clear (Figure 3).

The histologic examination of the excised corneal button showed a marked edema of the corneal epithelium and stroma (Figure 4). There was a definite break in Descemet's membrane (Figure 5). Over the area of this

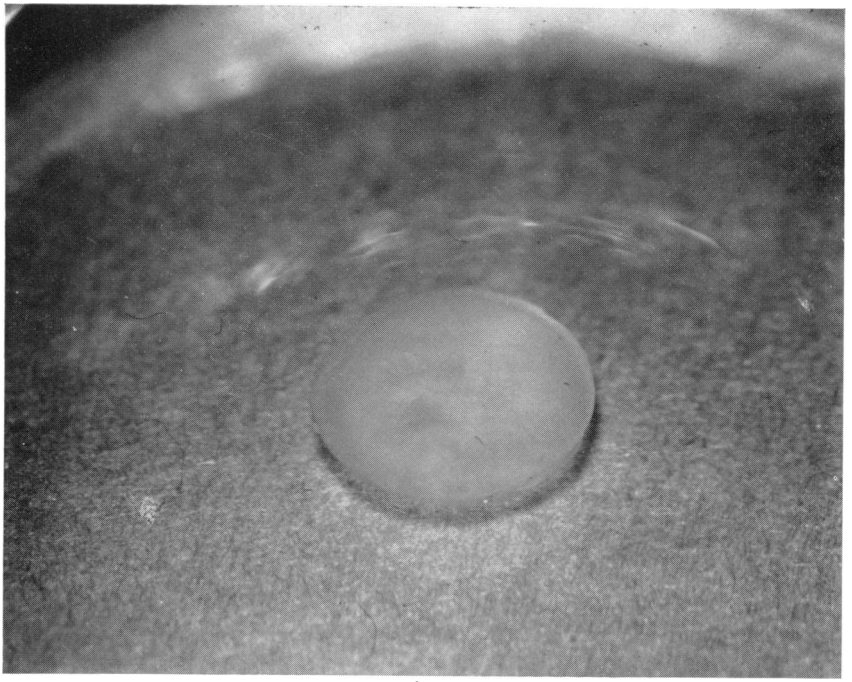

FIGURE 2. CASE 1.
The excised left corneal button.

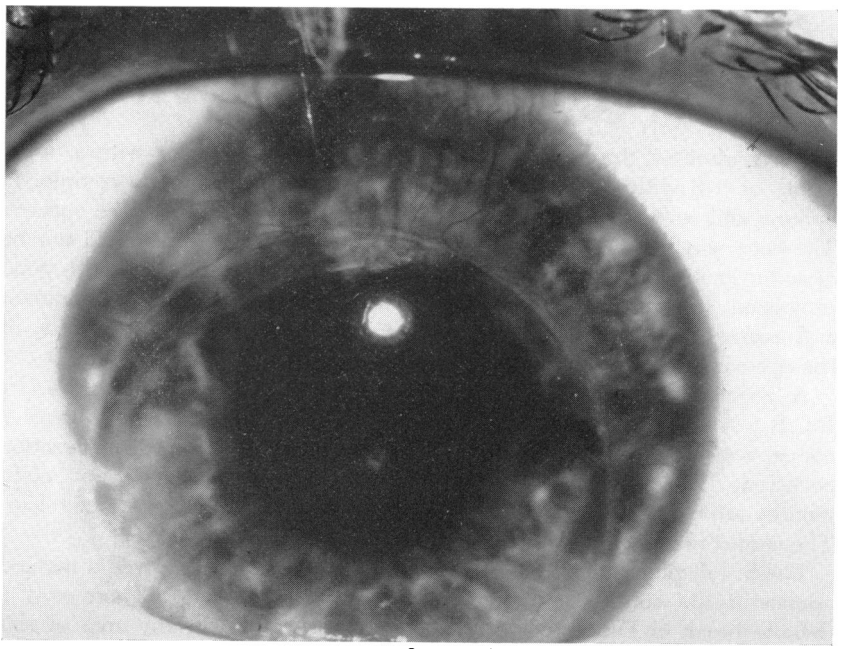

FIGURE 3. CASE 1.
The left cornea eight months after operation.

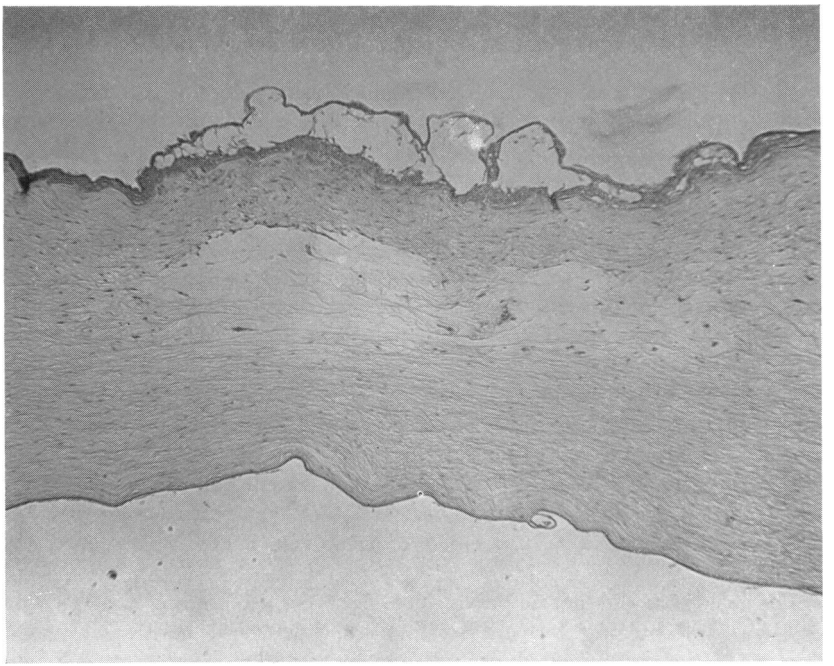

FIGURE 4. CASE 1.
Severe corneal edema with epithelial bullae and a cyst-like space in the stroma (H and E, × 42).

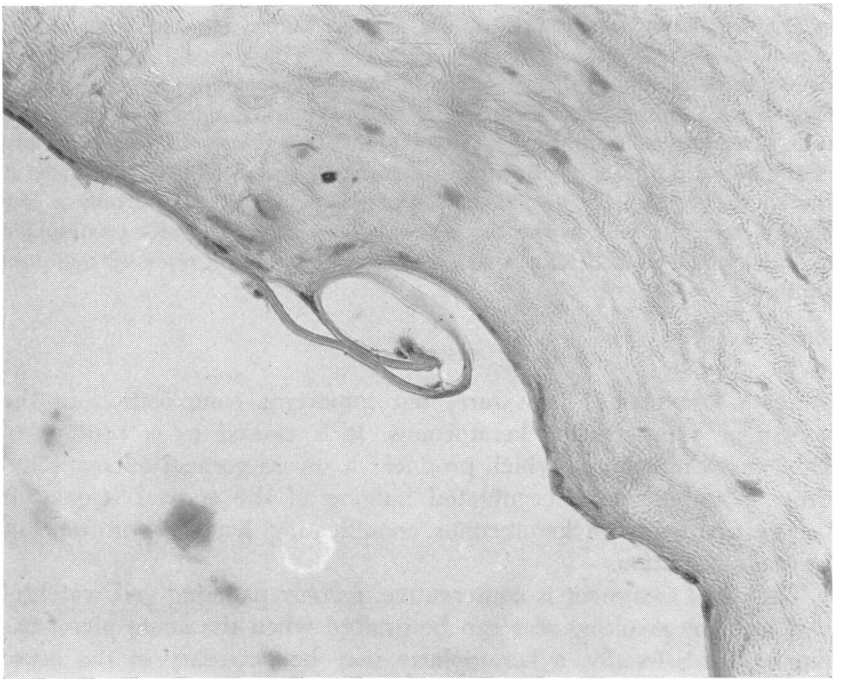

FIGURE 5. CASE 1.
Rupture in Descemet's membrane (H and E, × 293).

break the stroma was especially edematous leading to the formation of a cyst-like space in the center of the stroma. The epithelium showed vesicles and bullae over this cyst. The cornea was thicker than normal.

CASE 2

This 72-year-old woman knew that she had had keratoconus in both eyes for at least 50 years. For the last years the right eye had been her better eye. Suddenly, on July 26, 1966, she lost a great deal of vision in her right eye. This was connected with a sharp pain, as if something had hit her eye.

When she was first seen in our hospital on August 2, 1966, the right cornea showed a severe corneal edema with marked bulging forward of the corneal stroma. The cornea was milky white and the anterior segment could not be seen (Figure 6). Vision was reduced to hand movements. The left cornea showed an advanced keratoconus with scarring of the corneal apex. Vision in that eye was counting fingers at 2 feet. The patient was otherwise in good health and it was decided to treat this acute keratoconus with patching.

The condition did not improve. The right cornea became chalky white and was still bulging forward so that the lids could hardly be closed. Because of the visual difficulties and constant irritation a penetrating keratoplasty was performed (by A.E.B.) on November 12, 1966. An 8-mm. button was excised. The postoperative course was uneventful. The graft remained clear and four months later visual acuity with correction was 6/12.

The histologic examination of the excised button showed a thickened cornea which only appears normal at the apex. This was due to a posterior defect corresponding to the rupture in Descemet's membrane (Figure 7). The corneal epithelium was irregular with a marked edema of the basal cells. The basement membrane stood out conspicuously in the periphery of the button (Figure 8). Bowman's membrane was defective, especially at the apex (Figure 9). The apical part of the stroma contained only a few keratocytes. The bulk of the tissue was a homogenous, faintly eosinophilic material which stained with Alcian blue and probably represented a ground substance.

DISCUSSION

Acute keratoconus is a rare, but important complication in the course of a progressing keratoconus. It is caused by a rupture of Descemet's membrane which produces a severe corneal edema ("hydrops") and a more accentuated bulging of the corneal stroma. It occurs frequently in keratoconus complicating Down's syndrome or mental retardation.

The usual treatment is conservative, namely patching and watchful waiting. The resulting scar can be grafted when the acute phase has passed. Occasionally, a keratoplasty may be necessary in the acute

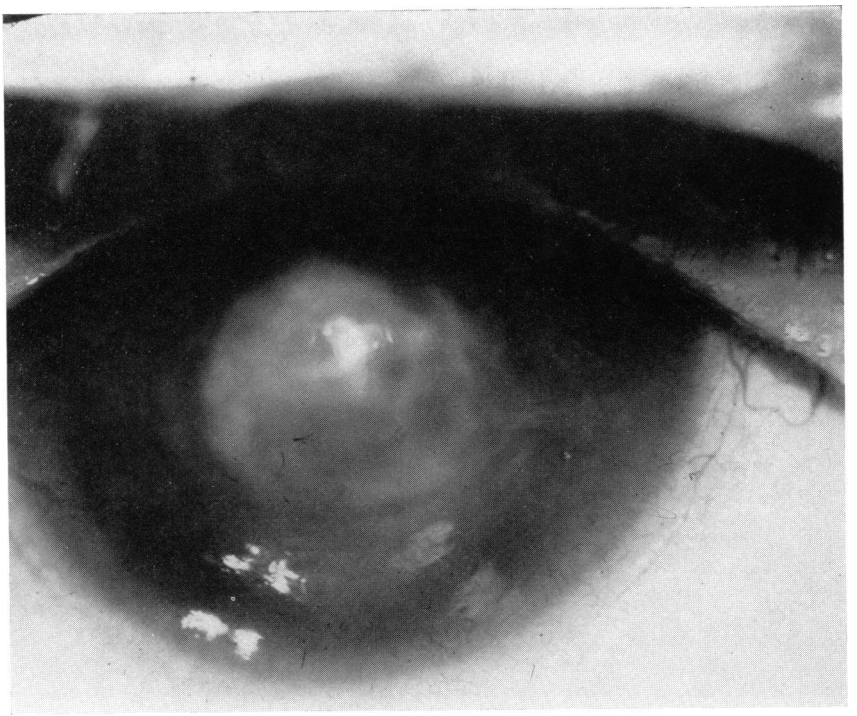

FIGURE 6. CASE 2.
Right eye before operation.

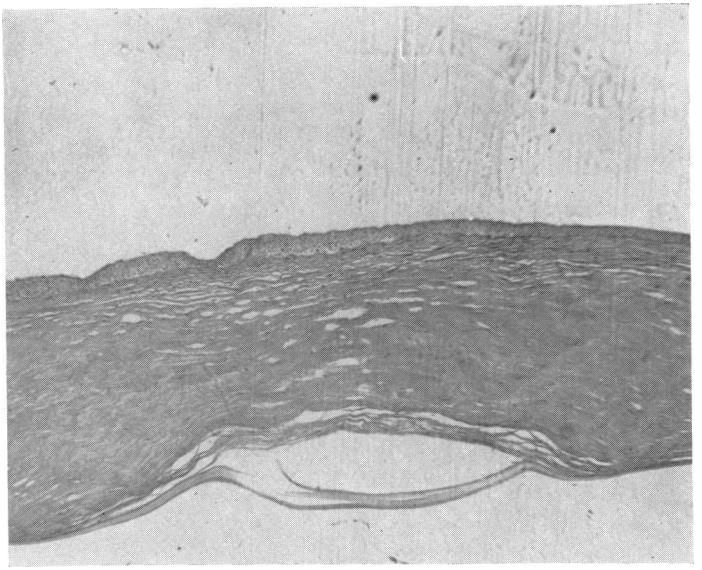

FIGURE 7. CASE 2.
Thickened cornea with thinning at apex (Alcian blue, × 40).

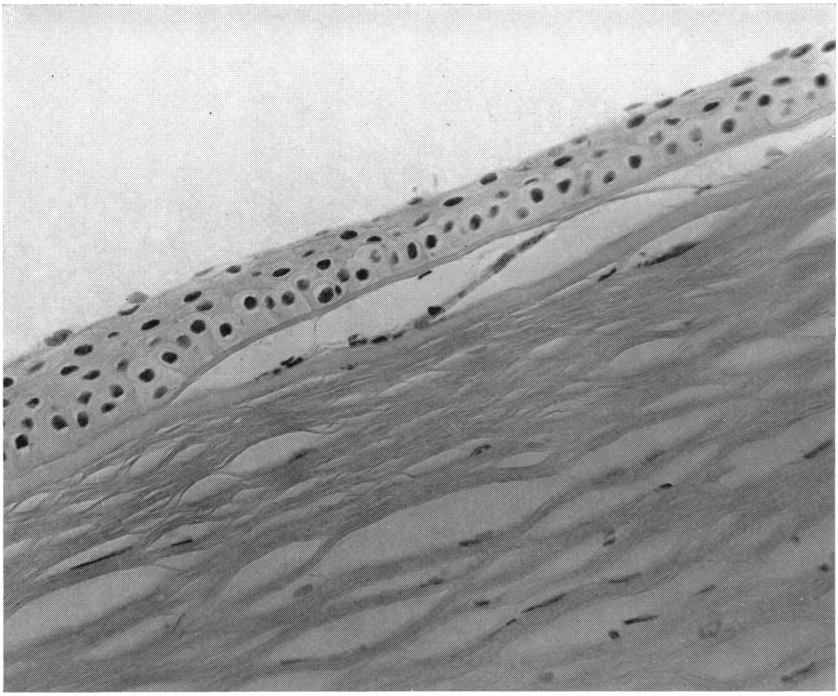

FIGURE 8. CASE 2.
Epithelial bulla with thickened Descemet's membrane (H and E, × 140).

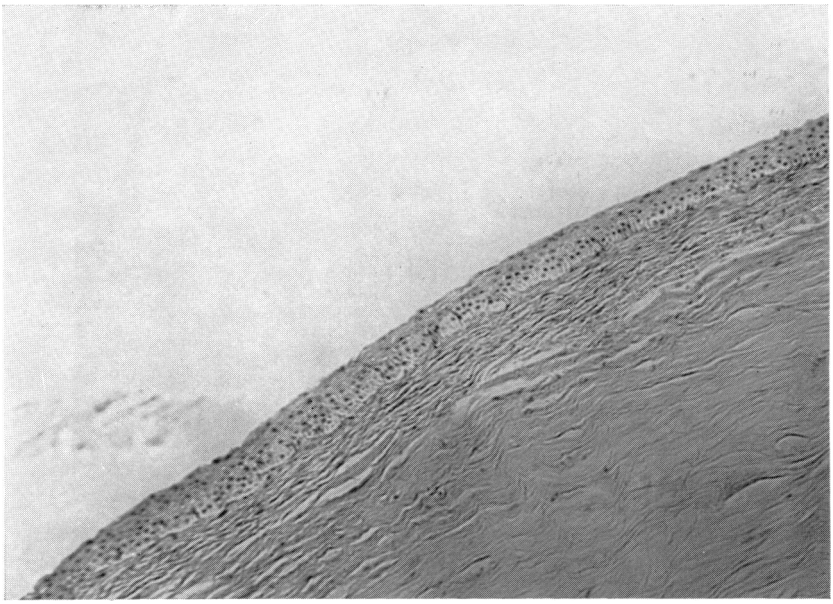

FIGURE 9. CASE 2.
Corneal edema. Bowman's membrane is absent. (H and E, × 85.)

phase when epithelial bullae and the inability to close the lids cause severe pain. This was the case in our first patient. In our second patient the corneal edema did not resolve. A complete, chalky-white opacification of the cornea resulted, due to an accumulation of ground substance in the corneal stroma. Poor vision in both eyes made surgical intervention in this patient necessary. Modern technique and armamentarium allow the grafting of large corneal buttons (8 or 9 mm.). In our two patients the good visual results justify such an operation.

CONCLUSION

This is a report of two patients with acute keratoconus on whom it was necessary to operate. The visual results were excellent. The histologic picture revealed by the excised buttons includes a break in Descemet's membrane, severe corneal edema, and cyst-like spaces in the stroma.

REFERENCES

1. Franceschetti, A., Keratoconus, in J. H. King, Jr., and J. W. McTigue, eds., The Cornea World Congress, Washington, Butterworths, 1965.
2. Rados, A., Keratoconus and mongolism, Arch. Ophth., 40:454–78, 1948.
3. Stucchi, C. A., and G. Erpelding, Keratocone aïgue et oligophrenie, Conf. neurol., 20:376, 1960.
4. Cullen, J. F., and H. G. Butler, Mongolism (Down's syndrome) and keratoconus, Brit. J. Ophth., 47:321, 1963.
5. Boeke, W., and H. Conrads, Zur Histologie der Hornhaut bei akutem Keratoconus, Graefes Arch. Ophth., 159:277, 1957.
6. Guenther, G., Keratoplastik in zwei Faellen von akutem Keratoconus mit histologischen Beitrag zur Pathologie der Hornhaut, Klin. Monatsbl. Augenh., 133:40, 1958.
7. Zajacz, M., Akuter Keratoconus, Klin. Monatsbl. Augenh., 143:503, 1963.
8. Zimmerman, L. E., cited in [4].

DISCUSSION

Dr. John Harry King. I thank the authors for sending me their interesting paper. I was somewhat distressed when I had read through the last sentence preceding the case reports—that "with the improvement of technique and equipment, penetrating keratoplasty may be performed in the acute stage and some authors regard this operation as the treatment of choice." Upon reading to the last page, I felt much better. The authors stated that the usual treatment is conservative and that occasionally keratoplasty may be necessary in the acute phase when there are unusual circumstances. I certainly agree that the two cases presented did offer complications which necessitated a surgical approach during the acute phase. But I think it

should be stressed that these are very unusual circumstances and that conservative treatment must be standard or at least be given a thorough trial before surgery. I do not agree with those who feel that operation is the treatment of choice in the acute attack.

During a severe hydrops the cornea may be greatly edematous, even to the periphery. Unless that patient has been under previous observation the examiner can have no idea regarding the extent of the cone. He is most fortunate if he uses a trephine that happens to include the entire cone and therefore achieves a good result. He is just as likely to have used a trephine that is too small and have the operation eventually end in failure, with graft edema and clouding, or a later recurrence of the cone on the edge of the graft.

The cause of the acute edema is of course a rupture of Descemet's membrane, resulting from the pressure of the intraocular fluids against a thinned, weakened cornea. Rupture of Descemet's membrane is usually followed by "self-sealing" when a reduced intraocular pressure is sufficiently maintained. The tissues come together not unlike a puncture in a self-sealing automobile tire. If the leak continues, it must be sealed mechanically and this is the function of the corneal graft. This sealing can be accomplished regardless of the size of the trephine. A good long-term result however demands the use of a trephine large enough to include the entire cone prior to the hydrops. The smaller the trephine that can be selected, the better the prognosis. The larger the penetrating graft the more fraught the procedure is with complications, especially in a markedly edematous host cornea.

Conservative treatment should consist of firm continued pressure dressings (with adhesive tape and two or more eye pads). Equally important, if not more so, the intraocular pressure must be reduced. This requires the use of Diamox in large doses, the restriction of fluids, and the local use of dehydrating agents. I have only seen one patient with marked keratoconus and hydrops in whom this therapy failed. And in this case surgery also resulted in failure. I would like to ask the authors if any measures other than "patching and watchful waiting" were employed in their two patients. The second patient apparently had hydrops for over three months—was patching alone applied for this entire period?

I enjoyed this presentation and should like to emphasize that the authors' judgment and technical expertise are not apt to be duplicated by the average surgeon. I therefore offer a plea that vigorous conservative therapy be used for acute keratoconus and that surgical treatment be reserved for the rare cases.

DR. J. REIMER WOLTER. When I saw Dr. Blodi's paper on the program it occurred to me that Dr. Henderson of Ann Arbor, Dr. Clahassey, and I had just submitted a paper on ruptures of Descemet's membrane in keratoconus to the *American Journal Of Ophthalmology* (63:1689, 1967). This concerned a 20-year-old male who had unilateral keratoconus. He also had

hypothyroidism and had been treated for that. This patient had an interesting history of three episodes of acute corneal hydrops which had come on suddenly and led to increasing corneal scarring. Finally Dr. Henderson did a corneal transplant, and I would like to show you briefly the histologic findings which confirm what Dr. Blodi just stated. There were three ruptures of Descemet's membrane corresponding to the three episodes of hydrops that this patient had experienced. The breaks were arranged horizontally in the cornea, and from the thickness of the new-formed Descemet's membrane on the ruptures we concluded that these occurred at different times and were of different age.

DR. RAMÓN CASTROVIEJO. I should like to congratulate Drs. Blodi and Braley for their interesting presentation. I think, however, that the term "acute keratoconus" should be used only when a conical protrusion of the cornea develops suddenly in an eye that previously had fairly normal corneal curvature. In reality, the cases presented by the authors are eyes in which a sudden rupture of Descemet's membrane in a pre-existing keratoconus led to the imbibition of aqueous humor by the corneal stroma and the development of acute hydrops.

Once the acute hydrops is established the treatment of choice is the daily application of a firm pressure bandage combined with the systemic administration of a hypotensive medication such as Diamox. With this treatment the acute edema subsides within a few days. Whenever possible it is preferable to reduce the acute edema before a keratoplasty is performed because in reducing the edema, the area to be excised, that affected with keratoconus, is frequently diminished in size and a smaller graft is then required. In addition, after the edema has been reduced or has completely subsided, the eye is quieter and the postoperative reaction is usually less pronounced.

Some patients do not have sufficient time to undergo prolonged treatment and in these cases keratoplasty can be performed without first reducing the edema if care is taken to excise all the edematous corneal tissue, as illustrated by the following case. [Slides showing a case of advanced keratoconus with acute corneal edema with the conus displaced downward before and after a partial penetrating keratoplasty with a 7.5-mm. square graft. Note how the graft is placed with one corner directed downward to include the displaced conus, while the opposite corner extends beyond the pupillary area so that the scar tissue of the incision will not interfere with the vision.]

Again I extend my congratulations to the authors for their interesting presentation.

DR. FREDERICK W. STOCKER. For the benefit of the younger members of this Society who have not had much experience with corneal grafts, I should like to emphasize that whenever possible one should reduce the acute symptoms of keratoconus before attempting a graft. The procedure shown here should be reserved only for desperate cases. The authors should be congratulated on their beautiful results in a very difficult situation.

DR. R. TOWNLEY PATON. On a certain Sunday afternoon a man, aged 40, was attending a baseball game. The Yankees were behind, and as he stood up to cheer the team a foul tip struck him in the eye. I saw this patient two weeks later. He had a very bad advanced hydrops. I treated the hydrops by cauterization to reduce it and then did a 7-mm. corneal transplant. The patient did very well for several months. Then he began to complain of severe headaches. I did not pay too much attention to this complaint, as the graft looked absolutely clear. His headaches became increasingly severe. Finally, when I looked in with the ophthalmoscope after a year, I saw that he had rather marked cupping of the disk. I then realized I was dealing with a case of traumatic glaucoma, and probably should not have operated but should have made that diagnosis. I therefore want to warn everybody who sees a case of unilateral keratoconus following trauma to check that they are not dealing with a case of traumatic glaucoma.

DR. HAROLD F. FALLS. I wish to emphasize an observation that most of us have made concerning the hyperextensibility of the joints and the hyperelasticity of the skin of mongolian children. These are evidence of a defect in collagen tissue and possibly explain the high incidence of keratoconus in this chromosomal-influenced disorder. Other examples of entities exhibiting hyperelasticity of the skin and hyperextensibility of the joints are Ehlers-Danlos syndrome and Marfan's syndrome.

Recently Dr. Kertesz and I had an opportunity to study a family with Leber's congenital amaurosis who had keratoconus in relation to that disease disorder. We were surprised to find a high incidence of hyperextensibility of the joints and elasticity of the skin in these individuals. Therefore, I call your attention to the possibility that keratoconus can be associated with diseases of protein metabolism.

DR. ROBISON D. HARLEY. I would like to comment upon acute hydrops seen in keratoconus associated with Down's syndrome. We have seen two cases recently at the Wills Hospital. The first one, a 12-year-old girl, was treated conservatively. Pressure dressings were advised but the attending nurse failed to achieve sufficient pressure. No improvement was noted after two days and a more adequate pressure dressing was obtained. After three weeks the cornea was clear except for a small opacity in the center. Certainly this was an amazing improvement in a short time. The other patient, a 15-year-old mongoloid, had a similar episode of acute hydrops in a keratoconus which appeared quite similar to the first case. She was assigned to a service which elected to do a graft. The first graft was beautifully performed but was extruded in a short time and a second graft was necessary. The second graft has become opaque after three weeks.

Chromosomal studies in each case showed 47 chromosomes—45 autosomes and 2 X-chromosomes. Keratoconus is common in mongolism and when acute hydrops occurs it would appear from our limited experience that

conservatism is preferable initially. It can be followed by corneal grafting when the acute process has subsided.

DR. ALBERT D. RUEDEMANN, JR. I think the authors should be congratulated for bringing this very interesting clinical entity to our attention. We are presently reviewing our private cases of this disease. We call acute keratoconus acute corneal hives superimposed on keratoconus, because in our series of twelve cases of this disease, eleven of the twelve had a known severe allergic history. One patient was a mongoloid who was operated on to clear the cornea and improve vision. One was operated on this past spring and was a proven hypopituitary and hypothyroid individual who could not read at the age of 12.

We feel these patients should not be operated on in the acute phase, but that the eye should be allowed to quieten down for a period of weeks to months, and then be operated on with a graft large enough to encompass the entire affected cornea. Most of these eyes require grafts of 8 or 9 mm. or larger. We like to use miotics and pressure dressings. Of our twelve acute cases we have seen seven in the past year. Last spring we had five cases from the first week in March to the first week in June, and we have had two cases this spring from April to date. In the acute series there were twelve cases. Two of the twelve acute cases perforated. Two of the twelve cases had a history of trauma: one was a belt buckle and the other was a sheet. Two of the twelve cases were bilateral.

Again I thank the authors for bringing this subject to our attention.

DR. PAUL A. CHANDLER. I am sure you are surprised to hear me discuss this paper, never having done a corneal transplant and only having seen one done.

Some of you may have heard Mr. Frederick Ridley of London, who has done so much work with scleral lenses, remark that he thinks many cases of ordinary keratoconus are caused by rubbing the eyes. Well, I was not much impressed with this idea when I first heard it, but a few months ago I had a 38-year-old woman with a history of uveitis for 15 years in one eye. The secondary glaucoma became rather severe, and I trephined the eye. The bleb was not very good, and other treatment was used. Among other things, I instructed her in how to press on her eye from below three or four times a day—ordinary massage. To my great surprise at a follow-up visit in a few weeks she had very marked keratoconus in this eye. It was not hydrops—just an ordinary, clear keratoconus, one of the most marked anyone could ever see.

So, perhaps in patients who have keratoconus, they should be questioned about rubbing their eyes and warned to avoid anything that will cause increased pressure on the eye. I daresay I am the only man in the room who has produced keratoconus.

DR. CLEMENT MCCULLOCH. I would like to reiterate Dr. King's remark concerning conservative treatment for acute corneal hydrops. Actually, I think there is another form of treatment that has not been mentioned here and which is very valuable.

I would like to describe the case of a 24-year-old woman with keratoconus who developed acute corneal hydrops. When I saw her the whole cornea was apparently involved, and the disk of edema extended at least 5 mm. forward, as well as involving the whole cornea. In the course of a week or so this large, round disk extended even farther forward and protruded between the lids. I realized that it was going to ulcerate and that further complications would ensue.

At that stage I turned down a conjunctival flap, as I would for a filtering operation. Having arrived at the limbus I dissected into the stroma of the cornea and extended this into the middle of the button of edema. When I entered the button of edema, the button collapsed and the anterior chamber collapsed. However, I passed a thin silicone seton into the center of the cornea, ran it out under the conjunctival flap, and closed the flap in layers. Following this operation, the collapsed button reformed slightly but a bleb appeared under the conjunctiva. Over the subsequent weeks the corneal button scarred more and more and eventually the conjunctival bleb collapsed. I was left with a scarred cornea and a flat conjunctiva and I could see the silicone seton running up across the limbus.

Three months after this procedure, I removed the silicone seton from the conjunctival side. At the present time I am left with a lady with a scarred cornea, as is shown in the slide, and a quiet eye. If I try a corneal transplant now I will feel much safer than I did in the acute phase.

DR. BRENDAN D. LEAHEY. I have always been a firm believer in conservatism and use of pressure on these eyes. Dr. Ted Terry of Boston was the first to publicize the use of pressure in the early 1940's. He became overly enthusiastic and invented a head band with a spring holding a pressure arm against the eyepad. After two or three successful cases, some eyes developed hypopyon. One such eye was badly damaged and I believe lost. I do not recall what the complication was. During the next few years the use of pressure was entirely out of favor in Boston. In the late 1940's we again started to use moderate pressure applied by means of a full pressure bandage. These were changed every three days and left on for three or four weeks. Even with this we had several cases that developed inflammatory signs and one with a slight hypopyon, proving that the eye does not support too much pressure for too long.

At the present time we are using pressure very successfully, but employ only ordinary elastoplast dressing over the eye. We also use prednisone systemically on the theory that it may cut down the amount of reaction. Dr. King recommended very firm pressure, but I think moderate pressure is far safer if it is to be used over a long period of time.

DR. CHARLES E. ILIFF. After listening to the discussion, one point seems to me interesting. Dr. Chandler states that he has produced a keratoconus with pressure. Other members have said that this is the way to treat keratoconus. I think it is extremely interesting that no one has said that you bandage only one eye. I feel that if you bandage both eyes, Bell's phenomenon will take over and the keratoconus will be more likely to continue. It should be emphasized that bandaging only one eye is the treatment of choice.

DR. BRALEY. We want to thank everyone for their fine discussions of this paper.

I want to tell you that there is another theory about the formation of keratoconus. If Dr. Dick Schultz were in the audience perhaps he would tell us about it, but as I do not see him, I will tell you.

I do not know whether any of you have ever visited a trout farm, or have seen the keratoconus that lake trout, particularly Lake Superior trout, develop. This is one of the most interesting phenomena I have ever seen. When they are raised in captivity, eighty-five per cent of these lake trout develop a keratoconus with complete rupture of their eye. This may be a very important reason why lake trout disappear. This disease among trout acts exactly like a keratoconus. A small cone forms which then goes on to the formation of a hydrops (if you wish to call this term "hydrops"), with ruptures in Descemet's membrane. Eventually the cornea is partly extruded and ruptured, and the bottoms of the troughs where these trout are raised are full of the lenses that have been extruded from these fish eyes. It is a most interesting ophthalmological picture. Eighty-five per cent of the trout develop a keratoconus at about 6 years of age.

We agree with everything Dr. King has said. We do not like to operate on these cases immediately unless there is some particular reason. In our instance we had to learn when these cases should be operated on. When the patient is crying and screaming and cannot see, sometimes you will do things that perhaps you should not do. We do not want to operate on any mongoloids, the 21 trisome particularly, because most of these people with connective tissue disorders develop a keratoconus that can be extremely painful. We do not feel that they should be operated on at least at that time.

It certainly is worthwhile to watch and wait in almost every instance. We are not agreed that there is an increased intraocular pressure, however. We feel this stretching is not due to pressure but to the stretching of the keratoconus itself. Most often we will wait at least three months before anything is done. We have followed the procedure of reducing the intraocular pressure by giving Diamox. However, this is not always necessary.

None of our cases had trauma, but we do know that the trauma occasionally produces a kind of hydrops of the cornea. In the instance we feel there is undoubtedly an angle rupture from the trauma, and this is one thing you must remember occurred.