TREATMENT OF GONOCOCCAL INFECTION BY DIATHERMY.*

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THE clinical investigation of the treatment of gonococcal infection by diathermy was commenced in the electrical department of St. Bartholomew's Hospital in 1913. An indication of the value of diathermy for this purpose was furnished by the results obtained in two cases of gonococcal arthritis. These cases had resisted long courses of treatment in the wards by other methods and were then sent to the electrical department. Diathermy was applied to the joints, and the results were so good that other cases of the disease were subjected to the same treatment. Equally encouraging results were obtained. It was therefore decided to investigate the effect of diathermy on gonococcal infection of other parts. Cases of epididymitis and orchitis were treated, and, afterwards, cases of endocervicitis and urethritis in the female and prostatitis in the male. Up to the present we have treated 67 cases. The purpose of this paper is to describe the results which we have obtained and to indicate our methods of procedure. The latter have been varied from time to time, and it is likely that further improvement will be suggested with gain of experience.

The reasons for the selection of diathermy for the treatment of infection by the gonococcus are the following. The organism mentioned can be destroyed at a temperature which is not high enough to damage the living tissues. In diathermy we possess a means of raising the temperature of the tissues *en masse*, whereas other methods of applying heat raise the temperature of the superficial parts only. The clinical results and bacteriological tests have abundantly justified the use of diathermy for the purpose mentioned, and the reasons just given furnish a rational explanation of the mode of action of the new method of treatment. In almost all our cases of gonococcal arthritis we were able, within a comparatively short period of time, to abolish the pain, reduce the swelling, and increase the range of movement; crippled joints were rendered useful, and patients who had been compelled to stay in bed before the treatment were able to walk about with a considerable degree of comfort after a course of diathermy. Cases of gonococcal orchitis and epididymitis without exception quickly lost their pain and swelling after diathermy, even if the symptoms were severe.

Convincing proof of the therapeutic power of diathermy in gonococcal infection was furnished by the disappearance of pain and swelling from joints or scrotum after the application of the treatment to the site of the original infection. Cases of gonococcal arthritis were freed from pain after application of diathermy to the urethra and prostate, or urethra and cervix, without the inclusion of the joints in the treatment. We have also had cases in which the application of diathermy to the joints did not procure much relief until the parts originally infected were included in the treatment.

We have applied diathermy to the urethra and cervix uteri in the female in cases in which these parts alone were infected. Such applications were followed by disappearance of the gonococci and cessation or diminution of the discharge. The failure to find gonococci in a discharge does not prove that these organisms are not present in the parts from which the discharge originates. But if repeated attempts to find them are unsuccessful and a

mucous discharge alone remains—not excessive in amount, and without bacteria—it may reasonably be concluded that the treatment has been effective. Further proof of the efficiency of diathermy in the treatment of infection of the cervix and urethra is afforded by the fact above mentioned—namely, the subsidence of arthritis after application of diathermy, not to the joints but to the parts originally infected.

The treatment of gonococcal infection of certain regions, whether by irrigation, external applications, or vaccines, is unsatisfactory. This is the case especially with the joints, the cervix uteri and urethra in the female and the prostate in the male. Almost all the cases which we have treated had been previously subjected to other forms of treatment, and we were able by means of diathermy to procure success where other methods had failed.

Sensitivity of the Gonococcus to Heat.

Gonococci are destroyed if the temperature of the medium on which they grow is raised a few degrees above normal. Cultures of these organisms do not survive if they are left overnight in an incubator and the temperature of the latter has risen to 102°. Some experiments were made by Santos to ascertain the temperature and the length of exposure sufficient to kill cultures of gonococci. He found that exposures to 43° C. for seventy-six minutes, to 44° C. for fifty-four minutes, and to 45° C. for thirty-seven minutes were required. Laqueur injected emulsions containing living gonococci into the joints of dogs, and found that the joints which were exposed to diathermy contained a sterile fluid while those which were not exposed contained living organisms.

Cases have been noted of the influence of pyrexia due to other causes on coexisting gonorrhoea. One case was that of a man who had suffered for a long time from gonorrhoea which had resisted treatment. When residing in West Africa he acquired blackwater fever; on his recovery from the latter the gonorrhoea had disappeared and did not return.

In addition to its direct action on the gonococci diathermy produces certain effects in the tissues which are prejudicial to the existence of the organisms. The increase of the supply of blood to the heated tissues probably has some therapeutic effect. The application of diathermy to mucous membranes causes an increased exudation of lymph and secretion of mucus. The drainage of the infected parts is thereby aided and it is possible that the heated lymph and mucus exert a germicidal action.

Treatment of Gonococcal Arthritis by Diathermy.

Our earliest experience of the action of diathermy on infection by the gonococcus was obtained in cases of arthritis. We shall therefore describe our experience in the treatment of this disease first.

The space at our disposal will not allow a detailed description of our methods of applying diathermy to different joints. It is necessary that the current should be directed *transversely* through the joints rather than longitudinally. The applications should last not less than twenty minutes each, and they should be repeated not less frequently than twice weekly. Longer and more frequent applications would probably procure quicker results.

In our first seven cases diathermy was applied to the joints only and the average number of applications was nine. Relief of pain was procured, however, by a considerably smaller number than nine, and the patients usually obtained some relief after the first treatment. Some of the subsequent cases did not obtain relief until the diathermy was applied, in addition, to the original site of the infection. It is now our custom, in all cases of arthritis, to apply diathermy to the urethra and prostate or urethra and cervix uteri as well as to the joints. Quicker and better results are obtained when this is done. In two cases, however, we were able to procure complete relief of pain by applying diathermy to the parts first infected without including the joints.

Up to the present time we have completed the treatment of 25 cases of gonococcal arthritis: 13 of these were in

* This paper is an abstract of a monograph which contains details of cases and particulars of experiments and methods. The monograph will be published as soon as possible.

male patients, 9 of whom had gonorrhoea when treatment by diathermy was commenced; in the remaining 4 the discharge had ceased before beginning the diathermy. In 6 of the 12 female cases there was bacteriological evidence of gonococcal infection; the remaining 6 had vaginal discharge; one of them had sought treatment at the special centre and in another the radiological appearance of the joints suggested gonococcal arthritis.

Of the 25 cases 19 were in out-patients who came from the special centre for the treatment of venereal diseases. The others were in in-patients at St. Bartholomew's or the West Middlesex Hospital. Three of the cases had been bed-ridden before admission to hospital. The ages of the patients varied from 16 to 56. In 7 cases one joint only was affected, two joints were involved in 8 cases, three joints in 4 cases, four joints in 2 cases, while in the remaining 4 cases more than four joints were affected. The knee was involved in 17 cases.

With two exceptions the cases derived the greatest benefit from diathermy; pain was abolished, swelling was reduced, and the range of movement was increased. Patients who had required the use of crutches or sticks were able to walk unaided and resume their work. Others who had been unable to follow their occupation owing to pain in their upper limbs were able to resume their work, and three bed-ridden patients were able to get up and walk about. In the cases in which the infection had persisted for long periods and caused thickening of the synovial membrane and ligaments and capsule of the joints and destruction of the articular cartilages slight swelling of the joints remained together with some limitation of movement. These cases were, however, freed from pain and tenderness and the joints could be used without discomfort, so that further treatment by other physical methods procured additional usefulness of the limbs. If the dire results which may follow long-continued gonococcal arthritis be remembered (Osler described this condition as "in many respects one of the most damaging, disabling and serious of all the complications of gonorrhoea") it may be claimed that the results of treatment by diathermy are far superior to those obtained by other methods.

In the two cases in which the results were less satisfactory we were unable to complete the treatment. One of these was that of a girl, aged 16, an in-patient, who had severe pains in many joints. The fluid from the cervix, on cultivation, grew one colony of gonococci. The application of diathermy to the joints procured some relief—she no longer screamed with pain when lifted from the stretcher on to the diathermy couch and was no longer sleepless at night. Diathermy was not applied to the cervix as general anaesthesia was necessary in order to pass a speculum. In the light of our later experience we are of the opinion that this patient would have derived complete relief if diathermy could have been applied to the cervix.

The other patient had to be discharged from the ward on account of unruly behaviour. During the period in which treatment was applied he derived some relief from the pain in his joints so that he had fair nights and his general condition improved. The discharge from his urethra did not entirely disappear, but he no longer passed clots of pus with pain and strangury, as had been the case before the treatment was applied.

Treatment of Gonococcal Orchitis and Epididymitis.

To apply diathermy to the testis and epididymis we have used electrodes made of sheet lead cut in a special way so that they can make even contact with the scrotum and its contents on the affected side. The other electrode was, in our first series of cases, placed on the hypogastrium. Afterwards we applied it to the prostate or penis in order to include the original site of the infection in the treatment.

Up to the present we have treated 26 cases. In no branch of treatment have we obtained results so consistently good and rapid as those following the application of diathermy to the testis and epididymis when painful, tender, and swollen as the result of infection by the gonococcus. Pain and tenderness diminish or disappear after

the first application, and after the third there are no symptoms or signs of abnormality save slight thickening of the epididymis without tenderness on pressure. We have never found it necessary to give more than four applications and in the majority of cases three were sufficient.

It is usually stated that pain and tenderness will subside from the testis and epididymis when the urethra has been successfully treated by the customary methods. We have had cases, however, in which the urethral discharge had disappeared after treatment, leaving, however, pain, tenderness, and swelling of the epididymis and testis, which would not subside until diathermy was applied. We have also had cases in which diathermy produced the results above described even though a discharge containing gonococci was still present.

In cases which respond successfully to methods of treatment other than diathermy the pain and tenderness do not subside before six weeks have elapsed. With diathermy, however, the period of treatment is a week or ten days, and the number of applications rarely exceeds three. This number would probably produce the same effect if given in less than a week, but in hospital practice we cannot as a rule treat such cases more frequently than twice weekly.

Treatment of Gonococcal Urethritis (Female) and Endocervicitis.

During our investigation of the action of diathermy on gonococcal arthritis in the female we found that some of the patients did not derive much relief until the regions first infected were subjected to the same treatment. This indicates that diathermy has some therapeutic action on the urethra and cervix when infected by the gonococcus. In order to ascertain the extent of this action we applied diathermy to cases of gonorrhoea in the female in which there was no complicating arthritis and noted the effect on the gonococci and the discharge.

For the application of diathermy to the urethra and cervix we have conducted experiments and as a result have devised methods the usefulness of which we have investigated. For reasons of limitation of space we are unable to describe these or give details of technique. We have used a bougie electrode for the urethra and have found that the patients were sufficiently sensitive to heat in this part to prevent the application of a current which would damage the mucous membrane. This is not the case with the cervix. This part can be cauterized by diathermy without pain to the patient. To apply a safe degree of heat a knowledge of diathermy currents and familiarity with their clinical use is necessary, but, briefly described, our procedure is to note the strength of the current previously used for the urethra and to apply an amount to the cervix proportional to the smaller extent of surface in contact with the bougie when it is in the cervix. Probably an easier method would be to use electrodes fitted with thermometers. At present we are occupied in the construction of such electrodes.

Up to the present we have treated 16 patients who, suffering from vaginal discharge, sought treatment at the special centre. Gonococci were found in 14, either in the urethra or cervix or in both parts. These patients had been subjected to treatment at the centre by the customary methods, and as the discharge and the gonococci did not disappear it was decided to try the effect of diathermy. Both the urethra and the cervix were treated and the average number of applications was four to each part. At the end of the treatment and at later intervals each case was examined bacteriologically. With one exception, no gonococci were discovered, nor were they found at later periods. The length of time for which the patients were under observation depended on the fidelity with which they obeyed their instructions to report for examination. It varied from two months to one year.

The failure to find gonococci is insufficient evidence of freedom from infection by these organisms. Four of our cases, however, stated that they were free from discharge and no discharge was visible on examination. Two of these cases did not report for further examination. The other

two were examined at later dates and both remained free from discharge, one after ten weeks and the other after four months. Three cases in which a slight discharge persisted were afterwards treated by zinc or copper ions and the discharge disappeared. These cases were seen again after two, three, and six months respectively, and no discharge was visible. In the remaining six cases the patients said that the discharge had diminished. In these the discharge was not purulent in appearance, and in one it was clear and resembled mucus. In one of the two cases in which gonococci were not found before the diathermy the discharge disappeared after the treatment; the patient was told to report again but did not do so. The other case could not complete the treatment as she had to leave London; her doctor reported that the discharge was "much less." The patient from whom the gonococci could not be made to disappear was probably reinfected as her husband also had gonorrhoea and was under treatment at the centre.

The question whether complete cure of gonococcal cervicitis or urethritis has been obtained cannot be answered by the absence of gonococci from the discharge. Complete subsidence of discharge is in its favour. Often, however, some discharge continues, and the question will arise in such cases whether the discharge is pathological. A discharge of pure mucus is not evidence of gonococcal infection. If, however, pus is present in the discharge it must be considered as pathological. A point in the treatment will often be reached in which although the discharge is mainly mucus there are still present small numbers of leucocytes. After ionization and diathermy in which sloughing has taken place leucocytes will be present as the result of the formation of granulations. Often, on the cessation of treatment, these will disappear and the discharge will finally clear up after a short time without further treatment. It is to be remembered that these treatments to the cervix *tend to maintain this muco-purulent discharge*. It becomes therefore a matter of judgement founded on experience when the treatments should be left off in the expectation that the discharge will eventually cease.

Treatment of Gonococcal Prostatitis by Diathermy.

At present we have not obtained sufficient evidence to enable us to make a definite conclusion on the action of diathermy on gonococcal prostatitis. Our results so far seem to show that the new treatment possesses therapeutic action in this disease. We treated one of our cases of arthritis by applying diathermy to the prostate only, and obtained the effects already mentioned—namely, abolition of pain, reduction of swelling, and increase of movement. We also noted the disappearance of pain and tenderness from the epididymis in a case of gonococcal infection of this part after application of diathermy to the prostate only. The following case also is suggestive. The patient gave a history of gonorrhoea. In his perineum there was a fistula leading to his urethra immediately behind a stricture of the passage mentioned. He complained of severe pain in the right lower limb. There was tenderness on pressure over the back of the thigh and flexion of the hip caused extreme pain. It was decided to apply diathermy to the prostate only. Complete and permanent relief of pain was produced, and the only symptom which remained was some discomfort on stooping with the knees extended.

It has already been mentioned that some of the cases of arthritis did not obtain relief until the urethra and prostate were also subjected to diathermy. In all these cases, save that described above, both prostate and urethra were treated simultaneously. We are therefore unable to state the region on which the diathermy exerted its therapeutic action—whether the urethra or prostate or both. Further light on this question would be thrown by the application of diathermy to cases in which only the anterior urethra was infected and to others in which the clinical evidence pointed to subsidence of infection from the anterior urethra with persistence in the prostate. This investigation is at present occupying our attention.

DIATHERMY FOR MALIGNANT DISEASE OF THE MOUTH, PHARYNX, AND NOSE.

WITH NOTES ON SEVENTEEN SUCCESSFUL CASES.

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FOR the last eight years I have been employing diathermy in the treatment of carcinoma affecting the mouth and pharynx. Unfortunately, the great majority of the patients treated were suffering from advanced disease; this was true of all the early cases, and of nearly all those treated in hospital. A very considerable number of patients were suffering from secondary deposits in the glands on one or both sides of the neck, and in some cases the glandular involvement was extensive. Cutting operations of magnitude had, therefore, frequently to be carried out in the neck; diathermy is rarely, if ever, of any use in dealing with the malignant extensions in the neck. Faulty technique and the too timid use of the diathermy electrode accounted for some of the failures in the earlier series of cases. Owing to the great size or unfavourable position of the growth, or the general cachectic condition of the patient, many of the cases dealt with would now be deemed unsuitable for any sort of treatment. Haemorrhage during the separation of the sloughs was a not infrequent occurrence. Since I have adopted ligature of the main vessel or vessels supplying the part in cases requiring extensive diathermy, or in patients with thickened arteries and high blood pressure, severe haemorrhage has not been met with.

When the growth is small, superficial, and situated some distance from important and vital structures, and when the glands are free from involvement, or only slightly invaded, there is an excellent chance of a complete and lasting cure. My experience is that, if local recurrence is going to take place, it will generally happen during the first six months. This, of course, does not apply to recurrences in the neck. When the primary growth is very extensive, deeply rooted, and situated in a locality unfavourable to its free destruction, and more especially when the secondary deposits in the neck are massive or fixed, there is little likelihood of effecting a cure, and there may be great risk in subjecting the patient to operation. However, most of the cases recorded in this article were described by others as "inoperable," and some of them were very extensive; it is difficult, therefore, to draw the line between cases which should be subjected to treatment and those which should be left alone. Much depends on the general condition of the patient and the special experience of the surgeon. Every practitioner should be alive to the grave significance of an ulcer or indurated area occurring in the tongue, mouth, or pharynx of a patient over middle age. The condition rarely proves to be simple, or due to any other cause than malignant disease. It is well, therefore, to regard every doubtful case as one of cancer until it is proved to be due to some other cause. To the practised observer the diagnosis of epithelioma is generally easy. Over and over again the author has seen patients who have been diagnosed as suffering from "septic ulcer," "cyst," "gumma," when the real trouble was epithelioma. Many cases of supposed syphilis are repeatedly injected with salvarsan or soaked with iodides. It is important to remember that a great many patients with buccal or pharyngeal cancer will give a positive Wassermann reaction.

In the majority of cases the growth is visible on ordinary inspection—it is generally best to use reflected light. If it is situated at the base of the tongue, low down in the pharynx, or in the neighbourhood of the larynx, a laryngeal mirror will be required for its inspection. In nearly all cases palpation with the finger is possible, and it should never be omitted, as the cartilaginous hardness of an epithelioma is one of its most characteristic features.

Microscopic examination of a fragment of the tumour