PERINATAL LESSONS FROM THE PAST

Wilhelm Conrad Röntgen (1845–1923), the discovery of x rays and perinatal diagnosis

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Wilhelm Röntgen's serendipitous discovery of x rays provided medicine and especially perinatal medicine with a powerful new investigative tool. Röntgen was born in the Rhineland town of Lennep on 27 March 1845. His German father Friedrich and Dutch mother Charlotte were cousins, coming from a well known family of merchants.¹ When Wilhelm was three, the family moved to Apeldoorn in the Netherlands and, at the age of 16 he attended the Utrecht Technical School. Expelled because of a prank, he then entered the Polytechnic School in Zurich in 1865, where three years later he acquired a diploma in engineering. The following year, under the direction of A E E Kundt, he obtained a PhD for studies on the properties of gases. When Kundt moved to the University of Würzburg as professor of physics in 1870, Röntgen accompanied him as his assistant, and likewise on to Strasbourg where he was appointed first privat-dozent, and then in 1876 associate professor in theoretical physics. In 1879 Röntgen was appointed professor of physics at Giessen, before moving back to a similar post in the University of Würzburg in 1888. Six years later he was elected to the highest office in the university, that of the rectorship.²

On 8 November 1895, Röntgen first observed the phenomenon that he named x rays. After three weeks of intensive study, assisted by his wife, he communicated his findings to the Physics-Medical Society of Würzburg in December. Within days his discovery had become a worldwide sensation as the following account from the *Vienna Presse* reveals. It was published in the *Manchester Guardian* in early January 1896:

"A Photographic Discovery: From our own correspondent: Vienna. Monday night. A very important scientific discovery has recently been made by Professor Röntgen of Würzburg University, the details of which have already reached Vienna, and are now being carefully examined by several scientific authorities here. Professor Röntgen used the light emitted from one of Crookes' vacuum tubes, through which an electric current is passed to act upon an ordinary photographic plate.

The invisible light rays, of whose existence there is already ample evidence, then show

this peculiarity; that to them wood and other organic substances are transparent, whilst metal and bones, both human and animal alike, are opaque to those rays. That is to say, they will for instance absorb the rays which have passed through a wooden case in which bones or metals may be enclosed. Thus it is possible to photograph in the manner described any bones or metals which may be contained in wooden or woolen coverings. Moreover, as human flesh, being organic matter, acts in the same way as such coverings towards the invisible rays from a Crookes' vacuum tube, it has become possible to photograph the bones—say—of a human hand, without the flesh appearing on the plate. There are photographs of this description already in Vienna. They show the bones of the hand, together with the rings that were worn on the fingers, metals, as I remarked above being opaque to these x rays—but they show nothing else. They are ghastly enough in appearance, but from a scientific point of view, they open up a wide field for speculation. Among the practical uses of the new discovery it is stated that it will henceforth be possible for surgeons to determine by help of this new branch of photography, the exact position of any bullet that may be embedded in the human body or, again, to render visible any fractures there may be in the bones prior to performing any operation on the respective part of the body. And there are various other uses to which the new method may be put, as for example, in connection with caries and other bone diseases. *The Presse* assures its readers that there is no joke or humbug in the matter. It is a serious discovery by a serious German professor."

Thus radiology was born.¹ The *British Medical Journal* also reported the discovery on 11 January 1896.¹ For the record, the glowing effect that occurred when electricity was passed through a vacuum tube had in fact been first observed by the German scientist, Johann Hittorf (1824–1914). Sir William Crookes, FRS (1832–1919) also described the phenomenon as "radiant matter" in a lecture he gave in 1869, a term actually used earlier by Michael Faraday in 1816.

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Figure 1 Wilhelm Conrad Röntgen (1845–1923).

Röntgen was a tall, dark, slender man (fig 1). He was a very honest straightforward investigator, a fine experimentalist, and an outstanding teacher. A modest man, he was meticulously tidy and took the greatest care of his apparatus. He was a scientist who lived for science. As Graham¹ has written: "He conceived clearly the problem he proposed to tackle, experimented skillfully and ingeniously, rigidly controlled and tested his results, and presented them precisely and logically with a remarkable economy of words." He disliked publicity and steadfastly declined to have his rays named eponymously or to accept any of the many offers made to commercialise his discovery. Many honours came to him. He received an honorary degree of MD from the University of Würzburg, the Rumford Gold Medal of the Royal Society, and also the Gold Medal of the Franklin Institute of Philadelphia. In 1901 he was one of the first recipients of the Nobel Prize, worth 50 000 Swedish kroner. He passed the whole sum on to his university to promote scientific study.

Although *x* rays had an immediate impact on many aspects of medicine, their application to obstetric and prenatal diagnosis was for the most part delayed because of poor penetration of the rays through the abdominal wall, uterine musculature, and liquor amnii before reaching the fetus. Still, both Varnier and Valliant succeeded in obtaining the *x* ray shadow of a fetus in utero in 1896 but only after the uterus had been removed at necropsy. Though a number of other "firsts" were recorded in the early years, it was not until the 1930s that rapid advances became possible with the development of a more powerful *x* ray beam. These various advances included the diagnosis of pregnancy, the position and presentation of the fetus, the detection of multiple pregnancy

(1911), the diagnosis of major fetal malformations such as neural tube defects, evidence of fetal death (Spalding's sign, 1922) and extra-uterine pregnancy (1898), assessment of fetal maturity (1935), radiological assessment of the pelvis and its capacity (1930 onwards), amniography (1932), and direct placentography (1934).³ Other advances included the improved use of contrast agents (first used in 1901) to outline hollow organs and blood vessels, cine-radiographic techniques (1935), and the percutaneous catheter replacement technique used in angiography (1953). More recently the development of computed tomography (1973) has permitted the three dimensional reconstruction of *x* ray images. The dangers of ionising radiation, first appreciated by radiologists within a few years of the discovery of *x* rays, but in respect to the fetus only in the 1960s, has led to their diminished use during pregnancy and the perinatal period and, to a large extent, their replacement by ultrasonography and magnetic resonance imaging. *x* Rays have also proved of value in spectroscopy and crystallography, in the diffraction analysis of the structure of organic crystals, essential techniques in modern analytical chemistry and physics. *x* Ray crystallography has had a major role in determining the structure of substances such as insulin and penicillin and, most importantly, of DNA, which in turn has led to the unravelling of the genetic code, an advance that is already having a profound effect on medicine and on the understanding of life.

Wilhelm married Anna Ludwig, the daughter of an innkeeper in 1872. She was six years older than him. Their marriage was a very happy one but they had no children of their own and therefore adopted their six year old niece Josephine in 1887. In 1900, Röntgen moved to Munich as Director of the new Physical Institute there. At the outset of the Great War he was 69. He sold his Rumford Gold Medal to support the war effort. In 1920 he was elected professor emeritus. Anna had died after a long illness in 1919, and Wilhelm himself died on 10 February 1923 at the age of 78 from cancer of the rectum. They lie buried together in the cemetery at Giessen.²

During his rectorial address in 1894, Röntgen had stated: "The scientist must consider the possibility, which usually amounts to a certainty, that his work will be superseded by others within a relatively short time, that his methods will be improved upon and that the new results will be more accurate and the memory of his life and work will gradually disappear."⁴ Much progress has indeed been made since Röntgen's discovery in 1896. However, the name of this altruistic and talented scientist is certain to remain fresh and honoured.

1 Graham H. X-rays and radium. In: *Eternal Eve*. London: Heinemann, 1950:574–609.

2 Hoffstaedt EGW. Wilhelm Conrad Röntgen and his "New kind of rays". *Triangle* 1970;9:271–2.

3 Strachan GI. Radiography in obstetrics and gynaecology. In: Munroe-Kerr JM, Johnston RW, Phillips MH, eds. *Historical review of British obstetrics and gynaecology, 1800–1950*. Edinburgh: E & S Livingstone, 1954:239–53.

4 Brailsford JF. Rectorial address of WC Röntgen, University of Würzburg, 1894. In: *The radiology of bones and joints*. 4th ed. London: Churchill, 1948:preface.