SOOT IN CELLS OF CHIMNEY-SWEEP'S CANCER.

BY

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Received June 7th—Read November 11th, 1890.

SINCE Pott¹ first described the disease it has always excited interest out of proportion to its relative frequency, and surgeons, especially in London, have recorded many cases. Two papers by Earle,² and Travers³ respectively, are to be found in the Transactions of the Royal Medical and Chirurgical Society. The interest lies in the fact that from a known cause, viz. from soot, a new growth may be produced in some persons, which has the anatomical structure of epithelioma, and which may extend to the neighbouring lymphatic glands, but no further. Moreover this purely local disease is connected with ordinary epithelioma of the malignant type by other cancers⁴ of somewhat similar causation, viz. that occurring among workers

¹ Pott's Works, ed. by Earle, 1808, vol. iii, p. 178.

² Earle, 'Med.-Chir. Trans.,' 1823, vol. xii, p. 296.

³ Travers, *ibid.*, 1828, vol. xvii, p. 344.

⁴ von Volkmann, "Ueber Theer u. Russ Krebs,," 'Verhandlung der Deutschen Gesellschaft für Chirurgie,' 1874, iii Congress, Berlin, i, s. 3.

in tar,¹ and paraffin,² and that from chewing or smoking³ tobacco.⁴

I shall, in this paper, confine my remarks to the points illustrated by the microscopic specimens, and this I do the more readily because Mr. Butlin is following in the footsteps of his predecessors at St. Bartholomew's Hospital, and has collected all the general information on the subject, both from published and unpublished sources. From him, therefore, we may expect valuable additions to our knowledge on the subject.

I have not been able to find that any previous observer has described the presence of soot particles in chimney-sweep's cancer.

The case from which the specimens were taken is a master-sweep, aged sixty-three, who formerly lived at Kingston, and is now in Croydon. In March, 1885, an ulcer, which is said to have been epitheliomatous in structure, was removed from over the left zygoma by Mr. Macnamara in Westminster Hospital. Although he comes from a family of sweeps, he is not aware of any members having suffered in a similar way. In August, 1887, he first came under me. The skin was dry and harsh, there was some eczema over the body, and in some parts dusky patches, but in others the skin was free from any pigmentation. There was a black ring in the skin round the neck, at the level of his collar, in which ring to the left of the middle line behind was an indurated ulcer about an inch and a half in diameter. At the level of his waistband was a similar ring, and in it, over the erector spinæ of one side, was another indurated ulcer two inches long by one inch broad. There was also a small patch of superficial ulceration on his left cheek, at some distance from the scar of the first operation.

¹ Ball, "Tar Epithelioma," 'Lancet,' 1885, i, 1037.

² Ogston, "Local Effects of Crude Paraffin," in 'Edinburgh Med. Journ., 1871, Dec., p. 544.

³ Esmarch and Langenbeck, von Volkmann, Discussion.

⁴ Tillmann's, "Ueber Theer Russ v. Tabakskrebs," 'Deutsche Zeitschrift für Chirurgie,' 1880, xiii, 519.

The two large ulcers were excised and immediately placed in alcohol, and the cheek was scraped.

In April, 1890, he returned with superficial ulceration again on his left cheek, about two inches square, which had the appearance of lupus. Scraping was once more done. With this exception he has remained quite well and there has been no affection of lymphatic glands.

Both the ulcers and the product of scraping were found to present the same appearance microscopically, and about one hundred preparations have been examined; most of the points mentioned below are to be seen in each of the sections. Various stains were used, including logwood, but it is difficult to observe the black cells in a specimen stained with the last-named dye, until the eye has become familiar with lighter stained specimens. Perhaps the use of logwood may have caused the appearance to have been overlooked, as certainly happened to me when I stained the first sections in this way.

Microscopic Sections.

Specimen I. (Fig. 1).—A vertical section through the ulcer, to show the general structure; stained in safranin. The growth is an epithelioma, portions being of the squamous-celled variety, with here and there an incomplete nest-cell, whilst other parts have rather the usual appearance of rodent ulcer, and consist of smaller oval cells. At the margin the disease was in course of extension by means of columns of cells growing downwards from the deeper layers of the epidermis, and more advanced columns have become flask-shaped and surrounded by leucocytes which have collected in the neighbouring tissues.

Specimen II.—An unstained section, which was immersed in 33 per cent. nitric acid for twenty-four hours. Black masses appear under a low power, scattered throughout the section, and collected in heaps. Under a high power the black material is observed to fill both large

cells and small cells. The outlines of the cells are clearly mapped out by the black material which they contain.

Specimen III. (Fig. 2.)—The section was stained in cochineal. Under a high power the growth appears to be composed of oval cells, amongst which spaces occur, and around which spaces the cells have a tendency towards a columnar shape. Between the oval cells and in the spaces are scattered large cells with single nuclei and a large amount of protoplasm, which have become filled with black granules, so that in the case of many of them little of the protoplasm of the cell is to be seen. A few small cells are also present, being likewise stained black by the material which fills them.

Specimen IV. (Fig. 3.)—The section was stained with picro-carmin, and is seen under a high power. At the margin of the growth, in the corneous layers of the epidermis there are soot particles, and among the cells of the rete Malpighii are some darkly stained by the black material within them. From the lower layer of these cells two columns have begun to grow down, and some of the cells in these columns are stained black by granules similar in appearance to the soot in the corneous layers.

Specimen V. (Fig. 4.)—The section was stained in safranin. Under a high power the still healthy epidermis, immediately beyond the margin of the growth, has the lower cells of the rete Malpighii, between the papillæ of the corium, filled with black granules.

Specimen VI. (Fig. 5.)—The section was stained with safranin and picric acid. A column of cells, seen under a high power, has grown from the epidermis and divided into groups of cells, some of which are filled with soot particles. Several of the cells appear to have a large amount of protoplasm, and to be in course of becoming the large cells seen in Specimen III.

Specimen VII. (Fig. 6.)—The section was faintly stained in primrose yellow. Under a high power a loosely formed nest-cell appears, having soot particles between its

concentric layers. Beside it is a portion of the growth, amongst the cells of which are some coloured black.

Specimen VIII. (Fig. 7.)—The section was stained with pale primrose yellow. The deep portion of the growth is seen, under a high power to be composed of cells which are mostly oval, but which have a more columnar appearance at the margin. This is the part of the growth which was extending deeper into the structures beneath. Amongst the cells of the growth are numerous smaller cells coloured black, especially occurring amongst the columnar cells of the margin.

Specimen IX. (Fig. 8.)—The specimen was stained in pale safrænin. Immediately outside the new growth, among the leucocytes and newly-formed inflammatory tissue are numerous cells, some large, some small, coloured black by the soot which they contain.

Specimen X.—Part of the growth as seen with the naked eye. The cut surface shows dusky patches.

The foregoing specimens show soot in the corneous layers of the epidermis, in the cells of the rete Malpighii, in the growing ends of the epithelial columns which begin the growth, in the cells of a column which has become flask-shaped and is tending to separate into groups of cells, and in the nest-cells which arise in the epithelial columns. Cells full of the same material, some large and some small, are found in numbers in the centre of the growth, at the deep growing margin, and in the tissues outside.

The soot can be traced into and around the growth by means of its black appearance, and the appearance is unaltered by treating the sections for twenty-four hours with 33 per cent. nitric acid, or with nitro-hydrochloric acid. Except for the soot particles in the corneous layers, all the rest is within cells. In some places, no doubt, a cell has been broken by the microtome, and the black granules are outside, but it can be easily seen that this extra-cellular position has been produced by the destruction of a cell.

Also here and there a black particle has fallen from the atmosphere in which the specimens were mounted. With this exception, and the contained soot, the sections have never been in contact with any other carbonaceous material.

The large cells which contain soot resemble the cells of the epithelial columns from which they appear to be derived, whilst the small cells are like the oval cells which compose the centre of the growth. The specimens, therefore, indicate that the cells containing soot are epithelial in origin.

Carbon and carmine have been shown to be taken up by cells and carried to the lymphatic glands, whether this be from a spot in the skin which has been tattooed, or from the lungs, *e. g.* of colliers, to the bronchial glands. Some¹ have stated that the cells which take up carbon are epiblastic in origin, others that they are mesoblastic.

In the present case the epiblastic origin of the black cells seems fairly certain, for the soot is manifestly in the cells of the epithelium to begin with, and there is no sign of any transference of the soot to leucocytes—*e. g.* by the epithelial cells breaking down.

These specimens, I think, offer simple explanations of some points in the clinical characters of chimney-sweep's cancer which have hitherto been obscure.

(1) These large cells having taken up soot which has entered the skin are to be found outside the growth and may travel to the neighbouring lymphatic glands, just in the same way as is the case with cells filled with innocuous carbon, and there set up in the lymphatic glands chimney-sweep's cancer. We should then have an explanation afforded of the way in which soot cancer may develop primarily in the lymphatic glands. Mr. Paget² removed, from a sweep aged forty-eight, the in-

¹ Virchow, "Ueber Lungenschwarz," 'Virchow's Archiv,' Bd. xxxv, p. 348; Tchistovitch, "Des Phénomènes de Phagocytose dans les Poumons," 'Annales de Pasteur,' 1889, Juli, p. 334 (with Bibliography).

² Paget, 'Med. Times and Gazette,' 1852, vol. ii, 414.

guinal glands on both sides. There was no other lesion except a dry and dusky skin. Mr. Lawson¹ has described two such cases. In one, a sweep, aged fifty-six, the left femoral glands formed a hard swelling which afterwards ulcerated continuously until the superficial femoral artery was opened. The skin was dusky from ingrained soot, but there was no scrotal lesion. In the second case the inguinal glands were attacked and ulceration took place into the external iliac. In my patient the glands have as yet remained unaffected.

(2) The presence of soot in the lower cells of the epidermis, and in the tissues outside the growth explains the dusky patches in the skin of sweeps to which Pott,² Astley Cooper,³ and others since then have called attention—dusky patches which no amount of soap and water will remove. In other parts the skin may be normally white as in my patient. Earle⁴ had seen many cases of ulceration on the cheek, and Travers⁵ likened the appearance to lupus. The growth at the line of the collar and waistband in my patient may be compared with Lawrence's⁶ case on the ear from contact with a soot-bag.

(3) The presence of the soot in the skin and tissues suggests that it may remain latent there until "predisposition" favours the starting of cancer. If that be so, we have an explanation of the fact which has until now proved puzzling, viz. the development of chimney-sweep's cancer years after the patient has ceased to come in contact with soot. In one of Earle's⁴ cases a man aged twenty-eight had a bubo which suppurated; then a fungating ulcer formed, which took on all the characteristics of the disease. He had been a sweep when a boy, until thirteen years old, and during that time had soot warts

¹ Lawson, 'Lancet,' 1878, vol. ii, 577.

² Pott's Works, ed. by Earle, 1808, vol. iii, 178.

³ Astley Cooper in 'Observations on the Testis,' 1830, p. 226, "Of the Chimney-Sweep's Cancer."

⁴ Earle, 'Med.-Chir. Trans.,' 1823, vol. xii, 296.

⁵ Travers, *ibid.*, 1828, vol. xvii, 344.

⁶ Lawrence, quoted by Paget, 'Lancet,' 1850, vol. ii, 265.

on the scrotum and groin. But for the last fifteen years he had not been in contact with soot, nor had he suffered from any scrotal cancer. Curling¹ records the case of a sailor, between forty and fifty, who had been a sweep in boyhood, but for twenty-two years had been at sea, out of all contact with soot, yet a growth occurred on the scrotum having all the genuine characteristics of a chimney-sweep's cancer.

In a case under Stanley² the man was a sweep until twenty-one, when the occurrence of a large ragged soot wart on the scrotum so frightened him that he left the work and became a hawker, in which trade he was not in the least exposed to soot. Yet the growth returned six years after and was removed by Lawrence. After another five years it returned again, but grew so slowly that it was not removed by Lloyd until he was thirty-nine. Finally the glands became affected and Stanley removed them with the overlying skin.

The presence of the soot in the skin further explains why recurrence may take place, not in the scar, but at some distance from it. This has often happened on the scrotum and elsewhere. In a sweep, aged sixty-six, under Curling,¹ a scrotal cancer had been removed thirty-six years before, later on a finger was amputated for the same reason, and later still a soot-wart appeared on a finger of the other hand.

(4) No doubt another factor besides the soot is required for the above explanations, viz. predisposition. But predisposition in the case of soot-cancer is not entirely an hypothesis, for there is evidence to support it at least on two points, viz. as regards age and as regards inheritance.

Earle³ said that although eczema and soot-warts were common enough among the boys, yet cancer did not

¹ Curling, 'Diseases of the Testis,' 1856, 2nd edit., "Chimney-Sweep's Cancer."

² Stanley, 'Med. Times and Gazette,' 1852, vol. ii, 414.

³ Earle, 'Med.-Chir. Trans.,' 1823, vol. xii, 296.

develop until after twenty and generally not until after thirty. Only this age limit appears to have been diminished when an inherited predisposition was also present. In one case only is cancer recorded in a boy, viz. by Earle, sen., in a boy of eight years.

Inherited predisposition was well marked. Earle saw instances of three generations—father, son, and grandson attacked. Hawkins¹ had a father and son under him at the same time for the disease. Cusack² removed a soot-wart from the hand of a woman who carried on a chimney-sweep's business. Twelve years before he had removed from the ear of her son a soot-wart, and another son had died of cancer.

It is obvious that in the great majority of sweeps this predisposition is absent and they remain immune.

(5) There is one point of general interest which the specimens show. Cells filled with the soot are seen among the leucocytes outside the margin of the growth. These black cells are epithelial in origin and therefore form the advancing portion of the disease. It has been for long an axiom in clinical surgery that a wide margin must be removed beyond the apparent margin of the growth, as seen either by the naked eye, or by the microscope. But it is impossible, as a rule, to identify the cells of the growth when amongst the leucocytes outside the well-defined margin. Here the black colour enables us to do so and thus to give an anatomical support to the surgical axiom of removal wide of the disease.

¹ Hawkins, 'Lond. Med. Gazette,' 1838, vol. xxi, 842.

² Cusack, 'Dublin Journ. of Med. Science,' 1842, vol. xxi, 137.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. iii, p. 12.)

DESCRIPTION OF PLATE I.

Soot in Cells of Chimney-Sweep's Cancer (W. G. SPENCE, M.S.).

FIG. 1.—General structure of the growth. 1. Epithelial cells. 2. Epithelial columns. 3. Portion of growth composed of oval cells.

FIG. 2.—Large and small cells in the centre of the growth filled with soot.

FIG. 3.—Soot in the corneous layers of the epidermis, in the cells of the Malpighian layer, and in those of the epithelial columns.

FIG. 4.—Epidermis beyond the margin of the growth. Granules of soot are contained in the cells of the Malpighian layer.

FIG. 5.—An epithelial column which has divided into groups of cells, some of which contain soot.

FIG. 6.—Epithelial nest-cell with soot amongst its concentric laminae.

FIG. 7.—The deep growing margin, showing many cells coloured black by the soot particles which they contain.

FIG. 8.—Soot contained in cells outside the apparent margin of the growth. 1. The growing margin. 2. Inflammatory small round cells.