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N. RH Blegvad

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Local Anaesthesia in Oto-Laryngology with special Reference to Conduction Anaesthesia.

By N. RH. BLEGVAD

Copenhagen.

During the last ten years the use of local anaesthesia in major surgical operations has gained a high position and there is to-day a movement through the surgical world which desires that all operations, which in any way allow of it, should be carried out under local anaesthesia. This movement has naturally also extended to oto-laryngology, and yet I do not think that it has obtained the strength which it ought to have, and I am especially of the opinion that local anaesthesia in major operations in our speciality cannot up till now congratulate itself on the popularity which it deserves.

The advantages of local anaesthesia are clear. We avoid, in the first place, the dangers associated with narcosis. To the risk which is usually run in every narcosis is added that which is peculiar to operations on the upper air passages, namely the danger with regard to respiration. Not only fluid material, such as blood and pus, may be inspired but also solid bodies such as extirpated tissue. I only need to name the numerous cases of pulmonary abscess after tonsillectomy under narcosis, which have been made public in America during recent years, and the result of which has been that the demand for local anaesthesia in tonsillectomy is arising in America with increasing force. In operations on the nose and the accessory sinuses the danger of aspiration can be much mini-

mized by the use of K u h n's peroral intubation but it ought to be recalled that in C h i a r i's clinic in Vienna out of 59 operations under peroral intubation no fewer than 4 deaths occurred, which were the direct result of intubation narcosis (S c h l e m m e r, Wiener klin. Wochenschrift 1913, Nr. 45). Further by using local anaesthesia narcosis-vomiting is avoided. This is a powerfull argument with war-surgeons, who lay great weight on patients having something to eat immediatly after operation (S c h l e m m e r, Archiv. f. Laryngologie, vol. 32, Nr. 2. and L a u r e n s, Soc. franç. d'oto-rhino-laryng., congrès de 1919. pag. 49). And lastly haemorrhage is avoided, which is, in itself, in many cases, of importance for the patient, especially in the case of one who is already anaemic and weak; but the diminution of haemorrhage has also the effect that the operation itself is made more satisfactory and can be completed in a shorter time. In spite of these especially great advantages the method as I have said, is not yet as popular as it ought to be. The reasons for this are easy to indicate. In the first place operations carried out under local anaesthesia are technically more difficult than those under narcosis. The operator must be completely master of the technique of local anaesthesia and he must have patience, so that, if even one portion of the field of operation is not completely anaesthetized, he will stop the operation and again take up the novocaine syringe or the cocaine pencil. He must not, during the operation, allow himself to drag or tear the tissues with retractor or forceps; he must not press his arms or hands on the patients throat or chest; he must not use unnecessary force in the evacuation of pus or blood, and he must be careful about what he says, for the patient hears all his remarks and can easily be made uneasy. But another, and most important cause of the difficulty of gaining adherents for local anaesthesia amongst patients is this, that it is not always what it ought to be, that is to say *a complete anaesthesia*. And it is in the attainment of complete anaesthesia that conduction anaesthesia shows so marked a progress that I am anxious to draw attention to the fact that we have here a method which is, at the same time, much more thorough than infiltration anaesthesia and also much more rapid.

Conduction anaesthesia came first into use for fingers and toes, that is to say, by an injection of cocaine into the proximal

phalanx of a finger or a toe, anaesthesia was produced into the corresponding finger or toe, contemporaneously with the application of an E s m a r c k's bandage (O b e r s t, 1888). The american surgeon M a t a s, as early as the year 1900 employed conduction anaesthesia on the head for the infraorbital nerve, but when first, in the year 1905, the discovery of novocaine made injections of large quantities of anaesthetizing solution possible, a possibility of the extended application of conduction anaesthesia to the larger nerves was created. For conduction anaesthesia of the scalp a much greater progress was indicated when we began to inject novocaine into the branches of the trigeminal nerve at the point of exit from the skull. For the working out of this technique we have to thank the Munich ophthalmologist S c h l ö s s e r (1903), although he did not use this method for the production of anaesthesia, except in the injection of alcohol into the nerves for neuralgia.

It was B r a u n (P e u c k e r t, *Archiv. f. klin. Chir.* 1910. vol. 66, pag. 377 and B r a u n, *Deutsche Zeitschr. f. Chir.* 1910. vol. 107, pag. 561 and 1911, vol. 111, pag. 321) who applied S c h l ö s s e r's technique of novocaine injection to nerve trunks and to whom thus belongs the honour of having introduced this form of conduction anaesthesia to surgery. On a foundation of careful investigation O f f e r h a u s (*Archiv. f. klin. Chir.* 1910. vol. 92, pag. 47) lays down accurate directions for the carrying out of injections into nerve trunks at their point of exit from the foramen ovale and the foramen rotundum.

Conduction anaesthesia consists, as is known, in the injection of novocaine either into, or in the neighbourhood of, a nerve, thus producing insensibility in the environment surrounding the whole periphery of the nerve. In our speciality conduction anaesthesia can be used first and foremost for the branches of the Trigeminal: the frontal nerve and the naso-ciliary nerve in frontal sinus operations, the anterior and posterior ethmoidal nerves in operations on the ethmoid and on the lacrymal sac, the maxillary nerve in operations on the maxillary sinus and also eventually on the septum nasi and the turbinates, the auriculo-temporal nerve and the auricular branche of the vagus in operations on the ear, and the superior laryngeal nerve and the cervical plexus in operations on the larynx and trachea.

First a few words about the technique in general. We always use K o c h m a n n's preparation of potassium sulphate in 0.4 % solution, by means of which the effect of the novocaine is perceptibly increased, so that the same result can be obtained with a weaker solution of novocaine (half the strength, perhaps even weaker). A sterile solution, consisting of 7 grams of sodium chloride and 4 grams of potassium sulphate dissolved in 1,000 ccs. of distilled water is used. In this is dissolved H o e c h s t's novocaine tablet B. which contains 10 centigrams of novocaine and 0.25 milligrams of suprarenine. After boiling the fluid is ready for use. For conduction anaesthesia I use a 2 % solution (that is to say 2 tablets to 10 ccs of the fluid), for infiltration anaesthesia a $\frac{1}{4}$ to $\frac{1}{2}$ % solution (one tablet to 40 or 20 ccs of the fluid). An hour before all major operations the patient is given an injection of an ampoule containing 0.3 milligrams of bromide of scopolamine and 2 centigrams of pantopone. This injection contains so little scopolamine that it is quite safe and it reduces the patient's psychic irritability so that it comes to pass that the patient, during the whole operation, lies comfortably half asleep. With regard to the dose of novocaine B r a u n lays down (Oertliche Betäubung, Berlin 1919), that 250 ccs of a $\frac{1}{2}$ % solution can be injected without any risk whatsoever, containing 1.25 grams of novocaine, and 40 ccs of a 2 % solution, that is 0.30 grams of novocaine. W e s s e l has a somewhat weaker dose (Klinisk Aarbog 1916) since he does not inject more than 0.30 grams of novocaine and 0.00025 grams of adrenalin on the head. In our speciality it is seldom necessary to go so far; the largest quantity I have used is 0.28 gram of novocaine with a doublesided maxillary sinus and ethmoid operation. For the injection an ordinary graduated record-syringe is used. The barrel must not be too thin, at least not for a deep injection. When F i s c h e r's syringe is used it may happen that the barrel breaks and it happened on several occasions that the piece could not be found (see for example M a x M e l c h i o r, Tandlægebladet 1921. Nr. 2). This can certainly be avoided if a sufficiently thick and strong barrel is used.

Contra-indications. According to B r a u n (Oertliche Betäubung, V. Aufl. 1919) we do not know, for certain, of any death after novocaine. C l a u s has reported two cases but the deaths

occured here some time after the novocaine injection and as the immediate result of a diagnostic insufflation of air into the maxillary sinus. And we now know that it is exactly this procedure which is extraordinarily dangerous and which can result in death, and therefore it would be wrong to place these deaths to the account of novocaine. *Braun* relates a case of death which happened in the practice of a dentist named *Balzer*. This death is, according to the description that *Braun* gives of it, identical with that which a danish doctor (not a dentist) *Baltzer Christensen* published in *Ugeskrift for Læger* 1910, pag. 321. It concerned a woman, 23 years of age who died 6 hours after an injection of 6 centigrams of novocaine and 0.27 milligrams of suprarenine. It is scarcely to be believed that the 6 centigrams of novocaine caused the death. On the contrary the suprarenine which was used played a possible part. The Editor of *Ugeskrift for Læger* states in a footnote to *Baltzer Christensen's* paper that the maximum dose (not the lethal dose) of suprarenine is 0.30 milligram. More recent experiences do not, however, agree with this. Since suprarenine has begun to be used in asthma by subcutaneous injection, it has been seen that doses of $\frac{1}{2}$ —1 milligram in a 1 % solution are harmless (*Braun*). *Fischer* (reference by *Möller*, *Deutsche zahnärztliche Wo.* 1910, vol. 13, pag. 35) is of opinion that the death referred to was the result of acute sepsis. As a postmortem was not made it is quite impossible to make any definite pronouncement as to the actual causes which led to death. In the year 1920 a death occurred again here in Denmark after a novocaine injection (*Max Melchior*, *Tandlægebladet* 1921, Nr. 2). The patient was a woman of 58 years of age who had had 22 confinements and who had no cardiac weakness. A dentist injected 10 ccs of a 1 % solution of novocaine into the upper and lower jaws. The solution was composed of one *Hoechst's* tablet B, which contains 0.25 milligrams of suprarenine. The patient died 5 hours after the injection. At the autopsy the cause of the death was found to be cerebral haemorrhage, therefore it would be highly improper to set this down as a death due to novocaine but naturally it cannot be denied that suprarenine, which, as we know, raises the blood pressure, may contribute to the occurrence of cerebral haemorrhage. In the 6.th edition of his text-book (1921)

Braun refers to three additional cases of sudden death from heart failure after injection of novocaine:

- 1) Brütt (Deutsche med. Wo. 1918, pag. 577) the same which is related below by the american committee.
- 2) Wiemann (Zentralbl. f. Chir. 1919, pag. 698).
- 3) Hering (Zentralbl. f. Chir. 1920, pag. 827).

In all 3 cases death supervened after the paravertebral injection of relatively small doses:

A committee was set up a year or two ago by the American Medical Association consisting of the laryngologists Emil Mayer, Ross Hall Skillern and Robert Sonnenschein, to investigate the question of the advantages and drawbacks of the different local anaesthetics in otolaryngology. The committee's reports is published in The Laryngoscope 1920, pag. 443 et sequ. In literature the committee found 3 cases of death through novocaine:

- 1) Wright (Journ. Lancet Minneapolis 1918, pag. 714): prostatectomy, intraperitoneal injection of 1,1 grain of novocaine, i. e. 6,6 centigrams of novocaine. Death after 28 hours.
- 2) Shoemaker (Surg. gyn. and obstet. may 1919, pag. 528): Subcutaneous injection of $2\frac{1}{2}$ cc 5 % novocaine.
- 3) Brütt (Deutsche med. Wo. 1918, pag. 577): A woman, aged 29, strumectomy. Injection of 140 ccm $\frac{1}{2}$ % novocaine (before the operation 0,0005 scopolamine and 0,01 morphine). Collapse immediatly after operation. Death $\frac{1}{2}$ hour after.

The committee sent out a complete inquiry form to the members of the American Medical Association. 85 % of the members answered the questions. By this means informations was obtained regarding 20 new deaths which, however, in 14 cases resulted from the injection of cocaine. In some of these cases death occurred immediatly after the injection into the tonsils of 10 % or 20 % solution of cocaine (in mistake for $\frac{1}{10}$ or $\frac{1}{2}$ %). In 4 cases death ensued after the injection of novocaine:

- 1) After the use of 1 drachme (= 3,7 cc) $\frac{3}{4}$ % solution for the tonsils.
- 2) A woman aged 30. First a 10 % solution of cocaine was painted on. Then an injection of 2 drachmes (= 7,4 cc) of a $\frac{1}{2}$ % solution of novocaine, for a frontal sinus operation,
- 3) A woman aged 23. 100 minims (= 6 cc) of a $\frac{1}{2}$ % solution of novocaine was used for injection into the tonsils.
- 4) A soldier in France. First there was two paintings with a 10 % solution of cocaine. After this 5 drachmes (= 16,5 cc) of a $\frac{1}{2}$ % or 1 % solution was injected into the tonsils.

In many of the cases the amount of novocaine involved was so small that it must be assumed that the patients concerned had an idiosyncrasy in regard to the substance. Thus novocaine is not quite without danger, but when we take into consideration what an extraordinary large number of novocaine injections have been used during the last 16 years, we must admit that the danger of local anaesthesia by the injection of novocaine is very small.

There are no contra-indications for the use of local anaesthesia in children. B r a u n asserts rightly that it is due to a misunderstanding when it is taught that local anaesthesia cannot be employed in their case. L u c (Rapport présenté à la soc. franç. d'oto-rhino-laryng. Congrès de 1912) has removed the septum in a nervous child of 7 under local anaesthesia. I have performed the same operation in a 10 year old child and also a total resection of the middle ear in a 16 year old child under local anaesthesia, and have carried out a double maxillary antrum operation in a 14 year old girl under conduction anaesthesia. L u c (loc. cit.) advises that, in choosing between local and general anaesthesia in the case of children, the surgeon should take the wishes of the parents into consideration: some parents are very nervous regarding the dangers of general anaesthesia, others are particularly tender towards their child and are afraid of it suffering pain. L u c's advice is certainly good in many cases, at least in so far as we may allow the parent's wishes to have influence on our decision, but in the last event we ought, in my opinion, to take up the position that it is the doctor, and not the patient, who, in the capacity of expert, should settle whether an operation should be carried out under general or local anaesthesia. One is naturally, of course, entitled to give a certain weight to the patient's wishes, when there is a question of a very frightened and nervous patient, who perhaps, has previously been exposed to a less successful local anaesthesia; but, even with nervous patients, we can almost always carry out an operation under local anaesthesia if we only give beforehand scopolamine-pantopon, and if the doctor manages to soothe the patient by his assurances.

Should it happen during the course of the operation, that, through an isolated manipulation, there is some perception of pain, the patient can be given a few whiffs of ethylchloride or ether, as

long as the painful impression lasts. This combination of local and general anaesthesia is often to be specially recommended. I have often, for example, used it with success in total resection of the middle ear, where it may be difficult to obtain complete anaesthesia of the cavum tympani; we can then spare the patient by giving a whiff of ether during the excochleation. This narcosis is of the same degree as obstetrical narcosis and only requires a small quantity of the anaesthetizing fluid.

The absolute indication for local anaesthesia presents itself in cases which exhibit contra-indications for general anaesthesia, thus in greatly enfeebled patients and (according to L u c) with patients suffering from grave hepatic disease whenever there is danger of their developing serious jaundice after narcosis. Further in patients with diabetes. The grave prognosis in operations on the ear amongst diabetics is due, in the first place, to the narcotizing fluid (L u c) and therefore general anaesthesia ought to be absolutely ruled out with such patients.

I shall now pass to the technique in individual areas and shall begin with conduction anaesthesia of the *Maxillary Nerve*, the second division of the trigeminal. This nerve and its spheno-palatine ganglion is found in the pterygo-palatine fossa, which the nerve crosses, when, coming from the foramen rotundum, it runs into the infraorbital canal. The pterygo-palatine fossa can be reached in two ways; either through the orbit, which I have never attempted, or through the cheek, a method which was — as said above — invented and worked out by *Offerhaus* (Archiv. f. Klin. Chir. vol. 92. 1910. p. 47). The distance from the skin of the cheek to the fossa is about $5\frac{1}{2}$ cm. and this distance can be measured off with a piece of cork on the canula (of the syringe) but this is really not necessary as it can be felt when the point of the canula slips right through into the fissure. *Offerhaus* holds that the canula should be inserted about 1 cm. below the lower border of the zygoma and immediatly in front of the edge of the masseter, which can be felt by causing the patient to clench his teeth. To begin with I followed *Offerhaus'* directions but I have learned by experience that one gets in more easily by choosing a spot for the puncture a little further back, about 1 cm. in front of the ramus of the jaw, the anterior edge of which can be

felt through the skin of the cheek. If, namely, the needle is inserted too far in front one risks that the prominent maxillary tuberosity forces the canula so far back that it knocks against the lateral lamina of the pterygoid process and cannot get into the fossa, a fact of which one can readily convince oneself by inspecting a skull. Before the injection the spot for the insertion of the needle is marked out, and this is anaesthetized by a little injection of novocaine into the skin. The direction in which the syringe ought to be inserted — if we imagine the head in the upright position — is almost straight inwards, and somewhat upwards in the frontal plane of the head. When we penetrate a little way we come up against the maxillary tuberosity, which we will pass behind, as near to the tuberosity as possible. When we get down about 5 cm., we, as a rule, knock against the lateral lamina of the pterygoid process with the point of the syringe. The syringe must now come a little further forward in order to penetrate into the pterygo-palatine fossa. Generally it must also be directed a little further upwards since at first it almost gets too low down. The fissure, as we know, is narrow in a downward, and wide in an upward direction, and the further up one goes the easier it is to penetrate into it. It is often difficult to alter the direction of the syringe when the latter is so far in; then there is nothing to do but to pull it a good way back and to push it in again. It is absolutely necessary to go on in this way until one reaches the fossa. It may happen that one must repeatedly withdraw the syringe before one succeeds in getting in it but it happens with increasing frequency that one more and more often hits the spot at once. A certain amount of daring is required at first to carry out the procedure, and one must not allow one self to be frightened if there is haemorrhage beneath the skin with the formation of a haemotoma. This can, indeed, in many cases not be prevented, unless the exact spot is at once reached, whenever the needle passes the larger pterygoid venous plexus, but it has no great importance, further than that it causes some swelling of the cheek some time after operation. In most cases one will be lucky enough to find the nerve itself. In such cases the patient, simultaneously, experiences a sudden pain, which spreads over the cheek and teeth and the patient is observed to make a marked grimace. When

the nerve is found 2 ccs. of a 2 % solution of novocaine must be injected into the fossa; when it is not certain that the nerve is reached 4 ccs. must be injected. In like manner 2 ccs. are injected on the maxillary tuberosity; this is best done during the withdrawing of the needle from the fossa, when it glides exactly alongside the tuberosity. Should the nerve be found we can see how almost at once ischaemic patches arise on the skin of the cheek as an indication of the commencing contraction of the blood vessels, corresponding to the area supplied by the nerve, and simultaneously anaesthesia ensues. If the nerve is not found it is necessary to wait $\frac{1}{4}$ — $\frac{1}{2}$ an hour; one can find by tasting with a needle on the cheek and the labio-buccal sulcus, whether anaesthesia has ensued.

Conduction anaesthesia of the second division of the trigeminal nerve comes first and foremost into use in operations on the maxillary antrum, which I always carry out according to Denker's method, since this method appears to me to allow of a better survey of the antrum than L u c-C a l d w e l l's — and since — with a successful conduction anaesthesia, it is not more unpleasant for the patient than L u c-C a l d w e l l's. If the maxillary nerve is completely paralysed, as it is in a successful conduction anaesthesia, there are only a very few points, which, in a maxillary sinus operation, are not found to be completely anaesthetized, but forwards, in the labio-buccal sulcus, at the frenulum, the mucous membrane is often innervated from the opposite side, so that a little $\frac{1}{2}$ % solution of novocaine must be injected under the mucous membrane there. The foremost part of the lateral wall of the nose, including the inferior turbinate, is innervated from the first division of the trigeminal, through the anterior ethmoidal nerve. In order to anaesthetize this area, conduction anaesthesia may be employed, and I have done this several times and this method would naturally be used if one were doing an ethmoidal operation at the same sitting, but in operation on the maxillary sinus alone one can extraordinarily well content oneself with infiltration anaesthesia; by injection through the nares, partially into the inferior turbinate, and partially into the lateral nasal wall, and moreover — after the periosteum in the canine fossa has been reflected — by carrying out an injection round the pyriform aperture, and especially subperiostially, into the inferior meatus.

I have used conduction anaesthesia in 39 Denker's operations. Only in 6 cases was the anaesthesia so poor that I was obliged to employ infiltration anaesthesia, but these 6 cases all occurred in early days, when I was not so courageous as I am now in persevering with my search until the canula was undoubtedly placed in the pterygo-palatine fossa. It happens very rarely now that the anaesthesia is incomplete and even in the 6 cases already mentioned the mucous membrane of the maxillary fossa was anaesthetized without it being necessary to paint it with cocaine, and it is just on this very spot that it is often difficult to obtain good anaesthesia with the infiltration method. It is astonishing how complete the ischaemia is in most cases with conduction anaesthesia. In an isolated case some bleeding occurs from the artery of the bone, otherwise the operation was completely bloodless. In 2 cases there was some delayed haemorrhage from the inferior turbinate whose anterior lower portion was exercised, but this cannot be laid at the door of conduction anaesthesia.

Further I have carried out 24 operations for ozoena, following Lautenschläger-Halle's method, under conduction anaesthesia. In 20 cases the anaesthesia was perfect, in 2 quite good and in 2 poor.

As the maxillary nerve also innervates the whole of the posterior and lower portions of the septum and as it is difficult to obtain a good infiltration anaesthesia in this area, I have carried out conduction anaesthesia of the maxillary nerve in 9 cases of submucous resection of the septum, but only in 2 cases with complete anaesthesia, in 2 with fair and in 5 with poor anaesthesia. But as a good anaesthesia in resection of the septum can be sufficiently attained by the old method (vide below) and as the procedure — a bilateral anaesthetizing of the maxillary nerve — is a rather large one, I cannot recommend conduction anaesthesia of the maxillary nerve in resection of the septum.

I have not met with any untoward results following injection into the maxillary nerve. As the canula passes close to the internal maxillary artery and the large internal pterygoid venous plexus, one cannot always avoid, as I have already said, coming upon a large vessel, with the result that a haematoma develops in the cheek, which sometimes may attain a considerable size, but, as

already stated, this is of no greater significance. In one case -- as the result of novocaine reaching the orbit through the inferior orbital fissure -- I have seen a transitory paresis of the lateral rectus, followed by dilation of the pupil. Looked at theoretically there is of course danger of infection occurring, but I have never come across such a case, nor have I seen any report of the kind in literature and I therefore think that we can conscientiously neglect the consideration of this danger. On the other hand a case of meningitis after injection of novocaine into the Gasserian ganglion has been reported, and therefore we must be content with the peripheral interruption of the branches of the trigeminal.

First division of the Trigeminal Nerve. The root of the ophthalmic nerve cannot be reached; we must therefore content ourselves with carrying out injection into the peripheral branches. It is possible -- according to Braun -- to reach the frontal and lachrymal nerves by making an injection into the side of the orbit, I have not found this necessary. I have been able, in the case of operations on the frontal sinus, to satisfy myself with an injection into these two nerves where they twist round or pass through the supra-orbital margin, where the notches in the bone generally can be felt. There about 1 cm. of 2 % solution of novocaine, is injected near each notch; in addition about 2 ½ ccs. of ½ % solution of novocaine is injected subcutaneously along the supraorbital margin; by means of this injection anaesthesia is obtained not only of the skin of the forehead extending from the orbit and as far up as the vertex, but also of the underlying periosteum and the bone. The anterior and posterior ethmoidal nerves are reached with an injection near the angle between the medial and upper wall of the orbit. The canula is inserted about one finger's breadth above the internal canthus and is driven down about 4 cm., care being taken that the point follows closely on the periosteum of the orbit. As the needle is withdrawn about 2 ½ ccs. of 2 % solution of novocaine are injected. With this injection anaesthesia of the frontal and middle ethmoidal cells is obtained and also of the mucous membrane of the fore part of the nose, both of the septum and of the lateral wall; in addition of the skin of the apex of the nose, and lastly, if care is taken to put a little novocaine directly under the skin at the point of insertion of the

needle, of the skin round the internal canthus and on the upper part of the nose.

In order to carry out a frontal sinus operation it is not enough to have induced conduction anaesthesia of these nerves. We must also make an injection into the maxillary nerve in the pterygo-palatine fossa, or else a perception of pain arises in the posterior ethmoidal cells, in the sphenoidal sinus and ultimately in the skin of the middle part of the nose. I have carried out the frontal sinus operation by Killian's method under conduction anaesthesia 7 times, in every case in conjunction with a maxillary sinus operation; in every case there was complete anaesthesia in the frontal sinus and in the frontal and middle ethmoidal cells: only in 2 cases was the anaesthesia of the posterior ethmoidal cells a little incomplete, so that infiltration anaesthesia had to be induced. When the patient has a bilateral pansinusitis, we operate first on all the sinuses of one side and then 8—10 days later on the sinuses of the other side.

In West's operation (dacryo-cysto-rhinostomy) it is sufficient to induce conduction anaesthesia in the anterior ethmoidal nerve; about 2 ccs. of 2 % solution of novocaine are injected along the medial orbital wall, the needle being inserted about 2 ccs. deep and a sufficiency of the solution being deposited just under the skin. This injection alone is, as a rule, sufficient to produce anaesthesia of the skin, the lachrymal sac and bone, as well as of the mucous membrane of the nose, so that as a rule, no other injection is required. But from the point of view of haemorrhage it is, however, wise to make use of a substituted infiltration anaesthesia of the nasal mucous membrane. In 23 cases in West's operations I have succeeded in obtaining complete anaesthesia after a lapse of 5 minutes by this method. Even haemorrhage, especially from the blood vessels of the bone, is less when conduction anaesthesia is employed than when infiltration anaesthesia is exclusively used.

For operations on the ethmoid, (removal of polypi, scraping out of cells) conduction anaesthesia of the anterior and posterior ethmoidal nerves can be used, as described above. I have attempted this in 7 cases but the anaesthesia was only good in 3 of these, in the remaining 4 it was very poor and I cannot recommend it.

although it is just in such operations that it is often difficult to obtain satisfactory anaesthesia by painting or infiltration. With this injection into the orbit oedema of the upper eyelid almost always develops, which can be so considerable as to prevent the patient opening his eye for a couple of days. In addition a haematoma may easily develop and I admit that the reason why the work so often fails is, that the escaping blood dilutes the novocaine solution so that the latter is prevented from exercising sufficient influence on the nerves. To this is added that it is only the frontal and middle ethmoidal cells which are innervated by the ethmoidal nerves; and in order to anaesthetize the posterior ones conduction anaesthesia of the maxillary nerve must be induced. But besides the drawback which results in the patient suffering for several days from oedema of the eyelid, with perhaps in addition marked suggilation, injection into the ethmoidal nerve can cause other discomfort and danger. K r e d e l (referred to by B r a u n) saw, as the result of an orbital injection, amaurosis of the corresponding eye which continued for 10 minutes. J a s s e n e t z k y observed a similar transient amaurosis which appeared the day after a frontal sinus operation. B r a u n is of opinion that this cannot be attributed to the injection unless it was caused by a septic operation. Still worse are two cases of which H a l l e has experience and regarding which he has very kindly given me a short report:

1) A patient of 45 with frontal and ethmoidal sinusitis. Operation by H a l l e's method (intranasal opening of the frontal sinus). Conduction anaesthesia of the ethmoidal nerve with $1\frac{1}{2}\%$ novocaine and suprarenine solution. A 3 cm. long needle is inserted in the neighbourhood of the frontal nerve and about 4 ccs. are injected there while the needle is passed downwards. The operation, whereby all the ethmoidal cells and the lower half of the infundibulum are removed, runs a normal course. The following day a marked swelling develops in the upper eyelid, but there is no pain or headache. 3 days later there is enormous swelling of the eyelid, swelling of the conjunctiva, pushing forward of the globe, no pupillary re-action and no perception of light in the eye. The next day a large incision was made along the middle of the orbital rim and the whole of the ethmoidal portion was exposed. There appeared to be no lesion of the papyraceous lamina which was reflected to lower the pressure. No pus was found. It was only 5 days later that pus developed in the lateral portion of the orbit. The eye was, and remained, blind.

2) A patient of 49, blind in the left eye as a result of syphilis with diminished visual acuity in the right. H a l l e found a right-sided frontal and ethmoidal sinusitis, which caused acute pain in the head and purulent discharge from the nose. An ethmoidal and frontal sinus operation was carried out, as described above. The following day marked swelling of the eyelid and pain. And incision was made in the middle line of the orbit but no pus was found. Four days later pus was found for the first time in the temporal portion. Complete and permanent blindness.

H a l l e is of opinion that the cause of these sad events is the occurrence of an intraorbital haematoma, which by pressure on the optic nerve, injured it. Perhaps this may even have been due to an infection. On account of these cases H a l l e has entirely given up the method of injection into the orbit, and I intend to follow him with regard to the posterior ethmoidal nerve. I have also mentioned that I no longer propose to inject the anterior ethmoidal nerve in the case of maxillary sinus operations and during recent years, in the case of frontal sinus operation, I have contented myself with infiltration anaesthesia of the middle and posterior ethmoidal cells. On the other hand I will not willingly give up injection into the anterior ethmoidal nerve in frontal sinus operations by K i l l i a n's method, nor in W e s t's method either, and it appears to me that in these the injection is made so far forward that there can be no danger of lesion of the optic nerve.

In resection of the septum it is necessary to carry out an extensive infiltration anaesthesia by injection of $\frac{1}{2}\%$ novocaine solution under the perichondrium resp. periosteum and to use numerous points of entry so that a layer of fluid may lie in every direction between the cartilage and the bone and the tissues covering them. This is first and foremost of importance for anaesthesia and for the limitation of bleeding, but at the same time the result is obtained that the perichondrium and periosteum are much more easily loosened. Meantime anaesthesia, can be completed by the induction of conduction anaesthesia as proposed by K i l l i a n. The most important injection is that into the naso-palatine nerve of S c a r p a. This nerve is most easily found at the posterior and upper angle of the vomer at the point where the nerve, after having twisted over the roof of the posterior nares winds obliquely downwards over the septum. The injection is made straight upwards and backwards into the septum opposite the posterior

portion of the superior turbinate; the canula should be pushed in to the point at which the patient feels a sudden pain, this being the indication that the nerve has been reached.

For operations on the inferior turbinate (especially with the galvano-cautery) it is not necessary to use conduction anaesthesia since complete anaesthesia can be obtained as follows. By means of a probe, dressed with cotton wool and moistened with a 10 % solution of cocaine with suprarenine added thereto, an energetic painting, resembling massage, of the entire mucous membrane of the turbinated bone is carried out. After 10 minutes it is again painted and when another 10 minutes has elapsed, yet again. Then one waits for 20—30 minutes. This method of painting three times and then a long interval, by which it takes altogether about an hour to complete the anaesthesia and which I came on entirely by chance, through a patient whose nose had been desensitized for the galvano-cautery and who was forgotten for half an hour — gives practically always complete anaesthesia not only of the mucous membrane but also of the periosteum, of the inferior turbinate. It is only in the case of patients with vasomotor rhinitis that it is difficult to produce anaesthesia, since touching the turbinate gives rise to a profuse serous secretion which soon dilutes the cocaine. In such patients it is necessary to make 4 applications of cocaine, and to see that the nose is cleaned — by washing or swabbing — immediately before each application. But keeping in mind the danger of poisoning, I make a rule to operate only on one side at a time.

The superior laryngeal nerve can easily be anaesthetized by injection on the thyro-hyoid membrane, using the technique indicated by Hoffmann for injection of alcohol. To find, for example, the right superior laryngeal nerve, the patient's head is turned to the left. With the left hand the surgeon seizes the larynx from the front and directs it, by pressing with his thumb, firmly over to the right side. Now, by palpation with the finger tips of the left hand the greater cornu of the hyoid bone can be easily found and also the superior cornu of the thyroid cartilage. In the middle of this, but a little nearer to the hyoid bone, the nerve runs; as a rule some pain on pressure will be found at the point where the nerve runs through the thyro-hyoid membrane. The

needle is inserted at about the further end of the greater cornu and is carefully moved about until a spot is found where the patient experiences pain which radiates to the ear or to the tongue. Here the point is fixed in the nerve and 2 ccs. of 2 % solution of novocaine is injected.

Conduction anaesthesia of the superior laryngeal nerve can be employed by operations on the interior of the larynx but this is not to be recommended. For one thing complete anaesthesia is not always obtained, since a part of the interior of the larynx is, as we know, innervated by the recurrent laryngeal, and for another it is much easier to obtain complete anaesthesia by painting. I have, in my numerous operations on patients with laryngeal tuberculosis always been able to produce satisfactory results by three energetic applications of a 10 % solution of cocaine with a 10 minutes' interval, followed by an interval of 20—30 minutes, just as in case of the inferior turbinate. If we wait sufficiently long after the last application the anaesthesia is complete, even for a deep application of the galvano-cautery.

In performing tracheotomy, anaesthetizing of the trachea is carried out as follows. By means of a papilla forming injection on the skin two points of entry are marked out on either side of the trachea along the middle of the area where the incision is to be made. From these two points of entry the injection is made according to the drawing (which is borrowed from Braun's book) partly in front of the trachea where a rhombus-shaped injection line appears, and partly into several points behind the trachea. I cannot support Braun's contention that complete anaesthesia of the whole area is obtained by this method. In order to be quite certain, before the trachea is incised, a little 4 % solution of cocaine can be injected into the lumen by Cauty's method, which is described below.

In order to make a *laryngeal fissure* it is sufficient to inject a rhombus shaped area in front of the larynx and trachea and at the same time to induce conduction anaesthesia of the superior laryngeal nerve as described above. Before the larynx is opened it must be anaesthetized inside. This can be admirably carried out by a method which the French surgeon Cauty has described (Cauty and Roché: L'anaesthésie locale et régionale en

oto-rhino-laryngologie. Paris 1920). The method consists, the front of the trachea and larynx being exposed, in injecting a few drops of 10 % solution of cocaine through the crico-thyroid membrane into the lumen. The point of the syringe is first directed upwards, the patient's head being bent sharply backwards, so that the cocaine trickles up into the larynx; then the point of the syringe is directed downwards and the patient is directed to sit up, so that the cocaine runs down into the trachea. I can testify that, by this method of balancing, a remarkably good anaesthesia of the mucous membrane of the larynx is obtained, so that in cutting through the larynx not the slightest coughing is set up, nor is there any haemorrhage. St. Clair Thomson reports (British Med. Journal. ref. Acta Oto-laryngol. 1920 vol. II p. 238) that for six years he has employed a similar method for tracheotomy but he makes the injection between two of the tracheal rings and uses only 5—15 drops of a 2 ½ % solution of cocaine. I am of opinion that St. Clair Thomson's example should be followed and a weaker solution of cocaine used. For if a 10 % solution of cocaine is used we are only slight away from the dangerous neighbourhood of the lethal minimum dose, which is round about 15 centigrams.

Anaesthesia of the *auditory meatus* is best carried out by v. Eicken's method. From a point below the meatus the canula is passed along the anterior portion of the mastoid process firmly upwards towards the suprameatal spine. Here one comes on the auricular branch of the vagus and in injecting the novocaine can be seen (1—2 ccs of 2 % solution is used) spreading out around the meatus whose wall arches forward. Thereupon the patient is made to open his mouth wide and from the same point an injection is made into the tissues in front of the meatus, where the canula is carried upwards to the root of the zygoma. By means of this injection the branches of the auriculotemporal nerve which supply the meatus are found. In operations on the tympanic cavity and the ossicles the method invented by Neumann is used; the injection is made into the upper meatal wall. The point of entry lies in the cartilaginous part of the meatus just about ½ cm. from the bony portion which is easily recognized by its lustre: the boundary between the cartilage and the bone is easily recognized when the auricle and the meatus are moved. The canula is

then inserted into the cartilaginous part of the meatus, the point is passed under the periosteum into the bony part and the injection is made here; one can then see the novocaine penetrate subperiostally under the bony wall of the meatus and run in into the tympanum where it spreads itself out under the mucous membrane. I have repeatedly removed the malleus and the incus under N e u m a n n's method of anaesthesia without the least suspicion of pain. Generally the tympanic membrane is also well anaesthetized.

Concerning the anaesthetizing of the *tympanic membrane* I have nothing further to add to my report thereon made at the Northern Congress of Oto-laryngology in Copenhagen in 1911 and on the XVIIth international Congress of medicine in London in 1913. The anaesthetic which I recommended consists of cocaine and acidum salicylicum ana gram 1 mixed in 2 grams of concentrated spirit. A little tampon soaked in this solution with the addition of a single drop of suprarenine is applied close up against the tympanic membrane, in such a way that care is taken that it is placed exactly against the upper part of the tympanic membrane, so that in this way conduction anaesthesia of the tympanic nerves is produced. Afterwards some drops of the fluid are instilled into the meatus which is closed with a little non-absorbent wool. After the laps of 20 minutes anaesthesia supervenes. In *Acta Oto-laryngologica* 1918, Vol. I. p. 204, G. H o l m g r e n reports that B l e g v a d's anaesthetic for the tympanic membrane has proved itself to be the most efficacious of the many different substances which he has tried in paracentesis of this membrane. In children it is, however, less suitable because it sometimes gives rise to a good deal of pain. Among old people H o l m g r e n has in some cases observed a permanent lesion of the tympanum, as a result of using this medicine and he therefore regards the use of salicylate of cocaine as contraindicated in old people.

To carry out *a simple chiselling of the mastoid* under local anaesthesia it is necessary to make a so called H a c k e n b r u c h's Rhombus round the outer ear, that is to say a linear infiltration with $\frac{1}{2}$ % solution of novocaine must be made into the subcutaneous tissue, so that a rhombus-shaped design round the auricle

will embrace the whole field of operation. The needle is inserted at a point above the auricle and the canula is first passed behind the ear and the solution is steadily injected either while the needle is being thrust in or — better still — while it is being withdrawn. Then a similar injection is made in front of the auricle from the same point. In the same manner the two lower legs of the rhombus are marked by injection from a point below the auricle. The whole field of operation and the auricle is now anaesthetized, and as all the nerves supplying the skin, the periosteum and the bone lying inside the rhombus, pass through the subcutaneous tissue and thus go through the zone infiltrated with novocaine, the nerve conduction is, in this way, interrupted and anaesthesia of the skin, periosteum and bony structure is established. As a general rule it may be remembered, that it is always unnecessary to make any injection directly into or under the periosteum, only care must be taken to anaesthetize all the overlying tissues, since all the nerves supplying the periosteum come from the overlying tissues. After making H a c k e n b r u c h's rhombus it remains only to desensitize the meatus which is done by v. E i c k e n s method. The whole area is now rendered anaesthetic, with the exception of the antrum which is innervated from the tympanic plexus. This must therefore be painted with a 10 % solution of cocaine or ethyl chloride, or ether must be used.

In making a radical operation *of the middle ear*, we proceed as described above in simple chiselling, but it is necessary to anaesthetize the tympanum in addition according to N e u m a n n's method. I have carried out the radical operation of the middle ear 6 times under local anaesthesia, once on a 16 year old girl, another time on a 17 year old girl. Only in one patient was there so much sensation in the tympanum that it was necessary to give a little ether during the scraping here and in the tube. Of the whole lot the tympanum is the only place in which there is sometimes a perception of pain under a well carried out anaesthesia. It is therefore always right to paint the tympanum and the tube with 10 % solution of cocaine before scraping out; but then one can also, as I always do, excochleate the mucous membrane of the tube down to the pharyngeal ostium. On one patient who, as the result of the injection along the anterior portion of the meatus being

made too deeply down, a slight facial paralysis which cleared up after 3 days, developed. The great advantage of local anaesthesia in this operation is that there is no bleeding, either from the bone or from the meatus; the result of this is that a meatal flap can be made at a much earlier stage of the operation which greatly facilitates the view. Generally there is no actual pain, but of course the chiselling is unpleasant for the patient, especially if the bone is eburnated: particular sharp chisels are required. It cannot be denied that the constant hammering on the skull is a source of great discomfort to most patients and I freely admit that local anaesthesia is not such a great advantage in mastoid operations as in the remaining operations in our speciality; one must select the cases which are suitable for it and I do not think that local anaesthesia can be used as the normal method in major operations on the ear to the same extent as it can be for example, in operations on the maxillary antrum or, above all, in laryngeal operations. In the case of labyrinthine fistula alone we must admit that B á r á n y is right, (address at the 3rd Northern Oto-laryngological Congress in Christiania 1920) when he says that there are great advantages in operating under local anaesthesia. By this method, one can, as I have been able to convince myself in one of my own cases, get warning when one approaches the neighbourhood of the fistula with one's instrument, since even the slightest touch near it sets up marked giddiness and nystagmus and the patient can by this means keep the surgeon informed all the time.

In tonsillectomy anaesthesia is carried out as follows: 40 ccs. of $\frac{1}{2}$ % solution of novocaine are employed: 20 for each tonsil. First a little is injected into the posterior pillar of the fauces: then my specially designed curved syringe is introduced into the supra tonsillar fossa in front of the upper pole of the tonsil: here 10 ccs. is injected into the capsule of the tonsil. If the syringe is placed in the correct position, the fluid can be seen bulging out the anterior pillar, so that ischaemia supervenes. The remaining 10 ccs. is injected into the base of the capsule of the tonsil under which the syringe is carefully guided into the one of the lowest lacunae, and when the bottom is reached, it is carried 1—2 mm. further down, so that the point stands in the capsule. The most important thing

in anaesthetizing is to be accurate with the injection over the upper pole of the tonsil; if this is properly carried out, so that the anterior pillar is made ischaemic, it becomes also anaesthetic; however, to be on the safe side, I am in the habit of injecting a few drops into the uppermost portion of the anterior pillar. One *can* operate immediately after the injection is finished, but recently I have begun to let the patient wait $\frac{1}{4}$ hour, so that one can always be sure of good anaesthesia. I always draw the patient's attention to the fact, that he may be able to feel the pressure in the tissues during the operation but else he will feel no pain at all. I can strongly recommend the use of a large quantity of fluid even if one can induce anaesthesia with less novocaine. The amount of novocaine used is only 20 centigrams, and of this a large part runs out again during the operation.

The use of local anaesthesia in *adenectomy* in children is not, in my opinion, attended with any advantage. In the first place painting the rhino-pharynx causes the children great discomfort, secondly even with a thorough cocaineizing of the tonsil, the operation is not free from pain, because one cannot avoid the discomfort which arises through dragging on the soft palate, pressure on the posterior pharyngeal wall, and the feeling of a large instrument in the throat, and thirdly and lastly in local anaesthesia there is grave danger of delayed haemorrhage. At the second Northern Oto-laryngological congress in Stockholm in 1914 I strongly recommended laughing gas narcosis (nitrous oxide narcosis) in adenectomy. When war broke out the importation of laughing gas (N_2O) ceased, and I turned to ethyl chloride with which I continue to be greatly pleased. I do the operation in the out-patients, operate on the child in the sitting position and use H e l - s t e d's mask. Before narcosis is begun, a rubber gag is placed in the child's mouth, when the operation is about to start this is replaced by a D o y e n - J a n s e n's dilatator. As in laughing gas narcosis, so in intoxication with ethyl chloride, it is important to allow the patient to waken spontaneously and not arouse him from narcosis by calling to him or in any other way. As a matter of fact, if the patient is aroused, it often happens that he awakens and declares that he has not been unconscious at all but has felt everything that went on.

Conduction anaesthesia indicates a very great progress for operations in oto-laryngology. It has, as has been stated, now and then trifling unpleasant accompaniments which I have already described above (development of haematoma, oedema, transitory paresis), but which are without great significance. Has it any drawback or dangers at all? It has the drawback that the technique, especially when the maxillary nerve is in question, is difficult, so that the performance is not always quite safe. But with increasing practice it happens with diminishing frequency that the anaesthesia is incomplete. Should this, however, be the case in some isolated instance, no great harm is done, since we can always proceed to infiltration anaesthesia, or give ether during those periods of the operation where pain or discomfort ensues. Further there is the danger, through one's own fault, of infection occurring as the result of deep injections, and this has resulted in H a l l e, as has been related, abandoning conduction anaesthesia of the ethmoidal nerves, but when we take into consideration how many undertakings of this kind are carried out, the whole world over, without disaster, the danger must be reckoned as very slight; but the danger, of course, exists and the greatest care is called for in the preparation of the fluid for injection and in the whole technique.