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Historia medicinae

Proposals for radium therapy in 1903

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The 1903 paper Vorschläge zur Radiumtherapie (Proposals for radiumtherapy) by Hermann Strebel (1868-1943) is of historical interest as it is the first proposal of the principles of afterloading and crossfire, cornerstones of modern brachytherapy. We present the first English translation of the original German of Strebel's important paper [1].

Key words: brachytherapy, radium, afterloading, crossfire, Hermann Strebel

Introduction

Crossfire and afterloading are the pillars of modern brachytherapy This, the first English translation of classic 1903 German language paper [1] by Hermann Strebel* (1868-1943, see Figure 1) demonstrates that this multifaceted Munich physician (surgeon, phototherapist, electrotherapist and radiotherapist) should be given priority for first performing afterloading and crossfire.

Proposals for radiumtherapy by Dr. med. H. Strebel

"The Becquerel radiation emitted from the metallic miracle radium, is currently used therapeutically, due to its effect (similar to X-rays) upon living tissue. In 1900, I proved (see: *Fortschritte auf dem Gebiete der Röntgenstrahlen*, Volume IV), that radium radiation causes growth retardation in bacterial cultures. Aschkinass & Caspari contemporaneously demonstrated that cell kill can be achieved, provided that a sufficiently strong radiumsource is used. Freund, Walkoff, Giesel, Aschkinass, Curie demonstrated the changes radium induces in skin, which are very similar to the dermatitis produced by X-rays. The microscopic nature of these tissue changes were studied in Neisser's clinic, and the macroscopic-pathologic conditions were demonstrated by Holzknecht and Exner.

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* Hermann Strebel also became a notable astronomer in the 1920s and 1930s whilst still practicing medicine. A biography including his achievements in medicine and astronomy will be published in *Nowotwory Journal of Oncology* [2]

Figure 1. Hermann Strebel. This photograph is from the *Portraitgallerie der Astronomischen Gesellschaft*, published in 1931 in Budapest by the Königlich Ungarische Universitäts-Druckerei

I believe that I was the first* who had the idea, to propose using radium for therapeutic purposes, by applying radium (encased in a pasteboard and paraffin impregnated paper container) to a lupus lesion for several hours. A moderate reaction resulted, followed by paleness of the lupus nodule. Further radiation caused an ulcer to develop, which scarcely healed, but the lupus was not cured. The lack of success seemed to me to be due to the poor quality radium source that I had then possessed**. Similar results were obtained by Halkin at Neisser's Clinic. Then, Danlos & Bloch later reported on their cure of lupus vulgaris with radium.

Recently, the experiments with radium radiation by Exner, Holzknecht and Scholtz gave encouraging results for cancroid, carcinoma, sarcoma, and malignancy, similar to the results with X-rays. Currently available radium sources have an activity of 1½ million uranium units, capable of inducing a dermatitis following a daily 10 minute exposure for about 8–14 days. If the exposure time is prolonged, a third grade dermatitis associated with high-grade tissue destruction, is induced. The longer the exposure, the earlier the appearance of inflammation, occurring in as soon as a few hours (Exner & Holzknecht). The application can be made by placing radium in an ebonite capsule enclosed by a plate of mica, on the site to be irradiated, leading to a reaction with a diameter of 5 mm.

The dermatitis caused by the irradiation of deep-seated cancer is very unpleasant, and is the reason that application times are limited. I consider surface application to be a poor utilisation of the radiation, as only that part of the radiation that is emitted directly onto the skin is utilised, and the fraction of radiation emitted laterally is wasted.

I have found that the following procedure provides a significant increase in the effectiveness of radium for deep-seated pathological processes, while avoiding damage to the skin. It can be achieved by a direct intratumoural application, instead of a surface application. The radium is placed in a drilled-out rod, which is placed directly into the centre of the tumour after puncturing the tissue with a trocar. In this way the irradiated volume can be enlarged by the homogeneous irradiation of the substance in all directions. Additionally, the intensity of tumour irradiation can be increased by lengthening the exposure time without increasing unwanted skin irradiation; the radium reacts directly with the tumour. It is essential that both the α- and β-radiation of radium be utilised. α-radiation has a low penetrability, but may be the main contributor to cancer cell damage, but cannot be achieved by surface application. On the other hand, this kind of radiation shows its beneficial effects with intratumoural applications. This method may prove advantageous in the treatment of rectal carcinoma. Irradiation of the tumour through the intestine would probably result in a nasty intestinal inflammation, that would probably result in ulceration. In contrast, if one were to insert a trocar into the tumour, followed by an intratumoural application of the radium, the tiny puncture would readily heal with pressure applied after instrument removal, and complications would be unlikely.

If the initial skin puncture site could be used for repeated insertions of the trocar in different directions, a larger portion of the tumour would be irradiated. In this way, a reduction of the tumour size can be obtained without affecting overlying skin or the intestine. The same method is possible in the treatment of the larynx, uterus, liver, etcetera.

The utility of radium as a replacement for X-rays will be especially successful, if the tumour is situated in narrow cavities, such as the nose, larynx, bladder, etcetera. Holzknecht has recommended an apparatus for such purposes. I reported in 1902 at the Karlsbad Congress, that the gonorrhoeal infection of the urethra could be treated with radium placed in the tip of a catheter.

I want to point out other aspects. Radium radiation has, in my experience, the capability of shrinking tumours. Pathological cells have less resistance to the destructive effects of radium than do those of normal healthy tissue.

Treatment of stomach cancer by the intragastric application of a powerful radium source would cause daunting gastritis; it is questionable whether a therapeutic result can be achieved by this approach. Perhaps it may be better achieved by frequent applications of a moderate dose, although a chronic ulcer might still result. Utilisation of induced radioactivity may be a better approach. Radium has the capacity to produce it in zinc, lead, bismuth, paper and so on; that is, produce a radiating substance for 24 hours which has the same quality as the inducing substance. Even, radioactive water can be produced by distillation of a several day-old solution of radium bromide (Curie, Debierne) or by placing a radium salt in a closed container with a dish of distilled water (Hoffmann). These secondary radioactive substances generally have the same radiation as the primary active substances. They are weaker, however, and lose their activity after 24-30 hours. Perhaps activated water, which can be produced without loss of substance and energy of the primary radiation source, can be used to treat carcinoma of the stomach by drinking the water at defined intervals. The water, containing a suspension of active powder, will come into contact with the stomach wall. The powder would be widely distributed by the water, and will remain after the water is gone, thus depositing the induced energy in the stomach. It remains to be seen whether the ensuing moderate effect will be efficacious.

This paper proposes several possible methods of utilising radium therapeutically; it is for capable investigators (Neisser, Pick, Holzknecht, Scholtz), to decide whether to attempt them. My own trials in this direction are not yet finished and will be the subject of a later report."

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* *Transactions of the VII Congress of the Dermatologists*, Breslau 1900, p. 488, and Freund, *Grundriss der Gesamten Radiotherapie*, 1903, p. 289.

** The radium sources were provided by Professor Grätz of the Institute of Physics, University of Munich."

Discussion

Hermann Strebel commenced experimenting with radium salts in 1900 and was probably the first to publish results on radium irradiation of bacteria [3]. However, he was more interested in the therapeutic uses of ultraviolet light, first publishing on this subject in 1899 [4].

In his 1903 paper [1] he suggests that he may have been the first to propose the use of radium for therapeutic purposes. He based this claim on a presentation that he had given in 1900 to the VII Congress of Dermatologists, in Breslau. However, the meeting in question occurred in Breslau 23-30 May 1901. Nevertheless, in the *Fortschritte auf dem Gebiete der Röntgenstrahlen* volume for 1900-01, Strebel writes [3] on page 131 'In my experiments I am guided by the thought that there might yet be a result that can be used therapeutically'. He is considering lupus, as he was aware of the results of Leopold Freund (1868-1943) and Eduard Schiff (1849-1913) [5] when treating lupus using X-rays. Since Strebel's paper [3] was published in early 1901, it is probable that he wrote his manuscript at the end of 1900.

It is very likely that he was the first to perform afterloading of a radium source through a previously created puncture. The New York surgeon Robert Abbé (1851-1928) is often incorrectly credited with being the first, based upon his publications of 1906 and 1911 [6, 7].

By placing his radium source through several tumour punctures sequentially, Strebel was implementing crossfire. It was left to Louis Wickham (1861-1913) & Paul Degrais (1874-1954) [8] to more clearly define the principle of this technique, which underlies most radiotherapy treatments (including brachytherapy, X-ray therapy and stereotactic radiosurgery).

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