

may, after a time, if the paroxysms are long and severe, have emphysema engrafted upon it.

The relation between asthma and emphysema, has, I know, been differently interpreted. Some authors<sup>1</sup> maintain that the emphysema is the cause of the asthma. But to my mind, independent of the positive proof we have that asthma really depends on bronchial spasm, the sequence of events in the clinical history of these cases, the inadequacy of such a lesion as emphysema for the production of the phenomena of asthma, and the presence of asthma in numerous cases without emphysema, all forbid our entertaining such a theory. But I must refer the reader, for a fuller consideration of this question, to a future paper on the *Consequences of Asthma*.

Such is a concise and cursory commentary on the above tabular arrangement of the varieties of asthma. Of these varieties there are three that deserve fuller discussion—*Hay Asthma*, *Asthma from Animal Emanations*, and *Asthma complicating Bronchitis*. These I must reserve for a future paper.

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ARTICLE II.—*The Pathology of Tuberculous Bone*. By CORNELIUS BLACK, M.D., Lond., Fellow of the Royal College of Surgeons of England, Corresponding Fellow of the Imperial Society of Physicians of Vienna, Member of the Pathological Society of London, etc., etc., etc.

(Continued from p. 882.)

#### STAGE OF GERMINATION AND ULCERATION.

THE third stage of tuberculosis of bone is marked by the germination and development of the exudation which occurred in the previous stage, and by the effect of that development upon the osseous and contiguous tissues. Owing to the limited space which the cancelli offer to the exudation, to the dense accumulation of the latter within their cavities, and to the consequent pressure upon the blood-vessels distributed upon their walls, the circulation through the capillaries of the cancelli is, in a great measure, arrested, or entirely stopped. From this condition two pathological results occur,—namely, the arrest, more or less complete, of the nutrition of the ultimate tissue of bone, and the imperfect development of the exudation within the cancelli. The more distant the seat of exudation from the source of vascular supply to the cancelli, the more palpably are the above two conditions effected. Hence, by way of illustration, the exudation within the centre of a short bone, or, in the head of a long bone, at a point equidistant from the termination of the medullary canal and the periosteum, does not acquire that development into cells as exudation immediately contiguous to the latter. The sole

<sup>1</sup> Br Budd, "On Emphysema and Asthma." *Medico-Chirurgical Transactions*, 1840, pp. 53 *et seq.*

cause of this is, the diminished or arrested circulation through these distant portions of bone, and the consequent absence of the necessary conditions for germination and growth. In proportion, therefore, to this partial or complete arrest of the circulation are the diminished vitality of the corresponding portions of the cancellous tissue, and the inability of the exudation to acquire a cell-formation. These conditions are highly favourable to the disintegration of the one and the fatty transformation of the other; but so long as oxygen is excluded, neither disintegration nor metamorphosis can take place. When, however, this oxygen has, either by a certain amount of continuance of the circulation, or by a *direct* communication between the tuberculous bone and the air, gained admission to the diseased parts, rapid disintegration of the bony texture and rapid transformation of the exudation may occur. Under this process, the walls of the cancelli disintegrate from the surface towards the centre of each partition, which in consequence becomes thinner and thinner, until at length it is entirely destroyed. Two cancelli are now broken into one; and this process continuing in other contiguous partitions, an excavation, involving the destruction of many cancelli, is at length produced. During this progressive destruction of the walls of the cancelli, a striking difference occurs between the diameters of the cancelli themselves and their osseous partitions which are thus affected, and those of healthy cancellous bone. This difference is much more palpably appreciated by a comparison of the healthy and diseased cancellous tissue under the microscope or in sketch, than by any comparisons of the difference of their respective diameters without such ocular demonstration.

FIGURE VII.

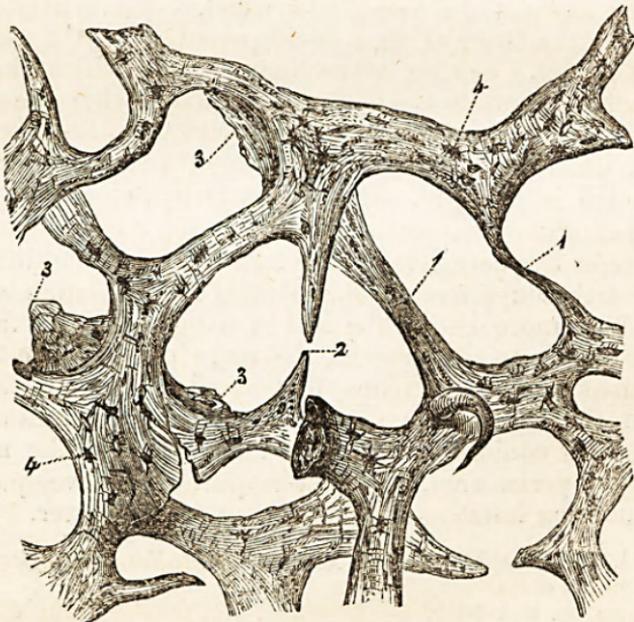


Fig. VII.—1. Cancellous walls greatly reduced in diameter by progressive disintegration.

2. A cancellous wall completely disintegrated at one point, showing the process of conversion of two cancelli into one.

3. Exostoses springing from the walls of the cancelli.

4. Lacunæ stuffed with tuberculous and osseous deposit.

Drawn under the Camera Lucida, by Mr Tuffen West.

From the above Figure, in comparison with Figure II., it will be seen that, during the above stage of tuberculosis of bone, the diameters of the cancelli increase in proportionate ratio to the diminution of those of their osseous walls by the disintegration of the latter, and that they both bear to those of healthy cancellous bone the following relations, as determined by mean measurement :—

MEAN DIAMETERS OF CANCELLI OF TUBERCULOUS BONE IN THE ULCERATIVE STAGE.

	Long Diameter.	Short Diameter.
A	14½	12
B	24	14
C	24	18
D	37	23
E	16½	10½
F	22	10½
G	19	16
H	24	22½
I	29½	22
K	27	11½
	237½	160
Mean average,	$\frac{237\frac{1}{2}}{1000}$ ths inch.	$\frac{160}{1000}$ ths inch.

MEAN DIAMETERS OF THE OSSEOUS WALLS OF TUBERCULOUS BONE IN THE ULCERATIVE STAGE.

<i>a</i>	.	.	7½
<i>b</i>	.	.	4½
<i>c</i>	.	.	2½
<i>d</i>	.	.	3½
<i>e</i>	.	.	2
<i>f</i>	.	.	4½
<i>g</i>	.	.	3
<i>h</i>	.	.	4½
<i>i</i>	.	.	4¾
<i>j</i>	.	.	4½
<i>k</i>	.	.	3
<i>l</i>	.	.	3
<i>m</i>	.	.	3
<i>n</i>	.	.	5
<i>o</i>	.	.	5
<i>p</i>	.	.	2½
<i>q</i>	.	.	5
<i>r</i>	.	.	4½
<i>s</i>	.	.	4½
<i>t</i>	.	.	14
			78
Mean average,			$\frac{78}{1000}$ ths inch

Whilst the destruction of the walls of the cancelli is progressing, as above shown, the exudation within the cancelli themselves, unable, from the absence of the circulation, to derive the pabulum of nutrition for its perfect development into cells, undergoes fatty degeneration. Hence, the microscopic examination of bone, which has undergone these pathological changes, shows partial or complete destruction of the walls of the cancelli (Figure VII.); whilst the contents of such cancelli consist of oil-globules of various sizes from a metamorphosis of a portion of the exudation, masses of exudation-matter more or less converted into fat, granular matter and patches of the lining membrane of the cancelli in a similar condition, together with the ultimate earthy particles of disintegrated bone (Figure V.).

As the deposit of tuberculous matter is not of equal amount throughout the affected cancelli, so neither does the process of ulceration in them observe the same period of time or the same ratio. The greater the amount of exudation within the cancelli, and the nearer this is to the source of vascular supply, the sooner does ulceration take place. Hence, the surface of a short bone, and next to this, in a long bone, the immediate neighbourhood of the termination of the medullary canal, are the seats at which ulceration, in tuberculosis of bone, first occurs. In the former, exudation into the superjacent soft parts, and its subsequent germination, growth, and degeneration, constitute abscesses, which open a communication between the surface and the diseased bone. In the latter, this condition of the superjacent soft parts may not occur until the exudation in the cancelli, near the termination of the medullary canal, has already germinated, attained its cell-growth, and degenerated into pus-corpuscles. In this manner, an abscess, confined within the substance of the bone, may exist for some time without any communication with the external air. This communication, however, at length takes place; and the external air, admitted, in consequence, into free contact with the tuberculous bone, its oxygen hastens the degeneration of the exudation, and the disintegration of the diseased bone. When oxygen gains access to the exudation within the cancelli, without the continuance of the circulation through the capillaries of the latter, such exudation undergoes fatty transformation with but little previous manifestation of cell-development; but where a continuance of the circulation through the cancelli is maintained in conjunction with the free admission of air to their contained exudation, the latter is first developed into cells, and then, as cells, transformed into pus. Pus, therefore, is *never seen* as a constituent of the contents of cancelli, which are *stuffed* with tuberculous exudation, which lie *within* the substance of a bone, and the circulation of which has been *obliterated*. But around these cancelli, in others which are but partially occupied by deposit, and in which the capillary circulation still exists, the conditions for the germination and growth of the exudation con-

tinue; the latter is in consequence developed into cells, which subsequently, by the action of oxygen, degenerate and become pus-corpuscles. It will thus be seen that, for the commencement of the process of softening, as arising out of cell-development, a certain amount or continuance of the circulation is necessary, and that where this is entirely arrested, this kind of softening cannot take place. In some parts of a tuberculous bone the cancelli are choked, as it were, with exudation, and the circulation is entirely obliterated; whilst the surrounding cancelli are but partly occupied by deposit, and in them the circulation is, to a certain extent, maintained. Where there is no circulation there is no *softening*, in the above acceptance of that term; and as there is no circulation through a tuberculous mass formed by a number of contiguous cancelli stuffed with exudation, it is certain that the above-mentioned form of softening does not, and cannot, commence in the midst or interior of such a mass. It must, therefore, commence at the *circumference*; and, in this respect, it observes in bone the same process and situation as tuberculosis in the pulmonary tissue. Like the latter disease, too, an excavation, once formed in the cancellous tissue of bone, increases by the continued exudation in its walls, by the subsequent germination, growth, and degeneration of such exudation, and by the consequent disintegration of the ultimate tissue of bone.

When the deposit of tubercle is unequal throughout the cancelli of the same bone, when, in consequence, there are, as it were, islets of bone, the cancelli of which are choked with exudation, whilst the cancelli of the intervening portions of bone are but partially occupied by deposit, the process of softening may commence at the circumference of each of such islets, and, in this way, separate and distinct excavations, as in the pulmonary tissue, may occur. When, again, the tuberculous exudation is limited to a certain number of the cancelli, the latter, by the germination and growth of the exudation, may be destroyed; but the circulation of the surrounding cancelli remaining, a plastic exudation may take place upon the surface of such excavation, and thus a healing process is established. It will readily be seen, that it is in the last-quoted extent of the disease that the removal, by operative procedure, of the tuberculous portion of bone is likely to be followed by a happy result; whilst, on the other hand, it is manifestly apparent, that where the tuberculous exudation has invaded the whole or the greater number of the cancelli of a bone, resection or amputation is the only means which promises a favourable result.

It has already been stated, that, during the progress of tuberculosis of bone, the adjacent articular structures become similarly affected; and, as the process of ulceration occurs in the latter, it is, as a general rule, by extension of the disease from the extremity of the bone to the adherent cartilage, and thence to the other structures of the joint. As a preparatory step, however, to the ulceration of the cartilage, an exudation is thrown out between it and the

extremity of the bone by the vessels of the latter, and this exudation, undergoing a certain development into cells, constitutes a seemingly false membrane, to which important functions, in the subsequent destruction of the cartilage, have been ascribed. Of itself, and by virtue of an inherent property, this false membrane has no power to cause the absorption of the cartilage; but, by interposing between it and the bone, from the vessels of which the cartilage draws its pabulum of support, the healthy nutrition of the latter is destroyed, and its subsequent ulceration is in consequence decreed. It is extremely rare to find this false membrane intervening between the whole extent of the cartilage and the adjacent bone. It much more commonly exists in patches, and these invariably correspond with diseased points of bone beneath. Where the cartilage is yet adherent to the bone, no such false membrane is to be found, and the condition of the bone beneath is proportionately normal.

Hence, the formation of this false membrane is but the natural result of the advance of the disease to the surface of the articulating extremity of the bone; and the subsequent destruction of the cartilage is no more ascribable to the influence of any power of absorption on its part, than is the destruction of the periosteum, or of the superjacent soft tissues, to an inherent power of absorption in the exudation which occurs beneath the former, and amongst the latter, in the progress of the disease to the surface of the body. The true explanation, then, seems to be, that where, in the progress of the ulcerative stage of tuberculosis of bone, the cartilages of the adjacent joints ulcerate, they, in a great measure, do so as the result of an exudation thrown out between them and their corresponding extremities of bone by the vessels of the latter, by which their normal nutrition is destroyed, and their subsequent disintegration induced. I say, "in a great measure;" because the ulceration of the cartilages is not entirely due to the effect of intervening exudation, but in part to tuberculous disease of the cartilages themselves. If, in such cases, a perpendicular section of a cartilage, at its unattached point, be examined in the microscope, it will be found, that the cells of its lowest portion are apparently increased in number—that they lie with their long diameter parallel to the surface of the cartilage—that they are larger than the cells of healthy cartilage—and that they are more or less crowded with granules, which manifest the chemical characteristics of oil according to the degree of metamorphosis which they have undergone. Some of these cells have burst, and discharged their granular contents into the surrounding hyaline substance; whilst, at other points, between cells which have not yet discharged their contents, granules are deposited, in variable number, in the substance of the cartilage. In the middle portion of such cartilage, the disposition of the cells is somewhat different. Instead of finding them arranged with their long diameter parallel to the surface of the cartilage, they generally observe, in this respect, an angle from  $45^{\circ}$  to  $85^{\circ}$ , whilst they are

less crowded with granules than those of the portion of cartilage subjacent to them. Notwithstanding this, they are widely different, in this respect, to the cells of healthy cartilage; whilst the intervening hyaline substance, although dimly granular in many points, is less so than that of the lowest stratum of this structure. If the examination of the cartilage be carried to its synovial surface, it will be found that the same pathological condition of its cells, the same parallel arrangement of their long diameter to its surface, and the same process of disintegration, as were observed in the opposite surface, may exist. This surface, however, may or may not as yet have undergone ulceration; for, where the tuberculosis commences in the adjacent bone, and thence extends to the contiguous joint, ulceration of the synovial surface of the cartilage is, as a general rule, posterior in time to ulceration of the opposite surface. When, on the other hand, tuberculosis commences in the synovial membrane, the contiguous surface of the cartilage is the one to be thus primarily affected. When such is the case, ulceration is preceded by an exudation between the synovial membrane and the subjacent surface of the cartilage, which is poured out by the vessels of the former, and which, by its subsequent development into cells, constitutes, as in the case of ulceration of the opposite surface of the cartilage, a false membrane, to the influence of which the ulceration of the contiguous surface of the cartilage has been ascribed. Here again, as in the opposite surface of the cartilage, this false membrane has no innate power of determining ulceration in the cartilage beneath; but, by interposing between the latter and the vessels which ramify on the surface of the synovial membrane, from which the contiguous surface of the cartilage draws its nutritive blastema, it obstructs the healthy nutrition of the latter, and thus favours its subsequent disintegration. If, at the time this exudation takes place, the air were freely admitted to it, instead of passing into a false membrane of nucleated cells, the latter would be converted into pus-corpuscles, and as such they would be discharged through the different sinuses communicating with their seat. Such, indeed, is their destination when this free access of oxygen to them has been accomplished. It is, therefore, the *conditions* under which they exist, rather than their vital tendency, which determine them to the formation of a false membrane; and the laws of vital dynamics teach, that structures, formed and existing under such conditions, can exert no special and individual action upon the tissues of the surrounding organism. If such were not the case, we should, in the foregoing instance, expect that a false membrane would be formed between the whole extent of the synovial membrane and the subjacent cartilage on which it is intended to operate; because, where nature designs a structure for a special purpose, it gives it an uninterrupted anatomical development commensurate with its physiological requirements. In contravention of this law, we find, in the case of the false membrane before cited, that, instead of existing

throughout the whole extent of the surface of the cartilage, it exists only at those points of it where ulceration is either present or about to commence, and that it is absent from all other portions of its surface. This pathological fact seems, therefore, to show, that its presence is without design, and that its existence is the *result*, and not the *cause*, of those conditions which determine the ulceration of the cartilage.

Although, in this advanced stage of tuberculosis of bone, the extension of ulceration to the adjacent cartilage is generally first manifested by the attached surface of the latter, yet it not unfrequently happens, that the synovial surface is the one primarily affected. This may occur when, shortly after the commencement of the disease in the bone, tuberculosis of the synovial membrane of the neighbouring joint supervenes, which may lead to ulceration of the subjacent surface of the cartilage before the disease in the bone has had time to extend to the attached surface of that structure.

In the chemical composition of bone, as well as in its structural relations, important changes occur during the progress of the ulcerative stage. Thus a comparison of the following analyses of tuberculous bone with those of the healthy structure, as detailed in a previous page, shows that tuberculosis gives rise—

- I. To a considerable increase of fat in the diseased bone.
- II. To a large diminution of the salts of lime.
- III. To a diminution in the organic matrix.
- IV. To an increase in the soluble salts.

Composition of the condyles of the femur in the ulcerative stage of tuberculosis.

Organic Matter.	1st Specimen.	2d Specimen.	3d Specimen.
	Female, age 24 years.	Female, age 10 years.	Male, age 29 years.
Cartilage and vessels, . . .	11.51	9.78	11.90
Fat, . . . . .	69.24	74.85	67.36
Inorganic Matter.			
Phosphate of lime with fluoride (?) of calcium, . . . . .	16.44	12.76	18.00
Carbonate of lime, . . . . .	1.90	1.62	1.90
Phosphate of magnesia, . . . . .	.20	.23	.21
Soluble salts, . . . . .	.71	.76	.63
	100.00	100.00	100.00

Composition of the head of the tibia in the ulcerative stage of tuberculosis.

Organic Matter.	1st Specimen.	2d Specimen.	3d Specimen.
	Male, age 21 years.	Male, age 8 years.	Female, age 10 years.
Cartilage and vessels, . . . . .	9.63	9.08	9.17
Fat, . . . . .	72.65	74.76	73.95
	82.28	83.84	83.12
Carry forward,			

Brought forward,	1st Specimen. 82·28	2d Specimen. 83·84	3d Specimen. 83·12
Inorganic Matter.			
Phosphate of lime with fluoride (?) of calcium, . . . . .	14·73	13·21	13·73
Carbonate of lime, . . . . .	1·87	1·75	1·90
Phosphate of magnesia, . . . . .	·19	·15	·15
Soluble salts, . . . . .	·93	1·05	1·10
	<hr/> 100·00	<hr/> 100·00	<hr/> 100·00

Composition of the astragalus in the ulcerative stage of tuberculosis :—

Organic Matter.	1st Specimen. Female, age 15 years.	2d Specimen. Male, age 12 years.	3d Specimen. Male, age 8 years.
Cartilage and vessels, . . . . .	17·02	9·97	14·95
Fat, . . . . .	56·76	76·98	63·33
Inorganic Matter.			
Phosphate of lime with fluoride (?) of calcium, . . . . .	22·04	10·51	13·10
Carbonate of lime, . . . . .	3·05	1·37	2·69
Phosphate of magnesia, . . . . .	·37	·17	·31
Soluble salts, . . . . .	·76	1·00	·62
	<hr/> 100·00	<hr/> 100·00	<hr/> 100·00

Composition of the os calcis in the ulcerative stage of tuberculosis :—

Organic Matter.	1st Specimen. Female, age 10 years.	2d Specimen. Male, age 12 years.	3d Specimen. Male, age 8 years.
Cartilage and vessels, . . . . .	7·91	8·75	13·41
Fat, . . . . .	81·63	79·59	70·18
Inorganic Matter.			
Phosphate of lime with fluoride (?) of calcium, . . . . .	8·16	9·27	13·22
Carbonate of lime, . . . . .	·97	1·07	1·87
Phosphate of magnesia, . . . . .	·10	·12	·25
Soluble salts, . . . . .	1·23	1·20	1·07
	<hr/> 100·00	<hr/> 100·00	<hr/> 100·00

Now, the increase of fat above shown, in the third stage of tuberculosis of bone, is no doubt due to the metamorphosis of the exudation contained within the cancelli; whilst the diminution of the salts of lime is referrible to a vital change in the organic matrix of the bone, by which the cohesion between that matrix and the ultimate earthy particles is destroyed, and the latter in consequence are liberated and set free. Hence, the diminished specific gravity and the great softness of tuberculous bone which has undergone the ulcerative stage. In all cases, in this stage, the disintegration of the cancellous walls reduces the quantitative proportion of cartilage below the standard of healthy bone; nevertheless the relative pro-

portion of organic matrix to the earthy salts of tuberculous bone *equals*, and, generally, greatly *exceeds*, the relation which these two constituents bear to each other in health. An explanation of this result is probably read in the structural character of the fibro-gelatinous matrix, in its slow subjection to the influence of oxygen, and in the particular character of the earthy particles and their mode of combination with the organic basis of bone. A mineral acid removes entirely the calcareous salts of bone from the cartilaginous matrix, and leaves the morphological character of the latter intact. Incineration, on the other hand, destroys the organic basis, and leaves the ultimate earthy particles unaffected. Hence, the two are not in chemical combination to constitute bone; but, on the contrary, the organic material forms a nidus, through which the earthy particles are distributed, and thus, by a *vital* influence, which pervades every living structure, they are held together, and evince the peculiar characters of bone. Whilst, however, the organic basis manifests no elementary structural formations beyond fibres, the earthy particles have a definite shape and size. Hence, in the separation of the two by the death of bone, the organic matter is wasted by inappreciably microscopical proportions; whilst the earthy particles are set free without change or diminution in size. This mode of disintegration gives a relatively greater loss of the calcareous salts than of the organic matter, and thus accounts for the great diminution in the salts of lime, which the previous analyses show to exist in the ulcerative stage of tuberculosis of bone.

The local symptoms which attend the above stage are those of the previous stage, with the addition of those which depend on the formation of pus within the bone, in the tissues superjacent to it, or in both. Where the disease has run an active course, there are now active congestion around the tuberculous deposit and in the tissues superjacent to the bone, increased swelling, pain, tenderness, and inability to move the affected limb without considerable suffering. Pus approaches the surface at one or more points, preceded by pain of a throbbing, shooting, lancinating, or gnawing character—by diminished mobility of the part—by restless nights—and by more or less disturbance in the general system. At length the skin is elevated in circumscribed portions, becomes red, tense, and affords, on manipulation, the sensation of fluctuation beneath. It now gives way, and a discharge of pus mixed with blood takes place. For a brief period the more urgent symptoms are less exquisite; but the air finding access to the interior of the diseased bone, a rapid degeneration of the tuberculous exudation occurs, fresh excitement in the superjacent parts takes place, pus in increased quantity is produced, and the disease hastens, as it were, to the destruction of both life and limb. In this rapid course the local heat and tenderness are very great; the skin around the openings of the sinuses is red; the edges of the latter are ragged, irregular, and undermined; and the pus is thin, bloody, ichorous, and often gritty to the feel from the

presence of the earthy particles of bone. The general symptoms, at this moment, are expressed by a hot and dry skin; quick, small, and feeble pulse; considerable thirst; loss of appetite; a clean, florid, shining tongue, smooth from the loss of its epithelium, and frequently with its papillæ apparently enlarged; diarrhœa; and scanty, highly-coloured urine, depositing a copious sediment of urates; together with hectic fever towards the latter part of the day.

In other cases not so acute, the urgency of both local and general symptoms is less marked; the edges of the sinuses are neither ragged nor undermined; but, on the contrary, they become thickened and everted, with depression of the surrounding skin; the pus, unequal in consistence and more or less curdy, is less bloody; and the general system is competent to the moderate discharge of its various functions.

In a third class of cases the symptoms are almost entirely local. There is little or no pain in the affected part, except on use or manipulation; the sensations arising out of the disease are more those of enlargement and incumbrance; the tissues above the diseased bone are thickened; the skin is cool, and depressed around the sinuses, which exhibit hard, everted edges; and the pus, scanty in quantity, is of variable consistence and colour. The tongue is moist, and either clean or covered with a thin, white fur; there is no thirst; the appetite is often regular; but the bowels are frequently torpid. The countenance is usually pale; the general surface cool; the pulse regular, soft, equal, and not accelerated; and the sleep undisturbed.

The following cases illustrate the above positions:—

CASE VII.—T. E., a girl aged 10 years, of *nervo-sanguineous* temperament, with light hair and eyes, and regular but stunted features, was admitted into the Chesterfield Hospital, on Sept. 5, 1856, for tuberculous disease of the knee-joint. Twelve months before admission, she received a blow on the knee from a stone thrown at her by a boy. She was ever afterwards lame of the joint, which gradually enlarged, and ultimately inflamed, suppurated, and rendered her unable to walk.

The knee, on admission to hospital, was flexed almost at a right angle, and was greatly enlarged from thickening of the soft tissues; the bony prominences were lost; and there were sinuses above, below, and on the outer side of the joint, from which a thin, curdy, unhealthy pus, sometimes mixed with blood, escaped. There was constant pain, which was greatly increased on any motion of the joint. She had lost flesh, had now a variable appetite, little or no thirst, no hectic, and the bowels were regular.

For five weeks she was enjoined perfect rest in bed, during which time the knee was treated with warm-water dressing and bread-sop poultices. The diet consisted of milk, light puddings, and, whenever the state of the system permitted, of a moderate quantity of animal food. For a short time there was an improvement in the local symptoms; but ultimately the case grew worse: the knee became exquisitely tender; the skin hot, red, and inflamed in patches; the edges of the sinuses thin, ragged, and surrounded by a bright, florid blush; whilst a thin, bloody, ichorous discharge constantly escaped through their openings. There were now headache, sickness, thirst, diarrhœa, hot skin,

burning of the palms and of the soles of the feet ; quick, small, and rapid pulse, and other symptoms of well-marked hectic.

At a consultation with my colleagues, it was decided to remove the limb. On the 17th of November, I performed amputation of the thigh whilst the patient was under the influence of chloroform. Three vessels required ligation. The flaps, except at the point of exit of the ligatures, united by the first intention. On the seventh day, two of the ligatures came away ; on the tenth, the femoral ligature separated ; and on the thirteenth, the stump had quite healed. The patient was shortly afterwards discharged from hospital in perfect health.

*Appearance of the diseased joint.*—The synovial membrane is of a pale yellow colour, thickened, pulpy, and apparently in a state of fatty degeneration. Where reflected over the cartilages of the joint, it can be scraped off as a semi-transparent jelly. The crucial ligaments are partly destroyed. The cartilage on the outer condyle of the femur is quite destroyed to the extent of an inch by five-eighths at its posterior part. The bone beneath is deeply injected with blood, soft, and spongy. The edges of the cartilage around this ulcer present a worm-eaten appearance, particularly at its posterior part. The cartilage of the inner condyle presents, about three-fourths of an inch from its posterior border, three irregular ulcers, of small size, and scattered over a surface half an inch square. The portion of cartilage between these ulcers is thinned, and easily separated from the bone beneath, which is deeply injected with blood. At the upper and anterior edge of the femoral cartilage is an irregular ulcer, three-fourths of an inch long by half an inch wide, laying bare the subjacent bone. On the outer articulating surface of the tibia the cartilage is entirely destroyed, with the exception of a mere rim at its circumference, which also presents a worm-eaten appearance from the existence of minute ulcers. The place left by the loss of the cartilage is occupied by a pulpy, fleshy-looking, gelatinous mass. On the inner articulating surface of the tibia are twelve small ulcers, perforating the substance of the cartilage, and scattered over the inner half of its circumference. The centre of this cartilage, over a space of three-fourths by half an inch, is very much thinned, and easily separated from the bone beneath, which shines through it of a bluish-red appearance. At the anterior part of this cartilage are two ulcers, perforating its substance, and measuring one-fourth of an inch in their longest diameter. The bone beneath is highly vascular. For two and a half inches below the articulating surface of the tibia the cancellous tissue is soft, easily broken down, and evidently much diseased. The condyles of the femur are in a similar condition. At the posterior part, immediately below the head of the tibia, is an opening communicating with the medullary canal, which for some distance is occupied by a reddish-brown, soft, unctuous, and gritty mass. This, under the microscope, is seen to consist of bony debris, blood-discs, pus-corpuscles, and fat-cells, which may be regarded as the contents of an abscess of the head and medullary canal of the tibia. The upper third of the shaft of the tibia is injected, and of a bright rose colour, in patchy distribution. The os calcis is extremely soft, its tissue opened out, filled with oil, and crushed by the slightest pressure between the thumb and finger.

Sections of the diseased condyles of the femur and of the head of the tibia exhibit, under the microscope, the characteristic changes of this stage of tuberculosis, namely, occupation of the cancelli by tuberculous deposit, detachment more or less complete of the lining membrane of the cancelli, partial or complete disintegration of the cancellous walls, exostoses springing at various points from the latter, and occupation by tuberculous and osseous deposit of the lacunæ.

CASE VIII.—W. H., a female, aged 44 years, of nervo-bilious temperament, by occupation a silk-winder, had suffered for twelve months from tuberculosis of the lower end of the right tibia. She stated that the disease commenced

without any known cause; that, at one time, the soft parts above the inner malleolus would be so painful, hot, and tender to the touch, as to render her unable to put the foot to the ground; and that, at other times, these symptoms were to a great extent in abeyance, which permitted her to walk, although lamely, a short distance to her usual employment. Some time after the commencement of the disease, pus formed over the inner ankle, and was discharged; and shortly afterwards, another collection of pus discharged itself immediately above the external malleolus. These openings continued when the case, twelve months after its commencement, came under my care. They were somewhat depressed below the general surface, had thickened, everted edges, were surrounded by an inflammatory halo, and discharged a thin, yellowish-looking, curdy pus, with now and then a slight admixture of blood. A probe, inserted into the inner opening, passed directly into the substance of the corresponding malleolus; whilst the outer opening had no direct communication with diseased bone. The synovial membrane of the ankle-joint, and the soft tissues superjacent to the latter, were thickened to the extent of producing considerable deviation from the healthy appearance. She had lost flesh, looked pale, had a small, soft, and feeble pulse; but otherwise her general health was not materially affected, except during occasional aggravations of the local disease, when considerable disturbance was manifested by the general system.

In the treatment, I cut down upon the inner malleolus, gouged away all the diseased bone, stuffed the wound with lint, and applied warm-water dressing. This mode of treatment, coupled with a generous diet, the use of cod-liver oil, and exercise upon crutches in the open air, commencing as soon as possible after the operation, healed the wounds in three months. Three years afterwards she remained well, could walk strongly, and felt no uneasiness in the previously affected parts; nevertheless the synovial membrane of the ankle-joint and the superjacent soft tissues remained in their thickened condition.

CASE IX.—J. K., a female of nervo-bilious temperament, at the age of 14 sprained her right ankle, and shortly afterwards again injured it. These injuries caused the joint to swell; but lameness did not supervene sufficiently to attract the attention of her parents until six months after the latter injury. A neighbouring surgeon was now consulted, who attended the case for the next twelve months, during which time pus formed, and was evacuated by the lancet. Two years from the time the disease attracted the attention of her parents I took charge of the case. There was now considerable enlargement of the soft parts around the ankle-joint, on the outer side of which a small fistulous opening, with hard, everted edges, existed. A probe, introduced into this opening, passed into the head of the astragalus, which was found to be diseased. There was no inflammatory blush around the opening, which was situated in the centre of a depressed portion of the skin, and from which a scanty quantity of sero-curdy looking pus escaped. Manipulation of the joint provoked a certain uneasiness, which amounted to pain on any attempt to stand or walk with the diseased limb. When at rest, with the foot elevated, the affected part was easy. In the early part of the disease the general health suffered, and the patient lost flesh, which she had not as yet regained. Her appearance was, therefore, pale and thin. The skin was cool, the pulse natural, the tongue moderately clean, the appetite regular, and the sleep but little disturbed. There was no thirst; the bowels were torpid, and menstruation was irregular.

In the treatment, the foot and ankle were surrounded by a starched bandage, in which a sufficient opening was made opposite the sinus for the exit of pus. The foot was borne about an inch from the ground by a sling passing round the neck, the patient was put upon crutches, and exercise in the open air was enjoined. The bowels were at first regulated by alterative doses of mercury with the compound rhubarb pill, and she took regularly, three times a day, four grains of the iodide of potassium in an ounce of bitter infusion. A generous diet was ordered, together with half a pint of porter daily. By and

by, the iodide of iron was substituted for the preparation of potash; and this, in a short time, gave place to the cod-liver oil, which was exhibited for many months, in doses from two drachms at the commencement, to an ounce three times a day at the termination of the case. During the exhibition of the cod-liver oil, a grain of the sulphate of iron, one-fourth of a grain of aloes, a grain of the extract of henbane, and two grains of the extract of gentian, were given in the form of pill every night and morning. Under this treatment she slowly but steadily improved; menstruation became regular, several small portions of dead bone separated and were removed from the sinus which led to their position, and, in a little more than two years from my first attention to the case, the wound healed. Three years and a half, however, elapsed from the assumption of crutches before the condition of the joint admitted of their being laid aside. Four years have already passed since this occurrence, and the cure remains complete. Her father, writing to me on the 5th of March 1859, says, with respect to this case, that the ankle-joint appears to be "quite sound"—that it is not now swollen—that the patient can use it pretty well, but not so freely as the other—that she can manage short distances without fatigue, but that a long walk even yet distresses the joint.

The indications of treatment which arise, in the above stage of tuberculosis of bone, have for their object:—

- I. To remove the diseased bone by manual operation, or to favour its separation.
- II. To favour the healing process by local and constitutional means, and to relieve urgent symptoms.

In fulfilling the former indication, it ought always to be borne in mind, that, before recovery can take place, those portions of diseased bone which have either lost their vitality, or retain this in a very small degree, *must* be separated from those which are not similarly affected. The first object, therefore, of the surgeon should be—to effect, with as little delay as possible, this separation, by the employment of those means which a full knowledge of the extent of the disease and of the particular features of the case may suggest. Now, it has been already shown, that the extent of the disease may vary from tuberculosis of a very small portion of a bone to the complete invasion of the latter. Hence, the treatment, as to the extent of manual interference, must also vary. When tuberculosis has invaded the whole of a short bone, or the entire extremity of a long bone, recovery cannot, after the manifestation of the ulcerative stage, take place with retention of the diseased bone. This, therefore, must be removed by operative procedure; and, to accomplish this object, either excision or amputation will be necessary. The former operation, when by it the whole disease can be removed, is the one to be preferred; and of its beneficial results many examples have of late occurred in the elbow, knee, and ankle. When, however, excision cannot compass the whole disease, so as to leave on recovery a useful limb, amputation of the latter above the seat of disease must be performed. This is especially necessary when, in tuberculosis of the head of the tibia, abscess of the medullary canal

has occurred in the manner before described. When, however, to operate by excision or amputation, and when to attempt a recovery without, must be determined by a careful and complete exploration of the diseased bone and adjacent joint. There should neither be too great haste to perform these operations, where there is still a probability that, by milder measures, the bone may yet recover; nor too much delay in adopting them, where the conviction of their necessity exists.

When the tuberculosis of bone is of limited extent, there ought, as a general rule, to be no delay in cutting down upon the diseased part, and in removing it, provided this can be done without opening a joint. This treatment is rendered palpably necessary by the fact—that the cancelli of the diseased part are stuffed with tuberculous exudation—that their lining membrane is detached from its connections and destroyed—that the lacunæ and their canaliculi are more or less occupied by tuberculous and osseous deposit—and that the nutrition of the diseased bone is consequently at an end. Its separation from the living bone *must* therefore take place; and this, where circumstances are favourable, is better effected at once by art than by the prolonged efforts of nature. In doing this, the rule—to gouge away the diseased bone until the latter bleeds from all points—is a good guide, as to the extent to which operative procedure should be carried. A limited tuberculosis thus treated, will frequently be followed by recovery, when, by non-interference, the disease would progress from little to more, and ultimately endanger the safety of the limb. This progression is, under such circumstances, due to the admission of air to the diseased bone, by which disintegration of the latter, and metamorphosis of the tuberculous exudation, are effected as before explained. It ought, therefore, to be an axiom in the treatment of this disease, to exclude air, as far as practicable, from contact with tuberculous bone. From this it follows, that abscesses connected with tuberculous bone should not, as a general rule, be opened; and that, where sinuses already exist, the diseased bone to which they lead, ought, when practicable, to be removed as soon as possible by operative procedure. Where the disease is too limited for excision or amputation—where its removal by the gouge is likewise impracticable, as is the case where tuberculosis affects that part of a bone which enters so fully as the head of the astragalus into the composition of a joint—and where, in consequence, the external air gains admission to the seat of disease through the cavity of the latter,—constitutional and local measures of position, and of a more gentle character than the above, are the only means to be adopted.

To favour the healing process, and thus to fulfil the second indication of treatment in this disease, regard must be had to both local and constitutional measures. So long as the local symptoms are of an acute character, the affected part must be laid at perfect rest in a non-dependent position; and must likewise be soothed by occa-

sional anodyne fomentations, and by the assiduous application of the warm-water dressing, or of a bread-sop poultice, which latter is, in many instances, productive of more benefit than the former remedy. At this stage the internal treatment should consist of an occasional mercurial alterative, together with anodynes, diaphoretics, diuretics, and occasional laxatives or mild aperients; whilst the diet should be of an unstimulating character. As soon, however, as the state of the affected part and the condition of the general system will admit of a tonic plan of treatment, this must be adopted without delay. With this view, the cod-liver oil, iodide of potassium in decoction of sarsaparilla or some vegetable infusion, the various preparations of iron in combination with vegetable bitters, together with a generous diet, and the cautious use of malt liquor or wine, will be prescribed with advantage.

An essential element, too, in the treatment at this point, is—active exercise in the open air. This ought *never* to be neglected when the patient is able to undertake it; nevertheless the affected part must not be used. To avoid this, slings, properly applied splints or bandages, and, in the case of the lower extremities, crutches, must be adopted. I am well persuaded that, were these means pursued to the extent which they deserve, a much greater success would attend the treatment of this disease than is at present the case. To confine the patient to bed when he is capable of leaving it—to torture him with setons, issues, or moxas, in the vain hope of curing the disease—and to allow a tuberculous bone to be used whilst the disease is yet progressing, are quite opposed to our views of the constitutional origin of tubercle, and to the pathological data which I have advanced. A free supply of oxygen is essential to the well-being of the body; motion of the latter, by accelerating the circulation and respiration, increases that supply; therefore, in tuberculosis, which requires the invigoration of the constitutional powers, exercise should be enjoined whenever it is not contra-indicated by other circumstances and conditions. Where, too, medicinal properties applicable to the constitutional treatment of the disease, exist either in the atmosphere or in the waters of a place, thither should the patient be removed as soon as practicable. Hence, the sea-coast for the former, and certain inland towns of England for the latter, reason, are the proper places of resort for such invalids.

By such means, then, as the above, timely applied and perseveringly carried out, we shall without delay, not only conduct the disease to the issue which its particular conditions indicate; but, by doing so, we shall frequently be the means of preserving lives, valuable in themselves, which would otherwise, by the continued ravages of the disease, be ultimately destroyed.