ON THE
CONDITION OF THE SKIN IN TINEA
TONSURANS.

BY

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IN a paper read at a recent meeting of the Medical and Chirurgical Society, Dr. Thin¹ described the condition of the skin in Tinea tonsurans. His specimens were taken from the horse, but at the same time I was myself engaged in the examination of the disease in the human scalp, and some of the results I stated to the meeting. I believe that Dr. Thin's is the first published account of an actual microscopic examination of the affected skin in this disease, the statements made by various authorities as to the localisation of the fungus being, apparently, founded on examination during life of epidermis detached from the surface, and hairs extracted from the follicles. Whether examinations of the deeper parts of the skin and of the hairs *in situ* have been made or not, it does not appear that any appeal is made to them by those writers on Tinea tonsurans who have discussed the manner of invasion of the hairs of the fungus; and I, therefore,

¹ "On the Condition of the Skin in Tinea Tonsurans," 'Med. Chir. Trans.,' vol. lxi, 1878, p. 179.

offer the present communication as a contribution to our knowledge on the subject.

When the opportunity, which I had long been waiting for, at last presented itself to me of investigating this matter, I had in view to ascertain whether the fungus was confined to the hair itself, and if not, how far it spread into the structure of the root-sheaths and hair-follicles; because it seemed that the deeper it extended, the less could one expect the various methods of treatment, by epilation or by parasiticides to be quickly successful.

On this point Dr. Thin's specimens from the disease in the horse confirmed the observations of Küchenmeister. The latter says¹ that the fungus is found in the substance of the hair itself, that it is never found between the cells of the epidermis and never in the scales which cover the head. Kaposi,² however, describes the *Trichophyton* as being found in the hairs and *their root-sheaths*, as well as in the layers of the epidermis in the vesicular and squamous forms of the disease.

The subject of the disease in the present case was a child aged 5 years, who died in Guy's Hospital from a large cheesy tubercle occupying the right half of the cerebellum, and invading the right side of the pons. The symptoms had first shown themselves seventeen months previously, and the child had been under my care in the hospital ten months. During the whole of this time he became steadily worse, and during the last six or eight weeks was only semi-conscious, fed with difficulty, and rapidly wasting. The ringworm affected a circular patch about two inches in diameter on the left side of the head over the parietal bone, and other smaller patches were scattered over the head. When first seen, there were numerous short broken hairs, and abundant desquamation of the epidermis in small branny scales; but there was no redness or tenderness. Very little hope was entertained on account of the intracranial disease, that any treatment would be successful, while the ultimate prognosis of the case was so

¹ 'Manual of Parasites,' vol. ii, p. 141, Syd. Soc., 1856.

² Hebra und Kaposi's 'Hautkrankheiten,' Theil ii, p. 638.

certainly fatal, that we could have none but a scientific interest in the cure. However, in May and June, an ointment of goa powder, and one of petroleum were from time to time applied. The former caused the usual erythematous redness, but no effect on the disease itself was observed, and at the end of July, the hairs extracted were still found to be loaded with spores. For the few remaining months of his life, during which the fatal symptoms made rapid progress, little attention was paid to the ringworm, though the hair was kept close cut for purposes of cleanliness. The boy died on December 14th, 1877.

After death a large portion of skin was removed from the left side of the head, and placed in a mixture of equal parts of alcohol and solution of chromic acid of about one per cent. strength. During February I commenced to work upon it, and made a great number of sections parallel to the course of the hairs, parallel to the surface of the skin, and in other directions. Some were stained in logwood, but by far the greater number in picro-carmin. In the latter sections it is not difficult to detect the affected hairs with a low power. The tissues of the skin, generally, take up the carmin in the usual way, but the horny tissues are stained by the picric acid alone; thus the cutis proper and the mucous layer of the epidermis are stained pink, as are also the corresponding hair-follicles, papilla, and outer root-sheath; but the horny layer of the epidermis becomes yellow; the hairs are yellow when small, and yellowish green or deep green when thick, or pigmented; while the inner root-sheath is variously coloured, very pale pink in the neighbourhood of the papilla, colourless or yellow in the rest of the follicle, with blotchings of deep pink, especially just where the hair swells out into the bulb. Where the hair is extensively diseased or utterly destroyed by the presence of numbers of spores it presents an orange-brown or reddish-brown colour, by which it is readily distinguished from the healthy green and yellow hairs; in thinner sections it has a paler brown colour.

Hairs and portions of hairs, are, however, often found in

which the disease is less advanced ; these are still in a position to assume a greenish colour and they are generally only recognised as diseased on more careful examination with higher powers.

What is then seen is that the shaft of the hair contains several fine filaments (or tubes) running parallel to the hair and to one another. I need not describe these further ; the appearances of the filaments themselves are, of course, not different from what may be seen in hairs extracted from the living subject. When the process of growth is more advanced and luxuriant, a high power shows that the hair substance is almost entirely destroyed. The space within the internal root-sheath has lost its uniform outline and is irregular, though not, as far as I have seen, to any great degree ; and this space is filled with the spores of the fungus. In the middle, and, as it were, separated by them from the sheath with which it ought to be in contact, lies the remnant of the hair. It has also the irregular outline, the opaque appearance and the fibrillated structure, with which we are familiar in hairs removed during life (Pl. I, fig. 1, and Pl. II, fig. 4),

In seeking out the limits to the growth of the fungus, I found some difficulty in determining the extent to which it spread in a downward direction towards the root ; as out of a large number of sections, only a few have fallen in such a way as to illustrate this point of the inquiry. I have never observed the soft tissue constituting the bulb of the hair to be completely involved, but in some sections I have seen mycelium threads extending as far as the point at which the shaft begins to swell out into the bulbous portion. In these the outline of the hair was still preserved, and though filled with threads it was not as yet obscured by separate spores (Pl. I, figs. 2 and 3).

I never found the fungus to extend below this point.

The difficulty of getting diagrammatic sections of hair, bulb, and papilla, is still greater ; and, although some of my slides show such sections, in these the hairs are healthy, and I have, unfortunately, not met with any diseased hairs,

cut exactly in the way indicated. On the other hand, I have examined numbers of papillæ, isolated, or in connection with short stretches of hair; and even in portions of the scalp much affected with the disease, I have never found them anything else than perfectly normal.

With respect to the extension of the growth in a lateral direction, this is clear that in none of my specimens are there any spores or mycelium threads in the outer root-sheath, which corresponds to the mucous layer of the epidermis; the cells of this layer are quite normal (Pl. I and II, figs. 1, 2, 3, 4). To determine the condition of the internal root-sheath requires careful examination. As I have said, in the advanced stage, the hair is both occupied and surrounded by spores, so that the latter come into actual contact with the internal surface of the internal root-sheath; and, in exceptional cases this root-sheath is so far obscured by them, that it would be impossible to say it was not involved. But the rule is for the inner root-sheath to be easily discernible, whether high up in the follicle near the surface, or low down near the papilla; whether the hair be in the condition just described, or only invaded by mycelium threads in longitudinal arrangement. It is remarkably well shown in Pl. I, figs. 2 and 3, how, in the early stage, the threads confine themselves entirely to the hair, without any attempt to encroach upon the tissues beyond; and Pl. II, fig. 4, shows the integrity of the inner root-sheath in the more advanced conditions.

As might be expected after this, the structure of the follicle itself, the cutis, and the subcutaneous tissue in which the follicle is embedded, show no signs of the parasite.

It only remains to speak of the epidermis. The horny layer can be made the subject of examination during life, and, perhaps, better than after death, as it is very likely to be loosened or detached by the fluid employed to harden the skin itself. I have succeeded, however, in retaining a considerable quantity of this layer, some of it in the immediate neighbourhood of diseased hairs; but though the presence of spores or threads in the horny layer would be particularly easy to detect, I have failed utterly to find them.

Since it is possible that the most superficial layers have been removed post mortem, the present specimens would scarcely justify me in saying the horny layer was never implicated. But it is remarkable how much of the horny layer of the epidermis may be completely free from infection even in close proximity to a diseased hair (Pl. II, fig. 4).

The deeper layer of the epidermis, like the outer root-sheath is never involved.

It will be seen, therefore, that these observations are in favour of the statements of Küchenmeister and opposed to those which Kaposi advances in reference to the implication of the root-sheaths. The hair-follicle, papilla and root-sheaths, the cutis, subcutaneous tissue, and mucous layer of the epidermis, are entirely free, while the only parts invaded are the hair proper, and perhaps the horny layer to a slight and superficial extent.

Of the breaking and twisting of hairs described by Dr. Thin, as well as the inflammatory changes, I have seen but little. The former condition may have been present at some or other part of the diseased patch, but in all the diseased hairs which were cut in sufficient lengths for such an observation, the straight course of the follicle was maintained, and no such fracture or twisting was seen. Only very rarely was I able to find any traces of inflammatory action. Here and there was a spot where the tissue was filled with young cells, but for the most part the whole tissue was quite free from cell-growth or vascular changes even in the immediate neighbourhood of the follicles of diseased hairs.

This need not be considered as contradicting Dr. Thin's observations; for, firstly, in the weakened condition of the child during the last months of its life, the hairs might grow with less vigour, and thus, more gently, and without distortion, expel the separated fragment; and, secondly, if the same cause were not sufficient to account for active irritative changes, it is clinically well known to us that the more chronic stages of *Tinea tonsurans* are unaccompanied by inflammation; and the disease in this case had lasted more than nine months.

From the results of the above investigation, I think one may infer that the mode of invasion of the disease is somewhat as follows :—Whether or not the fungus first takes root in the horny layer of the epidermis, the first point at which the hair is attacked is probably that portion of the shaft immediately on a level with the surface of the skin. There I should suppose the fungus grows well into the substance of the hair and spreads by the advance of mycelium threads certainly downwards towards the papilla, and perhaps also upwards into the free part of the shaft. Then these three changes must be going on simultaneously ; (*a*) the complete destruction of the hair at the part first invaded ; (*b*) the advance of the threads into the hitherto healthy shaft or root, and (*c*) the natural growth of the hair in an upward direction as it is supplied from the papilla. By this last action, the portion of the hair which is first attacked and most thoroughly diseased, is carried beyond the level of the skin, and thus, losing at the same time, both cohesion and support, the hair yields, and is removed by the usual daily accidents of friction by combing, brushing, &c.

The spread of the fungus in each follicle is necessarily measured by the growth of the hair, since we have seen that it is confined to the substance of the hair itself and does not extend to the other tissues. One cannot help recognising the essential difference between what the fungus invades and what it leaves untouched ; between the living root-sheath, follicle, and papilla, on the one hand, and the relatively dead hair-substance on the other. Dr. Thin, also, has remarked on the preference of the fungus for the most dead tissues such as the hair and the horny layer of the epidermis ; and with this fact in view one can see that the plant spreading down the hair would never be able to approach within a certain distance of the papilla, because of the formative power of the immediately adjacent hair-cells, which would enable them to resist its inroads, until, in their turn, they had assumed the dense, dry, dead condition of the more remote parts of the hair ; and should the papilla cease to form any fresh hair, the multiplication of the fungus spores in that follicle would be

necessarily brought to a stand-still for want of their own proper nutriment.

There remains the question whether one can from these results derive any suggestions as to methods of treatment or the operation of remedies in this disease. The local measures usually employed are of three kinds ; the practice of epilation, the application of irritants, and the use of so-called parasitocides. The difficulty presented by the last method is, that of ensuring the penetration of the agent to the deepest part of the follicle, for it is there, I take it, that the most active growth is going on. Though there may be thousands of spores in the rest of the follicle they have by this time exhausted their supply of nutriment, and it is in the deepest part only that is found the material for the further development of the fungus. Epilation labours under a somewhat similar disadvantage, namely, that an infected but not exhausted portion of the hair is apt to be left in the follicle. In a healthy hair, the weakest point is at the connection of the bulb with the papilla, where the cells are soft, and by steady traction the hair may be separated ; but, in one infiltrated with fungus the connection of the bulb with the papilla is relatively strong, and the portion which holds only the advancing threads of mycelium has more cohesion than that which has contributed to the development of crowds of sporules. Hence the hair will yield at this last point instead of at its junction with the formative papilla.

With regard to the action of irritants, many of which are of great service in curing the disease, Dr. Thin has offered an explanation which is not altogether improbable, namely, that the process of inflammation induced by their use, results in a persistent effusion of serum, which penetrating the hair-sheaths, and bathing, unceasingly, the spores that surround and infiltrate the hairs, acts destructively on the fungus. But I do not find, in my own observations, any material, either for the support or rejection of this theory, and I shall, therefore, refrain from discussing it. On the other hand, these results suggest to my mind that a most effectual and rapid cure would be brought about if, by any artificial means, a

complete shedding of the hair of the affected part be produced; as, in this way, the hair would be cast off from its very connection with the papilla, instead of being broken off at some higher part of its course, as in the process of epilation. Biesiadecki, in Stricker's 'Histology,'¹ thus describes the natural falling of the hair.

"The fall of the hair results from the circumstance that new cells form around the papilla. The last formed cells of the hair root, receiving no impetus from behind, become converted into hair-substance, and form either the conical or club-shaped inferior extremity of the shaft, which is composed of fibrillated hair-scales. * * * * The sheaths of the hair-follicle, which in consequence of their muscular structure (?) exert a constant pressure upon the contents of the hair-follicle, force the clubbed extremity of the hair, together with the sheath of Huxley, continuously upwards, and so contract that the vitreous membrane presses directly on the papilla; whilst at a higher point the internal surfaces of the external root-sheath come into contact. The new hair is developed from the old papilla."

If, then, the hair is affected with fungus, it will be seen that its separation from the papilla by the contraction of the follicle-wall would put a stop to further infection; the vital outer root-sheath acting throughout as an effectual barrier between the fungus-loaded hair in front, and the healthy young hair behind. Amongst my sections, I was fortunate in meeting with that of a follicle in which the hair is in the act of being shed, and I have made a drawing of it, as illustrating the point suggested (Pl. II, fig. 5). The very small portion of hair figured is healthy, and I am unable to say what was the condition of that in the upper part of the follicle; but it is clear that the new hair would be quite protected from infection by the old one. On the assumption that the fungus grows freely in the root-sheaths, and even in the papilla, as some seem to suppose, no cure could be expected from such a process; but the limitation of the

¹ 'Handbuch der Lehre von den Geweben,' vol. i, p. 612, and Syd. Soc. Translation, 1872, vol. ii, p. 257.

disease to the structure of the completely formed hair, which these observations so strongly demonstrate, is precisely the arrangement which renders possible its extermination in this way. How often a cure is brought about thus, must be still uncertain. It is at least possible that some forms of irritation, such as blistering, may act in this manner; but, with this exception, the irritations employed for ringworm are much less severe than that spontaneous inflammation of the skin, namely, erysipelas, which most often causes shedding of the hair. On the other hand, one would expect some falling of the healthy hairs also, if the irritants used in the cure of *Tinea* commonly acted as above suggested.

This at least seems to me worthy of consideration that could any means be employed to cause the hairs to be thrown off from the papilla, a cure would more certainly and more quickly result, than by the methods commonly in use.

In conclusion, I would suggest to future workers in this field, that much may possibly be learnt by observations on the skin in a stage of *Tinea tonsurans* advancing towards cure, a stage which, for the reasons explained, had not yet been reached in the present case.

DESCRIPTION OF PLATES I AND II.

On the Skin in *Tinea tonsurans* (Dr. F. Taylor).

Plate I, fig. 1.—Transverse section of a follicle with diseased hair. *a.* Outer root-sheath. *b.* Inner root-sheath. *c.* Spores of the fungus surrounding the hair. *d.* The hair-shaft split up by mycelium-threads and spores. Magnified 140 diameters.

N.B.—In this drawing and in Fig. 4 the spores are represented about twice as large as they should be. According to the scale given their size would be about $\frac{1}{50000}$ inch; their actual measurement was under $\frac{1}{100000}$ inch.

Figs. 2 and 3.—Longitudinal sections of hair-follicles. *a.* Outer root-sheath. *b.* Inner root-sheath. *c.* Hair filled with mycelium-threads. *d.* Soft pigmented cells surrounding the papilla. *e.* Wall of the follicle. *f.* Fat-cells. Magnified 104 diameters.

Plate II, fig. 4.—Longitudinal section of hair-follicle, running obliquely under the skin. *a.* Outer root-sheath. *b.* Inner root-sheath. *c.* Fungus-spores. *d.* Hair-shaft destroyed by mycelium and spores. *e, e.* Transverse sections of follicles from which the hair-sections have fallen out. *f.* Arrectores pili cut obliquely. *g.* Horny layer of the epidermis half detached by maceration. *h.* Mucous layer of the epidermis. Magnified 100 diameters.

Fig. 5.—Longitudinal section of follicle and papilla, showing the fall of a hair. *a.* The shaft of the hair, which terminates in altered cells, and does not form the usual bulb. *b.* Papilla. *c.* Walls of the follicle closely contracted upon the papilla (compare Fig. 2). *d.* Sudoriparous gland. Magnified 104 diameters.