the case. The history given was that the right ear had commenced to discharge when he was 4 months old and had discharged ever since. Upon admission, the right external meatus was full of foetid pus, and bare bone was readily felt by means of the probe. A fortnight before admission the child had fallen and injured the right hand, which now presented the typical appearance of tuberculous infiltration of the second metacarpal bone. For many months also he had had an enlarged testicle, which during his stay in hospital suppurated.

Family History.—Father and mother alive and healthy. One other child, also healthy. No family history of tubercle.

The right mastoid process was opened under chloroform, and a large quantity of purulent *débris* and necrotic tissue scraped out. A scraping was taken and used for an inoculation experiment. Five weeks afterwards the guinea-pig was killed, and scrapings taken from the diseased glands and stained for bacilli showed their existence in considerable numbers.

VI.—B. A., male, aged 11 years, had suffered from left-sided, purulent, middle-ear disease for many years. When admitted into hospital he was found to have a large subperiosteal mastoid abscess upon the left side, a meatus blocked with granulation tissue, and an extremely offensive discharge from the ear. For some days before admission he had suffered from severe pain in the head, and had had several rigors. Under chloroform the subperiosteal abscess was opened, and a fistula found in the mastoid cortex. After enlarging this a large cavity was found filled with cholesteatomatous and purulent *débris*. When this had all been scraped out the dura mater was found exposed for an area of about the size of a shilling. The surface was dark coloured and sloughy. The cavity was well washed with weak bichloride solution and packed with iodoform gauze. The patient made an uninterrupted recovery. Scrapings taken from the mastoid and placed under the skin in a guinea-pig's left hind limb about the level of the knee-joint produced a localised area of suppuration, and a small abscess formed but quickly healed. Each week the animal was carefully examined, but no enlarged glands could be detected. Six weeks after the inoculation experiment the animal was killed. The organs were found quite healthy. There were no enlarged glands and no evidences of tuberculous deposit anywhere.

VII.—H. C., male, aged 7 months, was brought to hospital with the following history. When 3 months old the left ear began to discharge. Very shortly afterwards the glands below the auricular attachment were found enlarged and painful, and about this time (a month after the commencement of the trouble) complete left-sided facial paralysis developed. Upon examination the meatus was found quite blocked with unhealthy-looking granulation tissue, and extensive cario-necrosis was easily demonstrated to be present. There was no external evidence of mastoid disease.

The family history showed nothing of importance. The child was an only child. The mother came of a healthy family; the father also was healthy, but was addicted to drink. A mastoid operation was performed just as in the previously detailed cases, and considerable quantities of softened bone and caseous *débris* were removed. A scraping of bone taken from the advancing edge of the disease was removed and used for inoculation purposes. Six weeks afterwards the guinea-pig was killed, and found to present the appearances of advanced tuberculosis. The glands were enlarged, and on section were cheesy. The spleen was packed with tubercles; many were also found in the liver, and a few in the lungs and kidneys. Scrapings from the glands stained for bacilli revealed their presence in considerable numbers.

VIII.—G. C. T., male, aged $2\frac{1}{2}$ years, was seen in consultation with Mr. Malim, of Rochdale, on account of the presence of a purulent discharge from the right middle ear, which had persisted for six months. The left ear had also been discharging, but at the time of the consultation was found perfectly dry and the membrane cicatricial. Examination of the right ear showed that Shrapnell's membrane was perforated, and that a small tuft of granulation tissue protruded through the opening. The probe demonstrated the presence of bare bone upon the posterior meatal wall and upon the roof of the middle ear. For a few weeks local treatment was tried. The tuft of granulation tissue was removed, and various astringent and antiseptic lotions were used. No real progress was however made, and as the tissues over the mastoid process became suddenly red and puffy an immediate operation was advised. The patient was put under chloroform, and the usual incision made. Upon opening the process much purulent *débris* and granulation tissue was found. This was all carefully scraped out and the cavity packed with iodoform gauze. At first the patient made good progress, but shortly afterwards the wound became very sluggish and refused to heal. The cavity was accordingly again scraped, and this time finally healed. When last seen a depressed mastoid cicatrix marked the site of the previous operation wound; the middle ear was quite dry, and the membrana tympani showed the existence of a large and dry perforation. No sooner had the right ear healed, however, than suppuration started again in the left middle ear, and was almost immediately followed by the formation of a subperiosteal mastoid abscess. When this was opened a minute fistula was found leading into the interior of the bone. The fistula was at once enlarged, and the operation conducted as in the previously detailed cases.

Inoculation made from scrapings taken from the left mastoid process was followed by the typical development of well-marked tuberculosis.

IX.—J. C., male, aged 5 months, was admitted into hospital on account of suppuration from both middle ears. The history given was that the child had from birth been very fragile, and at one time appeared to be rapidly emaciating. When 2 months old both ears commenced discharging simultaneously, and had discharged constantly until the time of admission to hospital. Upon examination the child was found to be pale and emaciated. Both ears were discharging freely. Upon the right side a subperiosteal mastoid abscess was found, and upon the left the tissues over the mastoid process appeared quite normal. The glands below both ears were found enlarged.

The family history was negative. Father alive; healthy; addicted to drink. Mother alive and healthy. No other children. Grandfather died of consumption.

Under chloroform the fistula leading into the right mastoid process was enlarged and purulent *débris* and caseous material scraped out. A

week later the left mastoid process was operated upon. The surface of the bone was dark coloured and sloughy in appearance. The bone itself was very soft and friable, and when opened the process was found to contain cheesy *débris*. Inoculation made from both mastoids produced typical tuberculosis in two guinea-pigs.

The child never appeared to make any progress after the operation. Severe diarrhoea set in, which no treatment appeared in any way to influence. Symptoms indicative of tuberculous meningitis set in suddenly, and the child died thirteen days after the operation had been performed. No *post-mortem* examination could be obtained.

X.—S. R., female, aged 19 years, had suffered from left-sided purulent middle-ear disease for many years. Examination showed that the left membrana tympani was almost completely destroyed, and bare bone was felt with the probe upon the posterior and superior walls of the middle ear. As ordinary methods of local treatment had been tried without avail, it was decided to perform a mastoid operation according to Stacke's method. This was accordingly done, and a scraping of bone was removed and used for inoculation purposes. The guinea-pig showed no signs of developing tuberculosis, and when killed six weeks afterwards, no enlarged glands and no deposits of tubercle in the liver or spleen could be detected. A slight inflammatory thickening round the site of the inoculation was found.

In the treatment of these tuberculous lesions where considerable destruction of bone has taken place, it is advisable to open the mastoid process at as early a date as possible, to scrape away all softened and caseous *débris*, to make free communication with the cavity of the middle ear and external auditory meatus, and to keep the parts well packed so that the process of granulation may proceed *ab imo*. Free dusting with iodoform powder has seemed to be beneficial. At times, when the granulating surfaces have shown a tendency to become sluggish, swabbing with chloride of zinc (gr. xv to 3j) has materially expedited matters. Great attention must also be paid to the state of the general health of the patient. Tonics such as *syr. ferr. iodidi*, *syr. iodidi*, cod-liver oil, etc., should be freely administered, while at the same time plenty of good milk and farinaceous food should be given. When circumstances admit, residence at the seaside or in good bracing country air should be ordered.

THE TREATMENT OF INTRACTABLE SUPPURATION OF THE MIDDLE EAR BY OPERATION THROUGH THE MASTOID,

BASED UPON EIGHT SUCCESSFUL CASES.¹

By THOMAS BARR, M.D.,

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THE present paper is based upon eight cases of chronic purulent inflammation of the middle ear, which, after the employment of all the ordinary methods of treatment through the external auditory canal and Eustachian tube, continued for months, and even years, were successfully operated upon through the mastoid. Four of these cases were operated on by Dr. Macewen and four by myself. Two were in the right ear and six in the left. Instead of describing these cases in all their clinical details, I prefer simply to place before you the salient points from which you may be able to judge of their significance:

1. In these eight cases the purulent mischief had been of very long duration. The duration of the shortest was three years, the others extended from fourteen to twenty-two years.

2. In every one, treatment through the external meatus and Eustachian tube had been previously carried out, in no case for less than a year, and in some for as long as seven years.

3. In none of the cases did the secretion before operation ever lose the odour of decomposition.

4. In every case the seat of the purulent formation was without doubt chiefly in the attic or attic and antrum, either with perforation in Shrapnell's membrane, or other clear evidence that the essential mischief was in these regions.

5. In no case were there any objective signs of mastoid complication.

6. In all the attic syringe had been employed, and in three cases the malleus had been removed in order to allow of more efficient treatment of the attic.

¹ Read in the Section of Otology at the Annual Meeting of the British Medical Association, held in London, July-August, 1895.

7. In regard to age and sex, the youngest was 14 years and the oldest 32 years; six were males and two females.

METHOD OF OPERATING.

The operation in each case was performed with the globular dental burr, supplemented by a gouge, as first suggested by Dr. Macewen. In regard to this method of operation, it is very important to employ burrs which are very hard and sharp, and those made at Philadelphia were found to be much the best. A dental engine of considerable power, either worked with the hand or foot, is required. The hand piece is held like a pen, and the lateral part of the burr is applied to the bone, which, as the burr rapidly rotates, is raised in flakes. To prevent excessive heat developing, as well as to allow of inspection of the parts, the burr should be momentarily removed every few seconds. It is possible with the instrument to avoid wounding any structure in however close proximity it may be. As Dr. Macewen observes, dark apertures, or a membrane such as a pyogenic membrane, or the sigmoid sinus or dura mater, are readily seen on the white polished surface made with the burr. By this mode of operating, even although there may be an abnormality in the relative positions of the interior of the cranium to the outer parts, the dura mater or lateral sinus need not be injured, although exposed. In one of these cases I encountered the sigmoid sinus, but this did not stop or interfere with the progress of the operation. In another the dura mater on the floor of the middle fossa was exposed without the least untoward result. In most cases the cortical substance was found to be very thick and hard, the cells being partially sclerosed, and converted into an ivory-like substance, the penetration of which was very difficult, and occupied considerable time. In some cases the operation was expedited by the use of a sharp gouge, if the bone were not too hard. The antrum was sometimes found surprisingly high up, even above the level of the linea temporalis, and deeply situated. In one case it was extremely small. The walls of the antrum were generally very hard, so that the strongest gouge produced little impression upon them, although the burr could always rub them down. When the antrum was freely opened, and all the morbid material removed or scooped out, the antro-tympanic passage under the roof of the middle ear was exposed by the cautious working of a small burr, so as to enable us to clear out from this space with small scoops and forceps not only the inflammatory products found therein, but also the malleus and incus, if these were found. When the tympanic cavity was situated far forward, it was not an easy matter to reach and explore it; it was then necessary to remove the postero-superior wall of the canal, or at least a portion of it (modified Stacke's operation). While working in this deep region, a reflector on the forehead was essential, with good artificial or natural light. The corresponding side of the face was carefully watched, so as to detect the slightest twitch which might indicate dangerous proximity to the facial nerve; but by keeping well up and avoiding the inner wall of the antro-tympanic passage, this nerve was in no case in the least degree injured.

AFTER-TREATMENT.

After the thorough removal, by means of syringing with antiseptics, of all disease products as well as the pulverised bone, the dry treatment was in the first place adopted. The spaces were filled with powder of iodoform and boracic acid (one of the former to four of the latter) and stuffed with gauze. A wood-wool pad, with an aperture for the auricle was placed over mastoid and side of head, and a bandage over all. In the absence of moisture through the dressings the parts remained undisturbed for a week, and sometimes for a fortnight, when, if moisture appeared, the powder and stuffing were removed, with or without syringing the cavities. Dr. Macewen preferred the dry treatment, but I found that unless the secreting process ceased entirely and early, the continuance of the dry treatment with infrequent dressing was not satisfactory. No doubt, if it were always possible to remove every trace of disease the dry treatment would be the ideal one, but with the conditions existing in the temporal bone in such cases this is not always possible. I have found, therefore, after the first two or three dressings that careful and regular antiseptic cleansing has been required for weeks and even months. A watery solution of carbolic acid or boracic acid was injected

once or twice a day through the opening in the mastoid into the external auditory canal, and *vice versa*. A spirituous solution of carbolic acid or boracic acid poured in or injected after the syringing appeared to be sometimes beneficial. In some, after the use of this for a time, one insufflation of finely-powdered boracic acid blown into the canal and into the artificial opening seemed to bring the secreting process to an end. I had in some cases to discontinue iodoform owing to its producing severe eczematous inflammation in the neighbourhood of the wounds. The cavities were always stuffed with gauze and in the mastoid opening granulation tissue had in my cases to be scraped away with the sharp spoon or touched with chromic acid.

RESULTS.

Of these eight cases, the first was operated upon on June 19th, 1893, the last on December 17th, 1894. In six cases the operation achieved ultimately the desired effect of bringing the discharge to an end, and in no case has there been up till now any recurrence of the discharge. In the other two there is scarcely a trace of secretion, only requiring syringing once a fortnight. The longest period which has elapsed since the establishment of the non-secreting condition has been fifteen months, and the shortest three months. From the operation to the entire cessation of discharge the time varied in the different cases from two months to eighteen months. In three cases very little discharge appeared at any time after the operation, and certainly within three months there was no indication whatever of a purulent process. In one case the dry condition was brought about six months after the operation, and in two cases the secretion had not entirely ceased until eighteen months had elapsed. Of the two still showing a very faint trace of odourless secretion, six months have elapsed since the operation in one and a year in the other. I think that, with larger experience of this operation, the time between the operation and the cure of the discharge will become much shorter. In one case two operations were performed: the first on February 26th, 1894, and the second in October, 1894. In the first the antrum was opened and a portion of the inner end of the canal was removed, while in the second operation the whole of the postero-superior wall of the canal was taken away with the outer walls of the antrum and attic ("Kuster's operation").

With respect to the artificial opening, it was found in certain cases difficult to maintain it for a sufficient length of time, owing to its tendency to contract in spite of thorough stuffing with gauze. I found, however, that while premature closure should be avoided, it was on the other hand not desirable in all cases to insist upon the maintenance of the opening till the discharge ceased. In 2 cases I found that only after the healing of the mastoid wound did the secreting process in the ear entirely cease. In other cases the opening readily remained as a tunnel-shaped passage leading into the antrum and attic becoming partially lined with epidermis, and non-secreting. In 4 cases out of the 8 the opening still remains. In one the canal leading to the attic still exists, a year and a-half after the operation. It is quite dry, partly lined with epidermis, and is kept occupied with gauze. In other 2 the opening behind has not yet, six and eight months respectively after the operation, been allowed to close, although quite superficial and perfectly dry. In the fourth, in which the whole postero-superior wall of the canal and the outer wall of the antrum and attic were removed, the external opening corresponds with the bony meatus, and leads into a cavity which has considerably contracted; it is perfectly dry and occupied by gauze.

In regard to the fate of the ossicles, the malleus was removed in 3 cases previous to the operation, and in 2 of these the incus was found between the attic and antrum, and removed. In 3 others the incus was removed at the operation, diminished in size by caries. In 1 case neither ossicle was found.

With regard to the effect on the hearing power. In 1 case the hearing was notably improved; in 3 cases it was slightly improved; in 2 it was unaltered; in 2 the deafness was increased after the operation.

In concluding, I would emphasise the fact that these 8 cases were not selected from a large series of cases because

of their success. They include without exception all the patients under my care who have been operated upon in this way since June 23rd, 1893. The results must be regarded as very encouraging, as in every instance the goal aimed at was attained—namely, the removal of a purulent process in the middle ear and temporal bone, which had for years baffled all other methods of treatment carried out personally by well-known specialists.

Dr. MILLIGAN (Manchester) agreed with Dr. Barr as to the advantage of the burr in the mastoid operation. In the treatment of those cases which depend upon suppurative disease of the tympanic attic he thought that the line of procedure to be adopted should depend upon the exact etiological factors which produce the suppuration. He had found distinct advantage in retaining a permanent mastoid fistula, not only on account of the ease with which the parts might be inspected, but also because he had found in several cases an improvement in the hearing.

A DISCUSSION ON CEREBRAL COMPLICATIONS IN RELATION TO MIDDLE-EAR DISEASE.¹

INTRODUCED BY WILLIAM MACEWEN, M.D., F.R.S.,
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IN A Section of the British Medical Association so largely consisting of specialists, it is with diffidence that a surgeon, not only addresses them, but ventures to open a discussion. The cordial invitation, however, of the Council of the Otolological Section, so courteously conveyed by your President, Sir William Dalby, caused me to dismiss the hesitancy, and I accede with pleasure to their request to open a discussion on cerebral complications arising from ear disease.

It is evident that the time at our disposal is insufficient to enable us to review even the pathology of the various forms of intracranial complications arising from middle-ear disease. It is necessary, therefore, to select a few points for discussion, without wishing to restrict others who may deem it advisable to introduce subjects which they consider of equal importance.

An opportunity has been afforded me so recently of expressing my views on abscess of the brain, meningitis, and sigmoid sinus thrombosis—the three main forms of pyogenic intracranial invasion arising from otitis media purulenta, that the Section will kindly take as read the observations which I might otherwise have found necessary to have placed before them to-day upon these subjects.

I will therefore direct your attention to three points. First, to a fallacy in differential localising diagnosis; secondly, to tubercle of the middle ear; and, thirdly, to a few points on bacteriology in aural surgery, especially regarding prophylaxis.

A FALLACY IN DIFFERENTIAL LOCALISING DIAGNOSIS.

When in a case of intracranial abscess a difficulty exists in localising the lesion to the cerebrum or cerebellum, it has been averred that the point can easily be decided by testing the function of the nerves to transmission of sound by bone conduction. It is alleged that if bone conduction be still intact the abscess is in the cerebrum, but if bone conduction be absent then the abscess is cerebellar. This statement is evidently based upon *a priori* reasoning, and it is founded upon at least two fallacies.

First, it is assumed that the path by which pyogenic organisms reach the cerebellum and there produce abscess is by way of the internal ear; and, secondly, it takes for granted that a pyogenic infective process spreading along the auditory nerve and its coverings would abolish the possibility of bone conduction. Facts are, however, decidedly against this hypothesis, and do not bear out the assumptions upon which it is founded. First, cerebellar abscess arises, as a rule, from pyogenic extension from the sigmoid sinus, and not by way of the internal ear, so that the seventh and eighth nerves in the internal ear remain unaffected and capable of performing

their function, and if the mechanism of hearing remains intact the auditory will transmit sounds aerial as well as by bone conduction, notwithstanding the presence of cerebellar abscess.

Secondly, even when the internal ear is the path by which pyogenic intracranial invasion takes place, bone conduction may remain intact. A case illustrating this occurred recently, and came under my care, suffering from purulent leptomeningitis, originating in otitis media purulenta. The patient, whose aerial conduction on the affected side was almost absent, yet retained the function of bone conduction, which seemed almost more acute on the affected ear than on its fellow on the opposite side. At the *post-mortem* examination there was extensive purulent lepto-meningitis, chiefly marked in the posterior fossa surrounding the right internal auditory meatus. A marked contrast was presented between the appearances of the seventh and eighth nerves on the right side (the affected side) and the corresponding nerves on the left; while the latter occupied about one-half of the lumen of the internal auditory meatus; the nerves and their pial coverings on the right side were so swollen that they occupied the whole canal, and were even compressed by the enclosing bone, as the portions of the united nerves, previous to entering into the canal, were more swollen than those inside of the canal. A semi-purulent exudation lined the pial sheaths throughout the course of the internal auditory canal, and was seen to pass outward to the cribriform plate on the one hand and into the internal orifice of the aqueductus Fallopii on the other. The pial sheaths of the lesser petrosal nerves were likewise inflamed, though to a less extent. Yet, while this patient lived she still retained the perception of bone conduction equally on both sides. A still further fact against this theory appeared in a case previously published by me,² in which "the hearing was absolutely abolished by aerial and bone conduction, yet there was no abscess in the cerebellum, and there was a superficial one in the cerebrum." Probably in the latter case the abolition of the function of the auditory nerve might have been due to previous chronic processes.

It may therefore be concluded that neither in its presence nor in its absence is bone conduction a reliable sign of localisation between cerebral and cerebellar abscess.

Tubercle of the middle ear in its relation to intracranial lesions has not yet received the attention which it deserves. It is one of the less obtrusive forms of middle-ear disease, spreading slowly, occasioning little pain or uneasiness, and being often accompanied by very slight mucoid discharge. In some cases, also, the disease reaches an advanced stage without occasioning perforation of the membrana tympani, yet its extension to the membranes, especially in children, whose sutures are still open, is always liable to occur. Two such cases have been under my observation. Both died from tuberculous meningitis, and *post-mortem* examination showed that the invasion of the inner membranes was clearly traceable to the tuberculous focus in the middle ear. The invasion was by direct extension through the ununited petro-squamosal suture to the membranes of the middle fossa of the skull. When the inner ear is involved, no doubt the tuberculous invasion proceeds by the pial coverings of the seventh and eighth nerves in the internal auditory canal. The grosser forms of tuberculous otitis media are familiar to every aurist, but they are not so apt to be followed by intracranial tuberculous complications, as in the advanced stages of tuberculous destruction of the middle ear, pyogenic processes are apt to be superimposed, and when this does occur the latter assumes the rôle (to borrow a current phrase) of the "dominant partner." Here, as elsewhere in the body, tuberculous products form excellent cultivation media for pyogenic cocci, which, when they are implanted on them, become vigorous, proliferate rapidly, and disseminate themselves into all the osseous erosions and softened membranes which the tubercle bacilli have been so insidiously and slowly accomplishing. If a breach, however small, can be found in the protective wall of granulation tissue surrounding the softened cerebral membranes, the pyogenic organisms will invade the intracranial cavity. It reminds one of the words which Shakespeare puts into the mouth of Richard II:

¹ In the Section of Otology at the Annual Meeting of the British Medical Association, held in London, July-August, 1895.

² *Pyogenic Diseases of the Brain and Spinal Cord*, p. 285.