

it is to be noted that there was a positive and undoubted change in the lumbar fluid.

At the same time, the examination of the fundus of the eyes revealed a distinct difference between the two optic papillæ, the most considerable alterations being found on the same side as the lateral sinus thrombosis.

On the other hand, the fever was quite continuous—not at all remittent, as commonly happens in the cases of thrombosis of the jugular vein.

Finally, it is to be considered that, no paralysis being present, there were no focal localising symptoms, and consequently no indications for operating on the skull.

CONCLUSIONS.

Thus, my conclusions will be :

(1) A genuine thrombosis of the longitudinal sinus may occur without being an extension of a septic infection from the nose.

(2) Epistaxis, as principal sign of the above thrombosis, may be entirely absent.

(3) The anatomical reason for the more frequent extension of thrombosis of the superior longitudinal sinus to the *left* lateral sinus is the broad and direct communication between these two blood-vessels, found in the majority of instances, while the straight sinus opens rather directly in the right lateral sinus.

(4) A preliminary exploration of the frontal sinus may be performed for the same purpose as exploratory laparotomy in abdominal diseases.

THE VALUE OF THE BLOOD-CLOT AS A PRIMARY DRESSING IN MASTOID OPERATIONS.

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To pursue a certain line of investigation, to regard its failures and disappointments as opportunities for the acquisition of further information, and, finally, to present the results attained, and the conclusions arrived at, to the criticism and judgment of one's colleagues is one of the gratifying labours which make for advance; for, proved or disproved upon the basis of its primal proposition, the result, in the record of acquired facts, is an addition to knowledge.

The observations here recorded, extending over a period of nearly twenty years, and now first presented in their entirety—previous communications upon this subject having been mainly the reports of cases—though limited to a circumscribed surgical field, have value as a contribution to the general study of the obliteration of surgical dead spaces, and are presented in reference to their significance in this respect as well as for their special purpose.

The earlier operations for the evacuation of the septic contents of the mastoid process of the temporal bone, consisting mainly in a simple perforation of the outer mastoid cortex with provision for drainage and a slow elimination of necrotic trabeculae and cortical bone by a granulosomatous process, naturally suggested the possibility of more rapid evacuation by a mechanical procedure. To effect this purpose more complete access to the mastoid interior than that afforded by a simple perforation of the cortex was necessary, and aural surgeons came progressively to make the outer cortical opening larger and to remove the mastoid contents by means of chisels and curettes until the present mastoid operation, as it has since been generally practised, was established. The after-treatment of the more complete mastoid operation consisted, usually, not in simple drainage, but in flushing with antiseptic solutions and in the packing of the resultant cavity, more or less firmly, with aseptic or antiseptic gauze, the usual result being a slow process of healing, attended by more or less painful manipulation extending over a period of weeks or even months. It was while following this, the accepted line of after-treatment at the time, distinctly unsurgical in the light of more recent knowledge, that certain observations suggested the possibility of obliteration of the cavity in the mastoid along more natural lines. Both the antiseptic irrigation, especially with corrosive sublimate solutions, and the tight packing were found to interfere with the process of repair, and the substitution of light gauze packing without the preliminary irrigation was found to leave blood-clots in the more dependent and more remote portions of the mastoid cavity. These clots sometimes contributed, by the formation of firm fibrous bands, to a lessening of the space and sometimes broke down and came away, the apparent cause of the liquefaction of the clot being a small portion of septic material; when the clot remained for a period of forty-eight hours or more and then broke down, the subjacent bone was found to be covered by healthy granulatoma.

Evidently, then, the blood-clot in the exenterated mastoid

cavity might be expected to act in one of two ways : it might bring about the formation of firm fibrous bands, the framework for a possible extension of the later osseous trabeculæ, or it might, after a temporary persistence, break down, leaving behind it an osteoblastic formation and healthy granulomata as the basis of a slower process of repair. If the blood-clot broke down under the incentive of a septic remnant, it was evident that the hope for its utilisation as repair material in anything more than a very limited area must have its reason in so complete an evacuation of the mastoid contents as to afford a surgically aseptic cavity. The already established mastoid operation of Schwartz, with its inclusive outer cortical opening and extensive evacuation, presented the operative measure, and the investigations of Schede¹ upon the blood-clot filling, in operations upon the long bones, encouraged the prosecution of tests as to its applicability as a repair process in the mastoid, a bone cavity apparently offering a greater promise of success than that afforded by the long bones, because of its distinctly delimited cortex and the ready accessibility of its interior.

To attain the desired ends, both as to investigative and reparative results, the operation naturally formulated itself upon the following lines. The cut through the soft tissues, sometimes straight, sometimes curvilinear, directly to the bone was made and retracted with as little mutilation of the cut edges as possible ; bleeding was controlled by means of the usual hæmostats, sponging with hot water, and the pressure of broad-bladed retractors, until a dry field, exposing the whole or greater part of the mastoid exterior, was obtained. The opening in the outer mastoid cortex was made so large as to include all areas of defective bone and to afford, in addition, ample access to all parts of the mastoid interior, the whole of the outer cortex, if necessary, being taken away. The contents of the mastoid cavity were then removed by means of chisels and sharp, long-tipped, unfenestrated spoons, down to the inner cortical walls, especial care being taken to remove the bases of the trabeculous projections with their interlamellar diploë, and to search out adventitious cortical cells and, by curetting, make them a part of the general cavity, which was then packed firmly with small, dry, involuted gauze sponges. These sponges were allowed to remain for a minute or more and, on their removal, the interior of the mastoid was subjected to careful visual and tactile examination, with the result, usually, of the detection of some small area of cortical vascularity contrasting with the surrounding clear

surface of the cortical bone; these vascular, or possibly necrotic, areas were carefully curetted, to the extent of entire removal of portions of the cortical wall, down to the underlying muscle or dura, as the case might be, and the procedure of packing and curetting was repeated until, as far as could be determined, the cavity was surgically clean. The cavity was then again packed with small, dry, gauze sponges and attention directed to the soft tissues; necrotic or suspicious areas were excised or curetted, all shreds and remnants removed, and the cut edges trimmed for apposition; the sponges were then removed and the cavity in the mastoid allowed to fill with blood from the cut surfaces of the soft tissues, which, so soon as clotting was evidenced, were brought into apposition and so retained either by gut sutures or by pressure pads, the lower portion of the incision being left free for seepage of serum from the clot.

As a preliminary to the mastoid operation the drumhead, even if perforated, was incised by a crescentic cut following the posterior superior periphery, this cut being sometimes supplemented by the passage of a curved spatula-shaped knife upward and backward toward the antrum, for the division of the horizontal mucous folds present in this locality in a considerable percentage of normal middle ears, and which, in suppurative disease involving the epitympanum, present an obstruction, by their engorgement and swelling, to effective drainage. The canal and middle ear were carefully cleansed and stopped with a gauze wick, which was removed after the operation, and the canal and middle ear again cleansed and plugged.

Even after so thorough and painstaking an operation it was not, at this period of the investigations, deemed wise to leave the mastoid wound undisturbed; on the first or second day the dressings were removed, and, even if there was no evidence of reaction in the wound, a sterile probe was passed through the clot from below upward superficially, or even into the antrum, with the result, not infrequently, of persistence of the clot and the establishment of a sinus through it, which subsequently closed; in some cases the tip of the probe was passed into the antrum and the outer end of the probe raised and lowered until the adhering edges of the outer wound had been completely separated and the clot fairly divided into halves, the result being a serous seepage throughout the centre, the lateral portions of the clot remaining firm. As might have been expected, clots which might have held broke down completely under this invasion of their reparative process, supplemented occa-

sionally by flushing with a corrosive or permanganate solution. In these latter instances the wounds healed subsequently by granulomata, but it was noticeable that the disrupted clot left behind it areas of firm, healthy granulosomatous lining of the mastoid cavity, affording the foundation for subsequent repair. In some cases, as an experimental procedure, granulomata thus formed were curetted, to free bleeding, with the formation of a secondary blood-clot and apparent hastening of the filling in of the cavity.

By this time, in 1891, the investigations having been about three years in progress—the material employed being mainly the mastoid cases in a three-months' service in each year in the aural department of the Massachusetts Charitable Eye and Ear Infirmary—it had become plain that the use of the blood-clot as a primary dressing not only favoured more speedy elimination of the surgical dead space, but considerably decreased the discomfort of after-treatment.

The blood-clot dressing was inapplicable, apparently, in cases in which it was necessary to maintain access to deeper-seated diseased parts, as in implication of the sinus, and with the presence of extra-dural abscesses, though since that time access has been maintained to the septic parts by gauze drains, allowing the remainder of the mastoid cavity to fill in with blood, with good and speedy results. In cases of extra-dural abscess, so called, the result of a spontaneous perforation of the inner cortical wall, with extrusion of the septic contents upon the dura, it has been possible, by enlarging the opening in the inner cortical wall to the limit of the dural adhesion and subjecting the parts to light curetting and dry scrubbing, to permit the extra-dural abscess cavity to participate, with the mastoid cavity, in the blood-clot dressing. That it was inapplicable under unfavourable systemic conditions in the luetic, the diabetic, and the phthisical was presumed and supported by the number of such cases in which the blood-clot broke down speedily with subsequently slower filling of the mastoid cavity by granulomata and the necessity for frequent stimulation of the repair process, but in others occurred some of the best results.

The more favourable cases were those in which the mastoid disease was an acute supplement of the middle-ear affection, or those in which the suppurative middle ear had been most thoroughly evacuated and drained.

With these differentiations there appeared to be a sufficient percentage of gain, in the shortening and amelioration of the after-treatment, to warrant a continuance in the investigations; but it

was not until 1891, and then by a purely accidental occurrence, that the extent of the protective and reparative capacity of the blood-clot, within the mastoid, was fully demonstrated. The patient, not a hospital case, was a man aged thirty, a musician, in good health, and living under favourable conditions. As the result of an acute infection of the right middle ear he developed a mastoiditis, which came to operation, after failure of the usual abortive treatment—rest in bed, light diet, laxatives, and the post-aural application of the cold coil. The operation included the crescentic peripheral incision of the drumhead, thus leaving the membrana vibrans intact, with the exception of a small perforation below, already established, the division of the tympanic mucous folds, and the mastoid operation as above described, the edges of the wound being closed by apposition. Light probing through the clot into the antrum was practised until the third day, when it was suspended in deference to the accident above mentioned, namely the appearance of an erysipelatous blush, about 1 cm. in diameter at the vertex, accompanied by chill and rise of temperature. Under these conditions the mastoid wound was left untouched, being kept covered merely by a light corrosive dressing.

In this case, as well as in many of the hospital cases, during the more conclusive period of these investigations, it was my good fortune to have the collaboration of Dr. Henry Lee Morse, who has since carried on similar investigations independently. We were mutually agreed both as to the propriety, in this instance, of leaving the mastoid wound untouched, and as to the importance of the conclusions to be drawn from the occurrence.

At the end of twenty-four hours the erysipelatous inflammation had invaded the temporal region and face. The edges of the mastoid wound were completely coapted, and so remained. At the end of ten days the active symptoms of the erysipelas had ceased, the mastoid wound was firmly healed, there was no drainage from the middle ear, the hearing was improving, and subsequently became nearly normal. The mastoid wound had been virtually closed and firm since the fourth day after operation, the mastoid presented a normal contour, and the incision was represented only by a slight linear scar.

With so clear an indication of the availability of the blood-clot, not merely for purposes of partial, but to the end of complete, repair, when applied to a surgically aseptised bone-cavity, the further investigations centred upon the study of the after-treatment of the mastoid wound with reference to the possibility of primary

healing ; a parallel study of the extent of the protective capacity of the blood-clot being made by applying it as a primary dressing in a series of unselected cases.

In these cases the importance of surgical cleansing of the middle ear, either by a preliminary operation or by the tympano-mastoid exenteration, was sufficiently demonstrated and the protective capacity of the blood-clot determined on an average of about forty-eight hours.

The percentage of primary healings of the mastoid wound—that is to say, of cessation of serous seepage from the lower portion of the wound, absence of granulomata, and healing within from seven to ten days after operation—varied, in the different series of grouped cases, from 12 to 50 per cent., the latter being selected cases, though I have the pleasure of knowing that others who have followed these observations have since attained even more than the latter percentage of success.

The conclusions arrived at in regard to the value of the blood-clot as a primary dressing, and as repair material for healing by first intention in mastoid operations, is drawn from less than 250 cases—a small proportion of the cases operated upon at the hospital mentioned, and even a smaller proportion of the cases coming under my personal care than would be the case but for the view that one of the important functions of such an institution is teaching, and the consequent custom of placing as large a proportion as possible of the operative cases in my terms of service in the hands of the junior surgeons under my supervision, these cases would not, of course, be includable as investigatory material.

The objections thus far presented to the use of the blood-clot in the mastoid as facilitating or affecting repair have come from various sources, on the part of both general and aural surgeons—doubt as to the results obtained, but doubt is a broad pathway to belief ; question as to the real shortening of the after-treatment, a question to be fundamentally answered only by practical experience and comparative observation ; and, finally, the least tenable of all, the expression of fear of the possible consequences of closing the mastoid wound.

When this closure is effected by the simple coaptation of the surfaces of the cut in the soft tissues, under lateral pressure from gauze rolls, by the interrupted suture, which can at any time be divided, or by the subcutaneous, continued suture, which can be immediately withdrawn, and while the superficial appearance of the operated region and the systemic symptoms are facile indicators

of the condition within, this objection would seem to fail of effect. Whatever the manner of the closure of the mastoid wound may be, the lower portion should be left free for serous outflow, and this outflow should be assured at subsequent dressings.

Several years ago, at a meeting of this Association in Leeds, Sir William Macewen made the statement that the American aural surgeons were afraid of the lateral sinus. Thanks to his brilliant and incisive teaching, that fear has long since passed away, as the records of sinus operations in aural hospital reports and in the *Transactions* of the American Otological Society abundantly testify; it required practical acquaintanceship with the subject to banish fear. To-day there would seem to be reason to repeat the statement, in an altered form, and to say that some of the American aural surgeons seem to be afraid of the blood-clot; it is only by practical personal experience that they can determine its value as a part of a repair process.

Were the percentage of healing by first intention in acute cases alone less than it has been proven to be by those who have fairly tried it, the result, in the mitigation of pain and discomfort, and in shortening the duration of after-treatment, would be well worth striving for, especially as success presupposes an advance in the surgical thoroughness of the operation itself and the application of a judicious consideration of conditions, which is as much a part of the real domain of surgery as is the application of structural knowledge or of manipulative skill.

The history of the mastoid operations from the time when a simple Wilde's incision was the limit of surgical interference shows a progressive development in the extent to which the mastoid cavity is laid bare and the completeness with which its contents are evacuated; but the history of the reparative process will not be complete without careful estimate and due consideration of the subject of this paper.

The modern mastoid operation is the outcome of a speedy mechanical substitute for the slower evacuation of the morbid mastoid contents by a natural process of elimination; this more modern after-treatment is the attempt at employment of a natural process by the utilisation of the most effective primary repair material which Nature affords.

The success thus far attained adequately justifies still further investigation, both as to the class of cases in which it is most applicable and the proper systemic preparation of the patient, while its entire safety and increased advantage when understand-

ingly used, with the proper surgical preliminaries, has been sufficiently demonstrated to warrant its taking its place as a rational surgical procedure.

CONCLUSIONS.

From the observations thus far made and still in progress it would seem that the following conclusions may be justifiably drawn.

(1) Of the larger bone-cavities susceptible to pyogenic invasion, both through the medium of the circulation and aerially, the mastoid cavity is the most readily accessible to surgical interference for the removal of its diseased contents.

(2) That the thorough removal of diseased tissue, to the inclusion of inflamed or necrosed portions of the inner mastoid cortex itself, down to the surrounding healthy soft tissue, supplemented by personal care in the after-dressings, is requisite to the best results obtainable in the reparative process, of which the surgical interference is the inceptor.

(3) That the mastoid cavity thus thoroughly cleansed, and safeguarded from without is subject to reinfection mainly through one channel, that leading from the middle ear, which cavity should itself be thoroughly cleansed and independently drained through the external auditory canal.

(4) That the blood-clot is not an inert filling material merely, but has in its serum a protective defence, viable for at least forty-eight hours after the formation of the clot, and in its clot a repair material capable of producing dense fibrous bands traversing the unified mastoid space.

(5) That the use of the blood-clot, completely filling a carefully exenterated mastoid cavity, results, when it persists in healing by first intention, in a varying percentage of cases.

(6) That the persistence of the blood-clot during the period of its protective viability only, even though it then breaks down and comes away entirely, results in the formation of foundation granulomata, which are a basis for subsequent repair, with speedier and more satisfactory results in healing than are obtainable when the wound is dry packed from the beginning.

(7) That the safety of this procedure is assured by the limitation of the protective viability of the clot itself, that it breaks down under a volume of pyogenic material which it is in itself insufficient to conquer, and provides exit along the line of least resistance through the surgically-created channel.

(8) That the only cases to which the blood-clot dressing are inapplicable are those in which, on account of pyogenic invasion of surrounding structures, it is desirable to keep the mastoid cavity open as a path of access, and those in which the systemic condition of the patient, or the extent of the local infection, do not warrant the expectation of speedy repair.

And, finally, it may be said that the betterment in the repair of the mastoid wound here cited is not the result of any special skill or new discovery, but is the outcome of the careful consideration and application of already accepted general surgical rules.

REFERENCE.

¹ M. Schede, "Ueber die Heilung von Wunden unter den feuchten Blutschorf, *Verhandlungen der Deutsche Gesellschaft für Chirurgie*, 1886.

DISCUSSION.

Dr. GEORGE A. LELAND (Boston, Massachusetts) said he well remembered the first case he tried after this blood-clot dressing had been suggested to him by the reader of the paper. The clot broke down in a few days, and it took many days to remove its decomposing and very odorous remains from the wound by peroxide of hydrogen and corrosive sublimate irrigation. After this very unsatisfactory experience he discarded the method for several years, but hearing more about it, and thinking that perhaps success was, as suggested by Dr. Blake, the criterion of a clean surgeon, it was again taken up four or five years ago, and had been used in selected cases more or less since. Some of the cases had broken down, and indeed infection would always be possible through the Eustachian tube and middle ear until some method was learned by which the tympanic attic could be shut off from the excavated mastoid. His cases had all been acute ones, or chronic ones in which it had been possible to leave only a very clean bony shell even if a clean dura were occasionally exposed. He had been able to find clear notes of only eighteen cases, of which eight were successful, all healing within five to seven days by first intention, and leaving almost no scar or depression, the middle ear having dried up, and the tympanic membrane being intact, and the hearing nearly or quite normal. Of those which broke down several did so within three to six days—one in a case of measles—the centre of the clot dissolving away, but leaving much of the mass in contact with the bone, which undoubtedly hastened healing by providing nourishment for the new granulations. One produced severe local cellulitis with marked febrile disturbance, which, however, rapidly subsided after partial reopening of the wound and hot corrosive irrigations. Another broke down after thirty days, but healed rapidly under the care of another surgeon. These cases had been alluded to elsewhere. Doubtless this was a good procedure in selected cases, but in his opinion it should not be used in the infectious exanthemata, in cases of cholesteatoma, and when the patient was too ill to have good resistance or reparative power. He had not dared to try it in cases of tympano-mastoid exenteration, preferring to carefully graft so as to have a better chance of preserving the hearing as much as possible.

Dr. W. SOHIER BRYANT had used Dr. Blake's physiological method of wound repair in all his operations on the mastoid, with two exceptions, during the past three years. These were cases in which it was not advisable to remove all the necrotic tissue. The results in the whole series of cases had been more than gratifying, both as to the rapidity of convalescence and the large amount of residual hearing.

The PRESIDENT congratulated the Section on the valuable paper given by Dr. Clarence Blake, whom he welcomed as their *doyen*. He asked Dr. Blake whether he applied the blood-clot method to the radical operation, and, if so, whether it prevented stenoses.

NASAL SARCOMA.

Dr. J. PRICE-BROWN (Toronto) showed a case of nasal sarcoma, with pathological specimens removed three years ago. He said: The patient is a man aged twenty-five whose history has already been reported in the journals. He has been quite well for a long time, and although there was a slight recurrence for a while in one spot—at the junction of the left posterior naris with the post-pharynx, successive electro-cautery burnings of the little affected area had finally removed the disease. It is several months now since the last cauterisation, and there is no appearance of the return of the disease. For the last two years the patient has followed uninterruptedly his regular occupation of electrician.

CIRCULATION IN THE LABYRINTH OF THE EAR.

Dr. GEORGE E. SHAMBAUGH (Chicago) exhibited preparations showing the circulation in the labyrinth of the ear. These preparations were celluloid in casts that had been made of the cavities of the labyrinth from material in which the blood-vessels had been previously injected. The casts had been cleaned in creosote, and then mounted in Canada balsam in glass cells. The specimens exhibited were complete casts of the whole labyrinth, and all of the vessels could be readily traced from the point where the labyrinthine artery entered the labyrinth until the veins united and left the labyrinth along the canaliculus cochleæ.