A Lecture

ON

TREATMENT OF MAMMARY CARCINOMA BY RADIATION.*

BY

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THE two objects of this article are, first, to describe how pathological observation shows that the whole of the breast itself should be radiated in carcinoma of that gland, and, secondly, to describe the method I adopt in delivering interstitial radiation to a breast containing carcinoma. Before embarking on these two subjects it is essential to make some observations on radiation of carcinoma in general.

Biological Effects of Radiation.

Treatment of carcinoma by radiation is in an exceedingly tentative and experimental state. All careful workers upon the subject deplore exaggerated hopes of success in all examples of carcinoma.

The energy discharged from a needle containing 1 mg. of radium element is terrific. At present we are judging our results from the effects of doses that may be a great deal too large and administered for too long a period at a time. If little or no result is detectable from a given dose, larger doses are employed, when, for all that is at present known, smaller doses frequently delivered in short periods at frequently repeated intervals might be more successful.

If Moppett's observations on x rays of different wave-lengths are correct they open up the question whether x rays may eventually prove of greater value than radium. Moppett has isolated wave-lengths that retard and those that stimulate growth. A proper manipulation of the wave-lengths of x rays that retard growth may replace all other forms of radiation therapy.¹

Boveri said that "normal cells produce malignant cells under the influence of x rays and radium and malignant cells in the same way (by means of x rays and radium) produce cells that are no longer able to live."² Radium emanation may also possess wave-lengths differing in the effects they induce. Boveri's statement would make the treatment of even a localized carcinoma a matter of anxiety were it not for the fact that the induction of carcinoma by means of radiation requires small doses spread over a very long period of life.

The success which external radiation has at present attained has been gained when the disease has been comparatively superficial and not deeply infiltrating, and also in the treatment of highly radio-sensitive tumours. Success of interstitial radiation has been attained when the carcinoma has been strictly limited to a localized area. In some instances, however, when these necessary provisions have been present, disappointments after external and interstitial radiation have arisen and damped the ardour of even the most enthusiastic practitioner. The failure in these instances may depend upon the error of underestimating the extent of the area that should be radiated. There are many other factors about which knowledge is at present incomplete; these are so little within our conception that all forms of radiation are thereby placed in a highly speculative position. When all the essential factors are known it must be hoped that they can be successfully applied or overcome as may be.

There remains the reverse side of the picture—namely, the application of radiation to those carcinomata that have spread to such a degree that the disease is no longer localized in the immediate area in which it began, but has spread more extensively in that area and has also reached other parts of the body. All means of radiation are at present unable to prevent the death of a patient in whom a carcinoma has reached these stages.

At this point it would be well to describe shortly what is meant by (1) external and interstitial radiation, and (2) the radio-sensitivity or radio-resistance of tumours.

External and Interstitial Radiation.

The method of external radiation is the application of the source of radiation at a distance from the affected parts. The source of external radiation may be either x rays or radium. External radiation can be delivered by the so-called radium bomb. On the Continent, where treatment by means of radium bombs has been compared with that by x rays, opinion on the whole does not consider that one method possesses greater sterilizing powers than the other, and that x rays are more generally and more cheaply available.

The method of interstitial radiation is the direct application of the source of radiation to the tissues so that it is in actual contact with them. The source of interstitial radiation is either radium element or its emanation. The interstitial application of x rays is at present impracticable.

Radio-Sensitivity.

The radio-sensitivity of a tumour is manifested by its regression after a given dose of external radiation. When rapid regression of a tumour occurs in these circumstances it is a radio-sensitive tumour. From this point of view the treatment of highly radio-sensitive tumours would be solved were it not for the fact that these tumours are usually the most malignant, and therefore are accompanied by wide and rapid diffusion over the body. Lymphosarcoma, carcinoma of the base of tongue, tonsil, and nasopharynx, and certain types of breast carcinomata belong to this category.

The rapid disappearance of a lymphosarcoma of the mediastinum or a transitional-celled carcinoma in the lymphatic glands of the neck after external radiation does not depend on the method of radiation so much as on the great radio-sensitivity of these tumours. Certain tumours that are not highly radio-sensitive regress under external radiation provided they are superficial and not too deeply infiltrating. The explanation of this fact is that the whole of these tumours is so close to the source of radiation that their resistance is overcome. Examples of squamous epithelioma and rodent ulcer come in this category. A highly radio-sensitive tumour will regress whether it be superficially or deeply situated, provided all its cells are within the range of external radiation. The cells of radio-sensitive tumours which cannot be reached by external radiation—that is, metastatic growths—are more likely to be inaccessible to interstitial radiation and also to the process of excision.

A tumour is described as being radio-resistant when it exhibits little or no signs of regression after it has been subjected to a given dose of external radiation. The subject of my paper—namely, carcinoma of the breast—as a rule belongs to this category. Nearly all malignant tumours, whether radio-sensitive or radio-resistant, regress on interstitial radiation, the reason being that the tumour cells of radio-resistant tumours are so close to the source of radiation that their resistance is overcome. External and interstitial radiation may induce the same changes or a modification of the same changes in the tumour, or the effects of an interstitial radiation may be more destructive in action.

Reaction of Surrounding Tissues.

While it is certain that the regression of a tumour after radiation depends on the effect of radiation on the tumour cells, there is also a considerable body of evidence that yet another factor involved is to be found in the reaction of the tissues in which the tumour lies. Dr. W. Cramer was the first to point out that the changes in the stroma which follow on radiation play an important part in the process which leads to the regression of the growth.³ More recently J. C. Mottram has adduced experimental evidence bearing on this point.⁴ He subjected transplanted tumours growing in mice to a dose of radiation known to be sufficient to produce regression of this tumour. He then transplanted these radiated tumours in gradually increasing intervals after radiation (one, two, three, four, five days, and so on) into fresh mice. He found that the tumours which had been removed and transplanted one or two days after radiation grew almost as well as a normal non-irradiated tumour, but if the irradiated tumours were

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removed and transplanted after a longer interval their growth in the new mice was at first much less active, and eventually they failed to grow altogether. This experiment shows that it was the prolonged presence of the radiated tumour cells in the organism of a radiated mouse which contributed to the lethal effect of radium. He attributed the effect on the organism of the host to an effect on the blood vessels. Other evidence which may be quoted is that of Russ, who showed that preliminary radiation of the skin inhibits the growth of a tumour subsequently transplanted underneath the irradiated area. Moreover, it is claimed that the dosage of radiation necessary to render the malignant cells of a transplantable tumour inert *in vitro* is much greater than that required to produce regression of the same transplantable tumour *in vivo*.

When it is considered that a trespassing malignant epithelial cell possesses no blood supply of its own, and that its maintenance depends upon the amount of nourishment it can obtain from the tissues into which it has trespassed, then the metabolic, biological, and trophic changes in these tissues may be of vast importance. The detrimental effect upon the radiated tissues in which the malignant epithelial cells are present has been ascribed either to deprivation of blood supply or to the constricting effect of cicatricial tissue that kills the epithelial cells by the pressure it exerts. There are many reasons that appear to me to render these explanations untenable. I will mention only one which seems to me to show that normal tissues can resist, at all events temporarily, the extension of rodent ulcer. The lines at which rodent ulcers often become arrested correspond to the boundaries of nerve areas.⁵ There is no mechanical, blood vascular, or lymphatic vascular arrangement that can arrest growth at these boundaries.

At present the precise relationship of this clinical observation to the failure of radiated tissues to allow the growth of transplantable tumours in them is not clear. The only merit of calling attention to the point is that it is another example of some inexplicable power possessed by the tissues of being able to resist the invasion of a growing epithelial tumour. I may say here that Dr. Cramer has produced experimental evidence that coincides with my clinical observations.⁶

RADIATION OF THE BREAST.

I will pass on to the first object of my paper and show how all my pathological investigations impress upon me the importance of exposing the whole breast to radiation, and not only that part of it containing the palpable lump. It appears to me illogical to radiate the axilla, subclavicular and supraclavicular regions, and intercostal spaces without radiating the whole breast itself. Clinical evidence alone cannot be trusted to indicate the area occupied by carcinoma in the breast. The only clinical feature that can possibly act as a guide to the area that should be radiated in the breast is the lump of disease in the gland.*

The lump in the breast consists of two parts that vary enormously in proportion to each other in different examples, and most frequently there is no clinical guide as to which of the two is predominant. The two parts consist of the primary epithelial neoplasm within ducts or acini, and the secondary epithelial invasion that has taken place from these sources. Frequently the lump consists chiefly of epithelial cellular invasion and a small area only of the primary growth. On the other hand, although the lump may be large the chief mass of it may consist of the primary epithelial neoplasm contained within normal but distended boundaries of ducts or acini. Even when the lump chiefly contains epithelial cells that are invading the connective tissue in the breast outside its ducts and acini, the primary epithelial neoplasia confined within normal boundaries may be more extensive than is generally supposed. It would

be fatal if radiation failed to include all the primary epithelial neoplasia within its sphere of action as well as all the invading cells.

Schimmelbusch's Disease.

At this point I must draw your attention to "Schimmelbusch's disease," unfortunately called by most people "chronic cystic mastitis." It is an important disease, because about 20 per cent. of all carcinomata begin in this lesion, which may be present in areas widely separated from each other in different parts of a breast.

The complete disease—that is, when carcinoma ensues—manifests itself in three decades in the patient's life. The first stage begins in the late 20 and early 30 years of life, and consists of a specific and typical desquamative epithelial hyperplasia. In this stage there is only the formation of cysts. The second stage corresponds to the late 30 and early 40 years of life; the desquamative process now begins to change, and when completed has actually changed into a benign epithelial neoplasm. At the end of this stage papillomatous tumours and tumours devoid of connective tissue elements fill and distend the affected ducts and acini. The third stage has been reached when usually at one part only the epithelial neoplasia has passed into the state of carcinoma, from which epithelial cells invade tissues outside the normal boundaries of ducts and acini. This fatal alteration in the nature of the epithelial neoplasia begins in the late 40 and early 50 years.

Schimmelbusch's disease may be confined to a small area of terminal ducts and their acini, or it may involve the whole tract of only one large duct, all its branches, and their acini. Moreover, two or more areas may be affected microscopically in the same breast. Clinical evidence of the extent of the area occupied by this disease is unfortunately very obscure and untrustworthy. From many points of view Schimmelbusch's disease is of practical importance in its relation to the area of a breast that should be radiated. It is true that it conforms to the usual experience in carcinoma of the breast in general—that is, that carcinoma as a rule appears in only one part of a breast, although epithelial cells may escape from the primary epithelial neoplasia in ducts and acini from many foci in that part.

I have specimens of only three breasts suffering from carcinoma arising in more than one segment. In two of these this multicentric origin occurred in Schimmelbusch's disease situated in widely separated parts. In the breast of the remaining specimen there is no sign of Schimmelbusch's disease.

Reasons for Radiating the Whole Breast.

It may be urged that, if carcinoma so commonly begins in only one part, why should it be so essential to radiate the whole breast? There are three reasons. First, it is impossible to say how far the escaped epithelial cells have disseminated in the breast; secondly, there may be other unknown parts of the gland which may contain epithelial neoplasia still confined within normal boundaries, and which in the course of time may end in carcinoma; and, thirdly, upon clinical examination alone it is rarely possible to know whether the carcinoma began in Schimmelbusch's disease.

It might be argued that, carcinoma having occurred in one place, epithelial neoplasia is not likely to become malignant in another. Dr. W. Cramer was the first to show that when a tar carcinoma has been removed from one part of a tarred cutaneous surface, a fresh focus of carcinoma may rapidly appear in another part that was previously not carcinomatous; and Dr. A. Leitch has shown that a limited application of tar which produces no immediate result may be followed at a long interval by carcinoma. These experiments convince me that it is not safe to leave in the breast an epithelial neoplasm that may be or may become malignant. From what I have said about the decades of life in which the sequence of events occur in the complete Schimmelbusch's disease, it can be understood that the occurrence of carcinoma in another focus of Schimmelbusch's disease in the same breast may take a considerable time in developing. Everything points to the necessity of radiating the whole gland, and not only the part that is clinically carcinomatous.

* Fallibility of clinical signs also applies to the axillary regions in fat and thin women. In thin women the failure to detect enlarged lymphatic glands in the axilla is an indication of importance that they may be free from carcinoma. It is not an infallible test, however for, as I have pointed out, the axillary lymphatic vessels at the point where they pass over the upper limit of the first rib may contain carcinoma when all the lymphatic glands in the axilla are free from the disease. It is a rare condition.

The remaining point that arises is that if radiation of the whole gland is indicated when Schimmelbusch's disease has ended in carcinoma, then why not radiate the whole of all cystic breasts as a preventive measure? I agree that if radiation is proved to be a successful form of treatment in epithelial neoplasm which is not malignant, the answer to this question would be that a complete radiation of all cystic breasts would be a wise precaution.

I have five breasts that bear upon the necessity of radiating the whole and not a part of the breast in carcinoma of that gland. The five breasts are rare examples of the disease. In all of them the whole epithelium of the breast in all the larger ducts, their branches, and their acini, has undergone epithelial neoplasia of a malignant-looking type. In the first specimen the whole of the epithelial neoplasia has undergone regression, and there is no microscopical evidence of carcinoma in the gland. The breast was thin, yet there was no clinical evidence of any pathological change in it.

The second specimen was also a thin breast. The whole of the epithelial neoplasia which looked malignant had undergone regression, except at one part where carcinoma had occurred and spread to a lymphatic gland in the axilla. The state of this lymphatic gland was the only clinical evidence that there was anything wrong with the breast.

In the third specimen the epithelial neoplasia has not undergone regression at any part, and from one duct, its branches, and its acini, epithelial cells have escaped and become diffuse over one quadrant of the gland, and also have heavily involved the rest of the body. The epithelial neoplasia, which affected the whole gland, gives all the morphological appearances of being of a highly anaplastic type. The extensive widespread diffusion of its cells confirms the morphological appearances. Clinical evidence of the carcinomatous part was abundant. There was no clinical evidence of the pathological state elsewhere in the breast.

In the fourth and fifth specimens the whole of the breast epithelium has been replaced by carcinoma, and the morphological appearances suggest that the whole of the epithelium of the breast has become carcinomatous. There was also widespread diffusion over the body, although the morphological appearances were not of so highly an anaplastic type as that in the third specimen.

There are many early examples in which radiation of the part of the breast that contains the lump would probably include the epithelial neoplasia in the terminal ducts and acini as well as the mass of invading cells that have escaped from it. There are no clinical signs that can indicate to the operator whether he is or is not dealing with such a localized distribution of disease.

Many examples occur in which radiation of the part of the breast that contains the lump would certainly not include either a dangerous-looking epithelial neoplasia in ducts and acini or the cells that have invaded the connective tissue of the breast outside them. For example, the lump in the breast illustrated in Fig. 1 was clinically recognizable as being a large one, and the enlarged glands in the axilla confirmed its carcinomatous state. There was no clinical evidence of extension of the dangerous-looking epithelial neoplasia in the ducts and acini that extended to the limits of the breast in the opposite direction. The epithelial neoplasia inside these ducts and acini has undergone gelatinous (colloid) degeneration, and there are also carcinomatous cells in the connective tissue outside them.

It may be said that it is exaggerating matters to found a system of radiation upon advanced cases of this kind. The answer to such a criticism would be: first, that there are no clinical signs by which a localized carcinoma can be distinguished from one that is diffuse; secondly, for all that is known the extent of the disease may have been always widespread and the lump a later manifestation; thirdly, evidence of wide extension is detectable only by microscopical examination; fourthly, there is no general correlation between the extent of the area occupied by the disease and the size of the lump or the length of time it has been noticed.

Clinically Undetectable Tumours.

I pass on to another clinical type of carcinoma of the breast which will arise in treatment by interstitial radiation. The example is as follows.

The woman was 42 years old, and a tumour she had noticed in her right axilla had been removed and proved microscopically to be carcinoma in a lymphatic gland. The woman was fat, and there was no clinical sign of a tumour in the breast. The right breast and the rest of the axillary glands were removed, and microscopical sections were cut of the whole breast. At the margin of the gland the carcinoma was discovered after many

whole sections of the breast had been cut and examined; it conformed to the general contour of the gland, and malignant-looking epithelial neoplasia also occupied a wide tract in the affected duct and its branches.

In this particular instance the tumour in the breast could not be detected by clinical examination. It was discovered during a complete microscopical examination of whole sections. Belonging to this clinical type are those instances in which enlarged axillary lymphatic glands lead to the detection of a very small primary tumour in the breast after a careful clinical examination. Radiation of the breasts belonging to this type may be considered from the following point of view. The rapid and wide diffusion of the growth indicates the presence of a highly anaplastic tumour, and therefore probably one that is radio-sensitive and would regress under external radiation. I should regard this particular clinical type as being an example in which treatment by external radiation should be first attempted, for the following reasons. The cases are inoperable from the point of view of cure. Sometimes breasts belonging to this clinical type weigh 3½ pounds. Interstitial radiation of these breasts would necessitate a dose that might be constitutionally dangerous as well as difficult to apply, and there is the clinical indication that the tumours belong to the radio-sensitive type.

A hard, solid, defined lump beside the nipple, and making it lean to one side, is generally a sign that the chief part of the breast is occupied by carcinoma. The following case is of practical importance.

The woman, aged 42 years, was married; she complained of an intermittent spontaneous discharge of blood from the nipple, beside which was a lump pushing it to one side. Whole microscopical sections proved that the lump beside the nipple was a metastasis from a carcinoma originating in the terminal ducts and acini at the outer margin of the gland, the presence of which was not indicated by any clinical signs. There was also a dangerous-looking papilloma, the cells of which were still confined within normal boundaries in the main branch of the duct leading into the carcinomatous epithelial neoplasm in its terminal branches and acini. This was the source of the metastasis beside the nipple and the haemorrhage from that structure. The complete radiation of this breast could have offered the only chance of success by means of that treatment.

Paget's Disease of the Nipple.

The evidence revealed by the systematic examination of whole microscopical sections made from the underlying breast in Paget's disease of the nipple proves that carcinoma can be present in breasts without causing a lump or any sign of its presence, and without any axillary lymphatic glandular involvement. A proportion of breasts underlying Paget's disease of the nipple contain no carcinoma, but, so far as my experience goes, they all somewhere contain a dangerous-looking epithelial neoplasm, sometimes in a large duct and at other times in distended terminal ducts and acini in two or more parts of the breast. The only wise plan is to subject the whole of all breasts suffering from Paget's disease of the nipple to interstitial radiation if they are to be radiated at all. I am speaking of the treatment of the underlying breast only in Paget's disease of the nipple. I do not know whether the cutaneous disease is affected by radiation. External radiation by means of x rays was quite unsuccessful in one case of mine.

Radiation versus Radical Operation.

The axillary, supraclavicular, and intercostal regions and the subcutaneous tissue of the chest should be radiated in every case, however localized to the breast the disease appears to be. The radical removal of an operable carcinoma of the breast will always be safer than an inadequate radiation of the gland. By the radical operation the whole of the carcinomatous area will be removed with certainty, and so will all potentially dangerous epithelial neoplasia that may exist elsewhere in the breast. There are, indeed, many observers who believe that in the present state of knowledge and experience the surgeon who embarks upon interstitial radiation only of a breast in which carcinoma is possibly completely removable, is taking upon himself a great responsibility. This statement will meet with general agreement. On the other hand, the treatment of carcinoma of the breast by means of radium will be of

comparatively little use unless it is completely successful in the sterilization of the earliest phases of carcinoma in that gland. I have begun my investigations in this subject by buying radium of my own and using it in a tentative manner upon those patients with early carcinoma who refused excision and those who were physically unfit on account of age or decrepitude for an operation of great magnitude. The results of five cases I have been able to treat so far support the conviction of Mr. G. L. Keynes,⁷ who believes that interstitial radiation is the operation of choice in the treatment of early carcinoma of the breast. So far as my experience has gone—and it has lasted only a few months—the tumours in the breast have melted away and have left no signs of their previous existence.

Secondary deposits in tissues outside the breast sometimes seem to be more obstinate in their resistance to interstitial radiation. It may not be that they are more radio-resistant. Their failure to disappear may be due to inefficient radiation. Radiation of secondary deposits is not so practicable, nor is it always possible to radiate safely and at the same time efficiently. The evidence thus gained may in the course of years lead to decisive conclusions. The final treatment by radiation will emerge after experience gained by the use of external radiation alone, of interstitial radiation alone, and by the combined use of external radiation and interstitial radiation.

Before considering the definite treatment of a carcinoma of the breast by means of radiation, the question arises whether a preliminary test of its radio-sensitivity by means of external radiation should be made. In the first place, if a tumour regresses rapidly after external radiation there is no need to consider the application of interstitial radiation, and excision is definitely contraindicated. The disease being highly radio-sensitive indicates that it is also highly anaplastic, and has therefore spread beyond all reach of surgical procedures. On the whole, the fact that so few carcinomata of the breast are radio-sensitive suggests that it would be wasting valuable time (about three weeks) to subject them to this preliminary test.

INTERSTITIAL RADIATION OF BREAST TUMOURS.

The present aims of interstitial radiation by means of the radium element are as follows: (1) To arrange the needles so that a small dose can be delivered evenly over the whole gland for a comparatively long time. (2) To arrange the needles so that the dose of radium element they contain cannot damage the skin to a great degree. Damage cannot be avoided in all instances. (3) To examine the blood before treatment so that the result of the examination may act as a standard by which subsequent changes may be estimated during treatment. The relevant data are the number of lymphocytes and polynuclear leucocytes, the shape, size, and number of red blood corpuscles, and the amount of haemoglobin. (4) The x-ray photograph of a chest may indicate the extent to which it may be involved by metastases.

The most difficult object to attain is the uniform distribution of the dosage. The breast is often a very mobile gland, and needles inserted with the breast in one position may be entirely disarranged when the breast assumes another position. The best method I find of controlling this disadvantage is to support a mobile breast in position while the needles are being inserted. An assistant holds it up in position by means of his thumbs and forefingers. Afterwards, if the breast is not kept in position by the needles themselves, it is controlled by means of carefully applied strapping.

The size of the breast affords another problem in interstitial radiation. A breast weighing $2\frac{1}{2}$ to $3\frac{1}{2}$ pounds consists chiefly of fat, and the glandular elements may be scattered in branches of connective tissue that are widely separated from each other by adipose tissue, or the gland may be more compact and an enormous collection of fat may surround it. There are no clinical means by which the arrangement can be discovered. The dosage of radium element to so large an area might be more than the blood could tolerate with safety unless it were administered piecemeal. In inoperable carcinoma of this kind I have adopted either this piecemeal treatment or I advise treatment by external radiation, hoping that the tumour may be radio-sensitive.

Technique of the Method.

At the present moment I possess 80 milligrams of radium element, distributed in twenty-nine needles varying in length. The radium element is distributed as evenly as possible throughout their whole lengths. Their filtration is 5 mm. of platinum.

3 needles	$8\frac{1}{2}$ cm.	of active length containing	5 mg. each.
6 "	7 cm.	" " " "	4 mg. "
7 "	6 cm.	" " " "	3 mg. "
7 "	$4\frac{1}{2}$ cm.	" " " "	2 mg. "
6 "	3 cm.	" " " "	1 mg. "

I make a great point of first fixing the ultimate position of the three longest needles. They are always inserted as the central needles of the bottom layer. They are too long

FIG. 1.—Whole microscopical section of an inoperable carcinoma of the breast. A, The nipple. B, The final position of the top of the radium needle inserted through the centre of the nipple. The radiation from this needle will include the disease if it has spread into the lymphatic vessels around the ducts or in the muscular walls of the ducts. In this specimen these regions are free from disease. C, The lump that was clinically obvious. D, The submammary connective tissue. E, The epithelial neoplasia contained in ducts and acini which looked malignant and in parts had undergone gelatinous (colloid) degeneration. F, The pectoralis major.

and slender to place in position without the aid of trocar and cannula. I have three of the latter. I introduce them and keep them in position while I insert the rest of the bottom layer of needles. All the needles in the bottom layer are inserted parallel to each other in the posterior part of the breast, so that subsequent radiation will include the posterior part of the breast, the submammary connective tissue, and upper fibres of the pectoralis major muscle.

FIG. 2.—The arrangement of the bottom layer of needles in large inoperable case of carcinoma of the breast.

In the next layer the needles are arranged parallel to each other and at right angles to the bottom layer. Whether three layers of needles are inserted depends upon the size of the breast. The centre of the nipple is perforated by a needle which is left in such a position that the situation of its eye corresponds to the base of that structure. Special attention is paid to the lump by passing additional needles through it and around its circumference. Lastly, the three long needles are passed into the three cannulae, which are then withdrawn, leaving the needles in position.

In order to help me gauge the number of needles and the position they should occupy I adopt the following method. I measure the circumference of the breast and mark the measurement on a clay surface. I have twenty-nine cylindrical blocks of wood which correspond in length

and circumference to the area of radiation of each of my needles. The size of these blocks of wood represents an area of 1 cm. in all directions. By arranging these blocks of wood I can estimate very nearly the number of needles I shall require, their position, and their distances from one another.

FIG. 3.—The second tier of needles arranged at right angles to those in Fig. 2, and the position of the needle in the central position among the upper ducts.

Figs. 2 and 3 represent the position of the needles in a recent attempt I have made to radiate the whole of a large breast that contained an inoperable carcinoma. The breast was so large that all my needles were employed upon the breast alone. The disease that had spread into other regions was radiated at a later time. As experience proceeds I am more and more tempted to fix the position of the needles by a preliminary insertion of cannulae. Fig. 2 represents the distribution of the bottom layer of the blocks, and Fig. 3 the distribution of the upper layer and the position of the needle inserted via the nipple (see B, Fig. 1). The blocks representing the distribution of the needles to the tumour in the breast are not shown.

Turning to interstitial radiation alone in the treatment of an excisable carcinoma in the breast, the problem seems to me to resolve itself into two chief questions: (1) Can a whole breast be efficiently radiated by this method? (2) Will time prove whether the regressions of the tumours are permanent?

Turning to the treatment of an excisable tumour, there can be no doubt that the properly conducted operation removes the disease, the breast, and a great deal more tissue than is necessary if the disease be completely limited to the breast, a state of affairs that is unrecognizable clinically. So far as subsequent microscopical examinations, together with clinical histories, can prove the existence of such localized carcinomata, I consider that tumours of this kind have been completely excised.

Finally, I desire to pay my tribute of gratitude to the pioneer work of Mr. G. L. Keynes,⁷ to which I have already alluded, and to the work of the staff of Westminster Hospital.⁸ I owe Dr. W. Cramer my thanks for his kind assistance in the experimental evidence contained in this article.

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THE MECHANISM AND TREATMENT OF PROSTATIC OBSTRUCTION.*

BY

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THE French urologist Legueu recently remarked that in the domain of urology the mechanical element plays an unimportant role, and that it is to the dynamic element that we must devote our attention if we wish to understand why an organ has ceased to function satisfactorily. There is no better example of this than that supplied by a study of the pathology of hydronephrosis. For years we have been trying to explain cases of hydronephrosis mechanically, and often we have been sorely puzzled because, although we could find a mechanical obstruction to the passage of urine in a great number of cases, there were others in which, search as we might, no obstruction could be discovered. Abnormal renal vessels, adhesions around the ureter, and ureteric strictures were pressed into the service without avail; there still remained cases of hydronephrosis that could not be explained. And then, with a change in our mental attitude and an increase of refinement in our methods of examination, it became apparent that the structural alterations in the kidney, known as hydronephrosis, might be the effect of a disordered function of that organ. By pyeloscopy it was shown that a disturbance of the peristaltic reflex, that propels the urine from calyces to pelvis, and pelvis to ureter, might lead on to the development of a hydronephrosis, and that, in the words of Legueu, dynamics rather than mechanical obstruction explained its etiology.

It has occurred to me that it might be interesting to apply the lesson that we have learnt from hydronephrosis to the study of prostatic obstruction. Is it possible that in addition to the mechanical there is also a dynamic or neurogenetic factor in the causation of retention following prostatic enlargement? The subject is too intricate to allow of its full discussion in this short paper, but it will nevertheless be of interest to touch on a few salient

points. As an introduction it will be advisable to deal first with the mechanical theory of prostatic obstruction.

The Mechanical Theory.

On one point all authorities agree—namely, that no relation exists between the degree of enlargement of the prostate and the severity of the symptoms it occasions. Formerly an attempt was made to explain this anomaly by blaming the middle lobe. It was said that when retention was caused by a prostate which on rectal examination felt only slightly enlarged, the retention was the result of a hypertrophied middle lobe that was pressed down on the internal meatus in the manner of a ball-valve. But a more careful study of cases of prostatic obstruction has shown that the middle lobe is of less importance than was formerly supposed, and that in a great many cases of retention it does not exist. Moreover, as Swift Joly has pointed out, the type of micturition that occurs when an undoubted ball-valve exists, say, in the shape of a pedunculated papilloma growing at the bladder neck, is quite different from that observed in cases of prostatic obstruction. In these true ball-valve cases micturition is either impossible or else unimpaired; there is never, as with prostatic enlargement, only a moderate degree of difficulty.

The ball-valve explanation of retention being unsatisfactory it is necessary to find another. Many theories have from time to time been put forward, but to my mind the most satisfactory is that published by Swift Joly in the *Proceedings* of the Royal Society of Medicine of 1923-24. This theory aims at explaining the retention that follows enlargement of the prostate by the ordinary laws of hydrostatics, but in order that it may work two conditions must be present. The first condition that must be satisfied is that there exists an intravesical projection of the growth which raises the internal meatus above the level of the bladder base; the second, that the tissues are sufficiently soft and free from infiltration to allow of their being moulded by slight alterations of intravesical pressure. Granted these conditions, Swift Joly explains retention by the action of urinary pressure on the intravesical projection. He points out that the increase of pressure caused by contraction of the bladder is exerted at right angles to its walls. It is therefore directed downwards and inwards towards its axis—that is to say, towards the

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