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WOUNDS OF THE VENOUS SINUSES OF THE
BRAIN.

AN ANALYSIS OF SEVENTY CASES.

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In the following paper I have embodied the results of a study of seventy cases of wounds of the great venous sinuses of the brain, collected from various sources. Of these cases five have come under my personal observation; and it was this experience which led me to investigate this class of injuries with special reference to their frequency and mortality, and to the determination of the method of treatment which has been employed with the most satisfactory results.

CASE I.—H. R. Wharton. Boy, twelve years of age, was admitted to the University Hospital, 1882, having been struck upon the occipital bone by the point of a stick thrown at him with great violence, producing a scalp wound, a little to the right of the occipital protuberance, an inch in length, and also a depressed fracture of the occipital bone three-quarters of an inch in diameter. The patient presented no marked brain symptoms at the time of his admission. On the day following his admission, Professor Ashhurst decided to elevate the depressed bone. The scalp wound was enlarged to give freer access to the wound in the bone. Several fragments were removed with the elevator and bone forceps, and upon the removal of the last fragment there was a furious gush of venous blood. Attempts were made to control the bleeding by grasping the walls of the sinus from which it arose with artery forceps, but were ineffectual, and the patient quickly

succumbed. Post-mortem examination showed that one of the depressed fragments had opened the Torcular Herophili, the junction of the superior longitudinal and lateral sinuses.

CASE II.—H. R. Wharton. M. M.,¹ twenty-four years of age, University Hospital, was struck on back of head by dump-car, August 30, 1886, and sustained a compound depressed fracture of the occipital bone. Trephined, and depressed bone removed by Professor Ashhurst, and when largest fragment was removed, which corresponded to the position of the junction of the lateral and superior longitudinal sinuses, there was a gush of venous blood, which was quickly controlled by packing the wound with antiseptic gauze. The patient made a good recovery. Five months afterwards the patient was admitted to the University Hospital with typhoid fever, which proved fatal. Post-mortem examination showed large gap in skull where bone had been removed, and a cicatrix in lateral sinus near its junction with the superior longitudinal sinus, and a well-organized thrombus occupying a portion of the lateral and superior longitudinal sinuses.

CASE III.—H. R. Wharton. C. M., aged thirty years, admitted to the University Hospital, 1883, under Professor Ashhurst's care, with an extensive scalp wound, and a compound depressed fracture of the posterior portion of the right parietal bone. A trephine was applied and the depressed bone was removed. Its removal was followed by free venous hæmorrhage which arose from the right lateral sinus. The bleeding was promptly arrested by packing the wound with iodoform gauze. The patient did well after the operation, and the packing was removed in a few days. The patient made a complete recovery.

CASE IV.—H. R. Wharton. J. M., aged eight years, fell into an area-way, a distance of six feet, striking upon the right side of the head, October, 1892. He was stunned for a few minutes, but regained consciousness, and walked in the house and went to his room and went to bed. I saw him a few hours after the accident, with his physician, Dr. Williams, and found that he had a large blood tumor over the right side of the skull. He was conscious and did not present any symptoms of cerebral compression. Early in the morning of the next day it was noticed that he became drowsy and did not move the left arm. I saw him again, and found that he could be aroused with difficulty, and that there was decided paralysis of the left arm and left leg. Considering it a case of hæmorrhage from the middle meningeal artery, I turned up a flap from the scalp, so as to expose the anterior inferior angle of the parietal bone, and found a fissure in the bone at this point. I applied a trephine and removed a disk of bone, but found the dura mater in contact with the bone, and no blood-clot present. I then enlarged the wound backward, following the line of the fissure in skull, and exposed an extensive depressed fracture at the posterior portion of the parietal bone. The depressed fragments were removed, and a large blood-clot, weighing four ounces, was exposed and removed. Free venous bleeding, which arose from the lateral sinus, occurred after the removal of the blood-clot, which was promptly arrested by packing the wound with iodoform gauze. The patient did well after the operation, the paralysis disappeared, and the packing was removed on the sixth day. The patient made a good recovery.

CASE V.—H. R. Wharton. A boy, aged fifteen years, was admitted to the Bryn Mawr Hospital in June, 1900, under the care of Dr. T. H. Branson, having been struck on the head by a heavy iron bucket falling from a derrick, causing a compound depressed fracture of the right parietal bone, the line of fracture being about three inches in length.

I saw the case shortly after his admission to the hospital. He was conscious and showed no signs of paralysis, and after removing the gauze dressings, which had been freely applied over the wound to control the bleeding, I found a depressed fracture of the parietal bone, almost parallel with the longitudinal sinus, about three inches in length, and about one-half to three-quarters of an inch from the sagittal suture. The posterior portion of the depressed bone extended to the median line of the skull.

Suspecting from the position of the fracture, and from the free bleeding which had occurred, that there might be an injury to the longitudinal sinus, I made provision for the control of the bleeding by having a quantity of strips of sterilized gauze at hand, to use promptly for packing if it were needed. I removed a disk of bone at the outer edge of the line of fracture with a trephine, and, by the careful use of an elevator and forceps, removed a number of depressed fragments; when I removed a large fragment near the median line, there was a furious gush of venous blood, which was quickly controlled by introducing the gauze packing. A very large amount of gauze was introduced before the bleeding could be entirely arrested. After the bleeding had been controlled, the edges of the wound in the scalp were brought together over the packing by silkworm-gut sutures, which were secured by bow-knots, so that they could be untied subsequently for the removal of the packing.

The patient did well after the operation; at the end of a week I again etherized him, untied the sutures, and separated the edges of the wound in the scalp; after soaking the gauze with distilled water, I carefully removed the packing piece by piece. When all the gauze had been removed, it was found that there was no bleeding; after introducing gauze strips for drainage at the most dependent portion of the wound in the scalp, the wound in the scalp was closed by tying the sutures which had already been introduced.

The patient did well, and the wound was healed in a few weeks. When he began to walk, it was found that there was some paralysis of the muscles of the left leg supplied by the external popliteal nerve, constituting a well-marked "foot-drop." This condition has greatly improved, and Dr. Branson, who had charge of the case, reports recently that the improvement has been continuous, and that at the present time the paralysis does not constitute a marked disability.

CASE VI.—Guthrie.² A heavy dragoon, at the battle of Salamanca, was thrown from his horse, and struck upon the vertex of the skull. He soon became lethargic, and a tumor was observed upon the top of the head. This on being incised showed a separation of the sagittal suture, from which blood escaped. Two crowns of a trephine were applied on the twelfth day, to permit of the discharge of blood, which had been extravasated from a wound of the superior longitudinal sinus. The patient recovered.

CASE VII.—Guthrie³ reports the case of a child, Sarah R., aged four years, who was struck upon the head by a rake, one of the teeth of which penetrated the skull near the anterior fontanelle, and opened the superior longitudinal sinus. Three or four ounces of blood escaped before the bleeding was arrested by a compress. The child developed a slight hemiplegia following the injury, but finally recovered.

CASE VIII.—Guthrie⁴ reports the case of a man who suffered from a fracture of the skull, with laceration of the superior longitudinal sinus, by the breech-pin of a gun. Free hæmorrhage occurred upon the removal of the breech-pin, and the patient succumbed to the free bleeding.

CASE IX.—Mullar.⁵ J. A., fifty-eight years of age, was admitted to the London Hospital presenting marked cerebral symptoms, and died twenty-four hours after his admission. He had received a fall, striking the head while intoxicated. Post-mortem examination showed a rupture of the straight sinus near its junction with the lateral sinus.

CASE X.—T. Longmore.⁶ Private J. D., injured by a rifle-ball, which divided the scalp and pericranium for three or four inches across the upper and back part of the skull. The ball had passed from right to left and from before backward, just anterior to the angle of the lambdoidal suture. He was rendered unconscious by the injury and never regained consciousness, and died in twenty-four hours. Post-mortem examination revealed a rupture of the superior longitudinal sinus beneath the seat of injury, and a large quantity of coagulated blood upon the surface of the brain.

CASE XI.—H. Ludlow.⁷ M. P., aged eight years, on May 10, received an injury of the head, producing a laceration of the right side of the scalp and fracture of the right parietal bone, the fracture extending upward from the squamous suture. The patient died from pyæmia, May 24, fourteen days after the injury. Post-mortem examination showed an accumulation of pus between the dura mater and the bone, and laceration of the superior longitudinal sinus, which contained blood-clot and pus.

CASE XII.—A. H. Buchanan.⁸ A woman, struck upon the vertex of the skull by flat-iron, sustaining a compound depressed fracture of the parietal bone. In removing the depressed fragments, as a portion of the internal table was removed, there was a gush of venous blood, which came from a wound of the superior longitudinal sinus, just under the sagittal suture. The bleeding was controlled by pressure with a sponge and a compress and bandage. The sponge and compress were removed in fifty-six hours, and bleeding again occurred; this was controlled by packing the wound with lint, and the patient ultimately recovered.

CASE XIII.—A. G. Reed.⁹ G. B., struck upon the head by a brick, producing a compound comminuted fracture of the cranium. In removing the fragments, a small spiculum of bone was found to have penetrated the longitudinal sinus, and free bleeding occurred upon its removal, which was controlled by packing the wound with lint. Death occurred from pyæmia on the ninth day. Post-mortem examination revealed an abscess and a small wound of the superior longitudinal sinus; the latter was occluded by a thrombus at the seat of injury.

CASE XIV.—John Adams.¹⁰ D. L., twenty-seven years of age, a sailor, was admitted to the London Hospital, having received a fracture of the vault of the cranium by falling from the yard-arm. Examination showed a compound depressed fracture three and a half inches in length across the vertex of the skull. Attempts were made to remove the depressed bone, but were abandoned on account of the free bleeding, which arose from a wound of the superior longitudinal sinus by a fragment of the depressed bone. The bleeding was controlled by lint packing and a compress. The patient died of pyæmia on May 1. Post-mortem examination revealed a wound of the superior longitudinal sinus by a fragment of bone. Fibrous coagula were found in the sinus.

CASE XV.—T. A. Gold.¹¹ H. B., aged six years, was kicked by a horse, sustaining a compound depressed fracture of the frontal bone two inches in diameter. A trephine was applied and the fragments were removed. Upon removing one fragment, free bleeding occurred from a wound of the superior longitudinal sinus, which was controlled by pressure, and finally was arrested spontaneously. The patient made a good recovery.

CASE XVI.—W. Parcels.¹² A man aged nineteen years was struck by a piece of grindstone over the right temporal bone. He was knocked down by the blow, but soon got up and resumed his work, but in twenty minutes became sick at the stomach and vomited. He was seen some hours afterwards by the reporter, and was then in a comatose condition, and he died thirteen hours after the injury. Post-mortem examination showed marked ecchymosis of the scalp at the seat of injury, but no fracture of the skull. Upon opening the latter there was found upon the right side of the brain six or seven ounces of blood-clot, and a rupture of the lateral sinus.

CASE XVII.—Sands.¹³ Boy, thirteen years of age, sustained a fracture of the right side of the skull from a fall from a horse, August 25. When admitted to the hospital he was comatose and presented paralysis of the left side of the body. Incision of scalp revealed an extensive depressed fracture of the right temporal and parietal bone, with escape of brain tissue. The depressed fragments of bone were removed, and in accomplishing the latter purpose bleeding occurred from the superior longitudinal sinus, which was controlled by gauze packing. Consciousness did not return, and he died two hours after the operation.

CASE XVIII.—Parkes, C. T.¹⁴ B. B., twenty-seven years of age, sustained a compound depressed fracture of the skull, on June 20, from being struck by a brick. There was profuse bleeding from the wound. Examination showed a compound fracture of the right parietal bone, one and one-half inches in diameter; there was also paralysis of the left upper and lower extremity. Removal of the fragments was followed by profuse hæmorrhage, which was controlled by packing the wound with gauze and the application of a compress. On June 21 the compress and gauze were removed, and hæmorrhage occurred from a small wound in the right lateral sinus about the size of a coffee grain. The wound was closed by introducing three catgut sutures, and the wound was packed with gauze,

and a compress was applied. The patient recovered with the disappearance of the paralysis, except an inability to extend the toes of the left foot.

CASE XIX.—A. H. L.,¹⁵ nineteen years of age, while sparring, received a blow upon the left side of the jaw and in a short time became unconscious, and later developed muscular spasms and Cheyne-Stokes respiration. There were clonic movements of right hand, and all four members were in a condition of tonic rigidity. Patient did not regain consciousness and died on the sixth day. Post-mortem examination revealed an effusion of blood, with a small laceration of the left lateral sinus near outer margin of temporal bone.

CASE XX.—Wm. J. Taylor.¹⁶ W. P. J., aged thirty-five years, was admitted to St. Agnes's Hospital, June 25, 1890, having sustained a wound of the scalp and a punctured fracture of the vertex of the skull, produced by a pick. The wound was large enough to admit the finger. The depressed bone was removed, and the surrounding bone cut away with rongeur forceps, exposing a wound in the superior longitudinal sinus, from which free bleeding occurred. The wound in the sinus was about one-quarter of an inch in length. The edges of the wound in the sinus were grasped with hæmostatic forceps, which effectually controlled the bleeding. The forceps were allowed to remain in position for seventy-two hours and were then removed, and the wound was packed with iodoform gauze. The patient made a good recovery, and was discharged from the hospital August 29, 1890.

CASE XXI.—W. H. A. Jacobson.¹⁷ M. K., aged forty-three years, received a blow on the head February 1, and became unconscious, and presented marked swelling of the scalp behind the right ear. He developed symptoms of compression and died February 3. Post-mortem examination revealed a large blood-clot over right side of brain, and a fracture of the outer table of the skull, which extended to the right lateral sinus. The hæmorrhage arose from injury of the lateral sinus by the fracture, which extended into the mastoid process of the temporal bone.

CASE XXII.—W. H. A. Jacobson.¹⁸ W. P. was admitted to the University College Hospital, having received a blow on the left side of the head by a bar of iron. He was unconscious on admission, and presented a wound two inches in length, situated two and one-half inches above the left mastoid. There was a fragment of bone deeply depressed, and when this was removed with an elevator, a stream of venous blood as thick as the finger gushed from the wound. Plugs of lint were introduced, which controlled the bleeding. Hæmorrhage again occurred upon the removal of the plugs of lint on the fifth day, which was controlled by packing the wound with lint. The patient died of pyæmia on the thirty-fifth day. Post-mortem examination showed a wound of the left lateral sinus not completely healed, and the sinus was filled with soft, decolorized, putrid clots. The condition of thrombosis extended into the mastoid vein.

CASE XXIII.—W. H. A. Jacobson.¹⁹ J. W. was admitted to Guy's Hospital February 13, 1875, having fallen from a horse, and sustained a contused wound of the back of the head. Upon admission he was irritable, and soon developed convulsions, and became comatose. He died February

17, four days after the injury. Post-mortem examination revealed an extensive blood-clot between the dura mater and the bone, and a fissure of the right cerebellar fossa of the occipital bone, with a wound of the lateral sinus.

CASE XXIV.—Phelps.²⁰ A man, from a fall on sidewalk, sustained an extensive comminuted fracture of the posterior portion of the skull. Two fragments of bone were removed and one was elevated, showing a large epidural clot. The patient had hæmorrhage from the right ear, developed stupor, and general muscular rigidity, and the sixth day after the injury developed unconsciousness and frequent general convulsions, and died on the seventh day. Post-mortem examination revealed an extensive fracture of the occipital and right parietal and temporal bones. A large epidural clot was situated beneath the fracture of the occipital bone; the posterior portion of the superior longitudinal sinus was filled by a thrombus; the walls were infiltrated with blood, and there was a large, partially decomposed thrombus in Torcular Herophili, extending through the right lateral into the petrosal sinus and internal jugular vein.

CASE XXV.—C. Phelps.²¹ A female, aged thirty years, was struck upon the head by a piece of board which had fallen thirty feet. She sustained a compound fracture of the anterior and superior portion of the right parietal bone. Trephining was resorted to, and the depressed bone removed; it was found that the superior longitudinal sinus had been lacerated by a fragment of bone. The patient recovered.

CASE XXVI.—C. Phelps.²² Male, aged thirty-three years, was struck on the head with a hammer and rendered temporarily unconscious, after which he walked to the hospital. Examination revealed a compound depressed fracture of the vertex of the skull. Depressed fragments of bone were removed, leaving an opening in the skull one and one-half inches by one inch in diameter. Free hæmorrhage occurred from a large wound of the longitudinal sinus, which was controlled by gauze packing. The patient recovered.

CASE XXVII.—C. B. Nancrede²³ reports the case of a man who received a wound of the right lateral sinus by a pistol-ball which passed through the mastoid process. The patient died of pyæmia. Post-mortem examination revealed a wound of the right lateral sinus.

CASE XXVIII.—A. Genzmer²⁴ reports the case of a woman, sixty-three years of age, in whom the superior longitudinal sinus was severed in removing a large sarcoma of the dura mater which had perforated the skull in its growth. In this case air entered the sinus, and the patient became collapsed, the respiration intermittent, and she died upon the table. Post-mortem examination. The heart was opened under water, and contained many air-bubbles and frothy blood; the left heart was empty. The arteries of the lungs and the subpleural vessels were partly injected with air.

CASE XXIX.—Prescott Hewitt.²⁵ Man, aged fifty-seven years, received an injury of the head, resulting in a compound fracture of the skull, opening the lateral sinus. The patient died of repeated hæmorrhages.

CASE XXX.—Navratil.²⁶ Girl, twenty-four years of age, sustained a

fracture of the skull, with perforation of the superior longitudinal sinus, with a spiculum of bone. He sutured the dorsal wound with a deep continuous suture, so that the sinus was included. During the application of the suture the bleeding was arrested by the application of a tampon. The bleeding was controlled and the patient recovered.

CASE XXXI.—Dr. J. E. Sheppard.²⁷ W., aged sixty-four years, received an accidental wound of the lateral sinus in an operation for mastoid disease. The bleeding was controlled by packing with gauze, and the patient made a good recovery.

CASE XXXII.—M. E., twenty-two years of age, received a wound of the lateral sinus in an operation for mastoid abscess. The hæmorrhage was controlled by packing the wound with gauze, and the patient recovered.

CASE XXXIII.—M. McL., aged fifty-five years. In opening a mastoid abscess in this case, the lateral sinus was injured and free bleeding occurred. The hæmorrhage was controlled by packing the wound with gauze, and the patient made a good recovery.

CASE XXXIV.—G. Luys.²⁸ Male, thirty-eight years of age, received an injury of the head in falling from an omnibus, and was admitted to the hospital in an unconscious condition. At the time of his admission there was bleeding from the right ear, the pulse was normal, and the respiration was slow and deep. Trephined over squamous portion of right temporal bone. Lateral sinus found perforated. Hæmorrhage checked by tamponing with iodoform gauze; hæmorrhage from ear also arrested by this procedure. A fracture was also found running to the base. The patient showed some improvement, but died on the fourth day. Post-mortem examination revealed a very extensive blood-clot over right side of brain, also fracture of squamous and petrous portion of temporal bone. The dura mater was torn in the neighborhood of the right cerebral fossa, extending obliquely to superior part of right lateral sinus, which was opened and gaping, a little less than a centimetre. A portion of the dura was caught in the fracture.

CASE XXXV.—Corporal W. S.,²⁹ aged twenty-one years, was wounded near Petersburg, Va., June 20, 1864, by a conoidal ball, which entered the mastoid process of the temporal bone and passed upward and backward through the occipital protuberance just above the Torcular Herophili. In its course the ball opened the superior longitudinal sinus. The patient became comatose, and died eight hours after his admission to the hospital.

CASE XXXVI.—S. W.,³⁰ aged twenty-four years, suffered from a gunshot fracture of the left parietal bone. In its course the ball severed the superior longitudinal sinus. The patient recovered with partial paralysis.

CASE XXXVII.—Cushing.³¹ A boy sustained a compound comminuted fracture of the vertex of the skull. There was extensive subconjunctival hæmorrhage with partial oculomotor paralysis, but no involvement of the seventh or eighth pair of nerves. The patient remained unconscious for three weeks, but his throat reflexes were good, and he would swallow food placed in his mouth. An incision was made and fragments of bone removed, and there was found a laceration of the longitudinal sinus. The boy made a good recovery.

CASE XXXVIII.—Hutin.³² A soldier, aged thirty-five years, received at the battle of Jena two gunshot wounds of the head, one dividing the two external tables of the skull for a distance of five or six centimetres, the other causing a comminuted, depressed fracture of both parietal bones obliquely, from before backward and from right to left, crossing the superior longitudinal sinus. He did not lose consciousness. The patient recovered.

Forty years afterwards he received a fall, sustaining a fracture of the thigh and a wound of the chin. He developed erysipelas and pleuropneumonia, and sixteen days later a parotid abscess. He also developed a painful, œdematous, fluctuating swelling at the top of the head, at the seat of the wound of the parietal bones, which was opened under the impression that it was an abscess, and was found to contain only black blood. It was found to communicate with the superior longitudinal sinus at the site of the old wound. The cavity was tamponed with charpie, and the bleeding was permanently arrested after three days. The patient died in a few days, but presented no head symptoms. Post-mortem examination showed a spine of bone four millimetres in length and seven millimetres in width growing from the bone at the seat of fracture, which had perforated the superior longitudinal sinus; the hæmorrhage, having leaked along the dura mater, had formed the tumor of the scalp.

CASE XXXIX.—N. R. Moseley.³³ Private E. S., aged eighteen years, was wounded June 3, 1864, at the battle of Cold Harbor, Va., by a conoidal ball, which fractured the occipital bone just above the left extremity of the superior curved line. The patient presented symptoms of compression of the brain, and later became comatose. The ball was removed from the left lateral sinus and the hæmorrhage was controlled by pressure with sponges. The patient died June 18.

CASE XL.—John A. Liddell.³⁴ Private P. K., twenty-one years of age, was wounded at Middleburg, Va., on June 21, 1863, by a carbine-ball, which produced a fracture of the right parietal bone near the junction of the coronal and sagittal sutures. Five days after the injury he became comatose. He was trephined, and two fragments of depressed bone were removed,—one about one and a half inches in length by three-fourths of an inch in breadth, embracing both tables of the skull, the other being a small fragment of the inner table. Upon the removal of the fragments bleeding occurred from the superior longitudinal sinus, which was controlled by packing with lint. The patient died June 27. Post-mortem examination revealed a laceration of the dura mater, and a considerable effusion of dark blood, which came from the superior longitudinal sinus.

CASE XLI.—B. W. Allen.³⁵ Private I. S., aged nineteen years, received a gunshot fracture of the frontal bone near the anterior fontanelle. He was admitted to the hospital and trephined, and fragments of bone removed. One week after the operation he developed pyæmia, and died of hæmorrhage from the superior longitudinal sinus sixteen days after the operation of trephining. Post-mortem examination revealed ulceration of the coats of the sinus, with small spiculæ of bone resting upon it.

CASE XLII.—R. G. Le Conte. A child, two years of age, was admitted

to the Methodist Hospital, having fallen from a second-story window and struck upon its head. There was no external wound of the scalp, but a large hæmatoma. The patient was unconscious and in collapse. The scalp was incised, and the parietal bones were comminuted near the vertex; fissures extended to the bones at the base of the skull. In removing fragments of bone free hæmorrhage occurred from the superior longitudinal sinus, which was controlled by packing the wound with gauze. The patient did not react, and died in a short time.

CASE XLIII.—W. H. A. Jacobson.³⁶ Man, thirty-five years of age, was admitted to the hospital with scalp wound, November 29, 1862, in a state of insensibility. He was dressed and sent out, but was returned later by the police, who found him insensible on the street. The patient was unconscious, breathing was slow, and the pupils were moderately dilated and fixed. Died without marked change in symptoms eight hours after admission. Post-mortem examination revealed no fracture of the skull, but large blood-clot over left hemisphere of brain, under the dura; blood also entered to the right side of brain under the crux cerebri. A lacerated wound was found in the left lateral sinus near the middle of its highest point.

CASE XLIV.—Gangolphe and Piery.³⁷ A young man, aged twenty-five years, in consequence of a fall down-stairs, suffered a fracture of the base and lateral aspect of the occipital bone, and a portion of the temporal bone. The lateral sinus was torn by divulsion, and a large hæmorrhage with resulting clot accumulated between the dura mater and the skull, compressing the brain over the anterior two-thirds of the temporal lobe and a portion of the parietal lobe behind the Rolandic zone. Subdural ecchymosis on the left side, covering the external surface and base of the left hemisphere. The symptoms were mistaken for those of apoplexy, which they resembled. There was coma, stertor, left-sided hemiplegia of the face, apparent left-sided anæsthesia, and contraction of the right arm and leg. A slight wound of the scalp, examined twice, did not extend to the bone. No fracture discovered until autopsy. Death on the fifth day.

CASE XLV.—Petit.³⁸ A child of ten years fell from a second story to pavement, and became unconscious. No bleeding from nose, mouth, or ears. Hæmatoma developed behind right ear. The patient exhibited unconsciousness and restlessness, alternating later with delirium. Retention of urine, constipation, vomiting for first day or two. Rapid pulse, contracted pupils, extremities insensible. Later, deep coma, general insensibility, contracted and insensible pupils, limbs flaccid, slow, deep, but not stertorous respiration. Death on third day. Post-mortem examination revealed a radiating fracture of the right lateral aspect of the skull, with laceration of the lateral sinus and large epidural clot, with extravasation of blood beneath the scalp; subdural ecchymosis on the same side, and intra-arachnoid effusion on the opposite side. Contusion of the brain.

CASE XLVI.—Aran.³⁹ Male, aged forty-one years. A fall down-stairs on the head. Bleeding immediately from left ear, continuing for two days. Upon the third day after the injury, after two days in bed, he

walked several miles, and later complained of headache and fatigue. He became delirious, and on admission to the hospital was observed to have a swelling over parietal region in superior posterior portion, several fingers' breadths in size. The right arm and leg were paralyzed and sensibility diminished. He died in coma on fifth day. Autopsy showed separation of left posterior portion of lambdoidal suture, and fracture of temporal, extending to base of mastoid. Another fracture extended through auditory canal. Comminuted fracture of petrous portion. Fracture of glenoid cavity. Lateral sinus torn where it reaches posterior lacerated foramen. There was a large epidural clot under left parietal bone. There was also intra-arachnoid ecchymosis and contusion of the brain.

CASE XLVII.—Larry.⁴⁰ A soldier was shot behind the right ear, the ball entering at the level of the mastoid process, grooving its base, fracturing the squamous plate of the temporal, and presenting two wounds of exit, one through the antihelix, the other at the level of the zygomatic arch. There were symptoms of concussion and compression. Larry enlarged the wound and trephined for the purpose of elevating any depressed fragments. A collection of blood was evacuated through the opening from between the skull and dura, and the patient immediately improved. The symptoms of compression were considerably diminished, but the intellect was confused, and the patient was deaf on the same side and limbs relaxed. Improvement continued for a few days, when the patient on going to stool fell, and died shortly after. Post-mortem examination revealed a rupture of the right lateral sinus, effusion of bloody serum in the lateral ventricles, and on the surface of the cerebellum, and at the entrance of the spinal canal and sanguineous pus in the superior longitudinal sinus.

CASE XLVIII.—Morgagni.⁴¹ A woman fell down-stairs, striking her head. She lost the power of speech immediately, also power of feeling and movement in limbs, especially lower extremities. There was bleeding from the nose and one ear, and she died in an hour. Post-mortem examination revealed a transverse fracture of the base, involving the petrous portion of the temporal bone, crossing the sphenoidal sinus to the other side of the skull, and opening the auditory canal. The lateral sinus and dura mater were torn, and there was a large extravasation of blood at the base of the skull. The cerebellum was slightly lacerated.

CASE XLIX.—Gaignere.⁴² Injury of the lateral sinus by an iron dung-hook. Profuse hæmorrhage. Pressure bandage controlled it. Recovered.

CASE L.—Marchetti.⁴³ Injury of the superior longitudinal sinus by a foreign body which penetrated to corpus callosum. Five pounds of blood lost. Controlled by astringents. Bandages removed at end of fourteen days. No more bleeding. Healing by granulation.

CASE LI.—Lamotte.⁴⁴ Transverse wound of both parietal bones by a sabre-cut, with simultaneous injury of superior longitudinal sinus, meninges, and brain. Hæmorrhage followed by serous fluid and white flakes. Recovery in two months.

CASE LII.—Mackenzie.⁴⁵ Injury of cavernous sinus through penetration of the sphenopalatine fissure by the stem of a tobacco-pipe. No fracture or injury of brain or extravasation of blood. Patient died. Post-

mortem examination revealed disorganization of the cavernous sinus and neighboring portion of brain and dura.

CASE LIII.—Chassaignac.⁶⁶ A man suffered from a deep penetrating wound of skull and brain, followed by loss of memory and of power on left side. Delirium, and death on seventh day. Post-mortem examination showed penetration of superior longitudinal sinus and left ventricle, which contained large quantity of serum and coagulated blood.

CASE LIV.—Broca.⁶⁷ mentions a case in Nélaton's clinic of simultaneous wound of cavernous sinus and internal carotid artery by an umbrella-stick penetrating the orbit. Result: arteriovenous aneurism.

CASE LV.—C. Bell.⁶⁸ A workman, aged sixty-three years, while pushing a heavy wheelbarrow after eating a hearty meal, suddenly became unconscious and fell, and after a deep inspiration died. Post-mortem examination revealed a rupture of the right lateral sinus, with an effusion of ten ounces of black and fluid blood into the arachnoid, covering the right hemisphere and the base of the brain. The walls of the sinus were thin and atrophic, and in the middle of the sinus there was an irregular tear. There was no fracture of the skull.

CASE LVI.—Schmucker.⁶⁹ Soldier, wounded by hand grenade, twice trephined, died on eighteenth day. Splintering of inner table, with one splinter penetrating the superior longitudinal sinus. In the sinus were found blood-clots and a mixture of blood and pus, and the walls covered and the posterior portion filled with granulations.

CASE LVII.—Chassaignac.⁶⁹ Case was struck on back part of head, skull fractured, and Torcular Herophili torn. Delirium. Death after a few days without symptoms of compression. Extravasation outside dura.

CASE LVIII.—Volmer.⁷¹ A fifteen-year-old boy fell fifteen feet, striking back part of his head on the firm floor. He was stunned, and died in convulsions on the same day. Post-mortem examination revealed no fracture, but a tear several lines in length in the middle of the right lateral sinus. Blood extravasated around cerebellum and into inferior occipital fossa in large quantity, partly coagulated.

CASE LIX.—Boinet.⁷² A forty-one-year-old male fell down-stairs while intoxicated and bled freely from left ear. No other symptoms. He felt so well that he walked three miles. After return felt fatigued and ill, complained of headache, fever, later delirium. On the second day there developed stertorous respiration, followed by coma, and death the fourth day after the accident. Post-mortem examination revealed a fracture of the left petrous portion of the temporal bone, extending into glenoid cavity; left lateral sinus widely opened at its point of termination in posterior lacerated foramen.

CASE LX.—Hedlund.⁷³ A farm-hand, twenty-seven years old, stumbled over a door-sill, fell over backward, and died in a short time. Post-mortem examination revealed no fracture of the skull. A long bony spiculum, four inches long, one-half inch wide, one-half inch thick, and weighing 190 grains, projected into the superior longitudinal sinus, which was torn throughout the corresponding distance. Whole brain covered with blood. Hedlund considered that the wall of the sinus had been gradu-

ally thinned by the pressure of the spine of bone, and the slight shock sustained in falling had torn it.

CASE LXI.—Gama.⁷⁴ A patient had superior longitudinal sinus torn by a depressed splinter of bone, large opening. Recovered under simple compression dressing.

CASE LXII.—Pott.⁷⁵ This surgeon opened the superior longitudinal sinus with a lancet in a girl aged sixteen years, who had a comminuted fracture of the skull. After removing the splinters, and thus laying bare the sinus, he bled the patient therefrom until she recovered consciousness. A charpie compress held with the finger for some time checked the bleeding. There was marked improvement of the condition, but death later from abscess formation on the upper surface of the brain.

CASE LXIII.—Pott.⁷⁵ An eight-year-old boy who, after a blow with a stick upon the vertex, developed a painless, fluctuating, and pulsating swelling the size of a walnut, which when opened gave exit to a flow of blood from its depths. Investigation showed a fracture over the sagittal suture and a fragment penetrating the superior longitudinal sinus. He was trephined, the fragment removed, hæmorrhage checked by a few minutes' compression with a charpie compress, and the patient recovered.

CASE LXIV.—Warner.⁷⁷ A thirteen-year-old boy received a severe blow upon the head, causing a depressed fracture of both parietal bones. Temporary unconsciousness. On the sixth day convulsions, vomiting, paralysis of the left side, double vision in right eye, left unaffected. On the eleventh day trephined and depressed fragments removed, and a wound of the superior longitudinal sinus by a splinter discovered, the splinter still in the wound. Its removal was followed by severe hæmorrhage, controlled by dressing. Improved for four weeks, then developed symptoms of compression and died of abscess of the brain.

CASE LXV.—Wharrie.⁷⁸ reports the case of a man who, in consequence of being knocked down by blows by the fist, immediately expired. He suffered from a rupture of the right lateral sinus, with extravasation of blood into the lateral ventricles and upon the base, and with great congestion of the vessels of the upper surface of the brain. Externally there was only an insignificant contused wound.

CASE LXVI.—Phelps.⁷⁹ Patient admitted to hospital unconscious, pupils contracted, skin cold and moist, bleeding from both nostrils, large hæmatoma in right frontoparietal region. Linear fracture discovered by incision. Death occurred in two and one-half days. Post-mortem examination disclosed a large hæmatoma over vertex of skull; separation of coronal suture and fissure in right parietal bone extending from it; large epidural clot over left parietal region, and another over right frontal region; superior longitudinal sinus filled with a firm blood-clot; epidural clot in left middle fossa; rupture of superior longitudinal sinus, with large pial hæmorrhage over left frontal, temporal, and parietal lobes.

CASE LXVII.—R. G. Le Conte. J. E., aged thirty-eight years, Italian, struck by falling lumber on crown of head. Both parietals fractured, and depressed area over two inches in extent. Great damage to inner table, with many small spicules of bone. Superior longitudinal sinus perforated

in seven places by these small spicules. Sutures used (fine silk) to close openings, then packed over with gauze. Shock very great. Three quarts of salt solution intravenously injected. Did not react, and died in two and a half hours.

CASE LXVIII.—R. G. Le Conte. R. G., aged seventeen years, roofer, Germany. Cause of injury unknown, as he was found unconscious in a building undergoing construction. Fracture of skull, with depressed fragments over left parietal bone; area about two and a half by one and a half inches. Superior longitudinal sinus perforated by a fragment; controlled by packing. Part of packing removed in forty-eight hours, and remainder twenty-four hours later. No further hæmorrhage. Case doing well, but still has marked aphasia, two weeks after the injury.

CASE LXIX.—Brodie.⁶⁰ A boy who received an injury of the head and died shortly after the accident. Post-mortem examination showed fracture of the base of the cranium, with laceration of the cavernous sinus, from which the hæmorrhage had occurred.

CASE LXX.—Bergmann⁶¹ reports the case of a man, whose occiput was badly injured by a blow on the back of the head, who on admission to the hospital was bleeding from the nose and mouth, and died in four hours. Post-mortem examination revealed œdema of both lungs and air embolism, the air probably entering through the injured longitudinal sinus at the Torcular Herophili at the seat of injury.

Wounds of the venous sinuses of the brain are of comparatively infrequent occurrence, which may in a measure be accounted for by the anatomical peculiarities of these venous channels; they are enclosed in a firm bony case, and their external walls are continuous with the dura mater. Their lining membrane is that of the veins; they are also closely attached to the cranial bones. It is only in exceptional cases that the sinuses are wounded unless the cranium has been fractured. The only sinus which is accessible to direct violence without fracture of the skull is the cavernous sinus, which can be reached by small objects without fracture of the cranial bones by way of the orbit and the sphenoidal fissure, and is the sinus which is most infrequently injured.

In looking over the literature of injuries of the venous sinuses of the brain, I have been surprised to find that comparatively few cases have been recorded. This is remarkable when we consider the great interest which has always been attached to injuries of the head and its contents, and the amount of work which has been expended in recording and

studying this class of injuries. It is to be accounted for possibly by the fact that in many cases of serious injury of the brain the symptoms presented were considered due to lesions of that organ itself, and the lesions of the venous sinuses, being thought to be of minor importance, were overlooked or not recorded.

Causes of Wounds of the Venous Sinuses.—Wounds of the venous sinuses of the brain most frequently result from direct injury to their walls by fragments of bone in depressed fractures of the skull, the sharp edges of the fragments frequently tearing the walls of the sinuses, but may also occur from the impact of foreign bodies, as the result of gunshot injuries and from divulsion of the bones of the skull, and they may also be torn or incised in operations upon the brain. These injuries may also occur in infants during birth. Litzmann⁶² has twice observed rupture of the superior longitudinal sinus in cases of a narrow, flat pelvis, with the promontory of the sacrum so arranged as to make deep pressure upon the side of the head, in consequence of which the sagittal border of the parietal bone pierced its coverings and opened the superior longitudinal sinus.

Laceration of the venous sinuses of the brain may also result from force transmitted through the bones of the skull without fracture.

Duchame-Moncharmant⁶³ investigated the resistance of the venous sinuses to traction, and found it less in children under twelve years of age.

Comparative Frequency of Injury of Special Sinuses.—It is also interesting to study the injuries of the special sinuses as regards their frequency. In this collection of seventy cases the superior longitudinal sinus was injured in forty cases, the lateral sinus in twenty-five cases, the cavernous sinus in three cases, the straight sinus in one case. Bergmann mentions two cases of rupture of the transverse sinus which are not included in this collection, and says that this sinus is liable to rupture when the force is applied from above and behind, as the result of which the skull is compressed in a downward direction.

It will be observed that in this collection of cases of injuries of the venous sinuses of the brain the longitudinal sinus was most frequently injured, and next in frequency the lateral sinus, and that the cavernous, straight, and transverse sinuses were rarely injured. It should be noted, however, that considerable difference of opinion exists among different observers as to the comparative frequency of injury of the various sinuses. Prescott Hewitt⁶⁴ thinks that the lateral sinus is more frequently injured than any of the other sinuses of the brain. Agnew⁶⁵ states that the superior longitudinal sinus is the one most frequently injured. Phelps⁶⁶ considers wounds of the superior longitudinal sinus most frequent. The superior longitudinal sinus from its position is more liable to injuries by direct violence, and is frequently injured by fragments of bone in fractures of the parietal bones and by foreign bodies penetrating these bones. The lateral sinuses appear to be more liable to injury by transmitted force than the superior longitudinal sinus; they are also infrequently penetrated by fragments of bone, but are sometimes torn by divulsion of the bone in fractures.

Gangolphe and Piery⁶⁷ present some interesting observations upon wounds of the various sinuses. They find that the rigidity, inelasticity, and close adherence of the walls of the lateral sinus to the bony walls of the skull render it liable to tears and to injury by fragments of bone in fractures, prevents its collapse when wounded, and precludes the chance of the spontaneous arrest of hæmorrhage. It is by its position readily accessible to injuries, being included with the superior longitudinal sinus and the Torcular Herophili in Gerard Marchants' Classification of *accessible sinuses*, as opposed to the others,—the *inaccessible*, which, though not entirely free from the risk of injury, are only exceptionally injured by traumatisms. The sinuses can be injured in two ways,—by foreign bodies and fragments of bone tearing it, and by rupture by disjunction of fragments in fractures of the cranial bones.

Duchame-Moncharmant and Carle conducted experiments upon skulls as to the liability of the lateral sinus to rupture by

disjunction, and found that lesions were comparatively rare. Chipault, in thirty cases of rupture of the venous sinuses of the brain, states that only four were of the lateral sinus. G. Marchant explains the relative immunity of the lateral sinus to the fact that in the occipital bone the two tables are separated by a thick layer of spongy bone, not easily splintered when fractured.

Wounds of the cavernous, transverse, straight, circular, and petrosal sinuses appear to be very infrequent. Wounds of the cavernous sinus which do not prove immediately fatal from hæmorrhage are apt to result in the development of arterio-venous aneurism. It is probable that these sinuses are frequently injured in cases in which there has been extensive disorganization of the cerebral tissues, and that the sinus lesions have been overlooked in the presence of graver lesions of the brain.

Prognosis.—In the preceding collection of cases of wounds of the venous sinuses, recovery followed in twenty-five,—35.7 per cent. of the cases,—and death in forty-five,—64.3 per cent. of the cases. In forty cases of wounds of the superior longitudinal sinus recovery occurred in sixteen cases, 40 per cent., and death in twenty-four cases, 60 per cent.

In twenty-six cases of wounds of the lateral sinus recovery followed in eight cases, 30.7 per cent., and death in eighteen cases, 69.3 per cent.

In three cases of wounds of the cavernous sinus recovery occurred in one case, 33.3 per cent., and death in two cases, 66.7 per cent.

In one case of injury of the straight sinus death resulted.

In view of the high mortality which has been shown to follow wounds of the venous sinuses of the brain, it is difficult to understand why many of the older writers considered these injuries not of a serious character. Brodie⁶⁸ says that wounds of the venous sinuses bleed profusely when there is a free opening in the bone made by accident or operation through which the blood can readily escape, but very slight pressure is adequate to the suppression of this as well as other venous

hæmorrhage. He also says: "I have never known of a case when such a collection of blood, in consequence of a wounded sinus, between the dura mater and the bone, or between the dura mater and the brain, was capable of interfering with the function of the brain." Hennen⁶⁹ mentions a case of wound of the superior longitudinal sinus from a sabre-cut, which bled profusely without producing fatal consequences, and remarks that he had seen the superior longitudinal sinus opened by splinters of bone, but had never seen anything approaching dangerous hæmorrhage from it; in truth, he considered bleeding from wounds of the head one principal source of the patient's safety.

Guthrie⁷⁰ says that a wound of the longitudinal or lateral sinus which permits of a free discharge of the blood poured out is of little comparative consequence; but it is, on the contrary, a very fatal injury when the blood is permitted to accumulate.

Pott, in a case of compound fracture of the skull, after removing the fragments of bone, which exposed the superior longitudinal sinus, intentionally opened the sinus and allowed a quantity of blood to escape, afterwards controlling the bleeding by pressure. This patient subsequently died of abscess of the brain.

M. Serres⁷¹ opened the superior longitudinal sinus in animals, and found that a large quantity of blood might be allowed to spread itself slowly over the surface of the brain without causing a loss of motion or sensation. This is accounted for by this observer by the fact that the blood from the veins and sinuses of the head flows more slowly and is more fluid and less coagulable than that from the arteries, and to the capability of the brain to bear pressure which is slowly and equably spread over it, while it is not able to resist a pressure that is more direct and more rapidly effected.

As has been stated, many of the older writers were inclined to consider wounds of the venous sinuses of the brain as not of a serious character. There are, however, certain risks in these injuries which cannot be overlooked. The first is hæmorrhage. Blood may escape from an external

wound and quickly exsanguinate the patient. Death resulted from this cause in seven cases in this collection. Blood may also escape from a wounded sinus and collect between the dura mater and the skull, thereby diminishing the capacity of the cranial cavity and causing mechanical compression of the brain, with the consequent changes in the circulation and nutrition of the organ which accompany this condition, and producing slowly or rapidly developing symptoms of compression of the brain. Blood may also accumulate beneath the dura mater. Intracranial hæmorrhage, more or less extensive, was present in twenty-six of the fatal cases.

In extensive wounds of the sinus the hæmorrhage is profuse; and if it does not escape from the wound, the blood accumulates slowly within the skull and soon produces marked symptoms of compression of the brain. On the other hand, if the wound in the sinus is small the amount of blood extravasated may be small, and it may be largely absorbed, leaving only a mass of fibrous tissue at the seat of injury. If the wound of the sinus be due to a fragment of bone or foreign body which has penetrated the sinus and remains impacted, the hæmorrhage may be insignificant, but upon removal of the fragment or foreign body profuse hæmorrhage may occur, which may prove fatal unless promptly controlled. It is possible in such cases to have recovery take place without removal of the fragment if the injuring body does not produce infection of the sinus, a limited thrombosis of the sinus resulting, for it has been shown that a partial occlusion of the sinus may exist without marked disturbance of the functions of the brain.

The greatest danger in wounds of the sinuses of the brain is from septic infection. In the present collection of cases a large number died of pyæmia and abscess of the brain. This cause of death is more frequently noticed among the cases reported before the introduction of the antiseptic method of wound treatment. Many cases of sinus wounds were complicated with injuries of the brain, and death in these cases resulted from cerebral hæmorrhage combined with that from the

wounded sinus, giving rise to general symptoms of compression of the brain.

Air embolus is an occasional cause of death, causing the fatal termination in at least two of the cases, reported by Genzmer and Bergmann, and may have been overlooked in some others.

The case reported by Genzmer, as well as his experiments, is of especial interest in this connection.

Genzmer records a case in which the superior longitudinal sinus was severed during an operation for removal of a large sarcoma of the dura mater, which had perforated the skull in its growth. The patient was a woman, aged sixty-three years, and the tumor was situated at the posterior end of the sagittal suture. The operation was performed by Volkmann. After turning down the skin-flaps, the opening in the skull was enlarged around the base of the tumor, the attachments to the surrounding dura from which it sprung were severed, and the tumor was then lifted up, and its remaining connection with the falx cerebri attacked with scissors. As the blood was sponged away in great haste, and the field of operation was momentarily visible, they suddenly heard the characteristic lapping noise, and the same instant the anæsthetizer who was administering the chloroform called out, "She is dying." The patient went into collapse, with snoring and intermittent respiration. The operation was completed; when the tumor was lifted and the last connections severed about the attachment of the longitudinal and transverse sinuses, and the field of operation sponged dry, the same sound was heard. The patient was pulseless, pupils dilated, barely reacting, extremities blue and cold. After bandaging arms and legs the pulse was perceptible for a short time; breathing continued, becoming more intermittent; consciousness did not return, and the patient soon died.

Autopsy confirmed the view that death was due to air embolism, as, when the right heart was opened under water, it contained many bubbles and frothy blood. The left heart was empty. The arteries of the lungs and subpleural vessels were partly injected with air. The inner organs were anæmic, but not excessively so. The longitudinal sinus was found to communicate with the wound in the dura and another very large vein of the skull.

Genzmer does not know of any other case in the literature in man, but Bernard has observed it in animals, when after opening the longitudinal sinus air was observed to find its way through the vertebral veins and vena azygos into the right heart.

Genzmer experimented on nine dogs, and in six of them observed the entrance of air into the circulation after opening of the longitudinal sinus. In two of the cases in which it was not observed, the animals had been tracheotomized, which lowered the negative pressure in the thorax, as the air easily found its way in. In all three the blood-stream soon ceased to pulsate with the breathing, and a clot was found after death in the central part of the sinus. Death occurred much sooner in the animals in whom air was found in the heart. Strong and dyspnoic breathing increased the risk of entrance, as did free bleeding, by lowering the positive blood-pressure. By sponging away the blood, air entrance was favored. Therefore, in operating on such cases, we must see (1) that the blood-pressure is not too much reduced; if much hæmorrhage is expected, before opening the sinus the patient's limbs may be bandaged, to raise the blood-pressure. (2) That the patient makes no forcible inspiratory movements; use deep narcosis. (3) That the wound in the sinus is kept covered with a layer of fluid; therefore do not sponge away the blood, and also irrigate with salt solution.

Repair of Wounded Venous Sinuses.—Wounds of the sinuses may heal without obliteration of the canal, or there may be partial obliteration, diminishing the capacity of the sinus at the point of injury. A thrombus may form at the seat of injury in the wall of the sinus and extend so as to completely occlude the sinus, often extending from the superior longitudinal to the lateral sinus. If this thrombus be non-infective, it appears to have little effect upon the functions of the brain, which is to be explained by the free intercommunication of the various sinuses. Obliteration of the largest sinus has been observed, with little variation in the functions of the brain.

Symptoms.—The symptoms which indicate a large extravasation of blood within the cranial cavity from a wound of one of the venous sinuses of the brain are not definite as regards the source of the bleeding, and are simply those of intracranial hæmorrhage. The symptoms are often indistinguishable from those arising from injuries of the meningeal vessels and from apoplexy, with the possible distinction that in bleeding from sinus wounds compression symptoms are apt to develop more slowly. It should also be noted that wounds of the sinuses are often associated with laceration and contusion of the brain itself, and complicated symptoms arising from both of these injuries may exist at the same time. If the pial veins are torn in conjunction with the sinus, the blood accumulates under the dura mater, and compression symptoms from intracranial hæmorrhage may develop earlier than in uncomplicated wounds of the sinuses. Unconsciousness is a very constant symptom in fatal cases, and comes on later in wounds of the venous sinuses than in wounds of the meningeal arteries.

Marchant,⁷² from his investigations upon wounds of the lateral sinus, concludes that the symptomatology is very variable, and that rarely can the source of the hæmorrhage be diagnosed before operation; the presence of some form of intracranial hæmorrhage causing compression of the brain is all that can usually be determined upon, and even this not always clearly. The symptoms may be those of cerebral apoplexy, as in one case he reported.

Diagnosis.—The diagnosis of wounds of the sinuses of the brain is often a matter of difficulty, from the fact that the symptoms presented are often similar to those resulting from lesions of the arteries of the meninges and of the brain. In wounds of the sinus in which there is an external wound, the location of this wound and the character of the blood which escapes will often assist in making a correct diagnosis. The most difficult cases are those in which a sinus wound exists without an external wound. In doubtful cases, when the diagnosis lies between apoplexy and lesions due to traumatism, the

decision as regards treatment should be in favor of the latter. In cases without distinct localizing symptoms, the comparative greater frequency of wounds of the meningeal arteries following traumatism should be borne in mind, and may be of value in forming a diagnosis.

Chipault,⁷³ in 117 cases of intracranial hæmorrhage, records seventy-two cases from injury of the middle meningeal artery, and thirty cases of wounds of the venous sinuses. Treves⁷⁴ says that intracranial hæmorrhage in from 80 to 85 per cent. of the cases arises from wounds of the meningeal arteries, and that in about 15 per cent. to 20 per cent. of the cases it arises from wounds of the venous sinuses of the brain. Phelps⁷⁵ records 300 injuries of the brain and membranes, and in this collection there are mentioned only four cases of wounds of the venous sinuses.

The diagnosis of wounds of the sinuses of the brain must therefore be made largely upon the site of the injury, the character of the blood which escapes, and in cases in which no external wound exists, by the slower development of the symptoms of cerebral compression.

Treatment.—In the majority of cases of wounds of the venous sinuses of the brain, when the wounded sinus is open to inspection through a wound in the scalp, and a fracture of the skull, the treatment is not a matter of difficulty; but in cases where these conditions do not exist, their treatment is attended with great difficulty. In cases of sinus injury without fracture of the skull, a trephine should be applied, and the bone removed by rongeur forceps to a sufficient extent to expose freely the injured portion of the sinus. The recommendation of Gangolphe and Piery in such cases, that the trephine be applied at the point of traumatism rather than at the point indicated by the symptoms, which may be misleading, I think is sound and should be followed. After exposing the wound in the sinus, the bleeding should be controlled by some of the various methods of treatment. The observance of the greatest care as regards asepsis cannot be too strongly urged in connection with the treatment of wounds of the venous sinuses,

for infection of these channels is always followed by fatal results.

In view of the high mortality which follows wounds of the venous sinuses of the brain, it is a matter of interest to study the different methods of treatment which have been at various times recommended to control the bleeding, and if possible to determine that method which has been followed by the best results. The methods of treatment which have been most employed are pressure by compress or gauze packing, ligation of the sinus, the lateral ligature, suture, and forceps pressure.

Gauze Packing.—The most widely employed method, and the one which seems to be the most generally applicable, is gauze packing. The results from this method of treatment have been most satisfactory, and the unfavorable results only have occurred in the cases reported before the introduction of modern methods of wound treatment, when material which was not aseptic was used as the packing material, and the wounds later became infected. It is in cases of depressed fractures of the skull, with wounds of the sinuses by the fragments of bone, that the most alarming hæmorrhage is apt to occur upon the removal of the fragments. Where depressed fragments of the skull occupy a position near any of the large venous sinuses, it is well to bear in mind the possibility of a sinus wound, and be prepared to control hæmorrhage if it occurs. This complication should be considered in cases which present symptoms of intracranial hæmorrhage, as well as in those which do not present such symptoms, for often the intracranial bleeding is insignificant, as the fragment of bone which has produced the wound in the sinus plugs it; and it is only when the latter is removed that dangerous bleeding occurs.

If the wound in the skull be a small one, it is well to enlarge the opening either with a trephine or rongeur forceps before the depressed fragments are removed, so that sufficient space may be afforded to expose the injured portion of the sinus and permit of the satisfactory application of the packing to control the bleeding.

The material which has been found most satisfactory for

packing is iodoform or sterilized gauze, which should be used in strips two or three inches in width. This is introduced with a director or elevator until a sufficient quantity has been applied to arrest the bleeding, and a gauze dressing is applied over the packing and held in place by a bandage. In other cases it may be advisable to close the wound in the scalp over the packing with interrupted sutures, to hold it more securely; the latter being secured by bow-knots so that they can be untied when the packing is finally removed, and again secured, thus obviating the necessity of a second introduction of the sutures. The packing should be allowed to remain in position for three to six days; after this time its removal is usually not followed by bleeding, and the wound can then be closed. The only disadvantage of this method of packing in these cases is that the wound is practically an open one for some days, and may prove an avenue of infection unless the greatest care is observed to prevent its occurrence. The prompt and complete control of dangerous bleeding by this method of treatment cannot fail to recommend it.

Ligation.—Ligation of injured venous sinuses has been recommended and practised with satisfactory results in some cases, and the complete occlusion of the sinus appears to have had little effect upon the functions of the brain. Ligatures do not appear to have been often used in controlling hæmorrhage from ordinary wounds of the venous sinuses, but seem principally to have been resorted to as a preliminary step in removing growths of the brain, or in accidental wounds produced in the removal of such growths. They have also been frequently employed in cases of operations upon the sinus for infective thrombosis. Kammerer ligated the longitudinal sinus an inch above the Torcular Herophili in an operation for removal of a sarcoma involving the dura mater above the sinus. Bergmann, Küster, and Navratil have also recorded cases in which they ligated the venous sinuses in operations upon the brain.

It is a difficult matter to pass a ligature around the longitudinal or lateral sinus unless the dura mater is freely incised

on each side of the sinus. In passing the ligature, the sinus itself may be punctured, or the vessels of the pia mater or the tissue of the brain lacerated, unless the operator has a very free exposure of the seat of operation, which is not often present in the ordinary accidental wounds. In applying a ligature to a venous sinus, great care should be taken not to injure the veins of the pia mater, as the blood-current is maintained through them after occlusion of the sinus. Stratton⁷⁶ directs attention to the difficulties and dangers of ligation of the venous sinuses, and confirmed his observations by experiments upon the cadaver. He says, "The sinus may be lacerated as the ligature is drawn taut, or pressure upon the cerebral tissues may be produced by great tension upon the dura, depressing it below its normal position. If relaxation of the membrane does not exist, as the ligature is drawn tight the dura, falx or tentorium—if the lateral sinus is being operated upon—must tear sufficiently and in such a direction as to permit easy and safe approximation of its walls. If, coincidentally with the tightening of the ligature, the dura could be incised, thereby cerebral pressure and laceration of the sinus might be avoided; even after tying the ligature incisions of the dura would relieve pressure upon the cortex by that membrane. Puncture of the pial vessels, which at their junction with the sinuses are of considerable size, may give rise to a fatal subdural extravasation of blood." He found in an experimental ligation of the superior longitudinal sinus upon the cadaver that no laceration of the sinus had occurred, and only a slight tear of the dura mater was present, but the dura was locally in a state of great tension, and was depressed beneath the inner surface of the skull for a considerable distance beyond either border of the opening in the bone.

Macewen recommends, it seems to me, a much safer procedure than ligation, which consists in a separation of the outer wall of the sinus from the skull, pressing it inward into the sinus, and tamponing the intervening space with gauze.

Lateral Ligature.—This procedure, which is very satisfactory in controlling hæmorrhage from small wounds of the

larger veins, would seem to be an ideal one in similar wounds of the venous sinuses of the brain. The successful application of such a ligature would require free exposure of the sinus, so that the size and site of the wound could be accurately determined before it could be grasped by forceps and the ligature applied. This form of ligature seems to me to be only applicable to small wounds, and is not to be recommended in large wounds on account of the inelasticity of the walls of the sinus. I have not been able to discover that this method of ligature has been employed in wounds of the venous sinuses of the brain.

Suture.—Suture of wounds of the venous sinuses by silk or catgut has been employed in a few cases with good results. This procedure was employed successfully by Navratil and Parkes in two cases in this collection, and by Le Conte in one case which proved fatal from other causes. It seems only applicable to small wounds of the sinus in which there is not profuse hæmorrhage, or, if in larger ones, in those in which there is a sufficient exposure of the sinus wall to permit of the control of the bleeding during its application by pressure upon either side of the wound.

The great advantage of the ligature, the lateral ligature and sutures in wounds of the sinuses, in addition to the control of the bleeding, rests in the fact that after their use the wound in the scalp can be immediately closed, thus diminishing the risk of infection.

Forceps Pressure.—This method of controlling bleeding from the larger veins has also been employed in wounds of the sinus in a few cases, and consists in grasping the wound of the sinus with hæmostatic forceps, and in allowing them to remain in position for two or three days. Dennis, W. J. Taylor, and Stratton have recorded successful cases following this procedure. Stratton, in excising a sarcoma of the dura mater, removed the growth with a portion of the longitudinal sinus, controlled the bleeding by clamps which were allowed to remain for three days, and there was no hæmorrhage after their removal, the patient dying on the twelfth day from other

causes. The method has the disadvantage of keeping the wound open, and thus incurring the risk of infection. Personally, I have always considered the procedure a dangerous one, in view of the fact that a patient with an injury of a sinus may develop brain symptoms, rendering it difficult to restrain him, and his uncontrollable movements may cause the forceps to inflict serious injury upon the cerebral tissues.

CONCLUSIONS.

(1) Wounds of the venous sinuses of the brain should be classed as dangerous injuries, being followed by a high mortality, from external or intracranial hæmorrhage or septic infection.

(2) They are especially liable to infection, resulting in septic thrombus and pyæmia, therefore the greatest care should be taken to render them aseptic and preserve them in that condition.

(3) The most satisfactory and generally available method of treatment consists in controlling the bleeding by aseptic gauze packing.

(4) Ligation of the venous sinuses presents definite dangers in itself, is only available in certain wounds, where a free exposure of the injured sinus is possible, and cannot be employed with advantage in ordinary accidental wounds of the sinuses.

(5) The application of a lateral ligature to a wound of a sinus is less difficult and dangerous than ligation of the sinus, but is only applicable to small wounds.

(6) Suture of sinus wounds is a valuable procedure in a certain class of cases, namely, small wounds which can be freely exposed.

(7) Forceps pressure is also a ready method of controlling hæmorrhage from wounds of the sinuses, but possesses no distinct advantages over some of the other methods, and its employment is accompanied by certain dangers.

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DISCUSSION.

DR. OSCAR H. ALLIS said that there was sometimes a difficulty in making diagnosis in head injuries. Some of the injuries would, of course, be sudden, and the symptoms would be masked.

On one occasion he assisted the elder Gross in an autopsy upon a man that had been thrown from a carriage, striking upon the head and profoundly concussed, but without wound of scalp or depression of the skin. Gross said that a surgeon of

considerable notoriety had urged very strongly that there should be a trephining of the case. He had watched the case, and refused to trephine it. At the autopsy there was found no topical hæmorrhage or depression of bone, but innumerable little points of hæmorrhages,—the size of a pin-head,—showing that his judgment, that trephining would do no good, was well founded.

Another point: To render the field of operation absolutely sterile, all the hair should be shaven from the head. This he knew to be the practice of Dr. Wharton. A partial shaving of the head leaves an area for contamination that often defeats the best surgical skill. Surgeons are now very generally, in all serious head injuries, demanding that the hair be entirely removed.

He recalled the case of a little child who fell from a piazza, backward, striking her head on an iron rake. The teeth went into the base of the skull. The case proved fatal.

DR. WILLIAM G. PORTER said that there were two things which had impressed him in cases of wound of the longitudinal sinus. One was the enormous amount of gauze which was required in some of them to arrest the hæmorrhage, and, in the second place, the absence of symptoms of cerebral pressure which one would naturally expect to occur from the presence for days of a large amount of gauze tightly packed between the skull and the dura mater. In a recent case of suicidal gunshot wound of the head, during the operation of trephining, the superior longitudinal sinus was opened. The hæmorrhage was frightful, but was speedily checked by gauze packing, and the patient made a good recovery.

DR. WILLIAM L. RODMAN said that he had always been much surprised at the comparative infrequency of these injuries, a fact emphasized by Dr. Wharton in his paper. In an experience of over twenty years, Dr. Rodman had seen but two injuries to the great sinuses of the brain, and he thought that rather remarkable, in view of the frequency with which the cranium is injured, especially in depressed fractures resulting from ordinary trauma, punctured wounds, gunshot wounds, and otherwise.

He fully agreed with the position taken by the essayist, that it will be exceedingly difficult to arrive at an accurate diagnosis

in cases not accompanied by fracture of the cranium; for it must be borne in mind that the middle meningeal will suffer much more frequently than the sinuses, and surgeons are therefore apt to trephine on its site rather than on the sinus.

He called attention to the exceeding necessity for acting promptly in cases of this kind, on account of the fact that blood which is lost from the brain always produces a greater amount of constitutional shock and depression than the same amount lost from any other part of the body. Therefore, it becomes not only necessary to control hæmorrhage from the brain with ordinary promptness, but with extraordinary promptness, if it can be done.

He thought that there was very little question that the packing with gauze was the most reliable method of controlling hæmorrhage in these injuries. Of the two injuries of this kind in his personal experience, one was controlled by gauze packing and the other by lateral ligature. He was far better satisfied with the one treated by packing than the one with lateral ligature. While lateral ligature seems ideally, as does suturing, better than forcipressure, in his judgment they are less so. Forcipressure is more quickly and easily applied, and is more certain in its effect on account of a small opening to work in. Although the essayist had brought out a very good point against the application of forceps, yet, when it is remembered that symptoms of meningitis or encephalitis are unlikely to occur until the third or fourth day, by which time the forceps can be removed with perfect safety, the objection is not so very great. Ligation of cerebral vessels is not perfectly satisfactory: these vessels have no sheaths, and the ligature is apt, on this account, to slip; and he thought one would feel a greater sense of security in using forcipressure next to gauze pressure, which in all instances should be preferred.

DR. G. G. DAVIS said that as regards frequency, he thought in a certain class of cases they are more frequent than the remarks here would appear to indicate. These wounds may occur by puncture. In that case injury to the skull is slight, but they most often occur in extensive fractures of the skull. Therefore, if a person's practice includes many cases of this severe class of injuries, he believed they would be found to be not so very rare. He could not conceive of a laceration of one of these sinuses oc-

curing in cases of concussion, or in other words, without a displacement of the bone. This occurs in those great crashing injuries which break in considerable portions of the skull. This accounts likewise for their fatality. The fatality is not due simply to the hæmorrhage, but rather to direct traumatism to the brain itself.

When it comes to the question of diagnosis, the blood in intracranial hæmorrhage may come from three sources,—from the meningeal arteries, from the large sinuses, and from the vessels of the pia mater. If the question of diagnosis is raised, he should think it would be not as regards that of injury of the sinuses themselves, but as regards some other source of bleeding. Injury to the sinuses would declare itself very quickly, because the blood would come directly to the external opening, the injury being compound. An epidural clot due to hæmorrhage from the sinuses is not likely to occur. He could not conceive of the blood from the sinus dissecting the dura mater away from the skull. The blood in the venous sinuses would hardly have force enough to do it. If there was an epidural hæmorrhage, the chances would be more in favor of its proceeding from the middle meningeal arteries. The other source of hæmorrhage would be subdural, and a subdural hæmorrhage would occur from concussion, and that, to his mind, with the middle meningeal bleeding, is almost the only hæmorrhage that would give rise to pressure symptoms.

The statistics which Dr. Wharton had quoted from Treves he did not quite understand. If he heard aright, it was 15 per cent. from the large venous sinuses, and 85 per cent. from the middle meningeal artery. Where do the subdural hæmorrhages come in? What part do they play in the question? He thought the statistics from Charles Phelps—it was about 1 per cent.—to be approximately correct.

Of the injuries he had seen to the sinuses, he could definitely recall two,—one of the superior longitudinal in a large crush of the vault of the skull, in which bleeding was controlled by pushing gauze beneath the edge of the skull; another, which he was inclined to think was of the cavernous sinus, but possibly the superior petrosal, or the ophthalmic vein, or some of the vessels closely around the cavernous sinus. The case was one of injury in which a man fell from a height and struck on an

iron wheel, rotating as he fell, striking on his forehead. He crushed in the right side of the frontal bone; the orbit was fractured, and there was a very large external wound. In cleaning up, there was a great gush of blood directly from the depths of the wound, which went directly downward and backward towards the posterior portion of the orbit. A large amount of gauze was pushed in, and it controlled the bleeding. It was afterwards removed, and the man recovered. These two cases he could recall definitely, but he believed that he had seen in other cases wounds of the lateral sinus. In these cases there were very severe injuries of the bones.

DR. ROSS related the history of an injury of the superior longitudinal sinus. A woman was brought into the German Hospital on the evening of the Fourth of July, in 1890, unconscious. The history was that she had been sitting on her door-step, when suddenly she fell over unconscious. A careful examination disclosed no cause for the condition. Dr. Deaver saw the case, and in passing his hand over her head found a lump on the top of her head, in the median line, and on looking he found a bullet. He removed it, packed the wound, and the patient got well. It is probable that the bullet, which had been shot by some person at a distance, went up in the air, and, on coming down, struck her on the head, penetrating her skull.

DR. ALLIS added, with regard to what had been said as to the frequency of cases, that he did not remember a single case coming to the Jefferson Hospital while he was assistant to Dr. Gross, and in his service at the Presbyterian Hospital. He noted that Dr. Wharton and Dr. Porter had referred to cases, but he had never seen one there. The only one he had—sent there from his private practice—was the little child already mentioned who fell on the rake, and struck probably the lateral sinus and at the base of the skull. He thought that this class of cases was comparatively infrequent.

DR. DE FOREST WILLARD said that he had certainly seen in the Presbyterian Hospital one wound of the lateral sinus and two of the superior longitudinal; one, only ten days since, was caused by an enormous fracture; a circumferential fracture, entirely encircling the head, passing through the base of the skull and up the opposite side; the skull being divided into anterior and posterior halves. The longitudinal sinus necessarily was torn

through, but there was no marked displacement of the fragments. He trephined in the parietal region, and as he approached the longitudinal sinus the hæmorrhage was simply enormous, but it was speedily and entirely stopped by packing with gauze.

In regard to the effect of hæmorrhage which has been alluded to, his experience had not been that the bleeding was more serious than from other parts of the body. He had been rather inclined to look upon it somewhat as of less importance than from other regions, *i.e.*, that brain cases have borne hæmorrhage well. There are very large venous hæmorrhages, but in the venous sinuses injuries the patient is often in a serious condition apart from the hæmorrhage.

DR. WHARTON remarked that he agreed with Dr. Allis as to the comparative infrequency of wounds of the venous sinuses. He also had been struck with the large amount of gauze packing which it was necessary to use in controlling hæmorrhage from the venous sinuses in certain cases.

He agreed as to the advisability of using suture in suitable cases; but believed that there were very few cases in accidental wounds of the sinuses where a suture could be very satisfactorily employed, and he thought, therefore, that packing was the most generally available method of treatment.

DR. RODMAN had spoken of the comparative infrequency of wounds of the venous sinuses and the importance of prompt action when a large venous sinus was opened. This he appreciated. He did not know of any more alarming form of hæmorrhage than that arising from the superior longitudinal sinus, if the wound is of any extent.

In regard to forceps pressure, it may, in certain cases, be a very satisfactory method of treatment; but the principal objection was the uncontrollable movements of the patient which might cause them to inflict injury upon the brain; so he preferred packing instead of forceps pressure, but the latter may, in certain cases, serve a useful purpose.

In wounds of the lateral sinus made in operations for mastoid abscess, the hæmorrhage is usually not so profuse or serious as in accidental wounds in fractures. The sinuses in these cases are probably more or less thrombosed, and the capacity of the sinus is very much diminished at the point of injury.

As to the suggestion of Dr. Davis that sinus wounds are

much more common than are generally supposed, this point he had brought out in the paper; namely, that in cases of extensive injury to the brain where the sinuses were injured, the symptoms of sinus injury were often masked by the grave lesions of the brain. He questioned Treves' statistics as to the frequency of injury to the middle meningeal and great venous sinuses. Treves, of course, makes this statement as regards extradural hæmorrhage. Phelps refers to a great many deaths from pial hæmorrhage. The hæmorrhage in cases of rupture of the pial veins is usually subdural hæmorrhage. Phelps records in 300 cases of traumatism of the brain a great many fatal cases resulting from injury to pial vessels; so that this variety of hæmorrhage is a cause of death, combined with hæmorrhage from the venous sinuses.

TRANSACTIONS OF THE PHILADELPHIA
ACADEMY OF SURGERY.

Stated Meeting, February 4, 1901.

The President, DE FOREST WILLARD, M.D., in the Chair.

THE BEST INCISION IN OPERATIONS FOR
MAMMARY CARCINOMA.

By WILLIAM L. RODMAN, M.D.,

PROFESSOR OF THE PRINCIPLES AND PRACTICE OF SURGERY AND CLINICAL
SURGERY IN THE WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA.

THE increasing frequency of carcinoma of the breast, the demonstrated hopelessness of partial and incomplete operations for its relief, together with the more than reasonable hope of cure following a timely and rightly done operation, warrant me in asking the attention of the Academy to a paper briefly considering the relative merits of well-known operative procedures.

Before doing so, however, we should recall the anatomy of the gland, pathology of the disease, and its natural tendency to disseminate by means of the lymphatics. The lymphatic vessels are far more numerous and complicated than Sappey and former anatomists had led us to suppose; for, instead of all such vessels converging to the nipple and thence passing by main channels beneath the skin to the axillary nodes, we now appreciate, from the teachings of Mascagni, Langhans, Küster, Stiles, and Heidenhain, based upon injections, that there are several other important, if not as much frequented, channels. There are two superficial sets of lymph-vessels; in addition to the axillary set, so dwelt upon by Sappey, a second one drains the sternal half of the gland passing through the