PRELIMINARY CLINICAL REPORT ON A NEW AND ECONOMICAL METHOD OF RADIUM THERAPY BY MEANS OF EMANATION NEEDLES.

By WALTER C. STEVENSON, M.D., B.Ch., D.P.H.,
SURGEON AND X-RAY OFFICER, DR. STEEVENS'S HOSPITAL;
SURGEON, ORTHOPAEDIC HOSPITAL, DUBLIN.

SINCE the publication of papers by Professor Joly¹ and myself² I have been enabled, by the kindness of the Council of the Royal Dublin Society, to carry out an investigation on this method of treatment. The results I have so far obtained with the limited supply of emanation at present at my disposal are, I think, sufficiently encouraging to justify a short account of the technique I have employed since April 9th. The method, and the results that can be obtained in favourable cases, are conveniently illustrated by the two following examples:

CASE I.—Inoperable Parotid Tumour.

Mrs. B. (Fig. 1). The tumour began nine months ago, and grew steadily. It was quite fixed to the lower jaw; the patient

Fig. 1.—Case I. Inoperable parotid sarcoma, before treatment.

Fig. 2.—Case I. Showing position of needles.

was unable to open her mouth, and fed herself by forcing food, usually crumbled biscuits, upwards under the overhang of the upper front teeth.

Mr. Keegan, to whom I am indebted for the following history, operated on the tumour in November, 1913, and found an indefinite growth, the size of a large cherry, infiltrating the masseter muscle, and without any sign of a capsule. The patient at the time would not allow any operation which might lead to disfigurement. Microscopic examination by Professor McWeeney proved the growth to be a mixed parotid sarcoma. The subsequent clinical history confirmed the diagnosis of malignancy, and later the case was sent to me by Mr. Blaney as inoperable, to try the effect of radium treatment.

At 11.15 p.m. on April 17th, I inserted from behind forwards into the tumour five needles, parallel to one another and about

Fig. 3.—Case I. Showing amount patient could open her mouth after one month's treatment. Before treatment she could not separate her teeth.

Fig. 4.—Case I. Fifty-two days after first treatment.

8 mm. apart. They contained altogether 5.08 millicuries of emanation in glass capillary tubes. I left them in till 12.45 p.m. on April 19th. The strength would then have been reduced to

D

3.8 millicuries, giving an average of 4.8 millicuries for thirty-seven and a half hours. On April 21st the patient could open her mouth a little better, and on April 27th considerably better. The tumour was also less fixed. On April 29th I inserted six needles containing 17.2 millicuries altogether, from behind forwards (average 15.5 millicuries), for thirty-five and a half hours. Immediately after removal they were re-inserted for twenty-four hours at right angles to their former position (Fig. 2). The average was 13.3 millicuries for twenty-four hours. On May 18th, a month and a day after treatment was begun, the patient could open her mouth to the extent shown in Fig. 3. On that date I inserted five needles containing altogether 4.4 millicuries of emanation in glands in the sub-maxillary region, and left them in for two and a half days (average 3.5 millicuries). For a fortnight after this dose I thought no effect had been produced by the very small quantity I had used, but I was mistaken, as soon afterwards a distinct diminution of the size of the glands occurred, and the patient was able to open her mouth still wider than illustrated in Fig. 3. During and for some days after each treatment the radiated tissues swelled, and the patient was unable to open her mouth so well. The photograph (Fig. 4) was taken on June 8th. The patient states she can now see her left ear in a mirror, and can put her finger in the external meatus, both of which she had been unable to do for some months. The tumour is no longer fixed. There is no mark on the skin to show where the needles were inserted. The patient has gained 6 lb. during the treatment. After the next treatment I intend sending her home for three weeks, and my present purpose is to give her another treatment in about two months.

CASE II.—Scar Fixing Wrist.

Miss K. T. (Fig. 5). The right wrist was burned and lacerated by a calendering machine five years ago, and she had done no work since; history of pieces of tendon having been cut away when first treated. For the past two or three years the fibrous scar was a constant source of pain, which kept her awake at night. The wrist and fingers were fixed in a flexed position, and she kept her whole hand quite rigid. She could move the thumb and first finger a little, the other three fingers not at all.

On May 7th six needles were inserted as illustrated (Fig. 5), and left in for forty-six hours. Average 5.5 millicuries. When the needles were removed the patient stated that the pain had disappeared. Five days later the scar was soft and the wrist could be straightened by strong extension. She could move her thumb and first finger better, and, to my surprise, could flex her other fingers to a considerable extent. She attended Steevens's Hospital as an extern patient for the next week or ten days for massage and manipulation, and her power of movement continued to improve and the pain did not return. She,

Fig. 5.—Case II. Showing position of needles in fibrous scar.

however, discontinued attending the hospital, and wrote to me saying her arm was much better and that she could not attend as she had again started work.

The results I have obtained in other cases still under treatment are also encouraging. A cancer of the floor of the mouth, with extensive glandular involvement, has improved; the glands are smaller and less fixed, and the floor of the mouth less prominent. A recurrent cancer of the breast has been considerably relieved of pain and tenderness, and the patient sleeps much better; the supra-clavicular glands, into which I inserted the needles, have diminished in size, and the oedema of the arm has considerably decreased. I have just begun treatment of malignant glands of the neck, which I was unable to remove by operation. There is already some diminution of haemorrhage in a case of cancer of the cervix uteri, which Dr. Tweedy found by an exploratory laparotomy to be too extensive for removal, and handed over to me. In this case the needles were inserted into three different localities of the cervix for twenty-four, twenty-four, and forty-eight hours respectively, and then the capillary tubes were removed from the needles and packed into a

small cannula, which was inserted into the os for three days, each day being pushed a little further up.

When the capillary tubes became too weak in emanation to be buried separately in a malignant growth, I have collected them into a cannula and used them for tuberculous sinuses, etc.

All the patients—eleven in number—on whom I have used the emanation were treated as in- or out-patients in Dr. Steevens's Hospital.

In no case did I use a general or local anaesthetic for inserting the needles; in the breast case I have inserted six needles a dozen times in various localities.

The needles I have used are ordinary steel serum needles as supplied by any medical instrument maker. I get them at Messrs. Smith and Sheppard, Dublin, for 6d. each with tops, and 3d. each without. Their external diameter is 1.4 mm., their thickness 0.3 mm., and the diameter of their bore 0.8 mm. The glass capillaries have as maximum dimension an external diameter of about 0.76 mm., an internal diameter of 0.46 mm., and a thickness of 0.15 mm.; 1 cm. of these capillaries would theoretically be capable of holding the emanation equilibrium of about 3 grams of radium at atmospheric pressure.

The emanation needles, as I have employed them, have decided advantages.

1. They are an economical method of using the therapeutic properties of radium.

2. Clinically, they are easily and safely employed, without an anaesthetic or the use of an operating theatre.

3. They admit of very accurate dosage.

4. They permit a tumour to be subdivided into areas which can be efficiently treated by small quantities of emanation.

The economy of rays has already been dealt with to some extent in the papers referred to. It depends upon the amount of cross-fire that results both from the primary and secondary rays, and also on the fact that the soft gamma and beta rays, which are in the majority, and which are usually screened off in deep radio-therapy, are here depended upon for their therapeutic effects. It is permissible to utilize these soft rays whether they be gamma or beta rays (or x rays and beta rays when x rays are used), because (a) they are all ionizing agents and must in any case result as secondary rays in every method of radiation by means of radio-active elements (or a Crookes's tube); (b) they are unhesitatingly employed in surface conditions when radium is used practically unscreened.

The collection of needles get, so to speak, at the surface of the deep parts, and radiate them as uniformly as it is possible to do at the surface; provided that the sources of radiation are within range of the soft rays—that is, the needles are not more than 3 cm. apart, which is about the average distance of human tissues traversed by these soft rays. (1) As in surface conditions due consideration is given to the relation between the length of exposure on the one hand and the amount of screening and of the source of radiation on the other.

I do not think I could have obtained as marked effects by any other method of radium therapy known to me, taking into consideration the duration of treatment and the amount of emanation available. From April 9th to June 8th I received altogether 139.7 millicuries of emanation in capillaries, or an average of 15.5 millicuries per week. It must be remembered that half the emanation had disappeared in 3.86 days, and owing to the hour at which it was necessary to collect and measure it, usually 5 per cent. was lost before I could insert it.

There is no difficulty and little danger in introducing fine needles into a growth that is suitable for this method of treatment. It is necessary to have some respect for large blood vessels, though I have found from experience that it is possible, with small quantities of emanation, to go fairly near the carotid, jugular, and subclavian vessels. Unless by a gross miscalculation or misjudgement, it is almost impossible to cause any extensive sloughing.

I have noticed on several occasions a bead of pus when I extracted a needle, especially if it had been left in more than thirty-six hours and contained a fair amount of emanation. The pus is sterile; I could get no growth from it in three days, although I plated it out on several occasions. The minute hole has always sealed up at once

and has given no further trouble. Lately I have made a practice of testing the firmness of the needles in the tissues. Soon after insertion the needles are grasped more tightly by the tissues; they then gradually become loosened again. If a needle has too little emanation, or is taken out too soon, it requires a little force to remove it, and a drop of blood usually appears at the hole left. When the needles were in a dependent position, they became so loose on one occasion that they dropped out. When they become loose I remove them, and reinsert them if desirable. The loosening of the needles and the formation of the pus may be due to some extent to the presence of a foreign body, but not altogether, so that I think that the firmness test has a distinct use in judging the effect produced, at least with the doses I have been employing.

It is obvious that this needle method admits of fairly fine adjustment of dose, as the dose depends on five factors: (1) The amount of emanation in each capillary; (2) the length of the capillary; (3) the number of capillaries used; (4) the distance between the needles, and (5) the time they are left in.

The duration of treatment depends upon the amount and concentration of the emanation in the capillaries and the thickness of, and distance between, the needles; but if these factors are constant, the duration is relatively independent of the number of needles, as a greater number of needles simply means a larger area of tissue under simultaneous treatment. Briefly, as the emanation decays, the plan is to leave the needles in longer and put them closer together.

Since it has been only possible to obtain an average of 15 millicuries of radium emanation per week, I have thought it best to employ six needles at a time. I insert them parallel to one another at one operation, but if possible, at right angles to the first position at the next insertion in the same area, as in Case 1. In the breast case I mapped out the area so as to leave as long an interval as possible between the treatments of adjacent areas, and thus to lessen the chance of over-exposure at any part. I endeavour to treat one part efficiently by insertions in various directions, before going on to the next. This was not a method of choice, but of necessity. In this particular case, however, it seems to promise as good a result as can be reasonably expected.

The essential point of this technique is to radiate deep structures on the same lines as superficial structures. It aims at uniformity of radiation with a minimum loss of energy by screening. It is nearly as suitable for radium salts as for emanations, since Professor Joly has shown that the salts, melted by an electrically-heated platinum loop, will flow into the smallest practicable tube by capillary attraction.

By the method one can, for instance, primarily attack the base of a rodent ulcer, not the surface; or both the base and the surface can be attacked simultaneously, which will give the maximum effect.

It is obvious that the therapeutic value of a given quantity of radium or its emanation is theoretically increased by this method as compared with other methods of burying. My clinical observations tend, I think, to confirm the theoretical considerations. I have frequently heard the statement that with less than 50 mg. of radium there is very little hope of doing much good in malignant disease. Only once did I use more than 22 millicuries of emanation—never as much as 30; yet the photographs and history of Case 1, in which only 17.2 millicuries was the maximum amount used at one time, show very definite effects.

In conclusion, I have to thank the Council of the Royal Dublin Society for providing me with radium emanation from the 34 mg. of radium (element) they possess at present. I am particularly indebted to Mr. R. J. Moss, the registrar of the society, for his kindness and the trouble he has taken to carry out the laboratory work, and for his skill in making the fine capillary glass tubes to fit the needles I use, for collecting the emanation in them, and for dividing the tubes into lengths suitable for the case to be treated.

REFERENCES.

¹ On the Local Application of Radium in Therapeutics. By J. Joly, Sc.D., F.R.S. Read at the scientific meeting of the Royal Dublin Society, March 24th. *Proceedings*, May 8th, 1914. ² *Medical Press and Circular*, March 11th, 1914.