ON THE
CONDITION OF THE SKIN IN TINEA
TONSURANS.

BY
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(Received January 8th—Read March 26th, 1878.)

ALTHOUGH the discovery by Malmsten of the tricophyton tonsurans is now more than thirty years old, there are some essential points relating to the growth of the parasite in the skin that are still unsettled. Küchenmeister, for example, in his classical work 'On the Parasites found in and on the Human Body,' published in 1855, states that the parasite in question can only live and increase in the substance of the hair shaft itself, and in the crusts which are found on the scalp, and that it is never found between the cells of the epidermis. Kaposi, on the other hand, in the chapter devoted to herpes tonsurans in Hebra's work 'On Skin Diseases,' states that similar fungous elements (conidia and mycelium) to those found in the hair shaft are also found between the cells of the root sheath. The subject thus raised by Küchenmeister and Kaposi deserves the special attention of pathologists at the present time. The solution

of questions of the highest importance in medicine are now waiting on information which is being diligently sought for on many sides, regarding the conditions in which low vegetable organisms can live and multiply in animal tissues.

Anything which can be learned about the position of the spores in ringworm, has therefore a general, as well as a special interest.

If Küchenmeister is right, then in this disease the fungus can only live on dead animal products, for such the hair shaft and the desquamated cuticle, which he designates as crusts, must be considered; if Kaposi is right, then the fungus lives and propagates in the midst of living tissue.

The observations that have been made hitherto in regard to the subject, have been limited to an examination of hairs extracted from parts affected with ringworm, or of detached epidermic scales. I am not aware of any observations made on sections of the skin of the affected parts. Yet it must be evident that it is only by examining the whole thickness of the skin that any satisfactory knowledge of the laws which regulate the growth of the parasite can be obtained; and I therefore venture to lay the results of a microscopic examination of the skin in ringworm before the Society.

It is not easy to obtain material for such an investigation from the human subject, but this difficulty is not of much importance as the disease occurs in several of the lower animals.

Cases of direct contagion from the dog or the horse to man are of common occurrence, and Mr. Fleming, the Veterinary Surgeon of the 2nd Life Guards, has communicated to me the details of a case in which a dog having become affected by lying on the cover of a horse which had the disease, communicated it to his master. In this instance the same stock (if I may use the expression) passed from the horse to the dog and the dog to man.

For the sake of convenience I have selected the horse for the study of this question, and I take this opportunity of expressing my sense of indebtedness to my friend Mr. Fleming, for the valuable assistance he has afforded me in

enabling me to familiarise myself with the appearances which the disease presents in this animal, and for giving me portions of skin for examination.

The facts which I have now to communicate are the results of an examination of two patches of ringworm skin from a seven-year-old mare, one of them being very recent, and the other of some duration. As the differences in the development of the characteristic appearances in the two specimens are only of degree, it is unnecessary to insist on them further.

The spores of the *trichophyton tonsurans* are found in and immediately surrounding the hair shaft, and plentifully between the latter and the internal root sheath. In this position they travel downwards from the free surface of the skin along the hair shaft to a considerable depth, but in no instance did I, in my sections, find them reach to the hair papilla. They travel deeper than the level of the sebaceous glands. Not only do they not extend laterally to the external root sheath, but they do not penetrate the internal root sheath, and they are never found in the substance or openings of the sebaceous glands. On the surface of the skin they are only found amongst the most superficial scales of the epidermis. If, therefore, by "crusts" Küchenmeister understood these superficial scales, and by the epidermis the rete mucosum and the deeper strata of the horny layer, my results are in accordance with his. They do not accord with the views of Kaposi.

The significance of these facts will be understood if we consider the relations which the different structures surrounding the hair shaft bear to the epidermis. These relations are acknowledged to be as follows: The hair shaft, with its cuticle, represents a special development of the horny layer, and the external root sheath is nothing more than a continuation downwards of a funnel-shaped projection of the rete mucosum. The layers of epidermic cells, which compose the internal root sheath, represent the cells of the lowermost strata of the horny layer. The parts of the hair with which the spores are found in contact are thus analogous

to the superficial epidermic scales of the horny layer of the epidermis. That is to say, the spores are found amongst lifeless epidermic products, and do not exist amongst those which still retain even the smallest degree of organic life.

The growth downwards of these spores in and around the hair shaft produces directly changes in the shaft itself, and indirectly very striking and important changes in the part of the corium which is near the hair.

At different positions of the hair in the cutis the shaft becomes bent, first at an obtuse, and then nearly at a right angle, and finally it breaks. The broken end of the upper part is then sometimes curled in a semi-circular form, the convex surface downwards, and there is a corresponding bulging of the external root sheath. The lower part of the shaft retains its strait position. These changes may be thus explained. There is a continual growth of the hair from the papilla by which the shaft is pushed upwards towards the surface. When the shaft has become weakened by the disintegrating effects of the growth of the spores, it first bends under the pressure from below, and finally breaks. The lower part of the shaft is then pushed past the detached upper part. The bending of the shaft produces certain mechanical effects on the external root sheath, which bulges and becomes wider.

In one section I found the outer part of it left in its original position in the skin at the level of the bent part of the shaft, whilst the inner part followed the displaced shaft.

In another section a different effect was seen. The internal root sheath had ruptured, and the black pigment of the hair shaft had streamed into the external root sheath, producing at one part decided changes in the cells in a circumscribed part of this sheath. But no spores were found amongst the escaped pigment, or in the affected part of the root sheath.

The fracture of the shaft frequently takes place at the level of the sebaceous glands.

The changes which take place in the skin surrounding the affected hairs are those characteristic of inflammation, from whatever cause it is produced. Microscopically, they consist

in the presence of numbers of colourless blood-corpuscles in and around the walls of the blood-vessels, and although to a less extent, between the bundles of connective tissue. At parts where the changes are advanced, the rete mucosum is found to contain colourless blood-corpuscles between its cells, and in a still more advanced stage, first the mucous layer, and finally the horny layer are completely broken down and all traces of them may have disappeared. In the latter case the free surface is covered with colourless blood-corpuscles (in this situation termed pus cells), and the degree of cell infiltration in the tissues of the cutis immediately under the surface is extreme. The superficial blood-vessels are in this case found distended with blood-corpuscles. But even in such cases not a single spore is found except immediately surrounding the hair shaft, both root sheaths and the connective tissue of the cutis being absolutely free from them.

In some sections oval or pear-shaped cavities were found in the rete mucosum, accurately limited by an even contour, and extending downwards into the upper part of the external root sheath. These cavities were filled with colourless blood-corpuscles, and amongst them a few single detached epidermic cells were found. The cavities were in the strictest sense of the word small abscesses. They contained no spores.

The manner in which these inflammatory effects in the cutis and rete mucosum are produced is hardly susceptible of direct demonstration, but it may be inferred if we take the facts I have adduced in connection with some of the laws which regulate the diseased processes comprised under the term inflammation. The growth of the spores in the hair shaft presupposes a decomposition of organic substances, some of the products of this decomposition being utilised by the growing fungus, others being left unassimilated. If, which is highly probable, some of these products are soluble, they will find their way between the cells of the root sheaths to the substance proper of the cutis. There they act on the tissues as irritants, and, as is always the case in similar circumstances, their action on the walls of the blood-vessels conduces to an escape of colourless corpuscles

from the vessels into the spaces of the surrounding tissue. These escaped, colourless corpuscles, may be so few in number that they are only found scattered singly through the cutis; or the injury to a limited part may be so severe as to cause them to accumulate as the pus cells of small abscesses.

The injury to the coats of the vessels can be recognised in the deepest layers of the corium, and at a considerable distance from the spores. It is made evident by the presence of colourless corpuscles in considerable numbers immediately external to the outer coat of the veins in the lowermost strata of the cutis, and in parts where the cell-infiltration between the bundles is insignificant.

The injury is not always limited to the blood-vessels and connective tissue of the corium. The epidermis itself is sometimes the seat of abscess, or is completely broken down both in its mucous and horny layers.

In addition to the irritation, or, as I believe it to be more accurate to describe the process, the destruction produced by the absorption of soluble substances foreign to the healthy tissue, a certain weight must be assigned to the effects of pressure. When the hair bends, the pressure of the lower part of the shaft is at the point of flexure no longer in a direction parallel to the root sheaths. On the contrary, at this point the root sheaths bulge outwards on one side, causing both pressure and dragging on the connective tissue of the cutis. A certain amount of pressure must also be secondarily induced by the escape of blood serum from the vessels. Although I have no direct evidence of such effusion, we know it must exist, for it is now established that it is the necessary and invariable concomitant of the escape of the colourless corpuscles in all inflammatory processes.

The relative weight that must be assigned to these two causes of inflammation, the existence of which I believe to be matter of legitimate inference, cannot be established with accuracy; but I am disposed to believe that the most important factor is the destructive influence exerted by the absorption of the soluble products that attend the growth

of the parasite in the hair; and for this reason. A great amount of cell-infiltration is often found surrounding hairs in which the spores, although present in considerable number, have produced no distortion.

I will not attempt to discuss all the various phenomena connected with the growth of the ringworm fungus, which are capable of reasonable explanation on the basis of the theory laid down in this paper. That theory is that the spores, whilst only capable of assimilating organic animal substances when these have been severed from the living body, yet exert an injurious influence by the production of hurtful soluble products in a position which facilitates their absorption; and also more indirectly by the results of pressure. The periods of life which are known to favour the occurrence of ringworm, and the conditions of health which are presumed to render it obstinate and its cure difficult, do so, it may be imagined, by combining certain anatomical conditions of the hair follicle, of whose nature we are ignorant, with a languid circulation, which enables the spores to escape contact with the living animal fluids which are fatal to them. Still that is only a subject of conjecture, although very plausible conjecture. It will be more profitable to examine the bearing that the theory has on treatment.

Ringworm of the scalp is treated by two classes of remedies, parasitocides which are also more or less irritants, and irritants pure and simple. It is needless to remark that experience shows that a large proportion of cases are cured by irritants of any kind whatever. Strong acetic acid, blisters, tar, irritating ointments containing mercurial preparations, are examples of such irritants. They have no essential property in common, except that they produce inflammatory action and consequent effusion of serum, and they all cure ringworm. It is, I believe, the inflammation that cures the ringworm. This opinion is strengthened by the fact communicated to me by Mr. Fleming, that in the horse patches of ringworm are cured if they are wounded by a cutting instrument.

The action of parasitocides is mostly, I believe, in the same direction. The parasiticide effect is of course exceedingly valuable, inasmuch as it destroys spores on the free surface, and thus gets rid of a source of danger to unaffected hairs, but a study of the sections described in the first part of this paper has satisfied me that it is very improbable that local applications can reach the spores that are in the deeper parts of the hair.

In some children ringworm may last for years, and may resist frequently provoked inflammation, and the persistent use of parasitocides. Next to carefully performed epilation—a treatment that is in many cases difficult effectually to carry out—the best treatment in such cases is to use an application that will keep up a slight degree of congestion of the affected skin over a considerable period, combined of course with some means of preventing spores taking fresh root on the surface. This principle is well understood by practitioners who have had much experience of these cases. The theory by which it is explained follows naturally from the facts I have adduced. A persistent effusion of serum, sufficient to penetrate the hair sheaths and bathe unceasingly the spores that surround and infiltrate the hairs, acts destructively on the fungus. Between this vegetable parasite, at least, and the living fluids of the body, there is no *modus vivendi*.

The delicate health that is undoubtedly frequently associated with ringworm must, if not caused, be aggravated by it. It is impossible for a chronic inflammatory process to exist without injury being inflicted on the system as a whole, and in this special instance there are causes at work which may be more hurtful than may at first sight appear. We have seen that the vessels are specially attacked, and it is more than probable that the diffusible substances which injure the walls of the blood-vessels pass into the general circulation, and the blood becomes contaminated with noxious matters.

[Some of the portions of skin examined were hardened in alcohol, and some in bichromate of potash, and subsequently

in alcohol. For permanent preparations those hardened by the latter method are best, and double staining with eosine and logwood is very advantageous. When sections from skin hardened in alcohol are first soaked in water, and then macerated in solution of potash, and examined either in the solution or in water, the position of the spores and mycelium and their relation to the structures of the cutis are brought out with great distinctness. Such preparations are useful for controlling preparations hardened in bichromate of potash and preserved in glycerine.]

DESCRIPTION OF PLATE XII.

The Skin in *Tinea Tonsurans*. (Dr. George Thin.)

[Figures 1, 2, 3, 4, and 8, are drawn as seen by a low magnifying power (Hartnack, ocular 3, objective 3). (The existence of spores in the hairs was ascertained by the use of a higher power.) Figures 5, 6, and 7, are drawn as seen by a higher power (Hartnack, ocular 3, objective 8, tube in)].

Fig. 1.—*a*, External root-sheath; *b*, connective tissue of the corium (the dots represent colourless blood-corpuscles); *c*, a portion of the external root-sheath which has become separated by the distortion of the hair; *d*, a sebaceous gland. Its form has been changed by the pressure of the hair.

Fig. 2.—*a*, External root-sheath; *b*, pigment which has escaped into the external root-sheath; *c, d, f*, sebaceous glands; *e*, a circumscribed patch of cells in the external root-sheath, the cells staining deeply by logwood. Pigment has escaped from the hair shaft into the patch.

Fig. 3.—*a*, The epidermis; *b*, a papilla; *c*, connective tissue of the corium with cell infiltration. (The shaft of the hair is bent.)

Fig. 4.—*a*, Connective tissue of the corium; *b*, a sebaceous gland; *c*, external root-sheath. (The hair-shaft broken.)

Fig. 5.—*a*, Cells of the internal root-sheath; *b*, spores of the trichophyton tonsurans lying between the internal root-sheath and the hair shaft; *c*, the external root-sheath; *d*, connective tissue of the corium.

Fig. 6.—*a*, External root-sheath; *b*, spores of the trichophyton

tonsurans lying between the internal root-sheath and the hair shaft; *c*, connective tissue of the corium; *d*, detached epidermic cell lying in an abscess in the rete mucosum; *e*, cavity in the external root-sheath and rete mucosum filled with colourless blood-corpuscles—(an abscess).

Fig. 7. (To show the manner in which the cell-infiltration in the cutis is produced.) *a*, The external border of the external root-sheath of a hair in which the existence of spores was ascertained; *b*, a blood-vessel. The small round cells in the drawing represent colourless corpuscles, those on the vessel being either in or immediately external to its wall; *c c*, bundles of connective tissue, cut transversely; *e*, a capillary blood-vessel—the vessel was indicated by a line of colourless blood-corpuscles, amongst which a nucleus of the vascular wall could occasionally be distinguished. After a longer course than is shown in the drawing, it approached close to the root-sheath of the hair.

Fig. 8.—*a*, rete mucosum; *b*, horny layer of the epidermis; *c*, mass of colourless blood-corpuscles (pus cells) on an exposed surface from which the epidermis had disappeared; *d*, blood-vessel distended with red blood-corpuscles; *e*, hair cut obliquely. (The hair seen by a higher power to be filled with spores.)