process, which was arrested by heparin, with resulting improvement in vision.

Dr. Gifford remarks that heparin is an expensive drug. This is true, as its preparation is a complicated procedure, and many pounds of beef lung are required to make one gram of heparin. The cost has, however, been gradually reduced. I believe that heparin is as important a scientific achievement as is insulin, although its field of application is more restricted.

Dr. Chandler will find the surgical uses of heparin discussed in Murray's 1939 Hunterian Lecture. It is a new drug, and the next decade will crystallize our knowledge of its therapeutic indications.

I may add that when heparin is used in the blood of an experimental animal, it may be perfused for hours through the capsule shown in the last slide, and the scratch will show no clotting.

In closing I wish to call your attention to the progressive nature of retinal thrombosis, for in a search of the literature I have not found this point mentioned; its importance can hardly be exaggerated.

VARIATIONS IN THE DEVELOPMENT AND REGRESSION OF BERGMEISTER'S PAPILLA AND THE HYALOID ARTERY

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Scaffolding is essential to the construction of buildings, and it has its counterpart in the developing human eye. The hyaloid artery arises from the disc in a cone-shaped mass of embryonic tissue known as Bergmeister's papilla, through which it passes to the tip on its way to the posterior surface of the vascular capsule of the lens. Within a comparatively short time the lens develops within the capsule, and all this tissue must then disappear in order that the vitreous and lens may be clear. The functions of the hyaloid artery are taken over by the ciliary vessels, which were originally of little importance. Errors in development or regression are very

apt to attract attention because of changed pupillary reflex in early life or defective vision at the school age.

In the first stage, the disc is very close to the lens, and the hyaloid artery runs a short course to the lens. As the eye develops the lens moves forward, and the hyaloid artery and its branches adjust themselves to the changed conditions in order to continue the supply of blood to the growing lens; the branches communicate laterally with the circular artery, the forerunner of the ciliary circulation of the adult eye. From the fourth to the seventh month there is a cone-shaped mass of embryonic tissue on the disc from the tip of which the hyaloid takes off. As the eye continues to enlarge the hyaloid branches are stretched, and should disappear entirely except for a few fine twirls, which, with the slit-lamp, may be seen hanging from the point of attachment of the main branch, below and internal to the posterior pole of the lens. The cone-shaped mass upon the disc should disappear, and with it not only the hyaloid artery stalk, but its own special vascular supply. The canal in which the hyaloid artery runs through the vitreous cannot be seen ordinarily, but in cases of sharp inflammatory processes, such as uveitis, iridocyclitis, etc., this canal seems to become dilated by new material just short of absolute transparency, leading one to assume that the walls of the canal of Cloquet merely fall together, leaving a potential space. Errors of development in a somewhat elaborate tissue such as this may produce most interesting conditions, but variations in the recession of these tissues contribute more important features, because they traverse tissue that must be absolutely clear.

Perhaps we should not attempt to draw too fine a line between the errors of development and those of recession. Various theories have been offered to account for these maldevelopments, but for present purposes we are concerned mainly with their clinical aspects. The mildest variation from the normal status of the papilla is the retention of a few bits of embryonic tissue upon the disc along the stalks

of the vessels as they pass from the pit at the disc center across the disc to the retina. Sometimes there is a delicate mass of this tissue clinging to the vessel trunks like a spider-web attached to the stems of a small bunch of grass a little above the ground, like an inverted umbrella. A more advanced type shows a thick mass of opaque tissue closely connected with the large vessel stalks, covering the entire disc. This is the epipapillary membrane, which has been well illustrated in the literature. An unusual case of this general type came to my attention some years ago, and shows also an odd arrangement of the blood supply of the retina. The disc was present, with a pit from which the central artery and vein would be expected to emerge but did not do so (fig. 1). Temporal thereto was the entrance of the posterior ciliary vessels in a circle, and upon these there was a thick mass of tissue resembling the closed thumb and fingers of a hand, with the forefinger pointing "this way out." The patient came because of convergent squint, and the eye had no central vision.

Another type of organization of papillary tissue consists of a round mass partly covering the disc. Such masses are elevated and appear to be cystic, but since none of them, so far as I know have been sectioned, we cannot state positively that they are cystic in nature. That these masses may be dilated and contain fluid seems certain. Dr. Levitt brought to the clinic a young woman with normal vision, who presented a most interesting fundus picture. With the large binocular ophthalmoscope a loop was seen in the interior, moving up and down with the movements of the eye, and coming to rest at the top of an apparently cystic space. We assume that this loop is a remnant of the blood supply of the papilla itself, and that it is similar to the vascular loops projecting from the disc into the vitreous, seen now and then with the ordinary hand ophthalmoscope. In this case the loop could not be seen with the hand instrument. More pronounced structures projecting from the disc involve not

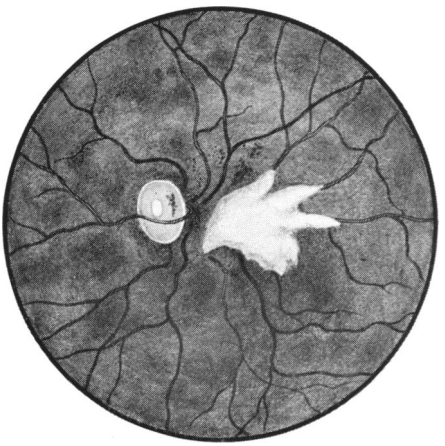

Fig. 1.—Embryonic tissue remains and absence of central retinal artery.

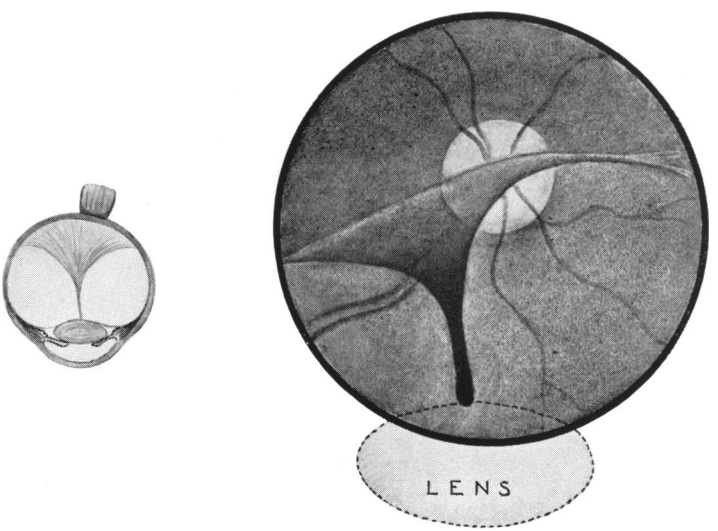

Fig. 2.—Retinal fold with persistent hyaloid artery attached to posterior surface of lens.

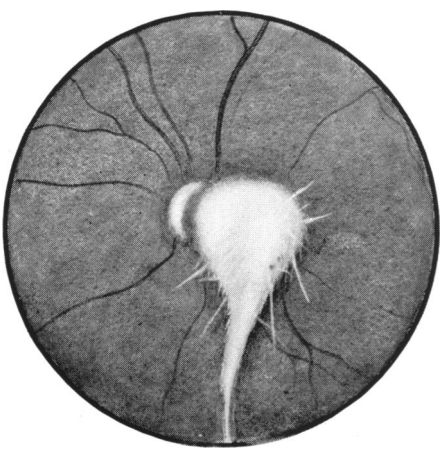

Fig. 3.—Result of an injury.

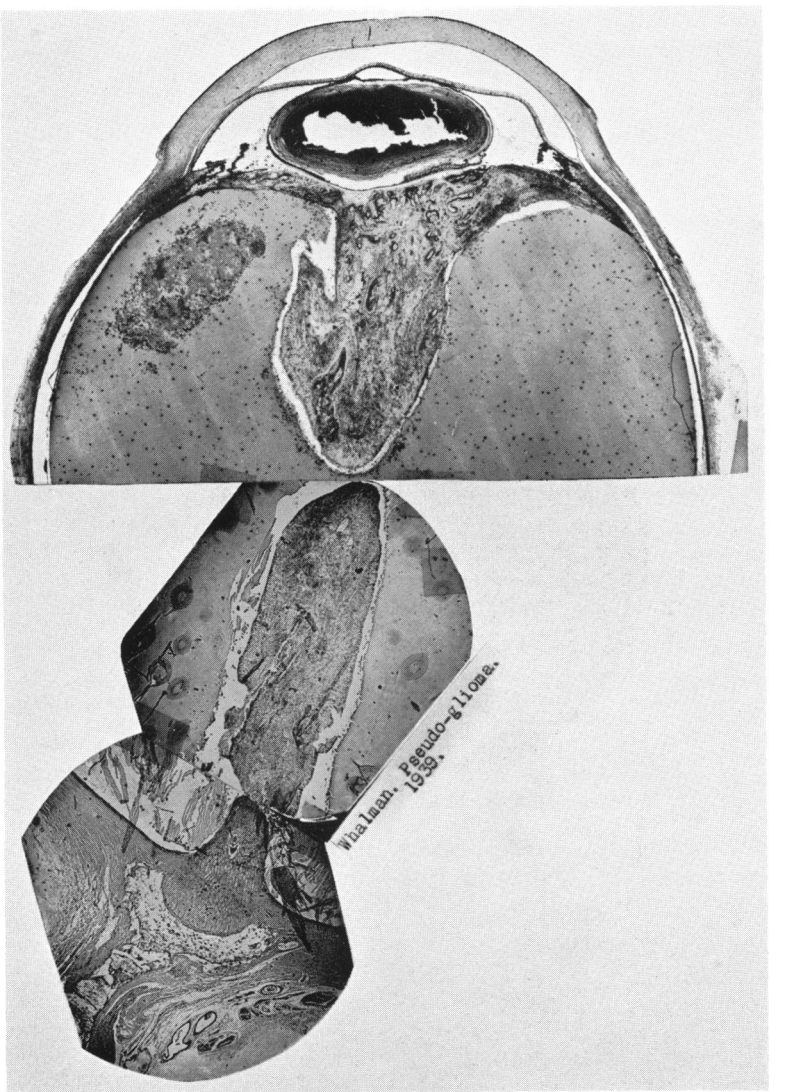

Fig. 4.—Persistent papilla, hyaloid artery, and pseudophakia fibrosa. Sections at three levels are arranged to show the connection between the disc and the vascular capsule of the lens.

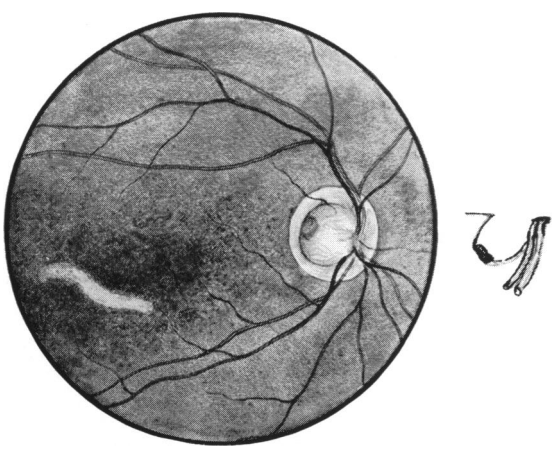

Fig. 5.—Coloboma of the disc and "pit."

only the papilla, but also the hyaloid artery and the canal of Cloquet. Modest remnants of the hyaloid artery projecting into the vitreous are not so rare, and quite a few can be traced forward to the lens itself. Occasionally, the canal of Cloquet becomes distended, and some very odd malformations of residual tissue can be seen ending in a dilated extremity short of the lens, with a similar bulge at the point of attachment posteriorly, giving the appearance of a dumbbell. In addition, there are usually seen in the fundus a number of queer curlicues, which, in the early days of the ophthalmoscope, were diagnosed as cysticercus. An odd and rare anomaly sometimes seen is the congenital falciform detachment of the retina, a retinal fold with a persistent hyaloid artery running forward to the lens in the free margin of the fold. Weve and Ida Mann have described several of these, and I am showing a case of this type with a double triangular fold, the artery running forward in the center of this double fold, like a mast with a triangular sail on each side. In addition, there are many bits of pigment on the anterior lens surface, with a number of persistent pupillary membrane remnants (fig. 2).

It would seem to be easy to differentiate these falciform folds of the retina from the effects of trauma, but Dr. Walter Moore had a case that was indeed puzzling. It was finally solved by the *x*-ray report of the presence of a foreign body embedded in the tissue. On hearing the report, the patient recalled having had an accident several years before, but he had previously denied having had trauma of any kind, and seemed honest about his declaration. Recently, one of my patients gave a history of having had poor vision in one eye since an accident that occurred during a hockey game. The eye had no direct vision, but was white and painless, and the tension was normal He had been struck in the eye by a skate, and there had followed a prolonged period of total blindness, pain, and a very red eye (fig. 3). Recovery took place and he has had no trouble for twenty years after

the accident. The mass projecting forward from the disc does not reach the lens, and from the forward portion of it many minute spicules project, like the displaced hairs of a brush, but the whole mass resembles some of the folds shown in articles describing these congenital falciform detachments of the retina.

Perhaps the most important of the anomalies of this group are those which, in typical cases, show a large, persistent Bergmeister's papilla, a large and persistent hyaloid artery, and a mass of tissue upon the posterior lens surface which has been termed the pseudophakia fibrosa of Czermak. In one of the reports of the Royal London Ophthalmic Hospital it was stated that of 24 eyes removed with a diagnosis of glioma, 7 were embryonic malformations. This type of pseudoglioma is very definite, and presents most interesting features. The mass of tissue upon the posterior lens surface is well organized, quite vascular, and connected to the ciliary segment of the vascular lens tunic by firm tissue, and usually to the disc by a hyaloid artery and more or less added tissue. The ciliary processes are undeveloped; the lens is small, but the angle of the anterior chamber seems normal. The eye itself is smaller than normal. Three cases of this type have come to my attention, and I am indebted to Dr. Whalman, of Los Angeles, for the privilege of studying the most interesting case of this group (fig. 4). This particular eye should be compared with the patient's other eye, which was buphthalmic, but there was also present a strand running from the lens to the disc—a persistent hyaloid artery. In the case of a boy with a similar eye, I was able to watch the patient from the fifth month until he was twelve years of age. When he was first seen, a diagnosis of this type of embryonic defect was made because of the color of the mass behind the lens—a cold gray; because of its position close to the lens, and not separated from it; by reason of the finding of a vessel carrying blood internal to the posterior pole; and by the fact that the pupil did retain some of its functions.

We are taught that it is wise to keep an eye in the socket of a growing child in order to encourage the orbit to develop fully. A picture of this boy will show that this eye is smaller than the normal eye, that the orbit is also smaller, and that the face is underdeveloped on that side. The wisdom of the long-established rule that in all cases of doubt an eye without useful vision should be removed cannot be disputed, and the advantage to be gained from leaving such eyes in place for the effect it would have upon the growing orbit is too slight to be considered. The well-behaved Bergmeister papilla should atrophy and leave behind a depression in the disc—the physiologic cup. Undoubtedly the extent of this atrophy has something to do with the clearness with which the lamina cribrosa may be seen with the ophthalmoscope, but probably the manner of closure of the ocular fissure has more to do with the size and depth of the cup and its departure from the normal than the atrophy of the embryonic tissue of the papilla. The critical point in this closure is the lower and outer angle of the disc, from which the usual ocular cyst projects backward, and where the coloboma of the choroid and that of the optic nerve join. We are more particularly interested in the less pronounced defects of this region, such as "pits in the disc." The physiologic cup in these cases is pronounced, and may be so deep as to be regarded as colobomatous, and in the depth of the concavity at one side is usually seen what is called a pit. This is in reality a mass of retinal pigment. There is a sort of hernia of the optic nerve sheath into which the retinal tissue dips and then emerges to pass on to its destination. This tissue is more or less malformed, and pigment masses clumped in one spot give the impression of a pit (fig. 5). George Coats was one of the first workers to study such eyes under the ophthalmoscope, and describe the arrangement. More recently Lauber found such an eye in a patient brought to the hospital *in extremis*. At the examination a sketch was made and compared with the microscopic details obtained

later, and the details of the two pictures were then compared with those Coats, Seefelder, and Ida Mann had previously pointed out. This type of coloboma very closely resembles a cystic defect described by Phinizy Calhoun, who examined the protruding eye of a child. He found a marked cupping of the disc of both eyes, and the protruding eye showed, in addition, a cyst attached at the lower angle of closure of the cleft in the nerve head posteriorly.

None of these anomalies are common, but it would seem that the clinical aspects of these cases should be recorded and illustrated, even if all the microscopic details cannot be supplied at the time. By placing these cases on record, other investigators can fill in the gaps from time to time, and finally both case histories and microscopic examinations of the various types will accumulate in sufficient numbers to satisfy even the most critical.

DRUSEN OF THE OPTIC PAPILLA: A CLINICAL AND PATHOLOGIC STUDY

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According to its scientific programs, only once in its long history has the attention of this Society been called to drusen (hyaline bodies) of the optic papilla. This was in a paper read by de Schweinitz in 1892, being the first American contribution on Drusen of the Papilla. It was based on one case, and it was unique in that the author reported not only the clinical but also the postmortem examination. The concretions were confined to the papilla and were found nowhere else, although a careful search was made of the optic nerves in their entire lengths, and of the brain. Strange to say, since 1921, except for a brief paper by Goldstein and Givner in