THE OPERATION OF CRANIAL DECOMPRESSION.

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There are few operations in surgery having the wide application and immediate beneficial results as cranial decompression, particularly the subtemporal method. It is an operation that has been much neglected in the past, and one that is capable of still greater usefulness in the future. It is a comparatively simple operation, requiring no special technique and no special training other than a thorough knowledge of the anatomy of the temporal region and the avoidance of operative complications; if, however, difficulties are encountered then the use of the best methods for controlling them must be known. Naturally, careful hemostasis is a most important factor in obtaining good results in all cranial operations as well as due respect and regard for the delicate nerve cells of the cerebral cortex by the avoidance of unnecessary and rough manipulation and digital examination; and, also, of the greatest importance, a strict asepsis.

Cranial decompressions have been limited in the past chiefly to the relief of intracranial pressure in cases of unlocalized cerebral tumor and in cases of fracture of the skull showing signs of medullary compression; the operation was performed not only to lessen the danger of a medullary edema but to avoid a secondary optic atrophy—so commonly observed in tumors of the brain. In these latter cases the site of the decompression was most frequently over the parietal area or the upper temporal region, and thus, as the tumor enlarged, the increasing intracranial pressure forced the underlying cerebral tissue through the bony opening, producing herniae cerebri of tremendous sizes—the bane of cranial surgery. Fungi cerebri were also a common result of such protrusions. Not only was this complication to be feared, but operative damage to the underlying motor area with resulting paralysis of the opposite side of the body was always risked; besides, the intracranial pressure in cases of fracture of the skull as well as in tumors of the brain frequently
produced a motor impairment by forcing the motor area upward through the bony ring of this decompression.

The reason for these complications is obvious. To remove an area of either parietal bone, not only may the underlying motor cortex be impaired at the time of the operation, but also subsequently by its protrusion upward through the bony opening. This is made possible by the extremely weak protection afforded by the scalp overlying the parietal bone; other than the cutaneous tissues in this area there is only the epicranial aponeurosis, so that even a moderate degree of intracranial pressure is sufficient to cause a hernial protrusion. If the decompression is performed in the parietotemporal area the cranial origin of the temporal muscle to the parietal crest must be destroyed, and thus the possible protection of the temporal muscle is lost.

In contrast to these methods of cranial decompression the subtemporal route offers an almost ideal operation for intracranial conditions, requiring either a relief of the increased pressure or an exploratory procedure; not only is the underlying cortex a part of the temporosphenoidal lobe (which is a comparatively "silent" area of the brain), but the removal of the squamous bone is technically less difficult, in that it is the thinnest part of the vault of the skull; again, the decompression opening is amply protected by the overlying temporal muscle, so that it is a rare occurrence to have a hernia cerebri following this method of cranial decompression; if the attachment of the temporal muscle to the parietal crest is carefully preserved, then it is practically impossible for a marked protrusion to occur (Fig. 1). In my opinion this method of cranial decompression should be the one always to be employed, and in this article when the word "decompression" is used it is the subtemporal decompression that is meant. In subtentorial lesions affecting the cerebellum, naturally a suboccipital decompression is to be preferred; especially is this true of tumor and abscess formations in it. As the tentorium strongly separates the cerebrum from the cerebellum, any increase of the subtentorial pressure is more effectively relieved by a suboccipital decompression than by a supratentorial operation; besides, not only may the lesion be removed at the same time, but the bony opening will be protected by a thick layer of occipital muscles, and thus a large hernia be prevented.

The purpose of the subtemporal decompression has been much enlarged during the past few years, and it seems that its usefulness is to be developed still more in the future. Although its chief function is the relief of intracranial pressure, yet it is a most valuable method of exploration. In these two divisions, practically all of the intracranial conditions for which the operation may be advisable can be classified, and the following is a brief consideration of them:

I. THE RELIEF OF INTRACRANIAL PRESSURE.
A. Tumors of the Brain.
1. Localized Tumors of the Brain.

(a) Large cerebral tumors: For fear the cerebral cortex would be much more extensively damaged by opening the skull directly over the tumor, it is frequently advisable in cases of high intracranial pressure first to make a subtemporal decompression on the side of the head opposite to the tumor and then to perform the osteoplastic "flap" operation to remove the tumor. In this manner not only may the tumor be enucleated with little impairment of the surrounding cortex, but in cases where the tumor is not found as localized clinically (an occurrence of only too great frequency), then the brain may be "dislocated," as it were, toward the opposite side of the head, as made possible by the decompression opening on that side, and in this manner an exploration can be conducted with but little or no injury to the surrounding cortex. This is a most important function of the decompression in facilitating the removal of large cerebral tumors; within the past year I have removed large cerebral tumors in three cases by this method, and I am confident the operation would have ended fatally if this procedure had not been used.

(b) Irremovable tumors of the base and of the mid-brain: Frequently these tumors are non-malignant, the most common one being the tuberculoma; my series contains four of them. It is of the greatest importance to prevent secondary optic atrophy and its resulting blindness by an early relief of the intracranial pressure.
These tumors may enlarge to a certain size, then remain stationary, become smaller, and even disappear clinically, so that if blindness is prevented during their stage of active growth, then an excellent result may be obtained. If the tumor should continue to grow, then the headaches and blindness may be delayed for months until the last stage of the condition.

2. **Unlocalized Tumors.** In the hope that the tumor may localize itself clinically and thus permit of its removal, and yet to prevent the secondary optic atrophy resulting from the increased pressure of its growth, it is advisable to perform an early decompression and, if necessary, a bilateral decompression. During the past year I have treated five cases in this manner; it is surprising to observe the improvement in such cases; a cessation of headache, nausea and vomiting, the rapid subsidence of the beginning “choked disk” —the forerunner of secondary optic atrophy and blindness. No case of high intracranial pressure producing “choked disks” should be permitted to remain weeks while a definite diagnosis is being made without a relief of that pressure by a decompression; only too frequently such cases are brought to the surgeon after blindness has occurred, and once an advanced degree of secondary optic atrophy has supervened there is little if any recovery of sight. Not only will an early decompression delay and even prevent blindness in these cases, but in will prolong the life of the patient by lessening the medullary compression, and thus the unlocalizable tumor may extend into a part of the brain producing unmistakable signs of its situation, so that the tumor can be successfully removed. This is the common history of tumors of the frontal and temporoparietal lobes, especially of the right cerebral hemisphere; as tumors of the frontal lobe extend posteriorly to the motor area then a motor impairment of the opposite side of the body appears, and if downward upon the optic nerve, then an ipsilateral primary optic atrophy results; motor aphasia frequently appears as tumors of the left frontal lobe extend backward into the motor speech area; in tumors of the temporoparietal lobe a similar motor impairment occurs if the lesion extends upward into the motor tracts or forward into the motor speech area.

In similar cases of suspected tumors of the frontal or parietal lobes, and if the intracranial pressure is not extremely high, it is advisable to perform an osteoplastic “flap” operation first, and if the tumor is not found or after its removal the brain is still under marked tension, then a subtemporal decompression can be performed by rongeuring away the squamous portion of the temporal bone and the lower portion of the bone flap itself; in this manner another scalp incision is avoided.

**B. Fractures of the Skull.** Whether the fracture is of the vault or of the base a decompression is advisable only when the fracture is associated with high intracranial pressure; naturally the palliative
expectant treatment of absolute rest and quiet, an ice-bag to the head, catharsis and liquid diet, are usually sufficient for those cases of fracture of the skull showing no marked signs of intracranial pressure; that is, a fracture of the skull is not an indication for an operation unless there are definite signs of an increase in the intracranial pressure. An ophthalmoscopy examination of the fundi of the eyes is the most reliable and accurate means of determining an increase of the intracranial pressure, whether this increase is due to a swollen edematous brain, a depressed fracture of the vault, or to an intracranial hemorrhage of extradural, subdural or intracerebral origin with cerebral lacerations. It is not so essential to remove the depressed area of bone or the intracranial clot as it is to offset the pressure effects of the depression or clot upon the cerebral cortex; naturally, in depressed fractures of the vault, the depressed area should be elevated or even rongeured away, and in cases of intracranial hemorrhage, the clot should be removed, but in many cases, even when their removal is possible, the intracranial pressure still remains high and it is this continued increase of intracranial pressure which damages the cerebral cortex and produces the impairment—both physical and mental. It is not so much a question of fracture of the skull as the effects upon the brain of the injury producing the fracture; in many cases a fracture of the skull is not present and yet a cortical hemorrhage and even cerebral lacerations may have resulted from the injury. It is in these cases of intracranial lesions resulting from injuries to the head and showing definite signs of increased intracranial pressure that an early relief of this pressure is advisable—not only to avoid the danger of a medullary compression and its possible collapse, and therefore the death of the patient, but to lessen the percentage of the post-traumatic conditions so common in these cases, such as persistent headaches, dizziness, changed personalities varying from the depressed state to a highly irritable condition, generally nervous instability, and even epilepsy in its different forms. A decompression should only be advised when there are marked signs of intracranial pressure as revealed by the ophthalmoscope. Signs of medullary compression, such as a retarded pulse, a slow and irregular respiration of the Cheyne-Stokes type, and a high blood-pressure are rather late signs of intracranial pressure, and if the patient is allowed to reach this dangerous condition, then it is doubtful if the patient will recover—operation or no operation; a medullary edema and collapse of the patient may occur at any moment.

1. Fractures of the Vault.

(a) Linear fractures with no depression of the fragments: In these cases a decompression should be performed if the intracranial pressure is high. It has been rare in my experience for fractures of the vault, unless small locally depressed ones, to be limited to the
vault alone; usually the "crack" extends downward to the base—the thinnest and weakest part of the skull. However, this type of fracture, as revealed by the Roentgen-ray, frequently shows no sign of intracranial pressure, and therefore an operation should not be considered.

(b) Depressed fractures of the vault should always be elevated. If this is impossible, then it is usually wiser to remove the depressed fragments, whether the intracranial pressure is high or not. The danger of local damage to the underlying cortex with the subsequent formation of adhesions, etc., rendering the cerebral cortex unstable and thus subjecting the patient to the frightful risk of epilepsy, is a calamity always to be feared, and especially in depressed fractures of the vault. If the intracranial pressure is high, then it is wiser to perform a subtemporal decompression on the same side of the head as the depressed area, and in this manner the general intracranial pressure is relieved. If the depressed area overrides either motor tract of the cerebral cortex, and the intracranial pressure is very high, causing a double papilledema, then it is advisable to perform the subtemporal decompression first and thus relieve the pressure, so that there will be less danger of injury to the motor tract when the depressed area is elevated or removed; otherwise the intracranial pressure may be so extreme as to force cerebral tissue through the fractured opening of the vault and a motor impairment of the other side of the body result.

2. Fractures of the Base. These cases should be treated by the expectant palliative method; however, if the signs of high intracranial pressure appear then an early decompression will not only save a larger percentage of patients than the other method of treatment, but it will lessen the number of post-traumatic conditions. In this connection it may be interesting to note that of the total number of 77 cases of fracture of the skull which were admitted during the year ending June 1, 1914, to the department of neurological surgery of the New York Polyclinic Hospital, 27 of them died; that is, a mortality of 35.06 per cent. Of these 27 cases, however, 20 of them were moribund upon admission—11 of them dying within a few minutes to two hours after admission, and the remaining 9 dying within six to twelve hours after admission; 36 cases of the 77 admitted were operated upon, with a mortality of 9 cases following operation; that is, an operative mortality of 25 per cent.; however, 4 of them revealed at autopsy subtentorial fractures with hemorrhage—a most dangerous condition, as it causes direct pressure upon the medulla; 2 died, nine and sixteen days respectively following the operation, from meningitis due to infected hematomata of the scalp; 1 died on the twelfth day postoperative from pneumonia—the patient being seventy-five years of age—and the ninth case died on the sixth day postoperative from a meningitis, probably due to a "slip" in the opera-
tive technique. Naturally the cases operated upon were the severe cases showing signs of high intracranial pressure. It is a mistake to operate upon these cases when in a condition of severe shock; it is better to wait several hours until the shock has been overcome, otherwise the operation is but an added shock.

C. Brain Abscess, Particularly of Either Temporosphenoidal Lobe. The accurate diagnosis of brain abscess is a most difficult one, and any operative procedure should always be conducted as an exploratory operation. As a rule, abscess of the cerebellum is diagnosed with less difficulty than abscess of either temporosphenoidal lobe or of either frontal lobe; therefore if an abscess of the cerebellum can be excluded in a case with the usual history of previous otitis media it is much wiser to perform a subtemporal decompression over the suspected temporosphenoidal lobe and thus be enabled not only to relieve the intracranial pressure (if present), due to the abscess, but to permit a careful exploration of the entire temporosphenoidal lobe through a non-infected area; if the abscess is found, then free drainage is afforded through the lower angle of the split temporal muscle, and the decompression will offset the pressure effects of the swollen edematous brain resulting from the exploratory punctures and the presence of the abscess itself; again a meningitis is much less liable to occur with free drainage and a lowered intracranial pressure than if the intracranial pressure were high enough to lessen the resistance of the tissues to an infective meningo-encephalitis; if the abscess should not be found then a relief of the intracranial pressure has been obtained and no harm done; the abscess may localize itself later. It is a dangerous procedure to puncture the dura blindly or open it through an infected area such as the mastoid; if the abscess is not found the danger of infection is great indeed; and if it is found the resulting cerebral edema can not be lessened by the small operative opening, so that the danger of a medullary compression is a serious menace; in my opinion, patients die not so much from the presence of the abscess, but rather from the cerebral edema with its resulting medullary compression.

Within the past year I have operated upon two cases of abscess situated in the anterior median portion of the left temporosphenoidal lobe, and if I had not used the subtemporal decompression I am confident I should have overlooked them. Again, in cases of suspected brain abscess it is much better to perform an early exploratory operation than to wait until the patient shows marked signs of medullary compression; the danger of the abscess rupturing into either the subdural space or the ventricle is then much greater.

My own series of operated cases of brain abscess is limited to 10. Of these 4 died: 2 from medullary edema resulting from a too small opening of the occiput in cerebellar abscess; 1 from a meningitis following the drainage of a left frontal abscess through
a small opening—no decompression having been performed; and the fourth one died from a large temporosphenoidal abscess—three to three and a half inches in diameter—which gnawed its way into the ventricle after a decompression with free drainage had been established. The remaining 6 cases recovered; 4 were situated in the temporosphenoidal lobes, and each one was drained through a subtemporal decompression; 1 a cerebellar and 1 a right frontal abscess—the latter case having a decompression performed until the abscess located itself clinically seven weeks later.

D. Cerebral Spastic Paralysis. Selected cases due to an intracranial hemorrhage at birth. Attention has been centred in the past upon the correction of deformities and the lessening of spasticity; the improvement following these operations has been only temporary in all but the mild cases. Naturally the cases of spastic paralysis due to a lack of development or malformation of the brain and its pyramidal tracts are not operated upon and could not be benefited by any cranial operation, but only those cases of cerebral spastic paralysis having a history of difficult labor with or without instruments, and upon ophthalmoscopical examination of the fundi, the definite signs of intracranial pressure are to be observed in the dilated retinal veins, edematous blurring, and haziness of the nasal halves of the optic disks and the more marked signs of old intracranial pressure—these are the cases that can be improved by merely a relief of the intracranial pressure; the local pressure effects of a hemorrhage or of its resulting cystic formation are offset by the decompression, and if the intracranial pressure is high then a bilateral decompression may be performed. If the hemorrhagic clot or its subsequent cyst can be removed, so much the better; but this is not possible in many cases. Naturally the longer the clot and its cystic formation are allowed to exert pressure upon the cortex the more impaired do the nerve cells of the cortex become; in my experience of 65 operated cases, however, only 5 of them revealed the hemorrhagic cyst in or beneath the cortex; that is, the cortical nerve cells were not primarily destroyed but merely impaired by the pressure of the clot and its cyst upon them, as was the condition in 45 cases observed at the operation; thus the longer the condition of intracranial pressure is allowed to continue, just so much more will be the impairment of the cortical nerve cells, resulting in a persistent and even increasing stiffness and spasticity, and a steady mental deterioration in the majority of cases. Most of my cases have been from five to eight years of age—the youngest six months and the oldest twenty-one years of age; the older the patient above twelve years of age the less was the improvement; but even the older ones are improving. The operative mortality has been 6 cases; 4 of these, however, were extreme cases of spastic diplegia under two years of age, very much emaciated and having great difficulty to breathe or to swallow;
this type of case should not be operated upon, as the anesthetiza-
tion alone is too great a risk. However, no case of spastic paralysis,
no matter how extreme, should ever be operated upon unless there
are definite signs of intracranial pressure as shown by a careful
ophthalmoscopy examination; in this manner the spastic cases
due to a lack of development and malformation of the brain and its
tracts are easily excluded and should never be operated upon, as their
condition could not possibly be improved by a cranial operation.
Naturally, sufficient time has not yet elapsed since the first operation
(June, 1913) to establish the permanency of the improvement in
these selected cases of spastic paralysis, but from pathology of the
condition we see no reason why the children should not continue
to improve as they are doing. A report in detail is to be published
soon.

II. As an Exploratory Procedure.

This is particularly true of suspected lesions of either temporo-
sphenoidal lobe, the lower portion of either motor area, the posterior
lower portion of either frontal lobe, and the motor speech areas.
It is a much more simple operation technically than the osteo-
plastic "flap" operation, requiring half the time, and the bony
opening can be firmly covered by the temporal muscle so that no
deformity results. Again, if an increase of the intracranial pressure
is found at operation then the decompression will relieve it.

Besides the cranial conditions selected above as being benefited
by the operation of subtemporal decompression, there are other
intracranial lesions for which the decompression may be used; but
this work is now in its experimental stage, and will be discussed
later.

Not only will a decompression itself relieve the increased pressure,
but a tapping of the lateral ventricle may be easily performed
through the decompression opening by means of a small blunt
cannula, and in this manner the presence or the absence of a dilata-
tion of the ventricles is ascertained—a most important aid in
ascertaining the location of the intracranial lesion; besides, the
ventricular tapping will greatly relieve the intracranial pressure—
at least temporarily.

The Technique of the Subtemporal Decompression. There
should be the usual preparation of the patient for an operation.
The side of the head selected for operation is carefully shaved, either
on the preceding night and a green soap poultice applied, or in
emergency cases the operative site is closely shaved just before the
operation. Unless there are clinical signs indicating a lesion of the
left hemisphere the decompression is always performed on the
right side in order to avoid the motor speech area, which is situated
in right-handed persons in the posterior portion of the third left
frontal convolution, and vice versa in left-handed patients. The
patient is placed upon his back with his right shoulder elevated
by a sand-bag, so that the right side of the head can be more easily made parallel to the table; in this manner the operative site is well exposed and it does not compel the operator, standing at the head of the table, and his assistants to assume tiring positions. The anesthetist is seated under a sheet at the waist of the patient, and in this way he is entirely excluded from the field of operation. The anesthesia in these cases requires the most skillful administration; especially is this true to avoid an extreme cyanosis and congestion not only during the induction of narcosis, but after the dura has been incised and the cerebral cortex exposed; coughing or even labored respirations at this stage of the operation may result disastrously by forcing the cortex through the bony opening; the cortex may be ruptured and serious hemorrhage occur. Dr. Charles S. Hunt, who has administered the anesthetic in all of my cases, uses a mixture of ether and oxygen most successfully; he has found it necessary to deepen the narcosis just before the dura is incised, otherwise the sudden relief of intracranial pressure will allow the patient to show signs of consciousness by coughing, etc.—a complication to be feared at this stage of the operation.

The side of the head and face are now carefully "scrubbed" with green soap and water for five minutes, and then alcohol is sponged over the operative area. Iodin is only used in emergency cases when the scalp can not be thoroughly prepared; it tends to irritate the skin in many cases and thus render a secondary infection possible. A superficial incision in the skin is now made to indicate the area of the operation, and then towels wet in a 1 to 3000 solution of bichloride are clipped to the scalp at each side of this incision; in this manner the head is completely covered and the towels can not become disarranged, so that there is little danger of infection.

By using the method of pressure-traction at each side of the incision and the forefinger of the assistant to compress the temporal artery as it passes over the zygoma, the incision can be made with little loss of blood—a most important factor in all cranial operations; a cranial tourniquet cannot be used in this operation, and the other methods for controlling hemorrhage of the scalp, such as deep sutures, clipping of the scalp, etc., are time-consuming, troublesome, and even dangerous by increasing the risk of infection; besides they are ineffective in many cases.

The incision itself is made vertically upward through the scalp from a point just above the zygoma and one-half inch anterior to the external auditory meatus to the middle of the parietal crest, and thus overlying the origin of the temporal muscle; it is about three to three and a half inches in length, and is parallel to the fibers of the underlying temporal muscle (Fig. 2). Small curved hemostats are used to compress the branches of the temporal artery, and then the temporal fascia is incised vertically and the fibers of the temporal muscle are split longitudinally and retracted, exposing
the squamous portion of the temporal bone. A sharp periosteal elevator is used to separate the muscle from the underlying bone; great care should be taken not to destroy the attachment of the muscle and its fascia to the parietal crest—otherwise the closure of the temporal muscle will be greatly weakened.

The Doyen perforator and burr are now employed to make a small opening at the lower angle of the operative area—that is, the thinnest portion of the squamous bone (Fig. 3). Small rongeurs enlarge the opening until it is possible to use a larger rongeur having one blade bevelled and flattened so that it can be easily inserted between the dura and bone; frequent explorations and removal of adhesions between dura and bone with the dural separator will prevent the dura from being torn. In this manner a circular opening as large as possible under the temporal muscle is made—extending from the base of the skull up to the parietal crest and having a diameter of two and a half to three inches.

Before opening the dura it is important that all oozing from the bony margins should be stopped; the best method for controlling this bleeding from the diploë and its sinuses is the rubbing of a bone-wax into the edge of the bone, and it is surprising how quickly this troublesome complication is overcome. Dr. Norman Sharpe
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has formulated a bone-wax which is most effective; its composition is as follows: white wax, 7 parts; almond oil, 2 parts; salicylic acid, 1 part. It should be kept in a 5 per cent. solution of carbofolic acid. This wax may be sterilized before each operation and then allowed to cool so that it hardens and is easily moulded: small

pellets, the size of peas, are then applied to the oozing bone. It is an effective method of plugging the middle meningeal artery when it channels the bone; it seems to me that it might be used in operations upon bone elsewhere—such as the mastoid, resections of bone, etc. It is far superior to the old method of using wooden

Fig. 3.—The temporal muscle retracted. Using the Doyen perforator to open the skull at the lower angle of the incision, that is, at the thinnest part of the squamous portion of the temporal bone. The Doyen burr is next used to enlarge this opening so that rongeurs may be employed.
pegs in cranial surgery. In fractures of the skull the middle meningeal artery is frequently torn in the subtemporal area, so that it is a simple matter to remove the clot and then plug the bleeding point with the wax.

The dura is now incised by carefully cutting through its outer layer first with a sharp knife; elevating the dura from the underlying cortex by means of the small dural hook inserted into its outer layer, the inner layer can now be safely incised until a small pinpoint opening is made; a grooved director bent at right angles may

![Diagram of cranial surgery procedure](image)

**Fig. 4.**—Dotted lines a show area of bone (two and one-half by three inches) removed. Incising the dura which is elevated from the underlying cortex by the dural hook b; c, middle meningeal artery; d, skin; e, temporal fascia; f, temporal muscle.

now be carefully inserted and the dural opening enlarged by cutting the dura upon the director (Fig. 4). When the dural incision is about one inch in length, I have found it easier and quicker to insert a spoon-shaped spatula and then cut the dura with a sharp pair of scissors; this method is not only safer, but it allows the incision to approach the dural vessels as closely as possible, so that these vessels may be clamped before being cut. Not only is it time-consuming and troublesome to ligate the dural vessels with silk or catgut, but it is dangerous to insert a needle beneath the vessels
before the dura has been incised for fear of puncturing one of the many cortical vessels lying beneath and thus complicating the operation; if the decompression is to be performed it should at least not injure the brain. An excellent method of dealing with the dural vessels is the application to them of the small silver V-shaped clips used by Dr. Harvey Cushing, and then the dura and its vessel may be safely cut between each pair of clips and no bleeding result; these clips may be left on the vessels, and I have never seen any ill-effects occur; in three cases at autopsy within two years after operation, the clips were found in situ; no tissue reaction had occurred, so that they are apparently not irritating foreign bodies; in some cases where the dura was very vascular I have used as many as eight clips. The clips are made by snugly wrapping German silver wire No. 24 around a rectangular rod and then bisecting the roll; V-shaped clips are thus formed, and after sterilization these can be put in a clip holder (similar to a hemostat with a grooved end) and slipped upon the dural vessel. This method saves much time and entails no risks.

The dural opening is thus enlarged in a crucial or stellate manner until the bony margins of the decompression are reached. It is important to incise the dura downward to the base of the skull so that the middle fossa of the skull can be easily and freely drained—so essential in all fractures of the skull with edematous, swollen brains with or without hemorrhage. Through this opening any underlying pathological lesion can be dealt with freely and safely; subdural clots may be removed in fractures of the skull; tumors enucleated and abscesses drained. Aided by the spoon-shaped spatula and a good electric head-light, the neighboring areas of the frontal lobe, the parietal lobe, and the posterior portion of the temporal lobe may be accurately explored for any cortical lesion. If the cerebral tension is high then the ipsolateral ventricle may be drained by the ventricle puncture needle; all parts of the temporosphenoidal lobe and even the posterior portion of the frontal lobe and the lower portion of the parietal lobe can be accurately explored in this manner in cases of suspected sub-cortical lesions, as tumors and abscess.

After the cerebral lesion has been removed or drained, or if merely the relief of intracranial pressure is desired, then a rubber tissue one-quarter inch in width and several layers in thickness is inserted at the lower angle of the wound and inside the dura beneath the temporosphenoidal lobe as far as possible; in this manner excellent drainage is afforded the middle cranial fossa. Before closure of the opening it is important that there should not remain any bleeding-points—no matter how small; small cotton pledgets wet in warm saline solution are frequently sufficient in many cases of cortical oozing, or a small piece of the temporal muscle applied to the bleeding point and then compressed for a few seconds will stop
a most troublesome oozing. When tumors are removed, then packs of cotton wet in warm saline solution and pressed for a few moments into the cavity of the enucleated tumor mass will quickly prevent a large hemorrhage; it is rarely necessary to leave packing intracranially.

The drain having been inserted beneath the temporosphenoidal lobe the temporal muscle is now sutured with interrupted fine black silk—usually in two layers (Fig. 5); then the temporal fascia and finally the subcutaneous tissues; the vessels of the scalp are not ligated as the mere suturing of the subcutaneous tissue is sufficient to compress their vessels; at times, however, the temporal artery itself is ligated. The skin is carefully approximated by fine black silk (Fig. 6). Dry gauze pads are now applied to the operative area, and after a cotton pad well covered with sterile vaselin is placed behind the lobe of the ear to prevent its being pressed against the skull and causing severe pain, the usual bandage of roller gauze is used and held in place by several strips of adhesive plaster (Fig. 7).

In operations of subtemporal decompression the dural opening is never sutured together; in the first place, if there is much intradural pressure, it would be impossible to approximate its edges, and secondly, to suture the dura would be to destroy the object
of the decompression—the relief of intracranial pressure; for in adults the dura is inelastic, so that there can be no real decompress-

Fig. 6.—Skin sutured with fine silk. All towels removed. A, drain of rubber tissue.

Fig. 7.—Dressings applied and held by bandage of roller gauze. A small pad of cotton and sterile vaseline is placed behind the lobe of the ear to prevent pain from its pressure against the bony skull; opposite ear left uncovered. Small strips of adhesive plaster used to hold bandage firmly.

sion if the dura is unopened or sutured after being opened. There is no danger apparently in leaving the dura opened; adhesions do
not form, and in three cases at autopsy, two of them revealed the formation of an entirely new dura. The overlying temporal muscle forms a safe protecting covering.

The postoperative treatment consists of a moderate elevation of the head and shoulders, with the administration of hot saline solution per rectum every four hours for the first day; if much operative shock is present, then hot black coffee per rectum may be given immediately after the operation. The patient should be quiet—morphin or codein being used if necessary. Water may be given by mouth as soon as the nausea ceases, and liquids on the following day; soft diet on the fourth day.

At the first dressing on the second day, the drain is removed and possibly one-third of the skin sutures. At the second dressing on the fifth or sixth day postoperative, all sutures are removed and the patient may now have a light diet. In uncomplicated cases the patient may leave the hospital on the tenth day postoperative. It is surprising how quickly patients recuperate from the operation—there being, as a rule, little if any shock.

The advantages of the subtemporal route over other methods of cranial decompression are chiefly due to its anatomical relations. Not only is the squamous bone underlying the temporal muscle the thinnest part of the vault of the skull and therefore less difficult to remove, but it exposes a part of the brain most frequently involved in cases of fracture of the skull where the middle meningeal artery is torn or the temporosphenoidal lobe is lacerated; in cases of abscess of the temporosphenoidal lobe following its usual cause an otitis media. With little difficulty the lower portion of the motor tract may be explored as well as the posterior portion of the frontal lobe, and on the left side the motor speech area is easily observed. Another important advantage is the fact that the part of the brain lying directly beneath the decompression opening is the cortex of the temporosphenoidal lobe—a comparatively silent area of the brain; for this reason any possible operative damage is not revealed clinically, and in cases of high intracranial pressure the protrusion of this part of the brain into the decompression opening does not produce paralysis, etc.—a frightful result of decompressions performed in the parietal area. That is, a subtemporal decompression relieves increased intracranial pressure without cerebral impairment. Besides it affords excellent drainage for the middle fossa of the skull at its lowest point—an important consideration in cases of fracture of the skull.

Again, the thick overlying temporal muscle not only makes possible a firm closure but also allows the underlying bone to be removed so that a permanent decompression results with no danger of a hernia cerebri. The scalp is not weakened by draining through the split temporal muscle and no unsightly protrusion occurs; the scar is always inside the hair-line. In men the rim of the
derby or straw hat affords some protection to the area of the decompression, although no protection is really necessary, as the temporal muscle is thick and thus the underlying cortex is well protected; besides the cortex itself is comparatively a silent area of the brain, so that even if it were injured by an object being thrust into the opening, no clinical signs would appear unless a large cortical vessel were torn.

The vertical incision of the scalp in this operation is far superior to the older method of a curvilinear incision over the parietal crest. Not only may the pressure-traction method of hemostasis be used much more effectively with the vertical incision, but the temporal artery is clamped at its lowest point and before it ramifies into numerous smaller vessels, whereas in the curved incision the many branches of the temporal artery are severed individually and each one must be clamped separately; again, it is easier to enlarge the bony opening downward to the base of the skull when the vertical incision is used—an important point for drainage in cases of fracture of the skull. To preserve the strong attachment of the temporal muscle to the parietal crest is difficult and even impossible when the usual curved incision is used; in this manner the decompression may so weaken the side of the head that a hernia cerebri appears as the intracranial pressure increases; especially is this true in irremovable tumors of the brain; this complication is a most rare occurrence following a decompression performed with the vertical incision and a careful regard for the attachment of the temporal muscle.

CONCLUSIONS. The operation of cranial decompression is one that should be used much more frequently than it is at present; especially is this true in the conditions of brain tumor, fracture of the skull, brain abscess, and selected cases of spastic paralysis due to an intracranial hemorrhage at birth.

The subtemporal method of cranial decompression is the ideal route; besides being less difficult technically it exposes an area of the brain most frequently involved. This permanent decompression opening does not weaken the skull in that the thick overlying temporal muscle protects it most adequately, so that hernia cerebri are not to be feared.

The operative mortality is low. Patients with intracranial conditions should not be permitted to become blind or to reach the dangerous stage of medullary compression without a subtemporal decompression being performed early.