The Arterial Supply of the Human Optic Chiasm

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The visual field changes that accompany pituitary tumors are among the most certain localizing signs in neurology. Most textbooks of anatomy demonstrate the decussation of the medial retinal fibers in the central chiasm by descriptions of the bitemporal field defects that occur in chiasmal compression.

However the distortion of the visual pathways by pituitary tumors is seldom limited to the central chiasm; more often pressure is distributed along the inferior surfaces of the optic nerves, optic chiasm, and optic tracts (Fig. 1). The altitudinal visual field defects that might be anticipated from such compression are rarely found. Moreover, anterior third ventricle tumors, which equally distort the optic pathways from above, cause patterns of visual loss that are less predictable and less regular. The central portion of the chiasm in which the decussating fibers are found appears to be especially vulnerable to distortion and compression from below.

This report includes observations at autopsy of the arterial blood supply of the extra-cerebral parts of the visual pathways. The peculiar derivation of the blood supply of the central chiasm suggests that vascular compression rather than neural compression contributes to the bitemporal hemianopsia so commonly seen in pituitary tumors.

Method

The removal of the brain at autopsy by traditional methods involves cutting across the visual pathways and inevitably destroying their vascular relationships. To circumvent this problem, several techniques of obtaining and studying autopsy material were employed.

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FIG. 1. A pathological specimen of a pituitary tumor. The tumor is several centimeters wide and distorts the inferior aspects of the optic nerves, chiasm, and optic tracts. The central chiasm is not selectively distorted, yet "examination revealed a bitemporal hemianopsia with a central scotoma of the right eye." (Published through the courtesy of Armed Forces Institute of Pathology; Acc. Number 219933-14.)

The initial anatomical observations were made during the course of the dissection of 225 autopsy specimens. These were obtained by removing the brain but leaving the anterior hypothalamus, infundibulum, optic chiasm, and optic nerves in situ. The block of bone containing the pituitary and surrounding structures was then removed with a motor saw for further dissection. These dissections were performed to delineate the patterns and frequency of the anatomical variations that surround the pituitary, but there was ample opportunity to observe the vascular anatomy pertinent to the local visual structures.
In 50 additional autopsies the chiasm and optic nerves were left attached to the brain which was removed in the traditional manner by sectioning the optic nerves at the optic foramina and dividing the pituitary infundibulum at the level of the diaphragm. Care was taken to preserve the chiasmal arachnoid and small vessels surrounding the visual pathways. Following fixation in formalin the chiasmal arachnoid was removed and the small arteries surrounding the visual pathways demonstrated by dissections.

In 200 additional autopsy specimens, the brain was removed leaving the anterior hypothalamus, infundibulum, optic chiasm, and optic nerves in situ. The bony blocks were removed with a motor saw and fixed in formalin. Then the pituitary gland and attached infundibulum, hypothalamus, and chiasm were dissected free from the surrounding structures and embedded en bloc in paraffin. Either sagittal or coronal sections of this material were cut to include these several structures and appropriately stained. Only the microscopic observations pertinent to the vascular supply of the visual structures are included in this report.

In five additional blocks of bone, the carotid arteries were injected after removal with red silastic (Microfil) to demonstrate more clearly the arteries surrounding the chiasm.

Results

The optic nerves, chiasm, and optic tracts pass through the circle of Willis, coursing below the anterior cerebral arteries and anterior communicating artery and above the posterior cerebral arteries, basilar artery, and posterior communicating arteries (Fig. 2). This allows a natural separation of the chiasmal blood supply into a superior and an inferior group of arteries. The superior group of vessels is derived from the two anterior cerebral arteries and, occasionally, from the anterior communicating artery above the optic pathways. The inferior group is derived from the basilar, the posterior communicating, the posterior cerebral, and the internal carotid arteries.

Invariably during removal of the specimens the vascular relationships were partially disrupted. In the fresh specimens, the specimens for microscopic study, and the injected specimens, those vessels above the optic pathways were partially or totally disrupted by the oblique section through the chiasm. In the fixed specimens, the vessels below the visual pathways were disrupted despite the care during removal. The totality of the blood supply to these structures could be appreciated only by combining the observations from the various specimens.

**Fresh Autopsy Specimens.** These specimens included the posterior portion of the circle of Willis; the small vessels extending from the circle of Willis to the visual pathways were usually preserved allowing dissection and descriptions of the inferior group of arteries. Most if not all of these arteries coursed toward the median eminence and infundibulum and are properly designated superior hypothalamic arteries. Between four and eight small vessels may be found on either side; rarely were these symmetrical in their number, size, or course. Numerous anastomoses were found in this arterial complex, and many small branches were seen to penetrate the inferior surfaces of the optic nerves, chiasm, and optic tracts.

**Fixed Specimens.** The fixed brains included the optic nerves and pituitary infundibulum in continuity with the rest of the brain. Despite careful removal, the inferior group of vessels was often disrupted, but those vessels above the visual pathways were invariably preserved and could be studied in detail. Moreover, these fixed specimens included the third ventricle and lamina terminalis, structures which bear important relationships to the superior group of vessels.

**Superior Arteries.** The superior group of arteries consisted of several small vessels that were derived from the two anterior cerebral arteries as they pass above the optic pathways. Between one and four small vessels arose from either anterior cerebral, more often than not the number was symmetrical. These vessels extended to the upper surfaces of the optic nerves and optic tracts but only to the lateral portions of the chiasm (Figs. 3-5). Occasionally a single small artery arose from the anterior communicating, but in most instances this artery was not present and it was always of much smaller diameter than the vessels in the lateral groups.

The lamina terminalis, covering the supra-chiasmal extension of the third ventricle,