Bödecker (C. F. W.)

NECROSIS.

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I propose to speak to you to-night of the case alluded to a few meetings since, namely, necrosis of the inferior maxilla. I will recapitulate its history.

On the 27th day of June, 1877, the patient, a married lady, thirty-eight years of age, a native of France, applied to me. Her temperament may be called bilio-nervous. The left eye protruded considerably from the orbit, the pupil was dilated to nearly twice the size of that of the right eye, and the patient was unable to use the other eye without shading or shutting the affected one. She complained of a bad taste in her mouth since July, 1874. Her gums had been swollen for two days, in the region of the first and second molars of the lower jaw, on the left side. On the 6th of July, 1874, she had consulted an eminent oculist of this city, who (she says) told her that the protrusion and partial blindness of the left eye was due to paralysis of the optic nerve. He applied electricity, and gave medicines internally, but without beneficial result.

While under treatment a severe neuralgia developed, which involved the whole of the left side of the body, and continued with greater or less severity up to the time she consulted me. After the development of the neuralgia she had consulted further with a number of eminent general practitioners, but without gaining relief from the pain, bad taste, or disfigurement.

I made a careful examination of her mouth, and found the first lower molar necrosed and loose. I advised the immediate removal of the tooth, which was assented to by the patient. I then dismissed the patient with the request that she would see me again.

Fifteen days after, on the 12th of July, the patient returned, and, on further examination, I was convinced that this was a case of necrosis. I made an injection of aromatic sulphuric acid into the socket, and informed the patient that the bone would have to be removed; that I believed the whole trouble originated there, and that perhaps, when it was taken out, she would be entirely relieved. The patient, greatly frightened, went to one of her physicians, who did not seem to understand the case, but took her to a professor of this city, and

both denied the correctness of my diagnosis. The professor said he believed there was a tumor forming, and that which the dentist supposed was necrosis was nothing but a root of a tooth, which should be extracted.

A few days after this the patient returned to me with a letter from the doctor, requesting the extraction of the root. I was surprised to receive such an opinion from such an authority. I reasserted my former diagnosis to the lady, and told her that both physicians had mistaken the dead socket, from which the tooth had been removed, for a root.

For the satisfaction of the patient and myself, I invited her to see Dr. W. H. Atkinson, who, after examination, pronounced it to be an unmistakable case of necrosis, and advised a continuation of the aromatic sulphuric acid treatment every other day. For the removal of the *débris*, I advised the patient to use permanganate of potash, ten grains to an ounce of distilled water, taking a few drops of this in half a glass of water, and rinsing the mouth with it as often as necessary.

After the ninth application of the acid I found a pretty large piece of bone loosening. I enucleated the yet attached periosteum and gum, and removed a sequestrum (measuring about one inch and a quarter in length) from the second molar to the first bicuspid tooth,—almost the whole mass, in thickness and depth, of the lower jaw,—leaving only the lower and outer border, and a very thin connection between the angle and symphysis, and involving the inferior dental canal, in which no living nerve nor vessel was present. I then rinsed the pocket with a solution of a teaspoonful of salt to half a pint of water, subsequently drying it with cotton, and again applying the aromatic sulphuric acid, and stuffing the pocket rather tightly with cotton.

The next day the patient was in excellent spirits ; able to see with her left eye, and rid of the neuralgia, as well as of the bad taste. I dressed with wine of opium, using the aromatic sulphuric acid every third to fifth day, till the 14th of September. I then found, as I expected, the second and first bicuspids loose, and extracted them, continuing the alternate use of aromatic sulphuric acid and wine of opium.

On the 24th of September I drilled away nearly the whole bone, from the second bicuspid to the canine tooth, leaving only enough to hold the jaw together. The part from which the first sequestrum had been removed was, by this time, almost filled by healthy granulations, and, on the whole outer side, had formed a sort of provisional callus, which enabled me to take away as much as I did without breaking the jaw. The patient, in this condition, was, of course, not able to eat anything but soft or liquid food. Continuing the dressing as before, small spiculæ of bone separated and came out with the cotton dressing, or were removed by the forceps.

On the 12th of November, the canine, and shortly after, on the 24th, the central and lateral incisor teeth of the same side became loose, and were removed. After this my patient became so weak and nervous that I was obliged to give up the acid treatment, only using the wine of opium daily, after thorough cleansing with salt water, requesting the patient to take plenty of out-door exercise during sunlight, to eat oysters, eggs, etc., drink wine or porter; in short to live on highly nutritive semi-solid food.

On the 15th of January, 1878, I removed the rest of the dead bone, extending from the canine tooth to the symphysis. This I accomplished, as before, with the large round bur of the engine, leaving but a thin plate of the body of the lower jaw, which I was sure was healthy. After this I made a few more applications of aromatic sulphuric acid and wine of opium, and to-day the patient is well. She has had no more neuralgia nor bad taste; can see with her left eye, though not as well as with the right one; but she is satisfied, and I am too.

How is it to be explained that such general disturbances arose from a piece of necrotic bone in the jaw? I think, in the following manner: By a reflex irritation of the inferior dental nerve upon the submaxillary and otic ganglia, which are in connection with the anterior branches of the superior cervical ganglion, and in direct connection with most of the cranial and some of the spinal nerves, the almost constant neuralgia, on the affected side, is easily explicable. The bad taste, I believe, had a double origin: first, directly from the necrotic point; secondly, from perverted action of the gustatory nerve, a branch of the inferior maxillary division of the fifth; lastly, as to the dilatation of the pupil, I think it resulted from paralysis of the iris and ciliary processes, the protrusion of the eyeball from a relaxation of the recti muscles brought on, I believe, by the irritation of the ciliary ganglion in connection with the third nerve (motor oculi), which supplies all the outer muscles of the eye, except external rectus and superior oblique, and the short ciliary nerves distributed to the ciliary muscles and iris.

Now as to the microscopical differences between normal and necrotic bone. The successful study of the elements of bone-tissue depends very much upon the method employed. The proper examination of bone-tissue originated in the second and third decade of this century, and was pursued by Howship, Havers, Henle, and others; all of whom resorted to dry bone, which they divided into thin slabs by the use of the saw, after which these were ground thin by a variety of devices, reducing each specimen to semi-transparency. Observations made in this way resulted in the theory of canaliculi bearing a solution of lime salts, hence the name "canaliculi calchofori." In 1850, Rudolph Virchow and F. C. Donders applied the cell doctrine of Schwann to the explanation of bone-tissue. They sometimes used

dry and sometimes fresh bone in their investigations, macerating it in dilute hydrochloric acid, whereby they liberated the elements of the structure more or less distinctly. The bodies so isolated presented, sometimes, nucleated structures connected together by branches; at other times, completely isolated bodies consisting of a central mass with projecting processes, and to these they gave the name bone-cells. Donders, in 1853, drew attention to the fact that bone-tissue had spaces filled by cell-like structures similar to those of other kinds of connective tissue. E. Neumann, in 1863, asserted that the so-called bone-cells were not the cells designated by Schwann, but spaces with offshoots having a more densely calcified wall than the other basal substance, and thus better able to withstand the reaction of solvents. These bone-cells are no other than the lacunæ, and their offshoots the canaliculi. Virchow came to believe that the cells were inclosed within the lacunæ, though without filling the whole space, and to this day adheres to the cell doctrine of Schwann, and claims it to be the only possible explanation of the bone-cells being inclosed in the lacunæ and their offshoots, containing a fluid, and ascribing to them the property of life, forgetting that a fluid as such is not endowed with life.

Inasmuch as the dry method of examination of bone-tissue prevailed exclusively up to the introduction of the wet method, by Heinrich Müller, in 1856, it is not surprising that it is frequently persisted in to this day. The nearer to the living state the examinations can be made, the more instructive and definite will the observation be. Hence the dry method is fast falling into disuse among those making histological researches.

In 1871, Edward Lang introduced the examination of living bone under the microscope upon the heated stage, by which he noticed amœboid motion in bone-corpuscles. By this management the lacunæ were proved to contain protoplasm, but the nature of the contents of canaliculi he said nothing about. The method of examining bone-structure introduced by Heinrich Müller, viz., to decalcify bone by the use of a solution of chromic acid, is to be preferred. Fresh, living bone should be introduced into a solution of chromic acid of from a half to one per cent., to which may be added, to hasten the decalcification, on every second or third succeeding day, a few drops of dilute hydrochloric acid. The vessel should be emptied and the fluid renewed about every fifth day. In this way bones are decalcified in a short time, and without considerable change. For thin bones two to three weeks are sufficient to soften them enough to produce sections of any degree of thinness by the use of the razor. Such sections may be stained by placing them in a solution of chloride of gold, of one-half to one per cent. in strength. An examination of such preparations will show that, within the lacunæ of the bone, nucleated protoplasmic

bodies are to be seen, with finely granular offshoots extending into the larger canaliculi, where they are lost to sight. From the surface of the protoplasmic body in the direction of the basis-substance many conical processes protrude towards the small canaliculi, with which they blend.

In 1873, C. Heitzmann described the net-like structure of protoplasm, and also observed the same arrangement in the protoplasmic bodies within the bone. He describes the net-like structure thus: "The nucleolus is connected with the wall of the nucleus, and this again with the granules by very fine threads, which are to be regarded as the living matter proper, while the fluid contained within these meshes does not possess the property of life."

One year before, namely, in 1872, this observer described and illustrated a bone-corpuscle from bone in the early stage of inflammation, in "Wiener Medicinische Jahrbücher," 1872, Plate IX. Fig. 3. This plate shows very plainly the shining, nearly homogeneous-looking bone-corpuscle, with offshoots in every direction, filling the whole caliber of the canaliculi. It solves the question of the contents of the canaliculi in bone, by direct observation. The living granular protoplasm in bone behaves precisely as in other tissues under the influence of the inflammatory process,—that is to say, the central mass becomes a shining and nearly homogeneous lump, the offshoots from which occupy the whole caliber of the canaliculi, and by this the analogy of bone to all other tissues is established. That is to say here, as elsewhere, the living part of the protoplasm forms a continuous net-work throughout the whole animal body, in the meshes of which a more or less fluid basis-substance is found, differing in its chemical properties in different situations, which in bone is glue-giving, and infiltrated with lime salts.

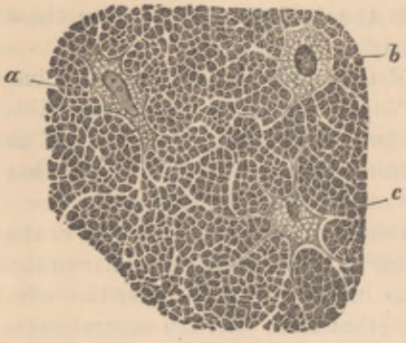
I have followed the methods, in my examination of bone-tissue, as above described. This enabled me, by the use of the razor, to obtain sections fit to be examined by an immersion-lens magnifying 800 to 1000 diameters. I noticed that the canaliculi could be plainly seen in sections, the basis-substance of which had retained a small quantity of lime salts; in completely decalcified specimens, they are very faintly discernible. According to my experience, it is better to stain the sections with a solution of chloride of gold of the half of one per cent., whereby a better view of both protoplasm and basis-substance is obtained. Another good way is to stain the sections with carmine and hæmatoxylin.

The results of my observations with high magnifying powers, 800–1000 diameters, are that bone-tissue presents faint parallel lines, dividing it into the so-called lamellæ, within which we find the bone-corpuscles, the shapes of which vary according to the direction of the cut and of the lamellæ. As bone-corpuscles are flattened lenticular

bodies, we will recognize them in this shape in the front view only. Longitudinal sections through these bodies give a spindle-shaped outline, small when cut near the boundary, broad when cut through the middle line of the lentil. A cross-section through a bone-corpuscle shows a somewhat irregular body. A cross-section from the compact bone of a lower jaw presents invariably bone-corpuscles in all three varieties.

Figure 1 shows three bone-corpuscles from the lower jaw of a man about thirty years of age, who died of an aneurism. All three bone-corpuscles are drawn in the front view, as seen by an immersion-lens of T. Grunow's, of this city, magnifying, with the eye-piece, 1000 times. The basis-substance I have drawn a little darker than a chloride of gold or hæmatoxylin preparation would appear under the microscope, but it will give a clearer idea of the whole. In Figure 1 we see three large spaces, showing a number of ray-shaped offshoots. Besides these coarse offshoots, innumerable extremely fine light ones are present. The larger as well as the smaller all communicate with each other in this way, forming a delicate net-work through the whole of the basis-substance. Within the three lacunæ of Figure 1 are present protoplasmic bodies. We observe in the center of the protoplasmic bodies *a* and *b*,—a shining, oblong nucleus in *a*, and a round one in *b*, in which the nucleoli are not distinctly visible. Around the nuclei we see a narrow seam, traversed by numerous very fine threads, which are cone-shaped. Their bases are directed towards the nucleus, from the periphery of which they arise, while their points are in connection with the nearest granules of the protoplasm. Within the protoplasmic substance there are finer and coarser granules, all being connected with each other by very fine threads. The seam around the nucleus, as well as the spaces between the meshes of the threads, are observable, being much lighter than the latter.

Fig. 1.



From the periphery of the protoplasmic body numerous thick offshoots enter the larger canaliculi, which sometimes can be followed up until they communicate with the protoplasm of other large neighboring canaliculi. Besides these many very fine offshoots run from the periphery of the protoplasm contained in the larger canaliculi towards the basis-substance. Some of them can be seen to enter the fine canaliculi, but their course cannot be distinctly followed. Figure

1, *c*, shows a protoplasmic body without nucleus; probably this has been cut near to its periphery without touching the nucleus. C. Heitzmann states that the nucleus, the granules, and the threads represent the living matter which fills all the coarse canaliculi. My preparations show a much finer net-work within the basis-substance than C. Heitzmann's figure before alluded to. Though I am not able to distinctly demonstrate the presence of living matter in the finest canaliculi, yet, as we find it in all other kinds of connective tissue, I am justified in assuming it. In normal bone the lacunæ and canaliculi are not entirely filled by the living protoplasm. On the periphery of each protoplasmic body we see a distinct light seam, traversed by the offshoots, which, in a cross-section, only show the living part of the protoplasm in the center of the canaliculus, hence leaving sufficient space for the nutrient circulation.

The minute changes of necrotic bone are very interesting, but it is impossible to study the differences between it and normal bone if the specimens be prepared from dry osseous tissue.

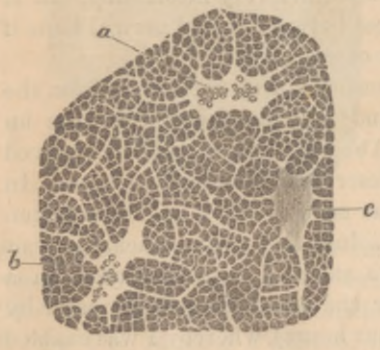
I have made microscopical examinations of necrotic bone from the lower jaw, in the foregoing case, and from another piece from an upper jaw removed by Dr. Frank Abbott. The methods employed were exactly the same as before described from normal bone. In both cases the necrotic sequestra, as soon as they had been taken from the mouth, were put into the solution of chromic acid, and cut in due time. As these pieces were small, I imbedded them in a mixture of paraffine and wax (after the extraction of the water by treatment with alcohol for twenty-four hours), whereby I was enabled to obtain extremely thin sections, some of which I stained with chloride of gold, some with hæmatoxylin, and some I mounted unstained.

The results of these examinations were as follows:

The outer surface of the necrotic bone, which, to the naked eye, looked rough and eaten out, when brought under the microscope showed bay-like excavations, known formerly as "Howship's lacunæ," in which there was visible a granular mass mixed with pus-corpuscles. In the middle of the bone I found all the Haversian canals more or less enlarged, some showing the bay-like excavations. The contents of the Haversian canals were everywhere the same,—a conglomerate mass of darkly-shaded granules, which I was unable to stain with carmine. These masses are the same that we see in decomposition of organic matter,—"micrococci." Here and there some medullary corpuscles and multinuclear protoplasmic bodies (myeloplaxes of Robin, giant-cells of Virchow) were recognizable. I did not see blood-vessels in any of the Haversian canals. In the necrotic bone I found the traces of former osteitis. The enlargement of the Haversian canals and lacunæ are direct proofs of this; the dissolving out of the basis-substance on the periphery may, on the contrary, have

been due to chemical changes, produced by infiltrations from the neighboring inflamed tissues. Billroth has shown that if pieces of bone or ivory are driven into living bone, in which they excite inflammation, they will afterwards exhibit a peculiar dissolving out of basis-substance analogous to that which we see in the primary stage of inflammation. The Haversian systems and concentrical lamellæ were unchanged. The lacunæ and canaliculi were yet preserved. In the necrotic preparation from the lower jaw I observed many lacunæ, in which the protoplasmic body, with its living net-work, was yet distinguishable, especially where the sequestrum had been attached to the periosteum. I found also, in the preparation from the upper jaw, some comparatively unchanged bone-corpuscles. But the majority of the bone-corpuscles, and especially in the neighborhood of the Haversian canals, had the appearance of a Roman numeral II; they were either empty, or their protoplasmic bodies were shriveled up (probably the remains of the living matter), only showing a few coarse granules, illustrated in Figure 2, *a*, *b*; but no signs of fatty degeneration could be seen, for the granules were stained violet by chloride of gold. Many lacunæ, as in *c*, showed no structure at all, the contents looking rather like a mass of coagulated albumen. In none of these lacunæ was the characteristic structure of protoplasm recognizable.

Fig. 2.



To sum up my observations, I found,—

First. The lacunæ contain a protoplasmic body, with a distinctly-visible net-like arrangement, to be regarded as the living matter of the protoplasm.

Second. The basis-substance is pierced by numerous coarse and fine canaliculi, communicating with each other, as well as with the lacunæ.

Third. The protoplasmic bodies, which do not quite fill the lacunæ, send offshoots of the living substance into the canaliculi, but can only be seen in the coarser ones.

Fourth. In necrotic bone, traces of former osteitis are visible, but no blood-vessels present in the Haversian canals, which are filled with micrococci.

Fifth. In necrotic bone, most of the lacunæ contain no protoplasm, but either a coarsely granular or a structureless mass,—remnants of the living matter and coagulated albumen.