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The Surgical Complications of Acute Middle-Ear Suppuration in 1,000 Cases of Mastoid Operation.¹

By HOLGER MYGIND.

When in the autumn of 1920, the 1000th mastoid operation in acute middle-ear suppuration was performed at the Otological Department of the Copenhagen Commune Hospital, I determined to go through this unusually large material in order to elucidate the surgical complications connected with this form of aural inflammation, with respect to their frequency, causes, extension, prognosis etc.

Amongst the surgical complications of acute middle-ear suppuration the first place is necessarily taken by acute otitis in the mastoid process, in connection with which subperiosteal abscess is often found in this region. Much less frequent, but of far more serious moment, are the various intracranial complications, of which especially meningitis, thrombophlebitis, cerebral abscess and subdural abscess are the 4 vital cerebral diseases; whilst perisinous abscess, epiphlebitis, epidural abscess, pachymeningitis externa and interna are, though frequent, of minor importance.

The indications, on which operative measures were taken in our clinic I have already given account of in 1906 (*Archiv für Ohrenheilkunde*, Vol. 74, 1907, p. 93), and I have nothing of importance to add to what I then stated.

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¹ Paper read in a combined meeting of the Danish Surgical Society and Danish Otolaryngological Society 9th December 1921.

The operation in nearly all the cases was a simple resection of the mastoid process; only in some few exceptional cases »radical operation» was resorted to, in order to obtain better access to the labyrinth when diseased or suspected of being so.

Own Clinical Material.

Of the 1,000 operations, 83, were cases of relapses; of these, the 75 patients had been previously operated at the clinic, 9 elsewhere; in 95 cases the operation was bi-lateral. Therefore the material embraces 830 patients whose distribution, as to sex, age and mortality appears in table I.

Table I. 1,000 Mastoid Operations Performed on 830 Patients Arranged as to Sex, Age and with Report of Mortality. (For Comparison 830 Patients with Uncomplicated Acute Otitis Media).

	Males		Females		Indiv. of both Sexes		Total	Deaths	Percent	Uncom- plic. Otit.
	Opera- tions	Individ.	Opera- tions	Individ.						
Under 1 Year	54	45	49	39	84	15	18,0	57		
1—4 Years	165	118	124	95	213	17	8,0	180		
5—14 »	139	113	108	93	206	19	9,2	308		
Total of Children	358	276	281	227	503	51	10,1	545		
15—19 Years	21	18	27	23	41	2	5,0	40		
20—29 »	36	34	61	55	89	5	5,5	85		
30—39 »	36	33	31	29	62	9	14,5	76		
40—49 »	33	31	30	27	58	10	17,2	41		
50—59 »	18	18	25	22	40	15	37,5	26		
60—69 »	17	14	11	10	24	6	25,0	11		
70 Years and over	13	11	2	2	13	4	30,7	6		
Total of Adults	174	159	187	168	327	51	15,5	285		
All Ages	532	435	468	395	830	102	12,3	830		

Remote and Direct Causes.

If we seek for the more remote causes of the otogenic complications table I will give us the following with respect to the influence of sex and age.

Sex. Males are considerably more frequently subject to complications of an acute middle-ear-suppurative than females, there being, of 1,000 individuals attacked, 524 males and 476 females, whilst the proportion of male and female population in Copenhagen in 1911 was 454 to 546.

The above is, however, no expression for male patients with acute middle-ear-suppurative being more predisposed to complications than females, for in accordance with the old experience that the male sex is more often attacked by ear diseases than the female, Table I shows that also the uncomplicated acute middle-ear-suppurative group has a greater number of males than females attacked, for of 1,000 patients in that group 525 were males and 475 females — that is, almost the same figures as for the complicated cases.

The male sex has a still greater preponderance in the children's ages in our material, but this is also the case in the general population.

Age. Table I shows that no less than 60,6 per cent of the patients operated upon were under 15 years of age although that age-class only represents 27,7 per cent of the population of Copenhagen. This enormous preponderance of the children-class is entirely due to the circumstance that acute middle-ear suppuration is so extremely common among children; for in the uncomplicated cases of this disease 65,8 per cent were children. There is, therefore, no reason to suppose that children with acute middle-ear suppuration are especially predisposed to surgical complications. A closer investigation shows that a sharp demarcation must be made between two principal groups: those over and those under 5 years of age. From the age of 5 to 14 the surgical complications are of much less frequency than one would expect, and it is this large group which gives the children's class its stamp. Under the age of 5 these complications are somewhat more frequent than could have been expected which is also the case after the age of 40.

It is also characteristic for the class under 5 years of age, that the intra-cranial complications are rarer; they appear namely in only 12 children of this class, i. e. 4,1 per cent. In children over 5 years of age they were 4 times as frequent, namely 35 cases, i. e. 17 per cent — the same percentage as that which holds good for adults.

Whilst speaking of age it may be of interest to state that the youngest patient operated on was 2 months old and the oldest 80; both recovered.

Right and Left Side. Of the 1,000 operations performed, 425 were on the right side, 385 on the left and the remaining 95 were ambilateral. The preponderance of right-side lesions is in accordance with K ö r n e r's experience in otogenic intracranial disease; according to this author the preponderance is not due to the greater frequency of right-sided middle-ear suppuration, but to special anatomical conditions favourable to the propagation of the inflammation on the right side to the contents of the cranium.

A closer investigation of my material, however, shows that it is not the appearance of intracranial complications, which cause the preponderance of right-sided cases, but that it is the mastoid otitis which is the decisive factor. In a former investigation of material, partially the same as the present, I neither found any preponderance of the right side in otogenic intercranial complications whether the cause of the middle-ear suppuration were acute or chronic.

Predisposing causes. Of these *tuberculosis* plays a very great part in the child-classes, for, though only 30 of the children, i. e. 6,0 per cent, exhibited evident tuberculosis before the operation, the post mortem examination often showed universal tuberculosis. This disease is, however, of even greater importance as a direct cause, — as will be discussed later on —, a remarkably large number of the children having tubercular otitis in the mastoid process.

As regards the adults I will mention *diabetes* (4 cases) and *syphilis* (4 cases).

Infectious diseases. It lies in the nature of the circumstances, that the acute infectious diseases, which experience teaches us are of so great etiological importance for acute middle-ear suppurations, do not play any very great part in this hospital material. Thus *scarlet fever* is only given in 20 cases, *measles* in 14 and *pneumonia* in only 12 as causes of acute middle-ear inflammation. It is especially noticeable that *influenza* was only given 34 times as cause; for during the epidemics of this disease, which have prevailed in Copenhagen in latter years, a remarkably large number of otogenic complications have been under surgical treatment in my

department. Acute otitis in the mastoid process as well as otogenic intracranial complications masses itself in such a remarkably great number of cases at times, that it gives the impression of an epidemic appearance, and this is nearly always contemporary with influenza-epidemics. Owing to this the number of resections of the mastoid process differ greatly in different years as will be seen from the following figures.

Table II. Number of Simple Mastoid Operations during different Years.

1913	1914	1915	1916	1917	1918	1919	1920	1921
43	72	72	67	68	48	93	165	75

It is noticeable, that nearly all the patients admitted to the hospital with acute middle-ear suppuration, had either suffered from sore throat or exhibited signs of either *angina tonsillaris* or *acute pharyngitis*.

Bacteria Forms. In the majority of cases when there was a sufficient quantity of pus in the mastoid process to allow of its being sucked up with a pipette, this was done and the sample was examined bacteriologically in the bacteriological department of the Commune Hospital.

A bacteriological examination of pus from the mastoid process was made 324 times, and the results obtained were as seen from

Table III. 324 Mastoid Operations Examined for the Presence of Bacteria.

Streptococci	138	times	with	11	deaths
Pneumococci	81	»	»	4	»
Staphylococci	18	»	»	0	»
Other defined bacteria	7	»	»	0	»
Bacteria undefined	31	»	»	1	»
No bacteria	49	»	»	0	»
	324			16	

It will be seen from the above that streptococcus otitis is much more frequent as a cause of complications than any other form of otitis. This is, however, perhaps to be accounted for by the circumstance, that streptococcus infection is a much more frequent cause of acute middle-ear suppuration than other forms of infection. My ma-

terial is not able to elucidate this circumstance and the various statements respecting it to be found in literature differ among themselves. One thing, however, is certain and that is that the mortality in cases of streptococinfection is considerably greater than that caused by other forms of infection. It will further be seen that the mortality was nil in the cases where no bacteria were discovered. —

The various pathological changes which were found by the operative autopsy will now be considered, supplemented with what information was obtained in the cases where death occurred and post mortem examination was performed.

Acute Otitis of the Mastoid Process.

In the nature of the case it is evident that an acute otitis was found in all the 83 cases of relapse, whilst among the other adults there were 14 cases (i. e. 4 per cent) and among the children 20 (i. e. 4 per cent) where no otitis could be proved on operation. Of these 34 cases there were 12, in which the resection was performed on account of cerebral complication, whilst in the remaining 22 cases the diagnosis, otitis, proved to be incorrect. In the majority of these cases the cause of the wrong diagnosis was the presence of a subcutaneous glandular abscess.

The Nature of the Otitis. In the great majority of cases, the acute otitis found on operating was of ordinary nature, showing itself by destruction of the osseous tissue and formation of red, bleeding granulations. In a number of cases there was no pus at all, indeed in a few cases not even pus in the mastoid antrum, in spite of a copious secretion of pus from the tympanic cavity — a circumstance which is worth consideration, as it is a very general supposition that the discharge of pus in cases of acute middle-ear suppuration always partially have their source in the mastoid antrum, and that particularly when the secretion is considerable. Most frequently, however, small *foci* of pus dispersed over the process were found or considerable collections of pus, especially in the vicinity of sigmoid sinus (see below under perisinous abscess).

In several of the patients belonging to the children's class, the otitis found on operating differed in its character from the above

described, the granulations being pale, and gelatinous, whilst the pus eventually found was discoloured or of colloid nature, giving rise to the suspicion that the otitis was of tubercular character. In the majority of these cases, however, we did not succeed in proving by microscopical examination the presence of tubercles, these only being found in 7 cases i. e. 1.4 per cent of the children operated upon. Some few of these cases of suspected tubercular otitis healed perfectly, but in the majority a retro-auricular fistula remained, with slack granulations etc. These wounds only healed under light treatment.

In only a few adult cases did the otitis present a tubercular appearance, and in only one of these was it possible to prove tubercles.

Finally I would mention, that in some few cases where, on operation, no otitis could be proved macroscopically, the microscopic examination of removed osseous tissue gave distinct signs of it.

The Extention of the Otitis. In the case-books of all the 1,000 patients operated on was printed a form in which the diffusion of the otitis, exposure of dura and sinus were entered, thus facilitating a survey of all the cases, they being, with regard to the diffusion of the otitis, divided into three groups. Of these the 1st group embraces cases, in which the inflammation was only present in the region adjacent to the mastoid antrum and the 3rd group those, where the whole interior of the mastoid process had to be removed by chisel and sharp spoon, whilst the 2nd group included all the cases lying between these two extremes.

A difference was found in children and adults, otitis attaining a much higher degree in adults than in children (see Table IV) which does not agree with the general opinion.

Table IV. Degrees of Destruction of Mastoid Process in Children and Adults.

	I	II	III	0	
Children	16	44	36	4	per cent
Adults	13	30	53	4	» »

It is natural to suppose that there exists a certain proportional relation between the diffusion of the otitis and the duration of the primary acute middle-ear suppuration, so that diffuse destruc-

tion of the osseous tissue in the mastoid process would be found particularly in those cases, where the middle-ear suppuration had been of long duration. A closer investigation of my material confirms this supposition, but it also shows that the percentage for the cases of total destruction of the interior of the mastoid process is only c. 10 per cent greater in those where the suppuration in the middle-ear had lasted over 8 weeks, than in those where the duration had been less. Further it was just in the group of children, whose middle-ear symptoms had lasted less than a week, that a strikingly high number of cases were seen with the most diffuse destruction of the mastoid process.

Finally it may be stated that mastoid operation was most frequently performed when the otitis had lasted over 1 but less than 2 weeks; next in frequency were those cases where the primary middle-ear inflammation had lasted 2 weeks, then 4 weeks, then less than 1 week, then 3 weeks etc.

We must, from the above, suppose that it is only in a lesser degree, that diffuse mastoidal otitis is due to the duration of the primary middle-ear suppuration, and that other factors enter here. Of these factors, there would seem to be ground for supposing, that the nature of the infection, in combination with special anatomical conditions, play the decisive part.

Periostitis of the Mastoid Process.

Acute middle-ear suppuration is well known to be extremely often accompanied by signs of acute periostitis of the mastoid process, and that especially when it is complicated with acute otitis in the mastoid process. The two principal forms, under which acute mastoidal periostitis appears, is characterised, as far as the one is concerned by diffuse swelling and tenderness (often in combination with redness and heat of the skin) of the integuments above the mastoid process, especially over the fovea and its vicinity; as far as the other is concerned, by the formation of subperiosteal abscess.

The former form, the non-suppurative periostitis, is of widely different importance as it appears together with the first sym-

ptoms of acute middle-ear suppuration, or it appears in a later period, or, eventually, continues after the first symptoms of middle-ear suppuration diminish, the pains in the ear and temperature decreasing, the secretion increasing etc.

The initial mastoidal periostitis namely often disappears entirely, even in cases where it has been very pronounced. It is necessary to emphasise this circumstance, as it is a general opinion among general practitioners that, especially when the objective signs are highly developed and there is also great pain and high temperature, immediate mastoid operation is demanded. Numerous patients are sent to the hospital with the notification that they require this operation, when this is not the case and when, in due course, the primary acute middle-ear suppuration has been cured under conservative treatment.

When, on the opposite, the mastoidal changes either persist or appear at a later period of the primary otitis, the conditions — and that especially in the later case — are quite otherwise. They are, namely in the great majority of cases, an expression of an acute otitis, requiring operative treatment.

Subperiosteal Mastoid Abscess.

When the mastoid periostitis is of a suppurative nature, the suppuration can, as we know, force its way out to the surface through a necrosis in the periost, and extend under the skin. There thus arises a subcutaneous abscess in the mastoidal region. Such an abscess may, in some few cases, arise from decay of the glands in this region; on incision, the operator will find the periost intact at the bottom of the abscess. It is much more frequent that the suppuration diffuses itself out into the subperiosteal cavity in the mastoid region, causing a subperiosteal abscess.

The great frequency of the subperiosteal abscess in the progress of an acute middle-ear suppuration, will appear clearly from the present material. If we subtract the 83 cases of relapse, in which pus was always found under the scar in the mastoid region, and therefore cannot justly be considered as cases of subperiosteal abscess, it will be seen that in the 917 resections of table I, there

were 281 cases exhibiting subperiosteal abscess, i. e. subperiosteal abscess was found in no less than 30 per cent of all the cases. Of these 281 resections 238 were performed upon children, making the percentage in the children's group rise to above 40 per cent, whilst the corresponding percentage in the adult class was only slightly above 13. In other words subperiosteal abscess is about 3 times as frequent in children as in adults.

In a former work I have pointed out, that the subperiosteal abscess in the mastoid region is so extremely frequently an expression of the presence of acute otitis in the mastoid process, that it becomes an indication for resection. A closer investigation of the present material shows that in only 4 cases was no otitis found by surgical autopsy, i. e. in only 1.4 per cent of the cases.

The extension of otitis in the mastoid process, in cases which also exhibit subperiosteal abscess, is, according to the present material exactly corresponding to the cases which exhibit no such abscess. On the other hand, cases with subperiosteal abscess enjoy a lower mortality. This is evident from the circumstance, amongst other, that of the adults, who died, only 5 had subperiosteal abscess, i. e. 10 per cent, and among children who died only 10, i. e. 20 per cent, whilst the corresponding figures, for the whole number of cases, was, as will be remembered, respectively 13 per cent and 40 per cent. A closer investigation of the individual cases shows, that this condition is an exact expression for the circumstance that intracranial complications are comparatively rare in conjunction with subperiosteal abscess. In several former works, I have shown, that intracranial complications appear with striking frequency, without there being any external mastoidal changes. It would seem, therefore, that we are justified in saying, — quite broadly — that inflammatory phenomena in the middle ear, which are more conspicuous towards the surface of the mastoid process, are least likely to spread inwards towards the interior of the cranium, and vice-versa.

The circumstance, that there are often slightly developed or no external mastoidal changes in intracranial complications during the course of acute middle-ear suppuration, should warn surgeons against placing a one-sided importance, when there is a question of resection of the mastoid process, upon the absence of mastoid peri

ostitis. The present material shows also, that diffuse and threatening ostitic changes in the mastoid process can be met with, without there being infiltration or tenderness of the mastoid region. Altogether out of the 879 mastoidal operations, in which ostitis was found in the mastoid process, no less than 194, or 22 per cent, showed no swelling or tenderness in the mastoid region, and in several of these cases the ostitis was very extensive.

Labyrinthitis.

The proportion of labyrinthitis as a complication of acute middle-ear suppuration is such a large and complicated question, that the contribution which this material can give to its elucidation will be the subject of a special treatise.

I will here only state that there, answering to 1,000 operated ears, appeared distinct signs of labyrinthitis 12 times in children and 23 times in adults i. e. respectively in 2,4 and 7,0 per cent of all the cases.

Slighter Forms of Intracranial Complications.

To the slighter forms may be reckoned episinuitis, episinuous abscess, external pachymeningitis and epidural abscess. They have all one thing in common, viz. that they in themselves are never fatal. The severe forms include trombophlebitis, meningitis, brain-abscess and subdural abscess, these being, as is well known, often fatal.

Episinuitis. This complication, which shows itself by deposits of inflammatory products, especially of graulations in and on the outer surface of the walls of sinus sigmoideus, is the most frequent of all intracranial otogenic diseases. It was found namely in 106 of the 1,000 operations, i. e. in 10,6 per cent. In 45 cases, i. e. 7 per cent, the patients were children, in 61, i. e. 17 per cent, adults. Most frequently this affection is of no importance, but in 25 cases it appeared in company with trombophlebitis, evidently forming the connecting link in the propagation of the inflammation from the mastoid process.

Perisinous Abscess. A circumscribed accumulation of pus on the outer side of the walls of the sigmoid sinus was found in 67 operations, i. e. 6,7 per cent of these. In 29 cases the patients were children, in 38 adults, giving a percentage of relatively 4,5 per cent and 10,5 per cent. The importance of this complication must also be principally sought in the circumstance that it forms a connecting link between the ostitis and the trombophlebitis present in 18 cases.

External Pachymeningitis. The inflammatory products one finds on the outer side of the dura mater are, also, nearly always granulations. They appeared 9 times in children and 17 times in adults, i. e. respectively 1,4 and 4,7 per cent of the operations performed.

Epidural Abscess. Accumulations of pus outside of the dura mater were found 3 times in children and 7 times in adults, i. e. in respectively 0,5 and 2,0 per cent of the operations.

It will be seen from the above that the slighter forms of intracranial complications appeared much more frequently in adults than in children.

Trombophlebitis of the Sigmoid Sinus.

Of the 1000 operations, inflammation of the walls of the sigmoid sinus combined with formations of a clot, was found 52 times, i. e. in 5,2 per cent of the cases. Of these cases 28 were children and 24 adults. This complication would thus seem to be comparatively more frequent in adults as the percentage is respectively 4,2 and 7,0. After operation trombophlebitis was developed once in a child and 3 times in adults; in two of the latter cases this was due to an accidental lesion of the sinus during operation.

The above mentioned 56 cases of trombophlebitis referred to 55 patients, as one patient was operated on both sides for this complication. Of these 55 patients 33 recovered, i. e. 60 per cent, a result, which is about the same as I published in a paper three years ago, where the causal middle-ear suppuration was either acute or chronic. The case for children is especially favourable as 20 of these, i. e. 71 per cent recovered.

It is a well known fact that otogenic sepsis now and again gives rise to metastatic lesions of the joints, the bursae, etc. It is remarkable in these cases of metastasia that such cases offer a particularly favourable prognosis, if either an acute or chronic middle-ear suppuration is the cause, and even if the case is a severe one. In the many cases I have, in the course of years, had under treatment, I have only twice lost patients with metastatic lesions of this kind. In the present material there were 7 cases, among which a pyarthron of the kneejoint, all ending with recovery; the remainder were serous forms.

Finally, I may state that trombophlebitis was, 10 times in children and 9 times in adults, complicated with meningitis.

Meningitis.

Otogenic acute diffuse leptomeningitis appears according to my experience, under two clinically different forms, which, however, certainly form a pathological anatomical unity: The diffuse purulent leptomeningitis and the »collateral meningitis».

The diffuse purulent meningitis, which is the most frequent form is — besides by the appearance of subjective and objective meningitic symptoms — characterised by the lumbar puncture giving a cerebro-spinal fluid which is turbid, there being found a preponderance of polynuclear cells, also frequently bacteria in the fluid. It generally is fatal, death occurring after a few days or in the course of a week.

»Collateral meningitis», which appears predominantly in younger individuals, displays the same subjective and objective symptoms of diffuse meningitis, but as a rule, slighter. The cerebrospinal fluid is clear, containing from 3 to 150 or 200 cells per cubic millimeter. Most often the mononuclear cells preponderate and the fluid is always sterile. This form most frequently ends by recovery.

In calculating the frequency with which otogenic meningitis appeared, it is not permissible to take the number of mastoid operations performed as a basis for the figures, as in several cases — altogether 7 children and 1 adult — a bilateral resection was per-

formed, as it was uncertain in which of the diseased ears the meningitis had arisen.

Meningitis was found on operation in altogether 30 children, i. e. 6,0 per cent, and in 33 adults, i. e. 9,1 per cent of the whole number. Meningitis is, then, the intracranial complication in which preponderation of the adult classes is least pronounced. Further, post-operative meningitis developed in 3 children, of whom 2 recovered, and in 5 adults, who all died. The percentage of recovery was considerably higher among children than adults, the figures being respectively 15 recoveries, i. e. 46,0 per cent for the former and 4 recoveries, i. e. only 10,5 per cent for the latter.

A combination of meningitis and trombophlebitis appearing in children, during the course of an acute middle-ear suppuration, would seem to offer a specially favourable prognosis, as 5 of 10 cases were cured, i. e. 50 per cent. This is doubtless due to the meningitis in these cases, as a rule, being secondary to the trombophlebitis and of the kind I have called «collateral meningitis», which, as I have just stated, offers an especially favourable prognosis.

With respect to the road by which the infection in middle-ear suppuration finds its way to the leptomeninges, my material shows the following. In 20 cases it seemed that the meningitis was labyrinthogenic, as they had distinct symptoms of disease of the inner ear. In 12 cases pathological changes were found on and in the dura mater, and it was, therefore, reasonable to deduce that this was the road taken by the inflammation. These cases include both the patients who exhibited meningitic symptoms before the mastoid operation and those who developed meningitis afterwards.

Cerebral and Subdural Abscess.

Cerebral Abscess was found in two children and 4 adults; 2 of these 6 patients recovered.

Subdural Abscess. This intracranial complication appeared 3 times in children, twice in adults. All these died.

Abscesses of the Neck.

There are still other surgical complications to be mentioned, namely, formation of abscess within the fascia of the sternocleidomastoid muscles, also abscess formed inside the deep fascia of this muscle, and finally abscess of the lateral region of the neck.

Abscess of the Sternocleidomastoid Region. It is not a rare thing to find, that an otitis in the apex of the mastoid process, or an accumulation of pus in the terminal cells, has caused, generally by perforation of the wall of a terminal cell, an abscess lying either directly inside the fascia of the sternocleidomastoid muscles or in the muscular tissue itself, or, what is more frequent, deeper than the deep fascia of the sternocleidomastoid muscles. In the latter case we get a form of osseous mastoiditis, which has been given the name of »Bezold's mastoiditis». Abscesses of this kind appeared 11 times in children and 22 times in adults — was therefore both absolutely and, especially, relatively much more frequent in adults. They easily escape notice when in an early phase, therefore one should have their possible existence well in mind in all cases, in which the point of the mastoid process is diseased.

Abscess in the Posterior Triangle of the Neck. This form of abscess was found 7 times in children and 7 times in adults, giving a relatively greater frequency to the latter class.

Mortality of the Surgical Complications.

As will be seen from table I mastoid operations for surgical complications, which arise during the course of an acute middle-ear suppuration, have a considerable mortality rate, namely 12,2 per cent; in the children classes 10 per cent, in adult classes 15,3 per cent. The mortality is still higher in the class for infants under 1 year old (18 per cent), and in the class between 50 and 60 years it rises to 37,5. It is lowest between 15 and 29, viz. 5,0 per cent.

This high rate of mortality is principally due to the appearance of the 4 frequently mentioned severe intracranial complications. This does not, as before mentioned, hold good for the age class under 5 years, in which there were only 9 patients of this kind.

As the mortality rate in cases of intracranial complication has been already touched when treating of the same, I will not here go further into this question, but will only quite briefly speak of the mortality rate in general and in uncomplicated otitis of the mastoid process.

As far as this latter complication is concerned, the mortality rate is very different when we have to deal with patients in the infant class (under 1 year) and with patients in the age classes above this.

The enormous mortality among infants proves, on closer investigation, to be due to the circumstance that a great many of the patients, at the time of operation, suffered from tuberculosis or rachitis or were atrophic. Bilateral resection of the mastoid process in rickety children, even when well nourished, is fatal in a strikingly large number of cases. I am, therefore, of opinion that the surgeon should be reserved with his indications for resection in such cases, and should if possible avoid universal narcosis. It is often difficult to determine the cause of death in rickety infants operated upon, as the post-mortem examination often shows only less important changes in the organs.

Tuberculosis and rickets, as cause of mortality, play also important parts in mastoidal operations for uncomplicated otitis in the mastoid process, in the age class from 1 to 4 years.

Taking the child-classes, however, on the whole, it must be said, that, when the patient is healthy, one sided mastoidal operation quite exceptionally leads to fatal results. In only 8 cases, i. e. 1,6 per cent was it probable that death was a result of operation and in 7 of these cases the cause of death was pneumonia caused probably by ether which was used in nearly all cases operated upon. As a contrast to this I may mention that in only 1 adult case was death caused by pneumonia after operation. My experience has also been that patients with pneumonia as a rule stand ether narcosis remarkably well.

Of the 268 adults with uncomplicated otitis (viz. without any of the 4 often mentioned severe intracranial complications being present at the time of the operation) 12 died, i. e. 4,5 per cent. The cause of death was in 1 case — as stated before — pneumonia, in 2 cases erysipelas and in 9 post-operative intracranial lesions.

Among the cases of post-operative thrombophlebitis there were, however, several, in which it was justifiable to doubt whether the disease had not been present at the time of operating. This intracranial complication has, according to my experience, a short period of latency, during which there is no rise of temperature or the temperature is not of septic character, and when puncture or incision of the sigmoid sinus yields fluid blood and no sign of the formation of a clot. In several such cases it has been possible to prove by means of the microscope inflammation in the walls of a part of the sinus excised in operating and also the commencement of the formation of a blood clot. In the majority of cases of post-operative intracranial operations it was impossible to discover the cause of the infection spreading from the petrous bone in to the contents of the cranium. The cases, in which meningitis appears several weeks after operation are especially enigmatical.

Concluding Remarks.

There is, on the whole, in many cases, something enigmatical in the appearance of the surgical complications in acute middle-ear suppuration, as they often show themselves in patients, whose general condition is excellent, where the discharge is copious through a large perforation of the drum head, or where there is good drainage with no signs of retention etc. In this connection, I may repeat the fact that, — in spite of there being an otitis in the mastoid process in the majority of cases of otogenic cerebral complication — it is remarkably frequent that all signs of such in the mastoidal region are wanting.

This circumstance induced me, as early as 1909, to express the supposition, that there must be special anatomical conditions in many individual cases, which are favourable to the spread of the inflammation from the primary focus to the contents of the cranium. That this supposition is correct has been proved by K. Wittmaack in his work published by him in 1918 (*Ueber die normale und die pathologische Pneumatisation des Schläfenbeines*). On the basis of a number of investigations this author has come to the result, that there can, in cases of otogenic intracranial lesions be proved

abnormal and quite considerable connection between the vessels of the mucous membranes in the middle-ear and in the pneumatic cavity in the mastoid process (where in such cases there is a deficient development of these cavities) on the one side, and the vessels of the dura mater on the other; also that the inflammation has travelled by this road. It is, thus, much easier to understand the pathogenesis of otogenic diseases, their tendency to sudden and unexpected appearance and finally their independence of such causal moments, as are well known in surgery to be of the greatest importance in the propagation of inflammation. One understands, that in many cases the complications are accidental and unavoidable and that their prophylactic treatment, -- be it either operative or otherwise --, frequently is of no avail.