FRACTURES THROUGH THE SINUSES

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Introduction

Fractures through the sinuses are a common type of head injury that have been studied by various rhinologic surgeons and neurosurgeons over the years. It seemed to me that a comparison between two periods of time in which such studies were made might be of interest. Therefore, a review of a careful study prior to the use of antibiotics compared to several in the present era of antibiotics was undertaken.

The following pre-antibiotic study by Calvert, C. A., was published in the Proceedings of the Royal Society of Medicine in 1942.

Out of 655 fractures of the vault or base of the skull, 103 or 15 per cent had fractures involving the sinuses. In 70 per cent the fractures were compound, not only into the nose, but also through the skin of the forehead. Thus an open wound often exists, and the important question arises how much should be done at operation in the acute stage for the fracture underneath.

Anosmia occured in 35 per cent in one or both nostrils. Dural tearing was more than twice as common in such cases as in patients with only slight or no impairment of smell whatever.

Apart from gross brain damage, the chief danger in cases of frontal or ethmoidal sinus fracture is laceration of the dural barrier and spread of infection intracranially from the nose. The question of whether the dura is torn or not is, therefore, of utmost concern. The knowledge that it is torn at once gives the case a more sombre complexion. The two unequivocal signs of dural rupture are leakage of cerebrospinal fluid from the nose and the presence of an intracranial aerocele.

I. **Cerebrospinal fluid rhinorrhea**

Of a total of 128 cases there were 21 with cerebrospinal fluid rhinorrhea, of whom 11 were treated conservatively and 10 were submitted to operation. Of the 11 treated conservatively, operation had been advised in some and refused. In others the cerebrospinal fluid leak had stopped and was assumed to be sealed off.

a) Conservative Cases - (11)
   7 well
   4 (3 developed meningitis - 2 died)
     (1 developed brain abscess - excision - recovery)

b) Operated Cases - 10 (dural graft)
   9 recovered without incident
   1 died of meningitis

II. **Intracranial aerocele - 9 Cases**

a) Conservative Cases - 6
   4 recovered without incident
   2 developed meningitis of whom 1 died

b) Operated Cases - 3
All recovered without incident

III. **Cases with positive evidence of dural tear - Without rhinorrhea or aerocele (13) cases proved at operation or postmortum**

These 13 cases along with the above 30 cases make 43 in all with positive evidence of dural tear complicating frontal and ethmoid fractures. 20 treated conservatively, 9 recovered without incident and 11 developed either meningitis or brain abscess of whom 6 died. 23 had a dural repair operation and of these 20 recovered without incident and 3 died. The 3 cases terminating fatally were all operated during the acute stage.

It is concluded that unless there is very definite contraindications on general grounds, all cases with a history of cerebrospinal fluid rhinorrhea or intracranial aerocele should be operated upon and their dural injury repaired.

Further decision for surgical consideration depends upon radiological findings. A wide gap in the posterior wall of a frontal sinus or any considerable displacement of bone in that situation, a fracture running down in the posterior wall of the frontal sinus to the anterior ethmoidal cells and widening rapidly as it descends, a fracture passing from one anterior cranial fossa across the cribiform plate to the opposite side of the base of the skull, a fracture associated with the projection intracranially of a sharp fragment from the back of the frontal sinuses or medial part of the ethmoid roof, which would be likely to penetrate the dura, would all have to be regarded as likely to be complicated by dural laceration and, therefore, probably best treated by operation. The same applies to the inverted "U" shaped fracture resulting from a blow on the side of the head in the region of the external angular process of the frontal bone. The posterior limb of this fracture passes down into the anterior temple region, whilst the anterior limb descends across the forehead to enter the frontal sinus on the same or opposite side, ending in the roof of the orbit. This is a dangerous type of fracture, especially when associated with much displacement at the fronto-zygomatic synostosis or with tilting of the crista galli over to the side. Either of these displacements suggests the likelihood of distortion in the neighbourhood of the ethmoid cells with fracture of their thin brittle roof. Any of these fractures, especially if accompanied by gross impairment of smell, would be regarded as a strong indication for operation, apart altogether from the presence of rhinorrhea or intracranial aerocele.

From Negus, V. E.: Discussion on injuries of the nose and throat. Proceedings of the Royal Society of Medicine, March 6, 1942.

Simple injuries

Simple injuries to the sinuses may be confined to effusion of blood into the antrum. Such a collection of fluid is best left alone, as it will in all probability absorb without immediate or subsequent trouble.

Simple fractures of the walls of the sinuses may not call for treatment, except in special instances.

Displacement of the lachrymal bone associated with inward displacement of part of the ethmoid plate, may lead to obstruction of the fronto-nasal duct.

Compound fractures

Compound fractures into the sinuses may present both cosmetic and functional difficulties. If the wound is clean, it may be possible to effect immediate closure without drainage. If, however, potential or actual sources of infection are present, it is desirable to provide free drainage, to cleanse lacerated skin edges, to remove foreign bodies and pieces of bone and then to dust the wound with sulphonamide powder. A full course of sulphapyridine, 1 gm. four-hourly, is given for three days. Failure to carry out this form of treatment, or excess of zeal in opening up bony layers or venous and lymphatic channels in early septic cases, may precipitate osteomyelitis or thrombophlebitis with possible spread to the meninges or the cavernous sinus.

After an interval of at least fourteen days, a further operation can be undertaken if necessary, according to the site and type of injury.

The maxillary sinus, if containing pieces of metal or fragments of bone, must be opened by the sublabial route as soon as possible after the injury, unless the wound itself is of sufficient size for the removal of foreign bodies. If an infection is present or impending, it is wise to provide an opening into the inferior meatus of the nose.

Clearance of the ethmoidal labyrinth may be required in injuries of this region. If infection is present, the operation should be postponed for fourteen days and is best carried out by the external route.

If it appears that obstruction of the naso-frontal duct might follow the operation, it is well to make a free communication between the nasal fossa and the frontal sinus and to insert a skin graft, held in place by a rubber tube.

The frontal sinus, if injured, may present the double difficulty of cosmetic repair and functional restoration. If the anterior wall is depressed, but still more or less intact, elevation may be possible. If, on the other hand, the wound is severe and the cavity of the sinus infected, there will be swelling of the mucosa and blockage of the naso-frontal duct, particularly if the injury extends downwards to the nose. In such a case it is essential to provide a free passage into the nose by enlarging the fronto-nasal duct. The operation should include the insertion of a skin graft.

If there be destruction of the anterior bony wall, it may be desirable to restore the lumen of the sinus and to replace its mutilated lining with a skin graft in the form of a sac, held in place by a bag of oiled silk packed with ribbon gauze.

It is extremely difficult, if not impossible, to obliterate a frontal sinus and a pocket is liable to be left, with continuation of suppuration. The restoration of the lumen and provision of a free new fronto-nasal duct, eliminates this source of chronic infection and at the same time avoids the severe disfigurement resulting from destruction of the anterior wall. Insertion of fat or bone grafts in such cases offers difficulties because of the probability of sepsis.

Compound fracture involving the posterior wall of the frontal sinus is of serious import and a radical operation may be indicated.

Fracture of the base of the skull may be of serious moment if it throws the meninges into communication with the nose or pharynx.

The following is a review of two excellent articles published in the Acta Otolaryngologica in 1960. One article by Frenckner, P. and Richtner, N. G. and the other by Powiertowski, H., Malecki, J. and Buttner, G.

According to Frenckner and Richtner the risk of potentially fatal complications following fractures through the frontal sinus has always been regarded as considerable since with or without concurrent injury of the cribiform plate, they are not infrequently associated with lesions of the dura and thus make possible the spread of nasal infections directly to the meninges.

After exhaustive clinical and roentgenologic examination a careful attempt is made to form a reliable conception of whether or not the patient has fractures or lesions within the frontal sinus region, which for this purpose should also include the anterior parts of the ethmoid bone and lamina cribosa. If there is damage, or justifiable suspicion of damage, the case is treated surgically at the earliest expedient time. Entrance to the sinus or sinsuses is gained via the conventional incision or at times in bilateral lesions through a horizontal transverse incision. The posterior wall of the frontal sinus and the cribiform plate are carefully explored. Thorough debridement of each fracture or other lesion is performed, the bone edges along the line of fracture are trimmed, and all bone fragments that can be located are removed. All coagula are removed and in the majority of cases, the entire mucosal lining of the frontal sinus as well, especially if there have been hemorrhages and lacerations in the mucosa. Many times minor hemorrhages in the mucosa on the posterior wall of the frontal sinus have proved to hide fractures or fissures with invagination of dural tissue or sinus mucosa and even in cases of small, apparently harmless fissures on the posterior wall the dura has proved to be scratched. If the dura appears intact and without injury anywhere, the operative field is left without further intervention. If the dura presents injury, the slits are sutured if possible, or, if the damage is more extensive, closure is accomplished with a muscle or fascia lata graft or by similar means. When there have been more extensive brain injuries, they have been treated surgically in collaboration with neurosurgeons. As a rule, no plastic operations have been done within the nose if the old fronto-nasal duct could have been retained and kept open. After removal of all damaged bony tissue and mucosa in the frontal sinus, and possibly the ethmoid cells as well, the frontal sinus is closed without external drainage in the great majority of cases. Particular attention is given during the operation to the possible presence of small sequestra protruding inward from the edges of the fracture in the posterior wall toward the dura and causing injury. In cases producing fractures in the ethmoid and sphenoid bones the ethmoid cells are thoroughly extirpated transfrontally and possible lines of fracture in the skull followed. The dura is exposed where there is a fissure or a fracture. The fracture should be traced with the greatest care in the roof of the orbit, where the dura is very firmly fixed to the bone and accidental dural fistulas easily arise.

Naturally, the patients are treated with massive doses of antibiotics and chemotherapeutic agents both in conjunction with the operation and for a sufficient period postoperatively.

All fractures were seen roentgenologically in the anterior wall whereas

only 18 out of 64 verified at operation in the posterior wall were seen roentgenographically.

Powiertowski, Malecki and Buttner report on experience in 90 patients; forty-two with recent injuries and 48 with intracranial infections after previous head injury. A team of specialists were formed consisting of neurosurgeons and rhinologists. Their procedure aimed at achieving a one-stage operation to accomplish (a) the abolition of a pathological communication between the cranial cavity and the paranasal sinuses by the repair of dural tears insuring against future infections, (b) the removal of all lacerated brain tissue or excision of the meningo-cerebral cicatrix and (c) the removal of an existing or potential inflammatory focus below the base of the skull (into the paranasal sinuses).

Their method consist of two procedures, one performed directly after the other, under intratracheal anesthesia. The first stage is performed by the rhinologist using the transantral approach. The mucosa of the maxillary sinus is either removed or left, depending on its state. The ethmoid cells are removed under visual control. From the same entrance the anterior wall of the sphenoid sinus is resected. A bilateral operation if performed if necessary.

Next the neurosurgical team performs a bilateral osteoplastic craniotomy. The skull is exposed and loose bone fragments are removed. The posterior walls of the frontal sinuses are removed if fractured; in such cases the mucosa of the frontal sinuses is carefully stripped off. If drainage to the nasal cavity is not anticipated, the remnants of mucosa around the fronto-nasal duct are scraped and impacted into it. If drainage is necessary, this duct is enlarged to a diameter of 5—6 mm. to allow insertion of a drain. Then the dura over the base of the skull is controlled intradurally and its lacerations are sutured and covered with fibrinfoam. The dural defects are covered with fascia lata. The roofs of the ethmoids and sphenoids are removed only when completely in fragments. In recent injuries lacerated brain tissue is removed and in old ones the cerebral cicatrix is removed, sometimes together with the entire pole of the frontal lobe.

The value of tomograms is considered particularly important as these pictures allow location of fractures and translocations of fractures. Further with the tomograms it can be stated with great exactness whether the dura must be torn or not, since the dura is always torn in cases with large fractures, translocations or destruction of the structure of the base of the skull over the sinuses. Dural lacerations over the sphenoidal plane are always large, even when caused by slight fractures without significant dislocations of the bone fragments. Farther, the tomograms allow an evaluation of the degree of damage to the deep bone structures of the face, especially as regards the ethmoidal labyrinth, sphenoids, septum nasi, conchae nasi and orbits.

The authors suggest the following as their indications for operation.

1) In patients with destroyed maxillary sinuses, ethmoid cells, and anterior walls of the frontal sinuses, but without radiological signs of fracture of the sinusial roof itself, only rhinological procedures are preformed. Linear, unilateral fractures of the posterior walls of the frontal sinuses may also be inclu-

ded in this group provided they are not complicated by rhinorrhea, pneumocranium or any sign of laceration of the frontal lobe.

2) Patients with recent injuries with fractures of the sinusal roof which caused lacerations of the dura, but who are without signs of marked destruction of the sinuses themselves, should only be operated intracranially. If these patients have previously suffered from sinusitis or if radiological examinations prove cloudings in some of the sinuses, indicating previous inflammatory processes, they must be excluded from this group.

3) The combined rhino-neurosurgical procedure is advised in all patients with fractures of the sinusal roof causing lacerations of the dura, with a simultaneous destruction of the sinuses themselves. This method is also indicated in patients who previously suffered from sinusitis, or who show radiological changes in some sinuses indicating an inflammatory process (as excluded from group 2), without regard to the injury. This operation should be performed on patients who have undergone an intracranial infection after a previous head injury with fracture of the base of the skull involving paranasal sinuses.

As a rule every patient after the above mentioned types of injury, resulting in rhinorrhea of long or short duration, should be operated intracranially. The operation on the sinuses should be evaluated according to the above mentioned indications.

The combined rhino-neurosurgical method was performed in 90 cases. The mortality rate was less than 5 per cent.

J. B. Erich, states that severe crushing injuries to the nose are invariably associated with fractures of the cribiform plate of the ethmoid bone. Reduction of nasal fractures should be delayed until the patients general condition is satisfactory. It is useless to elevate badly comminuted and depressed nasal bones unless some form of fixation is available for retaining the nasal bones in proper position.

When a malar bone is badly comminuted, the antrum should be opened thru a Caldwell-Luc exposure so the surgeon can insert an index finger within the antral cavity to manipulate the fragments into correct alinement. For immobilization, an intra-antral gauze pack is inserted and left for 2½—3 weeks. A Penrose drain may also be inserted with the pack.

From the standpoint of treatment, fractures of the upper jaw may be divided into: (1) fractures of the facial bones in which there is complete separation of the upper jaw from the rest of the skull, (2) horizontal fractures of the maxilla associated with one or more fractures of the alveolar process and palate, (3) unilateral fractures of the upper jaw and (4) fractures of the upper alveolar process. There is a specific treatment for each group.

The first group of maxillary injuries involves three types of fractures: The horizontal maxillary, pyramidal facial and transverse facial. These last two types of fractures are often associated with a fracture of the cribiform plate of the ethmoid. The initial treatment of pyramidal and transverse facial fractures should consist of antibiotics to prevent meningitis. Reduction of fractures should be postponed until the patients general condition is satisfactory. To secure good occlusion of dental arches, elastic traction must be used to reduce the fracture. This involves the application of hooked arch bars to the

teeth and the use of intermaxillary elastic bands to bring the teeth into occlusion. The most satisfactory method of immobilizing such fractures, is by traction wires attached to the upper arch bar passed thru the cheeks and fixed to a plaster head cap.

FRACTURES DES SINUS

Les fractures des sinus sont fréquentes dans les traumatismes de la tête. Une comparaison d'une étude faite avant l'aire des antibiotiques et de plusieurs études récentes a été faite.

En 1942 Calvert rapporta que sur 655 fractures de la voûte ou de la base du crâne, 103 ou 15% avaient des fractures des sinus. Dans 70% des cas les fractures étaient perforantes, non seulement dans le nez, mais aussi à travers la peau du front. L'anosmie était présente dans 35% des cas dans une ou dans les deux narines. Des déchirures de la dure-mère étaient deux fois plus fréquentes dans de tels cas que dans les cas avec odorat intact ou avec troubles minimaux de l'odorat.

Outre le dommage cérébral important, le danger principal de ces fractures des sinus frontaux ou ethmoïdaux est la lacération de la barrière durale et la propagation intracranienne d'une infection à partir du nez. Les deux signes de certitude de perforation de la dure-mère sont l'écoulement de liquide céphalo-rachidien par le nez et la présence d'un pneumocèle intracranien.

Dans 43 cas de fractures frontales ou ethmoïdales avec évidence de déchirure de la dure-mère, 20 cas furent traités de façon conservative. Sur ces 20 cas, 9 guérirent sans incident et 11 développèrent une méningife ou un abcès intracranien, entrainant la mort dans 6 cas.

Dans 23 cas, la dure-mère fut traitée chirurgicalement, et sur ces 23 cas, 20 guérirent sans incident et 3 moururent. Ces trois morts furent observées chez des malades opérés dans la phase aigue.

A moins de contre-indications définies sur le plan général, la conclusion est que tous les cas avec une histoire de rhinorhée de liquide céphalo-rachidien ou de pneumocèle intracranien doivent être opérés et la lésion de la dure-mère réparée.

Dans l'éventualité d'une atteinte (ou d'une suspicion suffisante d'atteinte), du sinus frontal, de l'ethmoïde ou de la lame criblée, Frenckner, P., et Richtner; N. G., déclarent que les blessés doivent être traités chirurgicalement le plus tôt possible. La paroi postérieure du sinus frontal et de la lame criblée sont soigneusement explorées. Les fragments osseux saillants sont coupés et retirés. Tous les caillots sont retirés et dans la majorité des cas, tout le revêtement muqueux du sinus frontal. Si la dure-mère apparaît intacte et sans lésion, le champs opératoire est laissé tel quel. En cas de dommage duremérien, les déchirures sont réparées par suture ou par greffe avec du muscle ou de l'aponévrose.

Toutes les fractures de la paroi antérieure étaient visibles radiologiquement, alors que seulement 18 des 64 fractures de la paroi postérieure vérifiées chirurgicalement étaient radiologiquement visibles.

Powiertowski, Malecki et Buttner rapportent leurs expériences sur 90 patients; 42 avec traumatisme récent et 48 avec infections intracraniennes après traumatisme cranien. Une équipe de spécialistes fut constituée, faite de neurochirurgiens et de otorhinologues. Leur méthode consiste en deux interventions, faites immédiatement l'une après l'autre sous anesthésie intratrachéale. Le premier temps est fait par le rhinologue par l'approche transantrale. Les cellules ethmoïdales sont retirées et la paroi antérieure du sphénoïde résequée. L'équipe neuro-chirurgicale procède alors à la craniotomie ostéoplastique bilatérale. Les fragments osseux libres sont retirés, et, si elles sont fracturées, les parois postérieures des sinus frontaux sont retirées. Dans une telle éventualité, le revêtement muqueux des sinus frontaux est enlevé. Les lacérations de la dure-mère sont réparées.

Les tomographies sont très importantes car elles peuvent indiquer le siège et le déplacement des fractures.

La méthode combinée rhino-neurochirurgicale fut utilisée dans 90 cas. La mortalité fut de moins de 5%.

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