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THE PATHOLOGY OF OSSEOUS TISSUE*

BY

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The title of this discussion embraces so many conditions that it is impossible in the time allotted to do more than mention some of the general principles and to touch on a few special points which may be of interest. Although "calcification" forms the subject of a separate discussion it cannot be omitted altogether in dealing with osseous tissue.

It may be asked: wherein does the pathology of osseous tissue differ from that of any other connective tissue? The answer is that such tissue is hard, owing to its mineral—mainly calcium—content. The hardness and calcium content modify the pathological changes in several ways. Any factor which affects calcium metabolism generally will affect bone. Also when dead bone has to be removed the process is a relatively slow one owing to this hardness. Further, for calcium to be properly laid down in bone, phosphorus is essential, so that bone pathology comes to be complicated by this Ca-P relationship and all the factors of balance, enzyme action, and hydrogen-ion concentration. In a sense calcification in bone is a fortuitous event, an afterthought as it were. An osteoid matrix is required before the calcium can be laid down, and the calcium may be removed from and redeposited in the original matrix.

Osteoblast and Fibroblast

The controversy about osteogenesis still rages, and though it is unprofitable to enter into it in detail, it cannot be escaped. Clinicians have warmly embraced the theories of Leriche and Policard and their school in place of the older specific cell, or osteoblast, idea. Most pathologists are inclined to be more conservative and still find a place for the osteoblast. Between the two extremes of Leriche and Policard on the one hand, and the older view, so well defended recently by Dubreuil, Charbonnel, and Massé, on the other, there would seem to be a reasonable middle way.

The osteoblast is, admittedly, a cell of the connective tissue group. It would seem to be specialized, even as the fibroblast is specialized, and produces a matrix—the ossein or osteoid tissue—even as the fibroblast produces collagen fibrils as its matrix. Normally, bone as we know it forms from the deposition of calcium in this matrix. That the osteoblast takes any part in the actual calcium deposition is doubtful. This is due rather to the physical condition of the matrix (Wells) plus the action of phosphatase enzymes splitting off the calcium and phosphorus ions from their organic combinations (Robison; Robison and Soames) and so making them capable of being precipitated in the matrix. That such action is a

reversible one is supported by the varying effect of pH on the phosphatase found in blood corpuscles (Martland). The effect of vascularity or anaemia on the calcification of bone is well known to the radiologists (Watson Jones and R. E. Roberts), and forms the main theme of some surgical pathologists (Greig). The variation in blood supply certainly affects the calcium content, probably owing to pH variations favouring the removal or deposition of calcium by enzyme action, also, it may be, owing to the varying phosphate supply, as an increase of phosphates, by intravenous injection, leads to decalcification (Salveson, Hastings, and MacIntosh). We do not yet know the exact mechanism of such varying vascularity.

The matrix of the bone is only secondarily affected; mainly by reason of loss of calcium and consequent diminution of rigidity new stresses are put upon this matrix, the cells of which react by activity and formation of new matrix tissue. This will be referred to later under certain specific lesions. It should be remembered that for the growth of new matrix vascularity is required, so that vascularity as such is not inevitably the accompaniment of decalcification.

The stumbling-block to the acceptance of the specific role of the osteoblast has been heterotopic bone formation. Those bony masses which form after injury to bone, especially with haematoma, could be regarded as due to migration and proliferation of osteoblasts from the bone when they are in continuity with it. But the rare cases in which bone is found—for example, in old calcified areas in the aorta—are hardly capable of such explanation. In such case it is reasonable to assume that the fibroblast has ceased to maintain its usual specificity of forming fibrils, and has formed a more homogeneous or hyaline matrix wherein calcium has been deposited to give an appearance of bone. Calcification without the regular form of bone is the rule in old fibrous, hyaline, or necrotic areas. Heterotopic bone is much less common than would be expected if fibroblasts could form, normally, either bone matrix or connective tissue fibres at will: it is a rare reaction of the fibroblast, and is determined by its unusual circumstances.

It will be convenient to refer briefly to certain types of bony changes.

Inflammatory Lesions

The acute lesions, such as osteomyelitis, are too familiar to require any description. It is virtually an infarct of bone that forms with resulting necrosis from vascular interference. The only difference between bone and other tissue is its hardness. The dead portion lies, it may be for months, because of the difficulty of dissolving it away.

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Its calcium is much less easily removed than that of the adjacent living bone because its blood supply is gone. The adjacent tissues, fibrous and bony, react in the usual way, forming eventually scar tissue, fibrous and bony.

The chronic lesions, whether following an acute process or slowly developing without antecedent acute stage, have the same characters as those of soft tissue, plus the fact of calcium deposition in the exuberant matrix formed by the bone cells.

Atrophic, Hypertrophic, and Dystrophic Changes

Simple atrophic changes resulting from disease or from pressure call for no special comment. The changes are similar to those in soft parts, and are due primarily to a cutting down of nutrient supply with slow absorption of tissue and no replacement owing to the inactive state of the osteoblasts. Autolytic changes occur in bone as in other tissues, but are much slower and less evident, as the matrix and cells, which are the autolysing parts, are impregnated with calcium.

Hyperplastic changes are seen normally as a result of increased stress—the heavier and rougher bone of the muscular individual—or they may follow the stimulation of inflammatory change—for example, in periostitis. Dystrophic changes are of great interest, and constitute the features of several disease entities of known and unknown etiology.

Osteitis Fibrosa (von Recklinghausen)*

Osteitis fibrosa is now clearly related to overactivity of the parathyroid, and has become a disease dealt with by the surgeon with very satisfactory results.

As regards the tumour of parathyroid causing the hyperparathyroidism, there is no definite histological evidence that one type more than another is associated with overactivity. Castleman and Mallory have found in parathyroid tumours associated with bone change that there is no preponderance of any special type. I can corroborate this in a number of cases: in parts the growth are only clear cells, in parts only dark cells, in parts the eosinophil type, with all variations in number and grouping of these types. On the other hand, Hadfield and Rogers have recorded cases of parathyroid tumour not associated with bone change, although having all the histological characters of the tumours causing hyperparathyroidism. These discrepancies recall the thyroid variations: a large goitre may be associated with no hyperthyroidism, a small one may cause marked hyperthyroidism. It is a matter of amount or concentration of essential hormone. We do not, as yet, know the factors underlying parathyroid hormone production, concentration, or neutralization.

The bone changes in osteitis fibrosa need no description. The feature that impresses is the overproduction of matrix without deposition of calcium, and the removal of calcium from pre-existing matrix. It is an active process, with temporary remissions. A somewhat analogous picture can be produced in rats by intermittent doses of parathormone (Schour, Tweedy, and McJunkin) where zones of decalcification alternate with zones of calcification in teeth. Also in rats following large doses of parathormone there is first bone resorption with osteoclasts in excess; later bone formation with preponderance of osteoblasts. Very small doses seem to cause normal bone formation at once (Selye, Mortimer, Thomson, and Collip). The removal of the pituitary did not affect the result. Jaffe, Bodansky, and Blair found in rats on an adequate diet with high calcium that parathormone injections over a long period led to extensive osteosclerosis of the metaphyses similar

to that following ingestion of phosphorus. They interpret this as a healing phenomenon, compensatory to the parathormone.

The excessive osteoid formation in osteitis fibrosa is a compensatory change comparable to that seen in rickets, and in both it becomes the seat of calcium deposition when the cause of the calcium deprivation is removed. The hardness being reduced, the matrix bulk must be increased in an attempt to attain rigidity.

In the other conditions which lead to loss of calcium from bone—poor calcium intake, vitamin D deficiency, acidosis, etc.—we do not know what the effect is on the parathyroid. It is described as being enlarged in rickets (Pappenheimer and Minor) and in osteomalacia, but there is no information as to its functional state in these conditions. The analogy of the thyroid again suggests itself. A thyroid may be enlarged as a compensatory measure without producing any hyperthyroidism, but later, when conditions have altered, such large thyroid may become relatively overactive for the individual and so give rise to hyperthyroidism.

Osteitis Deformans (Paget)

Here again the bone changes are too familiar to require description. It is the interpretation and causation of these changes that invite discussion. This condition is often less widely distributed in the bones than osteitis fibrosa, and, for some obscure reason, the skull is often markedly affected.

The "mosaic structure" is sometimes stressed (Schmorl and Knaggs) as a feature of the bone histology, but this is also often present in osteitis fibrosa (Schmorl). While there may be great matrix overgrowth—for example, in the skull—there is much more calcium deposition in such matrix than in the osteitis fibrosa case. The experimental work of Jaffe and others, already referred to in this paper, shows that a somewhat similar picture may occur in rats under repeated parathormone administration.

In osteitis deformans no constant parathyroid change has been shown; occasionally slight hypertrophy is seen, and many writers regard these changes as secondary and not causal. Chemically, blood phosphorus and calcium are normal, but usually the phosphatase is increased (O'Reilly and Race). Removal of parathyroids (Snapper) has been done without effect on the disease. Administration of parathormone (Colt and Lyall) seems to have very little effect on the established disease, though slight amelioration of symptoms may follow. On the whole it is a much slower process than osteitis fibrosa.

As far as the actual bone changes go the tendency is to stress the differences between, rather than the resemblances with, osteitis fibrosa, but in essence they are similar, varying in degree. In osteitis deformans there is bone resorption and bone deposition, the latter predominating; there is decalcification and calcium deposition, the latter tending to outweigh the former. With our present means of investigation we can only say that there is no obvious endocrine disturbance and no obvious biochemical upset. Cases of this disease are regarded as rare, but I am told by the radiologists that they not infrequently see changes recognized as those of osteitis fibrosa when examining for other conditions. Such minor degrees of the condition require further study on metabolic lines.

I had the opportunity to examine in detail a case of osteitis deformans recently and summarize the findings. For the clinical details I am indebted to Professor W. T. Ritchie, and for the chemical findings to Dr. C. P. Stewart.

* See Hunter and Turnbull; Dawson and Struthers, etc.

Report of a Case of Osteitis Deformans

The patient was a married woman, aged 65, who was admitted to Professor W. T. Ritchie's ward on April 25th, 1933, and died on May 16th, 1933.

HISTORY

The patient had had an operation three years ago; this cholecystostomy was followed by sepsis requiring multiple drainage. She complained of symptoms of cardiac decompensation, breathlessness on exertion, and oedema of feet and ankles at night—of a year's duration. She also suffered from "heart attacks," characterized by palpitation, paroxysmal dyspnoea, and congestion of head and neck. There was a history of rheumatic fever in childhood. The patient had always been very stout, and had had a very large head since childhood. Her brothers and sisters were likewise affected, but to a much less extent.

EXAMINATION

Her height was 5 ft., and weight 16 st. 1 lb. She was very obese, the fat being mainly below the level of the diaphragm, suggesting hypopituitarism. The old operation scar could be seen. There was oedema of the legs and dullness at the bases of the lungs. The head circumference was 64 cm.; ear to ear, 17 cm.; maximum width, 18 cm. Ordinary examination of the urine revealed nothing.

Blood Chemistry.—(May 13th.) Phosphorus, 2.4 mg. per cent.; calcium, 9.4 mg. per cent.; sugar tolerance: 104 mg. per cent. (9 a.m. fasting); 175 mg. at 10 a.m.; 146 mg. at 11 a.m.; 121 mg. at 12 noon.

X-Ray Report.—(May 10th.) "The left tibia shows early osteitis deformans. Typical change in 5th L.V. and in horizontal ramus of left pubis."

POST-MORTEM FINDINGS

Abstract of Record.—Paget's disease of the skull (other bones examined later). Cardiac hypertrophy and dilatation. Chronic venous congestion of organs.

General Appearances.—The body was that of a grossly obese elderly female. A well-healed scar was present in the mid-line of the abdomen, partly above and partly below the umbilicus. The head was unusually large, and the features were coarse and angular. Some hair was present on the upper lip. The skull was enormous; in its thickest portion it measured nearly two inches, and was very heavy and of a fine red, spongy mesh. The meningeal vessels were buried in deep furrows, and the dura was adherent to the inner surface. In places white fibrous areas occurred in this spongy mesh. The outer surface was undulating. Similar fine-mesh bone formation occurred in the lower lumbar and sacral vertebrae, the iliac bones, and the lower end of tibia. In the femur, parts of iliac bones, the tibia, fibula, clavicle, and humerus there was a variable amount of coarse trabeculation, with increased space between the trabeculae. Microscopically the bones showed the typical appearances, with great variation in different parts. The "mosaic" appearance was in evidence in skull and elsewhere. In the skull were large areas of new bone, some rich in osteoblasts, some older and more dense; in parts osteoclastic reaction was marked: the marrow spaces were filled with fibro-cellular tissue, though, in parts, islets of marrow cells were still apparent.

Endocrine Glands.—Parathyroid: Only one, relatively large, was found. It showed the usual structure; the majority of the cells were mildly basophilic; among these were groups of clear cells. Thyroid: Congested. Mixed colloid and "active" type—many acini were atrophic. Suprarenal: Much of this appeared normal apart from congestion. Other parts showed small haemorrhages in medulla, also small lymphoid collections towards inner zone of cortex and in medulla. The cortex stained irregularly, many cells being clear or vacuolated, other groups either basophilic or acidophilic. A small cortical adenoma noted naked-eye consisted of irregularly arranged cortical cells. Pituitary: Congested, otherwise normal. The cells were mostly chromophil, being fairly equally divided between oxyphil and basophil. Ovary: Atrophic, with a few small follicular cysts.

A chemical examination of a portion of skull bone gave findings similar to those for normal bone.

There are many other bone conditions to which various names are attached and which have clinical features of

interest but which do not as yet lend themselves to more than mere morphological descriptions. They appear in the surgical literature rather than in the pathological. From the general point of view they may be grouped under the headings mentioned: inflammatory, atrophic, hyperplastic, dystrophic. Frequently the joints are involved and we get into that maze of chronic arthritis and osteo-arthritis. In many of these a factor is often overlooked, that of previous injury—mechanical, infective, or biochemical. In a paper by Milne this has been very well shown. The cartilage itself may be damaged or the underlying bone be affected; in either case the cartilage suffers. It tends to crack and become ragged; adhesions may form through the gap, or the bone becomes dense beneath. Added to this is the constant stress to which joint surfaces are exposed, and it requires little imagination to reconstruct the process that has resulted in the end-product of an ankylosed joint, or an eburnated, atrophic condyle, often with adjacent overgrowth where the factor of pressure does not operate. A full discussion of joint lesions, while it may certainly be included in the pathology of osseous tissue, would require a complete session to itself and we should still be searching for aetiological factors.

Local bone changes are familiar to all and are not infrequently found, unexpectedly, in routine pathological examinations. Single cysts in bone may be traumatic following a haemorrhage and local resorption of the damaged tissue. Occasionally these occur as small areas filled with mucoid tissue. They have no relation to the hyperparathyroidism, although in local mechanism their formation is the same as that of the osteitis fibrosa cysts. These local rarefying conditions of bone have been studied in detail by Dr. E. S. King, whose monograph will, I hope, shortly appear in print.

Local hyperplasias may be the result of a focal infection. In infective conditions, such as endocarditis, foci of infection may form in bone as elsewhere, and the result is ultimately a bone scar. The osteophytic growth sometimes seen in the inner table of the skull in eclampsia (Rokitansky; Greig) belongs to the same group, though the aetiological factor is obscure in such cases.

Tumours of Bone

It is the experience of every pathologist to find secondary deposits in bone which require the most careful search before the primary site is identified. Certain tumours labelled "primary" in bone, such as the "endotheliomas" and "endothelial myelomas," have been subjected to a critical analysis by Willis, and, as he rightly points out, it is unsound to diagnose any tumour of bone as "primary" until all the possible sites of origin have been excluded by complete examination of the body. It is common knowledge how the prostate may furnish numerous secondaries in bone from an insignificant primary growth. Again, the suprarenal may shed metastases which overshadow their origin.

The actual reaction of bone to secondary deposits follows general lines, though much individual variation may occur. The bone may melt before one tumour, and in the case of another both tumour and bone trabeculae may exist without apparently taking much notice of each other. This is not infrequently seen in the secondaries of breast carcinoma, where the tumour cells fill up the marrow interstices with little obvious change in the bony framework.

THE SKULL

In the skull an interesting reaction often occurs to the dural fibroblastoma (meningioma). When the tumour cells come into contact with bone they seem to excite proliferation of its cells, and bone formation occurs in a form of symbiosis with the tumour. Such growths may

penetrate through the vault of the skull, and the firm, even hard, nodule is excised in the belief that it is a simple exostosis. The histological examination reveals its nature. Cushing and Penfield have recorded this type of growth.

Recently I had the opportunity of examining a most unusual form of this condition. The patient was a young woman who died in the Simpson Memorial Maternity Hospital, Edinburgh, with a diagnosis of eclamptic fits. At the post-mortem there was found great thickening of the vertex of the skull. Externally there was a smooth rounding of the frontal region extending from the left frontal region upwards and backwards towards the right frontal and parietal regions, where it faded into the general contour of the skull. The skull cap was extremely hard and thickened, and corresponding to the surface prominence was a furrowed irregular overgrowth of the inner table. From the basisphenoid arose a projection like a mushroom, hard, with a softer cap. This pressed up into the brain without actual invasion. In the middle and posterior fossae were several small pits into which the dura projected. The brain, apart from the pressure effects and congestion, showed no other change. Microscopically the mushroom-like projection showed bone permeated and capped by meningioma. This had also penetrated the base of the skull into the ethmoid cells. The hard, dense frontal thickening showed only markedly sclerosed bone without tumour.

There are many features of interest in this case, especially the pits formed in the base of the skull, which we hope to deal with when more data of other cases have been collected; but for the present purpose it serves to illustrate intimate bone response to this type of tumour. (For the clinical data of the case I am indebted to Dr. Douglas Miller and Professor R. W. Johnstone.)

Of primary tumours those which excite most interest are perhaps the "benign" giant cell tumour, "Ewing's tumour," and the other varieties of myeloma.

The osteogenic group of sarcomas require no special reference. They are of more interest to the radiologist from the point of view of the variable amount of bone that may be produced by them and the erosion that they may occasion in their bone of origin. Or, owing to the vascularity of some, the problem of differential diagnosis from a primary vascular condition may arise. Pathologically this group varies in cellularity and in capacity for producing an osteoid matrix with accompanying variable calcification. Ewing's tumour—the diffuse endothelial myeloma—and endothelioma I have already referred to.

"Benign" Giant-cell Tumour

The "benign" giant-cell tumour had better shed its benevolent title, for there is ample evidence (see Willis) to show that many of these tumours give rise to metastases. That malignancy only occurs with change in the type cell of the tumour has been advanced (Simmons), or that the tumour was from the start an osteogenic sarcoma (Geschickter and Copeland). The fact remains that tumours diagnosed by competent pathologists as conforming to the "benign" giant-cell type have become malignant. Whether this is due to change of type cell, or to obscured osteogenic character, the practical point is that all such tumours should be regarded as potentially malignant, and not dismissed with the doubtful blessing of "benign." A case occurred recently which bears on this point.

The patient was a woman, aged 52, who some twenty years previously had what was described as a simple osteoma removed from the upper third of her left humerus; unfortunately no record of the histology was available. She remained free of all trouble till about a year ago, when she noticed a lump in the region of the former growth. She came under the care of Mr. Struthers—to whom I am indebted for the clinical record—who found a lump about the size of a hen's egg, firm and attached to the left humerus. At biopsy (on March 23rd, 1934) the growth was reported as a tumour of

somewhat atypical giant-cell type. The mass was irradiated but did not improve, and a second biopsy (July 17th, 1934) revealed structure similar to the first but with cells of malignant type. It was decided to remove the arm at the shoulder.

Portions from different parts of the tumour were later examined and critically compared with the previous biopsy specimens. Whole areas of the growth showed only numerous large giant cells of osteoclast type mixed with spindle cells; other areas showed an osteoid matrix, in places mixed with giant cells; the blood vessels were numerous in parts and thin-walled; haemorrhages occurred. The margin of the tumour was well defined by fibrous tissue. Besides the giant and spindle cells other cells, often with two nuclei, of varying shape occurred in some parts; these cells seemed of definite malignant type (see Dawson and Struthers). The arrangement of the giant cells of osteoclast type was interesting: in many cases they surrounded thin-walled vessels, which they seemed actually to be invading.

There were no enlarged axillary glands. The patient was discharged in good condition. Some six months later she was admitted with obvious advanced pulmonary involvement, and died. At necropsy a large mass with much haemorrhage and adhesion to the pleura was found on the right side; there was a haemorrhagic pleurisy, and the right lung was collapsed. In it were several firm, crisp, well-defined white nodules, some with haemorrhages in them. In addition was the haemorrhagic growth noted in pleura. The other (left) lung had a large similar tumour mass lying along the line of the interlobar septum and involving both lobes. Microscopically the tumour showed all the features of the primary, including the osteoclast giant cells.

It may be said that this was merely an example of an osteogenic sarcoma arising on an old osteoma and giving metastases in the usual way. This is admitted, but the point is that from biopsy alone certain samples of tumour were undoubtedly of the giant-cell osteoclast type similar to the so-called benign. Only examination of a number of sections served to show the mixed character. There were no metastases elsewhere than in the lung, and it is conceivable that the biopsy sampling may have set free tumour cells into the wide vessels. The giant-cell grouping is interesting and suggestive, and they cannot be regarded merely as foreign body giant cells in such a case.

Giant-cell tumours may occur from the "cystic" areas of osteitis fibrosa, and in osteitis deformans sarcoma has been reported (Bird). In both conditions there has been undue activity of osteoblasts, osteoclasts, and fibroblasts in varying degree, and the final neoplastic activity of one or more of these types is in keeping with the analogous neoplasia occasionally supervening on an old-standing cirrhosis of the liver.

The Myelomas

These, strictly speaking, should be omitted as they are probably purely of marrow origin and the bone is only secondarily involved as in the meningioma, but they so frequently occasion bone injury and are of so much importance from a compensation point of view that they are mentioned here. The tumour may be single, more often multiple, and its curious simultaneous appearance in many bones gives support to the view of its multicentric origin in such cases. The commonest type is the plasmacytoma.

Two recent cases of unsuspected myeloma may be briefly cited. The first was only discovered at post-mortem. The patient was a middle-aged man who, after an injury to his back, was in receipt of compensation. When proceeding by bus to draw his allowance he complained of the jolting of the bus and had to lie up afterwards. He was sent into hospital, developed a bronchopneumonia, and died.

At post-mortem examination the sternum cut easily with the knife; the vertebral column was also unduly soft and showed several cystic spaces and indefinite pale areas in many vertebral bodies. A white mass was present in the lumbar region, continuous with a vertebral body, and said to be at the area concerned in the original injury. Microscopical examination showed a plasmacytoma type of tumour in the

mass and in most of the vertebrae, also in the sternum but not in any other bones. In this case the injury, a blow on the back, would seem to have dislocated some of the already present tumour in the vertebrae and so formed a local mass outside of the bone but quite unnoticeable clinically.

The other case was somewhat similar but without any question of injury. There was a slowly progressive illness with bone pain and weakness over a period of over three years with remissions. At necropsy the sternum and the bodies of all the vertebrae were permeated with plasmacytoma growth.

Endocrine Disturbances

The effect of excessive action of the parathyroid has been referred to under osteitis fibrosa. The other endocrines affect the bones merely as part of their general body effect. In acromegaly the bones are enlarged, though with a curious distribution; in cretinism they suffer with the other tissues in retarded growth. The vitamin effects also arrange themselves into those either more special to the bone as in rickets, or more general as in scurvy, vitamin A deficiency, and so on.

There still remains the group in which heredity seems the only explanation—for example, foetal chondrodysplasia; suppression or fusion of bones, especially of limbs; osteogenesis imperfecta, etc. Of these we know little or nothing. That there is an urge to form bone after its species pattern has been beautifully demonstrated by Dr. Honor Fell, and by the moving picture, by Cantì, of her chick bones growing *in vitro* from the merest speck of tissue into the form and semblance of a femur without any stress or pull of muscle. When we know how that end is attained we shall be able to understand better the pathology of osseous and most other tissues.

Illustrations of the various conditions referred to were shown at the meeting.

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CARCINOMA OF THE COLON*

BY

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In regard to carcinoma of the colon the problem before the profession lies in the fact that the mortality following operations for it is high—much higher than that of other abdominal operations. It is therefore a subject which deserves our earnest study.

The following will give some indication of the actual operative mortality rate.

	Operative Mortality Per cent.
Wilkie ¹	15
Statistics from some hospital records (Australia):	
Distal colon carcinoma	31
Proximal colon carcinoma	41
Rankin ² (Mayo Clinic):	
Resections for growths in left side of colon, with clamp and enterotome	9.6
Gordon-Watson ³	17.7
Cheever ⁴	17.6
Saltzstein and Sandweiss: ⁵	
Distal colon carcinoma	57
Proximal colon carcinoma	39

In these statistics—and they are taken from well-equipped clinics of master surgeons—you will notice that the mortality rate ranges from 57 to 15 per cent. What, then, will be the mortality rate for the "occasional" surgeon, performing an occasional operation and working in ill-equipped hospitals? It will undoubtedly be high. In these statistics it will also be noticed that the operation mortality rate for the proximal colon carcinoma is nearly as high as that for the distal colon carcinoma. This high mortality rate for carcinoma of the proximal colon is, in my opinion, unusual.

A "Benign" Type of Malignancy

Carcinoma of the colon is low in the grade of malignancy: it is unusual for it to metastasize early, and it is slow to recur after it has been carefully eradicated. Thus the remote results of operation for carcinoma of the colon should be, and are as a matter of fact, good: Crafoord⁶ found that in 121 patients, of whom seventy-one had survived the operation, there were thirty-three five-year cures and fourteen ten-year cures.

It will therefore be obvious that if its operative mortality rate could be improved carcinoma of the colon would be the one malignant disease eminently curable by surgery. It is a problem in which we are all involved—general practitioner, physician, pathologist, radiologist, and finally the surgeon.

Cause of High Operation Mortality

Most of the deaths after carcinoma of the colon are due to peritonitis, or to some effect of a peritonitis, such as ileus. Infection, then, is the prime cause of deaths.

From the point of view of a surgical operation the peculiar, subordinate, and "cesspool-like" function of the colon places it in a different category from other parts of the alimentary canal, such as the intestine or the stomach. The important duties of digestion and absorption must necessarily develop in the stomach and intestines a viscus stable of structure, high in vascularity, and low in bacterial content—a tissue with conditions most favourable for good repair after injury. On the other hand, in the colon, and particularly in the

* Read in opening a discussion in the Section of Surgery at the Annual Meeting of the British Medical Association, Melbourne, 1935.