EXPLORATION AND TREATMENT OF FISSURES FROM SKULL FRACTURES.

Read in the Section on Surgery and Anatomy at the Forty-seventh Annual Meeting of the American Medical Association, at Atlanta, Ga., May 5-8, 1896.

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The modern treatment of fractures of the skull, which includes the uncovering of all suspicious areas suggesting depression or the projection of bony spicule toward the dura, the removal of fragments and foreign matter of every description, the arrest of hemorrhage, adequate provision for drainage, faithful observance of asepsis both in operating and dressing, with such attention to the general condition of a patient as may be requisite, is, in a word, the impression that Lister and his teaching have made upon the surgical work of pre-antiseptic days.

The results obtained before that time through the faithful and painstaking application of surgical principles, of which cleanliness as then understood was the corner-stone, are scarcely less astonishing than those of to-day, if just consideration is given the work prosecuted in ignorance of the existence of bacteria and their appalling ravages.

The confidence and boldness with which the surgeon may now undertake explorations involving the gravest consequences, have really been the outcome of protection afforded from the toxic effects of septic disease by the gradual development of aseptic principles. Wonderful advances in saving lives and the brilliant results of daring operating have made the field of cerebral surgery a most attractive one during the past decade. With all the advantages, however, afforded by aseptic precautions, the mortality of skull fractures involving the base remains high. This mortality has an association with such elevation of temperature as to point unmistakably in the direction of septic infection as an explanation, and leads to the doubt of a perfect asepsis in all cases. Without question a certain share of the mortality is inevitable from severity of injury as well as from incidental complications that are independent of sepsis. Crushing injuries of the head with extensive laceration and destruction of tissue, together with abundant hemorrhage, will surely determine a proportion of more or less early and irremediably fatal results.

Of the patients who survive the immediate effects of injury, a number are subject to a comparatively slight rise of temperature for a short time, associated with varying symptoms of concussion, and ultimately recover. The remainder improve for an uncertain period from several days to a week or more, then gradually develop a temperature that, with occasional and irregular fluctuation, rises as the patient gradually sinks to his death. It is possible that of this last group some die from chronic inflammation of brain tissues following their contusion or laceration and the interference with its nutrition through the pressure effects of masses of clot, added to the degenerative changes characteristic of those processes. Progressively high temperatures common to fatal cases, however (though every care prescribed by aseptic rules be followed), and their similarity in other respects to those treated without aseptic precautions make it doubtful, to say the least, if sepsis has been completely eliminated from them.

The reduction of this mortality is a problem that now confronts the surgeon, and as an entering wedge

toward its solution, the importance of a series of observations that will establish beyond doubt the relation of sepsis to the fatal results can not be overestimated. Much may be accomplished by the systematic and accurate observation of all cases of fractured skull where there is any open surface requiring dressing or where any discharge exists, by making bacteriologic cultures, at intervals during life and at the autopsy; briefly, freedom from sepsis should be definitely and unmistakably proved in any fatal case by the unassailable evidence supplied by carefully made bacteriologic tests, to clear it from the suspicion of putrefactive infection. With the belief that such inspections will show cases heretofore unsuspected to be septic, and therefore requiring a more rigid application of aseptic principles, I venture to add that a logical deduction from the same combination of symptoms with wounds in other parts of the body would direct the attention of the surgeon to the vital importance of finding, if possible, the source of infection and applying the proper remedy.

In making this search, one is impressed with the invariable freedom with which the immediate seat of injury is now inspected, cleaned and dressed, relieving in a measure the region of direct violence from the suspicion of contamination.

In considering the more remote sources, the common association of bloody or serous discharges from the ear or nasal passages, continuing for days after the injury, and in some fatal cases to the end, suggests possibilities of bacterial infection through the extension of a fracture by fissures to the internal ear where an old otorrhea can supply the material in abundance for polluting the discharge from the interior of the skull; or, by the destruction of the membrana tympani, establish direct connection on one side with the air through the external auditory meatus and by the Eustachian tube to the cavity of the naso-pharynx, which Paul Raugé terms "the storehouse from which the infective elements passing through the tube into the tympanum are derived." Fissures communicating directly with the nasal cavity are of necessity open to the same infective influences.

A large percentage of those who die from skull fractures have these bloody or serous discharges, also those who survive for more than five or six days and then die. On the other hand, a good proportion of those who recover have the same history; from which it is proper to infer that such discharges are not in themselves necessarily fatal, nor the bony fissure associated with them. Another explanation for fatal cases must be found either in the character of the injury to the brain and its vessels, or that of the fissures through which the discharges escape. Admitting that cases of severe contusion or laceration may die in a few days, or less, with elevated temperatures but without septic infection, until time and observation shall prove that question beyond doubt, we have left as an active factor in the results, the differences in fissures produced by their location, the parts toward which they trend, and the mobility of the bones which they separate.

A fissure through bones fractured with so much force as to leave them loosely connected would be more likely to supply an avenue for infective material to reach the skull cavity than one that could be barely detected and closely resembled a crack in glass or porcelain. The variations between these extremes are common to all fractures and may explain a part,

at least, of the differences of results in cases presenting similar symptoms. Though the flow of blood or serum may be nearly alike in a given number of cases, the quantity is not a safe guide to the extent of bone separation.

I need not dwell upon the difficulty of making the middle ear as aseptic as it should be, to warrant a communicating opening with the brain free from danger. The cavity of the skull stands with that of the peritoneum, in the importance of maintaining perfect aseptic defenses. The most dangerous of the combinations described, a loose fracture extending into a suppurative ear, of long duration, with fresh bloody or serous discharges, suggests a way for attacking less serious cases, by approaching the septic area from the region of the direct injury. By the use of the rongeur, a fissure extending in the direction of the ear can be widened into a channel of half an inch, to the base, through which the brain or dura may be lifted with a blunt retractor and the extent of the fissuring determined. The auricle may then be dissected forward so that a fissure can be followed to the mastoid and into the auditory canal, permitting the protection of its inferior aspect, for a distance, by gauze. Having inserted a protection of gauze between the upper aspect of the fissure and the dura or base of the brain through the channel made by widening the fissure, the latter also may be packed with gauze connecting it with the gauze at the vertex, limiting hemorrhage and providing an excellent drainage apparatus from the vertex to the base of the skull without causing undue brain pressure. With a previous history of a suppurative ear the tympanum should be freshly disinfected after carefully protecting the injured parts. The auricle is then rolled forward and the region included in the aseptic dressing.

As the possibilities of infection can not be estimated before unfavorable symptoms develop, and as it is then too late to institute aseptic measures, however radical, a conservative treatment would naturally include, at the first inspection of the wound, a most rigid asepsis, the following out of fissures with the utmost precision, uncovering the whole circumference of the skull opening for that purpose, and providing unlimited drainage by widening the fissures into loosely connected bone, that extend in the direction of the base.

When nearly 50 per cent of brain abscesses originate in suppurative ear diseases, the isolation of this region from the brain and its attachments during the repair of a fractured skull becomes a serious question; whether, in view of a steadily increasing temperature in spite of our precautions, and in the absence of other causes, it may not be justifiable to make a more radical clearing and asepsis of the ear cavities than can be obtained without anesthesia. The danger associated with such a procedure through the possibility of forcing, by washing under pressure, septic material from the tympanum through the fissure to the interior of the skull, emphasizes the importance of an adequate *primary* asepsis of the ears in fractures connected with them.

Death may follow ear suppuration by injury from below as I have observed in a hospital case some years ago, where an attempt was made to commit suicide by firing a revolver, ball caliber 38, into the neck at a point in front of the sterno-cleido-mastoid muscle and on a level with the angle of the lower jaw. The

wound of entrance passed directly upward between that bone and the mastoid process and perforated the meatus, where the ball was tightly wedged and could be felt from the outside with a probe passed by the ear, as well as through the wound from below. Ready access to the ball was obtained by dissecting the auricle forward. After its removal suppurative middle ear disease followed and the patient died from a large cerebral abscess of the right hemisphere immediately above the infected area as shown by autopsy.

In conclusion I will add one case only as an instance of what the complete exploration and widening of fissures may accomplish in the prevention of infection through its abundant provision for drainage and asepsis.

A well-developed man, M. S., age 36, entered the Massachusetts General Hospital with the history of having been struck on the head with a large piece of coal that had fallen thirty feet. He was conscious, rational and without paralysis. The pupils were equal and reacted to light. Pulse 100 of fair strength. There was bleeding from the right ear and at the parieto-occipital angle a scalp wound two inches long connecting with a depressed fracture. The head was shaved and made aseptic.

Upon uncovering the fracture a circular depression of two inches diameter was found with shelving edges. After removing a few projecting points with the chisel, the fractured bone was elevated and the dura exposed. It was darkened from contusion but not torn. Pulsation was slight when the fragments were removed, and hemorrhage free.

Upon inspection of the opening into the skull a fissure was found on the right border extending in the direction of the right ear. The scalp was then dissected up in the direction of the fissure until the external auditory canal was reached. As the auricle obstructed a complete exploration, the incision was continued in the direction of the mastoid and the bony canal exposed by dislocating the auricle forward, showing an extension of the fissure anterior to the mastoid into the canal. The separation of the fractured bones was complete, permitting their easy displacement, to and from the brain, but not laterally from the line of fracture so as to permit a satisfactory examination.

It was clear that the hemorrhage from this fissure unless arrested promised everything in the way of sepsis. To close it and at the same time supply necessary drainage for the cavity above, it became necessary to widen the fissure to the width of the rongeur (one-half of an inch), from the opening at the vertex to the level of the base. Then it was easy to lift the dura from the region of the fissure and after washing out the cavity to pack it with iodoform gauze as before described. A few silk worm gut sutures through the skin and across the channel helped to keep the gauze from becoming displaced, and over all the usual aseptic dressing was applied, including the external ear.

His temperature reached 101 degrees for one night (the third after the operation), then remained between 100 degrees and normal during the succeeding two weeks. The pulse ranged between 60 and 75. He had a slight headache on the first day after the injury. The gauze drains were gradually removed; upon the thirteenth day the wound was granulating well and he was up and about the ward. There was deafness of the right ear and some facial paralysis of that side.

He was discharged well in two weeks, previous to which his ear was examined by Dr. J. Orne Green, who found that the fracture had involved the labyrinth with the facial and auditory nerves, and made the prognosis of permanent deafness.

DISCUSSION.

The Secretary, Dr. W. L. Estes, said: It seems to me that the questions involved in this paper should not pass unnoticed, as they confront every surgeon and may occur to every practitioner. Dr. Beach has brought out with great clearness the necessity of disinfection, the production of a septic state and the employment of proper drainage. These are the principles on which every surgeon works. Fractures at the base of the cranium are those which are perhaps least practicable in obtaining thorough asepsis and drainage. It seems to me that physicians do not recognize the necessity of proper disinfection of the avenues of asepsis, i. e., the nares and the external ear. It has been my fortune to have to treat cases which had been seen previously by the family physician who was not accustomed to work in aseptic surgery, and I have found that there has been absolutely no attempt at disinfection of the nasal passages or the external auditory meatus when all the symptoms have led to a fracture involving the base. It seems of the greatest importance that this Section should advocate and impress upon practitioners the absolute importance of disinfection when there is no question about the external cavities being involved. It is my custom to thoroughly douche or spray the nasal cavities, and to plug them anteriorly and posteriorly, if necessary, with some disinfectant gauze. After thorough disinfection of the external auditory canal I plug it also. Now as to drainage, it is sometimes a serious matter to do this in fractures of the lowest basilar indication. If it involves the area which is posterior to the auditory canal, it may be an easy matter, but if it involves the anterior area, it is more difficult. There is no question that the propositions of Dr. Beach are the proper ones. No matter what the danger may be, the greatest danger is in neglecting the matter. It seems of the greatest importance to widen the fissures, if necessary, and to be sure that adequate drainage is provided. The question of hemorrhage is a most dangerous one. The sinuses need not necessarily be injured, but the meningeal vessels would probably be those especially involved. Great care and blunt lifting of the dura will usually permit the securing of proper drainage.

CEREBRAL SURGERY; REPORT OF CASES.

Read in the Section on Surgery and Anatomy, at the Forty seventh Annual Meeting of the American Medical Association, at Atlanta, Ga., May 5-8, 1896.

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As this paper is one dealing with the general subject before this Section, I shall simply report cases, knowing that the points in regard to cerebral surgery as a whole will be taken up and discussed by men far abler and more competent than myself.

Case 1.—This case is presented, solely for the purpose of illustrating the very great difficulty which occasionally surrounds our attempt at cerebral localization in traumatic cases.

Robert C., aged 59, finely developed and nourished, February 22, 1896, fell about thirty feet through a dust chute in a cotton factory. Probably remained lying at the bottom of the chute for about one hour before being discovered. I saw him at 8:30 P.M., Feb. 22, 1896, in consultation with Drs. A. R. Walker, W. H. DeWitt and P. W. Good. This was about four hours after the accident.

Examination showed an extensive bruise of the scalp in the median line of the vertex, extending slightly farther to the left than to the right side. No fracture of the skull apparent. There was ptosis on the left side, hemorrhage from the left nostril, motor aphasia, both pupils were midway between contraction and dilatation and did not react. Patient was rest-

less, would arise from the bed and could stand upon his feet. Both arms and legs were used freely. He could understand what was said to him and made efforts to respond but was unsuccessful. No vomiting. Examination of chest revealed fractures of second and third ribs about the angles. The symptoms otherwise were negative.

Diagnosis: Fracture of base of cranium and fractured ribs. A very guarded prognosis was given. An ice-cap was ordered for the head and K. br. given every three hours in scruple doses.

February 23, patient seems some brighter; restlessness much less; sleeps soundly, snores considerably. Ptosis seems somewhat less. Other symptoms about the same. Continued treatment. Slight fever developed to-day. The future history of the case is one of increasing fever and gradually deepening coma. I did not see the case again until after death, he, in the meantime, being under the care of Dr. A. R. Walker. He died at 9:30 A.M., Feb. 26, 1896. Temperature just before death, 105.

Autopsy was made by Dr. Frank Fee, six hours after death. P.M. rigidity well marked. P.M. staining slight. Prominence corresponding to bruised area on vertex, depression anterior and posterior to it. Bruising over left side of chest.

Head: Large effusion of blood in the scalp at the vertex. No fracture. Brain had small bloody effusion in the most posterior and lowest part of the occipital lobes on each side, most marked on the right. Otherwise brain normal.

Meninges: Smoky from beginning inflammation. No pus. Middle meningeal artery of left side ruptured, about a dram of blood effused.

Base of skull: Two distinct fractures, one of left orbital plate and one of left cribriform plate. Fracture not extensive. Skull very thin.

Chest: Second and third ribs fractured posteriorly, fourth, fifth, sixth and seventh fractured near junction with costal cartilages. Heart and lungs normal.

Abdomen: All organs normal except kidneys and liver; these were fatty and the left kidney presented three cysts.

Cause of death: Fracture basis cranii.

Case 2.—Dr. H. H. Hoppe, Neurologist to the Cincinnati Hospital, had this man in his service. In order to save time I will abridge the medical history and confine myself to the essential points. These were Jacksonian epilepsy, the convulsion always beginning in the left leg, then involving the left arm, then the left side of the face and then becoming general. These convulsions occurred in groups, so that he would have ten to twenty in a day (status epilepticus). Following the convulsion the patient would have a left sided paresis, which would only remain for a few hours. After passing through these attacks, the patient would become maniacal, in which condition he was dangerous to those about him. These were in brief the only points bearing upon diagnosis.

From the above symptoms Dr. Hoppe concluded that some irritation existed in the leg center on the right side of the brain, and turned the case over to me for operation.

On August 31, 1894, after the usual preparation of the patient and site of operation, he was taken to the amphitheater for operation. Chloroform was the anesthetic used. A crescentic incision was made over the right parietal region, the bone having been previously "scored" with an awl to mark the course and location of the Rolandic area. After the flap had been turned back and the hemorrhage controlled, an inch trephine was applied and a button of bone removed over the area corresponding to the leg center. Before using the trephine, there was noted a blue line in the bone running downward and forward, almost parallel to and about one-half inch behind the Rolandic fissure. The opening in the skull was enlarged by means of a rongeur forceps, downward and forward. In the process of enlarging the opening, there was opened a large vein running in the diploe. This vein was what caused the bluish line above noted. It had eroded the inner table of the skull and had caused an absorption of the dura immediately under it, so that there protruded through the dura, a hernia of the pia and brain. I should state, lest the above description be misleading, that there was a varicosity in the vein