THE BRITISH JOURNAL
OF
OPHTHALMOLOGY

FEBRUARY, 1919

COMMUNICATIONS

A STUDY OF SOME RESULTS OF INFECTION OF
THE VITREOUS BODY WITH SEPTIC MATERIAL IN
COUCHED EYES*

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IN 1911 Professor M. Straub, of Amsterdam, read a communication before the Ophthalmological Society on the pathology of certain opacities which develop in the vitreous as the result of the deliberate infection of the ciliary body with tubercle bacilli.[†] The experiments, carried out on rabbits, were two in number, and had for their object the further study of processes, which he had observed to occur in the vitreous when that body had been made the seat of the original focus of inflammation. His principal findings were as follows:— (1) The optic nerve head was inflamed and swollen, and its cup was filled up by leucocytes. (2) In the vitreous body were found a number of leucocytes, seated on thin membranes, and lying on the plane between the granuloma, which had developed as a result of the infection, and the inflamed optic nerve head. (3) Aggregations of leucocytes were found on the walls of the cavities of the eye (on the cornea, on the retina, on the lens capsule, and in cavities of the vitreous). From these observations he concluded "that the lymph

*A communication to the Section of Ophthalmology of the Royal Society of Medicine.

†*Trans. Ophthal. Soc. U.K.*, Vol. XXXII, 1912, p. 60.

current of the vitreous goes by the optic nerve, and that chemotactical substances are brought by this current from the granuloma to the nerve." He also drew the inference "that in cyclitis" (presumably of traumatic origin) "a slight haziness of the optic nerve and the adjacent retina and a slight swelling of the disc must be expected." He attributed all the changes alike to chemotactic phenomena occurring as the result of the influence of toxins, which entered the vitreous and aqueous chambers by diffusion, or were carried into them by the lymph stream.

In the course of his address Professor Straub dealt with other matters, the majority of which do not interest us in this communication.

When the writer first began to study the eyes, which had been removed in the Madras Hospital, as the result of failure following couching for cataract performed by native surgeons, one of the first features to attract notice was the prevalence in these eyes of changes in the vitreous. This was not unexpected, for, in a large number of the cases examined clinically, it had been observed that ophthalmoscopy was rendered difficult or impossible as a result of opacification of the vitreous body. The results of endeavouring to remove couched lenses in India were so unsatisfactory that it became a rule of the Hospital to leave them alone save in very exceptional cases, the reason for this being that European surgery was apt to be discredited by the bad results obtained, which, under the influence of the coucher, were too often ascribed to the operation performed for the relief of the condition brought about by his clumsy and septic procedure. Colonel Kirkpatrick, the present Superintendent of the Madras Hospital, has removed a number of these couched lenses, and has been "struck by the rarity of vitreous escape, even after a fairly extensive investigation with a spoon, in extracting couched lenses." He adds: "I have noticed that the vitreous body becomes shrunken and extraordinarily tough, so much so that when an eye is excised (either for glaucoma or for iridocyclitis following Mahomedan interference), the whole globe can be held up by a strabismus hook transfixing the vitreous, though the latter appears perfectly clear. The vitreous undoubtedly does undergo shrinkage, and leaves a large space, which is occupied by aqueous" (Personal communication).

As time went on, we were enabled to collect a large mass of clinical and pathological material, the former consisted of the carefully taken notes of 780 consecutive cases in which couching had been performed, the latter of 54 globes, removed either for the relief of pain, or because they were deemed a possible danger to the other eye. In order to understand the changes in the vitreous body which we found in these globes, it is necessary to preface the discussion by a short statement of certain facts: 1. The methods of the

coucher are wholly innocent of any effort towards the attainment of asepsis or antisepsis. His hands are filthy, his tools worse, and his operations are conducted in the dirt and dust of an Indian village street, or on the mud-plastered pial, or foundation, of a native house (Fig. 1). 2. The virulence of the infective matter he conveys into

FIG. 1.—The operation of couching.

the interior of an eye varies enormously in different cases. Surprising as it may seem, the eye sometimes escapes infection. On the other hand, there is no doubt that a large number of couchings result in panophthalmitis. Between these two extremes, there stretches out a long line of infections, varying in type from the mild to the extremely acute. 3. The operation performed is not in all cases the same, for there are two distinct types of procedure practised by the Indian coucher, for which I have ventured to suggest the names of "the anterior" and "the posterior" operations respectively. In the former, the instrument enters through the cornea and attacks the lens through the iris or pupil (Fig. 2); in the latter, the route adopted is through the sclera behind the ciliary body, and the attack is upon the posterior capsule of the lens or its suspensory ligament (Fig. 3). In the former, the anterior portion of the uveal tract and the aqueous chamber are principally infected, whilst in the latter, the choroid, the retina, and the vitreous are made the primary depositories of the septic material introduced. (4) The amount of damage inflicted

accidentally on the different structures of the eye varies enormously, not only according to the technique adopted, but also with the skill of the surgeon and with the behaviour of the patient. To perform such an operation as couching without the aid of a speculum, and often without the employment of a local anaesthetic, would call for a high measure of dexterity even in a tractable and courageous patient, whilst with nervous, troublesome, ignorant, and undisciplined subjects, the operation must be difficult to the last degree. It is quite clear that the amount of trauma inflicted will have a considerable influence on the nature of any septic process set up by

FIG. 2.—The anterior operation.

FIG. 3.—The posterior operation.

the introduction of dirty instruments within the eye. Now, no one can examine a large number of couched globes anatomically without being struck by the extraordinary difference in the amount of injury inflicted. In some the operation has been so beautifully done that one looks in vain for the track of the wound, whilst in others the havoc wrought is excessive; thus, one may find large tears in the iris and ciliary body (Fig. 4), extensive detachments of the retina and choroid (Fig. 5), permanent fistulae in the investing tunic of the eye (Figs. 6 and 7), the vitreous extensively broken up by the dislocation of the lens, lenses driven through the retina into the subretinal space (Fig. 8), or through the pectinate ligament by way of the anterior chamber into the subchoroidal space (Fig. 9), etc.

There is a last preliminary point of some importance, and it relates to a tendency to deal with this material, as if, since it is founded on the material derived from an operation, which is rarely, if ever, done in European countries, it is only of interest to those who work in Eastern lands. I would ask you to forget for the moment the method by which the globes have been obtained, and to consider them simply as a series of eyes infected by the introduction into their interior of septic material of varying grades of virulence, attended by varying grades of accidental traumatism, and

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occurring in individuals of varying conditions of health and bodily resistance; in other words, to forget their Eastern origin, and to look on the subject in the broadest sense, as an opportunity of studying the results of a large number of experiments performed (unintentionally, it is true) by the Indian coucher on human material.

Having thus cleared the ground, we are in a position to study the subject of our paper, viz., the changes produced in the vitreous by the introduction of septic matter during the operation of couching. As has been indicated, the evidence of such changes varies enormously in different globes, but it can probably be found, if carefully sought for, in every case. In some, the presence of a few threads in the vitreous is all that is to be seen (Fig. 10), in others, a filmy mass is found in the chamber. This may be confined to its anterior portion, or may take the form of a cone, with its apex at the nerve head, and its base in the neighbourhood of the ora serrata and of the ciliary body. In other globes, comparatively firm masses are present, which are freely infiltrated with inflammatory material, either throughout their substance (Fig. 11), or in isolated foci (Fig. 12). In others, the contents of the vitreous are frankly purulent, the eye being in a condition of panophthalmitis. In yet others, the vitreous body is represented by a detached and shrunken conical mass, which may show a higher or lower grade of fibrous organization (Fig. 13). Lastly, there are eyes in which no evidence of the original vitreous can be made out, since the retina has become detached and inextricably matted with inflammatory material, which had first infiltrated, and later replaced, the vitreous contents, the iris and ciliary body being included in the felted mass (Fig. 14).

In seeking to ascertain the method of infection of the vitreous, a point that early attracted our attention was that in some cases the exudate found was confined to the anterior portion of the vitreous chamber, whilst in others, it extended backward, as has already been mentioned, in a cone, whose apex was tethered to the optic nerve. In no case was the posterior portion of the chamber alone affected. The suggestion that naturally occurred to the mind of anyone examining such specimens, was that possibly we were dealing with two distinct classes of case (1) those in which the anterior portion of the vitreous was alone affected by an exudate poured out from the ciliary body, and (2) those in which the whole of the vitreous was permeated, either by exudates from the whole of the uveal tract and from the retina as well, or by a direct infection of the vitreous body setting up such a chemotactic action as had been suggested by Straub. Further investigation proved that there was no real distinction between the two sets of cases, and that in all alike the whole of the vitreous body was involved. The first definite proof of this came from two specimens, which, when examined in India,

had shown a most definite cone of organized vitreous exudate, but which, when they arrived in England after a long sea journey, appeared to be typical instances of infection of the anterior portion of the vitreous alone. Once this clue had been obtained, the explanation was simple enough. The apex of the cone in the vitreous chamber is often extremely slender, and it is not difficult to understand that it might easily be broken through unless the specimen was very gently manipulated. This explains the specimens, which were altered during transit home, but the same line of reasoning will cover a number of others. If, in dividing the frozen globe, the surgeon is not extremely careful to cut just to one side of, and strictly parallel to the median plane, it is self evident that the slender apex of the cone may easily be divided, with the result that the mass of exudate will spring forward toward its large and firm attachment in the neighbourhood of the ora serrata; it is well known that the vitreous body is normally attached to an area round this belt. Again, there is abundant evidence that the cone of exudate in the vitreous has a strong tendency to contract under the pathological process following infection. Apart altogether from the fact that it is well known that organizing fibrous tissue tends to contract, our specimens show abundantly how strong this pull can be on adjacent structures. It may detach the retina and choroid from their beds; it may pull on the optic nerve, dragging it forward into the vitreous chamber; it may drag the retina forward over the ciliary body; and it may even shorten the antero-posterior diameter of the sclero-corneal envelope. It is, therefore, quite conceivable that the slender attachment of the apex of the cone to the optic nerve may be broken off even during life, as a result of this pull. If the fracture takes place very close to the nerve head, anatomical evidence that such a pedicle ever existed may only be obtainable under the microscope. The importance of getting a clear understanding of this matter lies in the fact that a further study of the specimens lends no support to the idea of a local infection of the vitreous body. Now if, following Straub's views, we were to argue that a dirty thorn or needle thrust into the vitreous would be likely to deposit septic matter there, just as we deposit bacterial organisms in a gelatinous culture medium in a test tube, we should probably be justified in expecting to find some measure of localization, or of septic action in the vitreous body. Such an expectation has been uniformly disappointed. The whole of the vitreous body appears, from the first, to be more or less evenly impregnated with inflammatory material, although, as might have been expected, the areas of most profuse exudation and of earliest organization are: (1) in the neighbourhood of the ciliary body and (2) in that of the optic nerve head (Fig. 13). The explanation of this peculiarity is obviously to be sought in the

closeness of these two areas to the sources of vascular supply, and not at all to the method of original impregnation of the vitreous.

Before leaving the subject, there is a farther point of interest to be considered. The greater advance in the organization of the cone of exudate in the neighbourhood of the ciliary body is only what might have been expected, and calls for no comment; but that in the neighbourhood of the optic nerve is less easy to understand; except on the assumption that there is some measure of lymph current passing backward from the vitreous to find an escape at the scleral foramen, either in or around the optic nerve. Microscopical preparations show definite blood-vessels in the apex of this cone of exudate (Fig. 14). These vessels are clearly tributaries of the central retinal vessels. Now, it is difficult to imagine that such a state of things could exist, except as a result of a backward flow of chemotactic substances toward the lymphatic channels in or around the optic nerve. It is not, perhaps, universally admitted that any such flow of lymph is usually present in the normal eye, the general tendency being to assume that this fluid escapes either: (1) through the anterior route (by the ligamentum pectinatum and iris crypts), or (2) by the equatorial route (around the venae vorticosae). Three possible channels of escape have been suggested for the lymph current at the posterior pole of the eye, viz.: (1) outside the dural sheath, (2) by the intervaginal space, between the sheaths of the optic nerve, and (3) along the central canal of the vitreous and the trunks of the central retinal vessels. Fuchs, speaking of this last channel ("Text Book of Ophthalmology," Fourth English Edition), states that while the matter is still under dispute, pathological processes argue the existence of such a lymph passage, which runs in the vitreous straight back to the head of the optic nerve, since even in slight inflammations of the anterior portion of the eye, the optic papilla may be found implicated, even though the rest of the back of the eye is still normal, so that we must assume that irritant substances from the focus of inflammation can get to the optic nerve by a direct channel through the vitreous. This, however, does not seem to be necessarily the only solution of the phenomena to which he refers. Leboucq ("Lymphatic Channels of Eye and Orbit," *Soc. belge d'Ophtal.*, No. 35, p. 46, and No. 36, p. 63) made a number of experiments on rabbits, which led him to believe that there is in the orbit a lymphatic system for the outflow of aqueous humour which is completely independent of the venous system. He found three channels of outflow in these animals: (1) an interior in the neighbourhood of the angle of the anterior chamber, (2) a median by the lymph sheaths of the vorticosae veins, and (3) a posterior by the lymph sheaths of the optic nerve. The fact that the last-named channels are to be found normally

in rabbits would invite the presumption that they might possibly exist, though probably not to the same extent of development in man. Such a supposition appears to find support from the following facts : (1) In this long series of septicallly infected globes the presence of a cone of exudate in the vitreous is practically a constant feature ; (2) the apex of that cone is always attached to the optic nerve head, or in its near neighbourhood ; (3) in a certain number of cases there is definite evidence of congestion or inflammation of the optic nerve head ; (4) the cone in question obviously represents *the whole* of the shrunken vitreous, and not merely the part surrounding such a central canal as Fuchs seems to visualize. The obvious explanation would appear to be that there is, even in man, some measure of lymph flow towards the posterior pole of the eye, and this carries with it for excretory purposes any septic products, which have been introduced into the interior of the eye by dirty instruments, or which are thrown into the vitreous body by the surrounding vascular structures, as a result of their inflammation. It might be argued that the vitreous body is, under normal conditions, attached to the optic nerve head, and that this fact would sufficiently explain the attachment in question. This is true ; but other points have to be taken into consideration, viz., (1) that the anterior attachment of the vitreous in the neighbourhood of the ciliary body has vascular and lymphatic relations with the important structures in its vicinity there ; (2) that the organization of the cone of vitreous, and such organization includes the formation, under favourable circumstances, of new formed blood-vessels (Fig. 14) proceeds most rapidly, and advances to the greatest extent, in the two neighbourhoods in question ; (3) that a distinct inflammation of the optic nerve head was present in a certain number of the globes examined anatomically ; and (4) that optic neuritis and optic atrophy were seen in other eyes examined during life. If all these points be taken into consideration, they appear to afford a strong presumption of the presence of a backward flow of lymph from the vitreous body to the posterior pole of the eye. Several specimens show in the middle of the cone of exudate what would appear to be an evidence of the existence of a hyaloid canal. Unfortunately, this surmise cannot be confirmed without destroying valuable and irreplaceable specimens.

To return to the paper read before the Ophthalmological Society by Professor Straub. In that communication, the author contended strongly for the acceptance of the term "hyalitis," on the ground that the deposition of septic matter in the vitreous body had been responsible for a chemotactic action, which had caused the inflow of inflammatory products into that body, and therefore had established a state of inflammation within it. To this exception was taken by Mr. Parsons on the ground that the rôle of the vitreous

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body was a purely passive one, and that the inflammatory action should be referred to the ciliary body in which it was really seated. It is true that in Straub's experiments there must have been an abundant and direct infection of the vitreous body with septic matter, but there was also present a very definite infection of the ciliary body itself, and the reaction set up in that body would seem to have been quite sufficient to account for all the vitreous changes observed. Our point is that it was not necessary to premise (1) an infection of the vitreous body, (2) the diffusion of the poison so introduced, and (3) the resulting chemotaxis to account for the phenomena observed, since the lesion in the ciliary body alone would have sufficed to explain all the changes present.

The same is true of all the globes which have been removed and examined after couching. It is possible, and even probable, that the introduction of a dirty instrument into the globe coincidentally with the wide opening up of the vitreous that occurred in many of the cases, caused an even more definite and widespread infection of the

FIG. 16.—Diagram to show the path of a lens during depression.

FIG. 17.—Diagram to show the path of a lens during reclination.

vitreous body than that met with in Straub's experiments (Figs. 16 and 17). Moreover, in very many cases, the instrument was actually introduced right into the vitreous itself, but one could not attribute the changes found to this infection of the vitreous alone, since one must obviously take account of the other structures of the eye which were injured at the same time, and not least of the ciliary body. Before going any further, we must therefore discuss shortly the lesions of these other structures, and the results which accrued from them.

The sclero-corneal tunic.—The coucher's instrument is introduced either through the cornea, the limbus or the sclera, and several of our specimens show the results of the inflammatory action induced in these structures thereby. Long afterwards, the track of the

instrument remains marked out by the reaction of the sepsis produced, or a permanent fistula of the cornea or the sclera may be left (Figs. 6 and 18).

The uveal tract.—In quite a large number of couched eyes one finds extensive scars in the iris, in the ciliary body and in the choroid, or in two or more of these structures (Fig. 4). In association with these injuries, we find a uveitis very widely prevalent. The intensity of this inflammation and its seat vary considerably. In some the evidence of iritis, of iridocyclitis, of cyclitis, or of choroiditis requires careful looking for, whilst in others, the inflammatory process had been so severe as to result in a fulminating panophthalmitis. A very important point is the type of inflammation present which, with one solitary exception, was always plastic in nature, and was mostly confined to the iris and ciliary body. The plastic mass poured out from these structures had in many cases enveloped the remains of the lenses (Fig. 14), which can be seen in process of disintegration under the action of phagocytosis or of fluid absorption (Figs. 19 and 20). Allusion has been made to one instance of proliferative uveitis, and in this one the nodule in the iris consists of mononuclear lymphocytes; epithelioid and giant cells are conspicuous by their absence. In the series of globes before us, we can trace every stage of the changes produced in the vitreous body as the result of the inflammatory action in the surrounding parts. Much depends on the stage at which we see the eye and on the intensity of the inflammatory process, which has been excited in it. In early and mild cases, the vitreous is found to be hazy, the membranes described by Straub are present, cellular elements are scanty and difficult to demonstrate, the anterior hyaloid membrane (the term is used without prejudice) may be definitely thickened and infiltrated with inflammatory material. In better marked instances, the exudate reaches such a pitch of organization as to cause it to assume (under preparation for anatomical examination) the familiar shape of the vitreous cone. This, in turn, becomes better and better marked as organization proceeds; the area of greatest advance of these changes is, as has already been stated, in the neighbourhood of the ciliary body anteriorly and of the optic nerve posteriorly.

It is significant that so large a collection of infected globes presents very little evidence of inflammation of the choroid in spite of the fact that several of the eyes were wounded posteriorly to the ora serrata. The leading choroidal feature was the presence of atrophy, though doubtless this was largely secondary. In one very interesting case a caseating mass was found in the eyeball between the retina and the choroid; in this was found a fragment of metal, which was most unfortunately lost. The strong but strictly localized inflammation around this mass suggests that it was of

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copper, an idea which derives support from the fact that these men use probes of that metal, wherewith to depress the lens, after making their preliminary incision. The extensive detachment of the retina in this case, and the other features of it, suggest strongly that the vitreous exudate, which, as we shall presently show, is responsible for the detachment of the retina, owed its origin to the uveitis present.

In the above argument there has been an underlying assumption that in all the globes under discussion the vitreous had been directly infected and widely laid open. Though true for the majority of the eyes, this is not so for all, and this brings us to a subject of more than ordinary interest. In a few of the cases we find the lens lying dislocated between the anterior hyaloid membrane (the term is used without prejudice and for convenience sake) and the iris, ciliary body, and ora serrata. Such are obviously cases of depression and not of reclinatio. There was therefore no opening up of the vitreous by the lens. Again, in one of these cases there is a strong presumption, and in another the certainty that the couching was performed from the front of the eye (as shown by an anterior synechia at the point where the instrument entered), and yet in both of these an organized vitreous exudate had formed (Fig. 21). It is therefore clear that we can find in the vitreous the exudate which characterizes the couched eye apart altogether from the opening up of that body, either by the dislocated lens or by the instrument used; its source must, in such cases, obviously be from the primary inflammation set up in the surrounding vascular structures by sepsis.

The retina.—Detachment of the retina occurred in 70 per cent. of the 54 globes examined. A few of the cases were slight in extent; the great majority were complete. If we put aside for the moment the consideration of those cases in which the detachment was either directly traumatic, or due to the haemorrhage following traumatism, we find that the rest, which constitute the great bulk of the cases, owe their detachment to the contraction of the inflammatory exudate which had been poured into the vitreous chamber, and which had formed adhesions to the retina. Every step of the process can be traced in the macroscopic and microscopic specimens. The earliest possible stage is seen under the microscope in sections of an eyeball, where the shrinkage of the exudate within the vitreous chamber had just commenced to lift the retina from its bed. The ultimate stage of the process is to be found in a number of globes, in which the retina is not only detached, but has shrunk posteriorly into a stick-like column, whilst it opens out anteriorly into a mass, in which the iris, the ciliary body, the lens, the remains of the vitreous and the retina are inextricably matted and tangled (Fig. 22). Every grade can be traced from the slightest detachments up to those we have just described. The degree of

separation of the retina is partly a question of time, but it is much more one of the character and grade of the inflammatory process excited in the eyeball, and of the time at which the examination is made. Obviously a great deal depends upon the nature and extent of the original infection. It will naturally be asked, what are the conditions which give rise to the formation of adhesions between the vitreous exudate and the retina. There are several: (1) The site of a retinal wound may form the point of connection between the exudate and the membrane (Fig. 5). (2) The deposition of septic matter within the vitreous chamber, and its wide diffusion throughout the hyaloid may set up a retinitis by chemotaxis. Evidences of such an inflammation of the retina abound in many of the specimens (Figs. 23 and 24). Such appearances

FIG. 24.—A collection of leucocytes, lying on the inner surface of the retina, superficial to its limiting membrane, and projecting freely into the vitreous. In the substance of the retina is the section of a vessel surrounded by a mass of leucocytes (from a couched eye).

would seem to be best explained on Straub's supposition referred to above. Everything that we know of the circulation of fluid within the vitreous would favour the idea that poisonous matter introduced into that body would speedily become diffused throughout its substance, and we may presume that its principal attack would be upon the wide surface of retina exposed to its influence. Now, a noteworthy point in our specimens is the presence of a number of greyish-white dots found scattered on its surface in a large percentage of the specimens. Conditions of time and space prohibit a full consideration of the nature of these dots which appear to differ widely in different globes, but in several of them they seem to find their explanation either in localized patches of proliferative retinitis, or in free collections of mononuclear cells lying on the surface of the retina. The two appearances are sometimes closely

correlated, though not always so. It will be remembered that Straub laid great stress on the presence of more or less sharply defined dots on the back of the cornea, on the retina, on the lens capsule, and on other surfaces. These dots he found to be due to aggregations of leucocytes, which he considered were attracted to the spots where they were found by chemotactic action. A comparison of Straub's illustrations with those here given (Figs. 23 and 24) will show a close similarity between the two. He hypothesizes the impregnation of the membrane attacked with the substance possessing chemotactic influence; this substance is spread over the surface and attracts leucocytes to it. Where the leucocytes are killed, owing to the intensity of the poison, fresh cells are attracted by the chemotactic influence of the dying leucocytes, and thus the slight inequalities of the first formation become exaggerated and give rise to the formation of the small heaps we have been discussing. This ingenious theory helps materially to explain the phenomena we have observed in these cases. Not the least significant fact in this connection is that in the cases we are now considering the brunt of the trouble appears to be borne by the retina, whilst the choroid almost uniformly escapes. (3) The deposition of inflammatory material may cause an infiltration and thickening of the anterior layer of the hyaloid. It is well known that the vitreous body is more firmly attached to the retina in the neighbourhood of the ora serrata than elsewhere, and the contraction of an inflammatory membrane in the anterior part of the vitreous will pull throughout its whole circumference on the retina in this neighbourhood, thus effecting a wide detachment of the anterior portion of the membrane. Our specimens illustrate this point well. (4) When the lens itself is the principal focus of the sepsis introduced, as it obviously often must be, the inflammatory action set up causes the formation of radiating bands from the lens-remains into the surrounding parts. The contraction of these bands will act powerfully in effecting retinal detachment. It is true that in a number of the cases an abundant subretinal exudate can be seen to have been present, but it seems obvious that this was in no way causative of the detachment. It was simply an effect of it.

To summarize our conclusions: An examination of these fifty-four globes removed after couching throws some light on the problems so ably studied by Straub, but lends no support to the view that the changes met with in such septic cases justify the assumption of the existence of a clinical entity to which we can give the name of hyalitis. Septic matter introduced into the vitreous is probably rapidly and widely diffused throughout the structure, and in so doing there is reason to believe that by chemotactic action, it may attract inflammatory material from the ciliary body and from the optic nerve head into the hyaloid

substance. It would seem also that it has a similar action on the retina, and possibly on the choroid as well, though of the latter the evidence is scanty. A far more important element is the septic infection of the ciliary body and of the retina and choroid at the time of the introduction of a septic instrument; in other words, it would seem likely that the changes found in the vitreous under these and allied septic conditions, are mainly to be attributed to cyclitis, and to a lesser degree to choroiditis and retinitis, it being understood that these changes are primary, that is to say, caused by sepsis introduced into those structures themselves, and not secondary, as Straub implied, to changes set up in those bodies by the chemotactic action of septic material distributed throughout the vitreous. It would be of the greatest interest if a series of experiments could be undertaken for the introduction of a deposit of septic material within the vitreous, without contamination of the tunics of the eye. The technique might be difficult, but with mechanical appliances, the difficulties should not prove insuperable.

Straub's paper dealt with the results of septic infection of the vitreous. Our material has enabled us to trace the same processes wider and further by virtue of the greater number of globes concerned and of the greater variability of the elements entering into them.

There are two factors to be taken account of in every one of these cases: (1) the stab-culture of the vitreous body and (2) the simultaneous infection of the surrounding vascular coats.

Our series furnishes no evidence in favour of the formation in the vitreous body of localized cultures of organisms, such as Straub alludes to. On the contrary, everything goes to show that the virus is early and evenly distributed by diffusion throughout the vitreous body. Under such conditions, it would appear to give rise to chemotactic action, as described by Straub. The brunt of that assault would appear to fall on the retina.

The formation of the characteristic exudate within the vitreous would appear to be very largely accounted for by the infection of the vascular tunics of the eye, and by the results of their inflammatory reaction to that infection. On the other hand, the even distribution of the exudate throughout the vitreous would appear to suggest the possibility that the septic matter within that body acts chemotactically upon all the surrounding structures throughout the extent of their contiguity with it and not least upon the ciliary body.

With regard to Straub's advocacy of the term "hyalitis," the academic view undoubtedly is that the vitreous is an inert body, that the real site of the inflammation is in the vascular structures surrounding it, and that the nomenclature adopted should make these points clear.

Straub, in support of his argument, cites the customary use of the term "keratitis," as a precedent for speaking of "hyalitis." The

fact that our specimens show new formed blood-vessels in the inflammatory tissue within the vitreous of certain of these eyeballs lends some support to such a contention. The conditions are, however, not quite parallel, the lymph channels in the cornea being, under normal conditions, more definite than those in the vitreous, where the process of nutrition is conducted by osmosis rather than by lymph flow. The vascularization of the cornea takes place much more readily in its more highly organized structure than does the same process in the vitreous. In the end, however, the difference would appear to be a matter of degree rather than of kind.

So long as those who use the terms understand exactly what they mean, little harm can be done, but, inasmuch as those terms will be transmitted to students and to many others, whose comprehension of the position will not be clear, it seems a pity to use the term "hyalitis."

The appearances so constantly observed in the vitreous, taken together with those found in several of the optic nerves, would seem to lend strong support to the view that some, at least, of the lymph from the eye takes a backward passage and escapes by channels in, or in the neighbourhood of, the optic nerve. This phenomenon serves to explain the occurrence of optic neuritis as a complication of septic wounds of the anterior segment of the globe.

FACTORS IN STEREOSCOPIC VISION AND IN THE VISUAL ESTIMATION OF DISTANCE

BY

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CAPTAIN R.A.M.C.

THE power of estimating distances with accuracy is essential to expertness in handicraft, in sport, and in any activity which controls the direction or the amount of a mechanical action.

In every department of life, therefore, this faculty is of importance, directly or indirectly; yet, owing to its very general possession and to its susceptibility of improvement according to the requirements we habitually make of it, the limitations and the illusions to which it is subject are readily overlooked. In few judgments are we more dependent on familiarity of circumstances and setting than in this one. The question is one which has assumed a peculiar importance in recent years, when so many men accustomed to living indoors have been transferred to a life in which visual judgments in the open are constantly called for,