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Petrositis: A Review of Recent Work

PRESIDENT'S ADDRESS

By HAROLD KISCH (London)

PETROSITIS is the term which has recently come into use for denoting inflammation of the petrous pyramid. The situation of the bone, wedged in as it is at the base of the skull, has made it difficult for surgical approach, so that the recent planning of definite surgical procedures to deal with the disease has been a matter of great interest.

It is noteworthy that Chamberlin, in Jackson and Coates' textbook, published in 1929, in summing up the treatment of the Gradenigo symptom-complex, says: "Although the mastoid operation, with the free drainage which it affords, does not ensure relief, it is the best means which we have, and certainly lessens the dangers of intracranial involvement." Nevertheless, previous to this a few cases of operative treatment had been recorded.

In briefly reviewing the progress that has been made since Gradenigo published his original paper in 1904, drawing particular attention to the apical cells and paralysis of the VIth nerve, I propose to limit my remarks to more or less recent work on: (1) Structure of the petrous bone. (2) Pathology. (3) Radiology. (4) Clinical aspects.

(1) *Structure of the petrous bone.*—The distribution of the air-cells in the petrous bone has been studied by many authors. In this country Cheatle's work is well known, and Bezold, Politzer, and others have described the cellular distribution.

Myerson, Rubin, and Gilbert published an anatomical study in 1934. Pneumatization of the petrous apex was found in 11%, a diploeic tip in 11% and a sclerotic tip in 71%. This compared with a pneumatized mastoid process in 38% and sclerotic in 30%. No bone up to $7\frac{1}{2}$ years showed a pneumatized apex, the youngest pneumatized tip being 15 years. The authors divided the cells into

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supracochlear and infracochlear groups, and found that the most common were the anterior surface cells above the cochlea, originating in the angle between the superior semi-circular canal and the facial nerve, and the jugular bulb group (subcochlear and posterior cochlear). In only two specimens were peritubal cells found leading to the petrous apex. Hagens, in his series (fifty bones), found pneumatization in 34%. Marrow was found in 94% of the petrous apices. Belinoff and Balan, in forty bones, found a diploetic type in 22·5%, a pneumatic type in 35%, and a mixed cell type in 42·5%. In 37·5% the structure of the mastoid process and pyramid apex was identical, and in 62·5% different. Glick describes a series of microscopic preparations of the temporal bone, and points out that pneumatic cells are present in the petrous apex more frequently than is generally believed. In a number of specimens he found bony dehiscences directly under the Gasserian ganglion. References to cell-tracts have been made by numerous Continental workers, and Kopetzky gives a complete list of these in his paper in the *Archives of Otolaryngology*, July, 1933. There are considerable differences in the estimates of the amount of pneumatization normally to be found, and this is probably partly explained by the difference in the technique of preparation.

Eagleton, in his paper on " Unlocking of the petrous pyramid ", discusses very fully the anatomical character and special peculiarities of the petrous bone. Quoting McMurrick, he says : " The internal third of the temporal bone contains an intracranial space-developing portion, the apex cells containing blood-forming marrow substance morphologically the same as the marrow of the long bones. The petrous belongs to the more primitive type of cartilage bone." He later points out that the blood supply is from the periosteum loops, the nutrient arteries of the apex being twigs sent from the carotid plexus to the compact cortex, and this fact, together with the fact that the apex is a growing bone and contains marrow cells capable of direct infection, renders the apex especially liable to infection reactions in mastoiditis.

(2) *Pathology*.—Pathologically, the disease petrositis is either a spreading osteitis or an osteomyelitis. There is not a great deal of microscopic work published, and the deductions from macroscopic appearances may be deceptive. It is interesting that the American authors whose recent work has focussed attention on the operative treatment of the disease hold divergent views as to the pathology. Kopetzky and Almour only recognize a coalescent petrositis, whilst Eagleton suggests that the condition is always osteomyelitis. Kopetzky and Almour state that the progress of the disease is the same as in a cellular mastoid, and its course can be followed macroscopically. All their cases occurred in pneumatized mastoid processes. At the original operation cells were found to extend

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well forward into the zygoma. In the region of the antrum and the area posterior to the superior semi-circular canal cellular elements were present. In most of the cases with which they dealt there was suppuration in the mastoid process which, in all except one case, preceded the development of suppuration in the petrous pyramid. In the majority of instances, suppuration in the mastoid process and the middle ear cleared up and an interval of time elapsed before the onset of symptoms denoting that the suppuration had spread into the perilabyrinthine tracts towards the pyramidal tip. These authors describe the routes of invasion as follows :

(1) From the antrum or epitympanic space above or below the superior semi-circular canal following the postero-superior surface of the petrosal pyramid into the tip. (2) From the peritubal cells into the pyramidal tip. (3) From the peritubal cells directly into the carotid canal and then rupturing into the cavum Meckelii.

Friesner and Druss give the following routes of extension from the middle ear and mastoid cavity to the apex, collected from the work of Perkins and others :

(1) Sublabyrinthine route, extending from the tympanum below the labyrinth and internal auditory meatus to the petrous tip. (2) From the mastoid antrum, through the subarcuate fossa or the petro-mastoid canal, which passes inwards beneath the superior semi-circular canal and reaches the layer of cells above the internal auditory meatus to the petrous tip. (3) Carotid canal by eroding the bone on the anterior tympanic wall or through one of the carotico-tympanic foramina, which give passage to the carotid branches of the tympanic plexus. (4) Layer of cells extending along the Eustachian tube, from the tympanum to the petrous tip. (5) Along the superior or inferior petrosal sinuses to the apex. (6) Extension of an extradural abscess of the petrosal sinus to the apex. (7) Induced trauma at operation or otherwise.

Friesner and Druss give a detailed microscopic study of three temporal bones in three cases of otitic suppuration associated with paralysis of the external rectus muscle. They trace the disease definitely through the cells and say that : " It cannot be denied that the majority of infections of the petrous pyramid that reach the apex do so by direct extension through the cells." E. P. Fowler, Junr., describes six cases of meningitis of otitic origin. Serial sections were examined in all of these, and petrositis was found. In none of the cases were there definite clinical signs of the disease, and he concludes that petrositis is much more common than is generally supposed.

An infection in the petrous will not necessarily reach the apex, and whether it does or not probably depends on the structure of the particular bone. Complete healing of the petrous may occur after simple complete mastoid drainage, or perforation of the cortex may

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occur, causing a subdural abscess, which may burst into the meninges after a quiescent period. Eagleton discusses very fully the pathology he found in his cases, viz. osteomyelitis. Ruskin describes the venous circulation of the petrous bone. His object is to show: first, that the earliest sign of involvement of the petrous bone, preceding the suppurative state, is disturbance of circulation in the venous network of the bone; second, that there are two outstanding syndromes, one described by Gradenigo with involvement of the VIth nerve and orbital pain, the other described by himself and characterized by œdema of the lower eyelid, temporo-maxillary orbital pains and trismus. In the former case the cause is congestion of the inferior petrosal sinus, and in the other in the pterygoid plexus.

(3) *Radiology*.—The study of this disease has been helped by radiologists, as the cellular structure can be demonstrated in radiograms. The verticomental position is generally used, and attention has to be directed to: (1) Amount of aeration. (2) Decalcification. (3) Loss of trabeculation. (4) Loss of continuity of details. Papers have been published by Geyman and Clerk, Nager, and H. K. Taylor.

(4) *Clinical Aspects*.—The clinical history of a case with invasion of the petrous apex is usually fairly typical. It begins with an acute otitis media, for which a myringotomy is performed. Later the mastoid becomes involved and a simple mastoid operation is carried out. During the post-operative stage conditions are fairly satisfactory, but occasional headaches occur. Then comes the "pain behind the eye" and occasional pain in other branches of the Vth nerve. The mastoid wound usually heals well, but discharge from the middle ear continues, or it may first clear up and then recur. There is an irregular temperature, running up to about 101° F. Signs of labyrinthine irritation and paralysis of the VIth and VIIth nerves may occur.

Following this: (1) Recovery may take place. (2) Meningitis may occur. (3) (Rarely), lateral or retropharyngeal abscess may form and, on discharge of the abscess, recovery may occur.

Eagleton says: "During the terminal stage all my patients presented a symptom-complex characteristic of pontine cisterna meningitis, viz. the patient is unconscious but not stuporous. He lies on his back with his head extended and his eyes closed. When spoken to he rouses and will answer questions, and then dozes again. There is some headache, but little of the agonizing pain and none of the general restlessness and screaming of cortical meningitis. In a few days he dies."

It is rare for the signs of petrositis to occur at the same time as the original otitis, but this has been recorded.

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Kopetzky and Almour now divide their cases into acute and chronic. The difference is one of degree, the drainage in the acute cases being insufficient, and an encapsuled extradural abscess is formed. At this period the symptoms are relieved, only to be followed by signs of meningitis if the condition is not relieved by operation. Paralysis of the VIth nerve occurring in suppuration of the middle ear recovers spontaneously in the majority of cases, usually after a mastoid operation. Its presence is not an indication for operation on the petrous, and its absence is no indication that the petrous is not involved. Meltzer discusses the Gradenigo syndrome fully, and Friesner and Druss show that in four cases submitted to microscopic examination, three showed certain evidence of involvement of the petrous, and in the fourth there was no such evidence.

The clinical difficulty is to decide when to operate and when not to operate. Careful watching, once the diagnosis of petrositis is made is indicated, but the appearance of signs of meningitis increasing in intensity makes interference advisable. The recognition of the Kopetzky interval with diminution of discharge is an important sign. If the discharge is increased at this time, a waiting policy should be adopted.

The practical conclusions I would draw are that :

(1) All cases showing extensive pneumatization of the mastoid at the primary operation should have the petrous apex radiographed.

(2) The occurrence of " pain behind the eye " in the presence of suppuration of the middle ear should be regarded as evidence of petrositis.

(3) Paralysis of the VIth nerve is not an indication for a petrous operation, but absence of paralysis of the sixth nerve is no indication that petrositis is not present.

(4) Operation is indicated : (*a*) When meningeal signs (increase in headache, torpidity, irritability, neck rigidity, vomiting) show themselves and increase ; (*b*) When radiological evidence shows increase of disease in the petrous ; (*c*) When the Kopetzky latent period shows with decrease of discharge from the middle ear.

(5) Petrositis may occur without the " pain behind the eye " and may result in meningitis. The diagnosis is extremely difficult and further work is required on the subject.

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ILLUSTRATIVE SPECIMEN.—**Right temporal bone from a case of petrositis.**

A girl aged 12 was admitted to hospital on 14.11.32 with a history of right earache (four days), and discharge from right ear (two days). Temperature 99·4° F. Typical case of mastoiditis, with no symptoms or signs suggesting complications.

17.11.32: Right cortical mastoid operation. Condition of bone suggested a hæmolytic streptococcal infection. Wound left open and lightly packed.

Convalescence normal: child discharged healed on 1.12.32.

On 29.12.32 she was readmitted with meningitis. Since her discharge from hospital she had been well except for an occasional headache; no eye pain. During the previous week she had been particularly well and had attended school. Lumbar and cisternal punctures carried out. Culture of hæmolytic streptococci from cerebrospinal fluid.

Post mortem report (Dr. Scott-Williamson).—Brain: Vertex injected, but no evidence of meningitis or spread of pus. Base: Purulent basal meningitis. Source of infection from a window of necrosis (healing) at the apex of the petrous.

The Treatment of Petrositis

By F. W. WATKYN-THOMAS (London)

FIRST of all, it is important to remember that, in the great majority of cases, petrositis is curable by an adequate mastoid operation, with systematic exenteration of all discoverable cells. It is rarely necessary to perform a radical operation; still more rarely is it necessary to carry out a deliberate exploration of the petrous pyramid.

Next, chronic petrositis is an uncommon condition. It does occur, and is sometimes responsible for sequestration of the petrous bone, cases of which are reported from time to time at our meetings. It seems probable to me that some cases which we describe as

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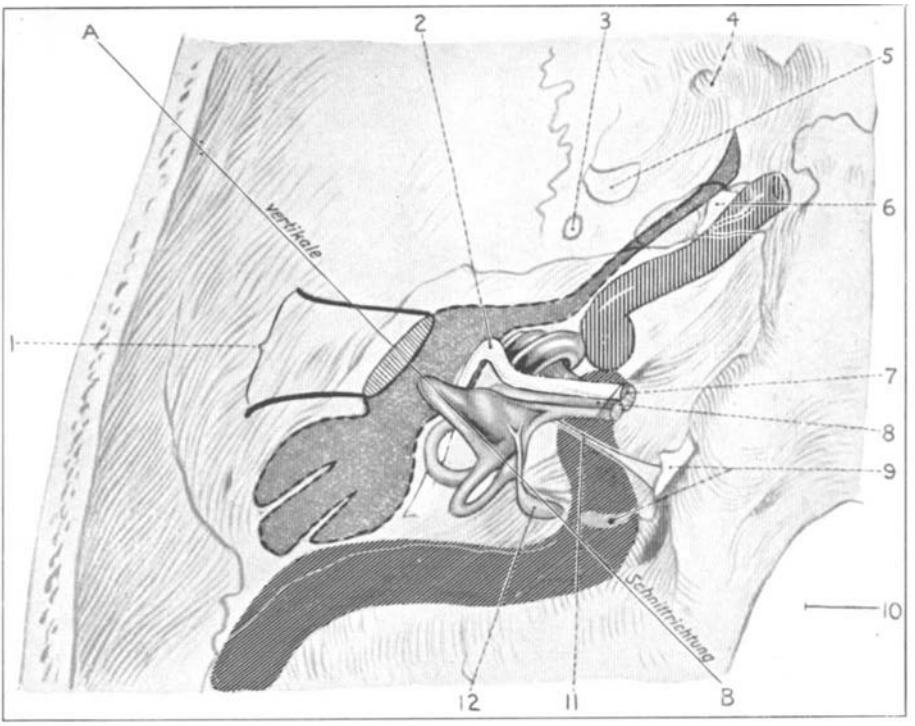


Fig. 1.

The relations of the left outer, middle and inner ear, as seen from above. (After Korning, Denker and Kahler's Handbuch.) Semi-diagrammatic.

A—B, plane of the superior canal.

1, External auditory meatus; 2, facial nerve; 3, foramen spinosum; 4, foramen rotundum; 5, foramen ovale; 6, foramen lacerum; 7, cochlear nerve; 8, vestibular nerve; 9, jugular foramen; 10, foramen magnum; 11, aqueduct of the cochlea; 12, aqueduct of the vestibule and saccus endolymphaticus.

Lateral sinus, area shaded by slanting lines.

Internal carotid, area shaded by vertical lines.

Eustachian tube, middle ear, antrum and cells, dark grey area.

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" latent labyrinthitis with necrosis " should rather be included in the category of petrositis. I refer to those cases in which a complete loss of labyrinthine function is revealed by the routine examination of a patient with chronic suppurative otitis media and, at operation, the labyrinth is found as a sequestrum in a granulating or pus-filled cavity. The most likely explanation of the condition is that the dense bone of the labyrinth survives the destruction of the surrounding cancellous bone, but the vascular supply of the labyrinth does not survive and so the whole labyrinth slowly dies. The slowness of the process would account for the fact that in some cases of " latent labyrinthitis " the most careful questioning fails to elicit any history of vertigo or other labyrinthine symptoms. There is also a small group of cases in which petrositis declares itself by the appearance of a lateral pharyngeal or pterygo-maxillary abscess.

In the majority of cases petrositis follows an acute mastoiditis, generally in a fully pneumatized mastoid, although cases have been reported in which the predominant structure was diploetic. Usually the petrosal invasion is a late complication, and occurs after the third week. I would say emphatically that the appearance of signs of petrositis in a patient on whom we have performed an adequate mastoid operation does not compel us forthwith to proceed to further surgical intervention ; still less are such signs an indication for immediate exploration of the petrous. If the signs, such as neuralgia and vertigo, are fluctuating but not increasing in severity and are associated with a free discharge, we may take it that the pus has found a channel of exit and we are justified in waiting, so long as there is no evidence of septicæmia and no signs of meningeal reaction.

I lay particular stress on the importance of a free discharge because in the most dangerous cases of all—the cases of mucosus otitis, in which the infecting organism is the so-called *Streptococcus mucosus capsulatus* (really probably Pneumococcus III), there is a most ominous absence of discharge. It is in these cases that the radiologist can help us most, for in mucosus otitis the destruction of bone is so disproportionate to the signs, or rather to the absence of signs, that skiagrams are often our only positive evidence of the advance of infection. The sudden cessation of discharge is a warning sign ; it may mean that the wall of the petrous pyramid has been perforated, and that the pus is leaking into an extradural abscess. The guiding signs which indicate further intervention are an increase of the local symptoms, evidence of septicæmia and, above all, any signs of meningeal irritation.

If we have to operate, what is the right operation to perform ? Technically the approach to the petrous pyramid is difficult (Fig. 1). The possible routes to the apex of the pyramid are from in front and below, or from above. But here I should like to say that our object

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is not to find the apex of the petrous, but to find the pus. The apex is an anatomical landmark, the pus is a surgical reality, and the apex is not the only point at which the pus can break through into the cranial cavity.

To Almour and Kopetzky we must give the credit for the first planned attack on the apex by the anterior route. Their line of advance is by perforation of the bone between the carotid canal and the cochlea (Fig. 2). Their method may be summarized thus :

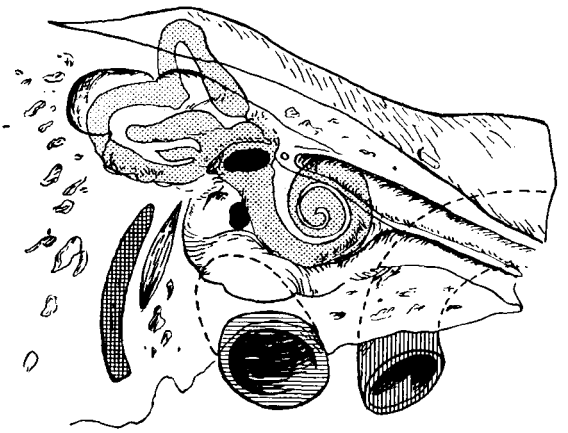


FIG. 2.

View of inner tympanic wall, showing the relation of cochlea and carotid canal.

An extensive radical mastoid operation is done, and the root of the zygoma and the anterior wall of the bony meatus are cut down until the mouth of the Eustachian tube is exposed. The tensor tympani muscle, and the processus cochleariformis are removed. A 1·5 mm. burr is driven in just posterior to the Eustachian orifice and directly below the tympanic roof at an angle of 20° to 25° to the axis of the external auditory meatus. This opens a pyramidal space bounded by the cochlea behind, the carotid canal in front and the Eustachian tube externally. It has been shown that the carotid canal is separated from the basal turn of the cochlea by a minimum distance of 6 mm. The apex of the pyramid is below and the base is above ; through this space the apex can be reached. The uppermost part of the carotid canal is below the roof of the Eustachian orifice. Ramadier has improved on this method by deliberately opening the carotid canal, and working along it.

There are great disadvantages to these anterior operations, apart from the technical difficulties. I do not think it is a fair objection to say that we should not perform an unnecessary radical operation : the patient's life is at stake, and in any case the amount

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of hearing which survives a severe petrositis is usually negligible. More valid objections are that the track for exploration is too narrow and there is no opportunity to inspect the dura ; as Almour very fairly points out, his method is not suitable for cases in which the pus has already broken through into the cranial cavity. Another, and a vital objection is that Myerson, Rubin and Gilbert, in 200 petrous bones found peritubal cells leading to the apex in two specimens only. The best-developed cells were those of the anterior surface group, between the facial nerve and the superior canal, and the subcochlear and posterior cochlear group (Fig. 3).

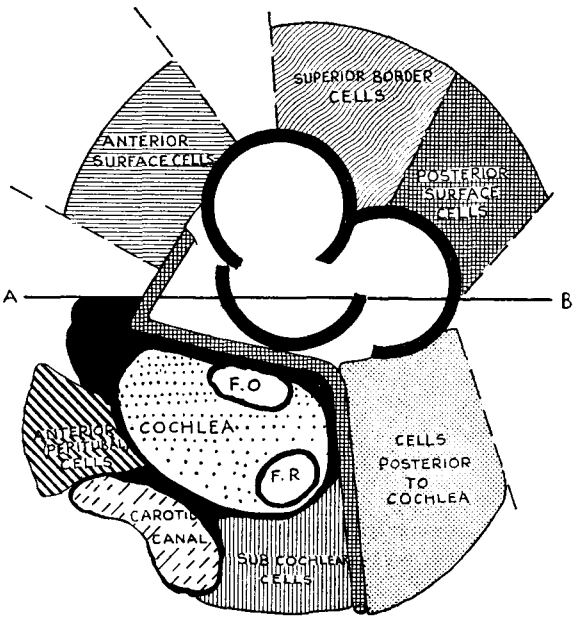


FIG. 3.
F, Facial nerve.
(After Myerson, Rubin and Gilbert.)

If, therefore, we cannot find a definite track of infection on exploration, probably our best course is to attack the petrous from above. Frenckner has devised a method of reaching the apex by exposing and defining the arc of the superior canal. Then with a very sharp curette he breaks through the softer bone which fills the concavity of the loop and thus reaches the apex. He has done this in two cases, both times successfully. This method, again, gives a limited approach. The most generally useful proceeding is that of Eagleton, which he describes as " unlocking the petrous ". The method is well known and had been modified in various ways

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by Voss, von Neumann and Ruttin. The essential point is a free exposure of the knee of the lateral sinus with the dura above and below, which allows us to attack the petrous pyramid in any direction. In the patient who is shown to-day the approach was along the postero-superior border with freeing of the superior petrosal sinus from its groove. In another case, a patient of Mr. Gill-Carey's whom I saw in consultation with Mr. Mollison and Dr. Symonds, the track of infection went forwards and the capsule of the temporo-mandibular joint was exposed in our approach. In this case the predominant feature was retro-orbital pain, but as a further complication there was a fistula on the external canal. The patient recovered with perfect hearing.

There is one point in particular on which I should like to ask the opinion of the Section, and that is the justifiability of extensive lumbar puncture in these cases when there is no evidence of meningeal infection? In the case shown I did not hesitate to remove as much cerebrospinal fluid as I could, because the fluid was already milky. If we remove a great deal of fluid it makes manipulation of the posterior fossa dura much easier, but when the fluid is not already infected would there be a risk of causing meningitis by such an extensive removal?

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ILLUSTRATIVE CASE.—**Recurrent mastoiditis—Petrositis—Meningitis. Recovery.**

A boy, aged 14. In 1931 a double simple mastoid operation was performed. In *July*, 1935, following an attack of acute tonsillitis, there was recurrence of discharge on the right side, with an abscess in the scar.

August 10th: Abscess incised; temperature fell to normal. *September 1st:* Discharged to convalescent home. *September 4th:* Temperature 102° F. to 103° F., re-admitted. *September 6th:* Exploration of mastoid. Cells in petrous angle found and opened.

There was a profuse discharge, which was not stopped by the operation. On *September 11th* temperature rose slightly, and from then onwards there was irregular pyrexia with slight occasional headache. There was no retro-orbital pain.

September 25th: Severe headache with vertigo, nystagmus to both sides, and vomiting. Temperature 103° F. By mid-day the

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patient was drowsy, with retraction of the head and positive Kernig's sign. The labyrinth reacted to the cold caloric test with normal change of nystagmus. Cerebrospinal fluid under greatly increased pressure. Dr. H. A. Lucas reported 12,960 cells per c.mm., 98 per cent. polymorphs, glucose absent, no organisms in film or culture.

Operation (with Mr. Gill-Carey).—The knee of the lateral sinus was exposed, the outer attic wall was resected ; tegmen tympani et antri freely removed, and a 5 cm. area of squamous temporal excised. After free lumbar puncture the dura was stripped along the posterior-superior petrous surface and the superior petrosal sinus was freed by removing the posterior petrous border with the gouge. A small abscess was found in the bone just external to the outer lip of the internal auditory meatus.

Lumbar puncture was done three times in the next two days, and the patient was given frequent intravenous injections of hypotonic saline. After the third day he settled down, and further recovery was uneventful.

Discussion.

(*Both papers were discussed together.*)

Mr. Brayshaw Gilhespy said that much had been made of mastoid surgery in respect of petrositis, but Kopetzky, in his paper, referred to apical petrositis as a complication of tympanic sepsis, not of mastoid sepsis, i.e. one might perform a mastoid operation and get a residual infection from the anterior part of the middle ear ; and, conversely, one might meet with patients with an anterior discharge from the ear, a condition which it was very difficult to clear up. In those cases one should be alive to the fact that there might be an apical petrositis which was keeping up a discharge. In that class of case also one should consider having a skiagram taken of the apex of the petrous bone. In the chronic cases the evidence was not conclusive, in his (the speaker's) view, that the labyrinth was not involved. At operation there were pathological findings in the region of the aditus and semi-circular canals, but no labyrinth tests were performed. Among such cases of chronic petrositis, latent labyrinthitis must be hiding. These, rather than the acute group, were the dangerous cases, and provided examples of petrositis seen in the *post mortem* room.

Mr. Stirk Adams said he had come to the conclusion that two separate clinical types of petrositis existed. The first was the petrous inflammation spontaneously resolving, while the second was a precursor to meningitis.

The first condition appeared to be very common and was often unrecognized. It was seen in children who made a slow recovery after an acute mastoid operation. In these children there might be no other signs but slight continued pyrexia and increased pulse-rate. Localizing signs were entirely absent and no headache occurred. This type was illustrated by the case of a child at present in the Children's Hospital, Birmingham. Six months ago an acute otitis media began during

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whooping-cough. Spontaneous discharge occurred and the otitis subsided. Six weeks later a second acute otitis began in the same ear, and a month later there was mastoid tenderness, with a slightly raised temperature. At operation a widely pneumatized infected mastoid process was found. Following this the temperature has remained intermittent for seven weeks, with a pulse-rate of 120. X-ray examination showed complete destruction of bone in the apex of the petrous on that side, while the child himself had been in perfect general health.

The second type developed meningitis some weeks after the incidence of the acute ear infection. In cases developing under observation diagnosis was not difficult, but some of these patients first came under care semi-conscious with meningitis, and he would like to hear what Members thought the right treatment in that condition, and especially whether they thought an attack on the petrous tip was justifiable in the absence of a previous history suggesting petrositis.

Figures for the incidence of cell-formation in the petrous pyramid had been quoted. He (the speaker) would add figures from fifty *post mortems* in the Children's Hospital, Birmingham. In only one of these, on a child aged 12, was a pneumatized petrous apex present. In all others no large cells were present, the entire petrous apex being composed of diploetic tissue with close-meshed trabeculae.

In reviewing the possible incidence of petrositis after acute ear infections he had examined his case-notes in this same hospital for the year 1933. In sixty cases of acute mastoid operations there were only five with an unexplained rise of temperature occurring during convalescence after the second week.

Mr. G. E. ARCHER said he would refer to one case of petrositis with extradural abscess followed by an operation and recovery. The patient was admitted because of acute otitis media, but there were no urgent symptoms. There had been a copious discharge for three weeks and a simple but extensive mastoid operation was done. There was a large-celled pneumatized mastoid. The patient seemed to be making a normal recovery except that the copious purulent discharge from the meatus continued, though the mastoid wound had healed. Then a course typical of petrositis developed; the patient had pain behind the eye, a Vth-nerve neuralgia, and VIth-nerve paralysis. Later complete loss of sensation of the Vth nerve developed, first for heat and cold, later for pain and touch. There was slight pyrexia, never above 99° F. This continued for three or four weeks. A skiagram revealed a shadow near the apex of the petrous bone. He (the speaker) first carried out an extensive mastoid operation, going far forward and making a careful search. This showed a small fistula in the anterior epitympanic region and one bead of pus. On opening this fistula he came upon a gallery of cells in the anterior surface of the petrous; a large abscess was opened in the region of the semilunar ganglion, and one or two drachms of pus came away. Recovery after this was rapid and complete.

The particular features of the case were the very large-celled mastoid, the copious purulent discharge persisting from the meatus, and the slight pyrexia in spite of this.

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Sir JAMES DUNDAS GRANT said he did not doubt that in his long career he had probably missed some cases of petrositis, but they could not have been common. Mr. Watkyn-Thomas had said, at the end of his description of treatment, that it was much more important to follow up the pus and make room for its escape than to carry out a definite prescribed operation. His (Sir James's) own impression was that by following this out, he and his colleague, Percy Jakins, obtained comparative immunity from meningitis.

Mr. E. D. D. DAVIS said that in his hospital and private practice of nearly thirty years he had seen only six cases which had Gradenigo's syndrome (acute otitis media, pain around the eye and paralysis of the VIth nerve). Two of these cases were doubtful. In the first the patient, a child aged 6 years, had a very pneumatic mastoid, with headache, a rise of temperature, and paralysis of the VIth nerve. He (the speaker) performed a complete simple mastoid operation, paying particular attention to the zygomatic cells and to the retrofacial cells extending up to the labyrinth. The cerebrospinal fluid was normal. The child recovered completely and remained well, i.e. for a period of two years of observation.

The second was a private case in a child of about the same age. The mastoid was very pneumatic. The complete operation was done, and everything went well for about two weeks, but at the end of that time the VIth nerve became paralysed, and the temperature was 99° F. The child ultimately recovered without any further operation.

The third case he saw was similar to the first two. The fourth was not a real case of Gradenigo's syndrome. The patient was under the care of a neurologist, had chronic suppuration of the middle ear, severe headache, pain round the eye, and paralysis of the IIIrd and VIth nerves. He (the speaker) performed a complete radical mastoid operation, and tried to reach the apex of the petrous bone. He took the upper route, i.e. he removed the roof of the mastoid antrum and tympanum and part of the squamous temporal bone to expose the middle fossa dura. The difficulty was to raise the dura from the upper surface of the petrous bone, and he had to be careful not to perforate the dura. The patient improved, but she still had oculomotor paralysis and headache. He did not find any lesion, and the true nature of the case was obscure.

The fifth case made him search the literature of Gradenigo's syndrome. The patient had acute suppuration of the middle ear. A complete simple mastoid operation was carried out, and after ten days he developed Gradenigo's syndrome. The mastoid was opened again, but no pocket of pus was found. He died of cavernous sinus thrombosis. The suppuration was traced through the carotid canal and venous plexus to the cavernous sinus. The temporal bone, unfortunately, was lost, and was not sectioned.

The last case was that of a young girl who had a simple catarrhal otitis media following acute nasal catarrh with paralysis of the VIth nerve. The paralysis disappeared with the catarrh, and no operation was performed. The cause of the symptoms was obscure.

In dealing with cases with Gradenigo's syndrome he preferred to

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carry out lumbar puncture. If the cerebrospinal fluid was normal he would perform a complete simple mastoid operation and wait; if the fluid showed a high cell count, likely to lead to meningitis, he would carry out a complete mastoid operation and search for pus in the petrous apex, taking the upper route. He agreed with Mr. Watkyn-Thomas that the crux of the whole matter was to find the pus when it existed.

Mr. T. B. LAYTON said that if the earliest signs of meningitis, which many preferred to call meningismus or meningeal irritation, were present, the patient's life could be saved only by finding the area of inflamed bone in contact with the dura.

He had been most interested in what Mr. Watkyn-Thomas said about draining off most of the cerebrospinal fluid so as to gain access to the region of bone of which he was speaking. If there was what he (the speaker) called meningitis and what others called meningeal irritation, even if there was no change in the appearance of the cerebrospinal fluid, he would not hesitate to withdraw that amount of fluid, so as to get at the little bit of inflamed bone which was causing the meningitis.

The PRESIDENT (in reply) reminded members that in his paper he did not deal with operation and treatment, but he wished to mention an interesting case in which a bullet had performed the Almour operation; the case was included in Mr. Scott's list of war injuries. It was that of a man who was brought into hospital suffering from great mental torpidity, and extreme rheumatic changes in his joints, which prevented the use of his arms and legs. He also had a foul discharge from his left ear. He had been in various military hospitals, without being materially benefited. He came under his (the President's) observation at the invitation of one of the physicians at the hospital where he was working at the time, and he suggested the wisdom of operating on the ear, to deal with the discharge, which seemed to be the cause of his condition. No help was obtained from the patient, as he would not give information about himself, and he had no documents, but next morning he (the speaker) received a message from him agreeing to an operation. He found the base of a bullet situated in front of the promontory; the bullet was removed with great difficulty as it was hard to get a grip on it. There was a gush of pus, and it was found that the bullet was directed up into the bend of the carotid artery, in the exact direction which would be taken by a surgeon doing the operation. It was of the type used by the Germans in the early part of the War; the patient had been in France with the first Expeditionary Force. At the time of the injury, he had felt only a click in his ear, and had fallen down; he was taken to hospital, to which he was able to walk. After the bullet had been removed his remark was, "There! I always told them it was there, but no one would believe me." He recovered completely, from the joint condition also, and when last heard of was quite well.

Mr. WATKYN-THOMAS (in reply) said that with regard to the question of the condition being a tubo-tympanic invasion one great difficulty always presented itself to his mind. In cases of tubo-tympanic suppuration it was very uncommon to find any damage other than that to hearing. When destruction of bone was present there was a

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discharge of thick pus and the discharge from an anterior perforation was always ropy and mucoid.

In reply to Mr. Stirk Adams on the question of meningitis in these cases: With the exception of that group of cases in which there was definite evidence that meningitis was caused by suppurative labyrinthitis and which was therefore best treated by translabyrinthine drainage, he thought that the attack on the petrous offered the best chance of saving the patient. Professor von Neumann's figures for meningitis were the best to date, and it was by a similar route that Neumann dealt with his cases.

With regard to stripping the dura from the superior surface of the petrous, he found that it could be done more easily by starting at the posterior angle. As much as possible of the bone should be cut away to get a good start with the stripping. He agreed that it was always difficult to strip in the neighbourhood of the superior vertical canal.

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