TRANSSCLERAL LACRIMAL CANALICULUS TRANSPLANTS*

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The fact that glaucoma is one of the common causes of blindness and one of the most difficult therapeutic problems encountered by ophthalmologists, justifies further research in an attempt to control this destructive disease. In view of the limitations of present-day management of that group of clinical entities which we classify as glaucoma, we are looking forward to the day when an adequate medical régime will entirely replace the surgical treatment of glaucoma. Medical treatment has many obvious advantages over surgical treatment. It seems more rational, and is the type of treatment in which the prospects for successful future advances seem more likely. Until that day when the satisfactory medical treatment has been established, it is still necessary to rely on the surgical approach to this problem in both the clinical and the research fields.

Of the more satisfactory types of operative procedures for the control of ocular hypertension have been those operations which utilize uveal epithelium to form a permanent channel through the sclera from the anterior chamber to the subconjunctival tissues in order to establish aqueous filtration. While these types of operations are performed merely to secure symptomatic relief, it has been demonstrated that they are fairly effective in preserving vision in many eyes when performed at a sufficiently early date. In view of the technical disadvantages of all these accepted operations, it is with considerable hesitancy that an even more complicated and

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technically difficult procedure is proposed, such as transscleral canaliculus transplants. However, this seemed an interesting field for surgical research, and consequently the following investigation was carried out.

THE PROBLEMS

It is the purpose of this thesis to report a series of experiments which were performed with the immediate objective of investigating the various early steps in the establishment of an epithelial tube through the sclera with the ultimate hope of finding a type of filtration operation that might be an addition to our operative armamentarium in the control of glaucoma. Since an epithelial tract of iris tissue functions satisfactorily in some instances and fails in others, another source of epithelial tissue was sought which would have anatomic and physiologic advantages over the uveal tissue. The tube-like structure of the lacrimal canaliculus seemed to satisfy this requirement. If it could be satisfactorily grafted into the sclera, it might be utilized as a source of epithelial tubing for the establishment of a drainage canal from the anterior chamber through the sclera to the subconjunctival spaces. The six main problems which presented themselves were: (1) Could the canaliculus be satisfactorily dissected from the lids and freed of connective tissue; (2) could it be placed into the sclera satisfactorily; (3) could it be maintained in position; (4) if it was maintained there, would it be grafted and remain viable or would it become necrotic, and (5) would the eye tolerate this transplant, and (6) if so, would it filter aqueous in the proper amount?

PROCEDURE

Problem No. 1 was solved relatively easily. In the spring of 1938 one eye of each of seven dogs was operated on. Under ether anesthesia the lacrimal punctum of Dog 1A was dilated and a lacrimal probe was inserted. A circular incision was made through the conjunctiva around the punctum, about

1 mm. from the probe. Dissection was carried down into the tissue about 3 to 4 mm. on all sides of the probe. When this depth had been reached, the probe was withdrawn slightly and the canaliculus was cut transversely, leaving a collar of canaliculus about 3 mm. long around the probe. The specimen was trimmed of connective tissue, and a satisfactory segment of the lacrimal canaliculus was obtained for transplantation.

Problem No. 2 was the placing of the graft into the sclera. A keratome incision was made through the sclera into the anterior chamber, but it was found technically impossible to place the graft into the sclera and the first eye was lost. This difficulty, however, suggested the necessity of inserting an obturator into the lumen of the canaliculus. Consequently, segments of metal lacrimal stylets, about 3 mm. long, were fashioned, and at the second operation the canaliculus was placed around the stylets quite satisfactorily. When the stylet containing the canaliculus was introduced into the keratome incision, the cornea was so displaced in Dog 2A that it became obvious that some type of procedure that would remove part of the sclera was necessary to accommodate the graft. Since a keratome incision had been made, the eye of Dog 2A was lost for further research. In the third experiment, which was performed on Dog 3A, the canaliculus was prepared as previously described. A keratome incision was made in the sclera, about 2 mm. back from the limbus. Then, with a Berens scleral punch, a 1 mm. segment was taken from the anterior lip of the scleral incision. The graft with the metal obturator was inserted and they fitted well into the scleral opening. The conjunctiva was closed over the metal obturator and the graft. Two days later the obturator had slipped out of position and the eye was lost. The fourth experiment, which was performed on Dog 4A, was similar to the foregoing experiment, except that an "L"-shaped stylet was used in an attempt to keep the graft from slipping. This seemed to work somewhat better, but

a severe incarceration of the iris occurred, which suggested the necessity of combining an iridectomy with the transplantation in order to prevent the development of iris synechia. In the fifth experiment, on Dog 5A, an angled stylet was introduced through the Berens punch wound after an iridectomy had been performed. On the third post-operative day the wound became infected and the transplant sloughed out. The same result was met with in the next two operations performed on Dogs 6A and 7A. All the operations in Series A were failures, and the conclusion was drawn that the stylet was too great a foreign body and proved an unsatisfactory obturator. None of the material from these experiments was adequate for microscopic study. The second step, namely, that of placing the transplant into the sclera, was not feasible, and the work was discontinued for two and one-half years, as the opportunity for further research was not available until the fall of 1941, at which time a second series of operations were performed. The animals in this series were termed B.

In September, 1941, this B series of operations was begun. Ten operations on nine eyes of six dogs were performed. It was recognized that a method to create intracanalicular pressure all along the canaliculus when it was placed in the sclera was necessary. This problem was similar to skin grafting, in which one of the paramount requisites is uniform pressure over the graft. This problem differed from skin grafting, however, in that the pressure had to be applied to the 360 degrees of the internal circumference of the canaliculus. Since the metal obturator had apparently failed in the previous series of cases, the necessity for a softer and absorbable obturator was recognized, and catgut was selected as a possible material.

Accordingly, on September 15, 1941, Dog 1 of Series B was operated upon under intravenous veterinary nembutal, 4 c.c. being injected according to dosage calculated on the body weight of the dog. The canaliculus was prepared according to the method described in Series A, and placed in physio-

logic salt solution. A large conjunctival flap was dissected, and a keratome incision was made 2 mm. back of the limbus, and about 4 mm. long, passing into the anterior chamber. An iridectomy was performed. With a Berens scleral punch a 1 mm. button was removed from the anterior lip of the keratome incision, to accommodate the canaliculus graft. The canaliculus was then removed from the salt solution. A long No. 0 catgut suture was threaded through the canaliculus, and then turned around and passed back and forth through the canaliculus seven times until it was no longer possible to pass further strands through the lumen. Close to each end of the canaliculus a loop of catgut was tied around the strands of catgut as they protruded from the lumen of the canaliculus, and both ends were securely tied. Next the strands which passed through the lumen were cut off close to the knots. Thus the implant consisted of a segment of canaliculus, about 3 mm. in length, through the lumen of which passed seven strands of catgut, which in turn were tightly tied at each end so that they formed a unified obturator. This implant was then inserted into the scleral opening made by the Berens punch. With a little manipulation it slipped snugly into the opening and seemed quite secure. The conjunctival flap was sutured back in place over the implant. The knot on the inner end of the implant could be seen in the anterior chamber, and the knot on the outer end made a slight protrusion under the conjunctival flap. This solved problem No. 2, namely, whether the canaliculus could be satisfactorily placed in the sclera. On the third post-operative day the dog died an anesthetic death, never having regained consciousness. The eye was immediately removed, placed in formalin, and sent to the Pathology Department for microscopic study.

The microscopic slides from this dog failed to show the operative field. Due to a technical error in the preparation of the sections no microscopic evidence of an operation having been performed was discernible. It is most probable that

additional sections from this eye and others in which the operative field was not located would have been fruitful, but for technical reasons this was not done.

On September 22, 1941, Dog 2 of Series B was operated on in a similar manner, but before the operation was completed the dog died an anesthetic death. The operation was completed, but no study was made or conclusion drawn from this experiment, and there was no material for microscopic study.

On September 29, 1941, the right eye of Dog 3 of Series B was operated on in exactly the same manner as was the right eye of Dog 1B. The graft fitted snugly into the opening which was prepared for it. The dog recovered from the anesthesia. Atropine was applied to the operated eye daily, as it was in all subsequent experiments. One week later the eye was examined and was found to be in excellent clinical condition. There was only slight conjunctival reaction, localized to the operative field, such as one sees in a trephine operation. The cornea appeared to be normal. Two weeks later the reaction had almost completely subsided, and the catgut was not visible in the anterior chamber. Five weeks after the transplant this dog was again anesthetized with 5 c.c. of intravenous nembutal, and the conjunctival flap was again elevated in order to explore the operative field. The area of the canaliculus was located, and it was found to be covered with a very thin membrane of tissue which was on the external surface of the sclera. Gentle stroking of the membrane with a spatula caused it to rupture, and the aqueous was lost without opening the sclera. This suggested that the aqueous was coming through the canaliculus but was being retarded by this thin membrane. The membrane was so thin that it seems likely that if the aqueous was under pressure, as in glaucoma, it would easily have permeated the membrane. This solved problem No. 3, showing that the canaliculus could be maintained in position. The conjunctival flap was then resutured.

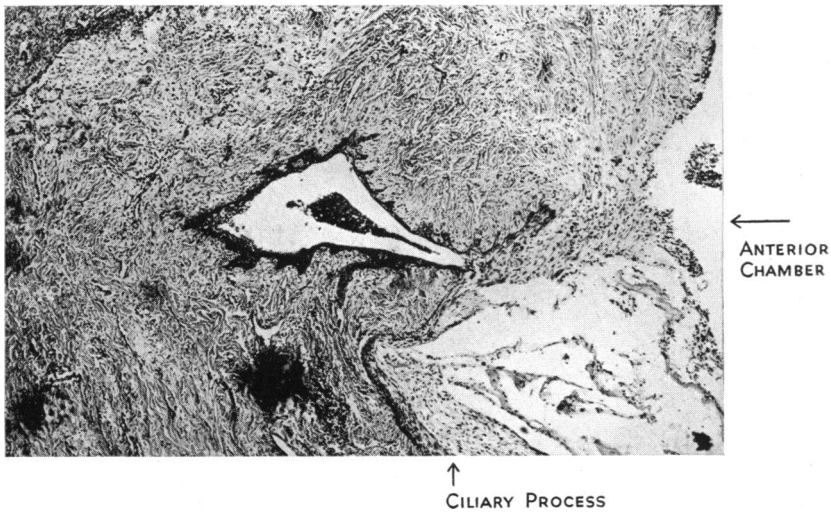

Fig. 1.—Dog 3, Series B (left eye).

Metal obturator. One week post-operative. Section shows canaliculus close to internal scleral surface, and the canaliculus epithelium is continuous with the epithelium of the anterior part of the ciliary processes.

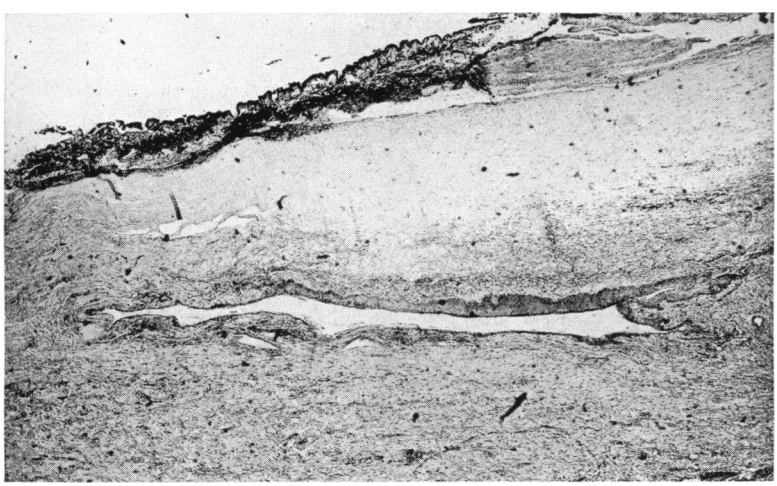

Fig. 2.—Dog 6, Series B (right eye).

Non-obturator technique. One week post-operative. Longitudinal section of canaliculus. The canaliculus is misdirected here, due to a technical error in operation.

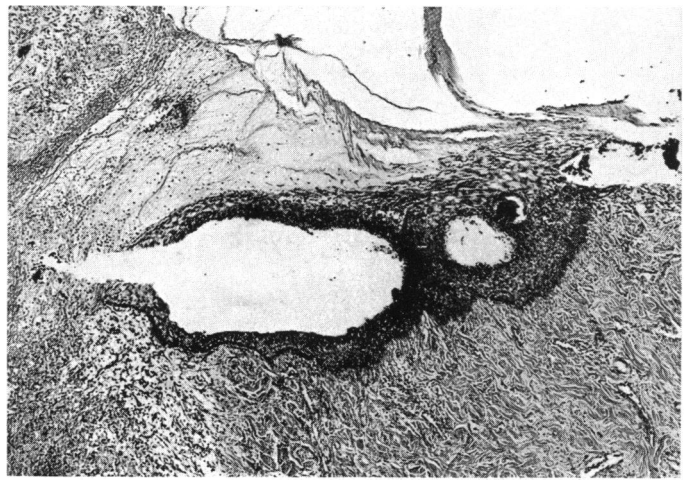

Fig. 3.—Dog 3, Series B (right eye).

Catgut technique. Eight weeks post-operative. This section shows canaliculus growing one-half way through sclera. The large open white area is not the anterior chamber, but a deep tear made in the sclera in preparation. The smaller opening is only part of the lumen cut obliquely. The lumen remains patent after eight weeks.

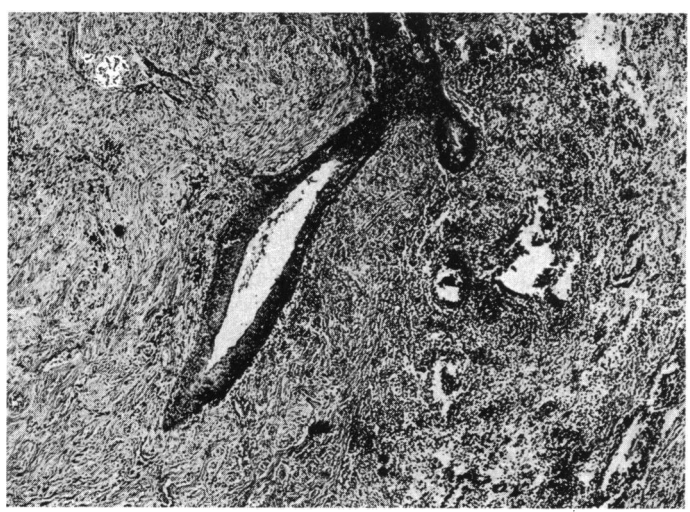

Fig. 4.—Dog 4, Series B (right eye).

Non-obturator technique. Two weeks post-operative. Canaliculus growing in center of sclera. The lumen is partly open and partly collapsed. This experiment shows that the transplant can be placed without an obturator, but the lumen remains open better in the catgut technique.

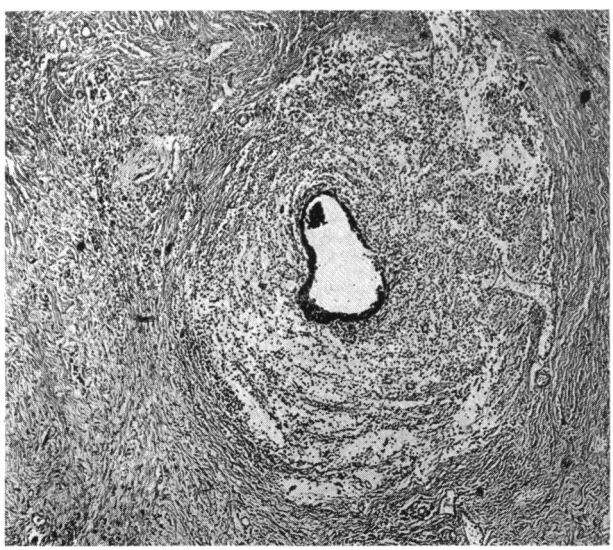

Fig. 5.—Dog 5, Series B (right eye).

Catgut technique. Three weeks post-operative. Section shows fair growth of epithelium with some necrosis. Around the canaliculus there is a zone of tissue composed of new granulation tissue, new round cells, edema, some pericanalicular connective tissue, and some new and active blood-vessels.

Ten days later the eye was examined, when the reaction was found to have subsided and the anterior chamber had formed. A hypodermic needle was introduced through the cornea into the anterior chamber, and sterile salt solution was forced in under pressure, through a syringe, to determine if the canal was patent, but no subconjunctival bulging over the area of the transplant could be demonstrated. One week later this eye was enucleated and sent to the laboratory for study. The pathologic material from this eye was properly located, and revealed the canaliculus with open lumen transplanted deep in the sclera.

On October 6, 1941, the left eye of Dog 4 of Series B was operated on in a similar manner. Eight strands of No. 0 catgut were drawn through the lumen of the canaliculus and placed in the sclera, as previously described. Ten days later the eye was in excellent clinical condition and the catgut was not visible in the anterior chamber. Three weeks after operation the eye was enucleated for microscopic study. Due to a technical error in the preparation of the sections, the field of operation was not visible in the microscopic specimens.

On October 13, 1941, the left eye of Dog 5 of Series B was operated on. The canaliculus was excised, a conjunctival flap was made, and a keratome incision was made 2 mm. back of the limbus. An iridectomy was done, and a scleral punch with the Berens instrument was made. Eight or nine strands of catgut were threaded through the canaliculus, and the transplant inserted into the punch wound. It snapped firmly into position, and the inner knot was visible in the anterior chamber; the conjunctiva was closed with a single suture. Examination two weeks later revealed that the knot had absorbed from the anterior chamber; the eye was soft, and a large pool of subconjunctival aqueous was present. One week later, or three weeks after this operation, sterile salt solution was forced under pressure into the anterior chamber, but no evidence of fluid exchange from the anterior chamber to the subconjunctival space was demonstrated.

On December 1, 1941, in the absence of other experimental material, and since this same eye looked as good as a non-operated eye, it was decided to do a second canalizing operation of a different type on this same eye. A conjunctival flap was dissected temporal to the area of the first operation. A keratome incision was made and a second iridectomy was done. At this time it was our impression that the previous technique had not been satisfactory, and another type of operation was performed. No catgut or metal obturator was employed and no Berens punch procedure was used. The canaliculus was sutured into the incision in the sclera. Two silk sutures were placed in the corneal margin of the incision and then passed through the side of the canaliculus without perforating the lumen; the sutures were then passed through the posterior part of the keratome incision, and the canaliculus, without an obturator, was inserted in the keratome incision. It fit snugly in place. The sutures were tied, and the canaliculus was in a very satisfactory position. It was hoped that the raw external surfaces of the canaliculus would graft to the surface of the incised sclera down through the depth of the wound. Pressure was to be obtained by the tightly drawn sutures, thus firmly opposing the two margins of the wound. The conjunctiva was closed. Two weeks later, after the two operations, the eye was in excellent clinical condition and was enucleated for study.

The microscopic sections revealed the transplanted canaliculus. In one area the lumen was cut so as to show that it still contained degenerating catgut. The epithelial cells were partly necrotic in certain sections, and the graft, although present, did not appear to be so successful as it was in some of the others. In some sections a partial section of the epithelium could be seen growing quite normally. The area where the non-obturator technique was used was not positively located in the microscopic section.

On November 17, 1941, the left eye of Dog 3 of Series B was operated on. The flap, the incision, the iridectomy, and

the Berens punch opening were all made in the routine manner. However, a metal (brass alloy) obturator, consisting of 3 mm. of a lacrimal stylet, was used. This stylet was fashioned so as to have two flanges on one end, which protruded laterally about 1 mm. on each side, so that the obturator could not slip into the anterior chamber. The stylet was placed in the lumen of the canaliculus. It fitted snugly into the punch opening with the canaliculus. The conjunctiva was closed. Examination one week later revealed that there was a severe reaction, that the cornea was very hazy in the upper third, and that the obturator had sloughed out of the place where it had been inserted and was almost ready to drop out of the eye. Salt solution injected into the anterior chamber did not come out under the conjunctiva, and one week after operation the eye was enucleated and sent for pathologic study.

The microscopic material from this eye consisted of 12 slides arranged in incomplete serial sections. The first five of these showed great thickening of the episcleral tissue due to young granulation tissue proliferation combined with intense cellular infiltration and edema. The sixth slide showed the canaliculus grafted and viable in the sclera, with a somewhat mild cellular reaction around the canaliculus. In one section the transplanted epithelium shows the opening of the canaliculus within the eyeball. The epithelium of the canaliculus can be seen growing over the internal margins of the scleral wound, and the epithelium of the canaliculus appears to be growing over to join the epithelium of the ciliary body. While these sections do not reveal an undoubted opening, it does show that the epithelial graft takes all the way through the sclera right down to and continuous with the ciliary epithelium. Following along the sclera in the other sections, the healthy transplanted epithelial tubing can be followed all along the depth of the sclera to the surface. The epithelium averages about seven cells in thickness. The lumen is patent all along the tube; the surface of the epithelium is

smooth, and the cells are viable. The basement membrane is intact, and adherent in its complete circumference in all the sections. This experiment answered problem No. 4, in that the graft would take and remain viable and not become necrotic. This and all the other eyes in this Series B answered problem No. 5, that the dog's eyes would tolerate the operation.

On November 24, 1941, the right eye of Dog 4 of Series B was operated on. Two silk sutures were inserted in the anterior margin of the scleral incision, and passed one on either side of the resected canaliculus, and then the sutures were put through the posterior margin of the scleral incision. The Berens punch was not used in this operation. The canaliculus was inserted into the scleral incision, so that one end extended into the anterior chamber and one end was left protruding under the conjunctiva. No metal or catgut obturator was used in this experiment. There was very little reaction, and the eye was in excellent condition when, two weeks later, this eye was removed and sent for pathologic examination.

Examination of the serial sections from the right eye of Dog 4B revealed that the area of operative interference was accurately located. In some of the sections it was possible to locate a portion of the transplanted canaliculus. The lumen was adequately open. The epithelium was intact, the cells were normal in appearance, and there were about 10 cells from lumen to basement membrane. The epithelium was neatly adherent to the sclera in its entire circumference and there was no evidence of operative activity in the sclera immediately adjacent to the canaliculus. There was slight infiltration of round cells, and there were quite a few more capillaries in the pericanalicular zone than are seen in normal sclera. Following the sections from the middle toward the external and internal surface of the sclera, it was found that the canaliculus became progressively smaller until, at either extremity, it appears that the lumen of the canaliculus was almost obliterated.

About 2 or 3 mm. from the transplant there was a low-grade, well-circumscribed abscess which extended through the sclera about half way. In its low-grade appearance this abscess resembled an early tubercle. While it extended along the transplant, it did not involve the transplant. It appeared as if it would become absorbed. There were no clinical signs of inflammation.

While this experiment was satisfactory from the standpoint of grafting, the canaliculus did not reach either surface of the sclera in the sections which we obtained.

On November 10, 1941, the right eye of Dog 5 of Series B was operated on. The steps of this operation were as follows: (1) The canaliculus was prepared; (2) a conjunctival flap was made; (3) a 3 mm. keratome incision was made and the Berens punch was used; (4) the opening in the conjunctival flap was sutured, as it was inadvertently buttonholed; (5) 11 strands of catgut were threaded through the canaliculus; (6) the Berens punch opening was twice enlarged, as the implant was larger than usual; (7) the implant fitted snugly in place, and the conjunctiva was closed.

Three weeks later the eye was in excellent condition, and it was enucleated and sent to the laboratory for microscopic study.

The microscopic report of the right eye of Dog 5B revealed that the canaliculus transplanted was viable, with open lumen growing in the sclera. The lumen was completely open and contained a transudate and some fragments of catgut. The epithelial surface was relatively smooth, and appeared to be about five or six cells in depth. A few of the cells appeared to be sloughing off the surface. The basement membrane was in complete contact with the surrounding connective tissue from the lid, and this in turn was in close contact with the adjacent sclera in its entire circumference. There was excellent capillarity and evidence of circulation in the transplant all the way up to the epithelium. The scleral fibers

coursing around the transplant were normal except for the slight curving displacement caused by the transplant. In none of the sections was there any evidence of scar tissue due to the operation. The transplant gave the appearance of normal structure in its normal locus. Some of the sections showed areas where small fragments of the mucous membrane had sloughed away, and the cells appeared less viable than in some of the sections which were surrounded with less connective tissue. In this section neither of the ends of the canaliculus was located.

On December 8, 1941, the right eye of Dog 6 of Series B was operated on. The procedure in this case was the usual flap, iridectomy, and keratome incision. The incision was enlarged laterally with scissors, and an iridectomy was performed. The canaliculus was prepared and sutured in place in the sclera with two sutures, as previously described, but the position was not satisfactory. The wound was closed. Convalescence was uneventful, and one week later the eye was removed and sent to the laboratory for study.

The sections from this dog's eyes show an excellent "take" of the epithelial tube. The tube can be demonstrated to extend from one surface of the sclera to a point quite deep in the sclera. The section is cut so as to give a longitudinal section of the transplanted canaliculus. The lumen is well opened. In some of the sections the catgut sutures which were used in this case can be seen coursing into the margins of the canal. The epithelium, which is healthy in most places, can be followed for a considerable distance traversing the sclera. Due to difficulty in getting it properly inserted at the time of operation, the direction of the canal is not correct, but the graft is very successful and it can be seen to be growing into the surrounding sclera. Although the specimen is only one week old, it is unquestionably growing quite solidly into the sclera along the entire course of the tube.

SUMMARY OF PROCEDURE

Seven eyes of seven dogs were operated on in Series A. While the operations were all failures, invaluable lessons were learned and applied to advantage in Series B.

In Series B the operation was performed on nine eyes of six dogs. For various technical reasons four of these specimens were of no value. Of the remaining five eyes, which came to fairly satisfactory microscopic study, all showed evidence of success. In two the evidence of success was not marked. In three it seemed quite satisfactory. In none of the dogs' eyes was there clinical or microscopic evidence which suggested that an entirely patent channel had been established. However, our efforts in this regard were not so complete as they might have been.

DISCUSSION

The encouraging features of this experiment were: (1) The relative simplicity of the procedure. (2) The minimal clinical reaction and excellent post-operative appearance of all the operated eyes (exception: metal obturator case). (3) The success of the "take" of the graft. As one studied the numerous microscopic slides prepared, one was constantly struck with the healthy appearance and completeness of the "take" of the epithelium. (4) The patency of the lumen. (5) The absence of untoward microscopic evidence of scleral reaction and scar formation.

The microscopic studies of the fate of the two ends of the canaliculus left something to be desired. This was partly due to the extreme difficulty of locating the ends of the tube in the microscopic studies. Problem No. 6, namely, would the canaliculus filter aqueous, remained unanswered because we did not have chronic intra-ocular hypertension in the dogs' eyes and our attempts to force aqueous through the canal were rather incomplete.

OBJECTIONS

There are many objections to this procedure, some of which are obvious and probably many others to which attention must be called. The first of these are the technical difficulties inherent in the preparation and the fit and maintenance of the graft. These technical difficulties have been fairly well overcome.

Clinical difficulties may present themselves, such as the presence of hypotony, ectasia, phthisis, and late infection, which must be considered as possible pitfalls, and which, if they do occur, may be disastrous or may be overcome by modifications of the technique. None of these, however, was encountered in the dogs' eyes.

There are biologic objections that may be encountered clinically and that have to do with the activity of the epithelial cells in the anterior chamber. Unsettled are the problems of their growth, necrosis, obstruction, or opening of the ends of the tube.

Optical objections also are to be considered, such as refractive errors, and the effects on the lens and iris.

One of the most important objections is bacteriologic. Although it was gratifying to see that none of the eyes showed clinical signs of infection, and only one eye exhibited microscopic evidence of infection, yet the series is too small to warrant great enthusiasm in this regard. The procedure we used in the operating room was designed merely to prevent the introduction of new organisms into the eye. Hands were scrubbed carefully, and the instruments received the usual preoperative care. The eyes were merely irrigated with boric acid, and they were carefully draped as in routine eye surgery. The canaliculi, which obviously were contaminated, were not subjected to anything stronger than physiologic salt solution. This was done in order to determine if intra-ocular implant infection was likely to occur, and in Series B this did not occur. These experiments were all terminated short of the time required for late infection, although one eye was followed uneventfully for eight weeks before it was removed.

CLINICAL APPLICATION

All the well-known rules and limitations which are inherent in animal experimentation and their application to clinical cases certainly apply in these experiments. Due cognizance is taken of the probable undue enthusiasm following the partial success of these intrascleral canaliculus transplants in animals, and the improbability of ultimate clinical success in crossing the gap between animal experiment and clinical application.

SIGNIFICANCE

After consideration of the more obvious objections and limitations, after the clinical observations on the dogs' eyes, and after studying the many microscopic slides in this experiment, the conclusion was reached that the procedure was sufficiently promising to warrant a clinical trial. Accordingly, a patient with glaucoma who had little vision to lose was selected for clinical trial.

CASE REPORT

On May 15, 1939, F. D., aged fifty-seven years, colored, came to the Temple University Hospital Eye Clinic for ocular treatment. He stated that one year previously he had had an operation on each eye performed elsewhere. His chief complaint was of failing vision. There was no history of ocular pain. Examination revealed that his vision, with glasses, was 6/60 in each eye. The external appearance of the eyes was normal except for an iridectomy at 12 o'clock in each eye. The visual fields were concentrically contracted to less than 10 degrees. The ocular tension was 43 (Schiötz) in the right eye and 18 in the left. The media were clear. Fundus examination revealed bilateral glaucomatous cupping of the disc. The diagnosis was advanced post-operative chronic simple glaucoma. Since there was so little residual function of the optic nerve, further surgical treatment at that time was considered inadvisable. During the next two and one-half years various combinations and concentrations of pilocarpine, eserine, and epinephrine bitartrate were used. The tension, however, remained elevated all this time, regardless of which medication was used, and in spite of medical treatment there was a progressive loss of vision in each eye. In

June, 1941, his vision was: O.D. = light perception; O.S. = 1/60. In December, 1941, vision in the right eye was nil and in the left eye it was 1/60. The tension in the left eye was usually between 36 and 57.

Since the right eye was blind, and for over two years was known to have chronic hypertension, and because iridectomy had previously been performed, this eye was selected as ideal for experiment. Consequently any reduction of tension which might occur could not be attributed to the iridectomy. Furthermore, if this eye, which had so long been ill, could tolerate the transplant, it seemed fair to conclude that the procedure might be applicable to eyes with much less advanced changes. On January 15, 1942, the right eye was operated on. At this time the intra-ocular pressure was 40 (Schiötz).

Operation

Under general anesthesia with sodium pentothal intravenously 6 mm. of the upper right canaliculus was dissected from the upper lid and freed of connective tissue. It was then immersed in 1:500 metaphen for ten minutes. A conjunctival flap was dissected. Next the canaliculus was dilated with a puncta dilator, at which time, due to overdilation, it was torn for about one-half of its length. Five strands of No. 0 catgut were threaded through the lumen with considerable effort. A keratome incision 3 mm. long was made 2 mm. back of the limbus through the sclera. The incision was enlarged laterally with scissors. A segment was punched from the anterior margin of the incision, but the obliquity of the incision prevented a complete punch wound to be made. The canaliculus was placed into the wound. The knot could be seen resting on the anterior lens capsule. This was due to the fact that the canaliculus segment was too long. The conjunctiva was closed. Technically, it was much less difficult to perform this operation on the human eye than it was to do so on the dog's eye.

Post-operative Course

The first two post-operative days were uneventful. On the third day, due to pressure of the catgut knot, a round spot of corneal infiltration developed at 12 o'clock. On the fifth post-operative day a localized grayish exudate formed in the anterior chamber beneath the area of corneal infiltration, and this was continuous with the anterior lens capsule. On the sixth post-operative day there was a rather severe reaction, and a definite hypopyon formed in the lower

part of the anterior chamber and lasted six days. It was doubtful if this represented actual intra-ocular infection or merely iris irritation. Sulfathiazol, was administered by mouth on the third post-operative day, and on the fifth day, a course of typhoid vaccine was begun. These measures controlled the untoward effects of the operation. On the tenth post-operative day the tension was 0 and on the sixteenth day it was 3. The reaction, while still fairly marked, was receding, the eye was comfortable, and the progress was quite satisfactory. There was a white mass of tissue at the external end of the transplant which seemed to be due to necrosis of the excessive amount of canaliculus outside the sclera. This mass of necrotic tissue absorbed in about four days. On the eighteenth post-operative day the tension was 14. On the twenty-fourth post-operative day the tension was 17. There was a visible area of localized elevation of the conjunctiva similar to that seen after trephining. The reaction had subsided. The one untoward effect of the procedure was partial opacity in the upper fourth of the lens. It would appear that the graft was successful, and that the canaliculus was filtering aqueous in this case. It seems most probable, however, that the opening will eventually close.

PROGRESS NOTE

About six weeks after completion of this report the subconjunctival pool of aqueous on the patient's eye disappeared and the tension returned to its preoperative level. The operative field was explored, and it was found that the external end of the canaliculus was closed by subconjunctival scar tissue. A transscleral lacrimal transplant was subsequently performed on this man's other eye and this case will be reported later.

CONCLUSION

In this one case the eye was able to tolerate this operation, and at least a marked reduction in tension was produced during the first three weeks of the convalescence. Further clinical trial seems justifiable, and numerous technical improvements are to be made.

Although it is possible that there have been reports of previous canaliculus transplants, I am unaware of them. This work is still in the experimental stages, and we are not in position to recommend it as a clinical procedure.