percha tube provided with a pressure sac, and then to one end of the cross branch of an instrument called *barboteur*, which is introduced into the bottle containing the mineral water, or other medicated agent. The vertical part of this instrument reaches the bottom of the bottle, from whence the gas which escapes, loaded with the medicated agent, passes into another tube for anal injection. If sulphuret of carbon is used, a teaspoonful is poured on cotton previously placed in the glass tube, the tube stopped with a little more cotton, and then placed on the one that connects the *barboteur* with the anal tube.

Fig. 1.

The carbonic acid gas, the medium in this case, is passed through plain water instead of through mineral water. When the mineral water is used, about six ounces of hot water should be put into a large bottle, and the half bottle of Eaux Bonnes water added, so as not quite to fill the bottle. This is to warm the gas. Dr. Bergeon has tried

Fig. 2.

many sulphur waters, but has found none equal to the Eaux Bonnes. He is still looking for a better one, more loaded with gas, and hopes that of Ponlippe at Naples may prove better.

Mentone.

ON FOUR CASES OF CORNEA-GRAFTING.

By W. JOHNSON, L.R.C.S., L.R.C.P.Ed.

THE following four cases of cornea-grafting were done in Jabalpur during the present year. They were all, I am sorry to say, though carefully done and attended to, unsuccessful; but it may be of interest to record my experience of an operation that has as yet been so seldom attempted. The only successful case I can find mention of is given in Juler's book (*Ophthalmic Science and Practice*, 1884), in which an account is given of the transplantation of a strip of cornea with conjunctival flaps from an enucleated human eye into the eye of a man whose cornea had been rendered opaque by an explosion. Good union took place, and a fair amount of vision was gained by the time the patient left the hospital. Subsequently, owing to exposure and privation, the transplanted cornea became opaque. Doubtless this resulted from the lowered vitality of the transplanted portion; and this lowered vitality of the graft and its inability to withstand the encroachment of the more vitalised tissues around it is the great difficulty I have found to exist.

Meeting with a large number of eye-cases among the Gonds, many of whom were totally devoid of any useful sight from the presence of thick cicatrices or sclerosed patches in both corneæ, or perhaps in one only, the other eye being entirely destroyed, the desire was forced upon me to try to restore a portion of sight to these otherwise hopeless cases. I had read of attempts at cornea-grafting in various books and papers; and on looking up my latest book (Juler's), I found the

description of Professor Wolfe's operation in the case mentioned above. After carefully considering the subject, I concluded to try the operation mentioned in De Wecker's work (page 145), and sent home for a trephine for the purpose. The trephine I ordered had four teeth, like the teeth of a saw set in a circle, each with one cutting edge turned in the same direction, so that when the instrument was rotated to the right it cut a circular groove. I soon found, however, by trial on sheep's eyes, that the tooth arrangement was a faulty one, as the teeth had a tendency to tear the corneal tissues instead of cutting them clean, and they also had a tendency to cause the instrument to deviate from the circular path first taken. I overcame this difficulty by getting the teeth ground down so that only a circular even edge remained. This was sharpened by grinding it from the outside all round. The next difficulty was to fix the instrument in one groove when in action, and not to allow it to travel over a large part of the cornea, as it tends to do owing to the mobility of the eye and the slippery tissues on which the trephine rests. This difficulty I met by getting an instrument made of bone, which consisted of a handle and a head, both flat and about an eighth of an inch thick. In the head of this instrument was a circular hole just large enough to admit the cutting end of the trephine and to allow it to rotate freely. When this was applied to the centre of the cornea, and pressed down, it served as a guide to the trephine and kept it to one spot when being used. That it might the better lie on the cornea, the under side was grooved to the curvature of the latter. When the trephine has well entered the cornea, or just before it has perforated, the bone instrument is removed, and the excision of the circular piece of cornea completed. The trephine cuts out a circular piece of cornea of about a quarter of an inch in diameter. This piece of cornea I usually found greatly thickened, sometimes almost an eighth of an inch instead of about one-twentieth of an inch, which is the thickness of the normal cornea.

I will first give my method of operating, and then refer briefly to the four cases operated on and their results. The first point to settle is whether the case is a suitable one or not. Only cases where the sight of both eyes was practically lost were selected. Then I endeavoured to satisfy myself of the healthy condition of the fundus by finding out if there was any perception of light and of shade, especially of sunlight, or the light of a lamp, etc. Having settled this point, I took the tension of the eye; got the history of the case, and so on. Eyes with staphylomatous cicatrices were rejected, as also were those with nystagmus. If the tension was about normal, the perception of light decided, and the history of the case in other respects favourable, I considered it a suitable one for operation. The younger the patient, and the shorter the time that has elapsed since the loss of sight, the more hopeful, *ceteris paribus*, will be the result of the operation. As to the cornea to be transplanted, I may say that I was practically restricted to animals' corneæ, as the enucleation of an eye of a native with the cornea intact is a very rare thing out here. Another reason for taking only animals' corneæ is that, if the operation is to succeed, and to be adopted in complete corneal opacity, we should from the number of cases be practically compelled to depend mainly on a supply of animal corneæ. I selected rabbits, both because they have several times been the subject of experiments on corneal grafting, and because they are not difficult to get, and also because, being small, they are easily managed—a point of no small importance where one has only the assistance of an imperfectly trained native. The rabbit's cornea has also nearly the same thickness, and nearly the same curvature as the human cornea.

Having anaesthetised the front of the patient's eye with cucaine, I trephined a circular piece from about the centre of the opaque cornea, by applying first the bone guide, and then the trephine through the hole of the former. If the bone guide be firmly pressed on the eye, no other instrument of fixation is needed, except, of course, the eyelid-speculum. When the trephine is nearly through, it is found to yield, and, perhaps, some vitreous escapes. It is now taken away, and the excised portion seized with small forceps, and entirely cut away with the point of a von Graefe's cataract-knife. This is usually necessary from the iritic adhesions at the back of the cornea. The edge of the wound is now well cleaned with the small knife and forceps, and any bleeding stopped with cold water. Sometimes the hardened remains of the lens or its capsule are found behind the cornea. These should be removed, and the vitreous allowed to present. All being ready, the selected full-grown rabbit is now killed by an assistant. I found it cheaper to do this than to waste anæsthetic and time in rendering it unconscious. Immediately the rabbit is killed, a portion of the centre of one of its corneæ is excised by the trephine in the same way as the piece from the patient's eye. For this purpose, a cutting edge of slightly larger diameter is fixed to the trephine. The graft is taken

up with small forceps, washed in warm water, and immediately put into the patient's eye. The object of making the graft slightly larger than the aperture in the patient's eye is now seen, for with a little care it can be easily put into its place, and being, as it were, a tight fit when the eyelids are carefully closed and padded, and bandaged, it will remain where it has been placed without the use of any sutures whatsoever. If it shows any tendency to sink into the eyeball, there is still usually no difficulty, as the reaccumulation of the aqueous and vitreous humours will press it outwards, and it will be kept in place by the pressure from within on the one hand, and the pressure of the eyelids from without on the other.

Another advantage in having the graft slightly larger than the aperture is that, being pressed more firmly against the edge of the latter, it grows to it more quickly, and, of course, its nutrition is also sooner re-established. This is, indeed, a vital point, and the success of the whole operation turns upon maintaining the vitality of the graft, and in restoring its nutrition as soon as possible. After this the patient is kept very quiet for two days, at the end of which he is laid on the table, the bandage removed, and the upper eyelid carefully raised to see if the graft is in the right position, and growing to the surrounding parts. The eye is again closed up for two or three more days, after which it is daily opened, cleaned, and examined, and carefully re-bandaged to protect the graft from injury. Very weak solutions of carbolic acid were used for cleansing purposes. After the first three days the patient is allowed to move about.

CASE I.—Boy, Hindu, aged 12; one eye destroyed, the other covered with a dense cicatrix, on the surface of which the epithelium was thickened and dried, as in a case of xerosis, only in this case the condition seemed to be confined to the cornea alone; it had resulted from ulceration four years ago. A portion of rabbit's cornea was grafted as above described; some vitreous was lost. The graft fixed itself without any difficulty, and without the formation of any pus. In a few days it began to be covered with thickened and opaque epithelium from the surrounding tissues. In this and the following cases the graft preserved its translucency (not its transparency, which is lost in a few hours) for a few days (four or five), and then gradually became opaque from without inwards, apparently from overgrowth of the surrounding epithelium.

CASE II.—Boy, aged 14, Mussulman. One eye lost, the other covered with a dense cicatrix from small-pox four years ago. Grafted rabbit's cornea, as in the previous case. Found the vitreous very fluid, and the aperture made by the trephine did not retain the circular form, but was somewhat oval, from irregular dragging of the cicatrix. On this account, I had some difficulty in properly placing the graft. This case ran the same course as the last, except that I tried to check the too rapid ingrowth upon the graft by mild cauterisation of the edge of the aperture. This was only done once, but it was followed by such a tendency to ulceration, that I avoided using caustic again. I may mention that the epithelium of the graft seemed to waste considerably during the first few days, on which account it took on a slightly roughened appearance.

CASE III.—A young Hindu woman. Only one eye was suitable for operation. After having removed the portion with the trephine, I found the eye nearly empty of liquid, although the eyeball still retained its form completely. On pressing on its sides, a thin liquid, not at all like healthy vitreous humour, appeared at the aperture. On asking the patient if she had any perception of diffused daylight, she said she could clearly perceive when the hand was, and when it was not, held in front of the eye. The graft from a rabbit's eye was put in. It fixed itself very well, but finally became opaque like the others.

CASE IV.—This was a Mussulman, about forty years of age. He had suffered from chronic ulceration of one cornea for some years, which, on healing, had left a dense mass of cicatrix. The other eye was much shrunken, and useless. Grafted from a rabbit's eye. The man left whilst I was away from home; but, on making inquiries, I learned that the graft finally became opaque and useless for vision.

These four cases all agree in this: the grafts fixed themselves, and grew to the surrounding tissues, without any difficulty. Then their vitality seemed gradually to decline, as shown by the progressive loss of transparency, and by the absence of feeling when touched, and also by the partial loss of their epithelium. Finally, they became red and opaque, apparently by overgrowth from the outside, and lost their individuality, and seemed to dwindle away. At the end of about three months it would be impossible to say, from the appearance of the eye, that a corneal graft had been made.

The result in these cases, though discouraging, will not prevent my pursuing the subject further; but they present several questions for careful consideration.

We may ask whether the corneal graft I made was sufficiently large to maintain its vitality under the new conditions. I see no reason to think that any alteration in size would materially affect the results given above, while to enlarge the graft to any great extent would certainly increase the difficulty of attaching it to its new place, as well as cause the risk of a considerable loss of vitreous.

Another point is that the corneal cicatrix or sclerosis into which the graft is put differs largely from the normal corneal tissue; its vitality is, in one sense, higher, and it is often more or less vascular, besides the irregular collections of leucocytes and cicatricial tissue. It is very doubtful how far such tissue can provide a proper supply of lymph and migratory corpuscles on which the normal corneal nutrition depends. Again, if we make the graft larger, we shall increase its mass more than we shall increase its periphery (it being a circular body); and as its nutrition is derived from the periphery, the demand for nutriment will increase in greater proportion than the source of nutrition will increase. This may be worth consideration.

Another question is whether the circular or the oblong form of the graft as proposed by Professor Wolfe would best secure the future nutrition of the transplanted portion. Theoretically, the oblong form has a longer periphery, and, therefore, a better source of nutrition for its mass. Has it any other advantage? Is the fact that the ends of the oblong graft are brought up to the edge of the cornea, as in Professor Wolfe's case, of any importance from this point of view? Those ends also, in his case, were fixed on either side by two attached strips of conjunctiva. Doubtless those strips were formed by Professor Wolfe with the object of thereby suturing the graft to the surrounding conjunctiva. Do they serve no other object? We know, for instance, that the operation of syndectomy (peritomy), in which the conjunctival and subconjunctival tissues are cut through around the cornea, arrests, through the agency of the cicatrix formed, a considerable part of the excessive nutrition that travels to the cornea in such diseases as pannus, sclerosis, etc. Conversely, we may assume, therefore, that, in addition to the pericorneal nutritive supply, part, at least, of the superficial nutrition of the cornea is derived from the conjunctival and subconjunctival tissues; and possibly the conjunctival flaps in Professor Wolfe's operation may partly serve as vehicles of nutrition as well as for attachment. His graft may thus, both from its shape and conjunctival flaps, possess advantages over the circular graft; but it has the disadvantage of not being so easily made and adapted as the round one, and the almost insuperable drawback of being limited either to human cornea, or of being derivable only from such other animals as have cornea about equal in diameter and curvature to the human cornea.

As we cannot expect that ocular therapeutics will stop short at the large cicatricial and sclerotic barriers that destroy the sight of many eyes otherwise comparatively healthy, we may hope that the operation of cornea-grafting will receive more attention in the future, and that the comparative merits of the different kinds of grafts, and their ways of adjustment, will be duly weighed and tested. Meanwhile, I am loth to give up the circular form of graft which I have experimented with, as it is so generally and easily applicable.

I have spoken of the "lowered" vitality of the graft as being probably the cause of the opacity which followed. It would certainly seem to be the chief cause in those cases where experiments have been made on animals, where both the graft and the eye operated on were healthy. But, perhaps, "perverted" nutrition would be a more accurate term to apply to the grafts in my cases; for I noticed that the opacity seemed to go from the outside inwards, instead of beginning at the centre, where nutrition may be supposed to be lowest. Another point probably of some importance to the final result was that up to the time when the opacity of the grafts was nearly complete, they had not regained any sensation, as shown by want of feeling when a small probe was pressed on their centre. This anaesthesia may not have been without influence on the nutrition of the graft.

The uniformity of the results in all cases, on the Continent and at home, that I find mention of—viz., advancing opacity and final uselessness for vision of the corneal graft—points clearly to some common cause or causes of failure, whether inherent in the eyes operated on, the grafts themselves, or the methods of operation, that will demand the attention of all future operators in this direction.

Jabalpur, E. India.

HOLMESDALE COTTAGE HOSPITAL.—Earl Stanhope, in presiding at the thirteenth annual meeting of the friends and supporters of the Holmesdale Cottage Hospital, at Sevenoaks, paid a high tribute to the nursing and medical staff.