of fibro-lipoma of the cornea of the size of a hen's egg. At first sight this appears similar to the present case, but it shows the important morphological difference that rudiments of the lens were present, thus retarding the date of origin until after the 10mm. stage at least. Stargardt places this case in the first group but this is debatable in view of the presence of the lens.

The present case resembles that of Stargardt most closely though it is not possible on the material at hand to prove the persistence of the hyaloid artery. The tumour was probably not as large as Stargardt's and only shows a slight constriction round its base, which was embraced by the lids. The condition appears, however, to be of sufficient rarity to warrant its publication.

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THE SURGERY OF THE VITREOUS:

A preliminary paper dealing with an experimental investigation into the Surgery of the Vitreous Body with special reference to its application in cases of Detached Retina, Primary Vitreous Disease, Haemorrhage or Traumatic loss of Vitreous.

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History

The vitreous body, the very origin of which is yet open to speculation^{1,2}, may in common with all living matter undergo changes both physiological and pathological that profoundly influence the vitality and function of its neighbouring structures. Between those delicate alterations of substance that produce the subjective symptoms associated with "muscae volitantes" on the one hand, to the sweeping havoc of a panophthalmitis on the other, lie conditions the ultimate termination of which are largely controlled by the state of the vitreous. A diseased vitreous body is a source of potential danger to sight both directly and indirectly, for in the first instance visual acuity must weaken when a hazy

medium has to be negotiated, while in the second place the disintegration of the supporting "gel" into a substance of little more than water makes the occurrence of such ophthalmic disasters as retinal detachment or haemorrhage mechanically more possible.

Regarding retinal detachment itself from a surgical standpoint no one operation at the present time can be said to hold out much help of permanent recovery although temporary benefit frequently results. The fact that so many surgical procedures are practised helps to strengthen the contention that none is reasonably successful.

De Schweinitz employs scleral puncture and salt injection. McMullen, repeated scleral puncture. Galezowski, a permanent drain with gold wire. Deutschmann performs a more drastic operation for diminishing the size of the eye globe itself; Müller excises some 20 mm. of sclera *via* Kronlein's approach, while Parker trephines and punctures and Meyer Weiner uses a horse-hair drain. Nor is this list exhaustive, and each records successes; but no one form of technique stands out prominently as the operation of election unless perhaps it be cautery and puncture, or trephine and puncture. Regarding the use of cautery one writer³, working experimentally, produces detachments by this means with a view to proving that the condition itself is the result of some change in the choroid whereby a post-retinal exudate is formed. On such grounds it would appear that the cautery as a means of cure is wrongly applied. Published results of the operative treatment of retinal detachment are confusing and variable. They range from something like 50 per cent. calculated successes, to all but complete failures and all in the hands of operators of repute. One authority, Vail (U.S.A.) in summarising the end results of a considerable number of cases studied by himself, comes to the unhappy conclusion that of these only some 20 may be maintained as representing permanent cures.

Object of this Paper

Approaching this discussion from another angle, we find studies of the vitreous body under normal and abnormal states dating so far back as 1741⁴; and coming nearer to the points at issue, researches concerning the effect on the eye of injections of foreign substances into the vitreous chamber⁵. The proposition at present under annunciation reveals an attempt to examine the subject of retinal detachment by dealing not only with the detachment as such, but also with the whole vitreous body should its state, from clinical observation, demand such procedure. The general principle of this vitreous surgery may prove of value also, where non-resolving haemorrhage, traumatic loss, or extensive primary disease makes such measures justifiable.

The Experiments

Seven dogs were made the subject of experiment in the investigation, which was designed to prove whether or not a tolerance existed, or could be without undue reaction established, between the vitreous of animals of the same species, and of animals of different species; and further, if such compatibility could be made out, whether vitreous retained in cold storage (for practical reasons) made any difference to the issue. The dogs were kept for varying periods after operation and the resulting series of ocular and constitutional changes are noted. At the conclusion of such time as was considered necessary for reactions to have reached their natural termination, the animals were destroyed. The eyes operated upon and in the case of the first four dogs, the unoperated eyes as well, were removed and prepared for section.

Technique

The technique employed was relatively simple and was not varied throughout the experiments. Vitreous was collected with adequate precaution against infection and injected into sterile test tubes which were immersed in a water bath at body heat. The period of times between obtaining the eyes (in the case of pigs and sheep) from the slaughter house and the extraction of the vitreous in the laboratory was on the average an hour—usually six eyes were used at a time so that sufficient vitreous might be to hand. Each eye in the case of pigs yielded 1·5 c.c. of vitreous without difficulty or complications such as the suction of lens or retinal substance into the syringe. The syringe was of the 5 c.c. "record" pattern, and had a needle of 2 mm. inside bore attached to it. A dog was anaesthetised (with chloroform and ether), the conjunctival sac washed out and a large speculum placed in position. Canthotomy was performed, and a long conjunctival incision was made parallel to the cornea and as near the equator of the globe as possible. A wide area of sclerotic was thus exposed and cleared.

Three fine silk sutures were taken and each in turn was made to enter and pass through the outer fibres of the sclerotic, twice, with a space of about 2 mm. intervening between the first and second insertion. This procedure gave a narrow strip of sclerotic controlled on either side by sutures. About 3 mm. separated one such suture from the next in vertical line. Owing to the extreme thinness of the dog's sclerotic (0·5 or 0·75 mm.), some difficulty was experienced in preventing complete perforation of the globe with the needles. Next, an incision was made down the line of guarded sclerotic. When the thickness of the sclerotic had been incised with a fine knife, a puncture opened choroid and retina and vitreous began to present. Next the needle with the syringe attached was

pushed well into the substance of the vitreous and 1 c.c. of it removed. After the sclerotic sutures had been knotted once and the edges of the wound drawn close about the needle, the syringe was now detached and another substituted which contained about 2 c.c. of foreign (*e.g.*, dog, pig, or sheep) vitreous, and this was then passed into the eye, digital pressure assuring the operator that the intra-ocular pressure did not rise too high.

It may be said here that sclerotic incision was found necessary, and no needle of any design could be made to perforate sclerotic tissue without undue pressure (7 and 9 oz.). When sufficient vitreous had been injected to leave the eye under normal conditions of pressure, the sutures were taken by an assistant and as the needle was withdrawn, tightened. By this means only a very slight vitreous loss was encountered, and the risk of losing an eye from "leakage" made exceedingly small. The wound of the conjunctiva was closed over in the ordinary manner.

Clinical and Pathological Results

Of the seven dogs subjected to operation, three were treated with pigs' vitreous, one with sheeps' vitreous, one as a control with its own vitreous removed as described and replaced, and two with vitreous taken from other dogs. The attached table gives in brief the general reactions taking place from the time of the operation till the dogs were destroyed and the eyes removed. It will be observed that of the seven dogs operated upon, two eyes were lost, two retained useful sight, and three suffered visual loss (except for perception of light) without, however, experiencing marked reaction. These results would appear on the surface discouraging, and if representing the terminal product of experiment, should undoubtedly be so regarded. It must be appreciated, however, that these issues express in themselves merely the elementary stage in the process of this investigation; the work thus far being concerned solely with the question of *tissue tolerance*. Confined to such grounds we see that so far as tolerance is concerned, the several cases show up in a satisfactory light, in so much as two only of seven operations failed, and one of these from immediate haemorrhage which is beside the issue. Of the six remaining the only gross lesion appeared in the shape of one case of keratoconus, from protracted deep keratitis (Case 1), and one case of absolute glaucoma of secondary form (Case 5), which resulted from the intermingling of sheep vitreous with that of dog. Pig vitreous seemed reasonably inert while intermixing dog vitreous could be achieved without fear. The question of vision at this stage must be taken in a very open sense for it should be remembered that vitreous injected through a 2 mm. bore needle is broken by its passage into globules which reform imperfectly and will therefore

DOG 1. (Operated eye) 1 c.c. pigs' vitreous.

DOG. 3. (1 c.c. pigs' vitreous.) Vision satisfactory after twelve weeks.

DOG 5. Sheep's vitreous 1 c.c. Destruction of eye from secondary absolute glaucoma.

cause very marked refractive changes. It is interesting in the circumstances to record two cases; in one of which vision was definitely good as tested by the ability of the animal to move easily among strange objects, and up a stairway, with the sound eye securely bandaged; while with the other dog the vision remained sufficiently good to permit these manoeuvres in a more restricted form. (Case 3 and Case 4.)

Pathologically the finding showed points of interest especially regarding the corneal changes. In no cases did the unoperated eye show alterations, either macro- or microscopical. The main features are summarised in the tables that have been drawn up and in the diagrams.

Field for future Investigation

If we can assume true compatibility between certain types of vitreous body, and the prospect of adequate vision under suitable operative technique, it remains then to perfect that technique by further experiment. Such a step demands the construction of a new type of syringe and needles of such bore that little damage may result to the vitreous substance during passage through them. Tests carried out on pigs' eyes have gone to show that the syringe should have a capacity of 10 c.c. and a minimum exit bore of 4 mm. The needle for the vitreous passage should have a 4 mm. internal bore and should be made oval in shape being thus 4 mm. across its widest diameter, and 2.5 mm. across the smaller with fine

rubber tubing between it and the syringe. The operation suggested demands the simultaneous insertion and withdrawal of vitreous, the point of "*exit*" being the internal peri-equatorial area, and the point of "*inlet*," the external peri-equatorial area. The needle to be employed for the "*exit*" would be bent at right angles so that it lies flat against the globe and does not hinder the internal ocular movements. Two fine eyelets welded to it would be available so that its position might be firmly fixed on the sclerotic by means of sutures. The needle to be employed at the "*inlet*" would have a similar design. Two syringes are necessary, braced in a common frame with a cross bar between them in order that they may be used either together or separately. With such an apparatus an outline of the operation suggested would be as follows:

(1) Attack first the detachment itself preferably by simple puncture or narrow bore trephine—and when the result is established (say three weeks) proceed with the next step.

(2) With the eye turned as far *outwards* as possible open the conjunctiva, retract it, and open the sclerotic between sutures (as described) adding two sutures for fixation through the eyelets in the needle. Pass and fasten the needle and attach rubber tubing.

(3) With the eye turned *in* as far as possible proceed as before, and fix the outer needle and tubing in place.

(4) Start by extracting vitreous up to 1 c.c. and then commence passing in the fresh vitreous from the outside syringe and continue until 5-6 c.c. have been inserted and removed.

(5) Close the wounds as described starting with the internal one.

Owing to other work the practical application of this technique has not been possible, but in view of the obvious stability found between certain types of vitreous it would seem a justifiable principle and one that might well be followed to its experimental conclusion.

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Pathological Findings

DOG 1. *Pigs'* vitreous 1 c.c. normal.

Cornea.—About double its thickness in parts. Epithelium intact. Substantia propria thickened and thrown into irregular waves chiefly the superficial layers directly behind Bowman's membrane. The fibres in this area are ill defined. Increase in number of corneal corpuscles. Increase of all elements immediately in front of Descemet's membrane. Endothelium in parts infiltrated by round and spindle-shaped cells.

Iris, lens, ligamentum pectinatum, clear.

Schlemm's Canal, clear.

Ciliary Body.—Some round-celled infiltration with disturbance of pigment cells. Migration of pigment cells.

Vitreous Body.—Areas of faintly staining material containing here and there scattered round cells. Migrated pigment cells. No leucocytes. No evidence (by oil immersion) of bacterial infection.

Optic Nerve and Retina.—Retina widely detached.. Appears normal until in region of nerve head. Here are again massed round cells and a band of tissue similar in appearance to the optic nerve projects well into the vitreous. It does not have the appearance of organised tissue. The unoperated eye shows no abnormal changes.

DOG 3. *Pig 1 c.c.*

Cornea.—One or two limited areas where the substantia propria is thrown into folds, and its continuity thereby broken. No definite cell invasion here and no thickening or alteration of the deeper layers. This condition can be seen to a very slight extent in sections of the normal eye and therefore may be explained as due in small part to the processes to which the eyes have been subjected in sectioning.

Iris, ciliary body, lens, vitreous and retina show no microscopical alterations.

The optic nerve is clear. (See diagram.)

DOG 4. *Dog into Dog.*

(Vitreous extracted and returned into same eye as control).

In the section of this eye and in those of the unoperated eye no abnormal changes can be noted.

DOG 5. *Sheep into Dog.*

Sections here show very profound reactions. Anterior chamber full of exudate and corneal distortion. Extensive iridic and ciliary body infiltration. Iris bombé. Destruction of lens. Marked vitreous reaction. Peculiar infiltration localised around nerve head, choroid and retina and lateral area. (See diagram.)

POST-OPERATIVE CLINICAL FINDINGS

Animal	Vitreous	Cornea	Lens	Vitreous	Retina and Disc	Vision	Duration of life after Experiment
(1) Dog	Pig 1 c.c.	Early marked keratitis developing in 24 hours, reaching maximum point in 10 days and partially resolving in a month. Left some ectasia	Not seen	Not seen properly owing to keratitis	Condition unknown	Ability to detect light and darkness	Six weeks
(2) Dog	Pig 1 c.c.	Eye lost at operation from haemorrhage	—	—	—	—	—
(3) Dog	Pig 1 c.c.	Early slight keratitis. Clearing up on 3rd week and leaving a very faint haze in upper outer segment after 30 days	Nil abnormal	A few dark floating bodies of moderate size	A slight detachment at site of operation	Satisfactory. Could move around unknown objects without trouble (Normal eye bandaged)	Twelve weeks
(4) Dog	Dog (control) 1 c.c.	Nil abnormal	Nil abnormal	Nothing to note in this case	Did not appear affected	Satisfactory by the object avoiding tests	Eight weeks
(5) Dog	Sheep 1 c.c.	Haze from + tension after 7 days. No keratitis. Iris blurred	Not seen after 3 days	Not seen after 3 days	Did not appear affected	Blind	Ten days; destroyed owing to secondary absolute glaucoma
(6) Dog	Dog 1 c.c.	Nil abnormal	Normal	Some floating bodies. No other reaction noted	Some doubtful pallor of disc	Perception of light	Five weeks
(7) Dog	Dog 1 c.c. Cold storage 24 hours	Some transient haze lasting 4 days with change in iris pattern. Small hyphaema after 12 days, resolving 18 days	Normal	Some floating bodies	Nil abnormal	Perception of light	Five weeks