

CAROTID - CAVERNOUS FISTULA

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The clinical features of cerebral aneurysm have become more clearly defined in recent years, due largely to advances made possible by arteriography and neurosurgery. Among the aneurysm syndromes which have benefited by the newer methods of diagnosis and treatment, is that of communicating aneurysm of the internal carotid artery and the cavernous sinus. Though the clinical features of aneurysm involving these structures is well-known, it is desirable to review them in the light of newer knowledge, in order to define their diagnosis and to suggest treatment.

REPORT OF CASES

Case 1 — W. S. (Jeff. Hosp. No. JH 13595) — A 57 year old white gardener with sudden loss of consciousness about a year before admission to the hospital. Eleven months later sudden almost complete closure of left eye. A few days throbbing headache in the left frontal region associated with a "hammering noise" in his head. A week later right eye involved. Examination revealed bilateral ptosis, more marked on the left, complete ophthalmoplegia on the left and almost complete on the right except for slight lateral motion. Corneal reflex absent on the left and diminished on the right. Definite impairment of sensation in the distribution of the left ophthalmic nerve. Distinct bruit over both eyes, in both temples and over both mastoids. A diagnosis of arteriovenous aneurysm in the cavernous sinus was made and the left common carotid artery ligated. The patient improved markedly. Later arteriography confirmed the diagnosis of left internal carotid-cavernous sinus fistula.

History — The patient was admitted on May 27, 1944 complaining of headache of one month's duration. One year before he had lost consciousness in his room and was taken to a hospital where he was found to be confused and irrational. He recovered completely and was well until one month before admission when he awakened in the morning to find that his left eye was almost entirely closed. Several days later he developed a throbbing left frontal headache associated with a "hammering-like noise" in his head. About one week later this condition extended to his right eye. About two weeks before admission he had three episodes of nausea and vomiting. On May 15, 1944 he was admitted to the Wills Eye Hospital where he was found to have a complete ophthalmoplegia of the left eye and almost complete paralysis of the right eye. A loud bruit was heard over the left globe which was transmitted widely all over the skull. The intraocular tension was elevated to 31 in the right eye and 41 in the left eye. The visual fields showed concentric contraction. The corneal reflex was absent on the left and

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appeared to be diminished on the right. There was definite impairment of sensation in the distribution of the left ophthalmic nerve. On May 24, 1944 a ligation of the left common carotid artery was performed with a marked improvement in the patient's condition. He was then transferred to Jefferson Hospital for further study. On admission he stated he had an aching sensation which extended from the occipital area down the neck to the shoulder. He was unable to see out of the left eye and vision in the right eye was poor. The past history was negative except for occasional episodes of precordial pain associated with dyspnea. Physical examination was negative except for the eye findings.

Examination — Neurological examination revealed the following: the left eye was more prominent than the right; the pupils were small, regular and reacted only slightly to light and not at all to accommodation; the left corneal reflex was decreased; there was marked weakness of all the eye muscles, worse on the left, with bilateral ptosis; there was a soft distant bruit heard over the left eyeball which was synchronous with the pulse; diplopia was present in all fields; the visual acuity was 20/50 on the right and 20/100 on the left; a definite left sided facial hypesthesia involving all divisions of the trigeminal nerve was present; the deep tendon reflexes were all overactive and equal and he had great difficulty walking heel-to-toe. Electrocardiogram showed a left axis deviation. X-rays of the skull were negative. Blood and urine studies were normal.

On May 31, 1944 Dr. Rudolph Jaeger injected 15 cc. of diodrast into the left carotid artery. The vessel seemed to be partially thrombosed. Roentgenologic studies were made immediately and indicated an arteriovenous communication between the internal carotid artery and cavernous sinus on the left side.

Neurological examination 15 days later revealed the following: the left eye was more prominent than the right; the pupils and discs were normal; the right ocular movements were full but there was distinct limitation of movement of the left eye outward, slightly inward and upward; convergence was about normal but there may have been slight limitation of the left eye; the corneal reflexes were absent; the cranial nerves were otherwise normal except for loss of pain over the entire face and head and extending down the anterior aspect of both arms; there was slight weakness of the right hand grip, marked weakness of both legs, and great difficulty in walking heel-to-toe; the biceps, triceps, patellar and Achilles reflexes were overactive and equal.

On June 17, 1944 Dr. Rudolph Jaeger injected 5 cc. of thorotrast into the right internal carotid artery. During the procedure the artery was temporarily closed for about 10 seconds, during which the patient became unconscious for not more than 5 seconds. No ligation was performed.

The patient was discharged one week later on June 22, 1944 greatly improved in the movement of his eyeballs, the recession of his exophthalmos and his general feeling of well being.

Summary — This patient illustrates the spontaneous onset of arteriovenous aneurysm of the cavernous sinus, not an unusual method of development, but the clinical picture is interesting because of the development of bilateral signs. The patient responded well to ligation of the left common carotid artery but attempted occlusion of the right internal carotid artery resulted in temporary loss of consciousness and no further occlusion was attempted. Despite his relatively advanced age (57 years) he withstood ligation of one common carotid artery very well and improved greatly in his symptoms despite only unilateral ligation.

Case 2 — S. W. (Jeff. Hosp. No. GH 3561) — A 50 year old colored housewife who, four weeks before admission to the hospital, experienced a sudden severe excruciating pain in the left parietal region of her skull, while doing routine housework. One week later sudden swelling and eversion of the left lower eyelid. Examination revealed inactive left pupil, left ophthalmoplegia, bitemporal hemi-

anopsia, and a marked bruit over the left eye and in the left temporal region, clearly transmitted to the right temporal region. X-ray examination of the skull revealed intracranial calcification of the left internal carotid artery. Partial ligation of the left common carotid artery.

History — The patient was admitted on September 2, 1943 with the chief complaint of headache and swelling of the left lower eyelid, of four weeks' duration. She stated that while attending to her household duties she felt a sudden severe excruciating pain in the left parietal region of her skull, which forced her to go to bed where she remained for three days. During this time the pain remained very severe and had a throbbing quality. It gradually decreased in intensity and on admission was felt as a constant ache with some throbbing quality, considerably relieved by an ice bag applied over the left eye. One week following the pain she noted a sudden swelling and eversion of the left lower eyelid which occurred overnight. It was tender to touch, and was associated with profuse lachrymation. The past history revealed that she had had "rheumatism" for the past 2 to 3 years involving the right elbow, right knee and the right ankle. She had had headaches as a child but none during adult life.

Examination revealed swelling and eversion of the left eyelid. The blood pressure was 150/90. There was a marked bruit audible upon auscultation over the left eye and in the left temporal region, clearly transmitted to the right temporal region. The remainder of the physical examination was normal except for the presence of a blowing systolic murmur at the apex.

Neurological examination revealed the left pupil to be smaller than the right; it failed to react to light and consensual responses. The right pupil reacted promptly to light and convergence. The left eyeball protruded and the left optic nerve was obscured in outline. There was only inward and slight downward movement of the left eyeball. The left corneal reflex was absent. The remainder of the examination was normal.

Blood studies were normal and the Wassermann and Kahn reactions of the blood were negative. Lumbar puncture revealed an initial pressure of 120 mm. of spinal fluid; the fluid was clear and colorless; there was 1 cell per cu. mm.; the protein was 36 mgms. and the Wassermann reaction was negative. Exophthalmometer reading was 20 mm. O.D. and 29 mm. O.S. X-rays of the skull showed a calcified shadow near the sella turcica consistent with an aneurysm of the internal carotid artery.

On September 23, 1943, a partial ligation of the left common carotid artery was performed by Dr. Rudolph Jaeger. Under local anesthesia the common carotid artery was elevated. By direct pressure it was completely occluded and the patient lost consciousness after about 60 seconds. She quickly regained consciousness on release of the pressure. It was thought best to partially occlude the artery by an aluminum band. On October 1, 1943 a second attempt was made to occlude the artery. When the aluminum band was tightened so as to permit about 1/4 as much blood as normal to pass through, the patient developed loss of consciousness and flaccid paralysis of the right side. The artery was left clamped for approximately 10 minutes and since her condition did not improve the band was loosened to permit about 1/2 the normal circulation to pass through. The patient then returned to normal. A loud bruit could be heard over the left eyeball, however, when the clip was opened to this extent. On October 11, 1943 the clip was tightened to a point where it permitted not more than 1/10 the normal amount of circulation. The patient remained conscious throughout this procedure. The next day she left the hospital against advice.

Summary — This patient represents an example of internal carotid-cavernous sinus aneurysm which developed spontaneously without previous evidence of injury. There were no unusual features of the clinical picture, but the demonstration of a calcified internal carotid artery by roentgenogram and the subsequent difficulties

encountered on ligation of the common carotid artery illustrate the fact that ligation must be approached cautiously in instances in which the circulation appears to be inadequate.

Case 3 — P. K. (Jeff. Hosp. No. KH 2697) — A 45 year old white miner fell off a scaffold striking the right side of his head. About one week later the left eye became swollen and red, and he noticed a continuous thumping in the frontal portion of his head, synchronous with his heart rate. Examination 2½ months later revealed a proptosed and inflamed left eye. The extraocular movements in his eye were limited especially outward and upward in which directions he experienced diplopia. There was a clearly audible murmur over the eyeball and above it. The left common carotid artery was ligated in several stages. Three weeks later he was moderately improved with a lessening of the proptosis, and a complete absence of the bruit.

History — P. K. was admitted on July 28, 1947 complaining of thumping in his head and swelling of his left eye of 2½ months' duration. On May 14, 1947 he fell off a scaffold 7 or 8 feet to a concrete floor, landing on the right side of his head. He was dazed but not unconscious and was able to return to work the next day. About one week after the fall the left eye became infected; two days latter it was swollen and almost closed but this disappeared in several hours. At the same time he became aware of a persistent thumping on both sides of his head in the fronto-temporal region, synchronous with his heart beat. The swelling of the periorbital region present several days after his fall returned and persisted, being greatest on awakening and receding during the day. In 1941 he had been struck on the vertex of the skull by a 6 lb. lump of coal during mining and sustained a scalp laceration. Physical examination was normal except for edema of the left eyelids and periorbital tissues. A bruit was heard over the left eye, obliterated by compression of the left internal carotid artery.

Examination — Neurological examination revealed that the left pupil was slightly larger than the right but reacted well to light, accommodation and convergence. There was obscuring of the nasal margins of the left fundus, with grayish discoloration of the temporal side and the veins were full. The eyeball protruded but was non-pulsating. There was 7/8 ptosis of the left eyelid and limitation of inward and outward movement of the left eyeball. Diplopia was demonstrable on outward, upward and downward gaze. The remainder of the neurological examination was normal. Vision was 20/30 in the right eye and 20/50 in the left eye. Exophthalmometer readings showed the left eye to be pushed to 10 to 12 mm. forward as compared to the right eye. The visual fields were normal. X-rays of the skull and routine blood and urine studies were normal.

On August 15, 1947 the left carotid arteries were exposed and a clip placed on the internal carotid artery by Dr. Rudolph Jaeger. Four hours later the patient developed a right-sided hemiplegia and the clip had to be removed. On August 18, 1947 the left common carotid artery was partially occluded by an aluminum band without harmful effects. Four days later it was completely closed by the clip. On September 6, 1947 the patient was discharged from the hospital at which time he was moderately improved with a lessening of the proptosis of the left eye, a complete disappearance of the bruit, and absence of the thumping sensation which had caused him so much distress.

Summary — The cavernous sinus aneurysm in this patient developed about one week after a head injury and was associated with exophthalmos, partial ophthalmoplegia, an audible bruit over the eye and an awareness of a pulsation in the head by the patient himself. Though the diagnosis of arteriovenous aneurysm was not verified by direct observation, the findings were such as to make any other localization impossible. Complete subjective relief followed common carotid artery ligation, but the ophthalmoplegia remained.

Case 4 — C. N. (Jeff. Hosp. No. LH 6520 M.F.) — A 50 year old truck helper who had been in a fight three weeks before admission to the hospital, was knocked down and struck his left forehead and temple against an automobile fender. The left eye became swollen and intermittent frontal headaches developed. Examination revealed a bruit over the left eyeball, proptosis of the left eye and marked limitation of its motion except for slight downward movement. Arteriogram revealed an internal carotid-cavernous sinus aneurysm. The left common carotid artery was ligated. Seven days later the bruit had disappeared, the proptosis had subsided and there was some improvement in the movement of the eye

History — C. N. was admitted on October 22, 1948 with the complaint of swelling and redness of the left eye and frontal headaches for the past three weeks. He had been in a fight resulting in his being knocked against a truck fender, striking the left forehead and temple, without loss of consciousness. Two or three days later he became aware that his left eye was becoming red and swollen and seemed to be protruding. At the same time he developed supra-orbital headache, located chiefly above the left eye and partially relieved by aspirin and heat. The headache was constantly present while lying down but intermittently while in the upright position. He stated that on one occasion he heard a throbbing noise in the left side of his head. Only occasionally was there double vision. Two days before admission he was seen at Wills Eye Hospital where examination revealed exophthalmos of the left eye, partial ptosis and marked limitation of the extraocular movements of the left eye in all directions but most noticeably in outward rotation. A loud bruit was heard over the left eye and left temporal region with transmission to the right temporal region. The only significant fact in the past history was that he had been told 8 months previously that he had high blood pressure. He was transferred to the Jefferson Hospital for further study.

Physical examination revealed a blood pressure of 110/70, mild systolic aortic and pulmonary murmurs, a left inguinal hernia, and bony prominences of his fingers suggestive of osteoarthritis. The remainder of the physical examination was normal.

Neurological examination revealed visual fields which were full by confrontation. The left eyelid was ptosed and movement of the left eye was markedly restricted except for slight downward gaze. There was a bruit over the left eyeball and over the left carotid artery in the neck. It was also heard faintly over the left temporal region. Digital compression of the left carotid artery in the neck resulted in disappearance of the bruit. Vision in the right eye was 20/20 and in the left eye 20/30. Exophthalmometer reading of the right eye was 18 mm. and of the left eye 29 mm. The left palpebral fissure was narrower than the right but the lid actions appeared equal. The pupil of the left eye was irregularly oval compared to the right but the reactions were normal. On ophthalmoscopic examination the right eye was normal. In the left eye the upper and lower disc margins were blurred but no measurable edema was noted. No spontaneous venous pulsations were noted, but the retinal veins were engorged, distended and tortuous. The macula appeared normal and no hemorrhages or exudates were seen. Apart from these findings the neurological examination was normal.

Laboratory studies revealed the following: The spinal fluid was under an initial pressure of 180 mm. of water; the fluid was clear and colorless; there was less than one cell per cmm., the protein was 28 mgs. and the Wassermann reaction was negative. Blood studies were normal. Urinalysis revealed one to two plus albumin, 2 to 5 pus cells, and 2-3 R.B.C. per high-powered field. X-ray of the chest was normal. There were marked degenerative changes in the vertebrae. Calcification of the blood vessels along the lateral aspect of the right femur was seen.

Arteriography was performed by direct exposure of the carotid artery. The arteries of the carotid system were found to be greatly distended and moderately

sclelosed. Arteriogram revealed abrupt cessation of the internal carotid artery in the region of the cavernous sinus, with a suggestion of a small aneurysm at this point. Because of the disappearance of the bruit by digital compression of the carotid artery as well as absence of neurological signs on temporary occlusion for one hour by silver clip, Dr. Rudolph Jaeger tied off the left common carotid artery in the neck.

The day following operation the bruit was gone from the left eye. Five days post-operatively the patient had a brief episode of confusion but no other ill-effects. Seven days after the ligation the bruit was still absent. The conjunctival and periorbital edema and chemosis had subsided considerably. There was still weakness of the 3rd and 4th cranial nerves but movements of the eyeballs were improved and the exophthalmos appeared to be improved.

Summary — This case of arteriovenous aneurysm of the left carotid sinus is of particular interest because of its rapid development. Three weeks after a head injury sustained as a result of a brawl, the patient developed headache and evidence of ocular paralysis. Thereafter the march of events was rapid, with resulting exophthalmos, paralysis of the 3rd, 4th and 6th cranial nerves, and a to-and-fro bruit over the left eye and temporal region. Because of disappearance of the bruit by digital compression of the common carotid artery, ligation of this vessel was performed in the neck, with resulting recession of the exophthalmos and improvement in ocular movements.

Case 5 — *M. L. (Jeff. Hosp. No. NH 8890)* — *Bilateral cavernous sinus aneurysms: carotid-cavernous fistula on the right and left saccular aneurysm.*

History — The patient, a 45 year old woman, was transferred to the Jefferson Hospital from the service of Dr. I. M. Tassmann in the Wills Hospital on 12/2/50. She had been well until about 5 weeks before entrance (10/3/50) when she suddenly developed a dizzy spell while undressing for bed. She described this episode as a "sinking, swimming sensation" from which she had suffered from time to time in the past. As a result of her dizzy spell she fell to the floor striking her vertex and left temporo-parietal region. She was dazed but not rendered unconscious and upon arising from the floor she became aware for the first time of severe pounding left fronto-temporal headache. Within a few minutes thereafter her left eye became swollen and her eyelid completely closed. On several occasions during this period she lifted her eyelid and found that she was unable to move her eyeball. Hot packs relieved her swelling but failed to improve the motility of the eyeball.

Three days after the onset of her trouble she experienced severe throbbing pain in the right fronto-temporal region associated with nausea and vomiting, while standing at a window gazing out the street. The following morning on arising she became aware of a noise in her head and swelling and ptosis of the right eyelid and prominence of the right eyeball.

The past history disclosed recurrent headaches lasting 1 to 2 days in the pre-menstrual period and relieved by aspirin. In December, 1949, about 11 months before her present symptoms, she developed weakness but not complete paralysis of the left arm clearing up in about 2 months. About 2 to 3 years before onset of her present illness she developed a noise in her head which persisted until 6 weeks before the onset of the trouble which brought her into the hospital. She described the noise as sounding like machinery, heard in all parts of her head and more pronounced when her blood pressure was elevated.

Neurological examination revealed bilateral exophthalmos, more pronounced in the right eye. On neither side was there pulsation of the eyeball. There was pronounced edema of the eyelids. There was complete ptosis of the left eyelid with complete immobility of the left eyeball; a dilated left pupil with loss of reaction to light and in accommodation; and loss of the left corneal reflex with hypalgesia over the supraorbital division of the left trigeminal nerve. The right

pupil was small and failed to react to light and in accommodation. The right eyeball was completely immobile and failed to move in any direction. The right corneal reflex was lost. No changes were found in the fundi, the optic nerves being well-defined and of normal color. Visual field studies performed in the Wills Hospital revealed normal fields for form and color, with no scotomas and no enlargement of the blind spots. Apart from the ocular findings there were no changes to be observed in routine neurological examination. A loud bruit was heard over the entire right side of the skull, most pronounced over the right eye and face, but heard faintly over the vertex and over the vessels on the right side of the neck. It was completely obliterated by compression of the carotid vessels in the right side of the neck.

Laboratory studies revealed the following findings: Urinalysis was negative except for a specific gravity of 1.012, a trace of albumin and an occasional red blood cell. Blood studies revealed: Hgb. 11 gm.; erythrocytes 3,620,000; leukocytes 4,500 with a normal differential count. The blood urea nitrogen was 9.2 mg. and 4.80 mg. on two occasions. The Wassermann and Kahn reactions of the blood were negative. Spinal fluid studies were not made. Roentgenograms of the skull revealed demineralization of the dorsum sellae and the floor of the sella turcica. The right anterior clinoid process was described as being shortened and different from the left.

Arteriography with thorotrast was performed on 12/6/50 by Dr. William H. Whiteley: on the right side there was noted a huge diffuse dilatation of the internal carotid artery just before its bifurcation into the anterior and middle cerebral vessels (fig. 1); the left internal carotid arteriogram revealed a saccular aneurysm arising from the lateral aspect of the internal carotid artery about one inch before its bifurcation into its anterior and middle branches (fig. 2).



Fig. 1 (case 5) — Internal carotid arteriogram showing carotid-cavernous fistula on the right.

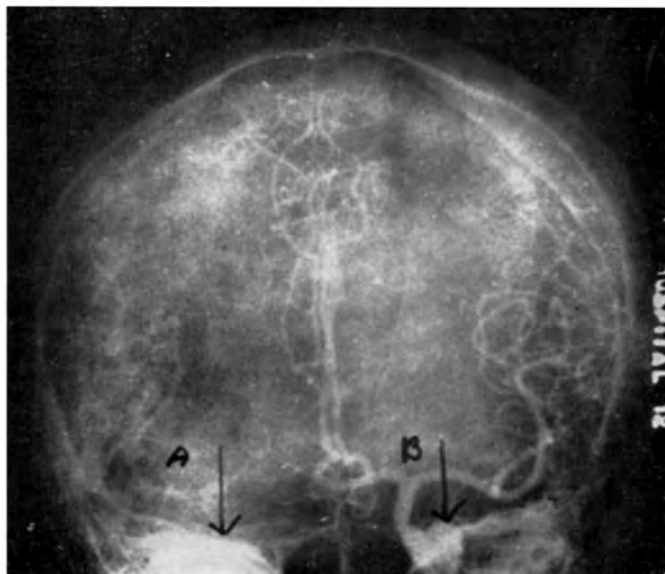


Fig. 2 (case 5) — Internal carotid arteriogram showing saccular aneurysm in the cavernous sinus on the left (B); also carotid-cavernous fistula on the right (A).

Summary — This patient, a 45 year old woman, developed a bilateral cavernous sinus aneurysm against a background of pre-menstrual headache extending over a number of years. She was known to have hypertension, and about 11 months before the onset of her present illness she developed weakness of the left arm lasting about 2 months. About 2 to 3 years previously she developed a noise in her head which persisted until 6 weeks before her present trouble. About 5 weeks before entrance into the hospital she developed severe left-sided headache and complete ophthalmoplegia followed in 3 days by right-sided headache and right ophthalmoplegia. Examination revealed bilateral exophthalmos, greater on the right, with complete ophthalmoplegia bilaterally. A loud bruit was heard over the right side of the face and head. Arteriography revealed a right carotid-cavernous fistula and a left saccular aneurysm. During the course of her hospital stay the patient recovered partial use of the right eye. She was discharged without operation. Review of her problem 5 weeks after discharge revealed complete return of movement of the right eyeball except for residual external rectus paralysis. The ophthalmoplegia of the left side remained unchanged. The bruit was still heard over the entire head but was loudest on the right side.

DISCUSSION

The subject of carotid-cavernous fistula or pulsating exophthalmos has been completely reviewed on several occasions. Sattler¹ gathered 352 cases to 1920 in his extensive monograph on pulsating exophthalmos, and Locke²

reviewed 588 cases to 1924. The subject has been reviewed more recently (1943) by Martin and Mabon³. The problem of communicating aneurysm within the cavernous sinus has been extensively studied therefore, and its fundamental features clearly defined. The five cases reported illustrate the main features of aneurysm in this location, and contribute in addition an unusual instance of bilateral aneurysms within the cavernous sinus, a carotid-cavernous fistula of one side and a saccular aneurysm of the other (case 5).

The symptoms of carotid-cavernous fistula develop dramatically in the majority of instances. The presenting symptoms in most cases is a bruit of which the patient is aware, described as synchronous with the pulse. Associated with it is protrusion of one eyeball which may be present at the onset or may be delayed in its development. These, the most prominent symptoms, may be associated with headache, diplopia, and complaints of failing vision in the affected eye. The symptoms are ordinarily of brief duration and help is quickly sought. Examination reveals unilateral exophthalmos with swelling and chemosis; an audible bruit heard over the side of the communication, but audible over the entire head; limitation of movement of the eyeball varying from involvement of a single muscle to complete ophthalmoplegia; often loss of the corneal reflex, and loss of sensation over the forehead in the 1st division of the trigeminal nerve.

Trauma is responsible for the development of the fistula in about 75% of cases, but spontaneously developing instances are not uncommon. Of the five cases recorded, three were spontaneous and two developed following trauma. In none of the five cases was pulsation of the eyeball found either by inspection or palpation. Lack of pulsation is said to be a feature at times of the spontaneous cases of carotid-cavernous fistula (Martin and Mabon), but it was absent in the two traumatic cases as well in the present series.

As illustrated by case 1, the exophthalmos is at times bilateral. Sattler has found that bilateral exophthalmos developed in about one-third of the cases, and was distinctly more frequent in the traumatic cases. Though it occurs simultaneously with the development of exophthalmos on the affected side, its occurrence in the opposite eye may be delayed for weeks or even months.

In four instances in the present series there was complete ophthalmoplegia on the affected side and in one instance impairment only of upward and downward movement. The variability in the degree of involvement of the ocular muscles is well-recognized and is dependent primarily on the position of the ocular nerves in the cavernous sinus. The visual acuity was reduced in two of the three cases in which it was recorded (20/50 and 20/100). In none of the present series was optic atrophy or papilledema observed, but in two instances (cases 3 and 4) the disc margins of the affected eye were blurred and the temporal side of the optic nerve had a grayish discoloration in one instance (case 3).

Treatment of carotid-cavernous fistula is usually surgical. Since most patients survive the rupture of the artery into the cavernous sinus, operation has been directed against the bruit and exophthalmos which constitute the problem of greatest importance to the patient. The procedures advocated for the treatment of carotid-cavernous fistula include: (1) ligation of the common carotid artery; (2) ligation of the internal carotid artery in the neck; (3) ligation of arteries and veins in the neck; (4) intracranial trapping; (5) non-operative treatment. The operation of choice appears to be common carotid ligation, since this is less hazardous than ligation of the internal carotid artery. Of the five cases recorded, four had common carotid artery ligation and one (case 5) recovered spontaneously. Of the four cases which received ligation the bruit disappeared in three instances, while in the other (case 2) the patient left the hospital before control observations could be made. In the other instances (cases 1, 3 and 4) there was improvement in the exophthalmos and in movement of the eyeball subsequent to the ligation. The spontaneous improvement recorded in case 5, though unusual, has been observed in other series and was described by Sattler who reported spontaneous cure in 16 of 322 cases of carotid-cavernous fistula.

Though improvement developed with ligation of the common carotid artery in the present series of cases, the preferred mode of treatment for carotid-cavernous fistula has not yet been determined, and there remain many instances in which ligation of other vessels are necessary, such as the internal or external carotid arteries. In rare instances trapping of the aneurysm becomes desirable when improvement cannot be accomplished by other means. Elimination of the bruit is of greatest importance in those suffering from carotid-cavernous fistula because of its demoralizing effect. If, in addition, the exophthalmos can be made to recede, much has been accomplished. Improvement in movement in the eyeball may take place over an extended period and may result in partial or complete return of movement.

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