THE RADIUM PLAQUE TREATMENT OF MALIGNANT DISEASE.

With Reports on a Series of Cases, and a Survey of the Literature.

Thesis for the Degree of Doctor of Medicine

by

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C O N T E N T S.

I.

INTRODUCTION.

Until a few years ago the treatment of malignant disease was almost exclusively surgical in nature, and the underlying principle was the total removal of the neoplasm. The presence of secondary deposits of any kind, rendered surgical intervention futile in the great majority of cases, and patients with a primary carcinoma and metastases were given a uniformly hopeless prognosis.

More recently, the addition of Radium to the therapeutic armamentarium has diminished the scope of surgery very considerably, and in numerous instances has rendered operative procedures unnecessary, since a large variety of malignant lesions, both superficial and deep, are readily amenable to surface radiation. In certain situations radium has entirely replaced surgery, while in hopelessly inoperable cases it has effected a considerable prolongation of life. No case is so advanced that it need remain untreated, and where total regression of the disease cannot be obtained, it is frequently possible to alleviate the patient's condition and secure a return to work for a variable period.

At the present time Radium Therapy is sharply divided into two methods of irradiation. I. Interstitial Radiation and II. Surface Radiation.

I. Interstitial Radiation consists of the introduction of radium salts or emanation in needles around the tumour and lymphatic area. It is essentially a surgical procedure, requiring in some instances a special operation of access, and a highly developed surgical technique. Interstitial radiation per se is not dealt with in any way in this thesis, except in so far as many of the cases quoted had previously received this form of treatment and were referred by the surgeon to the author for plaque treatment of recurrences or secondary deposits.

II. Surface Radiation may be sub-divided into two separate classes:-

(a) "Mass" or "Bomb" radiation, and
(b) Radium Plaque Treatment.

"Bomb" radiation consists in the application of massive quantities of radium concentrated in a small space, and kept at a relatively large distance from the skin. "Bomb" therapy has had a somewhat chequered career in this country. As early as October 1919 a bomb containing 5 grammes of radium bromide (equivalent to 2½ grammes of radium element) was installed at the Middlesex Hospital, and was in constant use until April 1921, when it was broken up. Lazarus Barlow (1) and MacLeod (2)

have reviewed the results obtained, and both writers comment very unfavourably on this method of treatment. Later a 4 gramme bomb on loan to the Westminster Hospital was broken up by the National Radium Commission, and their action was approved by the Interim Report of the Conference on Radium (3), but one year later the Final Report of the Conference on Radium (4), reversed this decision and stated that "It is desirable that a radium unit containing not less than 5 grammes of radium element should be established immediately". This 5 gramme unit is now in course of construction at the London Radium Institute (5). Furthermore Berven (6) and Cade (7) report excellent results from the use of 3 gramme and 2 gramme bombs respectively. In this chaotic state of opinion the whole question of bomb therapy must be regarded at present as sub judice.

The alternative method of surface radiation - Radium Plaque Treatment - forms the subject matter of this thesis, and the foregoing serves to show the relation which plaque treatment bears to radium therapy as a whole. Radium plaque treatment consists in the application of radium at a short distance from the skin, the radium being contained in specially constructed applicators, or distributed on the surface of a layer of rubber or specially prepared pastes. In the majority of the cases here quoted, the distance between radium and skin was standardised at 15 millimetres, and various media were

devised to maintain the radium constantly at this distance, while different varieties of screens were introduced into these media in order to protect the skin from an unduly severe cutaneous reaction. The direct application of unscreened radium to the skin surface has long been discontinued on account of the intense cutaneous erythema (often followed by sloughing) which occurs before a lethal dose can be administered to the malignant cells of a deeply seated tumour. Consequently it has been the aim throughout this work, to design the plaques in such a manner that the maximum dose of radiation might be administered to the deeper tissues with the minimum disturbance to the skin.

As a member of the staff of the Mount Vernon Hospital, London - an institution entirely devoted to the radium treatment of malignant disease - the present writer has been entrusted with the design and construction of the plaques used therein, and with the supervision of all the patients undergoing plaque treatment, and this thesis represents the results of a series of investigations carried out in that institution and in The Royal Infirmary, Glasgow.

The Radium Plaque Treatment of malignant disease as defined above, has not received the same degree of attention in this country as on the Continent. As Fitzwilliams (8) points out, lack of radium in this country has greatly hampered us in developing plaque therapy, while in Paris where

radium is almost unlimited, this method has been used with some success.

In the year 1931 when this work was first commenced, a study of the available literature very soon revealed the fact that little or no attempt had ever been made to treat the more deeply seated tumours by means of radium plaques. The treatment of rodent ulcers and skin cancers by plaques had been successfully undertaken from the very earliest days of radium therapy and an extensive literature was available giving full details of the appropriate technique, but if it was desired to treat a more deeply seated neoplasm, such as a brain tumour or a recurrent carcinomatous mass, only the scantiest information was obtainable. It has consequently been the aim of this investigation to devise suitable methods by which a lethal dose of radiation could be administered to the cells of a deeply seated tumour, without producing radium necrosis of the skin. A large variety of plaques and radium applicators have been specially designed with this end in view, and it will be shown that an entirely different technique is required to treat a deeply seated growth and a skin lesion.

This thesis then, is primarly concerned with the treatment of the more deeply seated lesions, and an analysis is given of a series of 109 such cases, all treated with radium plaques; skin lesions have been excluded from the series, as the value of radium plaques in skin cancers is not in doubt,

and the methods of treatment are well known, whereas hitherto very little attention had been paid to the plaque treatment of the deeper lesions.

Every patient in the series of 109 cases has been most carefully "followed-up" for a minimum period of at least two years and the results obtained represent a clear two years survival rate, therefore the technique employed is that which was devised over two years ago for the treatment of non-superficial malignant disease. Furthermore, two years, was regarded as being the minimum period required to form a reliable estimate of the value of the methods employed, but at the same time it was believed that if the treatment relieved pain, or enabled the patient to return to work, then it had at least justified itself as a therapeutic medium. No comparison with the results of surgery is possible, since almost without exception the patients had been referred by the surgeons for plaque treatment on account of the inoperability of the growth.

The question of the irradiation of deeply seated tumours, and the results obtained, will be dealt with in the following order:-

(1). The history and development of the radium plaque to present day methods.

(2). The pathology of irradiation and of the various types of tumour treated.

(3). The technique which the writer has devised for the present series of cases.

(4). The results obtained in a series of 109 patients.

(5). Discussion and comparison of results.

(6). Bibliography.

(7). Appendix, with notes of cases. These notes have been somewhat abbreviated as regards history, but full detail is given of the condition both before and after radium treatment, and in each case the radium technique and dosage is given in full.

II.

HISTORY and DEVELOPMENT.

The Discovery of Radium.

In the year 1895 Röntgen (9) published an account of his discovery of X-Rays together with a description of how they might be produced by means of an electrically charged vacuum tube, and conclusively proved that X-Rays were produced by the arrest of particles of the cathode stream. This discovery aroused the most intense interest, and gave rise to the question, - do any natural substances exist which spontaneously emit X-Rays without the assistance of electrical devices?

A search for such natural substances which would emit rays akin to X-Rays, was rewarded one year later by the discovery of Niewenglowski (10) who found that calcium sulphide on exposure to sunlight gave out some rays which penetrated black paper and affected a sensitised plate. A similar result was obtained by Becquerel in 1896 (11) while examining substances which were known to phosphoresce under the influence of light and he found that uranium in this capacity not only became phosphorescent but the effect lasted some time after exposure. A positive result was obtained on exposure to a photographic plate and this was true when the substance had not previously been exposed to the sunlight. Such substances emitting rays

spontaneously were termed radio-active.

After the discovery of spontaneous radio-activity all the other known elements were investigated in turn, but only one, Thorium, was found to possess this property. This discovery was made independently by Schmidt (12) and M. & Mme. Curie (13). The Curies continued their work and while examining a number of uranium minerals, including pitchblende, they noticed that this was much more radio-active than its uranium content justified. M. & Mme. Curie therefor concluded that pitchblende must contain, besides uranium, some very strongly radio-active substance, and they succeeded in isolating a previously unknown element to which they gave the name of "Radium". This discovery was communicated to the French Academy of Science in 1898 (14). Incidentally, and by the same process, two other radioactive bodies were discovered; polonium by Madame Curie and actinium by Debierne (15) and Giesel (16). Polonium and actinium are both more radio-active than radium, but are difficult to isolate in a pure and stable form, consequently they have not been subject to the same degree of commercial exploitation as radium.

Discovery of Biological Effects of Radium.

In 1901 Becquerel accidentally carried about a tube of radium in his waistcoat pocket, and some days later noticed that a severe inflammation of the skin had appeared. Pierre Curie repeated this experiment on himself and both observers

noted the caustic action of radium and concluded that the biological effects of X-Rays and radium were similar (17). About the same time Walkhoff (18) and Giesel (19) drew attention to the fact that radium produced a similar action to X-Rays upon the skin by causing a local inflammation followed by necrosis and ulceration. Following upon his self-inflicted radium burn Pierre Curie lent a small quantity of radium to Danlos for clinical use at the St. Louis Hospital in Paris, and Danlos (20) published an account of his work, which showed that a satisfactory clinical result might be expected from the use of larger quantities of radium.

In 1903 Halkin (21) described in some detail the histological appearances of the skin at different periods after irradiation, by experiments on the skin of animals. These were later confirmed by Thies (22), Dominici (23) and Guyot (24).

The value and understanding of the action of alpha, beta and gamma rays on tissues were not realised until 1907 when Dominici (25) began to screen off the alpha and beta rays with lead, and he published a paper on the treatment of cancer by means of gamma irradiation in 1907. This was exactly eight years after the report of the first skin cancers cured by radium by Senbeck of Stockholm in 1899 (26) a paper which had been unaccountably ignored until in 1904 Werner and Herschel (27) published results of their treatment on twenty-one patients by radium.

Although the cure of cancer was the aim of most of the early experimenters, attention was drawn to the action of radium on normal tissues, and to its action in some of the non-malignant conditions. In 1903 Halkin described the action on blood vessels; Thies (28) of the effect on the spleen of guinea pigs and white mice; Horowitz (29) of the extreme sensitiveness of the spleen, bone marrow, and lymphatic system towards radium in 1905; and by Heinke (30) on the spleen and lymph follicles in 1913; and by cases recorded by Renon, Degras, and Thibaut (31). Exophthalmic goitre was treated as early as 1916 by Quigley (32); Hodgkin's disease by Bowing in 1921 (33); and the leucaemias and pernicious anaemia in 1926(34).

Furthermore, Petit (35) has actually advocated and reported upon the use of intravenous injections of radium sulphate in the treatment of various morbid psychoses. Versatility in the use of a therapentic medium can surely go no further.

Development of the Radium Plaque.

The radium plaque as used to-day has been subject to numerous changes as the physics of radium became better known. Radium treatment by plaque aims at (a) a fixed distance from the skin to increase the depth dose, (b) cutting off from the skin all the beta and secondary radiations from the metal containers. The total depth dose is thus increased since the dose is limited by the skin reaction. In 1904 the Medical

Annual records a method of radium application - "The radium can be applied by means of a glass shield, something to the shape of a watch glass, being laid over the parts, the radium itself being enclosed in a cell (with mica front) attached to the concave side of the glass cover. The radium is held in a little button with an aluminium front. This is neatly mounted in a wooden handle. The button may be screwed to any required depth". This method of holding the radium in position continued until 1912 when Wichlan and Degras (36) described a method using adhesive tape. This had only been used in experiments on animals hitherto by Halkin. These workers also described the fixation of radium in the mouth by "godhiva" held in position by a rubber plate similar to a dental plate. The "godhiva" method did not aim at fixing the radium at a specified distance from the tumour.

Pinch (37) advised the use of small lightly screened metal plaques, which contained a relatively large quantity of radium in a small area and continued to use these until 1926, by which time their use had been almost universally abandoned, except by Quigley (38) and Larkin (39) in America, who continued to apply them in cases of Paget's disease of the nipple. Lars Edling (40) in 1917 used plaster material as a support for the radium tubes to give exact distance between the radium and the tumour, and also as a filter for secondary radiations. Other materials were experimented with, and Kerr Dental compound was chosen as the most suitable, and though it contained aluminium and manganese

they were in too small a proportion to produce secondary radiations. This was the first time the plaque, as known to-day, was used clinically. At a later period Esquerra, Monad and Richard (41) in Paris, produced a material known as Columbia Paste which possessed definite advantages over the material of Edling. This is a mixture of waxes and sawdust and has a fixed density. All beta rays are stopped by a thickness of 1 cm.

Since then "Sorbo" rubber or sponge has to a certain extent taken its place, as the physical properties are the same, and it has the advantage of being light and easily moulded to the patient.

In 1928, perforated Celluloid was proposed by Reverdin (42) in Geneva. This was known as Nidrose, and had previously been used for making splints. Its advantage over the other methods is its extreme lightness, but it has not come in to general use on account of its great expense. Also it does not become malleable until 85° Centigrade, and requires a model in plaster of Paris to be made before fitting.

In 1929, Gammaplast , a plaster apparatus made from reinforced paraffin wax, was used by Gian Giuseppe Palmeri and Giovani Paltrinieri (43) and revised in December 1931. This technique avoids the main drawbacks found in usual plasters, such as brittleness, great weight and difficulty in mouldings, but it is unfortunately expensive and difficult to obtain.

At the present moment however, it can be safely said that

Columbia Paste and "Sorbo" rubber, for ease of manipulation, cheapness and general adaptability, are superior to most other materials.

III.

PATHOLOGY.

BIOPSY.

At the beginning of this investigation the question was considered as to whether or not it was absolutely essential to perform a biopsy in all cases in order to establish the diagnosis. Until recent times it has been the habit to take microscopical sections from cases under radium treatment to prove their malignancy. This appears to have arisen in the first cases from the necessity of proving the results claimed for the action of radium; the microscopical section was a standing proof of the condition before treatment. This habit of taking biopsy from every case has been adversely criticised by many workers. Forssel (44), Keynes (45) and Cade (46) hold that the taking of sections is unnecessary and jeopardises the prognosis by increasing the chances of metastases due to cutting into the lymphatics already loaded with malignant cells. Webster (47) condemns both biopsy and interstitial radium needling on the ground that they transgress the established principle of 'noli me tangere' for a metastatic type of tumour, while Harmer (48) believes that if a biopsy is considered to be absolutely necessary, it should only be performed after preliminary treatment with X-Rays. In the cases which I shall consider here the diagnosis has been confirmed by microscopical section in those

cases which had been previously operated on, but in the other cases no biopsy was performed as the diagnosis on clinical grounds alone was considered to be sufficiently evident. The cases were referred to me by the surgeon-in-charge who already had made the diagnosis, and unless any doubt existed this diagnosis was accepted. As a matter of fact histological verification of the diagnosis was effected in approximately 82% of the cases described.

The EFFECT of RADIUM on MALIGNANT CELLS.

The biological effects and mode of action of radium are at present imperfectly understood, but it is generally stated that in small doses radium has a stimulating action on malignant cells, in medium doses an inhibiting effect, and in large doses a destructive effect.

The Stimulating Effect of small doses of radium is much disputed, and a great deal of contradictory work has been published. Over thirty years ago Bohn (49) in irradiating the eggs of the sea-urchin, found that growth was increased by small doses of radium, and this was verified by Lazarus Barlow and Victor Bonney (50) who found that the rate of division of the ova cells of Ascaris Megalocephola was increased by small doses of radium. More recently Goulston (51) has shown that small doses have a stimulating effect on the chorio - allantoic membrane of chick embryos. Rolleston (52) however, in reviewing the whole question, is inclined to doubt the stimulating effects of small doses, and clinical proof of the directly exciting action of radium has

never been demonstrated.

The Inhibitory Effect of larger doses of radium is more easily proved and Regaud and Lacassagne (53) found that ovarian follicles which were not killed outright by the rays, remain inactive for a period of several months before resuming activity. This has been confirmed by Canti and Donaldson (54) and also by Finzi (55). Furthermore the inhibitory action of radium is readily proved by numerous clinical findings in the treatment of malignant disease.

The Destructive Effect of large doses is the most important effect of radium, since almost all the indications for the therapeutic use of radium are based on the possibility of destroying malignant cells by appropriate treatment. The destructive effect however, can easily be carried too far and then results in a radium burn as in Case No. 30 of the present series.

The SELECTIVE ACTION of RADIUM.

The question now arises as to whether or not the rays from radium have a more marked effect on some types of cells than on others; and it is possible to answer this question in the affirmative. Bergonié and Tribondeau (56) promulgated a Law which says:- "The sensitivity of cells to the action of radium is directly proportional to their reproductive activity, the length of their mitotic phase and their lesser morphological and functional differentiation". In practice this means that the more rapidly growing tumours are the most sensitive to

radium, while normal tissues in permanent reproductive activity, such as lymphoid, ovarian, testicular and epidermal tissues which are in a constant state of growth are more sensitive to radium than muscular or nervous tissue where there is little activity. These facts are borne out by everyday experience in the use of radium, for the radio-sensitivity of the ovary and testicle are well-known, while the chief problem in the radium plaque treatment of malignant disease is to deliver an adequate dose to the deep tissues without destroying the more sensitive overlying skin. The deepest layer of the epidermis is highly sensitive to radium and can readily be destroyed, without apparent damage to the underlying dermis, or to the superficial cells of the Malpighian layer. This action of radium can quite definitely be called selective, because, among large numbers of cells all subjected to the same dose of radium, certain cells are found which are so sensitive to the action of radium, that they are easily destroyed, while their less sensitive neighbours escape untouched. The explanation of this selective action of radium, lies according to Lacassagne and Monod (57) in the increased numbers of mitotic processes present in malignant and reproductive tissue. Guillemont (58) proved that variations in the wavelengths of the gamma rays are not responsible for this specific effect, but that the selective effect lies in the cell itself. Malignant tumours are characterised by the more rapid division of their cells as compared with normal tissues, and consequently they respond to irradiation more rapidly than normal tissues.

Let us now consider whether the histological appearances of tumours (a) can be taken as an index of their sensitiveness to radium and (b) can serve to classify them in order of malignancy:- that is to say, can we by examining a section, tell exactly how the original tumour would respond to radium plaque treatment, and what degree of malignancy is present? I think that it is definitely possible to supply an accurate answer to both questions in the case of any given section. This point has been extensively studied in the Mayo Clinic by Broders (59 - 61) who has published tables of the grades of potential radio-sensitivity and malignancy of tumours on a basis of the degree of differentiation and anaplasia of the tumour cell. The basis of these tables is:- the higher the percentage of anaplasia present the higher the radio-sensitivity and malignancy of the tumour, while a high degree of differentiation and a high percentage of adult cells, lowers the radio-sensitivity and also the malignancy. Broders divides all tumours according to the above basis into four different grades. Grade I being the highly differentiated adult cell tumour of low malignancy and Grade IV those highly malignant tumours which show a marked degree of anaplasia with numerous cells of embryonic type. Ewing (62) defines anaplasia as excessive cellular overgrowth of atypical cells, with atypical nuclei, and numerous atypical mitoses.

This method of grading tumours, while undoubtedly useful in

many cases, has, however been adversely criticised by Plant (63) and Kolodney (64) who point out that several grades may be found in one and the same tumour, while even Ewing (65) has difficulty in estimating the radio-sensitivity and malignancy of certain bone tumours. Nevertheless a knowledge of the grade to which a tumour belongs is of considerable assistance in determining the technique and dosage to be employed when it is to be treated by radium plaques. Too often when a section is sent for histological examination, the clinician has to be satisfied with a brief report which states succintly "Epithelioma of Tongue" - a fact which is generally sufficiently obvious on clinical grounds alone, while if an assessment of the degree of malignancy, type of cell present and degree of differentiation or anaplasia etc. was stated, it would be possible to modify the radium technique in advance, in order to obtain the best results. Epithelioma in certain situations (e.g. pyriform fossa) is nearly always of the Grade IV type and shows a certain degree of selective radio-sensitivity, while Grade I epitheliomata are more radio-resistant and require a heavier dosage and suitably modified technique if a sufficient dose is to be administered to the tumour without inducing a radium necrosis in the surrounding normal tissues. This question will be further dealt with under the section on the technique of radium plaque treatment. In passing it may be noted that there is no definite relation between the radio-sensitivity of a tumour and the curability of the condition, as the highly radio-sensitive anaplastic

type grow very rapidly and have generally produced metastases before the primary is noticed, and while the radio-sensitive primary may frequently be made to disappear under the influence of radium, it is manifestly impossible to detect all the metastases or to treat them all, even if detected.

The MODE of ACTION of RADIUM.

We have seen that radium may have a Stimulating, Inhibitory or Destructive effect on living cells according to the size of the dose delivered, and also that some types of tumours are more sensitive to the action of radium than others, while it has been shown that radium has a selective action on certain cells; just how these effects are brought about, however, and the mode of action of radium is subject to much discussion and is not as yet fully understood. The various explanations which have been put forward have led radium workers to vary their technique from time to time so as to produce the maximum change in the malignant tissues.

It seems certain that the action of radium on malignant cells may be divided into Direct Action on the cell protoplasm itself, and Indirect Action on the blood and surrounding stroma, and there is no doubt that both processes play a part in the destruction of a malignant tumour.

Direct Action of the rays of radium on the cellular structures was first proved by Perthes (66) in 1904, when he demonstrated the disintegration of the nuclear chromatin following

irradiation, under circumstances which precluded the possibility of indirect action. The fact that the cell was very much more susceptible to this direct action during mitosis was originally demonstrated by Mottram (67), in 1913, by irradiating bean roots, where mitosis only occurs during the night. This susceptibility of the cell to radium during mitosis has been the subject of much recent work and Strangeways and Hopwood (68) state that the degree of susceptibility depends on the position of the mitotic cycle in the cell, and they suggest that the most sensitive phase is not actually mitosis itself, but that part of the cycle which immediately preceeds visible mitosis. Irradiation during this preliminary phase delays the onset of mitosis, causes it to be abnormal and finally produces the complete break-up of the nucleus with death of the cell. This has been confirmed by Canti and Spear (69) who studied the irradiation of tissue cultures and also independently by Champy (70).

The Indirect Action of Radium has been the subject of much speculation, and Ward and Smith (71) mention the production in the tissues by radium of "necrotoxins", cholines, and degeneration products of lecithin which are supposed to exert a toxic influence on malignant cells. Definite proof of the production of such toxins, is not however, forthcoming. Indirect action is more clearly proved by the work of Mottram (72) who states that regression of rat sarcoma can be obtained by general radium treatment to the animal as a whole, at the same time screening off the primary tumour from direct action

of the rays. This certainly seems to suggest the production of some circulating substance, or some general effect on the organism as a whole.

The earliest view on the indirect action of radium, was that irradiation stimulated fibrosis in the surrounding stroma which in turn strangulated the cancer cells. This "throttling" process has been clearly proved by Canti and Donaldson (73) to be purely secondary to the destruction of the cells, progressive fibrosis following on the disintegration of the cancer cells and being quite independent of any action by radium.

Irradiation was later believed by Strangeways and Fell (74) to interfere with the blood supply of the tumour by damage to capillary endotheluim leading to thrombosis, and more recently Beatrice Pullinger (75) has demonstrated that this capillary thrombosis is followed by anaemic necrosis of some of the cancer cells, secondary fibrosis, and pressure atrophy of many of the remaining cancer cells.

Finally, Russ (76) and his co-workers have contributed to the belief that the cancer cell in addition to the above phenomena, is killed by an indirect reaction due to changes brought about by irradiation on the surrounding tissues - the chief of these changes being the production of a particular lymphocytosis which will under certain conditions destroy cancer cells. The part played by this lymphatic response of the tissue to irradiation is of considerable importance in radium plaque treatment,

as the response varies with the technique employed. Sampson Handley (77) in his work on the genesis of cancer points out the importance of the infiltration by lymphocytes which is frequently seen in the neighbourhood of the advancing edge of a malignant tumour and Murphy (78) states that this tends to slow down the rate of spread. The actual mode of spread of cancer is by direct permeation of the surrounding tissues and by way of the lymphatics. Although our knowledge of the actual process of spread from the primary lesion to the nearest glandular area is incomplete, there are two obvious ways in which it may take place; the tumour may disseminate from the primary growth along the lymphatics "per emboli" or it may spread by direct growth along the lymphatic channels "per continuitatem". There is little doubt that cancer of the breast spreads "per continuitatem" and Bloodgood (79) is of the opinion that lingual cancer spreads in the same way. Consequently any therapeutic medium, such as a radium plaque, which tends to produce fibrosis of the lymphatic channels, and to induce an infiltration of lymphocytes at the margin of the tumour, will also tend to prevent dissemination, even if the direct action of the radium has failed to produce 100% mortality among the actual cancer cells. It is claimed therefore that in the radium plaque treatment of cancer one of the aims should be to encourage this lymphocytosis by specially arranged irradiation so that lymphocytosis shall take place round the spreading cancer cells in the lymphatics. It is believed that the normal tissues in this way can overcome at

least for a time the cancer, as carcinoma will not spread in areas in which much sclerosis has taken place. This has been shown experimentally by Ludford (80) who found that scarification after tarring actually prevented malignant changes, owing to the sclerosis which results. Clinically also it is well known that where a varicose ulcer has become carcinomatous metastases do not take place because of the surrounding sclerosis.

TYPES OF TUMOURS TREATED.

In the present series of cases the following are the types of tumours which were treated by means of radium plaques and these cases fall into four main groups:-

(1). Carcinoma of Breast.
(a) Recurrent Carcinomas.
(b) Primary Carcinomas.

(2). Cerebral Tumours.

(3). Secondary Carcinoma of Glands.
(a) Glands of Neck.
(b) Glands of Groin.

(4). Sarcomata.

1. Carcinoma of Breast (a) Recurrent Carcinoma (30 cases). All the patients in this group were referred by the Surgeons for plaque treatment of recurrences after the primary growth had been unsuccessfully treated either by amputation or by a complete interstitial radium needling. In no case had the primary tumour been treated by means of a radium plaque. The exact numbers treated originally by amputation and interstitial radium needling are as follows:-

Primary removed by Radical Amputation	16 cases.
Primary treated by Interstitial Radium Needles	14 cases.
	30 cases.

The distribution of these recurrences was as shown below:-

Recurrence in Supraclavicular Region	10 cases.
Recurrence in Vicinity of Scar.....	10 cases.
Recurrence in Axilla	7 cases.
Recurrence of Primary Tumour	3 cases.
	30 cases.

The time between the original treatment of the primary and the radium plaque treatment of the recurrence varied from five weeks to - in one case - ten years, the average period however being nine months.

All the recurrences were from spheroidal celled scirrhous carcinomata, and no encephaloid, colloid, or columnor-celled carcinomata are included in this group. Clinically all these cases were regarded as inoperable, and were given the gravest possible prognosis.

(b). Primary Carcinoma of Breast(11 cases). At the present time it is customary to submit all primary cases of carcinoma to operation or interstitial radium needling wherever possible, but in the cases in this group an anaesthetic was impossible for several reasons and the patients were referred for treatment by means of radium plaques. Seven of the patients were unfit by reason of age, heart disease, and exophthalmic goitre, two

refused amputation and two more were regarded as hopelessly inoperable.

The time between the first discovery of the tumour and admission to hospital varied between five months and eight years; on an average the growth had been present for twenty months before treatment.

Extensive glandular involvement was present in seven out of eleven cases, and in four cases no secondary deposits could be detected at the commencement of treatment. The group consisted of ten cases of scirrhous carcinoma in varying states of growth - mostly very advanced, and one Paget's disease of nipple without glandular involvement.

II. Cerebral Tumours (16 cases). All the cases in this group had previously been submitted to operation, and an unsuccessful attempt made to remove the tumour. In every case, without exception, a large bone flap had been turned down in order to gain access to the brain, and in closing the incision the bone was not replaced; thus a large decompressed area was present in the skull across which it was possible to deliver radiation without fear of inducing local necrosis of bone. Therein lay a distinct advantage as the dose delivered by the radium plaque was limited only by the skin reaction, and no account had to be taken of the possibility of delayed radium necrosis of the skull. This is of considerable importance as the chief value of radium in cerebral tumours lies in the difference of sensibility to irradiation

between normal brain tissue and the tumour. Normal nervous tissue is highly resistant to the action of radium, a fact conclusively proved by Goulston (81) who submitted the nervous system of animals to enormous doses of radium far in excess of clinical requirements, and this work has been confirmed by Sargent and Cade (82) as being also true in the human subject. On the other hand the presence of a decompressed area led in many cases to the appearance of a large cerebral hernia which increased the difficulty of accurately applying a radium plaque and delivering a uniform dose throughout the tumour.

In the majority of the cases it was discovered that anything like complete eradication of the disease was quite impossible, the surgeon merely removing a portion of the tumour for biopsy. A histological report was thus available in respect of every patient in this group, and it was found that all the tumours were gliomas. Considerable changes have taken place in the nomenclature of gliomas in recent years, largely due to the work of Bailey and Cushing (83) who describe fourteen sub-groups of gliomata and it is their classification which is followed in this instance. Gliomas only were dealt with in this series, and these belong to the three chief groups:-

Oligodendrogliomas	3 cases.
Astrocytomas	5 cases.
Spongioblastomas	8 cases.
TOTAL ...	16 cases.

The occurrence of three oligodendrogliomas in a relatively short

series of sixteen gliomas must be regarded as distinctly unusual, for according to Bailey and Bucy (84), who have made a special study of these tumours, they are among the rarest of all gliomas. The oligodendrogliomas are somewhat unique among neoplasms, in that while they are very cellular they grow slowly; they are highly radio-sensitive. The astrocytomas are also slowly growing tumours, but are much less cellular, display a more highly differentiated adult type of cell and are much more radio-resistant. Spongioblastomas on the other hand, exhibit large numbers of a more primitive type of cell, grow rapidly and are the commonest type of glioma. The cells are more radio-sensitive than those of the astrocytomas, but owing to the much more rapid rate of growth, the prognosis is less favourable.

In the above cases symptoms had been present for from three months to three years before treatment, the average period being eleven months.

III. Secondary Carcinoma of Glands (a) Glands of Neck (30 cases

In this group are considered thirty cases of malignant enlargement of the cervical glands, all of them being secondary to an oral primary tumour; the situation of the primary tumours was as follows:

Primary in Tongue ..... 14 cases.
Primary in Buccal Mucosa ..... 6 cases.
Primary in Lip ..... 10 cases.

In each case the primary tumour had received treatment at the hands of a surgeon, either by coagulation by diathermy or inter-

stitial radium needling; in no instance had actual surgical removal of the primary been undertaken. All the primary tumours were healed before the patient was submitted to radium plaque treatment for the glandular deposits. Histologically the relation in the primary tumours between site and malignancy, corresponded almost exactly to the classification described by Ewing (85). Those occurring in the anterior portion of the tongue showing highly differentiated cells with numerous cell-nests (Grade I), while those occurring posteriorly were of a more cellular and undifferentiated type with no tendency to cell-nest formation (Grade II and III). Similarly in the case of the buccal mucosa, the tumour occurring anteriorly displayed numerous cell-nests while the posterior tumours were of the undifferentiated type. In the lip cases, all the primaries were of the(Grade I) variety with copious cell-nests and a highly differentiated adult type of cell.

Well defined glandular metastases were present in every instance, and in twelve cases the glands were firmly fixed to the deep structures of the neck and adherent to the surrounding tissues, while in eighteen cases the glands were discrete and mobile; most of those latter cases occurring in relation to a lip primary. All cases were regarded by the surgeons as inoperable, either on account of the fixity of the glandular masses, or of the bilateral nature of the disease.

(b) Glands of Groin (10 cases). In this group the primary tumour was situated in the penis in six cases, and at the margin

of the female urethra in four cases.

All the primary growths had previously received surgical treatment either by means of diathermy or interstitial radium needling before treatment of the secondary deposits was commenced.

Histologically the penile cases all showed well marked cell-nest formation and were consequently of the (Grade I) type. In five instances the inguinal glandular enlargements were discrete and mobile, while in one patient the glands were fixed to the deep structures and fungating through the skin. The four primary tumours in the female urethra cases showed no cell-nest formation whatever, and were of the (Grade II) and (Grade III) type. In two of these cases the glands were firmly fixed and adherent and in the remaining two were freely mobile.

Sarcomata (12 cases). The cases in this group are divisible into three quite distinct types of tumour as follows:-

Periosteal Sarcomas	5 cases.
Fibro-Sarcomas	2 cases.
Lympho-Sarcomas	5 cases.

Among the periosteal sarcomas were three cases involving the lower end of the femur, one case of sarcoma of ilium, and one of the upper end of humerus. One of the femur cases had previously had a disarticulation of the hip performed and the tumour had recurred beneath the scar; none of the other cases had been operated upon. The chest was carefully X-Rayed in

each case before treatment was commenced, and no evidence of metastases could be found; furthermore none of the patients presented any symptoms such as cough etc. indicative of pulmonary involvement. With the exception of the case which had been operated upon, the diagnosis of periosteal sarcoma was in each instance based on the physical and X-Ray findings.

The fibro-sarcomas consisted of one rapidly growing case with very large fungating masses in the inguinal regions and another patient in which the tumour was of the slowly growing type and had been locally excised twice in the course of seven years. Histological verification of the diagnosis was thus available in both of these cases.

As regards the lympho-sarcomas, the tumour mass was present in the neck in three cases, and in the mediastinum in two cases. The neck cases were proved histologically to be definitely lympho-sarcomatous in nature, while in the mediastinal cases the diagnosis was based on the X-Ray findings and on the subsequent reaction to radium.

The time interval between the first appearance of the tumour and the application of radium plaques varied from two months to - in the case of one fibro-sarcoma - seven years. The average period (excluding the 7 year case) was eight months.

IV.

TECHNIQUE OF ADMINISTRATION.

The Objects of the Technique employed were, to deliver by means of suitably devised plaques a uniform lethal dose of radiation to the cancer cells and to the surrounding area, and to cause wherever possible the complete regression of the disease. Where complete regression of the growth could not reasonably be expected, it was at least hoped to relieve the patient's distress, and to secure a useful prolongation of life. This had to be obtained without permanent damage to the skin or the production of a radium burn and without impairment of functional activity of the surrounding structures. In considering how this could best be brought about, it was found that an almost bewildering multiplicity of factors were involved, particularly in regard to the radium - skin distance and the distribution of the radium on the surface of the plaque. Uniform radiation of the area involved being a sine qua non of the treatment, it was desirable that the radium should be fixed at some distance from the skin in order to obtain a uniform depth dose, while the consideration of certain mathematical formulae seemed to suggest that in order to obtain a uniform field the radium should be applied to the surface of

the plaque, either in concentric circles or in accordance with certain definite rules. Practical considerations however, nearly always prevent complete theoretical perfection, and the methods employed were largely a compromise between clinical convenience and mathematical efficiency.

The Radium Used consisted of a large number of tubes and needles each containing the equivalent of one milligramme and 1.5 milligrammes of radium element, distributed in each case throughout an active length of 16 m.m.

The Screens Used in the case of the needles and tubes themselves was a sheath of platinum 0.5 m.m. in thickness and was constant in every instance. Three large permanent plaques were constructed as described below, and in these, one milligramme tubes were inserted, ten at a time, into small silver boxes lined with lead, which boxes were in turn sealed and applied to the surface of the plaque. If we transform the additional screenage given by the silver and lead into terms of platinum screenage in accordance with the tables compiled by the Radium Belge (86) we find that in those large permanent plaques the total screenage was equivalent to a thickness of two millimetres of platinum. A screen consisting of a sheet of copper 1 m.m. thick was introduced into the centre of many of the "sorbo" rubber plaques, with a view to obtaining additional screenage with the minimum formation of secondary beta rays. The use of the copper screen being based on the work of Benner (87) who

discovered that metals with an atomic number between 26 and 50 give off very much weaker secondary beta rays than both lighter and heavier metals, consequently where a copper screen is employed it should be possible to administer a greater dose with a minimum skin reaction, a fact which Cade (88) has confirmed in practice.

The Plaques Used were constructed of either Columbia Paste or spongy "sorbo" rubber of 15 m.m. thickness; thus the radium was maintained at a constant distance of 15 m.m. from the skin. This distance was a compromise between practical difficulties and mathematical efficiency. It was realised that theoretically it might be desirable to increase the distance further in order to obtain a more uniform depth dose, but any increase of distance would have produced a falling off in the total dose over any given period, and would have entailed either an increase in the time of application, or an increase in the total radium applied to the plaque. Furthermore, Columbia Paste of more than 15 m.m. thickness becomes extremely heavy and uncomfortable for the patient to wear. The Columbia Paste used was made up of beeswax, paraffin wax, and sawdust all remelted together and allowed to cool in a flat tray as recommended by Leslie Spinks (89). To use the wax it was immersed in hot water at 55°C for a quarter of an hour, when it became soft and could be moulded to fit the patient. The radium needles were then heated and applied to the surface of the wax in which they became firmly embedded. The

"sorbo" rubber on the other hand was obtained in large flat sheets and cut to fit the patient as required, the radium being fixed in position by strapping down with sheets of rubber adhesive plaster.

The Problem of Distribution of the radium over the surface of the plaque was one of considerable complexity. In order to obtain a perfectly uniform field of radiation, two different principles of radium distribution could be followed.(I) The radium could be arranged on the plaque in certain linear or circular fashions and provided the geometrical form was accurately executed and maintained, then adequate mathematical proof was forthcoming of the uniformity of the field of irradiation and it was unnecessary to test the uniformity of the field by submitting the plaque to electroscopic or photographic tests; if the radium had been suitably placed, then uniformity of field followed as a matter of course and was capable of exact mathematical proof. (II) The second method which could be followed, was to arrange the needles in accordance with the dictates of clinical convenience, and then to test the plaque experimentally for uniformity of field either by means of a small ionisation chamber or by its effect on photographic film. The radium was then re-distributed as required, certain portions being reduced in intensity and others increased, until a uniform field was obtained. To a large extent this was the method employed in the present investigation.

A great deal of mathematical work on the distribution of energy round radium sources has been done, particularly by Sievert of Stockholm (90 - 92), Mazérès of Paris, (93 - 94), Martin, Quimby and Pack (95) of New York, and Mayneord (96 - 97) of London. Unfortunately all the above papers are by physicists who are dealing with radium as a mathematical and not as a clinical problem and the problem of transforming mathematical theory into everyday clinical practice bristles with practical difficulties which at first sight appear wellnèigh insolvable. An attempt in this direction has been made by Rose and Phillips (98) of Birmingham who appear to have achieved some success with radium arranged on a geometrical basis. One of the most useful papers studied however, was that by Souttar (99) dealing with the fields of radiation round radon seeds. If radium is distributed over the surface of a flat plaque in a series of concentric circles, then uniformity of the field of radiation is obtained if certain rules are observed. For instance, if a single circle of radium needles is employed then the diameter of the circle must be three times the distance of the radium from the skin, but if two concentric circles are used , of which the inner circle has half the diameter of the outer circle, then the diameter of the outer circle must be six times the radium-skin distance. Finally using two concentric circles and a central deposit of radium the diameter of the outer circle must be twelve times the radium-skin distance. Also the distribution of the radium must be such that the inner circle contains one quarter the amount of radium of the

outer circle and the central deposit should be one-sixteenth of the radium in the outer circle. If these conditions are observed then the field of radiation is homogeneous, and the intensity can be calculated at any point.

Let us however consider the practical difficulties involved in the clinical application of this method. If we use the third distribution of two concentric circles and a central deposit, (which is the most favourable), then the area of the plaque is limited to a circle having its diameter twelve times the radium-skin distance. As the present investigation was limited to plaques having a thickness of 15 m.m. then the maximum plaque area obtainable was 15 m.m. x 12 = 18 cms. - that is, a circle of 18 cms. diameter, which is insufficient for the irradiation of an extensive breast case. To obtain an increased area by this method it would be necessary to increase the thickness of the plaque, which in the case of Columbia Paste would have rendered it unduly heavy and difficult of manifulation. In addition the above distributions are calculated for a flat plaque and at the commencement of this investigation no information was available as to the effect of bending the plaque upon itself, such as occurs in applying certain neck and breast plaques. Also the units of radium available were very small 1 mgr. and 1.5 mgrs. and the employment of this method would have meant that only a very small quantity of radium could have been applied to even the largest plaques.

According to Souttar however the practical difficulties in the way of using this method have recently been overcome by Paterson and Fulton (100) at Manchester, by an extremely ingenious arrangement by which radium in rings of rubber tubing is held by cork supports above a nidrose plaque. This method would appear to be almost ideal on theoretical grounds, but had unfortunately not been published when this investigation was first commenced.

In the present series of cases uniformity of irradiation was obtained by empirical, rather than by purely mathematical methods. The radium was arranged on the surface of the plaque to give as nearly as possible an accurate mathematical distribution and the uniformity of the irradiation was then tested by photographic methods, and the radium re-distributed as was found necessary. Kramer (101) and Russ (102) have described methods for the autophotography of radium needles and plaques, by means of which the uniformity of radiation may be determined by placing the plaque on special rapid duplitized X-Ray films for a standard time and then developing under standard conditions, and this method was employed in the present work. The first illustration shows the action of three standard 1 mgr. needles, and a small experimental plaque. In this instance the film was taken before the radium had been re-distributed and shows the falling-off in intensity at the corners of the rectangle.

The Problem of Dosage divides itself into a consideration of (a) the Units of Dosage to be employed (b) the Total Dose to be delivered, and (c) the Time Factor.

(a) The Unit of Dosage most commonly employed in this country is the milligramme-hour, and is obtained by multiplying the total quantity of radium in milligrammes by the time of application in hours. This unit has been adversely criticised by Spencer and Cade (103) and many others on the ground that it does not provide any data by means of which the treatment can be repeated, - in fact it has been universally attacked by almost everyone engaged in radium therapy, without any adequate substitute being discovered. If the term milligramme-hour is to be used however, it must be accompanied by minute details of the number of containers together with their shape, size and filtration, and also details of their distance from the skin, total size of area irradiated, and time of application. If these details are given in full, then many of the objections to the use of the term disappear and in point of fact, this method with all its imperfections is still the one most generally employed in this country. Many attempts have been made to find a satisfactory substitute for the milligramme-hour, and in France the dose is measured in terms of millicuries destroyed, but this does not really tell us any more about the method employed than the milligramme-hour. Murdoch (104) in Brussels has attempted to express the dose as the amount of

energy liberated in the tissues and this is represented by the use of the term ergs/cm^3-hour. From a theoretical point of view there is much to recommend this unit, but practically there are many serious difficulties in the way of its measurement. The Roentgen Unit or "r" unit as it is called is much used in X-Ray work and recently there has been a move to apply it to radium theropy. It is based on ionometric observations, and furnishes a very accurate physical measurement of the energy absorbed. It does not however, take any account of wave-length, and while it is undoubtedly the most scientific unit available, it has not so far met with universal acceptance among radium workers. The unit most commonly used in mathematical calculations is the so-called "Natural Unit" and is the radiation produced by 1 milligramme of radium at a distance of 1 cm; it can readily be converted into Murdoch's energy units, or "r" units, but unfortunately it takes no account of the screenage of the radium or of other details of the applicator. In this somewhat chaotic state of affairs it was felt that in the cases herein described it would be advisable to adhere to the use of the term milligramme-hour, and at the same time to state all the relevant details of the treatment, rather than to use an intensity unit which might create confusion.

(b) As regards the Total Dose to be delivered to the cancerous area; if we knew in terms of energy units exactly how much radiation constituted a lethal dose to the cancer cells,

then we could deliver precisely that dose and then stop. Despite much research work however, it cannot be said that the lethal dose for a cancer cell, either in vivo or in vitro has been accurately gauged. Consequently it is desirable to deliver as large a dose as the patient will tolerate. Williams (105) states that "the most important principle in dosage is probably the fact that the useful therapeutic dose is determined, not by what will theoretically sterilise a growth, but by the dose which the normal tissues, stroma and blood-vessels, will stand without massive necrosis". Thus it has been our object to give the maximum dose possible.

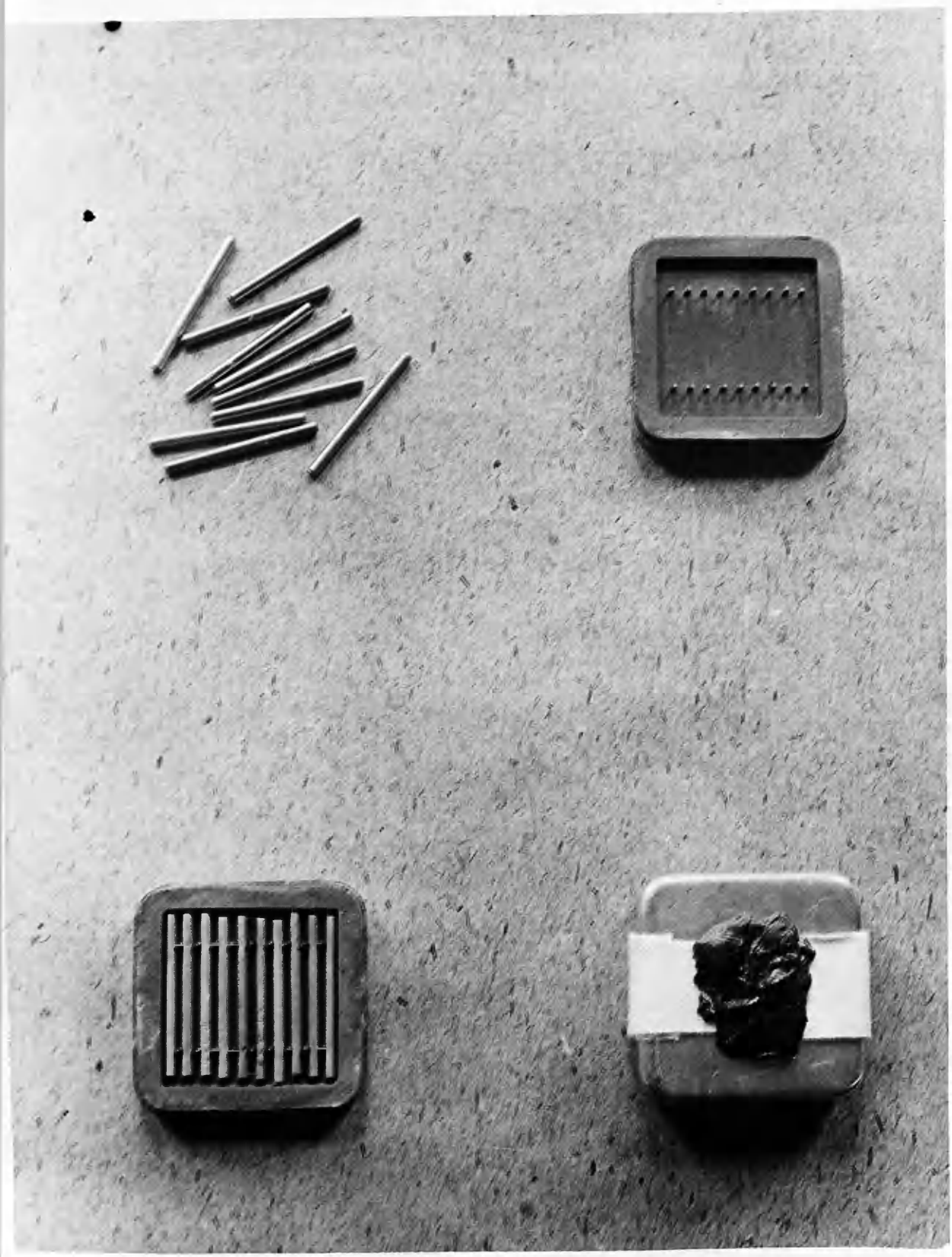
As the total dosage then, was always based on the maximum amount of radiation which could be given without permanent damage to the skin, a close watch on the skin reaction was essential. These reactions are broadly classed under three headings:-

I. Erythema, which consisted of heat and redness due to capillary dilatation and was accompanied by a slight sensation of irritation. It was as a rule followed by depilation and light pigmentation. In this series of cases where only gamma rays were used, erythema appeared after 6 - 12 days varying with the surface intensity of the plaque, and the number of hours per day for which it was worn. An erythema dose by itself through one port of entry is not sufficient to produce the best results and a larger dose was given with safety to almost all the cases quoted.

II. Radio-dermatitis is produced if the treatment is prolonged beyond the simple erythema stage, and this consists of destruction of the epidermis without permanent damage to the dermis. The primary erythema gradually becomes more intense and assumes a dark purple colour, this is followed by blistering and peeling of the superficial layers of skin, leaving a smooth, pink, moist area, with occasional pin-point haemorrhages. This condition of moderate radio-dermatitis is the stage which was aimed at in plaque treatment, and it was used as the index of maximum dosage. A radio-dermatitis may be produced with perfect safety as the skin heals rapidly, and no scar remains.

(c) The Time Factor in dosage has undergone considerable variation during the developement of radium therapy. Formerly large quantities of radium were applied to the skin for short periods, and the Medical Research Council (108) in reviewing the effects obtained from half-gram plaques having a surface distribution of 10 mgrs. per sq. cm. and applied to breasts for 20 hours, state that "the results were discouraging". Gradually the total quantity of radium was reduced and the time of application increased, until in 1929 the Lancet (109) in reviewing the situation, stated that all the available evidence was in favour of the use of small quantities of radium acting over relatively long periods. This plan of reducing the total amount of radium, in relation to plaque area, and lengthening the time factor has been followed in the present series of cases.

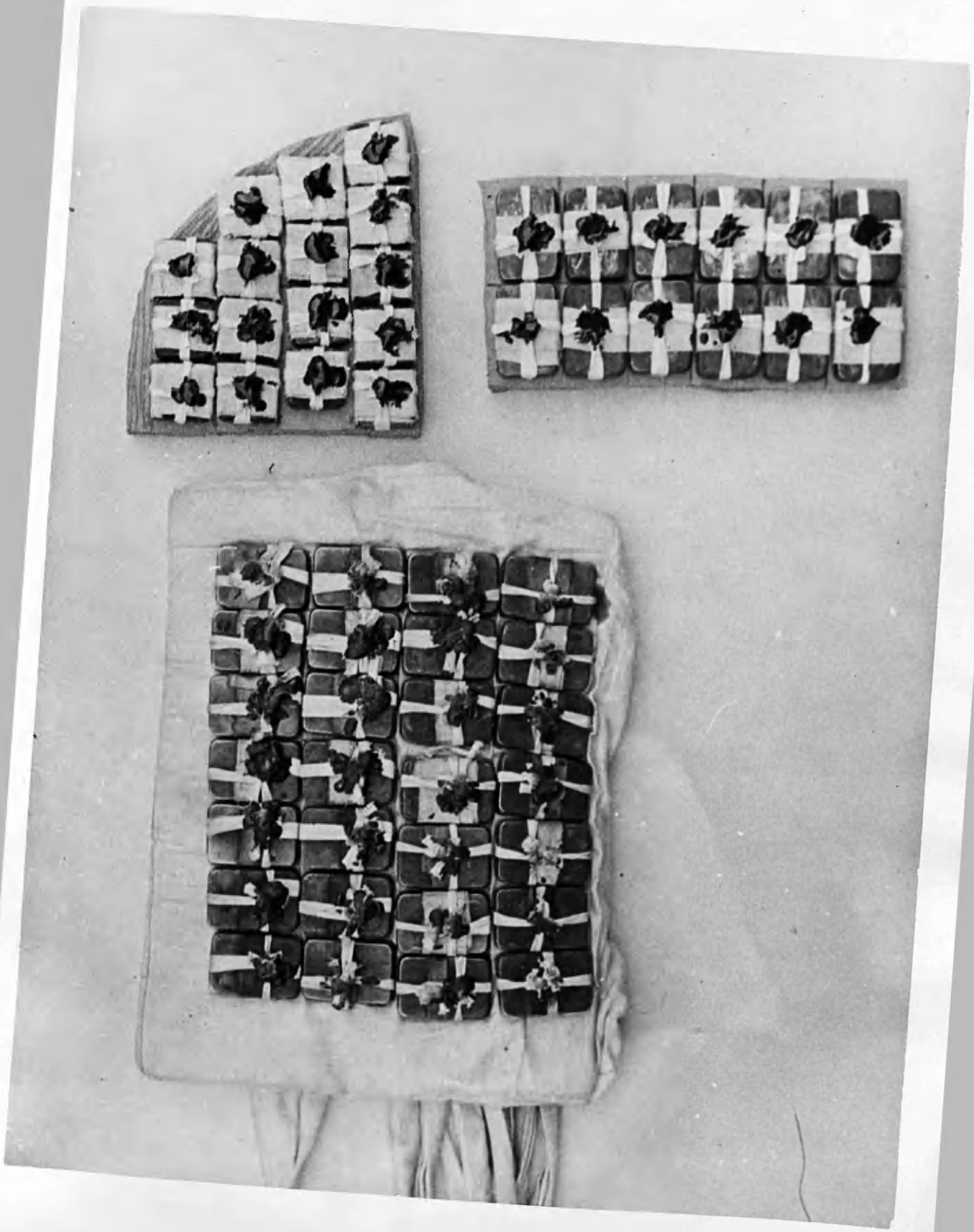
Another factor however has been introduced into the present series of cases, which was not as a rule applied elsewhere previously, and that is the principle of Split Doses. Formerly it was the practice to apply a plaque more or less continuously to the patient until the total dose had been administered, but here the doses were split up. In the case of the large permanent plaques used in the breast cases the dose was limited to 4 hours out of each twenty-four and this was continued each day (generally for about 20 days) until the requisite dose had been administered. In the case of Columbia Paste collars and "sorbo" plaques having a low surface intensity, the procedure followed was to apply the plaque in "sea-watches", i.e. 4 hours on and 4 hours off, so that the patient received 12 hours treatment and 12 hours freedom out of each twenty-four. This method of split dosage is believed to have certain practical and theoretical advantages, (e.g. in the breast series it was possible to treat eight patients simultaneously with the same plaques, as these were only worn for 4 hours at a time by each patient). The method is largely based on the experimental work of Spear (110) who discovered that the lethal dose for cancer cells in vitro is very much reduced if the time factor is increased and the dose is split up; and this, taken in conjunction with the work of Cramer (111) proving that doses of gamma rays quite insufficient to kill cancer in vitro, were in many instances sufficient to cause the disappearance of tumours in situ, seem to indicate that the technique of split doses might find a useful clinical application. In addition Russ (112) and



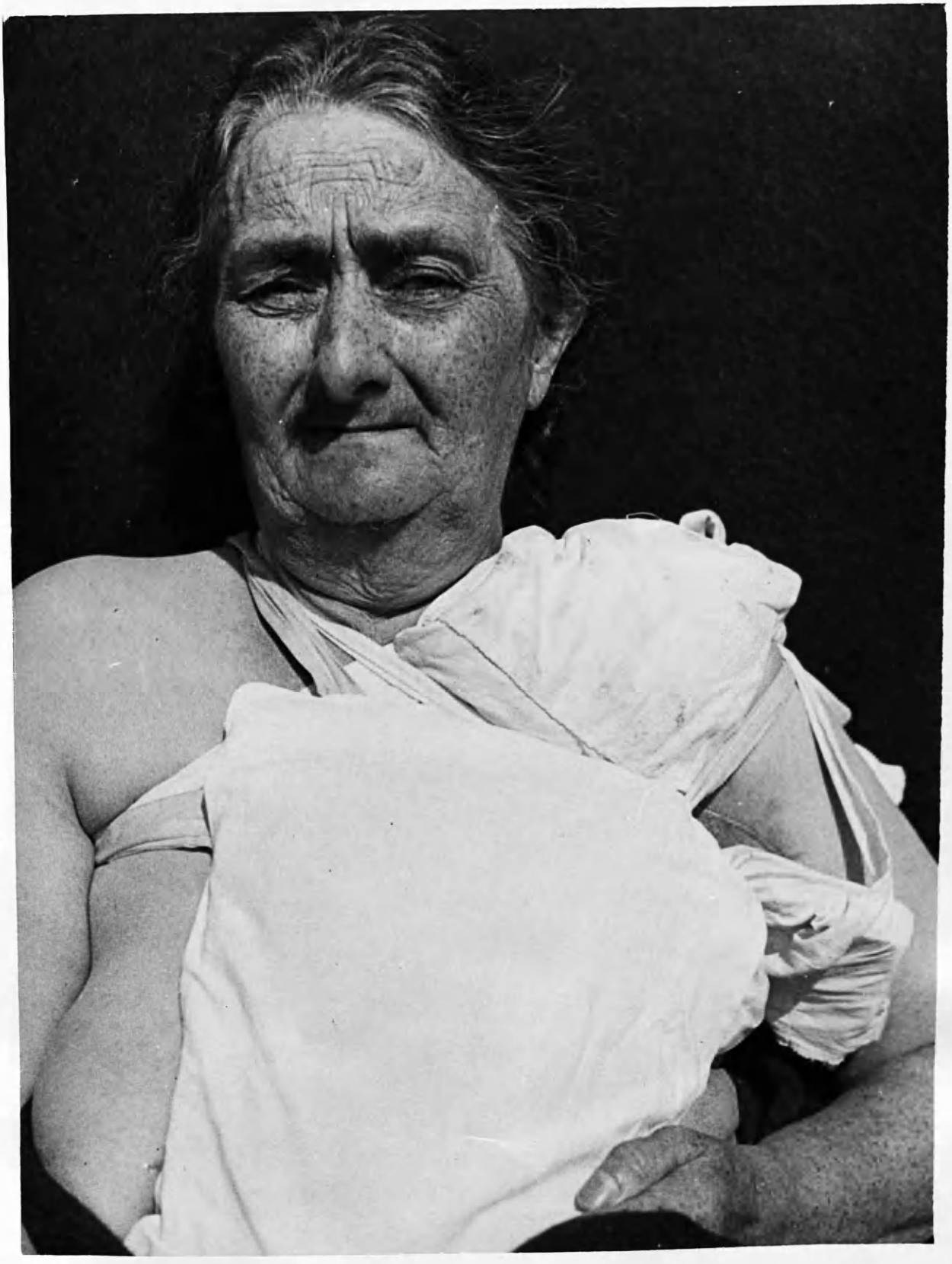
Mottram and Eidenow (113) working with Jensen's rat sarcoma, showed by splitting the dose that (a) a smaller dose was enough to produce a full lethal effect, and (b) split doses reduced the skin reaction, but did not reduce the effect on the tumour. Also Levitt (114) and Schall (115) have advocated split dosage in the analogous field of deep X-Ray therapy, while Donaldson (116) attributes the enhanced effects from split doses to the fact that a greater number of cells are exposed to radiation in the vulnerable stage of mitosis.

Several variations in the dosage took place according to the pathological grade of the tumour, as it was found that the highly differentiated Grade I type of tumour required a larger total dose to produce its disappearance that the more radio-sensitive Grade III and IV types, while in the latter types heavier screenage was introduced wherever practicable.

Regional Technique I. Breast Cases. The technique employed in the recurrent and primary breast patients was substantially the same in both cases, the object being to irradiate the whole breast and lymphatic area, and not merely a localised region. With this end in view three permanent plaques were constructed, the largest containing, 280 mgrs. of radium distributed over an area of 373.3 sq. cms. and having an average surface intensity of 0.75 mgrs./sq. cm; this plaque was used for irradiating the breast area and chest wall. The second plaque contained 160 mgrs. of radium on an area of 160 sq. cms. the average



distribution being 1 mgr./ sq. cm., and this plaque was applied to the supraclavicular area, while the third plaque carried 120 mgrs. of radium on an area of 160 sq. cms. having a surface intensity at the rate of 0.75 mgrs./sq. cm. and this third plaque was applied to the axilla. The supraclavicular plaque formed a segment of a circle, while the breast and axillary plaques were rectangular in shape. The radium used was in the form of one milligramme tubes, which were inserted - ten at a time - into small silver boxes lined with lead; the total primary screenage being equivalent to two millimetres of platinum. These boxes were then sealed, and fixed on the surface of the plaque, which was composed of "sorbo" rubber 15 m.m. thick. The second illustration shows the tubes and boxes, while the third shows the finished plaques. Before use the plaques were inserted into sterile linen covers, which were kept separate for each patient, and then strapped into position as shown in the fourth illustration. (N.B. in the case illustrated the axillary plaque has slipped slightly downwards after the fixing bandages were removed to permit of the photograph being taken). Treatment was carried out for 4 hours each day until the total dose had been administered, - generally in about twenty days. A few of the breast cases were treated by means of individually moulded Columbia Paste or "sorbo" rubber plaques, the radium being distributed as a rule in a series of cross-bars. Details are given in the case-histories of each of the patients where these plaques were used.



II. Cerebral Tumours were treated chiefly by means of a "sorbo" rubber helmet, the radium being first arranged separately on a sheet of rubber adhesive plaster which was then applied to the helmet, and the whole strapped on to the patient's head. The fifth illustration shows the type of helmet and radium used - as a rule the arrangement of the radium was in a series of concentric rings. In most of the cerebral cases a screen of 1 m.m. of copper was incorporated in the "sorbo" rubber. Some of the cases were treated by moulding a sheet of Columbia Paste to the head, and this was frequently of value where a large cerebral hernia was present. As a general rule these helmets were worn for 12 hours each day in split doses of 4 hours on and 4 hours off, until the total dose had been given. In every instance a preliminary decompression had been performed.

III. Secondary Carcinoma of Glands. These were treated on the general principles annunciated above, collars of Columbia Paste or "sorbo" rubber being moulded to the neck, and screens of 1 m.m. copper inserted wherever advisable. In the groin cases flat plaques were used and moulded as far as possible to the contour of the groins. A cross-bar distribution of radium was generally used on the collars, and a circular distribution on the groin plaques. In four of the groin cases permanent plaques of the breast type were used. Again the split dose method of application was in force.

IV. Sarcomata. In most of these cases it was found possible to mould one or two of the large permanent breast plaques to fit the diseased area, and all the periosteal and fibro-sarcomas were treated in this manner, the dosage being at the rate of 4 hours out of each twenty-four. Several of the lympho-sarcomas were treated with individually prepared plaques, as described in the case-histories, and these were worn in split doses of 12 hours per day, until the requisite dose had been delivered.

V.

RESULTS.

The following tables embody the results of treatment of all the patients dealt with in the present series of 109 cases. Separate tables are given showing the results in different regions, and in the last table the total results are summarised together in one table.

All cases have been closely followed-up for a minimum period of two years, and the results quoted in the tables show the state of affairs at the end of this period.

The cases are grouped under the following headings:-

Sympton free - indicates that the patient is still alive and that no obvious signs of disease could be detected at the end of the two year period.

Alive with Disease - signifies that the patient was still alive after two years, with the disease present in varying stages of severity, but not obviously moribund; such latter cases have been included among the deaths.

Dead. - Among the deaths are included two cases dying of intercurrent disease, and one case which died following an operation, despite the fact that in the last case no active signs of disease were found post-mortem. One patient untraced has been presumed to be dead.

I. Carcinoma of Breast.

Disease.	Total Cases.	Symptom Free.	Alive with Disease.	Total Alive.	Dead.
Recurrent Carcinoma of Breast.	30.	15.	3.	18.	12.
Primary Carcinoma of Breast.	11.	7.	1.	8.	3.
Total Breasts.	41.	22.	4.	26.	15.

Average survival period of cases dying before 2 years ..... 10 months.
Among the cases dying, three showed no improvement following treatment.

II. Cerebral Tumours.

Disease.	Total Cases.	Sympton Free.	Alive with Disease.	Total Alive.	Dead.
Oligodendrogliomas.	3.	2.	0.	2.	1.
Astrocytomas.	5.	3.	0.	3.	2.
Spongioblastomas.	8.	2.	1.	3.	5.
Total Cerebral Tumours.	16.	7.	1.	8.	8.

Average survival period of cases dying before 2 years .... 6 months.
One case showed no improvement.

III. Secondary Carcinoma of Glands.

Site of Primary.	Total Cases.	Sympton Free.	Alive with Disease.	Total Alive.	Dead.
Tongue.	14.	5.	3.	8.	6.
Buccal Mucosa.	6.	2.	1.	3.	3.
Lip.	10.	9.	0.	9.	1.
Penis.	6.	3.	1.	4.	2.
Female Urethra.	4.	2.	0.	2.	2.
Total Carcinoma of Glands.	40.	21.	5.	26.	14.

Average survival period of cases dying before 2 years .....$8\frac{1}{2}$ months.
Three cases showed no improvement before death.

IV. Sarcomata.

Disease.	Total Cases.	Sympton Free.	Alive with Disease.	Total Alive.	Dead.
Periosteal-sarcoma.	5.	o.	o.	o.	5.
Fibro - sarcoma.	2.	1.	o.	1.	1.
Lympho - sarcoma.	5.	2.	o.	2.	3.
Total Sarcomas.	12.	3.	o.	3.	9.

Average survival period of cases dying before 2 years ..... 6 months.
All cases dying showed transient improvement following treatment.

Total of All Cases Treated.

Disease.	Total Cases.	Sympton Free.	Alive with Disease.	Total Alive.	Dead.
Breast Cases.	41.	22.	4.	26.	15.
Cerebral Cases.	16.	7.	1.	8.	8.
Glandular Cases.	40.	21.	5.	26.	14.
Sarcomata.	12.	3.	0.	3.	9.
Total Cases.	109.	53.	10.	63.	46.

Average survival period of all cases dying before 2 years.... $7\frac{1}{2}$ months.
Seven cases failed to respond to treatment and showed no improvement whatever before death.

VI.

DISCUSSION OF RESULTS.

Before dealing with the group results we may refer to certain general observations and to certain factors which influence the results.

Subjective symptoms during or following treatment and directly attributable to the treatment were rare,. One patient, in whom no cardiac abnormality was detected complained of persistent tachycardia and palpitation during the period for which the plaque was applied, and the pulse rate rose from 80 to 110 per minute within a quarter of an hour after the commencement of the treatment and remained at this rate for at least one hour after removal of the plaque. It is doubtful if this state of affairs was produced by the irradiation per se. Three patients who were given fairly large doses suffered from persistent vomiting towards the end of the treatment but this cleared up within one week of the conclusion of treatment. Slight nausea and anorexia was met with in about 20% of the cases treated, but this never assumed any serious proportions, and invariably ceased a few days after the full dose had been administered. Among the primary breast cases are included one severe case of exophthalmic goitre and several advanced cardiac lesions, but

in none of these cases was the patient seriously inconvenienced by the treatment. The mortality rate was nil, there being no case in which the death of the patient could have been attributed to the radium treatment. One severe radium burn was produced in a breast case, but this patient is still alive and the burn has largely healed. In one of the periosteal sarcomas some extensive sloughing in the axilla may have been as much due to an overdose as to the tumour fungating through the skin, but definite histological proof was lacking. Except for those two cases no accidents were met with, and none of the patients were greatly distressed by the resulting radium reaction, the peeling of the superficial epidermis being relatively painless.

One of the outstanding features of the results obtained was the marked response of the tumour to radium therapy as out of a series of 109 cases only seven showed no improvement following plaque treatment. Malignant cachexia was not by any means a contra-indication to treatment, as several of the patients who were seriously ill and had very advanced lesions responded at once to treatment, though, as a rule in these cases the rate of irradiation was slowed down somewhat, and where the patient was anaemic a close watch was kept on the blood count. The general condition of all cachectic patients improved considerably and an increase in body weight was noted in all seriously ill patients following treatment. Relief of pain was as a rule proportional to the degree of regression of the disease, and in those cases in which the disease completely disappeared, the relief of pain was absolute and as a rule has

remained so. Practically every case however, in which pain was a marked symptom was alleviated, at least temporarily, and this was especially noticeable in those patients with cervical glands who so frequently complained of auricular pain. Ulceration and discharge which was present in several of the breast cases and in one of the sarcomas, was rapidly diminished, and in most cases the ulceration completely healed over, though in two of the cases this healing was only temporary, and others subsequently died of metastases elsewhere, the ulcer remaining healed at death.

I. Breast Group. In considering the results obtained in this group it should be borne in mind that all the cases were inoperable, those in the recurrent group having previously been subject to surgical intervention, while all the primary cases had been rejected by the surgeons in charge as either too advanced, or as the general condition of the patient did not permit of amputation. Consequently no comparison between the results of radium treatment and the results of surgical treatment is possible. Out of a total of 41 patients, 22 were alive and apparently free from disease two years after the conclusion of treatment, while 4 more were also alive but with various stages of the disease still present. It is reasonable to assume that but for the radium plaque treatment those 26 patients would have been dead, as the average life of a patient with inoperable carcinoma of the breast untreated, does not by any means extend to two years after the inoperable stage has been reached. Apart altogether from the prolongation

of life, the use of radium plaques as a therapeutic medium is more than justified by the relief of pain and ulceration which can be relied upon to occur in almost every instance. The Medical Research Council (117) in referring to the statistics obtained by the use of radium plaques in the Cardiff Royal Infirmary, draws particular attention to the relief of pain in cases of referred pain from supraclavicular glandular deposits, and this was noticed also in our own series of cases. Further proof of the value of radium plaques in breast cancer is obtained from the reports of the London Radium Institute (118) where between 1918 and 1927, 633 cases received surface radium treatment. Of these cases only 164 had primary inoperable tumours, all the others suffering from hopeless inoperable recurrences after a previous amputation. The results obtained were encouraging, as 26 out of 128 survived for 3 years and 11 out of 98 for over 5 years - this at a time when the technique was far from perfect and when only the most hopeless cases were ever referred for radium treatment. Birkett (119) on the other hand, appears to doubt the efficiency of plaque treatment, but Adair (120) working at the Memorial Hospital in New York and in reviewing their results states that it is the only possible form of therapy to apply to post-operative recurrences of breast carcinoma.

II. Cerebral Tumours. All the cerebral tumours treated had previously been subjected to an exploratory craniotomy and a large flap of the bone had in every instance been permanently

removed. In most of the cases it was found that anything like the complete removal of the growth was impossible, and radium plaque treatment was instituted with the object of causing the absorption of the residual mass. That it achieved this in one instance was conclusively proved by the post-mortem examination of a case of oligodendroglioma who died following a subsequent operation. Of the sixteen cases treated, exactly half were alive after two years, but it is difficult to draw any very definite conclusions from this in view of the fact that of the eight surviving cases, two were oligodendrogliomas and three were astrocytomas, while only three of the spongioblastomas were alive, and of these latter three, one had signs of active disease. It is well known that oligodendrogliomas and astrocytomas are not by any means highly malignant and those 5 cases might have survived for two years irrespective of treatment. It should however be noted that those five cases were all symptom free, and while their survival for two years without treatment is quite possible, it is in the highest degree unlikely that any spontaneous remission of the symptoms would have occurred. The response of the spongioblastomas, was less satisfactory as 5 out of 8 were dead after two years and only two were symptom free. The position of radium therapy in the treatment of gliomatous tumours would appear to have been accurately summarised by Boyd (121) who says:- "as the treatment of gliomas by operation is so very disappointing the reaction to radium becomes of great importance. Bailey and Cushing come to the conclusion that no

glioma has ever been really cured by radium alone, although the rate of growth of the more malignant types may be controlled. It is also wise to employ radium after the removal of the more benign forms, as operation often seems to increase their malignancy".

III. Secondary Carcinoma of Glands. If we consider first those cases in which the primary growth was situated in the tongue we find that these cases are the least satisfactory in this particular group. Out of 14 cases having tongue primaries 5 are symptom free after two years, 3 alive with disease, and 6 dead. The most important factor in determining the survival of the patient appeared to be the degree of mobility of the glands, although the site of the primary also influenced the progress as those occurring in the posterior third of the tongue showed a higher mortality than in the anterior two thirds. Greenwood (122) has stated that the average natural duration of the life in patients with carcinoma of the tongue is 15.5 months, so that even two years symptom free period represents a considerable addition to the patient's life. Those cases in which the lip was the primary site of disease showed by far the best results in this group as out of 10 cases, 9 were alive and symptom free after two years. It should however be noted that in each of these 9 cases the glands were discrete and freely mobile at the commencement of treatment and that the deep cervical glands did not appear to be involved. While active disease was present in

all the above cases it is probable that all cases of malignant disease within the mouth would benefit from the application of a radium collar irrespective of whether palpable glands were present or not, as the Reports of the Mount Vernon Hospital (123) show very unsatisfactory results where this has been omitted.

The groin cases displayed much the same response to treatment as the cervical cases, the more satisfactory results in the penis group as compared to the female urethra primaries, being entirely due to the advanced condition of the lesion in the latter.

IV. Sarcomata. An outstanding feature of this group was the fact that every case showed, in the first instance, a marked response to treatment, the tumour always shrinking in size and, in some cases disappearing entirely. This favourable response however was not as a rule long maintained and the mortality rate was high, only three cases surviving for two years out of a total of twelve. The general impression formed was that radium had a very definite local action when first applied to the sarcoma, but no influence whatever in preventing metastases. All the periosteal sarcomas died, while the fibrosarcoma surviving was not of a very malignant type; the two lympho-sarcomatous patients who survived the two year period both had extensive cervical and axillary deposits orignally, but both mediastinal lympho-sarcomas died. These results are not so satisfactory as those in the other group, the survival rate being 25%. Colwell (124) actually quotes an isolated case of lympho-sarcoma surviving symptom free for seven years, while Harmer (125) in a series of 66 lympho-sarcomas of the upper air-passages obtained "good results" in 50% of cases, and Cade (126) states that lympho-sarcoma of the tonsil responds much better to irradiation than carcinoma of the same region. Our own results however are more in accordance with the collected statistics published by the Medical Research Council (127). This report gives a list of 110 cases from seven centres and shows that the survival rate in lympho-sarcomas is 24% after two years.

VII.

SUMMARY AND CONCLUSIONS.

1. A description is given of the developement of the radium plaque to present day methods, together with an account of the pathology of irradiation and the biological action of radium.

2. The principles underlying the technique of radium plaque treatment are discussed and a consideration is given of the problems of dosage and radium distribution. A description is included of the technique used in the writer's own series, and the advantages of split dosage and additional copper screens are described. A general survey of the available literature is included.

3. The results obtained in a series of 109 cases of malignant disease during a period of over two years are tabulated and discussed, and a full account is given of each individual case.

4. On the evidence available we may safely conclude that malignant growths, even when very advanced, may be made to disappear completely by means of radium plaques, for a period of upwards of two years and perhaps for much longer.

5.- These results vary according to the site and histology

1. History of Disc. & Use of Radium as a Therap. agent.

2. Biopsy not regarded as necessary.

3. Stim. effect of small doses of Radium on malig. cells doubted.

4. Grades of malignancy.

I. Highly differentiated, spiny cell, slow malignancy, low malignancy = Radio-resistant.

IV. Marked anaplasia, numer. cells of embryonic type = high malign. & radio-sensitive.

5. Technique –

6. Results – all cases – 109 – 53 – 10 ... all types.

41 – 22 4 Br.
16 – 7 – 1 ccx.
20 – 21 – 5 – El.
12 – 3 – 0.

7. Concl.

Split doses.

Necrosis negligible.

Bibliography. 127.

of the tumour, Secondary Glands from epithelioma of the lip being the most successful in the present series and periosteal sarcomas the least successful.

6. In these cases in which complete disappearance of the disease was not affected, there was usually marked reduction of the growth, together with relief of pain, ulceration and discharge, and an improvement in the patient's general condition sufficient to justify a return to work.

7. The mortality and risks of the treatment are altogether negligible, and there is little discomfort to the patient.

8. It is reasonable to assume that in time these results will improve with an increase of the radium-skin distance, and a simplification of the practical difficulties in the way of applying the mathematical principles underlying uniform radium distribution.

I am indebted to the Honorary Surgical Staff of the Mount Vernon Hospital, London, and the Royal Infirmary, Glasgow, for many personal favours, and for permission to refer to cases originally under their care.

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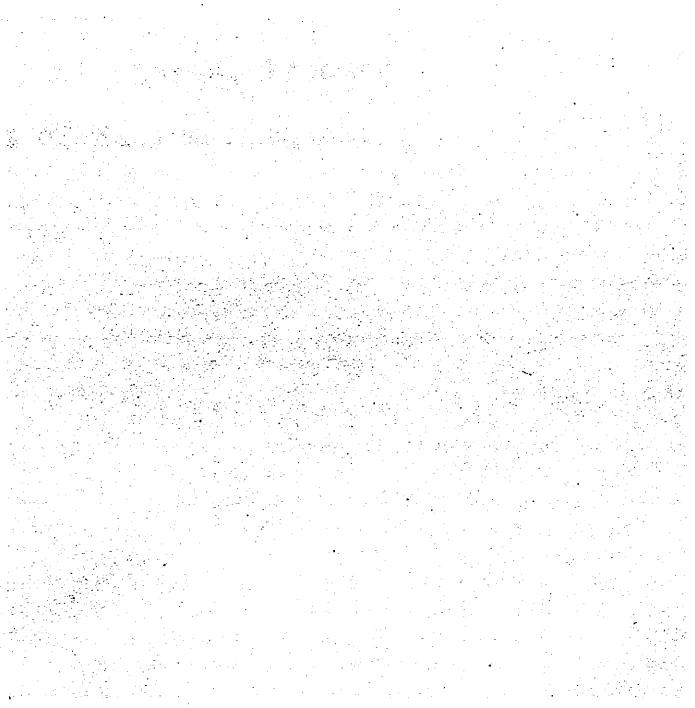

IX.

A P P E N D I X.

Notes on a Series of 109 cases of Malignant Disease treated by means of Radium Plaques.

Distribution of 109 Cases.

I.	**Carcinoma of Breast.**		
	(a) Recurrent carcinomas	30 cases	41 cases.
	(b) Primary carcinomas	11 cases	
II.	**Cerebral Tumours.**		
	Oligodendrogliomas	3 cases	16 cases.
	Astrocytomas	5 cases	
	Spongeoblastomata multiforme	8 cases	
III.	**Secondary Carcinoma of Glands.**		
	(a) Glands of Neck - Primary tongue	14 cases	40 cases.
	- Primary buccal mucosa .	6 cases	
	- Primary lip	10 cases	
	(b) Glands of Groin- Primary penis	6 cases	
	- Primary female urethra.	4 cases	
IV.	**Sarcomata.**		
	Periosteal sarcomas	5 cases	12 cases.
	Fibro-sarcomas	2 cases	
	Lympho - sarcomas	5 cases	
		Total.	109 cases.

1. Carcinoma of Breast.

(a) Recurrent carcinomas (30 cases).

Case No.1.

Hospital No.875. Mrs. B. aet. 52 years.

Three years prior to admission to hospital the patient had submitted to a radical amputation of the left breast, for an early carcinoma without glandular metastases.

She remained well for two years and nine months when a recurrence appeared near the scar of the operation wound. On examination a firm indurated nodule was found, about $1\frac{1}{2}$" in diameter and adherent to the skin and to the underlying structures. This nodule had been present for three months before treatment was commenced.

A rectangular permanent plaque - such as described in the preceeding pages - containing 280 milligrams of radium, and having an area of 370 square cms. and a Surface Intensity of .75 mgrs. of radium per sq. cm. was applied over the nodule and the surrounding skin for 4 hours per day for 23 days (92 hours). This resulted in a total dose of 25,760 milligram-hours. After the first ten days of treatment the nodule became progressively smaller, and an erythema appeared on the skin area covered by the plaque. This erythema soon changed to a deep purple, and peeling of the surface of the skin occurred a few days after cessation of treatment. When the whole dose had been given the nodule had almost completely disappeared, and the pain which had formerly been troublesome was no longer present. Two years later the patient was alive and well with no signs of disease and no complaint of pain.

Case No.2.

Hospital No.620. Miss J.W. aet. 44 years.

In Feb. 1929 the patient had a radical amputation of the right breast for carcinoma. She remained well until Oct. 1931, when she began to suffer pain in the upper part of the right arm, which she noticed was gradually becoming swollen.

On examination it was found that the anterior axillary fold and the upper third of the operation scar were hard and indurated, and obviously infiltrated with decondary carcinomatous deposits. Pain in the arm was now very severe and prevented sleep.

It was decided to irradiate the whole of the breast and lymphatic area, and for this purpose three large permanent plaques were used, as shown overleaf.

Area.	Mgrs.of Rad.	Surf.Intensity.	Time.	Dose.
Axilla.	160.	1mgr./sq. cm.	13days at 4hrs/day	8,320mgr.hrs.
Breast.	280.	.75mgrs./sq. cm.	27 " " " "	30,240 " "
Supraclav.	120.	.75mgrs./sq. cm.	23 " " " "	11,040 " "

Total Dose - 49,600 milligram hours.

The dose to each area was governed by the skin reaction, and the axillary plaque had to be stopped first, the supraclavicular next, and the large breast plaque last. An adequate erythema followed by peeling of the skin was obtained in all cases.

The pain completely disappeared, the induration vanished, and the patient's general condition was vastly improved.

She remained well for a further six months, and then she reported back to the hospital with a swelling on the spine of the right scapula, and an enlarged gland in the right supraclavicular fossa. The scar of the operation and the anterior fold of the axilla had remained well. Large permanent plaques were applied to the right scapula and the right supraclavicular as under:-

Area.	Mgrs.of Rad.	Surf. Intensity.	Time.	Dose.
Scapula.	280.	.75mgrs./sq. cm.	20days at 4hrs/day	22,400mgr. hrs.
Supraclav.	160.	1mgr./sq. cm.	17 " " " "	10,880 " "

Total Dose - 33,280 milligram hours.

The above second course of plaque treatment gave a very severe radium reaction; but the carcinomatous deposit, on the scapula, while smaller in size, was still present, and the supraclavicular gland was still palpable.

This case illustrates the futility of administering a second course of plaque treatment to an area which has previously been thoroughly irradiated. It also shows that the skin of very moist hirsute areas i.e. the axilla, tend to give a much earlier reaction than other areas, and consequently the axilla usually receives a smaller dose than the breast itself or the supraclavicular region. In a number of the succeeding cases e.g. Case No.3, the axillary plaque had to be discontinued before a full dose had been given, otherwise a radium burn with extensive sloughing of the axillary skin would certainly have resulted. The above patient died within four months from intra-thoracic metastases.

Case No.3.

Hospital No.851. Mrs. J.S. aet. 52 years.

This patient had a radical amputation of the left breast performed for carcinoma. At the time of the operation no glandular involvement could be detected and she was thought to be an early case. However, two months after the operation she reported with two hard indurated glands which were undoubtedly malignant situated above the middle third of the clavicle. She was accordingly referred for plaque treatment.

A permanent plaque containing 160 milligrams of radium, in an area of 160 sq. cms. and having a surface intensity of 1 milligram of radium per sq. cm. was applied to the supraclavicular area. In an attempt to supply "cross-fire" radiation to the base of the supraclavicular fossa a plaque was placed in the axilla containing 120 milligrams of radium in an area of 162 sq. cms. which gave the axillary plaque a surface intensity of .75 milligrams of radium per sq. cm.
The supraclavicular plaque of 160 mgrs. was worn for 21 days at 4 hours per day, giving a total dose to this area of 13,440 milligram hours.
The axillary plaque of 120 mgrs. was worn for 14 days at 4 hours per day, giving a total dose to the axilla of 6,720 milligram hours.

The glands completely disappeared and no trace of them could be found at the conclusion of treatment. Two years later no sign of any recurrence could be found.

The axilla did not tolerate radiation well, as the axillary plaque, despite its lower surface intensity had to be discontinued one week before the supraclavicular plaque, on account of an early radium reaction.

Case No.4.

Hospital No.853. Mrs. C. aet. 61 years.

The patient presented herself for treatment with a carcinomatous mass in the upper and outer quadrant of the left breast. The tumour was not fixed to the deep fascia, and the skin was not markedly involved, but two indurated glands were felt in the axilla. A radical amputation of the left breast was undertaken but it was found impossible to clear the axilla completely and one month after operation, the surgeon referred the patient for plaque treatment to the breast and lymphatic areas.

Large permanent plaques were applied as follows:-

Area.	Mgrs. of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgrs./sq. cm.	13days at 4hrs/day	14,560 mgr.hrs.
Axilla.	120.	.75 " " "	13 " " " "	6,240 " "
Supraclav.	160.	1 mgr. " "	13 " " " "	8,320 " "

Total Dose - 29,120 milligram hours.

Seven days after treatment had commenced the pulse rate rose to slightly over 100 per minute and remained high. The patient complained of great lassitude and slight nausea, with actual vomiting on one occassion. As a result of this, treatment was discontinued on the 13th day, and the patient's condition quickly returned to normal, and the pulse rate fell.

No radium reaction had been obtained when treatment was stopped, and it was felt that an insufficient dose had been given and that treatment should have been continued for at least another week. Eighteen months later the patient died with generalised metastases.

This case illustrates the adverse general effects sometimes produced when large quantities of radium are used at the same time; fortunately such cases are relatively uncommon, and as a rule treatment can be carried to an uneventful conclusion.

Case No.5.

Hospital No.508. Mrs. V.P. aet. 55 years.

This patient had previously had an interstitial radium needling of the breast for an undoubted carcinoma which had not infiltrated deeply, but which was associated with two enlarged axillary glands. Following the interstitial treatment the carcinoma and the glands disappeared, but four months later she reported at the hospital with a small superficial recurrence in the skin of upper and outer quadrant of the left breast. It was decided to treat this recurrence with a plaque, and a Columbia Paste plaque of 15mm. thickness was moulded to fit the breast and the skin surrounding the nodule. Fifty-two milligrams of radium distributed in fifty-two foci of one milligram each, and screened by 0.5 mm. of platinum, were applied to the surface of the Columbia Paste in such a manner as to give the irradiated area a surface intensity of 0.28 milligrams of radium per sq. cm. The plaque was worn for sixteen hours each day - in two split doses of eight hours each - for a period of eighteen days. At the end of the treatment

there was a well marked erythema of the skin, which was followed after about ten days by extensive peeling. The recurrent nodule of carcinoma had entirely disappeared, and when seen two years after the conclusion of treatment there was no evidence of disease in the breast or lymphatic area. The total dose administered by the plaque amounted in this case to 14,976 milligram-hours.

Case No.6.

Hospital No. 106. Mrs. A.P. aet. 55 years.

Three years prior to admission to hospital the patient had the right breast radically removed for a scirrhous carcinoma drawing up the right nipple; at that time no glandular involvement could be detected. She remained well for one year, when glands were found in the right supraclavicular region. These were treated at St. Mary's Hospital by a radium plaque; the details of this treatment are not available, but the patient states that it was followed by excessive peeling of the skin of the supraclavicular area, so it would appear that an adequate dose had been administered.

Two years later she reported to the Mount Vernon Hospital with what was undoubtedly a large mass of malignant glands in the right supraclavicular fossa, and stated that these had been present for nearly two months. Severe pain shooting down the right arm was the chief complaint, as it interfered very much with the patient's sleep.

Plaque treatment was instituted, and a large permanent plaque of 160 milligramms, with a surface intensity of 1 milligram of radium per sq. cm. was applied to the supraclavicular fossa for 4 hours per day for 21 days. Total dose - 13,440 milligram-hours.

A moderate reaction was obtained and the glands shrunk to about half their original size, but did not entirely disappear. Relief of pain however, was noticeable after the first week of treatment. The patient died six months later.

Here again as in Case No.2. we find great difficulty in successfully administering a second course of plaque treatment after an adequate first dose has been given.

Case No.7.

Hospital No.794. Mrs. E.G.P. aet. 47 years.

This patient had previously had a complete radium needling to the left breast and axillary areas, for a carcinoma of about 4 sq. cms. in size, which was associated with enlargement of the axillary glands. Three months later

she reported that she was suffering from a slight "tingling" sensation in the left arm and on examination a small indefinite gland was palpable in the left supraclavicular fossa. Plaque treatment was decided upon, and as the original carcinoma did not appear to have been completely absorbed it was thought advisable to irradiate the whole of the breast and lymphatic areas.

Large permanent plaques were applied as under:-

Area.	Mgrs.of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgr/sq. cm.	19 days at 4hrs/day.	21,280 mgr-hrs.
Axilla.	120.	.75 " " "	21 " " " "	10,080 " "
Supraclav.	160.	1 mgr. " "	21 " " " "	13,440 " "

Total Dose - 44,800 milligram-hours.

The dose was controlled by the skin reaction, and the breast plaque was discontinued two days before the others on account of slight sloughing of the nipple. A well marked erythema developed in all areas covered by the plaques. The supraclavicular gland had completely disappeared, and the patient stated that she no longer suffered from pain. Two months later the nipple had healed, and two years later the patient's local and general condition was excellent.

Case No.8.

Hospital No.375. Mrs. E.M. aet. 54 years.

A radical amputation of the right breast had been performed for an early carcinoma without glandular metastases, and one year later some minute nodules of recurrent carcinoma appeared in the scar of the operation wound, and in the surrounding skin. No evidence of deeply seated metastases was found, and consequently as great penetration of the gamma rays was not required, it was decided to apply a large plaque to the whole area of the breast, and to use a small quantity of radium - and consequently a low surface intensity - over a longer period of time than was usual.

A plaque of 15 mm. Columbia Paste was moulded to the breast, and fitted with 44 milligrams of radium in 22 foci of 2 milligrams each, and screened by 0.5mm. of platinum. As this relatively small quantity of radium was spread over a fairly large area, a low surface

intensity of 0.2 milligrams of radium per square cm. was obtained. The plaque was worn for eighteen hours each day (in two split doses of 13 & 5 hours) until a total of 450 hours had been given. The total dose received was 19,800 milligram-hours.

A diffuse and even erythema was obtained, and this was followed in seven days time by peeling of the surface of the skin. The skin nodules of carcinoma disappeared, and when seen six months later the patient was well and free from disease, but two years after treatment she had a cough suggestive of pulmonary metastases.

Case No.9.

Hospital No.630. Mrs. A.K. aet. 41 years.

A complete interstitial radium needling of the left breast and axilla had previously been performed on this patient for an operable carcinoma with two enlarged glands in the left axilla. An inadequate dose appears to have been given, for three months later the patient was found to have a small indurated area in the left breast, and the same pair of enlarged glands were still present in the left axilla.

It was decided to begin plaque treatment, and two large permanent plaques of 280 milligrams and 120 mgrs. were used as follows:-

Area.	Mgrs.of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgrs/sq. cm.	19days at 4hrs/day.	21,280 mgr-hrs.
Axilla.	120.	.75 " " "	19 " " " "	8,640 " "

Total Dose - 29,920 milligram-hours.

Both the mass in the breast and the axillary glands disappeared following this treatment, and when seen twentyfive months later there was no sign of recurrence.

In connection with the above case it is of interest to note that whereas it is nearly always useless to give plaque treatment to a recurrence from a primary which has also been treated by plaque the same does not hold good when the primary has been treated by interstitial radium needling. In cases Nos. 2 and 6 the difficulty of giving a second course of plaque treatment was seen, and in such cases the skin usually breaks down during the second course before an adequate dose has been delivered to the deeper structures. In the case discussed above however, the first treatment was given, not by plaque, but by interstitial radium needling, and this probably accounts for the success of the plaque treatment.

Case No.10.

Hospital No.799. Mrs. A.K. aet. 48 years.

This patient first presented herself for treatment with a well defined carcinomatous mass in the lower and outer quadrant of the right breast, and with one enlarged indurated gland in the corresponding axilla. She was treated by a complete interstitial radium needling, but reported four months later with a recurrence in the anterior fold of the right axilla. As there was also an indefinite fibrous mass at the site of the original tumour it was decided to treat the patient with a full course of large permanent plaques to all areas, as follows:-

Area.	Mgrs. of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgrs/sq. cm.	21days at 4hrs/day.	23,520 mgr-hrs.
Axilla.	120.	.75 " " "	21 " " " "	10,080 " "
Supraclav.	160.	1 mgr. " "	21 " " " "	13,440 " "

Total Dose - 47,040 milligram-hours.

At the conclusion of treatment a well marked erythema was present, followed in about eight days time by slight peeling of the superficial layers of the skin.

The recurrence entirely disappeared, but there was still a fibrous mass at the site of the original tumour. This case like the preceeding one, illustrates the value of plaque treatment in cases which have previously received interstitial radium needling. The mass was still present two years later, but patient had no complaints.

Case No.11.

Hospital No.703. Mrs. S.H. aet. 35 years.

This case bears a close resemblance to the preceeding one except that the patient is younger and consequently the prognosis is much less hopeful. Originally she had an early carcinoma of the right breast, without glandular involvement, and this was treated by a complete course of interstitial needling. Three months later a small gland hard and indurated, but not fixed, appeared in the right axilla, and she was referred by the surgeon for a full course of surface radiation by means of large plaques.

She received a course of plaque treatment in every respect similar to Case No. 10. the same three plaques being applied for the same period of time. A similar reaction was obtained with the disappearance of the gland. Ten months later she was alive and well and free from both pain and disease, but twenty months later she died.

Case No.12.

Hospital No.231. Mrs. O. S. aet. 50 years.

Eighteen months prior to admission the patient had a complete interstitial radium needling of the right breast for a carcinomatous mass measuring 6 x 4 cms. attached to skin but not to the deep fascia, and without any glandular metastases. Nothing untoward was noticed until two months prior to admission when a few skin nodules appeared in the region of the right anterior axillary fold. On examination three small nodules the size of a pea were found embedded in the axillary fold.

It was thought best, as deep penetration of the rays was not required in this case to give a small dose at each application, and to continue for a relatively long period with a plaque having a low surface intensity. It was considered that in this way a larger effective dose could be delivered to the skin without producing any undue reaction.

A plaque of "sorbo" rubber was constructed to fit the axilla, supraclavicular fossa, and upper part of breast; it had a thickness of 15mm. and was charged with 36 milligrams of radium evenly distributed over the whole surface, giving a surface intensity of 0.2 mgrs. of radium per square centimetre. This plaque was worn for eighteen hours each day (in two split doses of 13 & 5 hours each), until a total of 492 hours had been given.

Total Dose - 17,772 milligram hours.

A slight erythema developed, but was not followed by peeling of the skin. The skin nodules were no longer in evidence at the end of the treatment. Thirty months later no sign of disease was detected.

Case No.13.

Hospital No.758. Mrs. E.T. aet. 51 years.

Six months after a radical amputation of the left breast for an ulcerated cancer with enlarged axillary glands, the patient presented herself for treatment with a small nodule of recurrence about ¾" in diameter in the upper third of the operation scar, and with one enlarged gland in the left supraclavicular fossa.

A complete treatment with three large permanent plaques of 280, 120, & 160 milligrams was given:-

Area.	Mgrs. of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgrs/sq. cm.	21days at 4hrs/day.	23,520 mgr-hrs
Axilla.	120.	.75 " " "	21 " " " "	10,080 " "
Supraclav.	160.	1 mgr. " "	21 " " " "	13,440 " "

Total Dose.- 47,040 milligram-hours.

The response to treatment was satisfactory, and thirty months later the patient was alive and well with no sign of further recurrence.

Case No.14.

Hospital No.461. Mrs. L. G. aet. 65 years.

This patient had received a very full course of interstitial radium needling for a carcinoma 6 x 6 cms. in size in the left breast; the tumour being attached to the skin but not to the deep fascia; there was no glandular involvement. The reaction was very severe and a large raw area was left which took two months to heal. Five months later she was re-admitted to hospital with "neuritis" in the left arm, and on examination a mass of indurated glands was felt in the left supra-clavicular fossa.

Large permanent plaques were applied to the left supraclavicular fossa and to the breast as shown below, and on account of the previous large dose given by radium needles, the reaction was very carefully watched.

Area.	Mgrs./Plaque.	Time.	Dose.
Breast.	280.	11 days for 4hours/day.	12,320 milligr.-hrs.
Supraclavicle	160.	11 " " "	7,040 " "

Total Dose - 19,360 milligram-hours.

The above dose was somewhat less than that usually given to carcinomatous recurrences, but in this case a moderate radium reaction was obtained and the "neuritis" in the arm disappeared, while the mass of glands in the left supraclavicular fossa was much smaller. Two months after the cessation of treatment they had gone completely, and eighteen months later the patient was alive and well, but suddenly developed a cough and died from severe haemoptysis.

Case No.15.

Hospital No. 698. Mrs. E. G. aet. 46 years.

A swelling 4 x 6 cms. in size had been locally excised from the left breast under the impression that it was an innocent fibro-adenoma, but was reported as being carcinoma. The patient did not return to hospital until two months later when a palpable gland was found in the left supraclavicular fossa; nothing was felt in breast or axilla.

A large permanent plaque of 280 milligrams was applied over the breast, while a similar plaque with

160 milligrams of radium was applied to the supraclavicular region. The breast plaque was so applied that in this case (the patient being a small thin woman) that it served to irradiate the axilla as well as the breast.
Both plaques were worn for 4 hours per day for 25 days, giving a breast dose of 28,000 mgr.-hours, and a supraclavicular dose of 16,000 mgr.-hours, and thus a total dose of 44,000 milligram-hours. The result was eminently satisfactory, the supraclavicular gland being dispersed. Thirty months later the patient was alive and well without recurrence.

Case No.16.

Hospital No.776. Mrs. E. E. aet. 59 years.
For nearly three years the patient had noticed an occasional bloodstained discharge from the left nipple, and on examination a mass 4 x 3 cms. was felt beneath the nipple, which was markedly retracted. There was no glandular involvement. A complete radium needling was undertaken, and the patient remained well for nearly four months when it was found that tumour had commenced to extend.
She was then referred by the surgeon in charge for plaque treatment, which was given as shown below, three large permanent plaques being used.

Area.	Mgrs. of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgrs/sq. cm.	21days at 4hrs/day.	23,520 mgr-hrs.
Axilla.	120.	.75 " " "	21 " " " "	10,080 " "
Supraclav.	160.	1 mgr. " "	21 " " " "	13,440. " "

Total Dose - 47,040 milligram-hours.

The mass in the breast became smaller, but did not disappear. Three months later there was no change in her condition, the swelling remaining about the same size. Nine months after cessation of treatment she died from intra-pulmonary metastases.

Case No.17.

Hospital No. 498. Miss M. C. aet. 51 years.
This patient had a small carcinomatous mass in the left breast which was treated by interstitial radium needling; at that time there were no glandular deposits. Five months later the mass in the breast (which had disappeared following the radium needling) was found to have returned, and she was referred for plaque treatment.

A large plaque of 280 milligrams was applied to the breast for 4 hours per day for 21 days, thus giving a total dose of 23,520 milligram-hours. As a result the tumour almost entirely disappeared, except for a small nodule which had resisted all treatment.

For eight further months she remained free from symptoms, and then pain developed in the left arm, and examination revealed the fact that a mass of glands was present in the supraclavicular fossa, while one discrete gland could be felt in the axilla. Additional plaque treatment was decided upon, and she was given a plaque of 160 milligrams to the left supraclavicular fossa, and a plaque of 120 milligrams to the axilla. Both plaques were worn for 4 hours each day for 9 days, giving a dose of 5,760 milligram-hours to the supraclavicular fossa, and 4,320 milligram-hours to the axilla. At the conclusion of treatment the pain had entirely vanished, but as the plaques had to be discontinued on account of a premature radium reaction, an insufficient dose had been given and the enlarged glands while very much smaller were still present.

Three months later the patient died from generalised metastases.

Case No.18.

Hospital No. 683. Mrs. J. B. aet. 52 years.

In September 1931 the patient had a radical amputation of the right breast, and in January 1932 a mass of hard indurated glands was detected above the middle third of the right clavicle. She also complained of severe pain and swelling of the right arm.

Three large permanent plaques were applied as under:-

Area.	Mgrs. of Ra.	Surf. Intensity.	Time.	Dose.
Breast.	280.	.75mgrs/sq. cm.	15days at 4hrs/day.	16,800 mgr-hrs.
Axilla.	120.	.75 " " "	15 " " " "	7,200 " "
Supraclav.	160.	1 mgr. " "	15 " " " "	9,600 " "

Total Dose - 33,600 milligram-hours.

A slight radium reaction was produced, and the treatment was stopped, as the glands had entirely disappeared, and the patient was free from pain. The oedema of the right arm, however still remained, and was not affected by the radium.

The dose administered in this case was less than usual, but it was felt that there was no point in proceeding further, as a reaction had been obtained, and the patient was free from symptoms.

Unfortunately the patient returned to hospital four months later with the right supraclavicular fossa filled by a hard mass of glands. There was also some diffuse indefinite fullness of the left supraclavicular region which had not been present formerly.

Plaque treatment was applied to each supraclavicular fossa, the same plaque of 160 mgrs. being applied in turn to each fossa for 4 hours per day for 24 days. This resulted in each fossa receiving a dose of 17,760 milligram-hours, and as the plaque had a surface intensity of 1 mgr. of radium per sq. cm., this may be regarded as a very full dose. A very marked radium reaction resulted in both supraclavicular fossae, that on the right side being particularly severe. In both cases the glands entirely disappeared. Two years later the patient was alive and well, and there was no sign of recurrence. Some swelling of the right arm however, was still present.

In connection with this case it is interesting to note that in this instance a second course of plaque treatment gave what may be regarded as a moderately successful result, in contradistinction to Cases Nos. 2 and 6 where a second course was eminently unsuccessful. It should however, be noted that in the present case, the first course of plaque treatment was inadequate, as only a small dose was administered. This is almost certainly the reason for the success of the second course of treatment; but, on the other hand, if a full course had been given in the first instance, then the necessity for the second course might not have arisen.

Case No.19.

Hospital No. 507. Mrs. J. A. aet. 57 years.

This patient had had an early carcinoma of the left breast, without glandular involvement, treated by complete interstitial radium needling. The tumour disappeared and she remained well for nearly six months, when an indurated area which was certainly carcinomatous in nature, appeared along the outer margin of the pectoralis major.

A large permanent plaque of 280 milligrams of radium was applied over the area for 4 hours per day for 20 days, giving a total dose of 22,400 milligram-hours.

A moderately severe radium reaction resulted, and the recurrence completely disappeared. Two years later she was alive and well, and free from disease, although there was a residual area of fibrous thickening at the site of the primary growth in the breast.

Case No.20.

Hospital No. 903. Mrs. F. B. aet. 43 years.

A radical amputation of the left breast had been performed for what was proved to be an early carcinoma without apparent glandular metastases. Two months later a few hard indurated glands appeared in the left supra-clavicular fossa, and these were treated by radium plaques as follows:-

Area.	Millg. of Ra.	Surf. Intensity.	Time.	Dose.
Axilla.	120.	.75mgrs/sq. cm.	21 days at 4hrs/day.	10,080 mgr-hr.
Supraclav.	160.	1 mgr. " "	21 " " "	13,440 " "

Total Dose - 23,520 milligram-hours.

In this case the plaque to the supraclavicular region was reinforced by a plaque to the axilla, in an endeavour to irradiate the deeper portions of the supraclavicular fossa from below. The axilla tolerated the radium very well, and it was possible to apply both plaques for the same time. In case No. 3 where a similar attempt to irradiate the base of the fossa was made, the axillary plaque had to be discontinued prematurely.

As a result of the above treatment, the glands disappeared, and ten months later were still completely absent, but two years later she died from generalised metastases.

Case No. 21.

Hospital No. 892. Mrs. B. P. aet. 47 years.

This case bears a very close resemblance to the preceeding one. The patient had submitted to a radical amputation of the right breast for what was thought to be an early carcinoma without enlarged glands.

Unfortunately, about five weeks after operation a few discrete, indurated glands were detected in the right supraclavicular fossa. These were treated by the application of a plaque of 160 milligrams to the area for 4 hours per day for 21 days, giving a total dose of 13,440 milligram-hours. The glands disappeared as a result of treatment, an adequate radium reaction having been obtained.

It was not possible in this case to irradiate the supraclavicular fossa from below, by applying a plaque to the axilla, as the axillary scar of the operation wound has not completely healed when plaque treatment was commenced. Two years later there was no sign of recurrence.

Case No. 22.

Hospital No. 862. Mrs. L. C. aet. 61 years.

Radical amputation of the left breast was undertaken in 1922 for carcinoma without glandular metastasis (proved histologically). In 1924 a similar operation was performed on the right breast for a second early carcinoma (also proved histologically). In June 1932 - ten years after the primary operation - she presented herself with a definite recurrence in the left side of the chest wall. A firm indurated mass adherent to the skin, and about the size of a golf ball, was found about one inch medial to the scar of the left breast. An ulcer $\frac{3}{4}$ of an inch in diameter was present on the surface of the mass.

Treatment was commenced with a plaque of 160 milligrams of radium with an area of 160 square centimetres, and this was worn for 4 hours each day for 23 days, giving a total dose of 14,720 milligramme-hours. A moderate skin erythema was produced, the mass became softer, and the ulcer showed signs of healing. One month later the ulcer had completely healed, but as there was still some induration the same plaque was re-applied to the residual mass for 4 hours per day for 13 days, giving an additional dose of 8,320 milligramme-hours.

Twentytwo months after cessation of treatment the patient was re-examined and was found to be free from disease, the only sign being some pigmentation of the area irradiated.

Case No. 23.

Hospital No. 844. Mrs. M. C. aet. 66 years.

In February 1931 the patient submitted to a radical amputation of the left breast for carcinoma; she remained well until July 1932, when a small nodule appeared in the upper and inner quadrant of the right breast. This nodule was excised locally and was found to be carcinomatous in nature. Six weeks after the operation it recurred, and a few enlarged indurated glands were now detected in the right supraclavicular fossa.

A large plaque of 280 milligrammes was applied to the breast area, while a plaque of 160 milligrammes was placed over the supraclavicular fossa. Both plaques were worn for 4 hours per day for 20 days, resulting in a dose of 22,400 milligram-hours to the breast area and 12,800 to the supraclavicular. Total dose - 35,200 milligram-hours.

One year later both the nodule in the breast and the supraclavicular glands had disappeared, and the patient was leading an active life, but eighteen months later she died from pulmonary metastases.

Case No.24.

Hospital No. 688. Mrs. E. C. aet. 53 years.

In April 1931 the patient noticed a swelling in the right axilla, and this was subsequently excised and found to contain spheroidal carcinoma of the mammary type although no primary neoplasm could be detected in the breast. In January 1932 the axillary swelling recurred, and the patient was admitted to the Mount Vernon Hospital and received a full course of interstitial radium needling to the right breast and axilla; this was followed by complete disappearance of the axillary mass of glands. She remained well for six months, but in August 1932 reported with a recurrent mass of glands in the anterior fold of the right axilla. Further interstitial treatment being considered impossible she was referred for radium plaque treatment. At no time had the primary growth been discovered.

A permanent plaque of 120 milligrammes was folded round the anterior wall of the axilla and was worn for 4 hours each day for 21 days. Total dose - 10,080 milligram-hours. Despite the fact that a well-marked erythema resulted, no real improvement in the local condition took place.

Six months later - in January 1933 - the growth had extended widely in all directions, and in March 1933 the patient died from intrathoracic metastases.

The complete failure of plaque treatment in this case, to make any effect on the tumour, may be explained by the very heavy interstitial radiation which had previously been administered to the same area, and by the fact that the actual growth had been cut into, thereby greatly increasing the risk of metastasis.

Case No.25.

Hospital No. p. p. 28. Mrs. L. C. aet. 53 years.

In April 1932 the right breast was radically removed for carcinoma without any obvious glandular involvement. In August 1932 a firm indurated malignant gland was found in the right axilla, and it was decided to irradiate the axilla, breast, and supraclavicular area by plaques as shown below:-

Area.	Mgrs. of Ra.	Surf. Intensity.	Time.	Dose.
Axilla.	160.	1 mgr./ sq. cm.	21 days at 4hrs./day.	10,080 mgr-hrs.
Breast.	280.	.75mgrs. " "	21 " " " "	23,520 " "
Supraclav.	120.	.75 " " "	21 " " " "	13,440 " "

Total Dose - 47,040 milligram-hours.

Two years later she was alive and apparently free from disease.

Case No. 26.

Hospital No.366. Mrs. M. S. aet. 74 years.

In November 1930 the patient had received a full course of interstitial radium needling for an extensive carcinoma of the breast with glandular involvement of the axilla. Following treatment the mass in the breast became much smaller but did not entirely disappear, while the axillary glands totally vanished. She remained fairly well until November 1932 when she presented herself for examination with a large recurrence of the primary growth, but without any recurrence in the lymphatic area. The skin of the left breast was massively indurated over an area of 10 x 10 cms. and while not actually ulcerated, it was erythematous, nodular, and firmly adherent to the chest wall.

A circular plaque of 15 mm. thick Columbia Paste was constructed, having an area of 165 square cms., and this was charged with 80 milligrammes of radium in 80 foci of 1 milligramme each, giving the plaque a surface intensity of 0.5 milligrammes of radium per square cm.
This plaque was applied over the affected breast for 18 days at 12 hours per day (in split doses of 3 x 4 hours), giving a total dose of 16,960 milligramme-hours. A definite skin erythema was produced in the normal skin surrounding the tumour, while the surface of the growth peeled a few days after cessation of treatment. The induration was less dense, and the whole breast felt much softer.

Two months later the patient died of internal secondary deposits, which had not been suspected when plaque treatment was instituted.

Case No. 27.

Hospital No.886. Miss E. T. aet. 73 years.

In 1924 the patient had the left breast amputated for what was stated to be an early carcinoma, and the operation was followed by a full course of deep X-rays, presumably as a prophylactic measure. She remained well until 1928 when a recurrence developed over the left sterno-clavicular joint, which was treated in a provincial hospital by interstitial radium needling (dose unknown). The patient states that an ulcer developed at the site of the radium treatment early in 1929 and that she was told that all further treatment was useless. For over two years this ulcer extended gradually in size, and on examination in August 1932 a large area 6" x 5" was occupied by the ulcer which was centred over the manubrium sterni. The margins of the ulcer were heaped up, and histological

examination proved that the ulcer was carcinomatous in nature.

On account of the previous X-ray and radium treatment, plaque therapy was commenced very cautiously and the following plaques were applied to the ulcerated area, breast and lymphatics.

Area.	Mgrs. of Ra.	Surface Intens.	Time.	Dose.
Breast.	280.	.75mgrs./sq. cm.	15days at 2hrs./day.	8,400 mgr.-hrs.
Axilla.	160.	1 mgr. " "	15 " " "	4,800 " "
Ulcer.	120.	.75mgrs. " "	5 " " "	1,200 " "

Total Dose - 14,400 milligramme-hours.

In the ulcerated area a very early radium reaction was obtained, which seemed to indicate that the previous radium treatment had been in the nature of an overdose.

The ulcer bagan to epithelise almost immediately and three months later was reduced to the size of a florin. When seen twentyfour months after cessation of treatment it was about the same size but had a firm scab on the surface which did not require a dressing. The patient stated that she felt well and was able to perform all her household duties.

Case No. 28.

Hospital No. 744. Mrs. K. B. aet. 49 years.

For four months the patient had been aware of a swelling in the outer and lower quadrant of the right breast. On examination an indurated mass attached to skin over an area of 10 x 8 cms. was discovered, and two enlarged indurated glands were present in the axilla. This was treated by a full course of interstitial radium needling to breast and lymphatic areas, but four months later she reported with extensive secondary deposits over the skin of the right breast. The original swelling in the right breast had almost completely disappeared, but numerous skin nodules of growth were present all over the lower half of the breast. The axillary glands were still present though smaller than previously.

It was decided to treat the recurrence with a plaque, and a sorbo rubber plaque of 15 mm. thickness was prepared and fitted with 60 milligrammes of radium in 80 foci, distributed equally over the whole area of the breast and axilla. This plaque was worn for 10 hours

each day for 13 days, (in split doses of 2 x 5 hours) Total Dose - 7,800 milligram-hours. At the end of that time a uniform erythema had been obtained all over the right breast and axilla, and the skin nodules were much softer.

When seen three months after this course of plaque treatment the skin recurrences had disappeared and were replaced by areas of brownish pigmentation. The axillary glands were no longer present. Two years after treatment her condition remained as above, and she had no complaints.

Case No. 29.

Hospital No. 646. Mrs. M. R. aet. 67 years.

This patient had submitted to a radical amputation of the right breast for an extensive carcinoma with glandular metastases in the axilla. She remained well for nearly eighteen months when skin nodules of carcinoma appeared in the region of the operation scar. Some oedema of the right arm had developed a few months after the operation but as this did not increase in size it was attributed to the surgical removal of the lymphatics and not to recurrence.

The skin nodules were treated by means of a Columbia Paste plaque covering the whole breast area and carrying 80 milligrammes of radium. This was worn for 12 hours per day in split doses for 27 days giving a total dose of 25,920 milligram-hours. At the conclusion of treatment the skin had peeled slightly and all the nodules of growth had disappeared all over the irradiated area, but it was noticed that fresh skin nodules had appeared in the lower part of the axilla just outside the area of irradiation. To these new nodules a Columbia Paste plaque of 78.5 milligrammes was applied for 12 hours per day for 18 days, giving an additional dose of 16,956 milligram-hours. These nodules also disappeared, but fifteen days later further skin recurrences were detected over the lateral aspect of the right hip. These were treated by a sorbo rubber plaque of 30 milligrammes for 15 hours per day (3 x 5 hours) for 16 days, giving a total dose to the hip region of 7,200 milligram-hours; again the skin nodules vanished.

The patient remained well and free from discomfort for a further five months when she developed a carcinoma in the opposite breast which was rapidly followed by intra-pulmonary metastasis and death.

One interesting feature of this case is the rapidity with which the nodules of skin recurrence disappeared under plaque treatment, only to reappear again outside the irradiated area.

Case No. 30.

Hospital No. 617. Mrs. E. J. aet. 44 years.

This case has been introduced in order to demonstrate the dangers attendant upon the use of interstitial radium needling and radium plaque treatment at one and the same time.

In November 1931 the patient presented herself for treatment with a carcinoma of the upper and outer quadrant of the left breast, associated with one small indurated gland in the axilla. Interstitial radium needling was decided upon and 89 milligrammes of radium in the form of needles was inserted into the growth and surrounding lymphatic areas, there being an especially heavy concentration of radium in the region of the growth. As the overlying skin exhibited "peau d'orange" the surgeon resolved to treat this with a radium plaque, and in order to save time this was combined with the interstitial needling. A Columbia Paste plaque containing 50 milligrammes of radium on an area of 150 square centimetres (surface intensity 0.33mgrs. per sq. cm.) was applied to the skin over the tumour and this was worn constantly without intermission for one week while the radium needles were also in position beneath.

Dose by needles - 89 mgrs. for 168 hours - 14,952 mgr-hrs.
Dose by plaque - 50 " " " " - 8,400 " "

Total Dose - 23,352 milligram-hours.

This produced a considerable skin reaction and the tumour became very much smaller. Three months later however, in January 1932 the patient reported with extensive sloughing of the breast tissues at the site of the plaque and it was at once obvious that a severe radium burn had been inflicted. This sloughing continued through breast, muscle and ribs, until finally the pleura was exposed in places.
The first photograph shows the condition of the breast in February 1932. The burn healed with extreme slowness and the second photograph shows the breast exactly one year later in February 1933, where it will be noticed that while much smaller, there still remains a very considerable raw area.

This case illustrates in a somewhat extreme form the dangers of producing a radium burn by applying a plaque on top of buried radium needles. The explanation lies in the fact that the gamma rays from the plaque impinge on the buried needles and set up secondary beta rays which produce local necrosis of the tissues which extends rapidly under the influence of superadded infection. The patient is still alive and is able to walk about a hospital ward, but the functions of the left arm have been seriously interfered with.

Case No. 30.

1. Carcinoma of Breast.

(b) Primary carcinomas (11 cases).

Case No. 31.

Hospital No. 787. Mrs. L. M. aet. 75 years.

This patient had a large indurated fungating mass which almost entirely replaced the left breast and had been present for eight years. The growth was somewhat atrophic and was of the slowly growing type found in elderly subjects. Numerous small nodules of tumour were present in the skin surrounding the fungating area, and a few discrete glands could be felt in the left axilla.

She received a full course of treatment by means of permanent breast plaques as under:-

Region.	Plaque.	Area.	Surf. Intensity.	Time.	Dose.
Breast.	280mgrs.	370 sq.cm.	0.75mgrs/sq. cm.	4hrs x 22days.	24,640mgr-hr
Axilla.	120 "	160 " "	0.75 " "	" 4 " x 20 "	9,600 " "
Supracl.	160 "	160 " "	1 mgr. "	" 4 " x 22 "	14,080 " "

Total Dose - 49,320 milligram-hours.

The axillary plaque was discontinued 2 days before the others on account of an earlier reaction developing. A marked erythema followed by peeling of the skin occurred shortly after the conclusion of treatment, and the skin nodules and axillary glands had disappeared. A fortmight after the end of the treatment the growth was only $\frac{1}{4}$ of its original size and the patient's general health was very much improved. Two and a half years later there was no sign of tumour whatever. A small fibrotic area in the breast and pigmentation of the skin, were the only residual evidences of disease.

Case No. 32.

Hospital No. 864. Mrs. A. H. aet. 58 years.

This patient presented herself for treatment with an ulcerated carcinomatous mass about 2" in diameter, in the lower and inner quadrant of the right breast. The mass was firmly adherent to the chest wall, but X-rays did not reveal any lung secondaries or involvement of ribs. The swelling was first noticed ten months prior to seeking advice, and had been ulcerated for six months. No enlarged glands were detected, either in the axilla or supraclavicular region.

A large plaque of Columbia Paste was made, having a radium skin distance of 15 m.m., and was fitted over the supraclavicular, axillary and pectoral regions. The plaque was charged with 100 milligrams of radium in 100 foci of 1 mgr. each in needles screened 0.5 m.m. of platinum. The arrangement of the needles was such that a surface

intensity of 0.5 milligrams per sq. cm. was obtained over the actual area of growth and the surface intensity over the remainder of breast, axilla and supraclavicular area was 0.25 milligrams per sq. cm. The plaque was worn for 12 hours per day, (in 3 split doses of 4 hours each) until 42,000 milligram-hours had been given. The mass was gradually absorbed and a typical skin reaction developed.

Examined two months after cessation of treatment the growth was represented by a small granulating area about ½" in diameter. There was no induration of the surrounding area and the patient had put on weight. Two years after treatment she was alive and well with no sign of disease.

Case No. 33.

Hospital No. 797. Mrs. S. W. aet. 68 years.

Six months prior to admission the patient had noticed a small ulcerated area beneath the left nipple. This ulceration gradually extended until it completely surrounded the nipple, which became markedly retracted.

On examination an ulcerated erythematous area about 2" in diameter completely surrounded and replaced the left nipple and areola. A clear serous exudate was oozing freely from the surface. No palpable swelling was detected in either breast and there did not appear to be any glandular involvement. Clinically the case resembled a typical Paget's Disease of the nipple, but a small portion was removed for examination and it was shown that the ulceration was due to direct invasion by a spheroidal-celled carcinoma which had infiltrated the sub-cutaneous tissues and carium. There was no chronic inflammation or hyperplasia of squamous epithelioma nor were any Paget's bodies found.

A square plaque of 15 m.m. sorbo rubber was constructed having an area of 400 sq. cms. and containing 30 milligrams of radium in 60 foci (60 needles of 0.5 milligrams each, screened 0.5 m.m. Platinum and giving a surface intensity of .075 milligrams per sq. cm. This plaque was worn for 15 hours per day (in split doses of 5 hours each 3 times per day for a total of 32 days) giving a total radium dosage of 14,800 milligram-hours.

There was considerable erythema of the skin followed by very extensive peeling (probably due to omission of a copper screen). This healed up well however and the ulcerated nippular area scarred over. When seen 26 months later the patient was well and apparently free from disease.

Case No. 34.

Hospital No. 823. Mrs. S. G. aet. 52 years.

This patient had a superficial carcinomatous growth measuring 3 x 4 cms. present in the lower and inner quadrant

of the left breast. There was no ulceration although the mass was bulging through the skin to which it was firmly adherent. There was no apparent glandular involvement. The patient refused operation and so plaque treatment was commenced.

Large permanent plaques of 280 mgrs., 160 mgrs., and 120 mgrs. were applied respectively to breast, supraclavicular region and axilla for 4 hours per day for 14 days, giving the following doses:- Breast - 15,680 mgr-hrs.

Supraclavicular- 8,960 " "

Axilla - 6,720 " "

Total Dose - 31,360 milligram-hours.

There resulted a moderate radium reaction and the swelling became much softer and smaller, but did not entirely disappear.

Six months later there was very little change - the malignant mass in the breast was still present, but had not extended in any way and was much the same as when first seen. Two months later the patient died from intra-pulmonary secondary deposits.

Case No. 35.

Hospital No. 887. Mrs. S. K. aet. 76 years.

This woman had a carcinoma of left breast of three years duration. A large ulcerated mass was present in the upper and outer quadrant of the left breast. A raised and ulcerated edge was present resembling that of a rodent ulcer, numerous small skin nodules were found in the surrounding area. No enlarged glands could be detected but there were several nodules in the anterior axillary fold which appeared to be mainly in the skin.

The breast itself was very atrophic and the growth was obviously of a very slow growing type.

On account of the general debility of the patient any active surgical measures were completely ruled out, and she was referred for plaque treatment.

A plaque of 15 m.m. "sorbo" rubber was constructed, having an axillary extension and a screen of 1 m.m. copper was incorporated. The plaque was loaded with 40 mgrs. of radium distributed in 40 foci of 1 mgr. each and was worn for three days at 18 hours per day and then for 8 days at 16 hours per day, giving a total of 182 hours and a dose of 7,280 mgr-hrs. In this case on account of the very thin chest wall and the ulcerated nature of the growth and the atrophic condition of the skin, a radium burn was to be feared, and for this reason a copper screen was incorporated and the total dose carefully controlled.

As a result all the outlying nodules around the growth in the axilla, entirely disappeared and the ulcer healed over, while the central mass itself became much smaller. The patient's general condition was much improved. Twenty-five months later patient was alive and well but a small residual area of induration was still present in the left breast. It was impossible to be certain whether this area consisted of malignant tissue or of the fibrous tissue which so frequently replaces a malignant mass which has been irradiated.

Case No. 36.

Hospital No.900. Mrs. E. C. aet. 64 years.

This patient presented herself for treatment with a swelling in the upper and inner quadrant of the left breast which had been present for over six months. On examination a firm indurated mass adherent to skin and measuring 6 x 5 cms. was found and associated with this there was involvement of the axillary glands. The patient suffered from advanced exophthalmic goitre which rendered all operative measures impossible and consequently plaque treatment was undertaken as follows:-

Area.	Plaque.	Surf. Intensity.	Time.	Dose.
Breast.	280mgrs.	0.75mgr./ sq. cm.	15 days x 4 hrs.	16,800 mgr-hrs.
Supraclav.	160 "	1 mgr. " "	15 " x 4 "	9,600 " "
Axilla.	120 "	0.75mgr. " "	15 " x 4 "	7,200 " "

Total Dose - 33,600 milligram-hours.

An erythema of the skin was obtained after 15 days and treatment was stopped, at this time the swelling in the breast had diminished considerably in size, but the patient's general condition was very poor. The improvement in the local condition was not maintained and four months later the carcinomatous mass had regained its former size, while the supraclavicular glands were involved.

Six months later she died from extensive secondary deposits.

Case No. 37.

Hospital No. 898. Mrs. F. D. aet. 50 years.

The whole of the left breast was involved by a scirrhus carcinoma and enlarged glands were present in both axilla and supraclavicular fossa. The patient gave a history of eight months duration. The condition was hopelessly inoperable and as considerable pain was complained of, it was resolved to try plaque treatment, which was given as follows:-

Area.	Plaque.	Time.	Dose.
Breast.	280 mgrs.	21 days at 4 hrs./day.	23,520 mgr-hrs.
Supraclav.	160 "	21 " " 4 " "	13,440 " "
Axilla.	120 "	21 " " 4 " "	10,080 " "

Total Dose - 47,040 milligram-hours.

Considerable radium reaction resulted and temporary shrinkage of the growth occurred, but four months later the surface of the breast had ulcerated and the tumour appeared to be increasing in size. Death occurred seven months after the treatment had been discontinued.

Case No. 38.

Hospital No. 923. Mrs. N. P. aet. 60 years.

For five months the patient had noticed a small swelling over the inner third of the clavicle and also a small swelling in the corresponding axilla. No tumour could be detected in the breast, but a gland removed from the axilla was found hystologically to contain spheroidal celled carcinoma presumably derived from a primary hidden in the deeper structures of the breast. Plaques were applied as follows:-

280 mgrs.	to Breast	for 86 Hours	-	24,080	mgr-hrs.
160 "	" Supraclav.	" 86 "	-	13,760	" "
120 "	" Axilla.	" 86 "	-	10,320	" "

Total Dose - 48,160 milligram-hours.

The glands in both supraclavicular fossa and axilla completely disappeared and two years later the patient was alive and well with no demonstrable signs of disease.

Case No. 39.

Hospital No. 567. Miss C. S. aet. 56 years.

For one year this patient had noticed some retraction of the nipple together with a swelling in the axillary tail of the breast. More recently this swelling had ulcerated. Examination revealed enlarged axillary glands and considerable oedema of the left arm.

She refused all operative interference but consented to plaque treatment.

A 280 mgrs. plaque was applied to the breast, a 160 mgrs. plaque to the axilla and a 120 mgrs. plaque to the supraclavicular area, all for 4 hours each day. The 280 mgrs. plaque had to be stopped after eleven days on account of an early radium reaction

in the skin surrounding the ulcerated area. The 120 mgrs. plaque was worn for 21 days and the 160 mgrs. plaque for 16 days. She was then given one month rest and treatment was recommenced as before, but during the second application the 280 mgrs. plaque was stopped after 9 days and the 120 and 160 mgrs. plaques after seventeen days.
Total Doses are as follows:-

Area.	1st. Treatment.	2nd. Treatment.
Breast.	12,320 mgr-hrs.	10,080 mgr-hrs.
Axilla.	10,240 " "	10,880 " "
Supraclav.	10,080 " "	8,160 " "

Two months after cessation of treatment the ulcer had almost completely healed (the breast was softer) and the oedema of the arm was much less.

One year later her condition was almost the same, some residual induration was present in the breast and a trace of oedema remained in the arm.

Case No. 40.

Hospital No. 565. Mrs. R. W. aet. 47 years.

For two years the patient had been aware that there was retraction of the nipple and a swelling in the breast. On examination the whole of the left breast was found to be infiltrated with a hard growth which extended up towards the axilla. The skin was extensively involved, but not ulcerated, while enlarged glands were present in both axilla and supraclavicular regions. Gross oedema of the left arm was also present. This case was so hopelessly advanced that any form of the treatment was considered futile, nevertheless it was decided to attempt plaque theopy.

Plaques of 280 mgrs., 160 mgrs., and 120 mgrs. respectively were applied to breast, supraclavicular area and axilla for 4 hours each day for 24 days and the 160 mgrs. plaque was also applied to the breast for an additional 5 days.
Total doses were as follows:-

Breast	30,000	milligram-hours.
Axilla	11,520	" "
Supraclavicular	15,360	" "
	56,880	" "

A severe skin reaction was produced as shown in the first photograph, but when this had passed off the breast was softer and the oedema of arm much less. The second photograph taken

Case No. 40.

4 months later shows how the breast has fallen to its original position, it was soft and pendulous, but a mass was still present deep to the nipple. Two years after treatment the patient was alive and free from pain only slight oedema of the arm being present. She had put on weight and was able to undertake all her household duties.

Case No. 41.

Hospital No. 706. Miss N. B. aet. 47 years.

For nine months the patient had noticed a hard mass in the left breast, and on examination a carcinomatous mass 4 x 4 cms. was found in the upper and outer quadrant. The mass was attached to skin, but not to the deeper structures; the nipple was retracted, but no glandular involvement could be detected. This case was eminently suitable for operation, but as the patient suffered from advanced mitral stenosis, an anaesthetic was impossible and plaque treatment was decided upon.

Plaques were applied as follows to breast, axilla and supraclavicular areas.

Area.	Plaque.	Surf. Intensity.	Time.	Dose.
Breast.	280 mgrs.	0.75 mgrs/sq. cm.	22days at 4hrs/day.	24,640 mgr-hrs.
Axilla.	120 "	0.75 " " "	22 " 4 " "	10,560 " "
Supraclav.	160 "	1 mgr. " "	22 " 4 " "	14,080 " "

Total Dose - 49,280 milligram-hours.

The above treatment produced a well marked radium reaction and one month later the mass was half its original size. When examined two years after treatment the breast was normal except for a small area of induration the size of a pea- probably fibrous tissue - there was no sign of metastasis, but the condition of the heart had not improved.

11. Cerebral Tumours. (16 cases.)

Case No. 42.

Hospital No. 189. Mr. R. B. aet. 32 years.

For a period of nearly two years the patient had suffered from fainting attacks of short duration with complete loss of consciousness, also severe headaches, vomiting (latterly projectile in character) and increasing dimness of vision. Slight aphasia was present, but no ataxia or muscular pareisis.

In an attempt to remove the symptoms a large osteoplastic flap of bone had been removed from the left tempero-parietal region. A large tumour had been discovered extensively infiltrating the brain substance; this was considered inoperable and no attempt had been made to remove it. A small portion excised for examination showed the tumour to be in the nature of an Oligodendroglioma . Following operation a large hernia cerebri (see accompanying photograph) developed. The patient was then referred for radium theropy.

A cap of 15 m.m. "sorbo" rubber was constructed to fit closely all over the skull and 75mgrs. of radium was applied to this over an area of 150 sq. cms., giving a surface intensity of 0.5 milligrams of radium per sq. cm. over the area of the decompression. This cap was worn for 16 hours each day (in 2 doses of 8 hours each), until a total of 21,000 milligram-hours had been given. This produced complete depilation and considerable erythema, but the hernia was very much smaller (see photograph) and the patient's general condition considerably improved. The aphasia, headaches and vomiting completely disappeared. When seen two years later he was at work and had no complaints to make.

Case No. 43.

Hospital No. 280. Mr. J. H. aet. 47 years.

Six months before the patient was admitted to hospital, a large osteoplastic flap had been turned down in another institution, and the major portion of a large tumour evacuated from the right parietal region. Microscopically this was proved to be an oligodendroglioma. The patient had never been out of bed since this operation, and when first seen by the present writer, there was marked weakness of the left arm and leg with increased reflexes on the left side, persistent headache and occasional vomiting - all of which had greatly increased in severity during the preceeding two months.

A helmet of 15 m.m. Columbia paste was moulded to fit over the head and 75 milligrams of radium in foci of 1 milligram each, was distributed over the area occupied by the scar of the osteoplastic flap. This helmet was worn for 12 hours each day in three split doses of four hours each, until a total of 33,375 milligram-hours had been given. This produced a severe cutaneous reaction, but after 10 days the left-sided weakness was very much improved. Six months after cessation of treatment he had returned to his work as a butler. Shortly afterwards he was

Case No. 42.

persuaded by the surgeon who had performed the original decompression to submit himself to a second operation "to remove what was left of the tumour". Unfortunately the patient died on the operating table. At post-mortem no trace of the original tumour could be found.

Case No. 44.

Hospital No. 213. Mr. A. G. aet. 41 years.

For two years the patient had suffered from repeated attacks of Jacksonian epilepsy affecting mainly the left arm and left leg and latterly these were accompanied by unconsciousness and increasing dimness of vision. To relieve these symptoms he had submitted to a right lateral decompression when a very large tumour was found in the right parietal lobe, extending to the mid line above and almost down to the posterior end of the Sylvian fissure. Almost one half of this tumour was removed surgically, when it was found to be an oligodendroglioma. Following the operation he had an extensive left sided hemiplegia for 3 weeks; this gradually improved, but as the Jachsonian attacks had recurred and in view of the large amount of tumour still present, he was referred for radium treatment.

He was fitted with a "sorbo" rubber cap 15 m.m. thick and to this was applied 75 milligrams of radium surrounding the area of decompression. The radium was distributed evenly over the whole area in units of 1 milligram each screened by 0.5 m.m. of platinum. This was worn for 16 hours per day (in 2 doses of 8 hours each) for 15 days, giving a total dose of 18,000 milligram-hours. An adequate cutaneous reaction resulted and within a fortnight he had definitely begun to improve. The Jacksonian attacks lessened in frequency and severity and to a large extent he regained the use of his left arm and leg.

Two years later his Doctor reported that he was well and at work and completely free from epileptiform attacks. There was still however, some slight weakness of the left arm, which may have been due to damage inflicted on the right motor area at the time of operation.

Case No. 45.

Hospital No. 227. Mr. F.. L. aet. 39 years.

The patient gave a history of headaches for six months, projectile vomiting and gradually increasing"mistiness" of vision, accompanied by hallucinations of sound and severe pain in the back of the neck. Occasional transient attacks of unconsciousness, lasting a few minutes; no paralysis.

Examination showed marked bilateral papillodema and some slurring of the speech, no motor paralysis, but all tendon reflexes were slightly exaggerated. Ventriculography showed displacement of left lateral ventricle and third ventricle suggestive of tumour of left angular gyrus.

On June 20, 1931 he was operated on and had a posterior left osteoplastic flap reflected and a portion of tumour removed which was shown histologically to be a malignant astocytoma.

In July 24th 1931 a helmet shaped radium plaque containing 120 mgrs. of radium was applied over the area of decompression for 12 hours per day (2 doses of 6 hours each) for 18 days Total - 25,680 milligram-hours, surface intensity - .3 mgrs. per sq. cm.; then seven days rest and a second plaque of 60 mgrs. was applied for 12 hours per day for 10 days - also in split doses. Total - 7,200 milligram-hours. Total for whole treatment - 32,880 milligram-hours. He was dismissed much improved, his speech was much better and he had no headaches.

He was re-admitted one year later, with headaches and double vision and rapidly became unconscious. A plaque of .75 milligrams was applied for 20 hours per day for 10 days, giving a total dose of 15,000 milligram-hours. Patient did not respond to treatment and died within a few days.

Case No. 46.

Hospital No. 745. Mrs. C. R. aet. 32 years.

When first seen this patient had marked aphasia, and suffered from severe headaches. Three months previously a left subtemporal decompression had been performed and a portion of an extensive cerebral tumour removed - this was proved to be a malignant astrocytoma.

Plaque treatment was commenced with a view to destroying, if possible, the remainder of the tumour. A "sorbo" rubber plaque 15 m.m. thick and having a copper screen of 1 m.m. incorporated was used and was fitted with 63 milligrams of radium surrounding the decompressed area and giving a surface intensity of 0.4 milligrams per sq. cm. This was worn for 12 hours per day until a total dose of 21,000 milligram-hours had been administered.

At the end of this peroid there was total loss of hair over the area irradiated, accompanied by a moderate skin erythema, and some increased bulging from the flap of the decompression. This bulging was apparently reactionary in nature for it subsided within a few days. Two months later the aphasia had disappeared completely and there was no complaint of headaches. Thirty months later she was still alive and well and able to walk about the house but could not walk far alone on account of giddiness. There were no positive signs of any intracranial growth.

Case No. 47.

Hospital No.122. Mr. J. H. aet. 30 years.

For two years past the patient had suffered from intermittent frontal headaches combined with stiffness of the right leg and occasional generalised convulsions. There had been considerable loss of vision of the right eye for 18 months, projectile vomiting had occurred on two occasions when the headache was very severe.

On examination there was discovered well marked bilateral papilloedema and severe optic atrophy of the right eye. Slight right lower facial pareisis was also present and there was some

definite weakness in the movements of the right shoulder. Nystagmus was very marked on looking to the left.

At operation a left frontal osteoplastic flap was turned down and an incision was made into the left frontal lobe when large deep-seated tumour was found. A small portion of this was removed for examination and was discovered to be an astrocytoma fibrillare. It was quite impossible to remove the remainder of the tumour and the patient was referred for radium plaque treatment.

A plaque of "sorbo" rubber was constructed and incorporated in it was a copper screen of 1 m.m. thickness. The plaque was fitted with 70 mgrs. of radium in 70 foci of 1 mgr. each and screened by 0.5 m.m. platinum. This was worn for 16 hours each day until a total of 30,240 milligram-hours had been given. A very severe radium reaction resulted with extensive peeling of the skin, but this subsequently healed up inside one month.

Three months after treatment condition was much improved, there were no headaches, vision was better and a small hernia cerebri which had appeared following operation, now disappeared completely. Two years after treatment he was alive and well and had been in constant employment the previous year.

Case No. 48.

Hospital No. 722. Mrs. F. H. aet. 41 years.

For nine months the patient had been persistently troubled by severe frontal headaches, while for four months vomiting without relation to meals had been present. Incontinence of urine had appeared three months previously. She had been unable to work for nearly six months on account of headaches. There had been one transient attack of unconsciousness.

On examination there was slight but definite bilateral papilloedema and left oculo-motor palsy and paresis of the right side of the face and upper limb. Ventriculography showed the presence of a left frontal tumour.

At operation a large tumour was found on the left frontal lobe - histologically it was proved to be an astrocytoma . No attempt was made at the complete exterpation of the tumour and she was referred for radium treatment.

Treatment was commenced with a "sorbo" rubber helmet in which was incorporated a copper screen of 1 m.m. thickness. The plaque was fitted with 63 mgrs. of radium in foci of 1 mg. each over an area of 180 sq. cms. which gave the plaque a surface intensity of 0.3 mgrs. per sq. cm. This was worn for 12 hours per day (in split doses) until a total of 240 hours had been given. Total dose - 15,120 milligram-hours. Complete depilation resulted and there was a very definite cutaneous erythems. One month later the incontinence of urine and headaches had practically disappeared. In 28 months after treatment the patient was well and at work.

Case No. 49.

Hospital No. 272. Mr. G. H. N. aet. 51 years.

One year prior to admission to hospital the patient had a generalised epileptiform fit and this recurred at irregular intervals. For the six weeks immediately before admission he had suffered from headaches of extreme severity accompanied by projectile vomiting and gradually increasing dimness of vision.

Examination revealed a left homonymous hemianopia and bilateral papilloedema. There was slight left facial weakness and hypertonia and tremor of the left arm and leg. The left tendon reflexes were brisker than the right.

An exploratory decompression was performed and a large tumour was found in the right side of the brain substance and situated in the posterior end of the temporal lobe. There was extensive cystic change in the surrounding areas, - histologically it was proved to be an astrocytoma.

A radium plaque of "sorbo" rubber with a screen of 1 m.m. copper added was fitted to the skull and charged with 75 mgrs. of radium, the surface intensity being 0.4 mgrs. per sq. cm. This was worn for 14 hours per day for 20 days giving a total dose of 21,000 milligram-hours.

Following treatment a hernia cerebri which had developed after operation, almost immediately disappeared and the patient returned to work. Unfortunately a few weeks later he suddenly collapsed and died at work. The exact cause of death is unknown.

Case No. 50.

Hospital No. 281. Mr. C. S. aet. 49 years.

The patient had been troubled by occasional feeling of faintness and occipital headaches for six months. He became very irritable and finally Jacksonian motor attacks began in the right eyelid, right side of lip and right thumb. These attacks were followed by numbness. His speech became slurred and he developed a tendency to drop things from the right hand.

On examination a right hemipareisis was apparent and there was slight bilateral papilloedema.

Decompression revealed a large tumour extending from the region of the left precentral gyrus forward in the frontal lobe. It was proved a spongioblastoma miltiforme. No attempt at total removal of tumour was made.

A plaque containing 75 mgrs. of radium was made and fitted with a copper screen of 1 m.m.; the surface intensity was 0.3 mgrs. per sq. cm. and the plaque was worn for 12 hours per day for 25 days. Total dose - 22,500 milligram-hours.

A well marked reaction was produced and the headache was relieved almost at once, weakness of the limbs, however, remained. Four months later he became unconscious and died.

Case No. 51.

Hospital No. 663. Mrs. A. W. aet. 42 years.

This patient had suffered from intermittent occipital and frontal headaches for 14 months. She had also had occasional attacks of a tingling sensation in the tongue and left thumb. She felt her face drawn towards the left and there was occasional twitching movements. On three occasions these attacks were followed by loss of consciousness. For six months she had been constantly knocking against furniture situated on her left hand side and had had occasional diplopia.

Examination showed right papilloedema and left optic atrophy, left facial palsy and weakness of the upper lip. Ventriculography was suggestive of a large tumour of the right hand side.

At operation the osteoplastic flap was turned down in the right frontal region and a tumour was exposed, extending from immediatelt in front of the pre-central gyrus, forward and inwards. It was quite inoperable and was found on histological examination to be a spongioblastoma multiforme.

A "sorbo" rubber helmet with 1 m.m. copper screen was made and fitted with 75 mgs. of radium; the surface intensity being 0.7 mgrs. per sq. cm. This was worn for 12 hours per day for 20 days.- total dose - 18,000 milligram-hours.

She responded to treatment very well. The headaches disappeared and the muscular weakness improved. Vision, however, was now markedly affected. Two years later she was alive and well, her only complaint being that she had difficulty in reading.

Case No. 52.

Hospital No. 79. Miss E. H. aet. 33 years.

In January 1932 the patient first applied for treatment and complained of drowsiness, loss of memory, impairment of vision, occasional vomiting and severe headaches of six months duration with partial incontinence of both urine and faeces during the previous 4 weeks.

On examination she was found to suffer from slow cerebration with loss of concentration and memory for both past and recent events. There was bilateral papilloedema, and great weakness of the right external rectus, left sided ptosis and a right lower facial palsy, slight weakness of left arm and leg, but no inco-ordination. Left abdominal reflexes were totally absent, bilateral Babinski. Ventriculography showed displacement of ventricles to the right with dilatation of right ventricle and collapse of left ventricle.

The diagnosis was a tumour of the left frontal lobe; accordingly a large osteoplastic flap was turned down in left frontal and parietal regions and the anterior pole of the left frontal lobe was removed and found to be extensively infiltrated by a gliamatous tumour. After this had been done it was seen that practically all of the white matter of the remaining part of the frontal lobe was filled with tumour which it was impossible to remove. In closing the flap, the bone was sacrificed

as usual.

She improved temporarily after the operation and was able to walk about a little. However, one month later she relapsed and became lethargic, had difficulty with speech and was incontinent.

She was then transferred for radium plaque treatment and a helmet containing 40 mgrs. at 15 m.m. distance was constructed and worn for 16 hours per day continuously until 19,966 milligram-hours had been given. This resulted in a well-marked radium reaction and she improved enormously and went home. She continued well for 9 months and then relapsed. No more radium could be given in view of the fact that the skin has broken down during the first treatment and had not healed. She died shortly afterwards.

Case No. 53.

Hospital No. 375. Mr. J. F. aet. 47 years.

For three years the patient had suffered from dyspepsia and occasional vomiting, while for four months prior to admission to hospital he had increasing difficulty in reading the news paper. For nine weeks he had suffered from severe drowsiness and had at times great difficulty in keeping awake, while at other times he suffered from severe frontal headaches.

On examination he was found to be considerably disorientated as regards time and place. Slight bilateral papilloedema was present and there was definite weakness of the muscles of the right side of the face, and right upper limb.

Exploratory decompression revealed a large tumour, deep in the left parietal lobe which was proved to be a spongioblastoma multiforme. Removal was impossible and plaque treatment was commenced as under.

A plaque containing 75 mgrs. of radium, having a surface intensity of 0.3 mgrs. per sq. cm. was applied for 12 hours per day, until a total dose of 31,850 milligram-hours had been given. Complete depilation resulted together with peeling of the skin which healed up within a few weeks.

There was no immediate improvement in the patient's general condition but one month after treatment he was not disorientated and knew where he was and could recognise his friends. Three months later he was back at work; his only complaint being some slight difficulty in reading. Twenty-five months later he was still at work and had been in constant employment in the intervening period. There were no obvious signs of disease.

Case No. 54.

Hospital No. 963. Mrs. K. N. aet. 39 years.

For six months the patient had been troubled by occasional twitchings of the right side of the face with weakness of the grip of the right hand. Transient motor aphasia occurred with

occasional headaches. There was however, no history of vomiting, no loss of vision and no loss of consciousness. Ventriculography showed a distorted left lateral ventricle and that both ventricles were displaced to the right. Exploratory decompression revealed a tumour which was found lying deep to the Pre-and-Post Rolandic cortex on the left side and extending down to the Sylvian fissure. The tumour was found histologically to be a spongioblastoma multiforme.

A Columbia Paste helmet was moulded to the skull and fitted with 66.5 mgrs. of radium in 67 foci, which was worn for 12 hours per day for 25 days - total dose - 20,416 milligram-hours.

Depilation and moderate erythema resulted but there was no peeling of the skin. Six weeks later there was some improvement in the patient's condition. There had been no aphasia of any kind and she was speaking without difficulty; she could use her right hand freely. Unfortunately tumour commenced to grow and she died five months later.

Case No. 55.

Hospital No. 949. Miss K. H. aet. 59 years.

For one year prior to admission to hospital the patient had suffered from great irritability and unstableness of temper, accompanied by loss of memory and change in her personality. More recently severe frontal headaches had developed, with dimness of vision, general weakness and vomiting without nausea.

Examination revealed bilateral papilloedema and a left hemipareisis. The diagnosis of right frontal glioma was confirmed by an exploratory decompression, when a large tumour (found to be a spongioblastoma multiforme) was discovered. It was impossible to remove the tumour which was infiltrating widely.

Following operation she improved slightly, but as only a small portion had been removed for examination, it was decided to begin plaque treatment one month from the date of the operation.

A helmet of 15 m.m. Columbia Paste was constructed and charged with 80 milligrammes of radium, distributed over an active area of 160 sq. cms., giving a surface intensity of 0.5 mgrs. per sq. cm. This was worn in split doses for 12 hours each day, until a total dose of 20,000 milligram-hours had been administered. At the end of this period depilation was complete and a well-marked erythema was present.

There was some temporary improvement for two months after treatment, but shortly afterwards all the patient's symptoms recurred and she died.

Case No. 56.

Hospital No. 359. Mrs. S. McI. aet. 35 years.

This patient gave a three months history of vomiting, failing vision with severe pain behind the eyes and occasional

occasional headaches. There was however, no history of vomiting, no loss of vision and no loss of consciousness. Ventriculography showed a distorted left lateral ventricle and that both ventricles were displaced to the right. Exploratory decompression revealed a tumour which was found lying deep to the Pre-and-Post Rolandic cortex on the left side and extending down to the Sylvian fissure. The tumour was found histologically to be a spongioblastoma multiforme.

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There was some temporary improvement for two months after treatment, but shortly afterwards all the patient's symptoms recurred and she died.

Case No. 56.

Hospital No. 359. Mrs. S. McI. aet. 35 years.

This patient gave a three months history of vomiting, failing vision with severe pain behind the eyes and occasional

transient attacks of unconsciousness.

Examination showed a bilateral papilloedema, complete left homonymous hemianopia, lower left facial weakness, left hemipareisis (slight) and exaggerated left knee jerk.

A right sided cerebral tumour was diagnosed and at operation a large vascular glioma which was irremovable, was found in the right temporo- occipital region. About one-third of the visible tumour was removed and was proved to be a spongioblastoma multiforme. Following operation the patient's vision and headaches improved slightly, but as the greater portion of the growth was still in situ it was decided to attack it with radium.

A Columbia Paste helmet 15 m.m. thick was moulded to the scalp and fitted with 80 milligrams of radium over an active area of 220 sq. cms., giving a surface intensity of 0.35 mgrs. per sq. cm. This was applied for 12 hours per day until 25,000 milligram-hours had been given.

A well-defined radium reaction resulted.

Two years later the patient was well and free from symptoms of any kind.

Case No. 57.

Hospital No. P. P. Mr. L. W. aet. 38 years.

This patient's history was that he suffered from occasional attacks of vomiting unaccompanied by nausea, severe headaches and pain behind the eyes, for four months previously, while for the previous two months he had been unfit for work on account of inability to concentrate his attention. He suddenly became comatose and a right sided decompression was rapidly performed and a large deep-seated tumour was discovered which was quite inoperable. A small portion removed for biopsy proved it to be a spongioblastoma multiforme.

Three weeks after operation radium treatment was commenced by applying a rubber helmet 15 m.m. thick and carrying 80 mgrs. of radium at a surface intensity of 0.5 milligrams per sq. cm. This was worn for 12 hours per day for 20 days, giving 19,200 milligram-hours - which was as much as the patient could be persuaded to tolerate.

There was some slight temporary improvement in the patient's general condition for the next two months, headaches were slight and infrequent, vomiting entirely absent and he was able to walk short distances. Unfortunately swelling of the decompression area commenced and developed into an enormous hernia cerebri - He died three months later.

III. Secondary Carcinoma of Glands.

(a) Glands of Neck (30 cases).

Case No. 58.

Hospital No. p. p. Sir J. S. aet. 69 years.

For two years the patient had a carcinomatous ulcer on the left anterior margin of the tongue, the ulcer being about 1" in diameter. This had been previously treated by interstitial insertion of radon seeds, when it was noticed that a gland was present in left submaxillary region. This gland was indurated and fixed to surrounding structures and he was sent into hospital in order to have the glandular area treated.

A radium collar was applied composed of two layers of "sorbo" rubber each 7 m.ms. thick and inserted between these was a copper screen 1 m.m. thick. The total radium content was 50 mgrs. distributed as follows:-

	Radium.	Area.	Surface Intensity.
Left side of Neck.	30 mgrs.	50 sq. cms.	.6 mgrs. per sq. cms.
Submental region.	5 mgrs.	15 " "	.33 " " "
Right side of Neck.	15 mgrs.	50 " "	.3 " " "
	50 mgrs.	115 sq. cms.	

As the enlarged gland was on the left side, this was given twice the dose of the right side.

The collar was applied for 12 hours per day (3 doses of 4 hours each) for 22 days. Total Dosage:-

Left side - 7,920 milligram-hours.
Submental - 1,320 " "
Right side - 3,960 " "

Total -13,200 milligram-hours.

Depilation commenced on the 15th day and was complete on the 19th day. Extensive erythema was present at the end of treatment and the skin of whole area peeled. The enlarged indurated gland became smaller but did not entirely disappear.

When seen six months later the gland had regained its original size. The patient died of pneumonia a few weeks later.

Case No. 59.

Hospital No. 248. Mr. A. G. aet. 65 years.

For six months the patient had complained of pain and irritation on the right side of the anterior third of the tongue.

Examination showed a depressed ulcer about 2 x 2 cms. in size with indurated edges on the right margin of the tongue opposite the sharp stump of the first molar tooth. The tongue could be freely protruded and no enlarged glands could be detected at that time.

Interstitial needling of the tongue was carried out and a total dose of 4,800 milligram-hours was given and the patient was dismissed from hospital.

Three months later he returned for examination and one small freely movable gland was detected in each submaxillary region. He was referred for plaque treatment and a Colombia Paste collar 15 m.m. in thickness and containing 70.5 mgrs. radium was constructed with the following distribution of radium:-

	Radium.	Area.	Surf. Intensity.
Right side neck.	20 x 1.5mgrs.-30mgrs.	40 sq. cms.	.75mgrs./sq.cm.
Submental	7 x 1.5mgrs.-10.5 "	12.5 " "	.8 " "
Left side neck.	20 x 1.5mgrs.- 30 "	40 " "	.75 " "

The plaque was worn for 12 hours per day (in two doses of 6 hours) for 13 days. Dosage as follows:-

Right side - 4,680 milligram-hours.
Left side - 4,680 " "
Submental - 1,628 " "
Total Dose -10,988 milligram-hours.

A moderate reaction resulted with a uniform depilation and within a few weeks both the glands had entirely disappeared. He was then dismissed but returned after a further five months with a large mass of glands behind the right ear and infiltrating the insertion of the sterno-mastoid muscle. It was instantly noticed that this mass was just outside the area which had been treated by the radium collar and there was no sign of any recurrence within the treated area. Three months later the patient died.

This case illustrates in a very forcible manner the absolute necessity for a very complete irradiation of the neck in those cases where this form of treatment was decided upon. It was noteworthy that in this instance the irradiated area was perfectly healthy and that the recurrence was just outside the margin of the radium collar.

Case No. 60.

Hospital No. 338. Mr. R. S. aet. 67 years.

Four months prior to admission this patient had a carcinomatous ulcer at the left base of the tongue removed by diathermy and at the same time a block dissection of glands of neck on the left side was carried out. Four months later several large indurated glands (freely movable) appeared in the left submaxillary region and patient was referred for surface application.

A Columbia Paste collar 15 m.m. thick, containing 50 milligrams of radium (distributed as under) was worn for 12 hours per day for 16 days.

	Radium.	Area.	Surf. Intensity.
Right side.	23 mgrs.	46 sq. cms.	.5 mgrs. per sq. cm.
Submental.	4 "	12 " "	.3 " " "
Left side.	23 "	46 " "	.5 " " "

Total Dose - 9,600 milligram-hours.

A patchy depilation and slight erythema followed. Two months later the glands had entirely disappeared and when last seen two years after treatment, the patient showed no visible or palpable signs of recurrence.

Case No. 61.

Hospital No. p.p. Mr. V. L. aet. 64 years.

This patient presented himself for treatment with an early primary carcinoma on the left side of the tongue at the junction of the anterior and middle thirds. This was treated by interstitial radium and one month later it was decided to apply a radium collar to the neck as two small hard indurated glands were detected in the left submaxillary region. These glands were freely movable.

A collar of Columbia Paste was moulded on to the neck and worn for 12 hours per day for 25 days; the collar having a radium content of 50 mgrs. distributed as under:-

	Radium.	Area.	Surf. Intensity.
Left side.	30 mgrs.	50 sq. cms.	.6 mgrs. per sq. cm.
Submental.	5 "	15 " "	.33 " " "
Right side.	15 "	50 " "	.3 " " "

Total Dose - 15,000 milligram-hours.

A severe reaction appeared on the left side of the neck and a moderate reaction in the submental region and on the right side.

One month after treatment the glands completely disappeared and some pigmentation of the skin was the only abnormal sign present.

Twenty-two months later the patient was examined and no signs of disease were found.

Case No. 62.

Hospital No. 342. Mr. E. T. aet. 71 years.

For four years the patient had been troubled by pain in the anterior part of the tongue and during the year prior to admission to hospital a diffuse swelling had been present in this region. The Wassermann was strangely positive.

On examination it was seen that a long standing leukoplakia was present, superimposed on which was a large diffuse infiltrating carcinoma of the anterior part of the tongue.

This was treated interstitially and as there were enlarged indurated glands in both submaxillary and submental regions the patient was recommended for plaque treatment. These glands were fixed to the surrounding and deep structures.

A Columbia Paste collar of 15 m.m. thickness was used and was

charged with 60 mgrs. of radium in 60 foci of 1 mgr. each, screened by 0.5 m.m. platinum and was worn for 20 days at 12 hours per day (in split doses of 4 x 3 hours).

Total Dose. - 14,400 milligram-hours.

The area was such that a uniform surface intensity of .7 mgrs. per sq. cm. was obtained. In this case (as in most cases with a positive Wassermann) an excessively severe reaction resulted although the dose was not by any means large.

The glands almost completely disappeared with the exception of one small residual gland which persisted in the right submaxillary region.

The patient continued well for the matter of six months when he reported back with a large fungating mass on the right side of the neck. His general condition was very poor indeed and he died a few weeks later.

Case No. 63.

Hospital No. 330. Mr. J. F. aet. 77 years.

This patient gave a history of a warty growth having been present on the tip of the tongue for over two years. This primary was treated by interstitial radium needles and the patient was three weeks later referred for plaque treatment for two groups of medium sized glands; one in the submaxillary region on the right side and one in the posterior triangle on the left side. The glands were stony hard but not fixed.

A collar of 15 m.m. Columbia Paste was fitted with 50 mgrs. of radium, evenly distributed over the collar and having a surface intensity of 0.5 mgrs. per sq. cm. This was worn for 12 hours per day (in split doses of 4 hours each) for 20 days.

Total Dose - 12,000 milligram-hours.

The skin showed a moderate radium reaction with well-marked erythema, but no peeling.

The glands had completely disappeared within three weeks, and two years later there was no sign of recurrence.

Case No. 64.

Hospital No. 120. Mr. T. H. aet. 63 years.

For many years the patient had been troubled by painful areas on the tongue and ultimately a large tumour developed on the anterior third which was treated by radium needling. The Wassermann was strongly positive.

Two enlarged and indurated submaxillary glands were present on the right side and it was decided to treat this by means of a Colombia Paste collar. This was fitted with 50 mgrs. of

radium, so distributed as to produce a uniform surface intensity over the whole collar equivalent to 0.3 mgrs. per sq. cm. The collar was worn in split doses for 12 hours per day for 16 days giving a total dose of 9,600 milligram-hours. The reaction produced was severe as in all cases where the Wassermann is positive. Following treatment, however, the glands disappeared.

One year later a secondary primary growth appeared in the tongue itself but there was no evidence of any glandular involvement in the neck. Two years later he was alive and at work, the primary having received further treatment.

Case No. 65.

Hospital No.243. Mr. H. B. aet. 60 years.

An epithelioma of the left side of the tongue at the junction of the anterior and middle thirds had been excised six months before this patient was admitted to hospital.

At the time of the original operation no treatment of any kind had been given to the neck and he now presented himself with a large mass extending from the submental region across the submaxillary region and in to the posterior triangle on the left side. The mass was firmly adherent to the jaw and was uniformly hard and indurated throughout.

A Columbia Paste plaque was manufactured to fit over the left side of the neck and submental region only and was fitted with 43 mgrs. of radium over an area of 85 sq. cms. giving a surface intensity of 0.5 mgrs. per sq. cm. This was worn for 12 hours per day for 20 days giving a total dose of 10,320 milligram-hours. At the same time a dental plate was moulded to fit inside the mouth and 5 mgrs. of radium was applied to this. This was worn in four hour periods for a total of 52 hours giving a dose of 260 milligram-hours. The mass of glands became much softer and diminished in size for several months, but ultimately they fungated through the skin. The patient died of haemorrhage from the facial artery.

Case No. 66.

Hospital No.p.p. Mr. S. T. aet. 50 years.

A medium-sized epithelioma of the middle-third of the tongue had been successfully removed by diathermy, and as enlarged indurated glands were present on both sides of the neck the patient was advised to undergo a course of radium plaque treatment. All glands were movable and did not appear to be fixed to the surrounding structures.

A "sorbo" rubber collar was made (15 m.m. thick) with a 1 m.m. copper screen incorporated and 75 mgrs. of radium was distributed over the outer surface in such a manner as to give an average surface intensity of 0.5 mgrs. per sq. cm. This was worn for 12 hours per day for 17 days, giving a total dose of 15,600 milligram-hours.

Following treatment the glands could no longer be detected and two years later there was no obvious sign of recurrence.

Case No. 67.

Hospital No. 301. Mr. W. D. aet. 70 years.

A left sided epithelioma of the tongue had been treated by interstitial radium needling two and a half years previously. At that time no treatment had been given to the neck, because no glands were in evidence, but when he presented himself for treatment on this occasion a large mass of glands was present beneath the anterior-third of the left side of the jaw. The mass was fixed to the jaw and on the point of fungating through the skin.

A Columbia Paste plaque with a superficial screen of 1 m.m. copper was moulded over the indurated mass and loaded with 42 mgrs. of radium. This was worn for 12 hours per day for 27 days giving a total of 13,608 milligram-hours. Following treatment the malignant mass was reduced to about half of its former size, but still remained firmly adherent to the jaw. The condition remained more or less unchanged for a little over a year when rapid growth took place and the patient died shortly afterwards.

This case bears a very strong resemblance to Case No. 65.

Case No. 68.

Hospital No. 184. Mr. H. L. aet. 64 years.

An ulcer on the left side of the tongue which was proved by biopsy to be epitheliomatous in nature had been treated by the insertion of radium needles and had healed up satisfactorily.

Two months later the patient was referred for plaque treatment on account of a few enlarged glands of stony hardness in the submaxillary and posterior triangle on the left side. These glands were not adherent to the deep structures.

A Columbia Paste collar was made containing 60 mgrs. of radium and distributed in such a manner that 35 mgrs. irradiated the left side of the neck, 5 mgrs. the submental region and 20 mgrs. the right side of the neck. This was worn for 16 hours per day for 15 days and resulted in a moderate radium reaction, which was most noticeable on the left side. Total dose - 14,400 milligram-hours. At the conclusion of treatment the glands were no longer palpable and two years later there was no demonstrable sign of recurrence.

Case No. 69.

Hospital No. 178. Mr. W. A. aet. 78 years.

An epithelioma of the under surface of the tongue and extending downwards on to the floor of the mouth had been treated by

combined coagulation by diathermy and the insertion of radium needles. As numerous hard fixed masses of glands were present on both sides of the neck and adherent to the mandible it was decided to apply a radium collar to the neck.

A collar which was composed of Columbia Paste containing 50 mgrs. of radium at a surface intensity of .3 mgrs. per sq. cm. and was worn for 16 hours per day for 17 days, gave a total dose of 13,600 milligram-hours.

This produced complete depilation of the skin with a definite erythema but the glands did not markedly diminish in size. Three months later they were if anything slightly smaller; one year later they appeared to be very much the same in size.

He died fourteen months after plaque treatment; death being due to pneumonia. At that time there appeared to be very little difference in the glands from the time the patient was first seen - they had certainly not increased in size.

Case No. 70.

Hospital No. 232. Mr. F. S. aet. 62 years.

An extensive epithelioma of the posterior-third of the tongue, associated with bilateral enlargement of the deep cervical glands (which were in most cases firmly fixed and immovable) had been present for over six months. The primary growth was treated by insertion of radium needles and the patient referred for plaque treatment, to the glands of the neck.

A collar of Columbia Paste, carrying 50 mgrs. of radium at a surface intensity of .33 mgrs. per sq. cm. was applied for 12 hours per day for 20 days, giving a total dose of 12,000 milligram-hours.

Following treatment the glands became much smaller, but did not entirely disappear.

Two years later there was little change in the condition; indurated glands could still be easily palpated on both sides of the neck, and if anything the mass on the right side was larger in size. The patient had been constantly at work throughout the year.

Case No. 71.

Hospital No. 319. Mr. E. C. aet. 65 years.

A small epitheliomatous ulcer at the left margin of the anterior-third of the tongue had been treated by interstitial radium needling, and it was decided to apply a radium collar to the neck, on account of a small fixed indurated gland in the left submaxillary region.

A "sorbo" rubber plaque containing 40 mgrs. of radium in 40 foci and having a surface intensity of .5 mgrs. per sq. cm. was applied for 15 hours (continuous) per day for 16 days, when

it had to be discontinued on account of sycosis barbae. Total dose - 9,600 milligram-hours.

The skin peeled after 10 days and the infected surface cleared up one month after cessation of treatment. The gland was now much smaller and freely movable. Twenty-five months later there was no apparent sign of disease.

Sycosis barbae frequently occurs in these cases, but is seldom so severe as to cause the treatment to be discontinued.

Case No. 72.

Hospital No. 676. Mrs. C. W. aet. 66 years.

The patient had been troubled by a badly fitting dental plate for many years and ultimately a small ulcer appeared on the anterior surface of the alveolar margin near the incisions. A small portion of this removed for examination proved it to be epitheliomatous and the ulcer was treated by interstitial radium needling. As one small hard gland was present in the left submaxillary region, plaque treatment was decided upon. The gland was freely movable.

A collar containing 40 mgrs. of radium was moulded to the neck, the radium being distributed in such a manner that a surface intensity of 0.5 mgr. per sq. cm. was obtained over the submaxillary and submental regions. This was worn for 10 hours per day for 30 days, giving a total dose of 12,000 milligram-hours.

A moderate reaction resulted and the gland was no longer present at the completion of treatment.

The patient was alive and well and free from recurrence thirty months later.

Case No. 73.

Hospital No. 225. Mr. W. R. aet. 70 years.

A large ulcer on the floor of the mouth (right side) had been treated by interstitial radium needling and the patient was referred for plaque treatment for enlarged indurated glands in the right submaxillary region. These glands were not fixed to the deeper structures of the neck.

A collar of Columbia Paste was constructed and 34 mgrs. of radium was distributed over the submental and right submaxillary regions. This was worn in split doses for 16 hours per day for 20 days, giving a total dose of 10,880 milligram-hours.

A good reaction was obtained and the glands disappeared. Seven months later the primary growth recurred although the neck was still free from glandular involvement. The primary recurrence grew rapidly and eroded the lingual artery, causing death from haemorrhage.

Case No. 74.

Hospital No. 327. Mr. Wm. S. aet. 81 years.

The patient first presented himself for treatment with an epitheliomatous ulcer about 1½" in diameter in the buccal mucosa of the right side of the mouth, and a large mass of hard glands in the right submaxillary region firmly adherent to the horizontal ramus of the mandible and causing considerable pain. The ulcer was treated by insertion of needles and he was referred for plaque treatment to the glands of the neck.

The disease was so extensive that only palliative treatment was attempted and a small Columbia Paste plaque was made to cover the right submaxillary region and was fitted with 24 mgrs. of radium which was applied continuously for 7 days, giving a total dose of 4,032 Milligram-hours. This completely relieved the pain, produced a slight erythema and the mass of glands was slightly smaller.

He remained fairly well for five months when he returned complaining of great pain in the neck and an increase of size in the glandular mass. A large permanent plaque of 160 mgrs. was worn for 13 days at 4 hours per day, giving a total dose of 8,300 milligram-hours. This served to relieve the pain temporarily, but the glands did not diminish in size.

He survived for a further ten months (i.e. fifteen months from beginning of treatment) free from pain and ultimately died from mediastinal deposits.

Case No. 75.

Hospital No. 188. Mr. H. T. aet. 64 years.

This patient was admitted with a large malignant ulcer on the floor of the mouth, situated anteriorly and involving the frenum of the tongue and extending over the base of the teeth on the left side. The ulcer was of eighteen months duration. A few small indurated discrete glands were present in the left submaxillary region. After interstitial needling of the ulcer, a period of six weeks was allowed to elapse and the patient was then referred for radium plaque treatment for the glands of the neck.

A radium collar of 15 m.m. Columbia Paste was applied, containing 50 mgrs. of radium evenly distributed bilaterally and giving a surface intensity of .37 mgrs. per sq. cm. This was worn 12 hours per day (in 2 doses of 6 hours each) for 17 days (204 hours) giving a total dose of 10,200 milligram-hours. A dusky erythema of neck resulted with depilation. Within a further week the glands had completely disappeared except for one small indurated gland.

Six months later this gland was still present and a second Columbia Paste collar with 80 mgrs. of radium was constructed. The area was 56 sq. cms. on each side, giving a surface intensity of .72 mgrs. per sq. cm. This was worn until a total dose of

10,880 milligram-hours had been given when a considerable reaction occurred. The gland was now much smaller.

One year from the time of applying the first collar, he returned with several hard fixed glands in the same position. A small plaque of 15 m.m. of "sorbo" rubber with 30 mgrs. of radium and an area of 30 sq. cms. was placed over them, giving a surface intensity of 1 mgr. per sq. cm. and worn for 12 hours per day. After 3,240 milligram-hours had been given, an intense reaction resulted, the skin peeling intensively. The glands again regressed and at the present time (nearly two years from his first treatment) he remains well. There is however dense pigmentation and scarring of the skin of the neck as a result of the repeated irradiation.

The glands in this case proved very resistant, even after large doses had been given.

Case No. 76.

Hospital No. 239. Mr. R. V. aet. 52 years.

This patient was admitted with a deep necrotic ulcer at the base of the last right lower molar, with induration extending into the cheek and down over the horizontal ramus of the mandible into the submaxillary region. He gave a history of twelve months duration.

Interstitial needling was applied to the ulcer in the buccal mucosa and the case referred for radium plaque treatment to the indurated areas in cheek and submaxillary regions.

A Columbia Paste plaque was constructed having an area of 64 sq. cms. and containing 21 mgrs. of radium giving a surface intensity of .3 mgrs. per sq. cm. The plaque was applied for 10 days at 12 hours per day (in 3 split doses of 4 hours each), giving a total dose of 2,520 milligram-hours. The plaque was discontinued on account of erythema, though it was felt that an insufficient dose had been given. The induration was now much less and the patient was dismissed.

He returned in six months with a fungating mass $1\frac{1}{2}$" in diameter at the anterior angle of the jaw. A second plaque of Columbia Paste was made with an area of 60 sq. cms. and containing 30 mgrs. of radium, giving a surface intensity of .5 mgrs. per sq. cm. This was worn continuously for 312 hours giving a total dose of 9,360 milligram-hours. As a result the fungating area sloughed away and the patient was left with an ulcer 2" in diameter which refused to heal. He died a few weeks later as the result of a septic broncho-pneumonia.

Case No. 77.

Hospital No. p.p. Mr. G. H. C. aet. 50 years.

This patient complained of soreness on the floor of the mouth of one year duration. On examination a large ulcer was present on the right side of the floor of the mouth and extend-

ing upwards on to the under surface of the tongue. There was one hard indurated gland in the right submaxillary region. The primary epithelioma in the floor of the mouth was treated by interstitial needling and one month later plaque treatment was commenced to the glands of the neck.

A Columbia Paste collar was made and fitted with 60 mgrs. of radium. This was worn for 16 hours each day (2 doses of 8 hours each) for 10 days, giving a total dose of 9,600 milligram-hours. A mild reaction was produced with incomplete depilation, but the enlarged submaxillary gland disappeared.

Fourteen months later the primary growth in the floor of the mouth recurred, but there were no signs of any glandular involvement in the neck. Two years later he was alive and well, the primary recurrence having received further treatment.

Case No. 78.

Hospital No. 357. Mr. F. D. aet. 62 years.

An early epithelioma of the right side of the lower lip had been successfully treated by interstitial radiation. A few enlarged indurated glands could be palpated (all freely movable) and the patient was sent for plaque treatment to the neck.

A "sorbo" rubber plaque was made, which had incorporated in it a screen of 1 m.m. of copper. There was 7 m.m. "sorbo", 1 m.m. copper, 7 m.ms. "sorbo" and finally radium, giving a total of 15 m.ms. radium skin distance. This was worn for 12 hours per day in split doses of 3 x 4 hours for 21 days. The plaque carried 60 mgrs. of radium in 90 foci. Screenage 0.5 m.m. platinum. In this case the surface intensity on the neck side was .6 mgr. per sq. cm. and the submental .75 mgrs. per sq. cm. Total dose - 15,120 mgr.-hours. Depilation began on the 16th day and in this case there was very little obvious skin reaction despite the fact that a full dose had been given. This was attributed to the 1 m.m. copper screen which cut off additional beta radiations.

Two years later the patient was alive and well and free from recurrence. The neck presented no abnormality to palpation.

Case No. 79.

Hospital No. 341. Mr. G. J. aet. 75 years.

This patient presented himself for treatment with a very extensive epithelioma of the lip, of five years duration. The primary growth was treated with interstitial radium needling and he was referred for plaque treatment to the neck. On examination several enlarged glands could be detected in the submental and both submaxillary regions.

All glands were greely movable.

A collar of Columbia Paste was constructed 15 m.ms. thick and fitted with 60 mgrs. of radium in 60 foci of 1 mgr. each and screened by 0.5 m.m. platinum. In this case owing to the

increased prominence of the submental metastases an increased surface intensity of radium was arranged in this area as under:-

Region.	Area.	Radium.	Surf.Inten.	Time.
Rt.side neck.	40 sq.cm.	20 mgrs.	.5mgrs/sq.cm.	12 hrs./day for 22 days.
Submental.	20 " "	20 "	1 mgr. " "	12 " " " 22 "
Lt.side neck.	40 " "	20 "	.5mgrs. " "	12 " " " 22 "

Total Dosage:- Right side neck. - 5,280 milligram-hours.
Submental. - 5,280 " "
Left side neck. - 5,280 " "
Total - 15,840 milligram-hours.

Depilation commenced first in the submental region on the 14th day and elsewhere on the neck on the 16th day. Following treatment an extensive dusky erythema appeared, which in turn was followed by peeling, which was particularly severe in the submental region. The skin healed over again after about seven days and the glands were no longer palpable. Thirty months later there was no sign of recurrence.

Case No. 80.

Hospital No. 323. Mr. J. G. aet. 61 years.

For five months prior to admission the patient had noticed a slight swelling on the right side of the lower lip and subsequently this increased in size, and a small ulcer developed, not in the swollen area but somewhat to the left of it.

On examination a papillomatous mass 2 x 1 cms. was present on the right side of the lower lip and to the left of this a small epitheliomatous ulcer was present. A few discrete indurated glands could be detected in the submental region.

A Columbia Paste collar was moulded to the neck and fitted with 50 mgrs. of radium in 50 foci (50 needles of 1 mgr. each screened by 0.5 m.m. platinum). 15 mgrs. was concentrated in the submental region and arranged to give a higher intensity here on account of the enlarged glands being chiefly situated on this region. The collar was worn for 14 hours per day for 20 days; in split doses. Total dose - 14,000 milligram-hours. Considerable reaction appeared on the 16th day and the collar had to be discontinued on the 20th day. There was some peeling and sycosis barbae, and the hair began to fall on the 15th day and the skin cleared up.

When seen six months later there were no signs of enlarged glands and two years after treatment the patient was still free from disease.

Case No. 81.

Hospital No. 284. Mr. W. C. aet. 60 years.

For four months the patient had been aware of an ulcer on the right side of the lower lip, which ultimately attained the size of a sixpenny piece. This was excised widely by diathermy knife and the patient sent for treatment of a group of hard indurated glands, situated in the right submaxillary region. These glands were of stony hardness and were quite mobile. The submental region and left side of the neck presented no detectable abnormality.

A collar of Columbia Paste was constructed and fitted with 70 mgrs. of radium, distributed in such a manner that the surface intensity over the right submaxillary regions was .75 mgrs. per sq. cm. and elsewhere on the plaque a uniform intensity of 0.5 mgr. per sq. cm. was arranged. This was worn for 12 hours per day in split doses for 15 days, giving a total dose of 12,600 milligram-hours. A good result was obtained; all the glands disappeared within a few weeks following treatment and thirty-one months later the patient was alive and well and had been constantly at work for over a year.

Case No. 82.

Hospital No. 283. Mr. W. C. aet. 55 years.

A small ulcer, centrally situated in the lower lip, had been present for nearly six months before it was treated by interstitial radium needling. A few hard glands (all freely mobile) were present on the submental and both submaxillary regions. In order to treat these, a Columbia Paste plaque was constructed containing 60 mgrs. of radium distributed uniformly at a surface intensity of 0.33 mgrs. per sq. cm. After this had been worn 12 hours per day for 16 days in split doses, a total dose of 11,520 milligram-hours was delivered and an adequate reaction obtained. At the conclusion of treatment a well-marked erythema was uniformly present all over the neck but careful palpation failed to reveal any of the glands which had been previously present. Twenty-eight months later his condition was very much the same and there was no sign of recurrence in the neck.

Case No. 83.

Hospital No. p.p. Mr. D. E. F. aet. 62 years.

A large ulcer near the left margin of the lower lip had been treated by the insertion of radium needles before the patient was referred for plaque treatment to the neck.

Examination of the neck showed that there were several enlarged glands of stony hardness in the submental and in both submaxillary regions. On the left hand side one enlarged gland was found on the posterior triangle of the neck. A "sorbo" rubber collar 15 m.m. thick, incorporating a screen of 1 m.m. platinum

was fitted with 70 mgrs. of radium uniformly distributed to give a surface intensity of 0.5 mgrs. per sq. cm. This was worn 12 hours per day for 20 days, giving a total dose of 16,800 milligram-hours. A good reaction was obtained and all the glands disappeared. A little over two years later when re-examined, there was no sign of any recurrence of the glandular lesion.

Case No. 84.

Hospital No. 376. Mr. E. F. aet. 56 years.

Two years previously the patient had a small epithelioma of the lip excised. This recurred locally and was treated by the insertion of radium needles. A few small indurated glands were present in both submaxillary regions and all of them were freely mobile.

A Columbia Paste collar 15 m.m. thick was charged with 50 mgrs. of Radium giving a surface intensity of 0.33 mgrs. per sq. cm., and this was worn for 12 hours per day in split doses for 20 days; total dose 12,000 milligram-hours.

The glands disappeared following treatment and two years. later there was no recurrence.

Case No. 85.

Hospital No. 371. Mr. M. E. aet. 40 years.

For eight months the patient had noticed a small primary ulcerated area on the left side of the lower lip. This was treated by interstitial radium needling with a satisfactory result locally. There were however present, several enlarged submental glands all of which were of stony hardness, but quite freely movable and not fixed to any of the surrounding structures.

These were treated by a Columbia Paste collar which was charged with 60 mgrs. of radium and arranged in such a manner that a surface intensity of 0.75 mgrs. per sq. cm. was obtained over the submental area, and a surface intensity of 0.33 mgrs. per sq. cm. elsewhere. This was worn in the usual manner for 12 hours per day in split doses for 19 days, giving a total dose of 14,400 milligram-hours. A severe reaction resulted, especially in the submental region, but all the glands had disappeared one month after cessation of treatment.

Twenty-five months later, there was no sign of recurrence.

Case No. 86.

Hospital No. 366. Mr. J. H. aet. 75 years.

For eighteen months an epitheliomatous ulcer had been present on the lower lip, which had gradually assumed enormous dimensions and at the time of examination the lip was almost entirely replaced by an enormous cauliflower growth.

After this had been treated by the insertion of radium needles, the patient was referred for plaque treatment to the neck.

On examination it was found that while only a few discrete glands were present in the submental region, there was a large fixed gland the size of a pigeon's egg present in the left submaxillary region. This gland was firmly fixed to the deeper structures.

A Columbia Paste collar of 15 m.m. thickness was charged with 60 mgrs. of radium and distributed to give a uniform surface intensity of 0.5 mgrs. per sq. cm. This was worn for 12 hours per day for 20 days and resulted in a total dose of 14,400 mgrs.-hours.

Following treatment the submental gland disappeared and the submaxillary gland became very much smaller but still remained.

For five months the patient remained in stato quo and then the submaxillary gland grew rapidly and fungated through the skin. Death occurred two months later.

Case No. 87.

Hospital No. 369. Mr. H. B. aet. 70 years.

A very large malignant ulcer of the lower lip which had been present for nine months, was treated by interstitial radium needling and the patient referred for radium plaque treatment to submental glands which were present.

On examination it was found that there were several enlarged discrete glands in the submental region. These were very hard and indurated but were mobile.

A Columbia Paste collar with 60 mgrs. of radium arranged so that the submental area had a surface intensity of 0.75 mgrs. per sq. cm. and the remainder of the collar a surface intensity of 0.33 mgrs. per sq. cm. was worn for 12 hours per day until a total of 216 hours had been reached by which time a total surface dose of 12,720 milligram-hours had been administered. As a result of treatment a moderate radium reaction developed, which was most marked in the submental region. The enlarged glands however, were no longer palpable one month after treatment.

Twenty-five months later the patient was alive and well and no sign of recurrence.

III. Secondary Carcinoma of Glands.

(b) Glands of Groin (10 cases).

Case No. 88.

Hospital No. p.p. Mr. T. L. aet. 56 years.

This patient had a large epithelioma of the penis of eighteen months duration treated by interstitial radium needling and as it was found that a few discrete indurated glands were present in both groins he was referred for plaque treatment. The glands were freely movable.

Plaques of 15 m.m. Columbia Paste were moulded to both groins and each was charged with 50 mgrs. of radium in 50 foci of 1 mgr. each screened by 0.5 m.m. platinum. The area of each plaque was 150 sq. cms. which gave a surface intensity of .33 mgrs. per sq. cm. These plaques were worn for 12 hours per day (in three split doses of 4 hours each) for 16 days, giving a dose of 9,600 mgr-hours to each groin and a total dose of 19,200 milligram-hours.

A satisfactory reaction was obtained, depilation beginning on the 10th day and was complete on the 14th day. Treatment had to be stopped on the 16th day on account of severe erythema.

Three weeks later the skin of both groins had peeled extensively, and the glands were no longer present.

The groin, like the axilla sometimes tends to give an early reaction to plaques, a phenomenon exhibited by nearly all moist hirsute areas.

Twenty-four months after treatment the patient was alive and well and apparently free from disease.

Case No. 89.

Hospital No. 403. Mr. A. W. aet. 47 years.

In this case an extensive epithelioma of the penis had been treated by interstitial radium needling and was then referred for plaque treatment to the glands of the groin.

Examination showed numerous hard indurated glands present in both groins. These glands were movable and were not fixed to the deeper structures.

Two identical plaques were constructed, one to fit over each groin, and both plaques were charged with 50 mgrs. of radium, distributed to give a surface intensity of 0.33 mgrs. per sq. cm. Each plaque was worn for 12 hours per day (in 4 doses of 3 hours each) for 23 days, giving a dose to each groin of 13,800 milligram-hours and a total dosage of 27,600 milligram-hours.

A well-marked radium reaction was obtained in both groins, depilation and erythema followed by slight peeling of the skin and subsequent pigmentation. At the conclusion of treatment the glands were only a fraction of their former size and six weeks later they could no longer be demonstrated.

Twenty-five months afterwards there was no sign of recurrence and the patient had been continuously at work for over one year.

Case No. 90.

Hospital No. 255. Mr. B. S. aet. 54 years.

A large epithelioma involving most of the glans penis had been successfully dealt with by means of interstitial needling and the patient was referred for plaque treatment for a large mass of glands in both groins. The glands on the right side were fixed, but those on the left were freely movable. The Wassermann was strongly positive.

Two identical plaques were constructed each being fitted with 66 mgrs. of radium and having a surface intensity of 0.5 mgrs. per sq. cm. These were worn for 12 hours per day in split doses for 20 days, giving a dose to each groin of 15,840 milligram-hours and a total dose of 31,680 milligram-hours.

As in most cases where a positive Wassermann is present, a very severe reaction resulted and extensive peeling of the skin occurred; this however, cleared up without untoward incident in about six weeks. Following treatment the glandular masses diminished greatly in size, but did not immediately disappear. When examined one year later these was no definite recurrence, but both inguinal regions were heavily pigmented and there was considerable fibrosis of the underlying tissues. This patient who was a tramp was lost trace of, and his subsequent history is unknown.

Case No. 91.

Hospital No. 297. Mr. J. R. aet. 43 years.

A small primary growth in the penis had been treated by interstitial radium one month prior to treatment of the groins by plaques.

Both groins contained a few discrete glands of stony hardness, the largest gland being about 2 cms. in diameter. All glands appeared to be freely movable.

A permanent plaque such as was designed for the breast cases was applied to each groin for 4 hours each day for 13 days. Each plaque contained 160 mgrs. of radium and had a surface intensity of 1 mgr. per sq. cm.

Dose to Right Groin	- 8,320	milligram-hours.
Dose to Left Groin	- 8,320	" "
Total Dose	-16,640	" "

Treatment was discontinued as soon as a definite radium reaction was obtained and it was found that all glands were much softer and smaller, while a few weeks later the groins presented no palpable abnormalities. Twenty-six months later he appeared to be free from disease.

In this case as in the two following cases where the permanent plaques were also used, it was found that an

adequate reaction was obtained slightly sooner and with a lower total dosage, than in those preceeding cases where low intensity plaques of Columbia Paste were used.

Case No. 92.

Hospital No. 289. Mr. A. D. aet. 62 years.

Six years previously the patient had submitted to a partial amputation of the penis for an epithelioma (which was proved histologically following operation). He had remained well until a few weeks prior to his admission to hospital when he noticed a swelling in the left groin.

On examination an indurated mass the size of a hen's egg was found in the left groin associated with several smaller glands, while numerous small glands were also found in the right groin. There did not appear to be any recurrence of the epithelioma on the body of the penis. A block dissection of the left inguinal region was attempted, but as it was found impossible to clear the glands away completely, the Surgeon abandoned the operation and three weeks later when the wound has healed, the patient was sent for plaque treatment to both groins.

As in the previous case large permanent plaques were used of 160 mgrs. each and with a surface intensity of 1 mgr. per sq. cm. These were applied as follows:-

	Mgr.-hrs.
160 mgr. plaque to Lt. Side for 4 hrs/day for 14 days-	8,960.
160 " " Rt. " " 4 " " " 14 " -	8,960.
Total Dose (in Mgr.-hrs)-	17,920.

Following treatment the glands on the right side disappeared completely, but on the left an area of induration remained near the centre of the operation scar.

For six months little change occurred and then there appeared a rapidly growing mass of glands in the left groin which fungated through the skin and rapidly eroded the femoral vessels, producing death from haemorrhage.

There can be little doubt that this patient's chances of recovery were very materially diminished by having the glands cut into, but it would appear that the irradiation held the recurrence in check for a further six months, before death from haemorrhage occurred.

Case No. 93.

Hospital No. 261. Mr. L. M. aet. 59 years.

This patient had had a large epithelioma of the under

surface of the penis treated by interstitial radium needling, and five weeks later was referred for plaque treatment of the glands of the groin.

Both groins contained numerous small hard indurated glands, all freely movable. Treatment was commenced with large permanent plaques of 120 mgrs. each and a surface intensity of .75 mgrs. per sq. cm. being applied to the groins as shown below.

	Mgr.-hrs.
Rt. Groin 120mgrs. plaque for 4 hrs/day for 12 days.-	5,760.
Lt. " 120 " " " 4 " " " 12 " -	5,760.
Total Dose (in Mgr.-hrs.) -	11,520.

A satisfactory reaction was obtained, and when examined two years later, no demonstrable signs of recurrence could be detected.

Case No. 94.

Hospital No. 747. Mrs. M. T. aet. 63 years.

For two years the patient had been aware of a deep sloughing epitheliomatous ulcer of the urethral orifice extending downwards on to the anterior vaginal wall. This primary growth was subsequently treated by radon seeds, and she was advised to have plaque treatment to the groins.

A large firm indurated mass of glands was present in both groins and on both sides the glands were fixed and immovable.

Two identical Columbia Paste plaques of 15 m.m. thickness were moulded to the groins and 30 mgrs. of radium in 30 foci was applied to each; the surface intensity in both cases being 0.25 mgrs. per sq. cm. - these were worn as under:-

Left Groin for 10 hrs. per day for 20 days -	6,000 mgr.-hrs.
Right Groin " 10 " " " 15 " -	4,500 " "
Total Dose -	10,500 mgr.-hrs.

The plaque on the right side was discontinued first on account of an early reaction.

The glands became slightly softer, but did not appreciably diminish in size.

She died with generalised metastases four months later.

Case No. 95.

Hospital No. 754. Mrs. S. A. aet. 37 years.

An epithelioma of the urethral orifice had been present for ten months and this was removed by diathermy. At the time of the operation no glands could be felt in the inguinal regions, but three months after operation, hard indurated glands appeared in both groins; one was removed and was found to contain carcinoma.

Two large permanent plaques were used of 120 mgrs. each with a surface intensity of 0.75 mgrs. per sq. cm. These were applied for 4 hours per day for 13 days, giving 6,240 milligram-hours to each groin and a total dose of 12,480 milligram-hours.

An adequate reaction was obtained and the glands apparently receeded. Six months later recurrence took place, followed shortly after by death.

Case No. 96.

Hospital No. p.p. Mrs. A. B. F. aet. 60 years.

A small primary epithelioma of the urethra-vaginal junction having been excised by diathermy the patient was sent for plaque treatment to the groins in respect of one small indurated, but movable gland, on each side.

Two "sorbo" rubber plaques of 15 m.m. thickness and carrying 60 mgrs. of radium each, at a surface intensity of 0.5 mgrs. per sq. cm. were worn for 12 hours per day in split doses, for 20 days. Each groin thus received 14,400 milligram-hours and the total dose administered was 28,800 milligram-hours.

A severe reaction followed by extensive peeling took place and the glands could no longer be felt.

Two years later the patient was alive and well and free from recurrence.

Case No. 97.

Hospital No. p.p. Mrs. J. S. C. aet. 44 years.

In this patient the primary lesion was a small epithelioma at the margin of the urethra which had been successfully treated by interstitial radium needling.

A few discrete glands of stony hardness, but freely movable were present in both inguinal regions and these were treated by means of a "sorbo" rubber plaque 15 m.m. thick.

This plaque contained 50 mgrs. of radium with a surface intensity of 0.33 mgrs. per sq. cm. and was worn for 12 hours per day in split doses for 22 days. One plaque only was used and was changed from side to side every four hours. Each groin received a dose of 13,200 milligram-hours, and the total dose delivered was 26,400 milligram-hours.

A well-marked reaction developed, followed by extensive peeling of the skin and the glands disappeared.

Two years later there was no sign of recurrence.

IV. Sarcomata. (12 cases).

Case No. 98.

Hospital No. 860. Miss J. G. aet. 19 years.

This patient gave a history of a painful swelling on the lower part of the right thigh of four months duration. X-Ray examination showed a typical periosteal sarcoma involving the lower third of the right femur, with the presence of definite bony destruction. No metostasis could be discovered and X-Ray of the lungs was negative.

Treatment was commenced with a large permanent plaque of 280 mgrs. of radium and a surface intensity of 0.75 mgrs. per sq. cm. The area of the plaque was such that it covered the front of the thigh and half-way round the medial and lateral aspects. Consequently by applying it first to the anterior surface of the thigh and next to the posterior surface, the whole circumference of the tumour was irradiated. The plaque was used in this fashion for 4 hours each day, alternately being anterior and posterior in position, until a total dose of 26,880 milligram-hours had been given.

At the end of this period a definite skin erythema was obtained and one month later the tumour had diminished slightly in size. When seen three months later however, the improvement was not maintained and the tumour had resumed its original size. Plaque treatment was re-commenced as above and 22,320 milligram-hours were administered. In spite of this treatment, which induced a very severe radium reaction, the tumour continued to grow, pulmonary secondaries developed and when last heard of, eight months after the original treatment, the patient was moribund.

Case No. 99.

Hospital No. 353. Mr. A. R. aet. 55 years.

The patient gave a history of pain and swelling of the lower part of the left thigh of one year duration. X-Rays showed a very definite periosteal sarcoma of the lower end of left femur, with destruction of bone. No metostasis were detected. The upper part of the accompanying photographs show the leg before treatment.

A plaque of 280 mgrs. of radium was applied exactly as in the preceeding case, being placed alternately on the anterior and posterior surfaces of the thigh, until a total dose of 22,400 milligram-hours had been received. Temporary shrinkage of the tumour resulted in the next few weeks and six weeks later a second dose was administered in a similar manner until an additional 14,616 milligram-hours had been given. This induced a very severe skin reaction with sloughing over two areas as shown in the lower pair of photographs.

The patient remained well for a further three months, when the tumour commenced to grow again and rapidly increased in size; pulmonary secondaries developed, and it became obvious that a fatal termination could not be avoided.

Case No. 99.

Case No. 100.

Hospital No. 219. Mr. K. J. aet. 8 years.

A slight injury received while playing football directed the mother's attention to a swelling above the left hip. X-Ray examination revealed a typical periosteal sarcoma of the left ilium, the tumour reaching up to the level of the umbilicus and across the abdomen almost to the mid-line.

A large permanent plaque containing 280 mgrs. of radium at a surface intensity of 0.75 mgrs. per sq. cm. was applied over the tumour for 4 hours per day, until a total dose of 23,080 milligram-hours had been given. The position of the plaque was slightly altered each day in order to ensure that the whole tumour was evenly irradiated. Following treatment there was some diminution in the size of the growth, the upper limit of which was now about $1\frac{1}{2}$" below the umbilicus.

Three months later the tumour was still smaller and the 280 mgrs. plaque was re-applied and an additional dose of 3,840 milligram-hours administered. Plaque treatment however, had to be discontinued on account of vomiting and an increasing pulse-rate. Six months afterwards the tumour was less than half its original size; nevertheless the boy died from extensive pulmonary deposits a few weeks later.

Case No. 101.

Hospital No. 466. Miss M. P. aet. 9 years.

The child's mother stated that a swelling had been present at the upper end of the right humerus for nearly one year. There was no complaint of pain and limitation of movement was very slight. X-Rays showed a very typical periosteal sarcoma. X-Ray of chest was negative.

In treating the case, large permanent plaques of 280 mgrs. and 120 mgrs. were used as shown under;-the plaque being wrapped round the arm in each case. The surface intensity of both plaques was 0.75 mgrs. per sq. cm.

First Treatment:

Radium.	Time Applied.	Dose.
280 mgrs.	2 hours per day for 11 days.	6,160 milligram-hours.

Second Treatment (after 10 days interval).

Radium.	Time Applied.	Dose.
120 mgrs.	2 hours per day for 16 days.	3,840 milligram-hours.

Third Treatment (after another 10 days interval).

Radium.	Time Applied.	Dose.
280 mgrs.	2 hours per day for 10 days.	5,600 milligram-hours.

An early erythema developed and in order to allow the skin a rest, two intervals of ten days were inserted. The tumour gradually became very much smaller and three months after treatment the X-Ray showed what appeared to be a normal right humerus.

This improvement however was not maintained and after a further four months the patient returned with a local recurrence of the sarcoma which had almost regained its former size.

The 280 mgrs. plaque was again applied to the arm for 2 hours per day for 12 days, giving a dose of 6,720 milligram-hours.

Unfortunately an extensive radium burn of the axilla resulted and the arm had to be disarticulated at the shoulder joint. The patient developed a recurrence in the scar of the amputation and died three months after operation.

Case No. 102.

Hospital No. 294. Mr. H. S. aet. 44 years.

Six months previously the patient had had the right leg disarticulated at the hip for a periosteal sarcoma of the upper end of the right femur. He remained well for six months and then a recurrence developed beneath the operation scar. This recurrence grew rapidly and soon became an ulcerated fungating mass. X-Ray of chest was negative.

Treatment was commenced with a large permanent plaque of 160 mgrs. of radium, 1 mgr. per sq. cm. surface intensity being placed over the fungating area for 4 hours per day for 20 days.

An interval of ten days was allowed as the skin margins showed signs of radium reaction and then the plaque was re-applied for a further 10 days, giving a total dose of 19,200 milligram-hours.

The sarcomatous mass became much softer and smaller, but the surface did not entirely heal over. Five months later the patient died with pulmonary metastases.

Case No. 103.

Hospital No. 320. Mr. J. W. aet. 41 years.

Swelling had been present of the right groin for over one year. Four months ago the surface became ulcerated and simultaneously a similar swelling appeared in the left groin. Both of these extended rapidly in size, the surface being composed in both cases of a large excavating ulcer. The ulcerated area in the right groin measured almost 8" x 5" and in the left groin 1½" x 1". Small portions removed from both groins were proved histologically to be a fibro-sarcoma.

A plaque containing 280 mgrs. of radium was worn for 4 hours each day for 22 days, the plaque being applied to each groin alternately so that each groin received a dose of 24,640 milligram-

hours. The tumour responded to treatment very rapidly and in two months time both ulcers had completely healed over, although it was still possible to palpate a mass about the size of a pigeon's egg in the right groin. The patient returned to work and remained well for some time, but eight months after treatment he developed a severe cough and ultimately died from intrapulmonary metastases.

Case No. 104.

Hospital No. 351. Mr. A. F. aet. 37 years.

In 1925 the patient noticed a small swelling the size of a pea situated metially in the left groin. This was excised locally and was reported upon as being a fibro-sarcoma. In 1928 the tumour recurred at the site of operation and was again removed surgically; once more it was reported as being fibro-sarcom.

He remained well until June, 1932 when another local recurrence took place, but on this occasion it was of a more extensive nature and was associated with a diffuse induration beneath the skin surrounding the scar and covering an area of 3"x 4" in size. In view of the extent of the recurrence, operation was not considered to be advisable and he was referred for radium plaque treatment. A large permanent plaque containing 160 mgrs. of radium was worn for 4 hours per day for 20 days in the site of the recurrence giving a total dose of 12,800 milligram-hours.

Considerable radium reaction occurred and one month later the mass of induration of the left groin had disappeared.

When last seen two years after treatment he was alive and well with no obvious recurrence.

Case No. 105.

Hospital No. 839. Miss V. M. aet. 21 years.

For seven months a gradually increasing swelling had been present on both sides of the neck and this was proved histologically to be a lympho-sarcoma. A few enlarged glands were also present in both axilla.

It was decided to begin treatment with two permanent plaques of 160 mgrs. and 120 mgrs. respectively. The 160 mgrs. plaque was applied to the neck and the 120 mgrs. plaque to the axilla on the same side. These two plaques were worn together for 2 hours at a time and then changed over to the opposite axilla and side of neck and worn for a further two hours. The total dose and its distribution is shown below:-

Area.	Radium.	Surf. Intensity.	Time.
Left Axilla.	120 mgrs.	0.75 mgrs. per sq. cm.	2 hrs/day for 22dys.
Left Neck.	160 "	1.0 " " "	2 " " " 22 "

Area.	Radium.	Surf. Intensity.	Time.
Right Axilla.)	120 mgrs.	0.75 mgrs./sq. cm.	2 hrs./day for 22dys.
Right Neck.)	160 "	1.0 mgrs. " "	2 " " " 22 "

Dose.

Left Axilla.)	5,280 milligram-hours.
Left Neck.)	7,040 " "
Right Axilla.)	5,280 " "
Right Neck.)	7,040 " "
Total Dose.	24,640 milligram-hours.

The swelling in neck and axilla diminished very rapidly under irradiation and at the conclusion of treatment was only about one-third of its original size. One month later these swellings could no longer be palpated.

The patient returned to work and has continued there until the present time (25 months later).

Case No. 106.

Hospital No. 173. Mr. C. P. aet. 20 years.

The patient had complained of shortness of breath and a feeling of tightness in the chest for three months. There was some impairment of resonance over the superior mediastinum, and X-Rays revealed the presence of a large mediastinal tumour, which was assumed to be lymphosarcomatous in nature. The Wassermann reaction was negative.

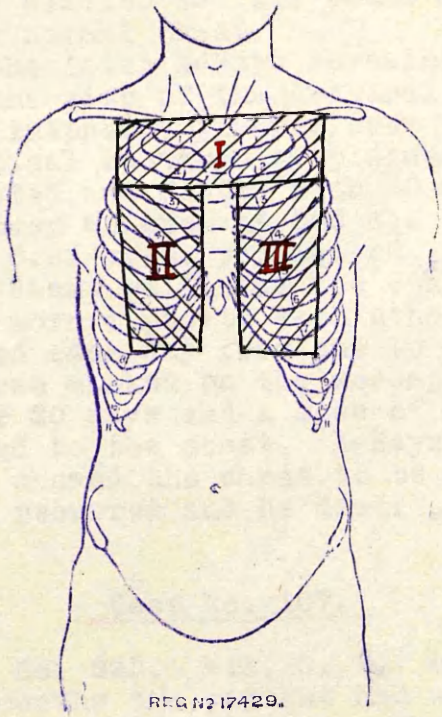
Two permanent plaques of 280 mgrs. and 160 mgrs. were applied to the chest wall over the site of the tumour - the 280 mgrs. plaque being placed anteriorly and the 160 mgrs. plaque posteriorly. Dosage was as shown below:-

Area.	Radium.	Surf. Intensity.	Time.
Ant. Chest Wall.	280 mgrs.	0.75 mgrs. / sq. cm.	4hrs/day for 15dys.
Post.Chest Wall.	160 "	1.0 mgrs. " "	4 " " " 15 "

Dose.

Ant. Chest Wall.	16,800 milligram-hours.
Post.Chest Wall.	9,600 " "
Total Dose.	- 26,400 milligram-hours.

Case No. 106.



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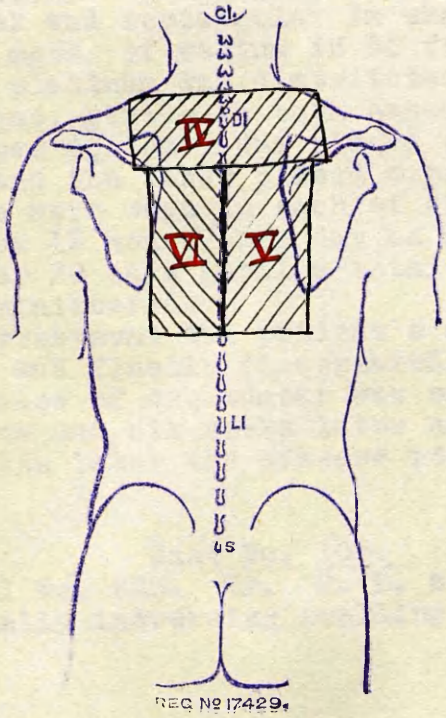

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The tumour responded rapidly to treatment and became progressively smaller and six weeks afterwards X-Rays showed an apparently normal chest.

Nine months later X-Rays revealed another small shadow situated at the site of the original growth and it was decided to apply low intensity plaques over the chest and back.

Two identical rectangular plaques of 15 m.m. "soebo" rubber were constructed and fitted with 50 mgrs. of radium, uniformly distributed over an area of 200 sq. cms. giving a surface intensity of 0.25 mgrs. per sq. cm. One plaque was applied to the anterior chest wall, and the other to the back. These plaques were worn opposite each other for 12 hours each day and were moved each day from one to another of the three positions shown marked on the accompanying chart. This was continued for 20 days and a dose of 24,000 milligram-hours was thus delivered to the chest. X-Rays taken at the conclusion of treatment showed the chest to be clear. One year later all his symptoms recurred and he died.

Case No. 107.

Hospital No. 632. Mrs. G. B. aet. 43 years.

For two months the patient had suffered from an irritating cough and progressive dyspnoea. There had been no loss of weight and no expectoration. X-Rays showed the presence of a mediastinal lymphosarcoma.

Two identical "sorbo" rubber plaques were made, each being 15 m.m. thick and rectangular in shape, with an area of 200 sq. cms. Fifty mgrs. of radium in 50 foci of 1 mgr. each screened by 0.5 m.m. platinum was distributed uniformly over the surface of each plaque, giving in both cases a surface intensity of 0.25 mgrs. per sq. cm. One plaque was applied to the anterior chest wall and the other placed opposite it on the patient's back. These were worn in each of the two positions shown on the chart for 12 hours each day on alternate days. This was continued for 20 days until a total of 24,000 milligram-hours had been administered.

During treatment the patient's cough gradually lessened in severity and finally disappeared. X-Rays of chest showed that the shadow of the tumour was only one quarter of its original size and six weeks later no shadow was in evidence.

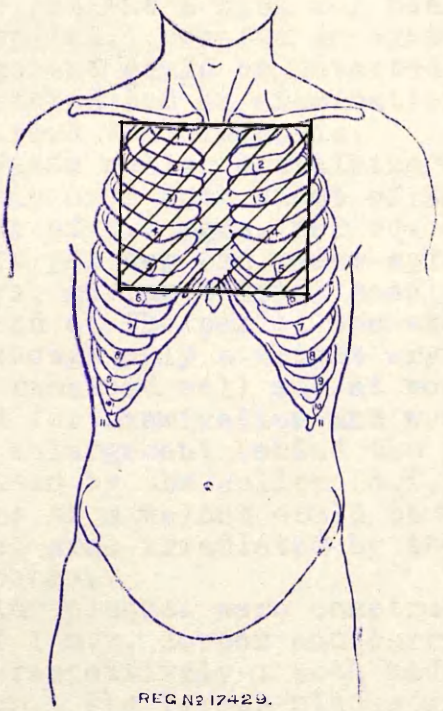
Ten months later the disease recurred and the patient died.

Case No. 108.

Hospital No. 286. Mr. R. L. aet. 24 years.

A gradually increasing swelling had been present on the

Case No. 107.



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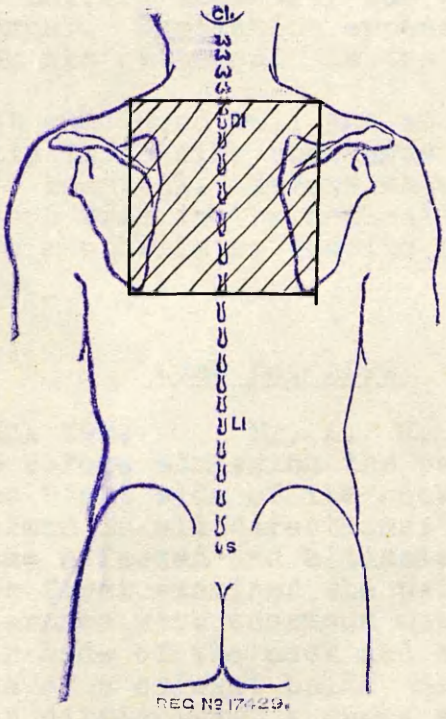

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left side of the patient's neck for nearly one year prior to admission to hospital. Despite an exhaustive examination no glandular enlargement could be detected elsewhere. Lympho-sarcoma was suspected and on examination of a small portion of tissue, confirmed the diagnosis.

A Columbia Paste collar containing 70 mgrs. of radium, distributed evenly over both sides of the neck and having a surface intensity of 0.5 mgrs. per sq. cm. was applied and worn for 12 hours per day (in three split doses of 4 hours each) for 12 days, giving a total dose of 10,080 milligram-hours. At the end of the period the swelling had entirely disappeared, although only a slight erythema had been produced.

The patient remained well and at work for eight months, when he reported for examination and was found to have a small glandular enlargement behind the left ear just beyond the area irradiated by the collar (c.f. case 59) while a swelling the size of a walnut could be detected in the left groin. The actual area irradiated by the original collar was free from recurrence.

Two triangular plaques were constructed of "sorbo" rubber with a screen of 1 m.m. copper and carrying 42 mgrs. and 33 mgrs. of radium respectively ; both had a surface intensity of 1 mgr. per sq. cm. The larger plaque was applied behind the ear and along the sterno-mastoid and the smaller to the left groin. Both were worn for 12 hours per day for 20 days, giving a dose of 10,080 milligram-hours to the neck and 7,920 milligram-hours to the groin. In the neck the same total dose as formerly was given, but the surface intensity was higher and the period of application longer. Depilation appeared on the 13th day and a severe reaction was obtained. In the groin a moderate reaction resulted.

The patient continued well and at work for almost two years when a gradually increasing shortness of breath forced him to return again to hospital. X-Rays showed a large and presumably lymphosarcomatous mass in the mediastinum.

He died two months later despite deep X-Ray and other treatment.

Case No. 109.

Hospital No. 392. Mr. A. K. aet. 32 years.

Ten months before admission the patient first noticed a swelling on the right side of the neck which rapidly increased in size and spread in all directions. The left side of the neck also became affected and ultimately both axillae were involved. When first examined the patient presented a grotesque appearance with enormous masses of tissue ballooning out from either side of the neck and with a mass in each axilla the size of a cricket ball. He could only move his head with great difficulty. A small portion removed for examination was reported upon as being a lymphosarcoma.

Two large permanent plaques of 160 mgrs. and 120 mgrs.

respectively were employed. The 160 mgrs. plaque was placed over one side of the neck and the 120 mgrs. plaque was fixed in the corresponding axilla and the two were worn together for 4 hours. These plaques were used alternately on each side, so that the patient received 8 hours irradiation each day in two doses of 4 hours to each side. This was continued for 15 days until the patient had received a total of 33,600 milligram-hours distributed as follows:-

Area.	Radium.	Surface Intensity.	Time.
Left Axilla.	120 mgrs.	0.75 mgrs. per sq. cm.	4hrs/day/15dys.
Left Neck.	160 "	1.0 mgr. " " "	4 " " 15 "
Right Axilla	120 mgrs.	0.75mgr. " " "	4 " " 15 "
Right Neck.	160 "	1.0 mgrs. " " "	4 " " 15 "

	Dose.
Left Axilla.	7,200 milligram-hours.
Left Neck.	9,600 " "
Right Axilla.	7,200 " "
Right Neck.	9,600 " "
Total Dose.	33,600 milligram-hours.

As a result of irradiation the cervical swellings melted away in a surprisingly short period, and at the conclusion of treatment were only about one quarter of their original size, while the patient could turn his head freely in all directions. Two months later, beyond a dense pigmentation of the skin of the neck and axilla, there was practically nothing to be felt. He has remained well to date (thirty months later).