OBSERVATIONS
UPON THE
MORBID APPEARANCES
AND
STRUCTURE OF BONES,
BEING THE SEQUEL OF A FORMER PAPER*.

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DIVISION II.

On Enlargement from swelling of the original substance of Bone.

HAVING in the preceding volumes of the Transactions pointed out the appearances and structure of nodes and exostoses, and also made some observations upon the formation of new joints, followed by a series of experiments to illustrate the exact mode in which the union of fracture takes place; I have now the honour to lay before the Society some remarks upon enlargement of bone, arising from spina-ventosa, and I

* See Vol. VIII. p. 143.

propose continuing the inquiry by examining the appearances and changes produced in bone, by inflammation of its more compact structure.

The term *spina-ventosa* has been applied to affections of bone so different from each other, that before describing the particular disease to which I consider this term most appropriate, I shall take the liberty to advert to the opinions of some few writers who have seen and attended to it.

Speaking of disease in the lower jaw, Wiseman observes, “ it is made hollow by an acid humour, which fretteth and corrodeth the alveolar and inner substance to the very external shell, in which case it thrusts out with great deformity.” He adds, “ I have made mention of this disease under the name of *spina-ventosa* ; and when this affects the jaws the teeth grow loose, and excrescences do arise which in progress of time thrust out the teeth. They sometimes pass their matter externally.”

In the translated edition of Petit, among other valuable observations, is the following. “ An old woman had for a long time a cancer in her breast, which gave her little disturbance ; she was seized with a tumor in the middle of the left thigh, for which she had recourse to surgery. On examining her, I found that the body of the bone was swelled quite round ; three days after it appeared to me to be more so. I judged there was an *exostosis* ;

the sharp and continual shooting pains confirmed me in this thought; and their perseverance in spite of the remedies prescribed made me believe that the exostosis would imposthumate, and that the consequence would be a caries. It fell out just so, after two months' constant suffering, till she broke her thigh in turning in her bed. A tumor of the same nature broke out in her arm, and another at the clavicle, but were not so painful, because the bones broke sooner than the thigh had done." Now although in the above account the disease is termed exostosis, its history seems to be clearly that of spina-ventosa.

Mr. B. Bell says, "in scrofula we frequently find the whole substance of a bone become swelled, particularly the extremities of the large bones, forming the joints of the knee, elbow, ankle, and wrist, the term spina-ventosa being given to this swelling." If, however, by the extremities of the large bones, the epiphyses are to be understood, the expression seems hardly correct, at least I believe it will be found that enlargement of these parts from disease of any kind is extremely rare indeed.

In Cooper's Surgical Dictionary, a work filled with useful and correct information, two cases are related of abscess within bone, which although mentioned under the head of spina-ventosa, do not appear to me instances of the disease, wanting,

as they do, that which has been generally considered its most essential character. The author, in a succeeding paragraph, with a diffidence which renders his acquirements more interesting, takes occasion to apologize for having stated what I conceive to be the plain fact. He says, "I described under the name of spina-ventosa a disease in which matter formed in the interior of a bone, attended with expansion of the part affected. In giving this meaning to the word spina-ventosa, the reader is already aware that I have only imitated many of my predecessors; and perhaps the original import of the term would vindicate me in so doing."

With regard to the pathology of spina-ventosa, I have, in my remarks connected with the attempt to arrange these diseases, ventured to state my belief that the natural secretions in the early stages form most commonly the contents of the tumor. This opinion was not brought forward without consideration, although I have not actually examined the recent soft contents of any early specimen of this disease. But we are in many cases enabled to reason correctly by analogy, as is subsequently proved by more direct evidence; and with relation to the present point, I have had opportunities of tracing the natural secretions in the cavities of bone under such various states of disease, some of them producing almost precisely the same effects as take place in spina-ventosa,

that there appears to me very little room for doubt upon the subject.

Spina-ventosa, then, is an enlargement most commonly affecting the cylindrical bones, including the whole diameter of the affected part ; generally connected in its progress, either with abscess of the soft contents of the tumor, or otherwise with a slow succession of changes, by which the bone with immense increase of size is at length totally disorganized.

The experiments and observations I have had the honour to lay before this Society, upon the formation and growth of bone, were made with a view to throw some additional light upon those principles of action by which the living powers are enabled to effect certain changes that take place both in health and disease, in these parts of the machine ; and considerable time and labour were devoted to the making out clearly and completely the exact arrangement of the ossific fabric at the unfinished extremities of the cylindrical bones. The ascertaining this curious and leading point, has enabled me to demonstrate the facility which this arrangement is calculated to afford, for the subsequent application of a power by which there is every reason to believe the deposit of fluid secretions is made to perform all that could be expected from mechanical pressure, established by

any other means, in regulating the growth, figure and structure of healthy bone.

The disease now under consideration exhibits occasionally the strongest illustration of the effect of pressure, in expanding or unfolding the structure of bone ; and I think it may be assumed, that spina-ventosa commences with a degree of excitement in circulation upon the fine secreting membranes within the great canal or medullary cavity of a bone, and by the extension of this excitement to the membranous sheaths, passing thence through the more solid parts of the bone to its outer surface. The precise degree of this excitement will be variable even in the same case, or at least its operation is not at all times equally manifest ; and as to constitutional circumstances connected with it, there generally appears more or less tendency to scrofula.

Most writers state the disease to be always attended with severe pain from the first, but I have in several instances seen the swelling proceed to considerable extent before it was noticed by the patient, who even then felt not the least pain, nor the slightest inconvenience ; generally, however, it is painful, and in some cases extremely so. I am at present attending a child in whom several such tumors have formed in succession. In two of these swellings the enlargement of bone conti-

nued to make progress for many weeks without the least pain.

There is great diversity in the progress of the disease ; it will in some instances advance further in a few days than it will in others in as many months. Wiseman says, " in children's fingers I have seen a bone swelled in a night, and a like tumor raised in the spongy bones of elder persons in a few days."

I have already stated my opinion that the apparent readiness with which the bone gives way, may partly be explained by the excitement pervading the contents of the canals in the solid parts of the bone, as well as those membranes within the general medullary cavity, in consequence of which the pressure is made to operate in an equal and diffused manner ; for while the general mass of contents is maintaining a degree of pressure from within, the parietes of the bone are still further unfolded by the extension of the same principle to the innumerable canals dispersed through the compact sides of the ossific structure.

Where suppuration has once taken place within a disease of this kind, I have never seen the discharge spontaneously cease ; nor does it seem to me reasonable to expect it should. The seat of the abscess is the enlarged cavity of the affected

bone: the parts more or less perfectly consumed by the ulcerative process are the soft contents of that cavity, and even those membranous expansions which by their greater degree of vascularity are able to resist the first impulse of the suppurative action, have their powers of life so exhausted by the excitement, that they are on examination generally found in a disorganized or sloughy state.

The above observations apply to tumors which, comparatively speaking, do not reach any very extraordinary size, and which generally take place before the age of puberty. In some instances, however, more particularly in adults, the tendency to suppuration never occurs, and the tumor consequently has only one prevailing character, that of permanent growth or increase, until eventually it attains an enormous magnitude.

In the first description of case, the soft contents in the early stage of progress may be considered as little else than an excess in the deposit of the natural medullary secretions; in the second, they consist of fluid secretions, thrown off by the medullary membranes, and confined within the cavities of the bone. In the former case, after a moderate accumulation of imperfectly organized matter, the operation of any accidental circumstance is sufficient to excite suppuration; but in the lat-

ter the progressive change advancing with a more steady pace, is scarcely liable to this consequence, although in the end its effects excite astonishment.

The fluid secretions within bones affected by this disease, have the appearances that are known to belong to scrofula, and seem to be principally injurious by the expansion they produce. The membranes themselves, consistently with what is observed in parallel circumstances, become thickened in proportion to the degree of extension they undergo, and in some parts they are occasionally found to have become cartilaginous, and even ossified ; the progressive steps to which change in the structure of membranes, I have traced in the paper already laid before the Society, upon the union of fracture.

Where an extensive formation of cartilage or of bone takes place in spina-ventosa, I believe it occurs merely as an accidental consequence of the near neighbourhood of some large medullary artery, conferring a comparative activity of circulation and vitality upon that particular part of the contents of the tumor*.

Du Verney, in his Treatise on the Diseases of

* Some interesting observations upon the circumstances under which new formed cartilage occasionally presents itself, may be found in Mr. Astley Cooper's valuable Essay on Exostosis.

the Bones, relates two very interesting cases of this kind, in one of which the humerus, in the other the femur was the seat of the disease. The first was that of a boy, who, from a fall, had an enlargement of the upper part of the arm, for which six months afterward he came to the Hotel Dieu, with a tumor of enormous size and weight, and a constitution so reduced that he died the following day. In the dissection, he states, "*Monsieur Saviard examina la tumeur avec un très-grand soin, & il l'ouvrit à l'endroit où l'on sentoit qu'elle étoit molle. On vit que tout le corps de l'os s'étoit extraordinairement enflé, & qu'il formoit lui-même le volume de la tumeur, dont le dedans étoit tout rempli de plusieurs petites cellules de différentes grosseurs & figures, qui formoient une substance très-friable, & spongieuse, & qui étoient pleines d'une sérosité purulente.*" This tumor, which weighed ten pounds, was confined to the upper half of the humerus, both ends of the bone remaining perfectly sound.

The second case was that of a man who had an immense tumor, occupying a great part of the right thigh, which no treatment appeared to relieve, and which after many years ended fatally. On dissection, the structure of the tumor was found to be in every respect similar to that just described, although it had attained a much greater magnitude, its weight being twenty pounds.

Having endeavoured to point out the leading distinctions in the character and tendency of spina-ventosa, as it occurs under different states of constitution ; and having taken the morbid anatomy of disease as a principal object in these essays, it only remains to bring forward some few demonstrative remarks, with a view to confirm the accuracy of the foregoing observations, and also to render more clearly intelligible the annexed illustrations.

In Mr. Heaviside's Museum there is a very comprehensive series of preparations, shewing the various causes and effects of expansion, together with the consequences of enlargement when produced by abscess within the medullary cavity of bone ; some of which preparations we shall now proceed to describe.

The first of these specimens (Plate III. *fig.* 1.) is the radius of the right arm, from a youth about fourteen years of age. The cause of expansion in this case evidently continued to operate for a considerable length of time previous to the establishment of the ulcerative process, a circumstance proved by the unusual degree in which the external parietes of the bone are not only laid open, but thrown back. An effect that, according to my mode of reasoning, must have taken place previously to the formation of abscess, because it may be fairly presumed that matter once formed would soon find at

least a partial, if not a free exit ; subsequently to which no very material alteration of figure from internal pressure could reasonably be expected to take place.

The epiphysis, it will be observed, has taken no part whatever in the disease.

The next preparation (*fig. 2.*) exhibits a very fine example of this disease in the ulna, at the same period of life as the above ; the epiphysis forming the olecranon not being yet completely ossified. In this instance also, the expansion had proceeded to a considerable extent previously to the formation of abscess.

It may be observed that the space surrounding the margin of the opening of the abscess, affords a curious contrast to the preparation last described. In this, the whole of the ossific structure is evidently much disturbed, every minute canal being so enlarged as to be obvious even to the naked eye ; in that the parietes are seen to be nearly thrown back, without any appearance of disturbance in the minute economy of the bone beyond the margin of the external opening of the abscess. In the latter case the central pressure co-operated with that kept up within the surrounding canals in the bone ; in the former the central pressure operated alone, proving that although both these agencies are frequently,

perhaps generally, employed, they are nevertheless individually competent to produce all the effects connected with expansion in the ossific fabric.

Another specimen exhibits disease in the humerus, from a young person sixteen or seventeen years of age. Nearly the inferior half of the cylinder is so much expanded as to be at least six times its natural diameter, yet the bone is decidedly lighter than in its healthy state. The internal contents have in this, as in the former case, co-operated with those of the canals within the solid sides, to produce an equally diffused expansion of the whole of the affected part of the bone. There are in this instance several openings, by which the contents of the abscess had made their way out; with regard to the epiphysis, which has not participated in the disease, it is almost entirely separated, in consequence of the great enlargement in the body of the bone.

A fourth very fine illustration of spina-ventosa, shews the disease extending itself considerably, and losing the appearance of a circumscribed tumor. It is an ulna, which the epiphysis marks as having belonged to a young person, between sixteen and eighteen. The affection has produced great enlargement of nearly three-fourths the extent of the bone; although the part at which the

affection originated is evidently near the joint, where the greatest degree of expansion has taken place, and where several openings point out the situation of the abscess, and the ultimately free passage afforded for the escape of the contents of the abscess.

There are in the same collection a great number of beautiful preparations of this kind, from the various bones of the hand and foot; one particularly, in which the first phalanx of the finger has been the seat of two distinct abscesses, while a third has taken place in the second phalanx; one consequence of which has been ankylosis of all three bones of the diseased finger. (See *fig. 3.*)

The last preparation that I shall at present take the liberty to bring forward, exhibits an instance of enlargement with abscess in one of the metacarpal bones of an adult; and it may here be remarked, that with considerable expansion of the bone a new appearance occurs, a change of colour, the parts immediately surrounding the abscess having lost the yellowish colour natural to bone, and become changed to a greyish white, so as to resemble a bone that has been calcined; a change which it appears probable may arise from the affected part having been partially deprived of its animal matter. (*fig. 4.*) This change in the colour of the bone, together with the age of the patient, renders it doubtful whether the disease

was in this instance at all connected with scrofulous disposition.

DIVISION III.

On Enlargement with increased interstitial deposit of ossific matter, producing a more dense and compact structure than natural; as happens in healthy Ossific Inflammation.

Inflammation of bone is one of those processes in the animal economy not yet perfectly understood; its distinguishing symptoms are by no means determined; and so little has its morbid anatomy been investigated, that Mr. Hunter, in his lectures, and many other surgeons since his time, speak of inflammation from a venereal cause, though in the course of my experimental inquiry I have obtained no certain evidence that inflammation of the bones ever proceeds from this cause.

The terms in which I have ventured to define this action, are liable to objection. They may be allowed to be accurate, but not adequate. In what relates to the minute anatomy of the parts, the account may be very well, but will it enable the practitioner to distinguish the disease when he sees it? To this, the only reply I can make, is, that although well aware how incomplete these ob-

servations are, I am not without hope they may prove, even at the bedside, useful, if only by shewing that it does not follow that because pain is felt in a bone, or because swelling may be perceived taking place, or even from both symptoms together, the bone must be inflamed, although they both occur in ossific inflammation; for if that were the case, every node which I have already shewn to arise from a lamina of new bone deposited upon the old undisturbed structure, would be considered inflammation, and every deep seated venereal pain in bone would be supposed inflammatory; although I hope to be able to demonstrate that affections of bone occurring in conjunction with venereal complaints, depend on a peculiar mode of absorption, in no instance connected either with interstitial deposit, or actual swelling of the part.

The best apology for having brought forward these papers in their present imperfect state, is the hope that they may be the means of eliciting the more interesting and more valuable observations of others; and the conviction that had I determined to wait till every point was cleared up, and every difficulty removed, such expectation could have terminated only in disappointment.

With regard to the circumstances by which inflammation of a bone may be distinguished in the living body, it will, in the first place, be marked by very in-

tense pain and sense of heat in the affected part of the limb, not much aggravated by external pressure, but connected with more or less excitement of the system; in the second place, it will be known by these symptoms occurring in a constitution otherwise healthy, for I believe that this affection never takes place but in a habit prone to phlegmonous inflammation.

But these circumstances will also occur in necrosis, and their extent as to severity and duration will be so variously modified, as to render it impossible to lay down general rules for determining the precise state of the internal parts by the external appearance. Practical opinion must be regulated by the estimate drawn from the consideration of every particular related to each case, the judgment being aided and strengthened by all the information we have been able to collect upon the subject.

The examination of the numerous specimens preserved in the anatomical collections of this metropolis, confirms the testimony of Sandifort, Weidman, and other eminent pathologists, in demonstrating that increase of bulk, and of weight, are the two principal characters of inflammation in bone. Sandifort also points out the occasional existence of fistulous passages, leading out from the medullary cavity, in this disease; and Mr. Hunter, in drawing a comparative view of inflammation in hard and in soft parts, does the same thing; but

no one has gone further than merely to state the fact, at least as far as my reading extends. Upon this point, I hope to demonstrate to the satisfaction of the Society, the progressive operation of the living powers in the production of fistulæ; although, in fact, the whole circle of morbid changes to which these parts of our frame are liable, are so closely linked together, and form so curious and so intricate a chain, that it seems to me less difficult to examine and make them out, than it is afterwards to separate one from another, so as to set each in a distinct and clear point of view.

The being able to draw a very close line between the symptoms in any particular case, and the changes produced in the affected bone, although the first object in importance, is the last in attainment. I have watched many important cases with unremitting attention, and noted the progress of some of them for years, and have at last been prevented learning the event by some accidental circumstance from which I lost sight of the patient. The singularly valuable opportunities, however, that I have possessed, in having access to Mr. Heaviside's Museum, have operated as a powerful counterpoise to these and many other difficulties.

Impressed with the importance of the present inquiry, and anxious for its success, I deem it

right to state that during its progress I have not chosen to trust exclusively to written notes upon a particular appearance, but have uniformly preferred the more laborious and slow, because the more secure mode, in making a complete series of tracings by the solar microscope* of every alteration of structure I have yet seen ; so that by preserving the exact appearance of each specimen in a form most convenient for subsequent reference, I have in a great measure succeeded in placing my collection of microscopic specimens of diseases in bones on the same footing with other collections of diseases, where every known change of structure is as it were enabled to stand forward and plead its own cause.

* For a considerable improvement in the mode of producing a clear and strong image by the solar microscope, I acknowledge with much pleasure my obligation to Dr. Roget, who, when its construction and defects were explained to him, very kindly proposed calling to see it when in action, an offer that, from one so extensively and deeply conversant with all the branches of mathematical science, could not be otherwise than acceptable.

Upon witnessing its operation, he at once pointed out that by diminishing the aperture of the lens through which the image of the illuminated object was transmitted, the clearness of the figure would be rendered much more perfect. I immediately made the experiment, by introducing a piece of blackened card, lessening the diameter of the aperture from one inch to one quarter of an inch, and was very agreeably surprised at the great increase in the beauty and brightness of the image. The real importance of this improvement can only be appreciated by those who have been engaged in researches similar to the present.

From all that I have been able to ascertain, it appears that inflammation of bone commences with excitement of circulation upon the membranes lining the longitudinal canals, or medullary cavities of the part. This excitement I have myself traced, in examining the contents of the canals so circumstanced, in their recent, and also in their injected state.

Having proceeded thus far, the next point of interest to determine was the state of the secretions under this excitement. This was ascertained by the careful examination of various dried specimens of inflamed bone ; one piece, in particular, exhibited the appearances of inflammation with considerable thickening, near the upper end of the femur. It was divided into longitudinal slips, parallel to the axis of the bone ; and the surfaces, rendered smooth, were examined in the compound microscope. The natural medullary contents of the canals were very distinctly seen, reduced to an adipocerous state, the constant effect of maceration upon these secretions. The actual presence, and even the peculiar consistence, of this substance was readily proved, by dislodging it with a needle point, while under inspection in the microscope.

The canals throughout the affected, as well as the healthy part of the bone, were found to contain one and the same kind of soft matter ; equally

abundant in the inflamed and tumid parts, and in those that were evidently beyond the sphere of irritation*.

The consideration of these appearances, first suggested to me the idea of obtaining a comparative view of these canals with their soft contents, and also of the same canals subsequent to the removal of their contents. For this purpose, a thin section of the specimen was so placed in the solar microscope, as to exhibit the magnified image very distinctly upon the screen. In tracing this drawing, the necessity which obliged me powerfully to illuminate the part on which I was at work, afforded an unexpected confirmation of the accuracy of my former observations, for the heat of the concentrated solar rays were soon observed melting down the medullary matter so rapidly as scarcely to allow time for the tracing to be made complete. The same piece was then calcined; and when reduced to a smooth surface and the structure cleared out, it was again placed in the microscope, so as to exhibit a second figure answering in magnitude to the one already taken. (See Plate IV.) These tracings afforded the clearest proof that under the greatest degree of change to which these canals appear to be liable from inflammation, the me-

* For the particular sense in which the term irritation is here applied, I must beg leave to refer to the 63d page of the eighth volume, where it is fully explained.

dullary contents suffer no material alteration as to their sensible qualities ; from which I think it may be presumed, that any degree of increased action short of that which by destroying vitality would induce necrosis, is consistent with the continuance of the healthy actions of these membranes. Neither is this singular. The same excitement that in the pleura or peritoneum changes the natural texture of the membrane, pouring out a quantity of coagulable lymph, is so far from arresting the natural functions of the part, that one of the most frequent, and often one of the most formidable, consequences is the greatly increased quantity of serous deposit.

With regard to the condition of the membranes themselves, I have in various instances been enabled to ascertain that under certain states of excitement, as in that connected with exfoliation or necrosis, the membranous expansions within the longitudinal canals become thickened, pulpy, and granulated, as proved by their appearance when injected. Under inflammation, however, these circumstances occur most evidently. Several arguments in support of the above facts have been already laid before the Society, in a former paper*.

I shall now proceed to describe the changes produced by inflammation upon the earthy part of the ossific fabric, attending to the minute

* Vol. VIII. from page 62 to page 66.

appearances of inflamed bone, subsequent to its having passed through the fire; and tracing these appearances along the line, from the state of perfect health on to that point at which all the consequences of inflammation may be perceived.

The first perceptible change consists in a degree of uniform enlargement of the longitudinal canals, without any swelling of the general mass of the bone, or any increased deposit of phosphate of lime. The canals still retain the fine polish peculiar to them, and may be considered as exhibiting the effect produced by irritation only, in which the membranes commence a slow but uniform absorption of the surrounding substance. (Plate IV. *b.b.*)

The next change is marked by the canals losing entirely their healthy appearance. The longitudinal sections of these tubes, instead of even or gently inflected lines, present very unequal figures, the sides appearing as if scooped out with a semi-circular chissel. This appearance is consequent to the membranous sheaths becoming not only thicker, but distinctly tubercular, or granulated, in their texture.

Where the inflammatory action has reached a higher point, the affected part of the bone is rendered tumid, and a new appearance occurs; for in addition to the abovementioned effects from ab-

sorption, a considerable deposit of ossific matter takes place. (Plate IV. *c. c.*)

The act of secretion can only be detected in the particles last laid down, for the more remote deposit is found to be so perfectly identified with the original bone as to prevent its being clearly distinguished; although by estimating the aggregate thickness of all the parts making up the solid side of the bone, it may be proved to have received a considerable addition of phosphate of lime.

In the compound microscope, the loose or scarcely attached particles of the phosphate of lime may be seen scattered in abundance, proving evidently the fact of secretion. These ossific particles may be observed deposited upon the sides of all those canals that have been subjected to active inflammation; but the freedom of secretion does not appear to bear any particular or necessary relation to that of absorption, for these two actions are very variably proportioned to each other, in different cases, and even in different parts of the same specimen.

In the foregoing view of the progress and effects of inflammation upon the bones, and indeed in all my previous observations upon health, as well as disease, the Society will have observed that the phosphate of lime, or earthy principle, is consi-

dered as related to the irritable or vascular system in bone, much in the same way that the materials of a building are related to the workmen employed in raising it. The vascular system, in connection with the irritable soft parts, are not only the active agents where activity is required, but their very constitution may be regarded as a security for the observance of certain provisional laws, essential to the safety and welfare of the general economy.

Where either as the result of external accident or internal disorder, the healthy action of any part of this system is disturbed, an impression of irritation arises; and this irritation is extended in one direction or another, according to circumstances, in the manner of a continuous sympathy, the results of which frequently exhibit the most demonstrative evidence of the perfection of that great scheme, by which the whole circle of operations and movements in the animated creation are harmonized and held together.

The particular direction in which a continuous line of irritation is propagated, will in most cases depend on the nature of the impulse required for ensuring the most favourable termination of the disease; to support, however, this position to its full extent, would be to anticipate in some respects observations that may with more propriety be made under the head of necrosis.

In the progress of inflammation in bone, the turn as well as intensity of action will vary extremely. Where, as sometimes happens from fevers, inflammation settles itself upon the membranes of the medullary cavity of a bone, the mischief, confined at first to one spot, forms a sort of point, or centre of action, from which all other impressions emanate. If this first centre of action proves intense, it disposes to the formation of a second, and between the two a consequent line of active irritation is presently established. This tendency in other parts of the economy is too well known to need illustration. It occurs under various circumstances, but in none is it more important, as regards the safety of the general system, than in inflammatory affections of the bones*. The principle appears to me to convey a precept of the highest possible consequence, in a practical point of view. It proves that the laws of irritability, which belong to all the soft structures in the body, are in effect extended to the more solid and less sensible texture of the ossific fabric, operating in various ways towards the reparation of injury, either by the restoration or the removal of the injured part; and it more especially illustrates the importance that nature attaches to the confinement of purulent fluid, in pointing out those provisions assigned even to the most inert materials

* A very instructive case of this kind is published in the excellent and truly Practical Observations in Surgery, by the late Mr. Hey, of Leeds.

of our frame, for the essential purpose of ensuring the production of a free outlet whenever matter is formed.

The considerable attention I have bestowed on the effects of inflammation, has enabled me to demonstrate the above circumstances relating to the production of fistulæ ; and to those who have attended to the foregoing observations, there will, I apprehend, be little difficulty in perceiving how this consequence is brought about*.

It has been stated that inflammation commences with excitement of circulation in the membranes lining the longitudinal canals, this excitement operating internally by continuing and apparently increasing the quantity of secreted medullary matter, and externally by the progressive absorption of the surrounding bone ; that in its more complete establishment these membranes become altered in texture, thickened and granulated, this change being connected with further increase in the quantity of medullary secretion, and externally

* The principle upon which the absorption of bone takes place in carious spine, is, I believe, in some respects similar to that just explained. For a late opportunity of minutely examining the recent state of this disease, I am indebted to the kindness of my friend Dr. Merriman, who evinces the same pleasure in forwarding the inquiries and pursuits of others, that he experiences in the zealous and successful prosecution of improvement in that which is more particularly his own line of professional science.

with alteration in the appearance of the canals, corresponding to the granulated structure assumed by the absorbing surfaces of the membranes lining them ; that in this stage tumor takes place, and in addition to absorption there is interstitial deposit of bone, these two actions observing no invariable relation to each other ; and lastly, that according to the violence of the internal excitement, a line of irritation is propagated to some other part, the direct tendency of which is to establish a more intimate communion between the two points.

Now, the extensive and free communication of the canals, demonstrated in a former paper on healthy bone, proves the readiness with which any impression of irritation from within the medullary cavity may establish its second point upon the periosteum covering the external part of the affected bone ; and the above examinations have shewn that where this happens, the prevailing turn of action between the two points is always in favour of absorption, and the quantity of bone is thus progressively diminished until eventually the whole is removed, giving place to the recently formed granulated soft contents ; and these also in turn, exhausted by excess of irritation, presently fall into ulceration, leaving eventually a free passage for the escape of purulent matter, sloughy membranes, or both, from the medullary cavity.

Having now traced forward the changes pro-

duced by the inflammatory and suppurative actions within bone, it only remains to make some few remarks upon the appearances connected with the decline of the increased action.

It is natural to expect, and indeed frequent examinations after death have proved, that where from inflammation a bone has become enlarged and heavy, it remains so, at least for many years afterwards*. The inflammatory attack having gone by, the increased activity of interstitial absorption and deposit subsides, while the membranous sheaths of the canals and cavities within the substance of the bone by slow degrees recover their natural structure and functions; the ultimate result of which is, that the medullary cavities and canals from being rough, as in the active stages of inflammation, present again the smooth and polished surfaces exhibited in health; there, however, the change appears to rest. (See Plate V. *fig.* 2. and 3.) The subsequent condition of bone so circumstanced, bears a close analogy to that of new bone or callus, formed after a fracture, the structure of which has been already shewn in my paper upon that subject. In both

* A very singular case of inflammation of the superior maxillary bones, the history of which I have given in my Surgical Observations, I have lately had the opportunity of seeing after death, through the polite attention of Mr. Langstaff; in whose valuable collection the parts are preserved.

The bones are extremely heavy; but as neither of the tumors have been divided, the structure of course is unknown.

cases the mass of the ossific deposit constitutes a permanent tumor, any appearance of subsequent reduction of size being justly referable to the progressive decrease of thickening in the surrounding parts, and to that cause only. (See Plate V. *fig.* 2. and 3.)

It has been stated in the early part of this paper that increase of bulk and of weight, are the two principal characters of inflamed bone ; with regard to these circumstances, I made the following comparative examination, which proves that increased weight does not imply increase in density.

A transverse section, one-fourth of an inch in thickness, was removed from a femur much enlarged and very heavy, in consequence of inflammation produced by a partial necrosis at its lower extremity. A corresponding section was also taken from a large-sized healthy femur. The mean diameter of the cylinder of the inflamed bone was two inches and one-eighth, that of the healthy specimen seven-eighths of an inch ; the weight of the inflamed piece was 3vss. ; that of the healthy bone scarcely 3ij. In this instance, therefore, the increased bulk had pretty nearly kept pace with the increased weight, and consequently there was no reason to conclude that any material increase of density, beyond the healthy standard, had taken place ; and this opinion was borne out by the appearance

of the specimen under the microscope, for in point of number the canals were in about the same proportion as in healthy bone, although in figure and arrangement they had assumed entirely new characters.

The annexed illustrations demonstrate the progressive changes that take place in the minute organization of bone, under inflammation, exhibiting particularly the mode of formation, and early appearance of a fistulous passage leading out from the cavity of an inflamed bone ; they also afford a comparative view of the alteration of structure that occurs from inflammation in a cylindrical bone, and that which occasionally takes place from a similar affection of the flat bones of the cranium.

Spina Ventosa.

Fig. 1.

In the Radius.

Fig. 2.

Ulna.

Fig. 3.

Phalanges of the Fingers.

Fig. 4.

Metacarpal Bone.

J. Stewart sculp.

J. Horslip del.

Appearances from Inflamⁿ

Fig. 1.
Longitudinal Canals.

Nat. Size.

Fig. 2.
Femur.

Nat. Size.

Fig. 3.
Cranium.

Nat. Size.

EXPLANATION OF THE FIGURES.

PLATE III.

FIG. 1.

An interesting example of spina-ventosa, in the radius.

FIG. 2.

An enlargement of the ulna, from spina-ventosa.

FIG. 3.

Diseased phalanges of a finger, affected with spina-ventosa.

FIG. 4.

Spina-ventosa, in a metacarpal bone.

The above specimens are all from Mr. Heavyside's Museum.

PLATE IV.

A longitudinal section of a portion of inflamed femur, five-eighths of an inch in length ; as exhibited by the solar microscope.

The object in preparing this specimen was, to demonstrate on one graduated scale the different

effects arising from the various degrees of excitement, connected with an attack of inflammation. A drawing was made in 1816 for this purpose, and in order to obtain it more minutely correct it was made on a larger scale ; upon which account, however, it was subsequently laid aside, and the present one taken the following season, was preferred as being more convenient ; comprehending a moderately magnified view of the whole sufficiently distinct, and capable of being rendered quite perfect by the addition of a small part, represented as seen on a much larger scale, which part forms the first figure on the next plate.

- a.* That part of the specimen where the first and least degree of change is observable in the minute structure of the bone.
- b b.* The longitudinal canals at those parts where the excitement has effected those changes connected with absorption, without having proceeded to that stage productive of increased deposit.
- c c.* Other canals, continuous with the above, where the roughness of surface marks the recent deposition of ossific matter.
- d.* The seat of the more completely established inflammatory action, where the appearance of the canals is marked not only by the considerable absorption, but also by the more diffused deposit of ossific matter, with a degree of external tumor ; the latter circumstance resulting from the pressure of the soft con-

tents producing a slow developement of the old structure, and a fresh deposit of ossific matter, the joint effect of both these operations being an increase more or less considerable, in the quantity or substance of the original bone.

e e. Some of those points at which it may be perceived that the actions in the soft contents of the canals are, from some cause, taking a turn favourable to absorption; which cause, is no other than the increased irritation established in the continuous sympathy, by which the membranes covering the inside and outside of the bone are connected together; and which operates by increasing the quantity or volume of the soft contents of the canals, while it diminishes nearly in the same proportion the quantity of bone interposed between those canals.

f. Exhibits the final result of the action just adverted to. The continued absorption, and the increasing volume of the soft contents in the longitudinal canals upon the immediate line of sympathy, having at length brought the membranes of the various canals into contact with each other, or in other words, removed the whole of the interposed bone, the space is of course occupied by soft parts only; and as this action is extended across all the canals situated between the two surfaces of the bone, the whole of the bone upon that

line is removed, and a fistulous passage out from the general medullary cavity is the result.

- g.* The external opening of the fistula.
- h.* The internal opening of the fistula, which is yet incomplete.
- i.* The square figure, including that portion of the specimen which forms the following figure.

PLATE V.

Fig. 1. The part included within the lines marked *i.* upon the former plate; exhibiting on a much larger scale, and consequently with more minute accuracy, the appearance of the surfaces and sections of the longitudinal canals under inflammation.

Fig. 2. Exhibits the appearance of a longitudinal section, one-tenth of an inch in breadth, of a femur that from inflammation had been much increased in bulk and in weight. The structure of the bone, it may be perceived, does not when magnified appear to be more compact, although in figure and general character the canals are much altered from their natural condition, demonstrated in the illustrations given with a former paper*. They

* See the lower figure on the left hand of PLATE VI, in the 7th Volume of the Transactions.

had, however, in the present instance recovered their smooth and polished surfaces.

Fig. 3. A section of the frontal bone of a cranium which had suffered a severe as well as tedious attack of inflammation, rendering it more than twice its natural thickness, extremely heavy, and so compact that it was difficult to perceive any remaining trace of diploe with the naked eye, the bone having the appearance, and taking the polish, of ivory.

This affection appeared to originate from the irritation produced by a part of the external table, which had been destroyed by necrosis, while the powers of the constitution were not competent to effect its separation; the circumstances of the case may, however, perhaps be noticed on some future occasion.

- a.* The margin of the internal table of the frontal bone.
- b.* The margin of the external table.
- c.* That part of the specimen where the cells of the diploe are most completely obliterated.
- d.* A considerable and extensive cellular space, where the obliteration of the natural structure has been less perfect.