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A brief history about radiotherapy

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Abstract: Radiation therapy or radiotherapy is a therapy used as a part of cancer treatment for more than 100 years. This essay is a contribution towards a study of this theme about the discovery and evolution of radiotherapy, particularly to describe its history, the main types of radiotherapy and methods of treatment complementary to radiotherapy.
Keywords: Brief history of radiotherapy,types of radiotherapy, methods of treatment complementary to radiotherapy

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I. Introduction

The main objective of this brief essay is to describe the history of the discovery and evolution of radiotherapy, over time. There are three key milestones in the history of radiotherapy, namely the discovery of X-rays, the discovery of natural radioactivity, and the production of artificial radioactive elements. These three historical references, along with the in-depth knowledge of the atomic and nuclear structure, where the names of Niels Bohr and Ernest Rutherford are unavoidable [1], it will determine the evolution of radiotherapy throughout the 20th century. Radiation therapy is a therapy that uses ionizing radiation to control or kill malignant cells or cancer. In historical terms the term cancer (from the Greek "karkinos") [2] was proposed for the first time by Hippocrates, who argued that the roots of this disease resided in a humoral imbalance that was deposited in the patient's body. This conception prevailed until the 19th century. Currently, it is known that cancer has several causes [3] and its biological basis is a source of profound research [4].There are several techniques of radiotherapy, which I will mention later, that might be prescribed by a medical oncologist with the intent to cure or as adjunctive therapy [5]. The precise treatment (curative, palliative or adjuvant) depends on the type of tumor, location, stage, as well as the health of the patient. Radiation therapy is also applied in other treatments for non-malignant diseases (such as vascular restenosis), although it is limited by the risk of radiation inducing malignant cancer [6].

I also want to point out that alongside the technical procedure for curing cancer [7], it is necessary to take into account the social problems associated with this disease that require a multidisciplinary approach [8]. Indeed, with the technological advancement of medicine, the survival rate of cancer patients has increased, but the patient has to cope with the side effects [9] of radiation therapy, such as fatigue, nausea, infertility, local ulceration, depression, insomnia, and anxiety [10]. Thus, more and more oncological physician takes into account the quality of life of the patient after cancer treatment [11].

II. Methods

In this brief essay on the discovery and evolution of radiotherapy, I collected and analyzed the main scientific books and technical articles on this area of study that are available in academic terms, seeking to make a useful synthesis to the reader who intends to have a succinct idea about the subject in question, but without neglecting the scientific rigor in this analysis. Within the various bibliographic sources available, I selected a sample composed of the 45 most important items on this topic, based on the "impact factor" of the article, and the "reference" books on the subject (from "classic" to current).

III. Results and Discussion

The results of this research work about the history of radiotherapy leads me to mention in the first place the discovery of X-rays by Wilhelm Rőntgen, in 1895 [12]. In 1896, Emil Grubbe and Victor Despeignessought to use X-rays to cure cancer [13]. In 1897, Leopold Freund [14] and Eduard Schiff also proposed X-rays to treat some diseasesand, in 1899, TageSjögren became the first person to successfully treat a person with cancer through X-rays [15].

In 1898, with the discovery of radioactive elements polonium and radio by Marie Curie, a new stage in the history of radiotherapy has begun [16]. In fact, soon after the discovery of the radio there was speculation by Ernest Besnier whether the radiation from these elements could be used in the same way as the X-rays [17]. It was believed that the radio element could have therapeutic effects [18], although it could also have adverse effects on the patient, such as burns, which was confirmed by Otto Walkhoff, and later by Henri Becquerel.

The issue of radiation dosage and treatment time, what is referred to as «fractionated radiation therapy», is one of the most determinant factors in the history of radiotherapy [19]. In fact, Claude Regaud proposed that cancer treatment could be more effective if the radiation was taken in smaller doses over several weeks. In1900, Thor Stenbeck cured a skin cancer patient with small doses of radiation. In 1918, this experience was reinforced by Friedrich and Krönig. In 1922, Henri Coutard [20]verified the minimization of the side effects of radiation in a patient with tongue cancer treated with small doses of radiation. In 1935, hospitals began to follow this treatment plan [21]. In the 1980s the quadratic linear model was proposed to describe the effects of radiation on irradiated tissues [22].

On the other hand, between 1950 and the early 1980s, the field of radiotherapy began to use cobalt therapy machines (using a cobalt-60 source that emits gamma rays) that allow the treatment of deeper and "difficult" cancers, while X-rays only allow thetreatment of superficial tumors [23]. Subsequently, the linear particle accelerators [24] have begun to replace the cobalt units, since they have the possibility to produce higher energies, through a linear acceleration structure [25], without radioactive sources inside them. The calibration of this type of apparatus is done through the so-called basic dosimetry [26]. Since the 1970s, the design of radiotherapy treatment machines has developed a lot, having for this purpose been invented the computerized tomography, such as 2-D and 3-D (that usesthe clinical dosimetry plan [27]), as well as the integrated computerized image therapy, such as IMRT and IGRT(that uses the inverse planning [28]).

In technical terms, there are three main types of radiotherapy [29], namely radiation through external therapy (or teletherapy), radiation through internal therapy (or brachytherapy) and systemic therapy with radioisotopes. The differences between the first two arerelated to the position of the radiation source [30]. In teletherapy the source of radiation is outside the body, whereas in brachytherapy the source of radiation is within or near the body. Most people who perform radiotherapy receive the therapeutic modality of teletherapy or conventional therapy for the treatment of cancer.

There are seven main types of teletherapy [31], such as conventional external radiation therapy or 2-D [32], conformational radiation therapy or 3-D [33], stereotactic (or precision) radiation therapy [34], radiation beam intensity modulation or IMRT [35], image-guided radiation therapy or IGRT [36], volumetricmodulation therapy or VMAT [37] and particle therapy [38].

On the other hand, brachytherapy [39] uses radioactive isotopes (iodine-125, gold-198, iridium-192) in direct contact with the tumor, whereas systemic radioisotope therapy uses the chemical properties of a substance containing a radioactive isotope (iodine- 131, Yttrium-90, Lutetium-177).

IV. Conclusions

As a summary of this essay, I want to mention that radiotherapy has proven to be the most effective cancer technique in the history of cancer treatment [40]. The constant innovations on the different techniques of radiotherapy, referred briefly in this essay, have allowed to get better results in cancer treatment, with fewer adverse effects for the patient, even in cases of tumors that are more difficult to treat. It should be added that the combination of radiation therapy with surgery, chemotherapy, hormone therapy or immunotherapy, together with the early detection of the disease, has been the key to increasing the success of oncological treatment in all parts of the world [41]. Prevention has also been an effective means of combating cancer. It is known that some cancers can be prevented through proper diet [42], namely, vegetables, fruits, fish instead of red meat, sugars and excess sedentary lifestyle and tobacco. However, there are a number of different approaches to the problem of cancer, which vary according to the country in question [43]: different emphasis on prevention and education of the person's behavior, choice of different types of treatment for the same situation of cancer.

In conclusion, the constant effort of scientists, biomedical engineers and oncologists [44] has allowed the history of radiotherapy to be increasingly successful in the treatment of cancer, although there are still relatively high rates of mortality in this health area (about 8 million people worldwide die of cancer every year). In Portugal, cancer mortality is below the European average [45].

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