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HISTORY OF ONCOLOGY

Otto Hahn (1879-1968): pioneer in radiochemistry and discoverer of radiotherapeutic mesothorium

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Summary

Otto Hahn was a German innovative chemist. He had discovered various radioactive elements, as well as the nuclear fission. He finally received the Nobel Prize for his participation in the atomic energy project, which Hahn and others considered that could be a factor used for peaceful means like cheap electricity and cheap industrial products. His greatest discovery though in oncology was mesothorium, a radioactive element that had been used to treat all cancer types at the beginning of the 20th century.

Key words: *cancer, mesothorium, nuclear fission, Otto Hahn, radiochemistry, radiotherapy*

The first steps of Otto Hahn

Otto Hahn was born in 1879 in Frankfurt-on-Main. He studied Chemistry and Physics at Marburg and Munich, obtaining his doctorate degree on organic chemistry in 1901 at Marburg. He worked as a distinguished member of Ernest Rutherford's (1871-1937) team at McGill University, in Montreal, Canada.

It was in September 1905, when Hahn had moved to McGill in Montreal Canada, to learn more about radioactivity, under the guidance of Rutherford [1]. His work at McGill's laboratory was essential as he published three treatises, announcing the discovery of thorium C, later identified as *212Po*, of radioactinium, later identified as *227Th*, while he had investigated the alpha rays of radiothorium [2-4]. During 1904-1905, Otto Hahn had spent a year in Sir William Ramsey's (1852-1916) laboratory at the University College in London, where he worked on radiochemistry, an unexploited field at that time. During 1905, experimenting on radium salts, Hahn discovered a new radioactive element, that he named radiothorium (*228Th*), which at that time was believed to be new, while in fact it was another isotope of the known natural element thorium (*223Th*), an intermediate product between natural thorium (*223Th*) and thorium X (*224Ra*) [1]

The discovery of mesothorium

In 1906, Hahn moved to Berlin, where during 1910, he was nominated Professor of Chemistry [1]. In Berlin he collaborated with the German Nobel Prize winner Hermann Emil Louis Fischer (1852-1919), a distinguished Professor of the University, who placed a laboratory at his disposal. Inside this old sub-equipped laboratory, Otto Hahn by using the technology of atom splitting developed by Marie Skłodowska-Curie (1867-1934) and the radioactive recoil as well, he obtained new radioactive products [6]. He discovered mesothorium I, mesothorium II and the mother substance of radium,

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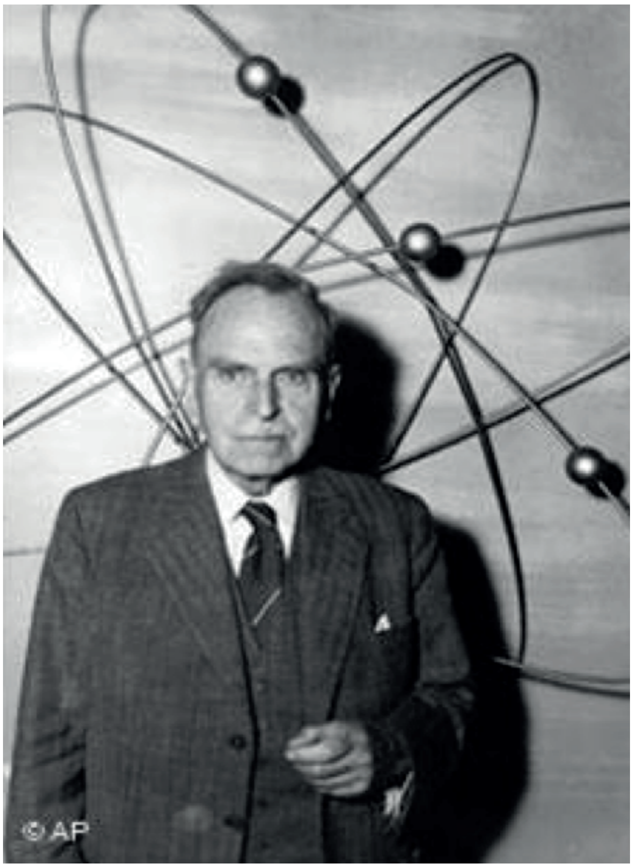

Photo 1. Otto Hahn, 11/08/1955 in Geneva. Associated Press..

ionium. While Pierre (1859-1906) and Marie Curie had discovered 226Ra, which was firstly used in radiation treatment, it was Hahn's mesothorium I (228Ra), that assumed great importance, as it had the same radiation effect, with only half the cost to be manufactured [5]. Hahn then entered the field of radiotherapy in oncology and was nominated for the Nobel Prize, though without receiving it. Soon Otto Hahn was asked by E.L. Fischer to give lectures in order to explain radiation activity and his findings to other Professors in Berlin. It was a challenge for the audience to believe that a young scientist, at the age of 31, could understand in depth the new field of radiation activity and that he had discovered mesothorium [5,7].

Two wars and a Nobel Prize

During the First World War, Hahn as a member of a scientific team in Berlin was ordered by the commander of the German Military Forces to produce, test, and put in use poisonous warfare gases. His work in chemical warfare was successful by the production of mustard gas and chlorine gases, but he was opposite in using them as military strategic weapons. Before the end of the war he had returned to his laboratory, where during 1917-1918 he discovered protoactinium (*91Pa*). In February 1921, Hahn published his report on his discovery of uranium Z, later known as *234Pa*, which was the first recorded example of nuclear isomerism. For this discovery, in 1923, he was nominated but did not receive the Nobel Prize for a second time. Both, *91Pa* and *234Pa*, had no use outside the scientific research [7,8].

By using his new "emanation method", a radioactive measurement to investigate the surface and structural properties of a particular nucleus, he established the field of "applied radiochemistry", which was the title for his treatise, published during 1933 [7,8]. During that era the idea that heavy atomic nuclei could break down into lighter elements was regarded as totally inadmissible. In 16-17 December 1938 he did his experiment: the "radium-barium-mesothorium-fractionation experiment". By bombarding uranium with neutrons, he splitted (or busted as he called this split) uranium which gave traces of barium and other elements. Thus, Hahn proved nuclear fission [9].

During the Second World War, he was suspected by the Allied Forces of working for the Nazi regime on the German Nuclear Energy Project, and as soon as after the end of the European part of the war he was moved by the Allies in an unknown location in England, where he had learned of the dropping of the American atom bombs on Hiroshima and Nagasaki. He was devastated, as he had considered himself partly responsible. On 15 November 1945 he was awarded the 1944 Nobel Prize in Chemistry for his discovery of the fission of heavy atomic nuclei (Photo). He still believed though that his discovery was a crime against humanity and started a huge struggle for the prohibition of nuclear weapons [10]. Consequently, among other things, he initiated the Mainau Declaration of 1955, in which he, and a number of Nobel Prize winners, focused the attention of the public to the dangers of atomic weapons and warned nations against their use "as a final resort". In 1956 Hahn and 51 other Nobel Prize winners signed a document urging nations worldwide to prohibit the nuclear weapons for military purposes. For these worldwide peaceful efforts he was proposed several times, between 1957 and 1962, for the Nobel Peace Prize, unfortunately without being awarded. In 1968 after an accidental fall Otto Hahn died. The Max Planck Society, in which he served as a President, and was by then an Honorary President, published the following obituary notice: "On 28 July, in his 90th year, our Honorary President Otto Hahn passed away. His name will be recorded in the history of humanity as the founder of the atomic age. Germany and the World lost a scholar who was distinguished in equal measure by his integrity and personal humility" [11].

Otto Hahn's contribution in radiotherapeutic oncology

During 1913, the American newspaper "New York Times", announced the substitution of radium with mesothorium to cure cancer tumors. Experiments all over Europe demonstrated that mesothorium had identical curative results as radium. Radium was a product of uranium and thus its scarcity made it hard to obtain. Meanwhile mesothorium was a product of thorium, easier to find and cheaper to produce [12]. Mesothorium meant to be the mainstream in radiotherapy of the era. There was no doubt for scientists that the steady development of Roentgen-rays and the rays of the radioactive substances will eventually lead to a sure, painless and harmless cure of all sorts of neoplasms, benign and malignant; there were even prospects of the cure of infectious diseases (tuberculosis, sepsis) through these rays. Firstly mesothorium entered the field of uterine cancer, to destroy the malignant cells that were more vulnerable to the destructive effects of radiation, as they were rapidly dividing, and to minimize postoperative complications such as hemorrhage [13-15]. In August 1914 von Wassermann (1866-1925) exposed extirpated rat cancer to mesothorium and inoculated the cancer into susceptible animals, but growths did not result. He asserted that the death was nuclear, not cellular; the proliferating power of the cell was destroyed but the cell was not killed [16]. Mesothoriun soon became the radioactive element to treat all cancer types (i.e. leukemia, larynx cancer), and countries, especially Germany, were fighting to secure adequate quantities of mesothoriun for their cancer patients, in such a way that its value gone up three hundred per cent [17]. The following years mesothorium's side effects diminished its usage [18]. But Hahn's greatest discovery entered the field of angiography thanks to the Portuguese neurologist Antonio Egas Moniz (1874-1955) by the form of "Thorotrast". Unfortunately "Thorotrast" was discovered to be retained by the reticuloendothelial system, with a biological half-life of several hundred years, so that applied patients suffered lifetime exposure to internal radiation, and therefore mesothorium's applications faded in the next decades [19].

Conclusion

Otto Hahn is regarded as a pioneer in radiochemistry and the father of nuclear chemistry. His discovery, mesothorium, was used in radiotherapeutic oncology to treat all cancer types, and became an expensive commodity at the beginning of the 20th century. During his career Hahn faced ethical and moral accuses as one of the founding fathers of nuclear age [20], but felt some comfort knowing that his mesothorium treated cancer patients. Today we all face the same dilemmas about nuclear weapons and radiotherapy's side effects.

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