

On certain anatomical relations between abscess of brain and aural disease / by James A. Adams.

Contributors

Adams, James A.
University of Glasgow. Library

Publication/Creation

[Glasgow?] : [publisher not identified], [between 1800 and 1899?]

Persistent URL

<https://wellcomecollection.org/works/sg9688gj>

Provider

University of Glasgow

License and attribution

This material has been provided by This material has been provided by The University of Glasgow Library. The original may be consulted at The University of Glasgow Library. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

75

ON CERTAIN ANATOMICAL RELATIONS BETWEEN ABSCESS OF BRAIN AND AURAL DISEASE.

By JAMES A. ADAMS, M.D., F.F.P.S.G.,
Demonstrator of Anatomy in the University of Glasgow.

c

THERE is no part of the human body which, in proportion to its size and its relation to other parts, presents so many important points for the consideration of the medical man as the organ of hearing. Nor is there another department of medical science which promises larger returns for the labours of the pathological and scientific surgeon. And yet, until a comparatively recent time there was scarcely another branch of surgery in the profitable cultivation of which there was so little of real progress. The late Professor Syme, I am told, when lecturing on diseases of the ear, used to divide them into two classes—the “incurable,” which he said were treated by the aurists, and the “curable,” which were treated by the surgeon. And this was said at a time, forty years ago, when beyond the extraction from the external meatus of a polypus, or an accidentally imbedded pea, or of some hardened wax, or the puncture of the membrana tympani, or the catheterisation of the Eustachian tube, there was little that the surgeon could advance as a creditable set off against the pretentious placebos of drops, lotions, ear trumpets, and other paraphernalia of the aurist of that day.

But of late, and especially at the present time, so great is the diligence shown by painstaking and able observers, that the general practitioner regards with no feeling of jealousy or desire of depreciation, the more equal platform from which his co-labourer, the specialist aural surgeon, now deals with a class of ailments that affect so largely the health, comforts, and material interests of the community.

It is in this spirit of sympathetic association that I now submit some observations relative to abscess of the brain,

associated with disease of the ear, the pathology of which has not, in my opinion, been as yet sufficiently recognised.

It was long a popular belief that "a running from the ear" was rather a healthy affection than otherwise, and even in the ranks of the profession there may still be found individuals who, although not prepared to contend that otorrhœa is actually beneficial, nevertheless do not regard it as worthy of, or necessarily requiring earnest treatment. But it is substantially a disease, or rather the indication of disease. For the structure and functions of the middle and internal ear are always seriously affected when purulent discharges are of long continuance. Such discharges are, therefore, no longer to be regarded as at the worst simply an unpleasant secretion, a mere troublesome affection having no other result. They are properly to be considered as symptomatic of one, or it may be, of several conditions, and the purulent matter itself is further to be looked upon as certainly provocative of a great extension of the original lesion if neglected. "As long as discharge from the ear is present," says Wilde, "we can never know how, when, or where it may terminate, or to what it may lead."

The greater number of diseases of the ear, and nearly all which are characterised by suppurative discharge, involve the walls of the tympanic cavity. Kramer states that 56 per cent of all aural diseases are situated in the middle ear. And when it is borne in mind that there are only barriers of thin bone between the middle ear, the internal carotid artery, the internal jugular vein, the lateral sinus, the internal ear, &c., and that these barriers are sometimes deficient or imperfect, it is matter of surprise that the extension of diseased action from the ear to the brain is not of still more frequent occurrence than has yet been shown. But although the conservative processes that defend the delicate brain tissues from invasion are powerful, there is accumulating evidence of diseased condition of brain, originating more frequently than is commonly supposed from disease of the ear. And of these, abscess of the brain, the result of neglected discharges from the ear, is very frequent.

So far, therefore, the practical importance of "a running" from the ear is evident. But the *rationale* of the pathological processes involved is, in certain conditions, somewhat obscure.

Dr. Barr, Lecturer on Aural Surgery in Anderson's College, of whose special ability I have on several occasions had

personal knowledge, read a communication to the Glasgow Medico-Chirurgical Society, in April 1880, in which he said—“There may be readily developed out of the diseased condition of the ear morbid changes in the walls of the vessels, which, by passing along to the dura mater, may set up inflammation of that membrane, or to the sinuses, may excite phlebitis, with the attendant danger of the formation of thrombi and purulent deposition in other organs. . . . After the dura mater is involved, the inflammatory condition probably passes to the brain *by contiguity of tissue*, as there is no direct vascular or lymphatic connection between the dura mater and the substance of the brain. How is the great fetor of the pus in the brain to be accounted for? How do the bacteria get admission to the purulent matter when there is no actual opening in the dura mater or bone, and *no direct vascular connection*? These are questions regarding which I would gladly hear the views of any member of the Society, and especially of Dr. Coats or Dr. Foulis; also, how the *extension from the middle ear of the suppurative process takes place when a portion of healthy brain tissue intervenes between the dura mater and the abscess?*”

From frequent observations in the Anatomical Rooms, I had hitherto held the belief that in certain conditions there was a direct vascular connection between the venous blood from the ear and the substance of the brain, but as Dr. Barr's statement passed unchallenged by the well informed gentlemen who were present, I shrank from expressing at the moment the contrary conviction I held. Subsequent reflection and further special investigation have, however, satisfied me that there is a fair solution of the problem.

That my argument may be clearly followed, I propose to show—1. That aural diseases are more frequent in the early than in the later stages of life, and that suppurative discharges from the ear follow the same law. 2. That, contrary to what might be expected, and to what is currently believed, abscess or suppuration in the brain, whether encysted or diffuse, is much more frequent in advanced life than in early age. 3. That there are anatomical peculiarities of structure in the organ of hearing which differ in the infant and in the adult, which explain the greater frequency of abscess of the brain in adult life as originating from disease of the ear. 4. That under certain conditions there is an abnormal state of the cerebral circulation which admits of a direct vascular connection between the ear and the brain.

Dr. Kramer,* in an elaborate analysis of 2,000 cases of aural disease, states that 504 occurred in the first ten years of life, or about 25 per cent of the whole number. And Dr. Wilde† gives a very comprehensive statistical table of 2,385 cases of diseases of the ear of every kind registered at St. Mark's Hospital, Dublin, of which 411, or nearly 18 per cent, were under ten years of age.

Substantially, therefore, the experience of both these eminent aurists is in accord as to the large proportion of cases which occur in early life. And what is true of aural disease in general is still more markedly evident in those that are characterised by suppurative discharges uncomplicated with caries, or growths or injuries.

Of the 2,385 cases registered by Dr. Wilde of diseases of the ear of every kind, there were 528, or 22 per cent, described as otorrhœa pure and simple, and of these, above 41 per cent occurred under ten years of age. Between the ages of eleven and twenty there occurred above 31 per cent, thus making 72 per cent of cases of otorrhœa under twenty years of age out of the entire number of cases of that disease at all ages.

Although cases of inflammation of the external auditory canal—not including eczema—are sufficiently frequent, yet actual suppuration of that region is a rare disease. When chronic suppurative discharge issues from the ear, it will, as a rule, be found to have its origin behind, and not in front of the membrana tympani. Dr. Roosa,‡ when showing the comparative infrequency of suppurative affections of the outer ear as contrasted with those of the middle ear, notes, that of 2,271 cases of inflammation with suppuration of the external and middle ear, observed in certain specified hospitals in New York, there were 1,769 cases wherein the suppuration proceeded exclusively from the middle ear. And, in a more exact reference to cases occurring in private practice, he states that of 1,000 cases of the different varieties of aural disease observed by himself, only 132 were cases of affections of the outer ear. There can, therefore, be no question of the great prevalence of otorrhœa at all periods of life, but particularly so in early life.

But my second proposition, that abscess or suppuration in the brain is comparatively rare at the early ages, is not in

* *Resumé in B. & F. M. Rev.*, 1847.

† *Aural Surgery*, 1853. P. 102.

‡ *Pract. Treatise on Dis. of Ear*. P. 365. New York, 1873.

accord with current opinion. So far as I can gather from my contemporaries, and from general medical literature, this statement is much opposed to the common belief. And, in consideration of the greater frequency of suppurative discharges from the ear in early life, the fact is, on first sight, remarkable and unexpected; and yet the evidence is very clear.

Lebert* has carefully analysed the histories of 80 cases of abscess of brain from all causes, one-fourth of which were the outcome of caries of the petrous portion of the temporal bone. And though his investigations show that abscess of the brain may occur at all ages, he has noted, as a general result, that the most frequent period is between the sixteenth and thirtieth year. But this general fact, although of great significance, is not sufficiently definite to establish my proposition. I have, accordingly, constructed a table of 105 cases, consisting of a digest of 76 cases compiled by Drs. Gull and Sutton, and published in Reynolds' *System of Medicine*, vol. ii, p. 581, and of 29 cases additional given on the authority of twenty-five observers, and collected by myself from scattered publications in general medical literature, chiefly within the last ten or twelve years. I have classified these cases under four divisions, with as much carefulness as the published details admit; and I consider that the table is fairly representative, not only of the relative frequency of abscess of the brain from all causes within the periods of life specified, but that it is also fairly illustrative of the special causes which originate suppurative deposits within the brain.

| CAUSES OF ABSCESS OF BRAIN. | TOTAL. | AGES. | | | |
|---|--------|-----------|-----------|-----------|-------------|
| | | Under 10. | 11 to 20. | Above 20. | Not Stated. |
| Disease of Ear with Caries of Bones, | 24 | 2 | 8 | 14 | ... |
| Suppuration from Ear. Caries, if present, not stated, | 20 | 2 | 6 | 11 | 1 |
| Injuries of Head, | 20 | 1 | 6 | 11 | 2 |
| Disease in other parts of Body, | 41 | ... | 4 | 31 | 6 |
| | 105 | 5 | 24 | 67 | 9 |

* *Virchow's Archiv*, Band x, p. 391.

This table shows that there must be conservative conditions protecting the brain in early life. Less than 5 per cent of the cases occurred in childhood, and above 72 per cent occurred in adult life. This non-liability to abscess of brain, from whatever cause, is still more evident in the following table, consisting of cases wherein the suppurative deposits either originated exclusively from, or were directly associated with, disease of the ear. This table is constructed of the 44 cases comprised in the preceding table, together with 30 cases collected from various sources by Dr. Roosa, and of 6 cases recorded by Toynbee, and are irrespective of those included in Dr. Gull's synoptic list, part of which is taken from Dr. Toynbee's classical treatise.

| CAUSES OF ABSCESS OF BRAIN. | TOTAL. | AGES. | | | |
|--|--------|-----------|-----------|-----------|-------------|
| | | Under 10. | 11 to 20. | Above 20. | Not Stated. |
| Caries or Necrosis of Temporal Bone, | 46 | 6 | 13 | 26 | 1 |
| Suppuration of Ear. Caries, if observed, not stated. | 34 | 3 | 7 | 23 | 1 |
| | 80 | 9 | 20 | 49 | 2 |

Here it is seen that only 9 cases, or 11 per cent, occurred in childhood, and above 63 per cent in adult life. And if to this table there is added cases of injuries of head, the conclusion remains substantially unchanged to the effect that whatever the originating cause may be, and even where the originating causes are restricted exclusively to diseases of the ear and injuries of the head, it remains abundantly evident that abscess of brain in childhood is rare when compared with its frequency at other periods of life.

I may note here that in those cases in the preceding tables, wherein the ages are "not stated," I would feel warranted from the context of their records in assuming that they were adults; but whether so included, or entirely set aside, the estimate I have drawn is not substantially impugned.

Whatever the age, there is abundant evidence that diseases of the ear originate a large proportion of cases of abscess of the brain. The proportion has been estimated at a high figure by that very careful and competent observer, Von Tröltsch,* who says, "perhaps half of all cases of abscess of

* *Surgical Diseases of Ear*, p. 66, *Trans. of Syd. Soc.*, 1874.

the brain take their origin from suppurative inflammation of the ear." If I form a ratio from the table at p. 5, the proportion of cases of abscess of brain, associated with diseases of the ear, is seen to be 42 per cent, and if both tables, pp. 5 and 6, are thrown together, the proportion is 56 per cent, and these tables are therefore so far an evidence that the estimate given by Von Tröltsch is not far from the truth.

The question naturally arises, since children are more subject to aural discharges, and since aural disease is the most frequent originating cause of abscess of brain, why should children be so largely exempt from liability to abscess of brain? The explanation will be found, in a large measure as I believe, in considerations arising from a comparison of the structure of the organ of hearing in the child and in the adult, and of the changes the organ undergoes as it approaches full development.

In the child the mastoid process of the temporal bone is in a very rudimentary condition. It does not form a large projecting promontory as in the adult. In section it is comparatively homogeneous, and only minutely porous, resembling *in petto* the surface of a fine sponge. It contains few mastoid cells properly so called, excepting one large cell, the *antrum mastoideum*, continuous with a rudimentary tympanic cavity. In nearly its entire thickness the mastoid process of the child forms a barrier of bone extending backwards between the tympanic cavity and the groove on the inner wall of the temporal bone for the lateral sinus.

In the adult, on the contrary, the mastoid process is large, and projects considerably. It is hollowed out into numerous large cells, which are in communication, and are, indeed, an appendage of the tympanic cavity, with which they are continuous. The aperture of communication between the purely mastoid cells and the tympanum is much narrower in the adult than it is in the child. This important fact which, so far as I can ascertain, has not been hitherto noted, is very apparent on examination of a series of sections of young bones at different ages.

The cells occupy and completely transform that portion of the mastoid which intervenes between the tympanum and the osseous wall of the lateral sinus. The mastoid cells are not *entirely* formed, by invasion backwards, of cells which are in communication with the antrum. The whole mastoid process gradually becomes converted into cells which inter-communicate and ultimately lead into the antrum at its posterior wall.

There is, therefore, in the adult only a thin screen between

the large cells of the mastoid and the lateral sinus. Not unfrequently there is no osseous barrier; for I have, in several instances, found the lining membrane of the mastoid cells in direct contact with the dura mater.

In the child, the outer surface of the temporal bone, where the squamous unites with the mastoid portion, the line of junction is only partially ossified, and often so defective as to permit a readily formed opening through which, at times, is spontaneously discharged the purulent contents of the tympanum and antrum.

But in the adult this suture is completely ossified, and the outer layer of bone, instead of being weakened by the development of the mastoid cells, is on the contrary strengthened by the attachment of the powerful muscles which, by their strain, induce a stimulated nutrition and consequent thickened cortex to the bone. Near the meatus, where no muscles are attached, the bony cortex is thinner, and the mastoid cells are nearer to the surface, a fact not to be lost sight of when that useful operation of trephining into the mastoid cells or into the tympanum is desirable or necessary.

In the adult there is not unfrequently only a thin lamina of bone forming the roof of the tympanic cavity (the *tegmen tympani*); and in some instances, although rarely as I believe, it is altogether deficient. According to Toynbee and certain other aural authorities, this defective condition or complete absence of the *tegmen tympani* has been seen so frequently as to constitute fully 5 per cent of cases. But I am well satisfied that this percentage can only be derived from an examination of temporal bones in which disease has more or less existed. For, to satisfy myself on this point, I have made a very careful examination of above one hundred healthy crania, and in no one instance did there exist such deficiency. I have therefore no doubt whatever that in the majority of cases where the *tegmen tympani* is found deficient it was more or less a consequence of a previously diseased condition that has induced atrophy and absorption. The alleged greater frequency of caries of the *tegmen tympani* than of other portions of the temporal bone, if such does actually occur, must be due to other causes than actual deficiency of the bony roof.

The tympanic cavity, together with the mastoid cells, which may be considered analogous with the cells and sinuses of the organ of smell, is lined with a delicate fibro-mucous membrane, which to other uses adds that of a periosteum in nourishing the structure of the bone. The large surface presented by this membrane explains the profuseness of discharge which charac-

terises "a running ear," while the number of cavities and the complexity of the communications explains the difficulty and occasional impracticability of efficient topical treatment, especially in the adult, because of the more extensive and more complicated surface presented. And hence the advantage of early attention to cases of running ears, and hence also the increasing gravity of the prognosis as the disease becomes more and more chronic, because there is an increasing probability of diseased action having extended from the tympanum into the mastoid cells or into the sinuses, and this probability becomes all the greater in the adult because of the comparative feeble vitality of the thin laminae of bone which screen the cerebral cavity from the inner surface of the temporal bone. But this liability to the extension of diseased action in the direction of the brain cavity is not so great in the child, where a comparatively limited surface only is presented by the partially undeveloped tympanic cavity and single mastoidean cell, and where the thick barrier of bone between the tympanum and the interior of the skull is at the most active stage of growth and of reparative power. The differences which exist between the organ of hearing in the child and in the adult extend to every part of the structure, and exercise an influence that modifies all the pathological conditions that can arise. Thus, the dura mater, which in the child is closely adherent to the temporal bone, and also to the wall of the lateral sulcus, becomes in after life lax in its connection with the bone, and contributes little nutriment through such connection as exists. That nutriment in the adult is furnished substantially by the vessels of the fibro-mucous membrane that lines the mastoid cells of the interior. Therefore, when suppuration occurring in the tympanum of the adult extends into the antrum and other mastoid cells, this lining membrane, in its depraved state of nutrition, and subject to pressure by an accumulating diseased secretion, becomes incapable of supporting the healthy vitality of the thin lamina of bone that forms the walls of the mastoid cells where they abut upon the lateral sinus, or where they form the roof of the tympanic cavity. Caries or necrosis is a frequent result. But when suppuration occurs in the tympanum of the child, the diseased action is hindered from extending backwards and inwards by a barrier of thick well nourished bone; and, therefore, it is rare in the child that such suppurative action penetrates the lateral sulcus or the lateral sinus. And in a degree greater than in the adult it is also hindered from penetrating through the tympanic roof.

The tendency of the suppurative flow is nearly altogether

outwards in the child, because the purulent matter finds less hindrance and a readier vent to the external surface through the thin and frequently imperfect suture that forms the junction of the squamous with the mastoid process of the temporal bone behind and close to the meatus. Hence the greater frequency of caries of the mastoid bone behind the ear which is observed in the child. In this connection I note that, notwithstanding the frequency of caries of the mastoid process, and the important benefits that unquestionably have resulted, and may further be expected from surgical operation upon this part, the most recent text books on Surgery either omit all reference to caries of the mastoid, or make the barest allusion to it as if it were a disease of rare occurrence.

As to the mode in which disease progresses from the ear to the brain, the general opinion seems to be that the temporal bone becomes carious, and, as a consequence, the dura mater ulcerates, and the arachnoid, the pia mater, and ultimately the substance of the brain, participate in the disease as the result of direct extension from the ear, or by contiguity of tissue as conjecturally explained by Dr. Barr. And when purulent matter has actually exuded from the mastoid cells through the osseous walls of the lateral sulcus, or has penetrated upwards and laid bare the roof of the tympanic cavity, it is easy to recognise how the ulcerative action by mere contiguity of tissues should extend and form purulent deposits in the brain. But this is not the whole case. Purulent deposits in the brain are not always the result of this diseased action. For in some instances an abscess is developed in the brain without manifest ulceration of the mucous membrane of the tympanum or cells, and without caries of the bone. No doubt, abscess of the brain, associated with diseased bones of the ear, is more frequent than where no caries or necrosis of these bones has been observed. Nevertheless, so far as my data go to illustrate this point, the difference in relative frequency is not excessive. For, of the cases of abscess of brain associated with disease of ear, given in table, p. 6, there were 34 in which no carious or necrosed state of the bone had been observed, or at least noted, although from the descriptive context, if any such diseased condition had existed, it would almost certainly have been recorded.

I do not think it necessary to pause here and enquire whether it is more probable that the suppurative action may have extended, in some of the cases, from the brain to the ear rather than from the ear to the brain. The consensus of well informed opinion is, that the diseased condition extends

from the ear to the brain, and that only in very exceptional circumstances can there be a probability of its extending *from the brain* to the ear.

These considerations lead to the question of the possible or probable conditions under which suppurative action attacks the brain in cases where the bones are not carious nor necrosed. Some observers believe that a sufficient explanation is to be found in the continual irritation produced by chronic inflammation of the mucous membrane, with want of free outlet for the accumulating depraved secretion. For, it is argued, the vessels which nourish the tympanum have, so far as is known, no direct connection with the substance of the brain, and therefore there exists no direct route along which septic matter can travel. And this is the very important problem to which Dr. Barr has directed attention. I venture, however, to affirm that under certain conditions which often exist in cases of abscess of brain associated with disease of ear, an indirect route may be established, and that a consideration of certain peculiarities in the anatomy of the brain, and its relations to its osseous envelope, furnishes a sufficient or a very probable explanation.

Hitherto I have restricted my considerations to the influence exerted upon diseased action by peculiarities in the structure or anatomical development of the osseous portion of the organ of hearing, so far as these modify diseased action occurring in early as contrasted with adult life. I have now to speak of peculiarities in the blood circulation in the bones of the cranium and in the sinuses, and of conditions under which that circulation becomes altered and thereby furnishes a new and a direct route along which disease-producing influences may be conveyed from the ear to the brain.

When the dura mater is being separated from the surface of the brain, there are seen small fibrous bands which stretch across and connect the two surfaces near the base of the brain, and chiefly opposite the sinuses. These are veins. At two points they are larger than elsewhere, and three or four vessels are often comprised in one band. Two sets of these veins enter the lateral sinus, one from the under surface of the cerebellum, and the other from the under surface of the middle and posterior cerebral lobes. I have further observed, with unvarying frequency, one, and sometimes two veins which leave the inferior surface of the middle cerebral lobe and enter the superior petrosal sinus.

The usual flow of blood along these veins is *from the brain*

towards the ear, and, therefore, under usual conditions, they cannot carry any septic matter from the ear or against the stream. But the cerebral veins, and all the veins inside the cranium, have no valves, and, therefore, when any impediment occurs in the normal current, there takes place a reversed flow, and the blood reaches its ultimate normal destination by collateral channels and circuitous routes. What are the conditions which may cause such an impediment and such a reversed flow, and where is that obstruction most likely to occur?

In the adult, as has already been observed, the lateral sinus is in close proximity, and sometimes in immediate contact with the fibro-mucous membrane of the mastoid cells, and there are numerous small veins which pass *from the cells into the sinus*. These veins, originating in a diseased membrane, readily propagate their inflamed or diseased condition to the corresponding coats of the lateral sinus. An equally ready channel for the conveyance of septic matter contained in the tympanum or mastoid cells exists in the perivascular spaces of these mastoid veins, and along these spaces the irritating matter can travel with little hindrance until it emerges within the cranium between the fibrous coats of the lateral sinus and the osseous groove in which it rests. The pressure and irritation caused by the retained pus gives rise to more or less thickening of the walls of the sinus, to a diminution of its natural calibre, and to consequent obstruction. This irritative or inflammatory action may induce thrombi. Not only may, but frequently does induce thrombi. In detailed reports of cerebral abscess, it is very frequently noted—although without drawing the deduction to which I am leading—that the lateral sinuses contained thrombi; and I think it likely that, if attention is given to this occasional association of thrombi in the sinuses, with co-existing abscess of brain, the presence of clots in the sinuses will be more frequently recorded. But this is a point that I will elucidate at greater length subsequently. Irrespective, therefore, altogether of actual caries or of necrosis of the temporal bone, the walls of the lateral sinus are exposed to irritating influences propagated from the tympanum and mastoid cells.

Septic matter contained in those cells may enter the mastoid veins directly, and be carried into the lateral sinus. The *modus operandi*, by which blood cells pass through capillary walls from within outwards, or from without inwards, without actual breach of surface, has been sufficiently shown by

Cohnheim and others. Klebs* has shown how bacteria pass into the circulation from a surface bathed with septic matter, and has traced their penetration into the interspaces of the cellular tissue either with or without the aid of wandering lymph corpuscles—has observed their penetration through the eroded walls of a vein into the circulation, and has detected their presence in thrombi within the veins. And the experiments of Koch, in which he produced artificial traumatic infective diseases, have abundantly demonstrated that the soluble poison "sepsin," which exists in putrid blood, and also the various forms of microscopic parasitic germs, known under the names of bacteria, micrococci, zoogloea, &c., can permeate the vascular tissues and become located in the heart, lungs, liver, and other organs. He revels in description of the various modes in which the various *forms of infective germs assail the organs and tissues*. "It is quite possible," he says, "that the bacilli grow into the vessels and enter the circulation through spaces in their walls, which permitted the exit of the much larger red blood corpuscles." He tells us that, after subcutaneous injection of septic matter "in the capillaries the bacilli congregate," particularly at the points of division, and that "one meets everywhere with vessels containing free bacilli, and with white blood corpuscles with bacilli in their interior," &c. He shows that these infective microscopic organisms differ in size, form, and in most other points, and describes six out of many varieties which he believes to exist, and shows various modes in which they affect the living organism. Of one variety—pyæmic—he says, "the manner in which the *micrococci*, as it were, *spin round the blood corpuscles and enclose them*, seems to me to be quite characteristic of this particular form," and is disposed to believe that the large metastatic deposits in the liver and in the lungs do not arise by gradual growths of a mass of micrococci, but *by the arrest of large groups of micrococci and of the clots associated with them* found in the manner described in the circulating blood; in other words, *by true embolism*." Of another variety—septicæmic organisms—he says, "*they never enclose the blood corpuscles*, even when they have accumulated in large numbers in the interior of the blood-vessels. They rather push them on one side. They do not cause coagulation of the blood, and thus emboli do not occur." And, when referring to the remarkable distinction in physiological character of the different classes of these parasitic

* *Vide* Koch on "Infective Traumatic Diseases." *Syd. Soc. Trans.*, p. 31. 1880.

microscopic germs, he says, "I scarcely know a more striking example than the case of the *bacillus* and of the chain-like *micrococcus* growing together in the cellular tissue of the ear; the one passing into the blood and penetrating into the white blood corpuscles, the other *spreading out slowly in the tissue in the vicinity* and destroying everything round about." The observations of Koch, although in their main portions restricted to generalisations, are yet so remarkably suggestive as to be in some respects special. Thus, to my mind, they stimulate reflection and give aids in explaining why at one time an abscess in the brain associated with disease of the ear is characterised by unpleasant fetor, and that another is bland and innocuous, &c., &c.

The lateral sinus may therefore become inflamed, may receive septic matter carried from the tympanum and mastoid cells, and may become more or less occluded through various causes. At one time the obstruction is explicable on simple mechanical principles; at another time it is based on the action of pathological stimuli. These conditions are well illustrated in a report on "Thrombosis and Embolism" by Weissner,* wherein he gives an analysis of 74 cases collected by Lanceraux. That observer distinguishes an inflammatory and a non-inflammatory form of thrombosis of the cerebral sinuses. Of the 74 cases, he alleges that 39 were of the former and 35 of the latter. But neither Virchow nor Dusch, who have treated ably of this condition, admit the distinction. Inflammatory thrombosis of the sinuses, according to Lanceraux, is invariably connected with lacerations of the scalp or bones of the head. In 39 of the cases collected by him, there were 30 in which caries existed, and 24 in which "otitis interna" was present. The sinuses adjoining the seat of mischief were always diseased, while the superior longitudinal and the symmetrical blood channels were rarely affected. Purulent meningitis or abscesses often occur, not only in the vicinity of the obstructed sinus, but also sometimes at a distance, and unconnected with it. Effusions of blood are alleged to occur only in exceptional cases, because by means of the previous inflammation collateral channels have been formed which, he states, is not the case in non-inflammatory thrombosis.

Dusch† concludes generally that coagulation of blood in the sinuses may be due to the propagation of a coagulum from the neighbouring veins in cases of caries, necrosis, and wounds of the cranium, and of extravasation of blood into the sub-

* Schmidt's *Jahr.* Vol. 117. P. 209, 1863.

† *Brit. Med. Journ.* April, 1861.

stance of the brain. Or it may be due, he says, to any cause either of a local or general nature, such as anæmia, feeble heart, or the compression of the sinuses by tumours; and to the latter cause I may add, as already adduced, to reduced calibre of the sinus from thickening of the coats.

But whatever the cause of obstruction, the flow of blood is arrested just as it should pass out of the cranium into the internal jugular vein. The venous blood thus intercepted or retarded must then reverse its normal course, and go to swell the stream flowing through the sinuses on its way to the heart by the internal jugular of the other side. But from their structure, the sinuses are practically non-dilatable, and therefore every collateral channel is overtaxed to carry off the accumulating blood. The superior petrosal sinus on the affected side, which is fed by veins from the inferior surface of the middle cerebral lobe, and also *by veins from the tympanum and internal ear*, is the first to become overcharged. As the obstruction is distal to the entrance of the cerebral and cerebellar veins already referred to, they also become turgid, and also have their normal flow reversed more or less. They are then liable to convey some of the blood which was intercepted at the lateral sinus into other sinuses, such as the inferior petrosal or longitudinal. These veins, however, are dilatable, and have exceedingly thin walls, which, under distension, are liable to become varicose. The effect of this distended varicose condition is a continued and localised pressure upon the delicate surface of the brain, together with consequent oedema and impaired nutrition.

The chain of diseased process is therefore considerable, and very connected, and quite sufficient to induce softening or other form of diseased action, as suppuration. And this altogether irrespective of the liability to the deposit of septic matter which, if present in the lateral sinus, has now, by the circuitous channel I have described, direct access to the surface of the brain. It is to me, therefore, very clearly evident that blood flowing from the tympanum or internal ear can, under the conditions I have specified, pass directly into the lateral or into the superior petrosal sinus, and from thence by the cerebral veins direct to the surface of the brain. And thus, as I contended at the outset, although admittedly there may be no *normally* direct vascular connection between the ear and the substance of the brain, there is nevertheless an *abnormal* or indirect connection which in certain conditions does exist.

It forms no part of my subject to deal with the practical

aspect of the questions that naturally arise, having reference to treatment. I have restricted myself to anatomical and pathological considerations, in the belief that I will have contributed a sufficiency of suggestive matter in my references to the importance of early and earnest attention to the diseased condition commonly called "a running ear," and as an important department of the necessary treatment, in directing attention to the probable, nay, certain value which should be placed on the operation of trephining the mastoid in cases of retained pus.

EXPLANATION OF PLATE.

Figure 1. Drawing of right temporal bone in adult. A-B, the squamo-mastoid suture through which pus may exude in young subject. C, the styloid process.

Figure 2. Left temporal bone in young subject. A portion of squamous plate has been cut away to show the single mastoidean cell or antrum mastoideum (D). The mastoid process is seen in section (F) to be destitute of cells. The tympanic bone or ring is also shown (E).

Figure 3. Right temporal bone in adult, with squamous plate and cortex mastoidei removed by one cut. Shows antrum mastoideum (G); the inner wall of tympanum (H); the mastoid cells very fully developed (K); and the styloid process (P).