Experimental Deflection of the Course of Optic Nerve in the Chick Embryo.* (18471)

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The fibers of the optic nerve of vertebrates grow from the ganglion cells of the retina into the diencephalon, where the bundles from both sides intersect to form the optic chiasma. The present study is a first attempt to analyze the factors determining their orientation and distribution, particularly the guiding role of preformed pathways and the selectivity of associations (see Weiss)(1). In normal development, the epithelial tube of the optic stalk serves as guide channel for fiber growth between eye and brain. It was of interest, therefore, to investigate the course the fibers would take if deprived of this channel.

Materials and methods. Since the first optic fibers in the chick embryo reach the future chiasma region after 70 hours of incubation (2,3), the stalk had to be severed and its stump deflected at approximately this stage. Into an incision between the eyes made by a fine glass needle, a triangular piece of shell membrane, cca 0.2 mm long, was introduced as a barrier. These fragments had previously been immersed in glycerine-egg albumen, then in alcohol for coagulation, then stained with Nile blue sulphate and finally washed in boiled water. The eggs were closed again with caps of egg shell(4). Four to 5 days p. op. the embryos were fixed, stained and sectioned (Bodian's formalin-protargol; Cajal's pyridine-silver).

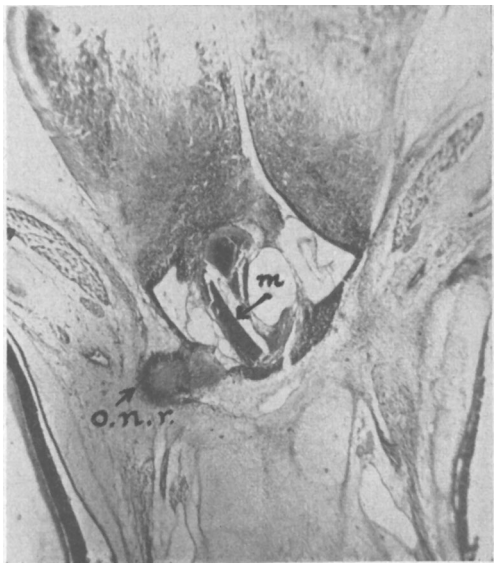

FIG. 1.

FIG. 1 and 2. Sections through chiasma region at different levels of same chick embryo with shell membrane (m) blocking and deflecting right optic nerve (o.n.r.); course of left optic nerve (o.n.l.) normal. × 22.

Results. In most of the 30 otherwise successful cases, the membrane was found displaced at some distance from the chiasma. In these cases, the optic nerves and chiasmata were normal, indicating that the severed stumps of the stalk had healed and restored a normal growth channel. In 6 cases, however, the membrane had remained in the desired blocking position and deflected the outgrowing nerve fibers. In a typical case, shown at two different levels (Fig. 1 and 2), the membrane (m) can be seen in the path of the nerve (o.n.r., Fig. 1), whose course is then turned downward toward the pharynx (Fig. 2), in contrast to the opposite normal optic nerve (o.n.l.). Specifically, the results in the other 5 cases were as follows. *Cases B and C*: One optic nerve totally deflected toward the pharynx, the other divided into a diencephalic and a pharyngeal branch. *Case D*:

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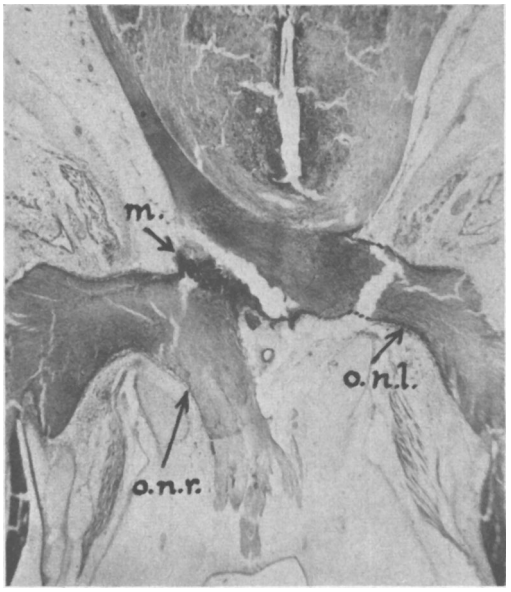

FIG. 2.

Both optic nerves blocked from meeting and from crossing midline, so that each terminates on its side of the brain, with part of one also deflected toward the pharynx. *Case E*: One nerve in direction of brain, but without entering it, terminates in connective tissue; the other with branches into both brain and pharynx. *Case F*: Both nerves deflected into pharynx.

After obstruction of their normal pathway the outgrowing fibers followed the matrix of the surrounding connective tissue which led them to abnormal destinations. Knoblike endings of these optic stray fibers were seen in the connective tissue, in perichondrium and in the pharyngeal epithelium. Even in their abnormal courses, the outgrowing fibers tended to associate into solid bundles by fasciculation(5). Yet there was no evidence of any neurotropic attraction toward the brain. On the other hand, once the fibers had entered the brain wall, their courses and terminations seemed to tend to become typical. The results are in agreement with the principles of "contact guidance"(1) and "selective fasciculation(1)."

Incidentally, cases with only a single optic nerve penetrating the brain furnished an experimental demonstration of the partial decussation of optic fibers in the chick (Fig. 3).

Summary. The effects of early transection and mechanical obstruction of the optic nerve in the chick embryo were studied. The deflected fibers follow abnormal courses determined by the surrounding connective tissue matrix without evidence of neurotropic attraction by the brain.

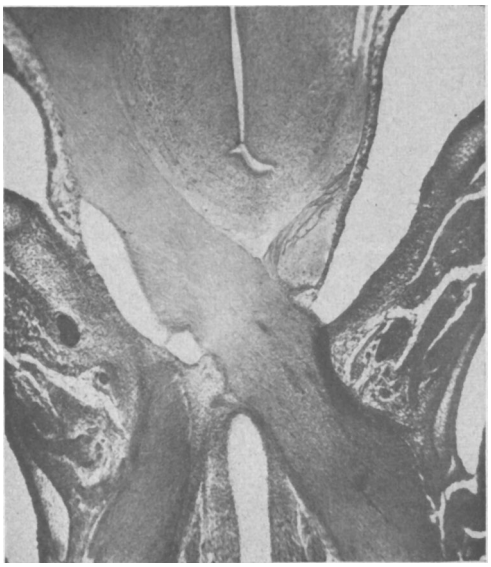

FIG. 3.
Chick embryo with deflected right optic nerve, showing partial decussation of fibers of unaffected left optic nerve. × 27.

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