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**HISTOLOGICAL CHANGES BROUGHT ABOUT IN THE NASAL
MUCOUS MEMBRANE BY THE APPLICATION OF THE
GALVANO-CAUTERY: A STUDY OF THE PROCESS OF
HEALING IN THE MUCOUS MEMBRANE OF THE NOSE
AFTER A PORTION HAS BEEN DESTROYED OR INJURED.**

Thesis for the M.D. Degree of the University of Aberdeen.

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THE use of the galvano-cautery in the treatment of diseases of the human body dates from the beginning of the nineteenth century (1).¹ The first, however, to publish much about the results to be gained by this method of treatment was Middeldorf (2). Twenty years ago the galvano-cautery, especially in the burner and snare form, was much used in the nose, many, indeed, considering it to be *the* treatment in various diseased conditions of this organ (3, 4, 6). Middeldorf himself stated clearly that the use of the galvano-cautery had its limitations, and that it ought not to be used in every case or on every occasion. This was for a long time forgotten, and it has to be admitted that by many the cautery treatment has been much abused. As a consequence of this abuse, many rhinologists, in this country and abroad, preferred to use the cold cutting methods, and only very occasionally applied the cautery. Within the last few years, however, the cautery has

¹ The numerals refer to the bibliography appended to the thesis.

justly regained, to some extent, its past position; and it is now looked upon by most eminent rhinologists as the best method of treatment in many cases, especially those in which there is congestion and hypertrophy of the inferior turbinates (6, 7, 8, 9, 10, 11, 12, 13, 14).

Schech of Munich, one of my teachers, writes that in certain nasal affections the galvano-cautery is, and will remain, indispensable, and that it is, in many cases, the only method of successful treatment (5).

Clinically, one of the great advantages of the cautery is, that with care and a little practice the operation is an easy one and is in most cases bloodless, thus rendering any plugging of the nose unnecessary. When used in suitable cases the results gained by this method of treatment are just as good as—nay, even in many cases better than—those to be gained by any other method.

Much has been written about the tissue changes produced by the cautery when applied to various parts of the body (15). Very little has, however, been published in the way of an accurate study of the action of the cautery on the nasal mucous membrane after any injury. The *New York Medical Journal* of May 12 and 26, 1900, contained papers on this subject by Beaman Douglas (17), and more recently one of the workers in Dr. Brühl's Poliklinik, in Berlin, has published an article on the action of glacial acetic acid and chromic acid on the nasal tissue (21).

The turbinate bodies, of which the inferior is the one most frequently treated, have a structure in many respects peculiar to themselves. This being the case, a study of the changes brought about by injury to these is not uncalled for, especially as some things of practical value may ensue therefrom, and some points, later more fully to be gone into, are doubtful.

In order that the results should be as reliable as possible the tissue examined was in each instance taken from patients in whose cases the cautery treatment was indicated. One of the lower animals might have been used, but results so obtained cannot, without any further reason, be applied to the human subject.

The tissue in every case cauterised and afterwards excised was part of the inferior turbinate body in the pathological condition of rhinitis hypertrophica and rhinitis hypertrophica vasomotorica. From various text-books one finds, unfortunately, that the changes produced in these diseases are not constant and even vary greatly in different patients (18, 19, 20). In the diseased mucous membrane there may be a great or small amount of connective tissue and

much or little of the cavernous variety. The hypertrophied tissue often contains, besides a large number of mononuclear round cells (lymphocytes), a not inconsiderable number of polynucleated cells (leucocytes), which are mostly situated just beneath the epithelial basement membrane. Deeper down one may also find loose areolar tissue which might, at first sight, be thought to be due to œdema following the injury. These points must be specially noted in order that a previously existing condition may not subsequently be ascribed to the action of the cautery. These difficulties are to a great extent avoided by endeavouring, in the removal of a portion of the injured tissue for examination, to include a piece of the neighbouring uninjured mucous membranes.

The method employed in securing the specimens for examination was as follows: After anæsthetising the mucous membrane of the hypertrophied turbinate, by means of a freshly prepared 10 per cent. solution of cocain, the flat or pointed cautery burner was applied to the diseased part, allowed to glow, and after being sunk in sufficiently was gradually drawn from behind forwards. One or two such furrows were made. The depth to which the cauterisation was carried was purposely altered in different patients in order that one might more clearly distinguish and recognise to what extent the tissue was cauterised beyond the actual seat of application. The exact routine I followed in doing the operation is laid down at the end of the thesis.

At intervals varying from a few minutes to six months after the cauterisation a small piece of the turbinate, usually from the front part, was excised with spoon-shaped forceps or with scissors. The exact times are these: A few minutes after cauterisation; 24 hours after cauterisation; 48 hours after cauterisation; 72 hours after cauterisation; 96 hours after cauterisation; 7 days after cauterisation; 10 days after cauterisation; 16 days after cauterisation; 30 days after cauterisation; after healing (six months).

In all eighteen patients were operated on. The general health in every case was good.

The tissue, after excision, was immediately placed in 10 per cent. solution of formalin and in due course embedded in celloidin. The stains used were hæmatoxylin and eosin; a few were stained with borax carmine; a number were stained specially for elastic tissue as Weigert recommends.

I shall now give a detailed account of the treatment of ten of the cases and the subsequent microscopic examination.

CASE 1.—Mr. S—, aged forty-six. Diagnosis, rhinitis hypertrophica, pharyngitis chronica. April 18, 1903: At 12 noon one furrow was made from behind forwards with a pointed burner along the lower part of inferior surface of the inferior turbinate. From the front part of the turbinate, which was much hypertrophied, a small piece was cut away with a pair of nasal scissors within an hour after the cauterisation. The cauterisation specially of the part excised was purposely somewhat superficial, so that the extent of the cautery action might be more clearly demonstrated.

Microscopic examination.—Compared with its depth, the superficial cauterisation is a rather extensive one. One part of the preparation is laid bare of epithelium and basement membrane, and is covered instead by an irregular yellowish-brown layer (coagulated blood). This layer is firmly adherent to the underlying tissue, which has not a normal appearance. This portion of the surface, which is free from epithelium, is separated from that part which shows the normal stratified columnar epithelium by a fairly large stretch of altered and partially destroyed epithelium on one side. On the other side there is no such large interval. The epithelium above-mentioned is partially detached from the surface, is irregular in form, and shows no proper stratified arrangement. Several of the cell-nuclei are, however, very well preserved. The basement membrane is somewhat swollen, but it is nowhere absolutely uncovered by epithelium. In one place one can see a detached strip of epithelium without any recognisable basement membrane; this is perhaps a tongue of epithelium which has by some mechanical means been pushed over the uncovered surface. The tissue just under the surface is more deeply stained with hamatoxylin than other parts of the preparation; the centre portion of this tissue shows no nuclear staining, which, however, becomes more and more distinct the further one examines laterally and in the depth. The deeper lying tissue is mostly glandular and fibrous; many of the gland acini, as also the fibrous tissue bundles, are only just distinguishable as such. The necrotic tissue immediately below the surface is very reticular in character, resembling somewhat a rude meshwork. The cavernous spaces, which are neither large nor numerous, contain comparatively few blood-corpuscles; this is probably partly due to the action of the cocain. The blood-vessels are also contracted and show small empty lumina. At different places in the preparation one sees loose areolar tissue and the appearance of oedema, but the last shows no direct relationship to the cauterised portion.

Summary.—The destruction caused to the epithelium is extensive. The basement membrane seems to offer no special resistance to the cautery action, but, on the contrary, appears to be easily destroyed. There is as yet, naturally, no sign of inflammation. A better therapeutic result would have been obtained if the cautery had been passed more deeply into the turbinate body.

CASE 2.—F. L—, boy, aged nine. Diagnosis, rhinitis hypertrophica. February 27th, 1903: Cauterisation of the left lower turbinate performed at 12 noon. One furrow was made with the pointed burner. Twenty-four hours afterwards (*i.e.* at noon on the 28th) a piece was taken away from the front half of the turbinate with forceps. In this case, on examining the nose no slough was to be seen—merely a distinct furrow. This patient had the bad habit of continually picking his nose, and he had in all probability torn away the slough, because, according to the mother, the boy's nose had bled a great deal at home. The swelling and secretion after the cauterisation were very moderate.

Microscopic examination.—One notes at once that there is a considerable defect extending from the free surface down to the bone. In form this defect is like an old-fashioned purse—broad at the surface, narrowing rapidly and then gradually

becoming broader as it extends downwards. Its edges are irregular and covered with a thin yellow-brown layer (blood-coagulum). In the deepest part of the defect a portion of the slough is still present. The surface on each side of the defect is covered with epithelium, which, although not normal in close proximity to the defect, rapidly becomes so as one examines away from the defect. Where there is no epithelium there is no basement membrane. The tissue forming the walls of the furrow is altered throughout. It is stained much darker than the rest of the preparation. One cannot distinguish the separate connective-tissue bundles, nor is the outline or form of the glands distinct, though here and there single nuclei are still discernible. The walls of the cavernous spaces are very thick and have a homogeneous appearance. In the examination of preparations removed at a longer interval after cauterisation we shall find that a large part of this altered tissue dies, and is after a time thrown off. Here and there one sees somewhat dilated blood-vessels whose lumina are filled with red blood-corpuscles. By ordinary microscopic examination no changes in the bone or periosteum are to be detected. The remainder of the preparation shows the usual picture presented by hypertrophied mucous membrane. There is nowhere any accumulation of leucocytes, although a number of separate ones are to be seen.

Summary.—When the depth of the cauterisation is considered the loss of epithelium, in this instance, is relatively a small one. There is no extensive oedema, nor is there as yet (up to the end of the first twenty-four hours) any trace of a leucocytic infiltration.

CASE 3.—J. A—, labourer, aged thirty-eight. Diagnosis, rhinitis hypertrophica. February 12, 1903: A cauterisation was performed at 12 noon on the inferior turbinate with the pointed cautery, two furrows being made. At 12 noon on the 14th (i.e. after forty-eight hours) a small piece of the turbinate was removed with a pair of sharp forceps.

Microscopic examination.—One portion of the preparation shows no nuclear staining. There is a slough which, broad at its commencement on the surface, becomes gradually narrower the deeper it extends. It has really the form of a triangle, the base being on the free surface and the apex in the glandular layer of the mucous membrane. In thin sections the slough appears to be separated from the surrounding tissue. The slough is also not so deeply stained as the neighbouring tissue, which, in turn, has a different stain from parts of the preparation more distant from the slough. In the immediate neighbourhood of the slough epithelium and basement membrane are wanting, the surface here being covered by a thin, yellow-brown, in places almost black layer (altered blood coagulum). Epithelium is present at some distance from the slough. It is, however, very irregular in thickness and in the cell-arrangement. At one spot the basement membrane, although considerably torn, is bare. As one gets further from the slough the epithelium becomes more and more regular in form, the nuclei are distinctly stained, and finally we have the appearance presented by hypertrophied mucous membrane with from five to six layers of cells and a basement membrane 20–25 μ thick. There is a large amount of connective tissue running through the whole preparation. The white fibrous bundles are clearly defined, but in the region of the slough they are much less distinct; in fact, many seem more or less homogeneous. This change has undoubtedly been brought about by the action of the cautery. The tissue under the slough is somewhat oedematous and contains many clear spaces, the most of which are partially filled with well-preserved blood; some are filled with a homogeneous-looking substance which shows a few red blood-corpuscles and leucocytes scattered around the edge. This substance is probably coagulated lymph or secretion. Each of the above-mentioned spaces is

of a cavernous nature, although the endothelium forming the wall is not always distinct; yet their form and position distinguish them from artificial fissures. There is a large amount of glandular tissue present, but here, again, the glands lying near the slough are very indistinct, and many of the acini, besides being irregular, show no nuclear staining. The larger part of the glandular tissue is normal. The slough itself contains many red blood-corpuscles, but apart from these it shows no structure whatsoever. Along its under border there is a small number of round-celled nuclei, but there is no appearance of any leucocytic accumulation. Along the cauterised edge of the preparation there are a few polynuclear leucocytes, but one cannot, with certainty, affirm that there is a sign of acute inflammation because hypertrophied mucous membrane may show many such nuclei. The blood-vessels are in a condition of hyperæmia.

Summary.—The cauterisation is somewhat superficial, the changes extending only into the glandular tissue. The surface destruction is more extensive than that in the depth. The epithelium and basement membrane are much more injured than the connective and glandular tissue. A slight amount of œdema is present. Any leucocytic infiltration, if at all present, is very small; therefore, supposing such does occur, it is either already past or has not yet set in. Clinically the cauterisation was not deep enough.

CASE 4.—H. B.—, student, aged nineteen. Diagnosis, rhinitis hypertrophica; dislocation of nasal septum to the right; on left side nasal spur.

February 17, 1903, at 12 noon, cauterisation was performed of the right inferior turbinate—two furrows with the pointed burner. Seventy-two hours subsequently—i.e. at noon on the 20th—a piece of the front half of the right inferior turbinate was removed with forceps. (Unfortunately, this was rather small.) A few hours after the cauterisation there was, according to the patient, a good deal of secretion from the right half of the nose, and on the next day the lower part of the cavity was full of secretion and the part cauterised had swollen considerably. The nasal septum being dislocated to the right made the symptoms more trying to the patient. After three days the secretion was much less, and after the lapse of five weeks there was a very favourable result with free air-passage on the right side.

Microscopic examination.—Besides being somewhat small, the preparation contains a number of artificial clefts or spaces, and this makes it difficult to say if there is œdema present. There is also no absolute normal epithelium to be seen. A fairly extensive portion of the surface is formed by tissue showing no nuclear staining; as this extends downwards it narrows very little and is not pointed or wedge-shaped. Except at one spot the slough is really free and the underlying tissue is decked by a yellow-brown layer (blood-clot). A mucous-looking mass containing many leucocytes and red blood-corpuscles is present, and remembering the history of the case, this can be regarded as a result of the cauterisation. At the same time, it must not be forgotten that ordinary nasal secretion may contain a large number of leucocytes. Epithelium and basement membrane are to be distinguished a little distance from the edge of the slough; the epithelial cells are very irregular in form, and their nuclei are indistinctly stained. The basement membrane wherever present is covered with epithelium; in one place, where the epithelium is very thin, it looks swollen and shreddy. With a low power one can see an accumulation of nuclei, especially at the edge of the slough and just beneath the basement membrane. This is a leucocytic infiltration. There is no evidence of the leucocytes having pushed their way into the slough itself. The glandular tissue is much altered, especially that in the immediate neighbourhood of the slough. The form of the glands is indistinct and they do not show good nuclear staining. There is no marked increase in the amount of fibrous tissue whose

bundles are in many places much split up—for the most part artificially—into fissures which contain secretion and red blood-corpuscles. In the deeper structures there are cavernous blood-spaces. The nuclei of their endothelial walls are, however, not well stained. The blood-vessels in the neighbourhood of the slough have thickened walls and wide lumina containing well-preserved red blood-corpuscles. The deeper lying vessels show a well-defined endothelium with small empty lumina.

Summary.—As this preparation shows no normal epithelium it is difficult to say exactly how extensive has been the surface action of the cautery, but the superficial destruction does not seem to be disproportionate to that beneath. There is undoubted evidence of leucocytic infiltration, which has therefore occurred within the first seventy-two hours after cauterisation. As the cases examined at different periods within forty-eight hours showed no such infiltration, it is proved that this first shows itself on the third day.

CASE 5.—Miss K—, aged nineteen. Diagnosis, rhinitis hypertrophica. The inferior turbinate of both right and left side were very much enlarged, as also the right middle turbinate. April 22nd, 1903: The right inferior turbinate was burnt at 12 noon with the pointed cautery, two furrows being made from behind forwards. Ninety-six hours subsequently (i.e. at noon on the 26th) the front part of the turbinate was cut off with scissors; two small pieces were cut from the cauterised part; one piece was decalcified in hydrochloric acid formalin solution. After cauterisation there was a good deal of swelling on the right side, but no other unpleasant symptom. By the third day the swelling and secretion were very much less.

Microscopic examination.—There is no difficulty in recognising the different parts of this preparation. The first thing one notices is a large wedge-shaped defect, whose base is at the surface, and the apex, blunt and rounded, pointing downwards. The edge of this defect is irregular in outline, is covered with a thin layer of coagulated blood, which shows a coarse net-like structure, and which is more deeply stained with hæmatoxylin than the rest of the preparation. In the defect there still lies a large portion of slough which, towards the surface, is covered with a fairly thick layer of secretion and many leucocytes. In many of the sections the boundaries of the slough are distinct, but it is still firmly seated. The tissue around, especially in the deeper parts, shows very indistinct nuclear staining, although several of the gland acini and fibrous tissue bundles are quite distinct. This portion of the preparation contains, scattered through it, a considerable number of leucocytes, and in the spaces distinct accumulations of the same. More externally, but still within the area of cauterisation, there are large cavernous spaces present, whose endothelium is, however, only in places preserved. Several of these contain many unchanged red blood-corpuscles, and a few lying close to the normal tissue show the leucocytes lying along their walls. A large portion of the much-altered, though not totally destroyed, tissue dies, as is proved by examining specimens removed at a later stage after cauterisation. The epithelium covering the normal tissue is rather irregular in form and arrangement. The basement membrane is quite distinct, and just under it are a number of mononuclear round cells. In the deeper parts there is much fibrous tissue, and in the neighbourhood of the seat of cauterisation œdema is present.

Summary.—Signs of inflammatory reaction, in particular leucocytic infiltration, are present at the end of the fourth day. No invasion of the slough by leucocytes from the surrounding tissue has been demonstrated.

CASE 6.—Mrs. K—, aged thirty. Diagnosis, rhinitis hypertrophica of left inferior turbinate. March 10, 1903. The left lower turbinate was cauterised at 12 noon

down to the bone. At 12 noon, on the 17th (*i.e.* after the lapse of one week), a small piece of the cauterised turbinate was removed with forceps. This patient was anæmic, and the nasal mucous membrane was of a very pale colour. The application of a ten per cent. solution of cocain caused [very little change in the size of the turbinate. The reaction to the cautery was considerable, but except for blockage of the nose for a day or two and an abundant secretion, the patient had no complaint.

Microscopic examination.—The slough itself has, for the most part, already separated. The tissue thus uncovered is not by any means normal; it shows for some considerable distance the effects of the cautery. The outline of the glandular acini can be made out, but the staining is very imperfect. The fibrous tissue bundles are indistinct, although the elongated cell nuclei are to be distinguished. This part of the preparation also contains many lymphocytes and leucocytes. On the surface, near the free edge of the normal epithelium, one can see the primary stage of granulation tissue—accumulations of polynucleated cells mixed up with a few cells having large oval and much less deeply stained nuclei-fibroblasts. Epithelial regeneration is not clearly demonstrable; karyokinetic figures are not visible. On the surface of this preparation there is no altered or partially destroyed epithelium; that which is present has a distinct basal membrane; the cells are regular in arrangement and outline, and show well-stained nuclei; beneath this is also the commencement of the normal submucous tissue and properly stained glandular elements. One can therefore justly maintain that the epithelium, altered but not totally destroyed by the cautery, has perished and been cast off. That part of the preparation beyond the field of cautery action contains much glandular tissue and a moderate amount of connective tissue. The vessels show no special change.

Summary.—Young, newly-formed granulation tissue is present at the end of the first week. Normal epithelium and submucosa begin at an equal distance from the seat of application of the cautery; there is, however, more total destruction of epithelium shown by its absence over a certain part of the submucosa. There is an abundance of leucocytes.

CASE 7.—Mr. W—, aged forty-two. Diagnosis, rhinitis hypertrophica of the anterior part of the right lower turbinate. April 1, 1903: The hypertrophied portion was treated at 12 noon with the galvano-cautery. Ten days subsequently *viz.* at 12 noon on April 11, a small piece of the mucous membrane was removed by the forceps. Towards the end of the first week after treatment the patient complained of headache, malaise, and difficulty in swallowing. He was suffering from a mild attack of tonsillitis, which was, however, more marked on the left side. On April 12 the patient developed an attack of influenza, lasting over a week. This must be remembered when examining the tissue for signs of healing.

Microscopic examination.—This preparation shows a very distinct space or defect of a V-shape, the open part of the V being at the surface; the apex, which is blunt, pointing downwards. In this furrow-like space there lies a three-cornered blood clot which contains many leucocytes, and which is attached at one place to the edge of the furrow by a sort of bridge, largely made up of leucocytes. All the tissue lying round the furrow is very much changed by the cauterisation. Here and there are to be seen accumulations of leucocytes, but not nearly to the same extent as in the preparation removed four days after cauterisation. Along the edge of the furrow there is at places young granulation tissue visible. The surface of this altered tissue has no epithelial covering except for a little distance before the spot at which normal tissue and epithelium begins. Here one finds a

thin layer of newly-formed epithelial cells, some of whose nuclei show karyokinetic figures. The capillary blood-vessels present show no special change.

Summary.—The process of healing—the formation of granulation tissue and new epithelium—has begun, but in quantity and quality it does not compare favourably with Case 6. Any sign of acute inflammation such as oedema, dilated blood-vessels, leucocytes lining the vessel walls, is not present.

CASE 8.—Mrs. C—, aged thirty. Diagnosis, rhinitis hypertrophica, right and left lower turbinates. February 24, 1903: Fairly extensive cauterisation of right inferior turbinate was performed at 12 noon. After the lapse of sixteen days (*i. e.* at noon, on March 12), a piece from the front part of the turbinate was removed by the forceps. After the cauterisation there was a considerable amount of local reaction, swelling of the nasal mucous membrane, and increased secretion. This lasted between four and five days, during which time the patient complained of a little headache.

Microscopic examination.—One part of the preparation, which is of a slough-like nature, is entirely separated from the rest. Except for a knob, or onion-like structure, the surface portion of this part shows no structure: deeper down glandular elements, showing, however, no nuclear staining, are to be seen. There are no distinct fibrous tissue bundles, but there is a large accumulation of leucocytes. I believe that at the time of the cauterisation the above-described portion of the preparation was not completely destroyed, but that its vitality was so affected that it could not recover, and finally became detached. What makes this almost certain is the fact that the remainder of the preparation, except along the edge underlying the above-mentioned slough-like tissue, shows well-developed and excellently stained tissue elements. The exact significance of the knob-like structure, which still shows a few distinct nuclei, is difficult to determine. It may be one of the so-called “schleimige Metamorphose des Epithels der Drüsen Ausführungsgänge,” as described by Cordes (22). Certainly one must admit that the *schleimige* (mucous) structure would not lead one to expect any special resistance to injury, but it is also possible that its peculiar form and arrangement may have afforded it some protection against the cautery. Between the comparatively healthy tissue and the first described part lies fairly well developed granulation-tissue. Many fibroblasts are present, and several of the nuclei of the connective-tissue cells show signs of karyokinesis. Normal epithelium and basement membrane begin on the surface, a little distance from the edge, under the separated slough, the small intervening space being covered by two or three layers of epithelial cells, the most superficial of which are of a squamous type. This new epithelium extends tongue-like over the free edge into the furrow. It has no basement membrane. The cavernous spaces visible are for the most part empty. There is no loose areolar tissue or any sign of oedema.

Summary.—By the end of the second week the healing processes have made considerable progress. The tissues seriously involved in the cauterisation have been almost entirely got rid of. One may infer this from the fact that the preparation itself (leaving out of account that portion which is separated off) shows very little sign of having sustained any serious injury. It is certain that much of the tissue altered by the cautery is, after the first few days, cast off, but that does not exclude the possibility—nay, even probability—that a portion of the less affected tissue recovers both its normal structure and function.

CASE 9.—Miss S. D—, aged nineteen. Diagnosis, rhinitis hypertrophica, both inferior turbinates. April 1, 1903: The right inferior turbinate was cauterised at 12 noon. Thirty-four days afterwards (*viz.* at 12 noon on May 4) a small

piece of the cauterised tissue was removed by the forceps. The turbinate treated had become much less in size, but it had not yet completely healed. Microscopically, nothing was found worthy of special note.

CASE 10.—H. G—, labourer, aged nineteen. Diagnosis, rhinitis hypertrophica. November 23, 1902: The right and left inferior turbinates were cauterised at 12 noon with the flat burner. After the lapse of more than five months, viz. at 12 noon on May 2, 1903, the anterior portion of the right inferior turbinate was removed by the forceps. Macroscopically, the turbinate showed a white-pink colour; its surface was smooth, but there were two distinct depressions, the original seats, probably, of application of the cautery. The inferior meatus of this side was free to the passage of air, and the application of a ten per cent. solution of cocaine to the mucous membrane caused very little diminution in the bulk of the turbinate.

Microscopic examination.—The picture presented is very interesting; one part of the preparation specially has taken up much of the pink (eosin) stain; it consists of well-formed, closely packed bundles of white fibrous tissue—cicatrix; the deeper-lying bundles are looser and more wavy. There is a minimum number of nuclei present, viz. those of the long fibrous tissue cells and those of the simple mononuclear round cells. Glandular and cavernous tissue are both absent, but in the neighbourhood of the normal turbinate a few gland acini are to be distinguished. Other parts of the preparation show normal glands, and just under the surface many round-celled nuclei. There is no sign of cystic dilatation of any of the ducts of the glands. The surface of the preparation has no undulated appearance, and is much more level than normally. The cicatrised part is covered by a layer of epithelium, which in some places is of a stratified squamous variety, in others very irregular in form and more or less transitional. Here and there under the epithelium there is a very thin membrane-like structure, which may, to some extent, represent the basement membrane, but there is no well-formed and distinct basement membrane as in the normal turbinate. A few vessels are present, but, in accordance with the anæmic appearance of the turbinate, they are insignificant in number and size.

Summary.—As far as the sub-epithelial tissue is concerned, the result obtained has been a good and adequate one. Part of the turbinate tissue has been replaced by good cicatricial tissue—a sclerotic sort of fibrous tissue with very few blood-vessels. As above mentioned, the epithelium is of a more or less transitional type; it is improbable that perfect columnar epithelium is again generated, and it seems certain that at the end of the healing process squamous epithelium is the form most frequently present and most abundant. No distinct basement membrane is developed during the healing process. One sees that the turbinate has undergone material diminution, brought about by the cicatricial contraction.

Résumé.—From the examination of the foregoing preparations the following conclusions are arrived at. Inflammatory reaction begins between the second and third day, and reaches its height on the fourth or fifth day. It may be well to recapitulate the important signs: Situation of the leucocytes along the walls of the blood-channels; infiltration of the tissue with leucocytes; œdema. In most cases the action of the cautery on the surface is proportionally more extensive than in the depth. Of all the tissues the least

affected is the bone ; in a few cases there are distinct changes to be noted in the tissue immediately surrounding it. The peculiar cavernous tissue structure and the glandular tissue suffered most from the cauterisation. Important changes in the blood-vessels or a thrombus formation was not found in any of the specimens. The basement membrane offers no special resistance to injury ; on the contrary, it appears to be easily destroyed, and after six months, at any rate, is not re-developed in its natural form and extent. No changes were found in the bone or periosteum which could with certainty be ascribed to the cautery. The exact site of application of the burner is totally destroyed, and becomes a slough. According to the degree of cauterisation this is bounded below and laterally by a greater or smaller portion of tissue which, it is true, still shows some structure and nuclear staining, but which does not recover from the injury, and towards the end of the first week (on the sixth to the ninth day) is separated off from the healthier and less affected tissue. This loss of tissue gives rise to a defect which is first of all filled with granulations. These in time give place to genuine cicatricial or scar tissue. The granulation loops spring from the healthy or comparatively uninjured tissue along the edge of the defect, and they are quite distinct on the seventh or eighth day.

Newly-formed epithelium is first visible about the fourth day ; after fourteen days it can be seen as a sort of tongue lying over the granulation tissue and extending into the defect.

I have not been able to demonstrate that this new epithelium is, even partially, derived from the glandular tissue, cells or ducts. There are no newly-formed glandular off-shoots, or any glandular regeneration through an invagination of the new surface epithelium such as one sees in the similar tissue of the stomach and intestine.

The wound caused by the cautery heals ordinarily in about six weeks' time ; the turbinate or part of turbinate treated gradually presents a more or less pale appearance, with one, two, or three depressions indicating the seat of the cautery application.

The turbinate is not only diminished in size and extent, but the liability to sudden changes in its volume through alteration in the vascularity of the cavernous tissue is also diminished.

Microscopically we have seen that at the places corresponding to the scar the usual mucous membrane is replaced by a more or less compact fibrous tissue, the surface of which is covered with a thin layer of epithelium. The injury produced by the cautery can be a very extensive one. Whole tracts of mucous membrane can

be destroyed, and the total action may be much more extensive and far-reaching than one would imagine. It is not my object in this thesis to discuss the different methods of treatment in hypertrophied conditions of the nasal mucous membrane, but there seems little doubt that, in many cases, specially where it is advisable to treat only a certain part of the turbinate, the galvano-cautery is the best means at our disposal.

A word may also be added about the so-called submucous cauterisation which theoretically ought to cause less surface destruction; practically, however, it is not found to be so useful—when, for example, after the application of cocain the swollen tissue retracts back strongly and lies firmly on the bone. The results obtained are also less certain and not so lasting; at the same time, this method of cautery treatment is preferable in the few cases of hypertrophy of the posterior end of a turbinate which cannot be seized with the cold wire snare.

Unpleasant sequelæ immediately after or within a few days of the cauterisation do sometimes occur, but they are rare.

A thesis has been published recently upon the regeneration of the nasal mucous membrane by Dr. Citelli (23). He removed portions of mucous membrane for examination by means of forceps or scissors without having, however, previously used the galvano-cautery. After reading his paper, I find that many of our results are the same, although, as one might expect, the cautery wound is much more extensive and requires a good deal longer time to heal. Citelli has not referred to the condition of the basement membrane of which Douglas in his work made special mention.

The following method of cauterisation seems to me to commend itself.

(1) The patient should blow the nose, and if necessary one may cleanse the cavity by syringing with a warm ten per cent. boric acid solution;

(2) Mop up any excess of fluid with small pledgets of cotton-wool;

(3) Apply a freshly prepared ten per cent. solution of cocain, either on two or three small bits of cotton-wool which are allowed to remain in place for a couple of minutes, or by painting the turbinate with a probe several times;

(4) Again very gently remove all excess of fluid, so that no subsequent scalding can take place;

(5) The burner must be placed on the posterior part of the hypertrophied tissue to be cauterised, must be pressed deeply into the tissue, allowed to glow, and drawn slowly but continuously forwards.

It must not be allowed to cool before being removed from the tissue. (This may be repeated once or twice) ;

(6) Insufflation of a little mild antiseptic powder, *e.g.* xeroform.

(7) The patient should avoid alcoholic stimulants and tobacco. Confinement to bed is not necessary, but the patient ought to keep in as fresh and pure air as possible.

(8) The patient must always be examined within eight days after the operation, in order to see that the wound in the nose is well and that there are no complications, such as synechia.

BIBLIOGRAPHY.

1. *Real Encyclopädie der Gesamten Heilkunde*, 1895, vol. viii, s. 247.
2. MIDDELDORF.—*Galvano-Kaustik, Ein Beitrag zur operativen Medicin*, Breslau, 1854.
3. VOLTOLINI.—“*Krankheiten der Nase*, 1888,” *Theil über Electro-thérapie*.
4. SCHECH.—*Krankheiten d. Mundhöhle, d. Rachens und d. Nase*, 1st Auflage, 1885.
5. SCHECH.—*Krankheiten d. Mundhöhle, d. Rachens und d. Nase*, 5 Auflage, 1896.
6. MACKENZIE, Sir MORELL.—*A Manual of the Throat and Nose*, 1880.
7. HEYMANN.—*Handbuch der Laryngologie und Rhinologie*, 1900.
8. LERMOYEZ.—*Thérapeutique des Maladies des Fosses Nasales*, 1896.
9. MCBRIDE.—*Diseases of the Throat, Nose, and Ear*, 1892, p. 269.
10. BALL.—*Diseases of the Nose and Pharynx*, 4th edit., 1901, p. 127.
11. HALL (DE HAVILLAND), and TILLEY.—*Diseases of the Nose and Throat*, 2nd edit., 1901, p. 25.
12. BOSWORTH.—*Diseases of Nose and Throat*, New York, 1889, p. 145.
13. BROWNE (LENNOX).—*The Throat and Nose and their Diseases*, 5th edit., 1899, p. 175.
14. WILLIAMS (WATSON).—*Diseases of the Upper Respiratory Tract*, 1901.
15. BARDELEBEN.—“*Galvanokaustic*,” *Real Encyclop. der Gesam. Heilkunde*, 1895, Bd. viii.
16. BRUNS.—*Galvano-Chirurgie*, Tübingen, 1870.
17. DOUGLAS (BEAMAN).—“*A Study of the Application of the Galvano-cautery in the Nose*,” *New York Med. Journal*, 1900, May 12th and 26th.
18. KLEMPERER.—*Heymann's Handbuch d. Laryngol. und Rhinol*, 1900. *Nase*, 1st Theil, s. 386.
19. STÖRK.—*Die Erkrankungen der Nase, d. Racheus, und d. Kehlkopfs*, 1895, vol. i, s. 74.
20. ZUCKERKANDL.—*Normale und Pathologische Anatomie der Nasenhöhle und ihrer Pneumatischen Anhängen*, 1893.
21. MEYER.—“*Histologische Beiträge zur Wirkung der Trichlor-essigsäure und Chromsäure*,” *Zeitschrift f. Ohrenheilkunde*, 1903, xlv, vol. i, p. 81.
22. CORDES.—“*Ueber die Schleimige Metamorphose des Epithels der Drüsen Ausführungsgänge in der Nasen-schleimhaut*,” *Arch. f. Laryng.* 1900, x, s. 123.
23. CITELLI.—“*Zur Frage der Regeneration des Nasenschleimhaut beim Menschen*,” *Fraenkel's Arch.*, 1903, vol. xiv, Bd. ii, s. 351.
24. ZARNIKO.—*Krankheiten der Nase*.
25. ZIEGLER.—*Lehrbuch der Allgemeinen Pathologie*, 10th Auflage, 1901, s. 368.
26. HAMILTON.—*Text-Book of Pathology*, 1889, vol. i, p. 268.
27. MARCHAND.—*Der Process der Wundheilung*, 1901.