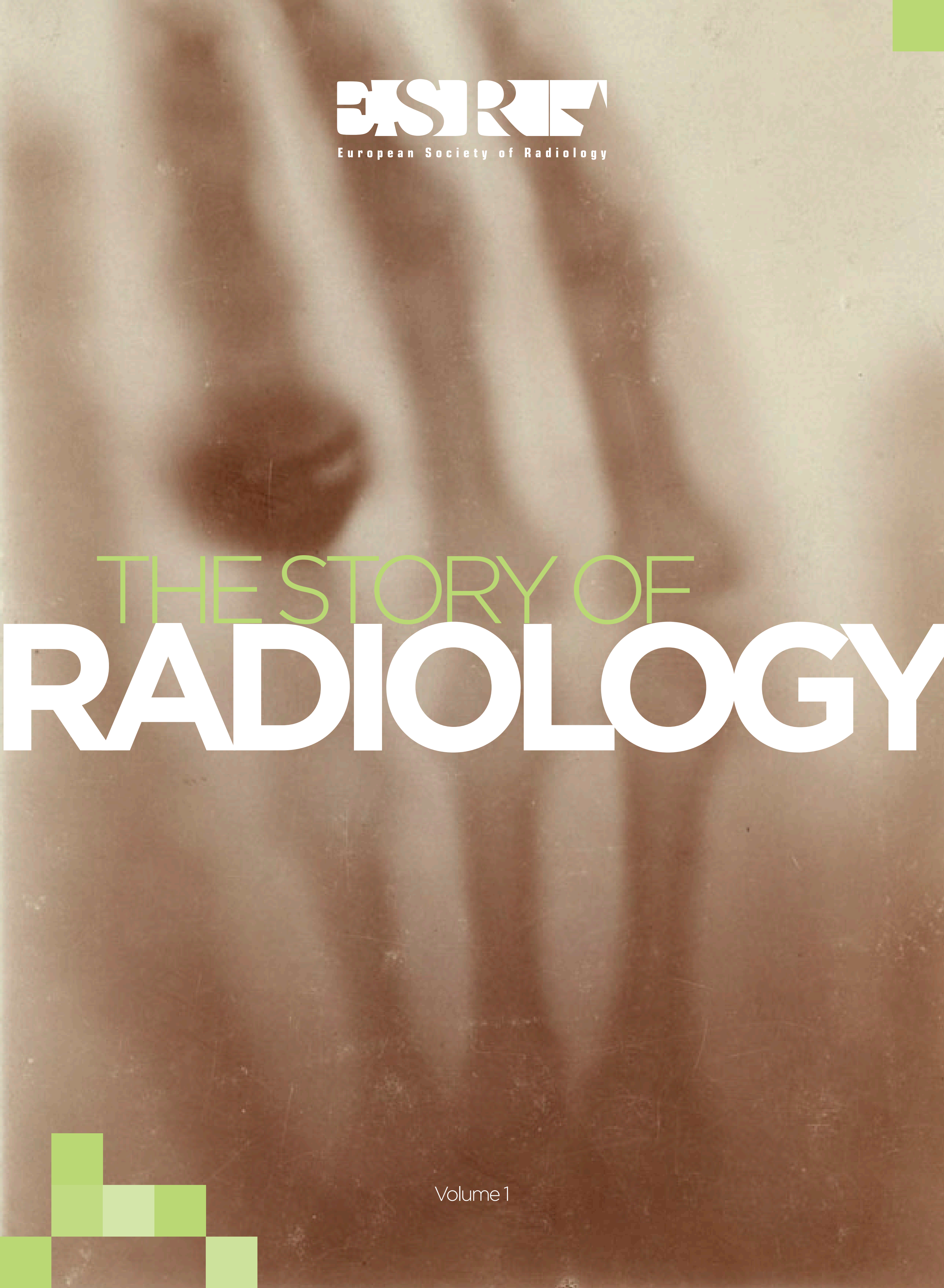

ESR
European Society of Radiology

THE STORY OF RADIOLOGY

Volume 1

INTERNATIONAL DAY OF RADIOLOGY

AN INITIATIVE OF THE ESR, ACR AND RSNA

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Coordination: ESR Office
Neutorgasse 9, 1010 Vienna, Austria
Phone: (+ 43 1) 533 40 64-0
Fax: (+ 43 1) 533 40 64-441
E-mail: communications@myESR.org
www.myESR.org

Managing Editor: Julia Patuzzi
Editors: Simon Lee, Michael Crean
Art Direction & Layout: Robert Punz

Photo Credits:
see page 94.

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THE STORY OF RADIOLOGY

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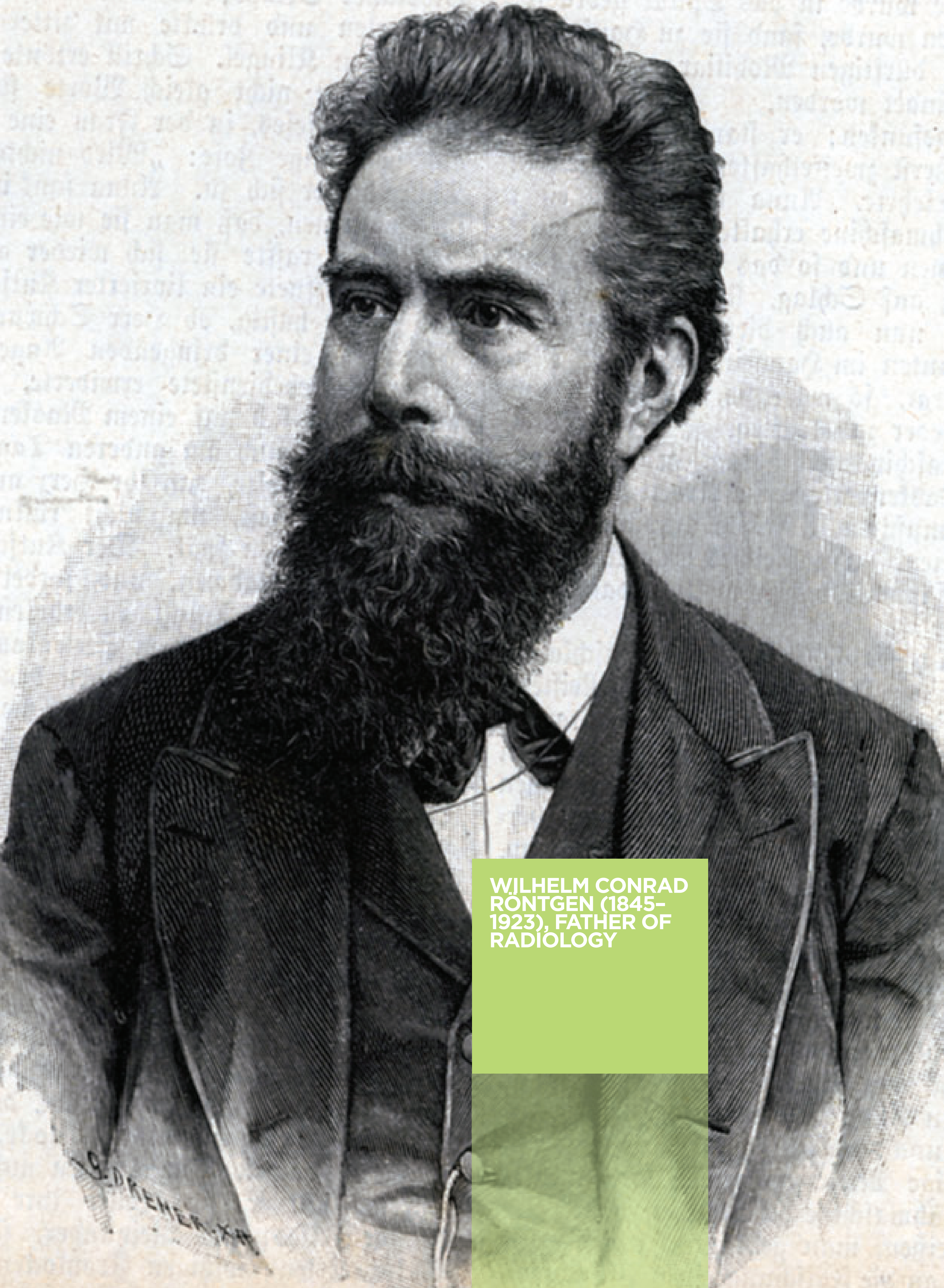


WILHELM CONRAD RÖNTGEN (1845–1923), FATHER OF RADIOLOGY

THE STORY OF RADIOLOGY

AN INTRODUCTION

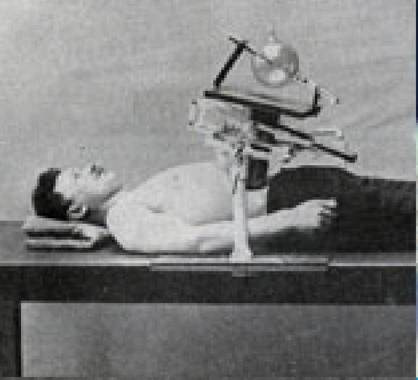
The world of radiology has plenty to celebrate. It may have taken more than a century for this to be organised on a global scale, but this just gives us even more history to look back on.

The trend was started with the first European Day of Radiology, celebrated on February 10, 2011, but it quickly became clear that the idea should be developed into a global initiative. With that in mind, the European Society of Radiology (ESR), together with the Radiological Society of North America (RSNA) and the American College of Radiology (ACR) decided to launch the first International Day of Radiology (IDoR) on November 8, 2012, which is being celebrated with numerous other radiological societies from all over the world.

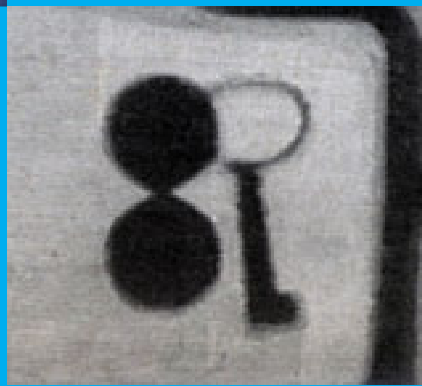
Early on in our preparations for IDoR 2012, it was agreed that among our planned projects there should be something dedicated to the radiological community; that we should not just celebrate the current state of imaging, but also the 117 years of progress and the pioneers who led the way here, to remind radiologists, radiographers and related scientists of the history and highlights of their discipline.

Cooperation with the International Society for the History of Radiology (ISHRAD) and the German Röntgen Museum was the next logical step, and you are now holding the results of this rewarding collaboration in your hands.

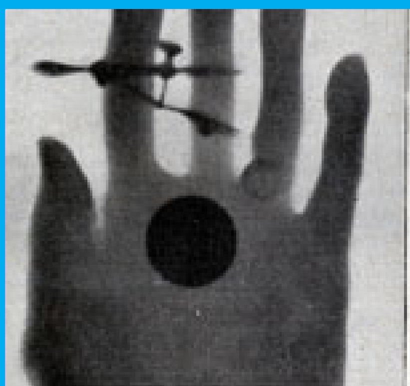
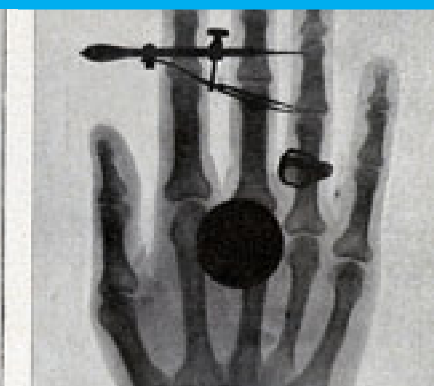
The articles in this booklet only cover a small proportion of the rich and extensive heritage of our discipline, but with some luck – and lots of hard work – we hope to provide you with some more (hi)stories for future celebrations of the International Day of Radiology.



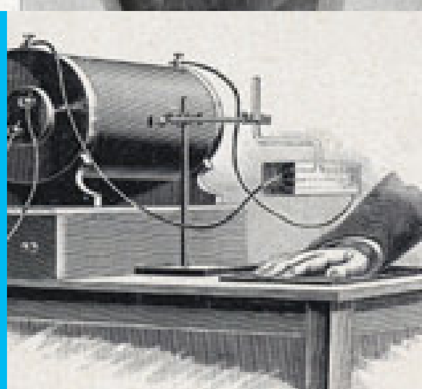




A FUNFAIR FOR THE SCIENCES: POPULARISING X-RAYS FROM 1896 TO THE PRESENT


BY UWE BUSCH




Galerie berühmter Zeitgenossen

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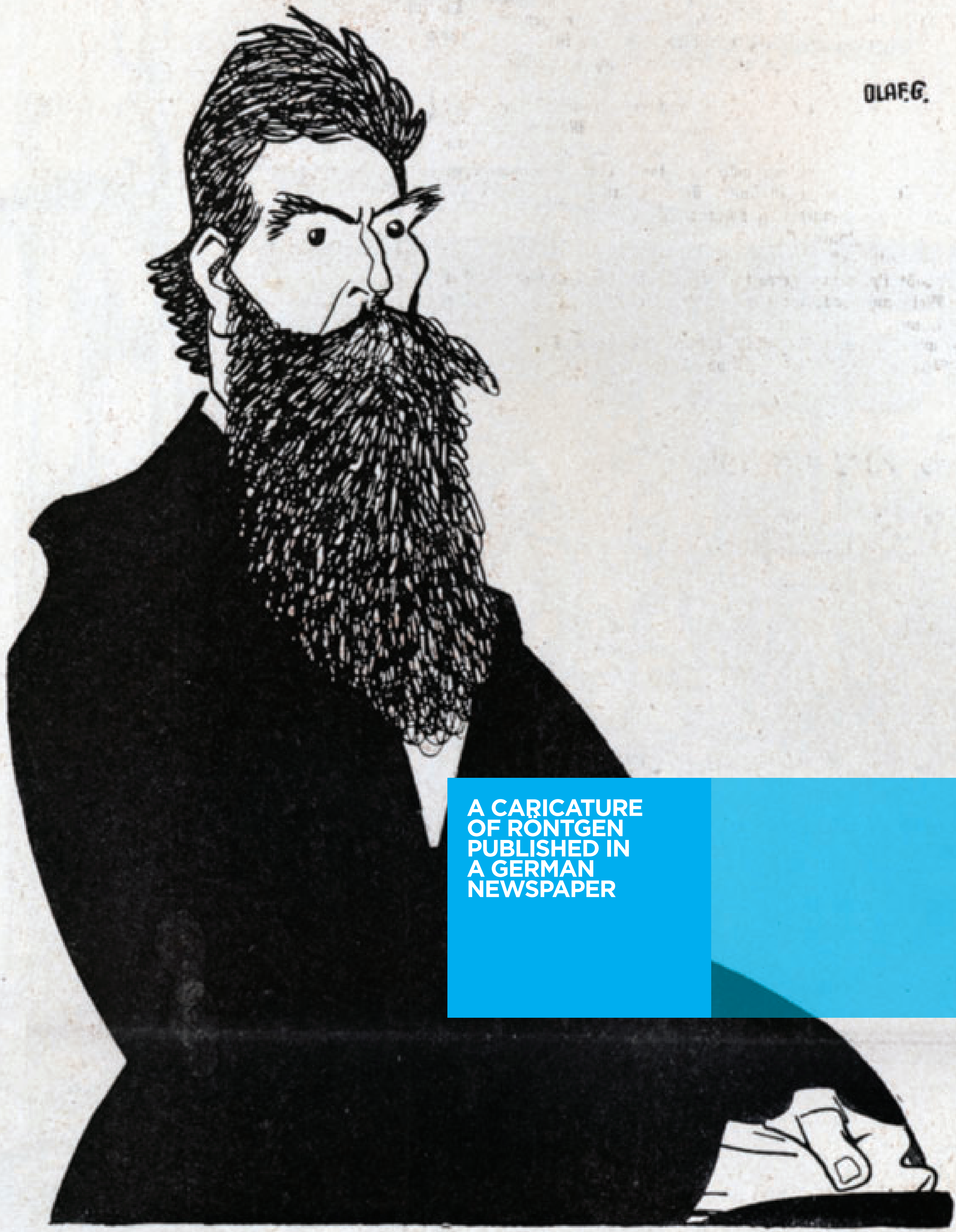
(Zeichnung von O. Gulbransson)



A CARICATURE OF RÖNTGEN PUBLISHED IN A GERMAN NEWSPAPER

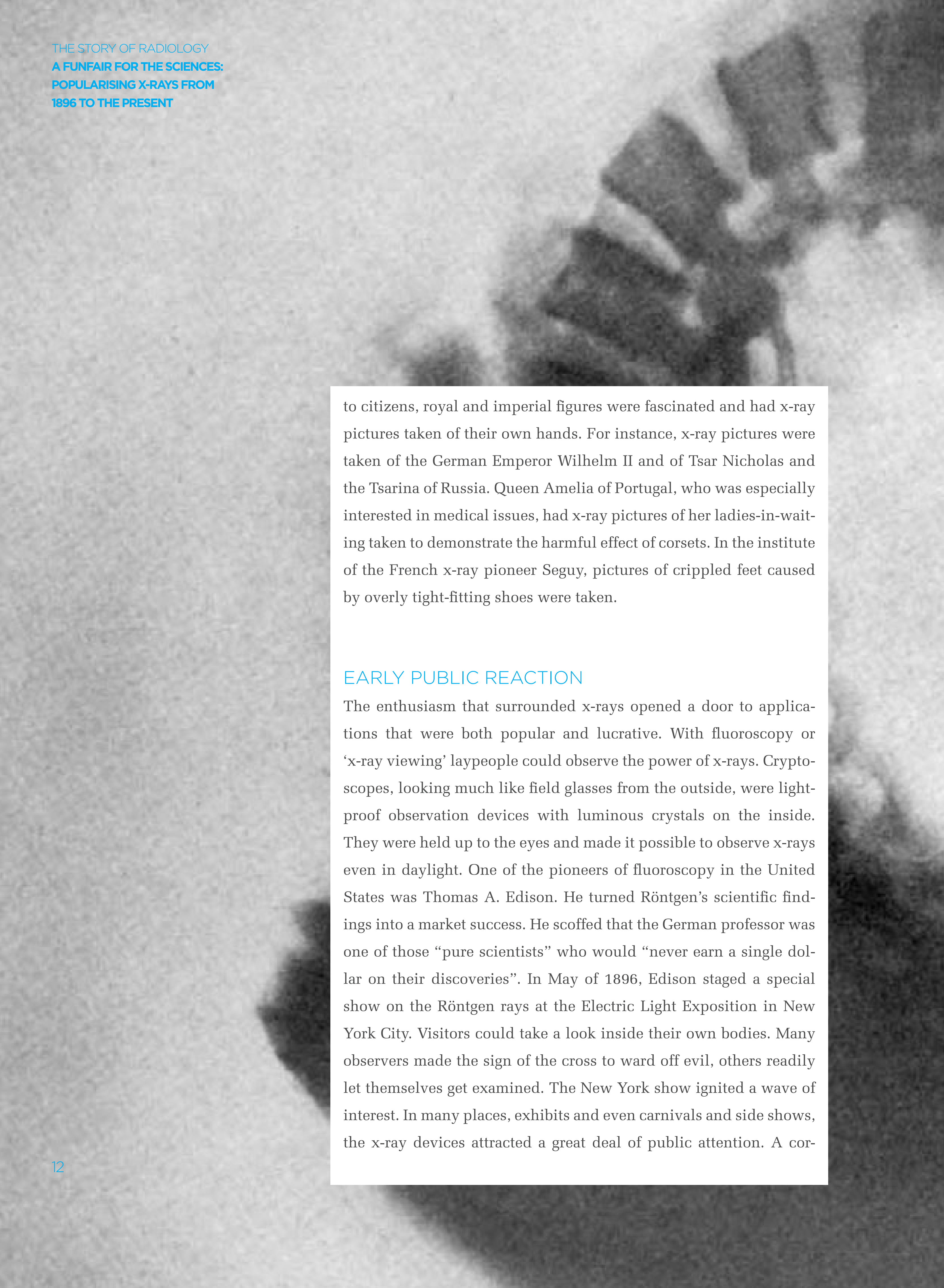
X-rays became a part of popular culture in the twentieth century. Rumours about x-rays' mystical powers arose towards the end of the nineteenth century, shortly after their discovery. They stirred the imagination of artists, charlatans and advertisers. X-ray technology became a metaphor for seeing through things. This mythical 'x-ray vision' revealed things beneath the surface, things that otherwise would have remained hidden. Advertisers, in particular, knew how to capitalise on this concept. Comic-strip figures with x-ray eyes competed with other cartoon figures in a brightly coloured, ever-expanding world of popular culture.

SENSATIONAL NEWS IN JANUARY 1896

On Saturday, December 28, 1895, Wilhelm Conrad Röntgen handed over his manuscript to the secretary of the physical-medical society in Würzburg saying: "Now, all hell can break loose." And indeed all hell did break loose. Three days later, Röntgen received the special prints that he had sent to his colleagues together with New Year's greetings and nine photographs. Among his colleagues were the physicians Kohlrausch, Lummer, Kelvin, Schuster, Voller, Warburg, Exner, Poincaré, Stokes, Michelson and Boltzmann. Many scientists, like the physician Otto Lummer of Berlin, believed that Röntgen was telling fairy tales, or they shook their heads saying that up until then Röntgen had actually been a fairly reasonable man. His first support came from Berlin, where his photographs were presented at the 50th anniversary of the German Physics Society. The rapid dissemination of the sensational news, however, can be attributed to his fellow student and professor of physics at the University of Vienna, Franz Exner. During a discussion on the night of January 4, he told his colleagues about Röntgen's discovery. Röntgen and Exner had both been assistants to Röntgen's mentor August Kundt in Zurich. The very same night, Ernst Lechner, professor of physics at the University of Prague, wrote the first article on the sensational discovery together with his father, editor of the Vienna daily *Die Presse,* and the article was published the next day. Without actually printing pictures, both authors gave an excellent and concise summary of the most spectacular aspects, particularly the impressive and somewhat eerie images of bones made through the flesh. Considering its possible applications, the older Lechner gave free rein to his imagination. In retrospect, however, his reflections can indeed be called prophetic, as his predictions with reference to medical diagnostics were confirmed just a few months later. Once the news reached the Vienna bureaus of Reuters and *The Daily Chronicle,* the story was telegraphed to London and from there went all around the world within days. Newspaper articles in the *Frankfurter Zeitung* (January 7/8, 1896), *The Electrical Engineer* (New York, January 8, 1896), *Würzburger Anzeiger* (January 9, 1896), *The Electrician* (London, January 10, 1896), *The Lancet,* the *British Medical Journal* (January 11, 1896), *le Matin* (Paris, January 13, 1896), *Nature* (London), *The New York Times* (January 16, 1896), *Science* (New York, January 24, 1896) and *la Settimana* (Florence, January 25, 1896) were to follow. The most remarkable of these was the article published in the *Frankfurter Zeitung,* which, besides the possibility of pain-free diagnostics of broken bones and foreign objects, anticipated the development of (computed) tomography: "… when giving further rein to one's imagination it might seem possible to perfect the method of the photographical process using the rays of the Crookes' tubes in a way that only the parts of the soft tissue of the human body remain transparent while simultaneously exposing a deeper slice on the roentgen plate which would be of priceless value for the diagnosis of numerous other groups of diseases than those of the bones ..."

The high level of scientific interest in the new rays manifested itself in 1896 through the publication of 49 monographs and 1,044 special papers on x-rays. Throughout, the questions covered a large range of scientific fields. Within the field of physics, it was the nature of the rays that was predominantly discussed. The behaviour of the crystals was examined under x-radiation, and scientists discussed the question of extraterrestrial x-ray sources from sunlight. In medicine, special emphasis was put on the use of x-rays in surgery and internal medicine. The course was set for skeletal radiology, angiography, thorax diagnostics, stereo radiography, neuroradiology, gastrological and urological radiology, gynaecological radiology, dental radiology, veterinary radiology as well as radiation therapy. Furthermore, the effect of x-rays on bacilli, flies, plants and food was tested. In the course of 1896, however, the drawbacks of x-rays were discovered and researchers set out to look for technical solutions to radiation exposure.

In the history of science, rarely has a new discovery or invention met with such strong reaction and public interest. Röntgen's new rays did not fail to have an effect. To expose what had, until then, been hidden from view, fascinated and unsettled people at the time. Here, the new rays were of great interest throughout society. In addition



to citizens, royal and imperial figures were fascinated and had x-ray pictures taken of their own hands. For instance, x-ray pictures were taken of the German Emperor Wilhelm II and of Tsar Nicholas and the Tsarina of Russia. Queen Amelia of Portugal, who was especially interested in medical issues, had x-ray pictures of her ladies-in-waiting taken to demonstrate the harmful effect of corsets. In the institute of the French x-ray pioneer Seguy, pictures of crippled feet caused by overly tight-fitting shoes were taken.

EARLY PUBLIC REACTION

The enthusiasm that surrounded x-rays opened a door to applications that were both popular and lucrative. With fluoroscopy or 'x-ray viewing' laypeople could observe the power of x-rays. Cryptoscopes, looking much like field glasses from the outside, were lightproof observation devices with luminous crystals on the inside. They were held up to the eyes and made it possible to observe x-rays even in daylight. One of the pioneers of fluoroscopy in the United States was Thomas A. Edison. He turned Röntgen's scientific findings into a market success. He scoffed that the German professor was one of those "pure scientists" who would "never earn a single dollar on their discoveries". In May of 1896, Edison staged a special show on the Röntgen rays at the Electric Light Exposition in New York City. Visitors could take a look inside their own bodies. Many observers made the sign of the cross to ward off evil, others readily let themselves get examined. The New York show ignited a wave of interest. In many places, exhibits and even carnivals and side shows, the x-ray devices attracted a great deal of public attention. A cor-

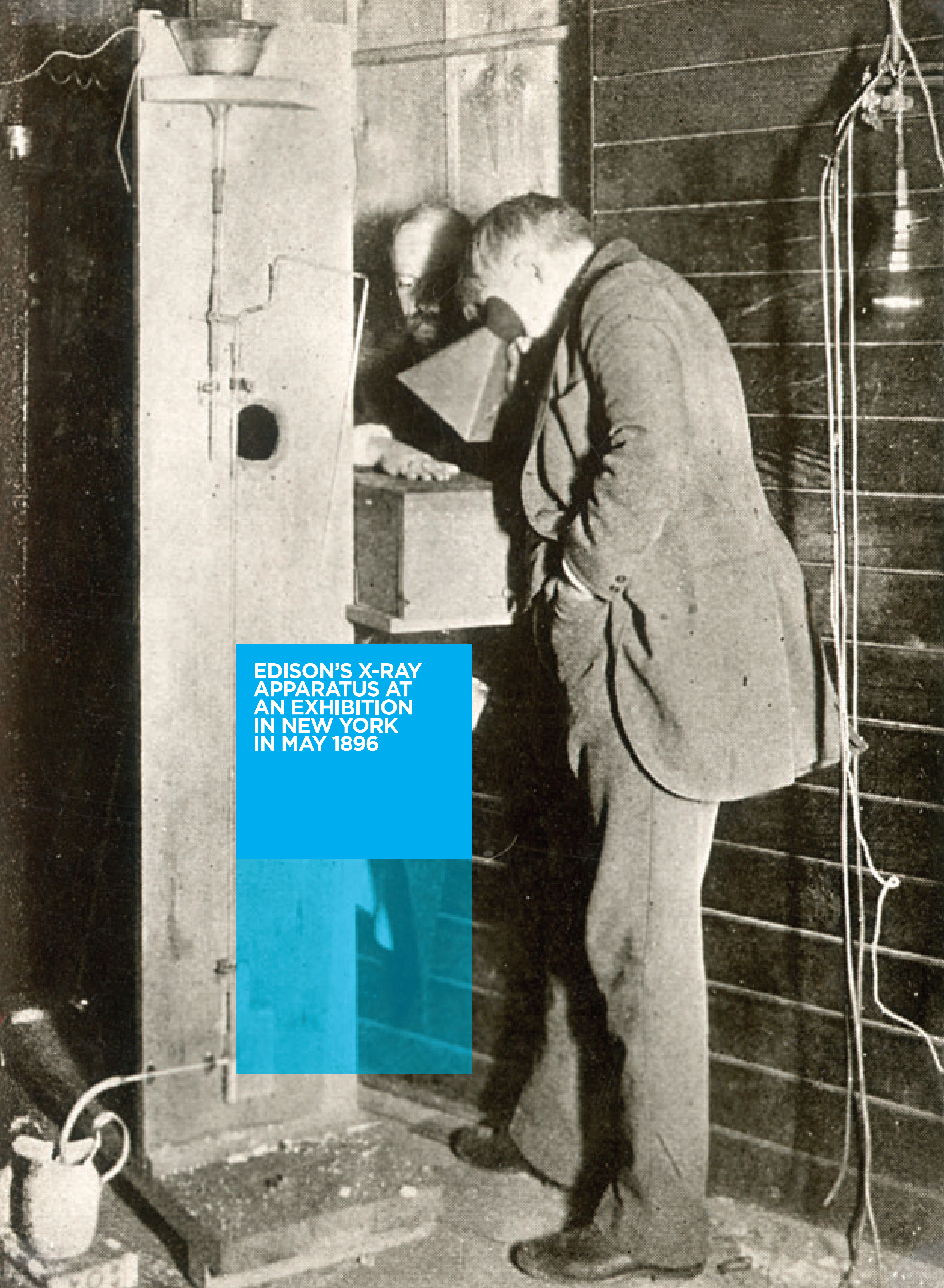
respondent for the British medical journal The *Lancet* reported in October 1896: “A fearful mother asked to find out whether her son had actually swallowed a missing three-penny piece. A young maid, on the other hand, wanted to have her fiancé x-rayed without his knowledge, so to determine whether his innards were healthy.”

A real Röntgen fever spread around the world. The commercial use of x-ray technology turned science into something of a spectacle. There was no sense of any need to deal with the hazardous radiation sensibly. Edison terminated his Röntgen shows in 1904 after his chief assistant, Clarence Dally, died of burns caused by x-rays.

A LOOK INTO POP CULTURE

Röntgen’s discovery provided the material for many an urban myth. As early as March 1896, a London company advertised x-ray-proof underwear in *Electrical World* magazine. Concerns over people being exposed before the eyes of others got the guardians of public morality up in arms. A bill to prohibit the use of x-rays in opera glasses was even submitted to the state legislature in New Jersey, U.S., on February 19, 1896.

Charlatans were up to new mischief. Hypnotic effects were ascribed to x-rays and they enhanced necromancy sessions and séances. The alchemists’ age-old dream of transforming base materials into gold had allegedly come to fruition after a piece of metal was irradiated for three hours. A New York daily reported that these amazing rays were being used at the College of Physicians and Surgeons to project



EDISON'S X-RAY APPARATUS AT AN EXHIBITION IN NEW YORK IN MAY 1896 anatomical drawings directly into medical students' brains. Criminals were to be brought to reason by the same method.

The rumours over the mystical powers of x-rays were endless. Later, as reports began to take on an ever more cynical tone, x-ray technology became a popular metaphor for seeing through things. Advertisers in particular knew how to capitalise on this fascination. From that point forward comic-book figures with x-ray eyes competed with other cartoon figures in a brightly coloured, ever-expanding world of advertising.

Certainly Röntgen would never have wanted to become a celebrity. But in spite of that, his work found its way into popular culture, and remains there to this day.

FROM JAMES BOND TO CELLOPHANE TAPE

The fantasy of x-ray vision was and still is present in the media, from serious literature to Superman comics, from cinema to advertising for glasses. In many cases there is an erotic aspect. Many people also associate x-rays with fortune telling and the occult.

In the years following Röntgen's discovery, a wave of 'x-ray euphoria' gripped large segments of the population. X-rays were celebrated in many newspapers as a panacea, often because journalists themselves didn't know any better. This attracted the attention of business people who smelled big money in the popular enthusiasm for technology and the curiosity of the masses. Fluoroscopes and accessories for x-ray photography became big sellers. The so-called 'shoe fluoroscope', which beamed x-rays through the shoes and showed the outline of the foot inside the shoe, lured customers into shoe stores. What many people didn't know was that x-rays are all around us, all the time. That is because some of the cosmic x-rays, emitted by the sun, stars, black holes and other cosmic objects, penetrate the earth's atmosphere. And we too generate x-rays when we unreel cellophane tape, for instance.

"SEEING IS MORE RELIABLE THAN FEELING!" – A SHOE THAT FITS PROPERLY

This was the advertising slogan a shoe shop used to promote the pedoscope in 1936. This device made it possible to see, from the outside, how well a shoe fit. As an expression of modernity and the prevailing zeitgeist, it promised every customer, whether they were flat-footed or splayfooted, a shoe that fit properly. The pedoscope was invented in 1924 by Clarence Karrer in Milwaukee, Wisconsin, U.S. A market soon developed for this device, which was based on the fluoroscopy process and used a fluorescent screen. It was soon felt that x-ray observation was a part of 'the customer service provided by every competent and forward-looking shoe dealer.' There were three openings at the top of the upright wooden case, providing a view of the feet being examined. A 50 kilovolt cathode-ray tube running at from three to eight milliamperes was used. The only shielding between the feet and the tube was a thin aluminium filter. Some versions made it possible to select from three different radiation strengths: the highest for men, a medium setting for women and a low setting for children. Additionally, most had a button to regulate the radiation

SHOE FLUOROSCOPE

period. This was between five to forty-five seconds. X-ray machines were a common sight in shoe stores until the beginning of the 1970s. More than ten thousand shoe fluoroscopes are thought to have been in operation in American shoe stores at the beginning of the 1950s. The largest companies to manufacture shoe-fitting fluoroscopes were the X-ray Shoe Fitter Corporation of Milwaukee, Wisconsin in the U.S. and the Pedoscope Company of St. Albans in the U.K. In Switzerland, the Bally company launched the 'Pedoskop' in the early 1930s. This was intended to support their promotional campaign for the 'Vasano' and 'Sanoform' brands, which were to become synonymous with a comfortable, properly fitting shoe. An advertising film, 'The First Bally Shoe', addressed mothers in particular, encouraging them to buy the right shoe for their children, with the slogan "Get healthy footwear for the youngsters!"

"THE HUMAN HAND IS PARTICULARLY WELL SUITED AS A TEST OBJECT ..." – X-RAY PHOTOGRAPHY FOR LAYPEOPLE

X-rays and photography were inseparable from the very beginning. Photography did not play any role at all in generating the mysterious rays, but it was indispensable in proving their existence and clarifying their effects. That is why professional photographers, immediately after the rays were discovered, claimed radiology as a part of their professional field. Laypeople also experimented with radiography. Instructions were published written so as to be generally accessible. One was an 1896 booklet entitled, 'Die Photographie mit Röntgen'schen (X-) Strahlen. Mit Anleitung zum Experimentieren

SPECIAL X-RAY EQUIPMENT FROM THE 1930S: THE OMNISCOPE DEVELOPED BY THE GERMAN ENGINEER ROBERT POHL auch für Laien' [Photography with Röntgen's (X-)Rays. With Experimentation Instructions also for Laypeople]. Soon to be found in every large town were shops that sold the required equipment: Hittorf tubes, glass vacuum tubes, induction coils and bromide-silver plates or films. The induction coil cost about 240 marks in 1898, the Hittorf tube cost seven and a half marks. During the same period a chemical worker earned about 120 marks per month and a chair cost almost four marks. Some art historians assume that this 'new photography' inspired artists like Picasso and Georges Braque to create their monochromatic, multi-perspective paintings.

At the beginning of the twentieth century, many people believed that it would be possible, with the help of x-rays, to detect human thoughts and feelings or to make a fourth dimension visible. At the Sorbonne in Paris, a committee for photographing invisible forces was founded in 1909. The fluoroscope had already been invented in 1896 that made x-rays temporarily visible by way of phosphorous compounds applied to glass screens. When the x-rays impinged on the phosphorous compounds, they generated visible light, which the observer perceived as an x-ray image. In the same year, fluoroscopes became the main attraction at annual carnivals and fairs, along public boulevards and in department stores. High society used another type of fluorescence as entertainment during its soirées. When an x-ray tube was switched on in a darkened room, all the glass objects in the room began to emit a greenish light. The surreal and uncanny atmosphere could, however, be heightened even further by having someone enter the room whose clothing had been treated with phosphorous compounds. The person lit up, due to the x-rays, like an extraterrestrial apparition.

BETWEEN SUPER-HEROES AND VOYEURS – RÖNTGEN IN THE ARTS AND MEDIA

The term 'x-ray vision' is often associated with brawny men possessing supernatural powers and who, using the most modern technology, take up the battle against criminals and extraterrestrials. In *The World is not Enough* James Bond wears x-ray spectacles, just like Clark Kent in *Smallville,* the television adaptation of the Superman comics. Numerous documentary films were made in the first half of the twentieth century. In 1937, Martin Rikli used x-ray images to make a movie featuring everyday occurrences, such as a woman applying make-up, a cat eating and a hen laying an egg. Rikli worked in the Cultural Department of the German film company UFA, which produced short documentary movies for instructional purposes, the so-called 'cultural films'. These received government subsidies and were shown in cinemas before the main feature.

The 1963 American movie entitled *X* (*The Man with the X-Ray Eyes* in German) showed an entirely different, darker picture of the view behind the scenes. A scientist, who with the help of a serum was able to see through objects, ultimately rips out his eyes since he cannot deal with the flood of stimuli and information. Reflected quite clearly in this movie is the change in attitude towards x-rays. The cause-and-effect relationship between x-rays and numerous serious illnesses had made its way into the wider public consciousness. X-rays were seen not only as an opportunity, but as a threat.

As a phenomenon relevant to society, it continued to be the object of satire and humour. The first cartoons on the topic even appeared before

1900 and were aimed above all at the titillating and erotic aspects of voyeurism. The best-known contemporary satires have appeared in the television series *The Simpsons* and in advertising. In *The Simpsons* episode entitled 'HomЯ' an x-ray image reveals that, when he was a child, Homer pushed a lead pencil through his nose and into his brain.

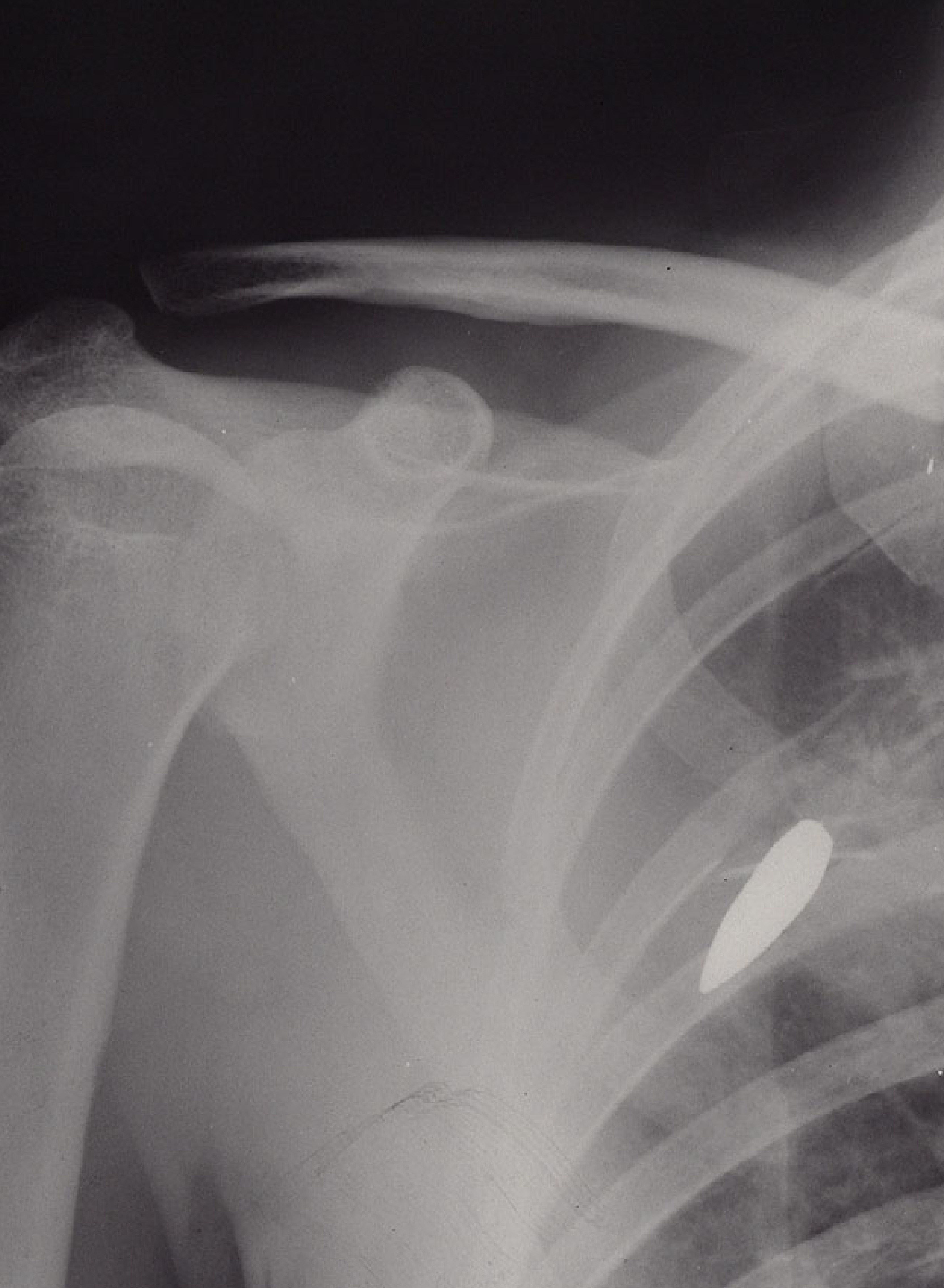
JUST BECAUSE IT SAYS 'X-RAY' ON THE OUTSIDE, DOESN'T MEAN THERE'S X-RAY ON THE INSIDE

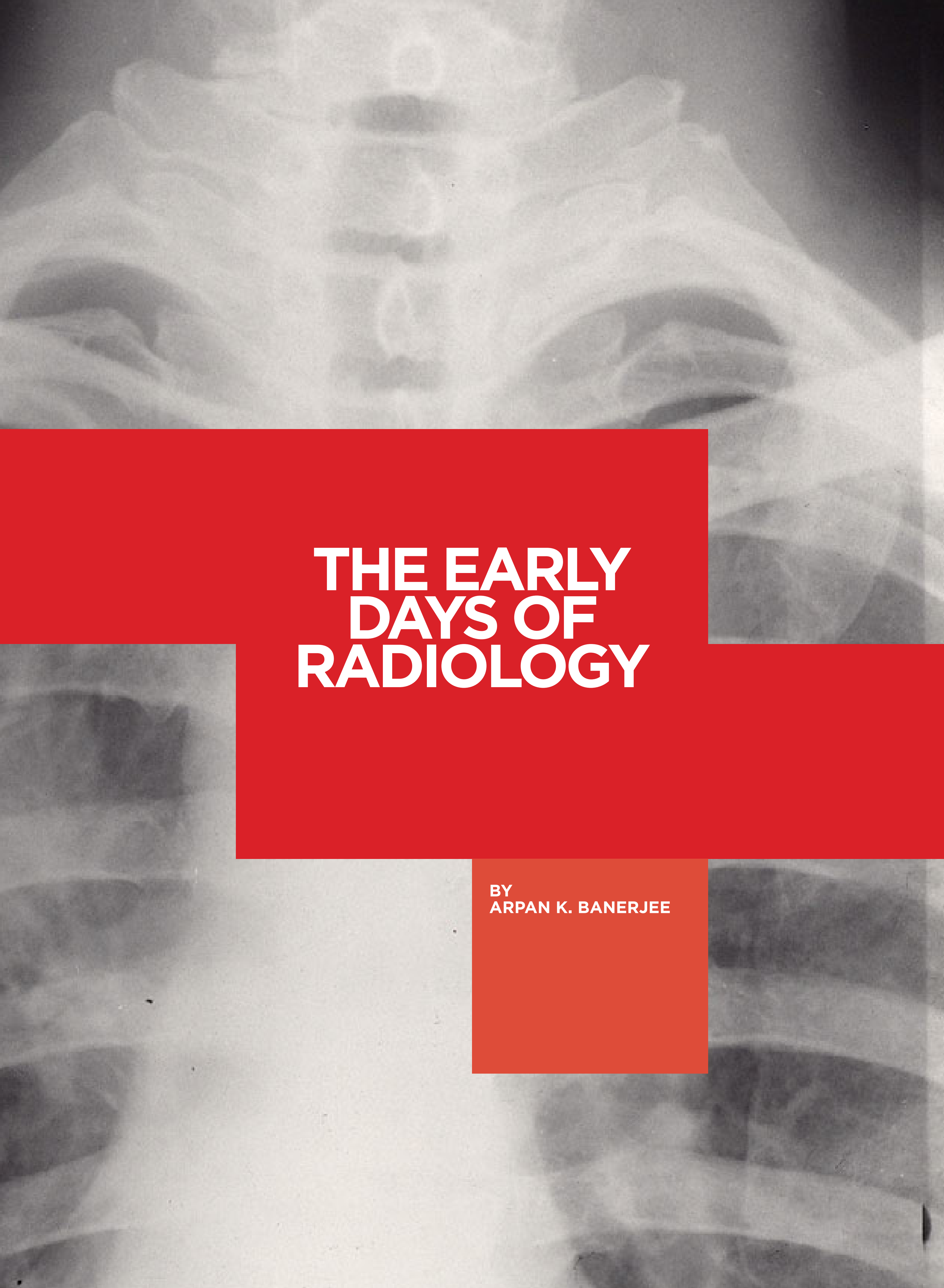
Entering the term 'x-ray' into Google, eBay or YouTube leads to thousands of results. 'X-ray specs' are one well-known example here. They were invented in the 1960s by the American Harold von Braunhut, owner of a mail order company featuring quirky gag items. As early as the 1940s, however, there had been a predecessor to the x-ray specs: the 'Wonder Tube joke novelty' made by the S.S. Adams Company of Asbury Park, New Jersey. Both devices were based on the same principle: the diffraction of light through an extremely dense grid. This produces two images that are slightly offset. The area where the images overlap appears to be darker. Thus, if you observe your hand, the bones are perceived as being the darker areas.

A similar sham is the 'Envelope X-Ray Spray', that is said to make envelopes transparent for a period of time. An effect such as this can be created, for example, by petrol, methanol or liquid nitrogen.

Also devoid of any type of ray is an app for iPhones. This app can supposedly produce an x-ray of the user's hand on the phone's display. The illusion is created by an x-ray image of a typical right hand, stored on the iPhone. When the unit is tilted the visible section of the image shifts with startling effect as the iPhone is moved over the hand.

COVER OF 'DER FLOH', GERMANY 1896





THE EARLY DAYS OF RADIOLOGY

BY
ARPAN K. BANERJEE

A PARADIGM SHIFT: A NEW TECHNOLOGY CHANGES MEDICAL PRACTICE

In 1962 Thomas Kuhn, a distinguished American philosopher and historian of science, published an important monograph entitled 'The Structure of Scientific Revolutions'. In this book (originally published by the logical positivists of the Vienna Circle) he introduced the concept of paradigm shifts, which refers to the fact that science does not always progress in a linear, incremental fashion, but rather that there are from time to time major ideas and inventions, or paradigm shifts, which contribute to knowledge and alter the way we think or deal with major scientific issues. It could perhaps be argued that Röntgen's momentous discovery of x-rays was a paradigm shift, in that it completely revolutionised the way medicine is practiced and had a profound effect on the healthcare profession in the following century.

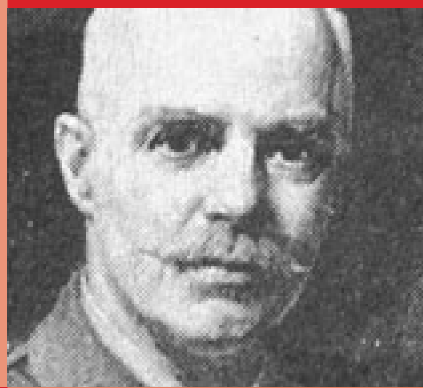
Before the discovery of x-rays, medicine was constrained by a lack of techniques to look inside the ailing body and diagnosis was often heavily dependent on clinical evaluation. Within a short period of time following Röntgen's discovery it became clear that x-rays would open up a possibility which was almost limitless in the evaluation and exploration of the human body. This would lead to more accurate diagnosis, which could help guide the treatment that was then available.

FOREIGN BODY LOCALISATION

Early radiologists used x-rays to localise foreign bodies, which then helped surgeons identify them and remove them safely without caus-

HEINRICH ALBERS-SCHÖNBERG

ing excessive damage to the tissue. One of the British pioneers of using x-rays to localise foreign bodies was the Birmingham based radiologist John Hall Edwards, who published papers on this subject, including an early letter in the *British Medical Journal* in 1896. Hall Edwards was a British radiologist who made a great contribution to radiology and developed expertise in military radiology during the Boer War in 1900, as well as being one of the first to recognise the harmful effects of radiation. He went on to suffer the effects of radiation dermatitis and eventually had his hands amputated. He became one of the early radiation martyrs whose name is remembered at the martyrs' memorial in the grounds of St. George's Hospital in Hamburg, where the German radiologist Heinrich Albers-Schönberg worked. Schönberg, a great German radiology pioneer and a founder of the German Röntgen Society in 1905, also died from radiation injuries in 1921.

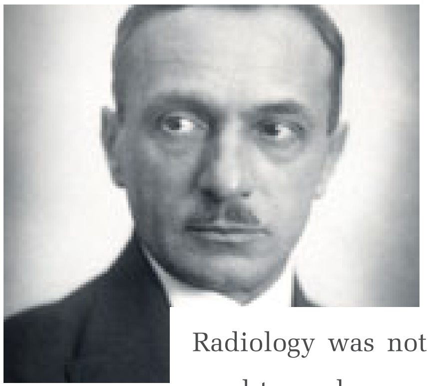


JOHN HALL EDWARDS

SKELETAL SYSTEM

The role of x-rays in evaluating the skeletal system was soon apparent. One of the great European researchers in this field must surely have been Alban Köhler who, in 1910, published an important book entitled 'Encyclopaedia of Normal Limits in Röntgen Images'. Köhler was a radiologist in Wiesbaden, Germany and was a prolific publisher of papers on skeletal radiology. He soon realised that by using x-rays it was possible to examine congenital musculoskeletal problems, in addition to abnormal metabolic conditions and disorders of skeletal ossification. Other important early researchers included Robert Kienböck, an Austrian radiologist in Vienna, who was also interested in radiation therapy of bone tumours.

GUIDO HOLZKNECHT



Radiology was not only useful in assessing trauma, but could be used to analyse accidental injuries and provide medico-legal opinions in medical disputes. Evaluation of soft tissue, however, proved more difficult with x-rays. For this reason soft tissue problems, especially if superficial, were analysed by clinical examination rather than relying on imaging. This probably explains why mammography took some time to be introduced into medical practice, with surgeons relying on clinical examination alone almost until the latter half of the twentieth century.

CHEST IMAGING

In the investigation of the chest, the role of radiology was quickly established. Early radiographs of the chest could show the diaphragm and the heart, and pleural effusions were soon identified. The pioneering radiologist from Boston, Francis Williams, made many advances in the field of chest imaging, in particular with relation to tuberculosis, then a common clinical problem.

In 1896, Thomas Edison invented a modified fluoroscope with a tungstate screen. Fluoroscopy of the chest was introduced soon after and enabled the radiologist to observe segments of the lungs and the mediastinum. European researchers in this field included Heinrich Albers-Schönberg and Guido Holzknecht.

Improvements in x-ray generating equipment, photographic plates, and fluorescent screens allowed for more accurate fluoroscopic assessments of the chest. Lung tumours became identifiable, the heart and the aorta could be assessed, and movements of the diaphragm were also made visible.

In 1913, William D. Coolidge (1873–1975) invented the Coolidge tube, which had a cathode filament made of tungsten. This was an improvement on the Crookes tube. The same year also saw the discovery of the anti-scatter grid by Gustave Bucky, which helped reduce harmful radiation doses.

Throughout the 1920s and 1930s, there was a steady improvement in the intensifying screen and radiograph films which contributed to better images of the chest. In 1929, Philips began production of the first rotating anode tube, called the Rotalix.

It soon became possible, as the decades progressed, to analyse the radiological findings for a wide variety of diffuse pulmonary diseases. Pioneering strides in this field were made by the distinguished American radiologist Henry K. Pancoast. He was in fact the first professor of radiology in the United States, being appointed in 1912 at the University of Pennsylvania. In the same year he was elected President of the American Roentgen Ray Society. He published widely on pneumoconiosis, but he is probably best remembered today for his description of an apical tumour in the chest, also known as Pancoast syndrome.

In Europe, pioneering studies were made by the German radiologist Franz Groedel (1881–1951). Since 1910, he had been in charge of the radiology department in Frankfurt and did important early work on the diagnosis of lung and heart diseases.

ALFRED BARCLAY

CONTRAST MEDIA

Scientists soon realised that it was difficult to assess the vascular system using plain x-ray alone. The gastrointestinal system and urinary system were also difficult to investigate. This led to the invention and application of various contrast media.

GASTROINTESTINAL SYSTEM

For the GI system, the first contrast media included lead acetate, which was soon replaced by Bismuth. Barium sulphate was introduced in 1910, making studies on the GI system possible. Early researchers in the field of GI imaging included Walter Cannon, the Harvard physiologist who performed studies on the stomach using Bismuth salts. In Europe, Hermann Rieder, in Munich, made great strides in the field of GI imaging. The Swedish anatomist/radiologist Gösta Forssell started using spot-film radiographs in 1908, allowing for more detailed assessment of the mucus membrane of the GI tract. Forssell was one of the pioneers of Swedish radiology and was the founding editor of *Acta Radiologica.*

Guido Holzknecht (1872–1931), a radiation martyr, performed fluoroscopic examinations of the GI tract as early as 1905, in Vienna. Holzknecht was instrumental in founding and leading the famous Vienna school of radiology.

In Britain, Alfred E. Barclay, a leading light in British radiology, made advances in the field of upper-GI tract imaging, especially the oesophagus. The colon was probably first examined by Schule who

THE MARTYRS' MEMORIAL IN THE GROUNDS OF ST. GEORGE'S HOSPITAL IN HAMBURG, GERMANY used a mixture of Bismuth and oil enema. The initial studies were single contrast. The first double contrast enema was introduced by Laurel of Uppsala, Sweden in 1921.

INTRAVASCULAR CONTRAST AGENTS

The development of intravascular contrast agents was another important milestone in the development of radiology. Numerous agents had been tried, including strontium bromide for venography and arteriography by Berberish and Hirsch, and sodium iodide for intravenous (IV) pyelography. It was not until 1929 that uroselectan was tested by Dr. Moses Swick, an American urologist visiting Prof. Alexander von Lichtenberg's department in Berlin. This was an important breakthrough in the investigation of the vascular system, and made it possible to perform intravenous pyelography. It was not until the Norwegian Torsten Almen's discovery of low-osmolar contrast media that a major breakthrough in this field was made. Today, these low-osmolar contrast agents are still used, especially in computed tomography studies and angiography.

Once IV contrast media were available, radiologists decided it would be possible to image the vessels, including the coronary vessels. Pioneers in this field included Werner Forssmann from Germany, who in 1929 passed a catheter from his antecubital vein to the heart and injected contrast media to visualise his right heart. Cardiac catheterisation was born. With the advent of uroselectan (an organic iodine introduced by

Swick in 1929) it was possible for pioneers to experiment with the vascular system over the next two decades, eventually resulting in the pioneering studies of Seldinger and his catheterisation techniques, which opened up a whole new field of angiography.

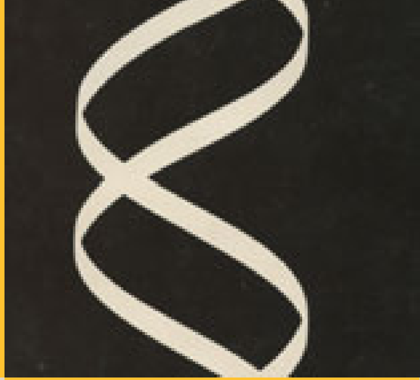
MODERN IMAGING

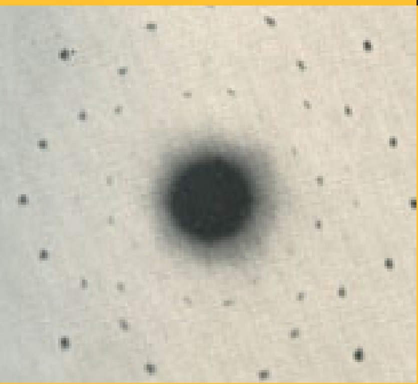
The last three decades of the twentieth century saw radiology make even further strides. Sonography was born (research by the Swedish cardiologist Edler and the Scottish obstetrician Ian Donald et al.) again changing medical and obstetric practice with a safer technique, without radiation, for assessing the body, as well as the foetus in utero.

Following Hounsfield's pioneering research and innovation in the UK, the 1970s saw the birth of CT, arguably an even more important discovery than that of x-rays. This was followed by MRI, which was made possible through the work of Edward Mills Purcell (Nobel Laureate in Physics 1952), Paul C. Lauterbur (Nobel Laureate Medicine 2003), Raymond V. Damadian and colleagues, as well as the British researcher Sir Peter Mansfield (Nobel Laureate Medicine 2003). Nuclear medicine tests also came of age with the development of positron emission tomography (PET). However, none of these would have happened without the discovery of x-rays and the curiosity and ingenuity of our pioneering forefathers.

Die erste Röntgen-Durchleuchtung eines Krystalles.

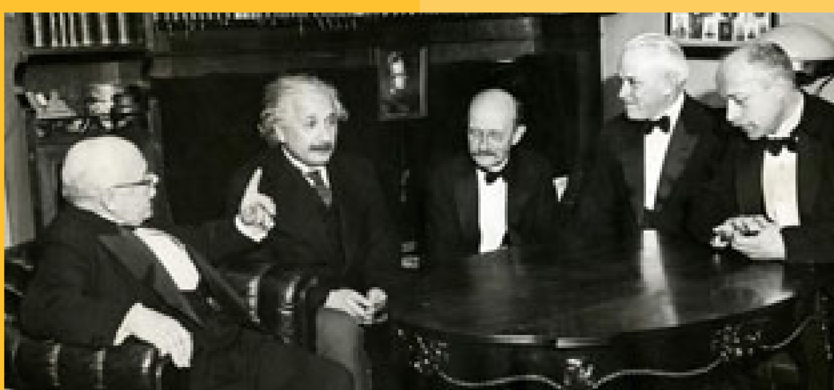
M. v. Laue





MAX VON LAUE AND THE CENTENARY OF X-RAY DIFFRACTION: 1912–2012

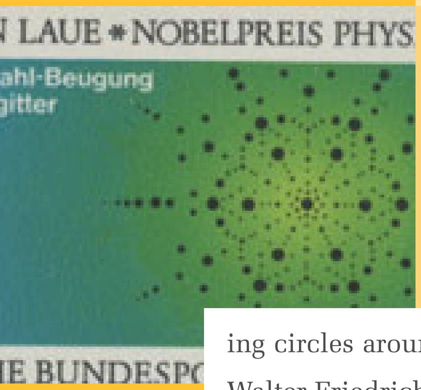
BY
ADRIAN THOMAS



Wilhelm Conrad Röntgen discovered x-rays on November 8, 1895 and nothing has been the same since. Röntgen did not know what the rays were and so he used the prefix 'X' to denote the unknown quantity. In his famous paper of 1895, Röntgen wrote:

"May not the new rays be due to longitudinal vibrations in the ether? I must admit that I have put more and more faith in this idea in the course of my research, and it now behoves me therefore to announce my suspicion, although I know well that this explanation requires further corroboration."

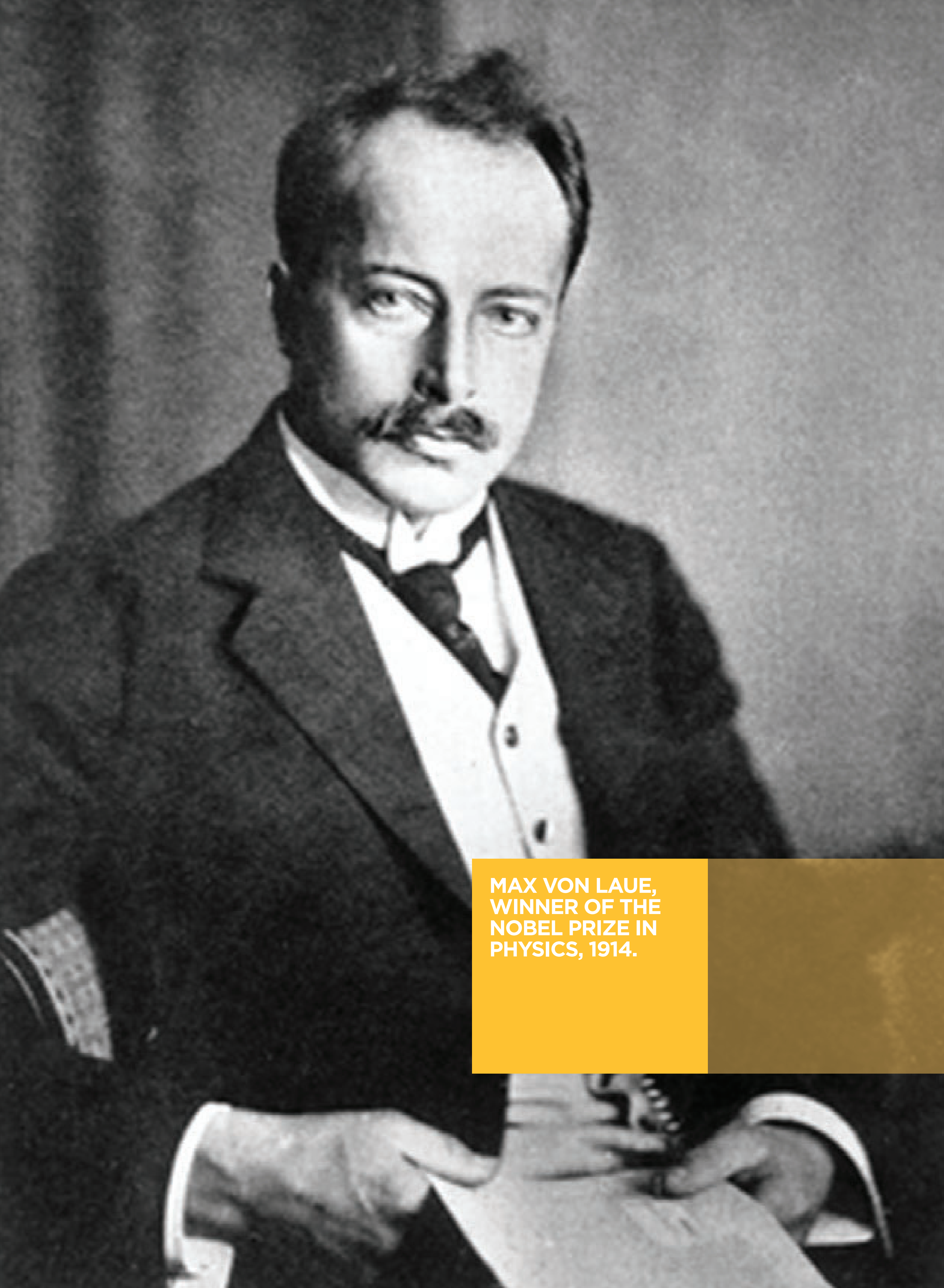
The answer to Röntgen's question was left for others to solve. Max von Laue (1879–1960) was a lecturer (Privatdozent) at the Institute of Theoretical Physics of Munich University. In 1911, Paul Peter Ewald, from Sommerfeld's Institute in Munich, was studying the propagation of electromagnetic radiation in a space lattice. Ewald proposed a resonator model for crystals; however, the model could not be tested using visible light, since the wavelength of light was greater than the space between the resonators. It occurred to Max von Laue that x-rays might have a wavelength of similar size to the spaces in the crystals, and so they could be used to test the model. If the wavelength of x-rays were many times shorter than those of light then that would also explain the previous failures to produce diffraction effects using gratings that were only suitable for visible light. In May 1912, von Laue passed a fine pencil beam of x-rays through a copper sulphate crystal and recorded the diffraction pattern on a photographic plate. The resulting photographic plate showed a large number of well-defined spots, which were arranged in intersect-



ing circles around the central beam. The results were confirmed by Walter Friedrich and Paul Knipping. Max von Laue then went on to develop a law that connected the scattering angles and the size and orientation of spacing in the crystal, and for this he earned the Nobel Prize for Physics in 1914.

Max von Laue's discovery proved that x-rays were electromagnetic waves and that they were of a short wavelength. Thanks to diffraction studies it became possible to measure the wavelength of x-rays and also to study the inner structure of materials. The work of von Laue was taken up by Sir William Henry Bragg (father) and William Lawrence Bragg (son) in Leeds, UK, and they both conducted important research on x-ray crystallography. In 1912–1913, William Lawrence Bragg developed Bragg's law, which connected the observed scattering with reflections from evenly spaced planes within a crystal. The Braggs both shared the 1915 Nobel Prize for Physics for their work on crystallography. The earliest structures to be examined were, of necessity, simple in nature and of one-dimensional symmetry. The structure of common table salt was determined in 1914. As computational and experimental methods improved over the following decades, it became possible to examine ever more complex material. This work resulted in the study of protein structure, and then, spectacularly, to the determination of the double-helical structure of DNA.

The work of Max von Laue on diffraction gave solid evidence to the theory that x-rays were waves of electromagnetic radiation; however, x-rays also behave like particles because they can ionise gases.



MAX VON LAUE, WINNER OF THE NOBEL PRIZE IN PHYSICS, 1914.

Indeed, it was this gas-ionising property of x-rays that caused William Henry Bragg to argue in 1907 that x-rays were not electromagnetic radiation at all, a view that seems rather curious to us now. We now know that x-rays consist of photons and, as such, show characteristics of both particles and waves. The idea of the photon had been proposed by Albert Einstein in 1905, however it was not until 1922 when Arthur Compton demonstrated the scattering of x-rays from electrons, that the theory was generally accepted.

In 1979, both East and West Germany issued stamps, independently, to commemorate the centenary of Max von Laue's birth. Sweden issued a stamp in 1974 on the 60th anniversary of his Nobel Prize.

It is Dorothy Crowfoot Hodgkin who should be particularly remembered for developing x-ray crystallography to look at biological molecules. It was Hodgkin who determined the structure of cholesterol in 1937, vitamin B12 in 1945 and penicillin in 1954. Hodgkin was awarded the Nobel Prize for Chemistry in 1964, and in 1969 she determined the structure of insulin.

Perhaps one of the best-known uses of x-ray crystallography was to understand the nature of the DNA and RNA molecules that are vital to life. The British biophysicist Rosalind Elsie Franklin (1920–1958) conducted crystallographic studies of DNA, RNA, and carbon compounds (coal and graphite). Franklin started working at King's College London in 1951, where Maurice Wilkins (1916–2004) was working with fairly crude apparatus. Maurice Wilkins and Ray Gosling had been working on DNA before Rosalind Franklin. In the summer of 1950, from a moistened sample of DNA fibres they obtained x-ray diffraction images of DNA using a modified x-ray diffraction apparatus. The apparatus had been filled with hydrogen to reduce background scatter. Alec Stokes, who was a colleague of Wilkins and Gosling, looked at the patterns and suggested that the DNA molecule could be helical. In 1950, specialist apparatus did not exist and a great deal of improvisation was called for. Records show that the camera was made airtight by using a condom.

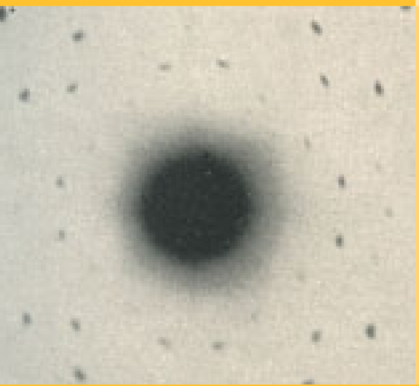
Franklin's later work on x-ray diffraction images of DNA contributed to the discovery of the DNA double helix. Her data was used to formulate Crick and Watson's 1953 hypothesis of DNA structure. Her x-ray diffraction images indicated that DNA had a helical structure, and her material was shown to Watson without her consent. Franklin's scientific contributions to DNA structure are sadly often neglected. It was 60 years ago, in 1952, that Rosalind Franklin, along with Ray Gosling (who was her PhD student), took one of the world's most important images. In their famous experiment they stretched a strand of DNA across a paperclip and set it on a piece of cork. A fine beam of x-rays was passed through the strand of DNA and the diffracted paths were recorded on photographic paper as 'Photo 51'. The resulting image proved the helical shape of DNA.

James Dewey Watson (b. 1928) is a molecular biologist from the U.S. He initially studied at the University of Chicago and Indiana University, and also worked at the Cavendish Laboratory in Cambridge, England. It was in Cambridge that Watson met Francis Crick (1916–2004).

Watson worked in Copenhagen University in 1950 for a year of post-doctoral research with Herman Kalckar and Ole Maaløe. Knowledge of genetics was still quite basic, and it had yet to be determined whether protein or DNA acted as genetic material. Watson went with Kalckar to a meeting in Italy and he heard Maurice Wilkins talk about his work on DNA using x-ray diffraction.

In 1951, Linus Pauling published his model of the amino acid, alpha helix, which was based on his x-ray crystallography and molecular model building.

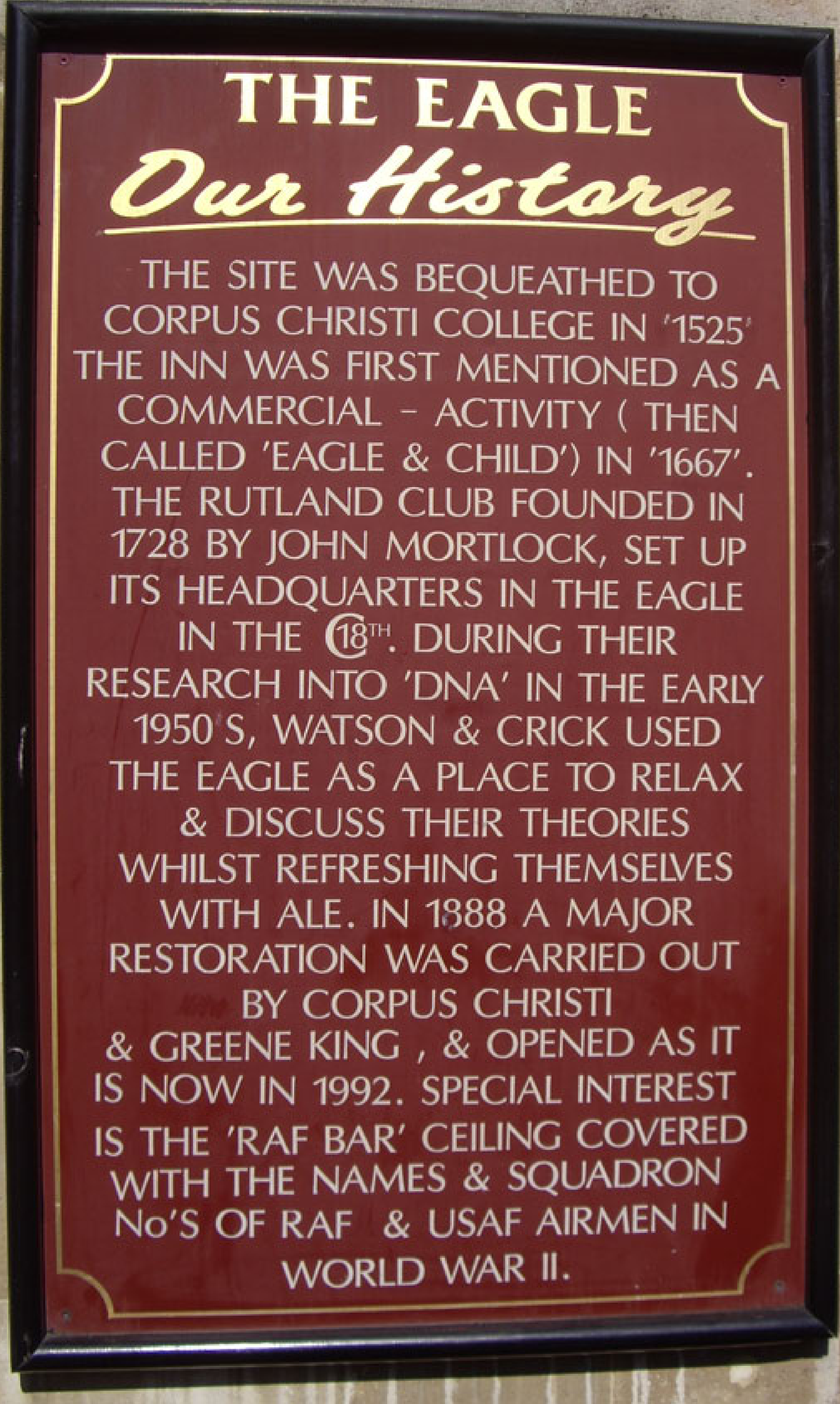
Finally, in March 1953, Watson and Crick worked out the double helical structure of DNA. This was announced by Sir Lawrence Bragg, who was the director of the Cavendish Laboratory, at a Solvay conference on proteins, which took place in Belgium on April 8, 1953. There was little initial interest in the discovery. On April 25, 1953, a paper by Watson and Crick was published in *Nature* presenting what is seen by many as the most important scientific discovery of the 20th century. Watson wrote his bestselling book 'The Double Helix' (1968) about the discovery of DNA structure, which is one of the great science books of the 20th century and presents the science with few illusions. C.P. Snow said, "Like nothing else in literature, it gives one the feel of how creative science really happens." During their research they often visited pubs, such as The Eagle, where there is a commemorative plaque outside and a warm welcome inside. Whilst Watson presented competition with Linus Pauling as a major motivation for the work, this was not a view shared by Crick. The key to the solution was in the fruitful collaboration between Watson

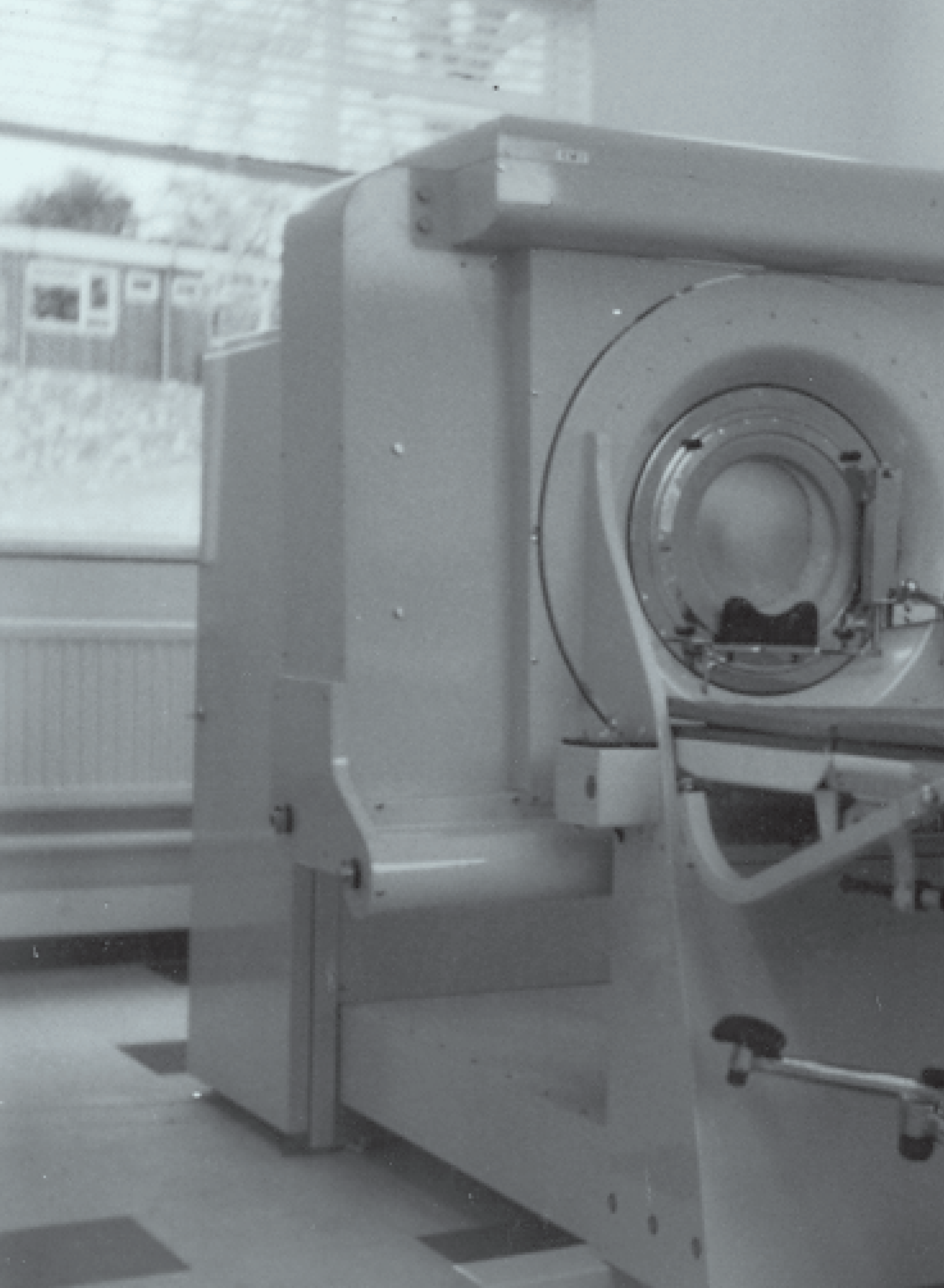


and Crick, whereas unfortunately Wilkins and Franklin could not cooperate. In his book 'The Double Helix' Watson acknowledged the work of Rosalind Franklin.

Our knowledge of DNA has developed remarkably since the 1950s and influences all areas of medicine. The Human Genome Project is a worldwide programme of research and helps our understanding of cellular structure and how genetic factors cause and influence disease. In 1990, Watson was appointed Head of the Human Genome Project at the National Institutes of Health; however, he left because of disagreements over the patenting of gene sequences. Watson was against ownership of any laws of nature and stated, "The nations of the world must see that the human genome belongs to the world's people, as opposed to its nations."

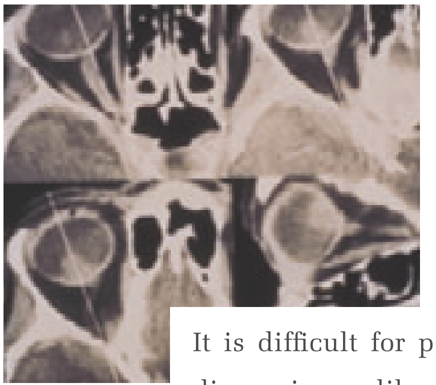
In 2007, James Watson became the second person to publish his fully sequenced genome online, in collaboration with scientists at the Human Genome Sequencing Center, Baylor College of Medicine. Watson was quoted as saying, "I am putting my genome sequence online to encourage the development of an era of personalised medicine, in which information contained in our genomes can be used to identify and prevent disease and to create individualised medical therapies." It is this challenge to create individual treatments and personalised medicine that radiology will face in these early years of the 21st century.


THE EAGLE
Our History
THE SITE WAS BEQUEATHED TO CORPUS CHRISTI COLLEGE IN '1525' THE INN WAS FIRST MENTIONED AS A COMMERCIAL - ACTIVITY (THEN CALLED 'EAGLE & CHILD') IN '1667'. THE RUTLAND CLUB FOUNDED IN 1728 BY JOHN MORTLOCK, SET UP ITS HEADQUARTERS IN THE EAGLE IN THE C18TH. DURING THEIR RESEARCH INTO 'DNA' IN THE EARLY 1950'S, WATSON & CRICK USED THE EAGLE AS A PLACE TO RELAX & DISCUSS THEIR THEORIES WHILST REFRESHING THEMSELVES WITH ALE. IN 1888 A MAJOR RESTORATION WAS CARRIED OUT BY CORPUS CHRISTI & GREENE KING , & OPENED AS IT IS NOW IN 1992. SPECIAL INTEREST IS THE 'RAF BAR' CEILING COVERED WITH THE NAMES & SQUADRON No'S OF RAF & USAF AIRMEN IN WORLD WAR II.



1972 – 2012 FORTY YEARS OF CT

BY
ELIZABETH BECKMANN
AND ADRIAN THOMAS



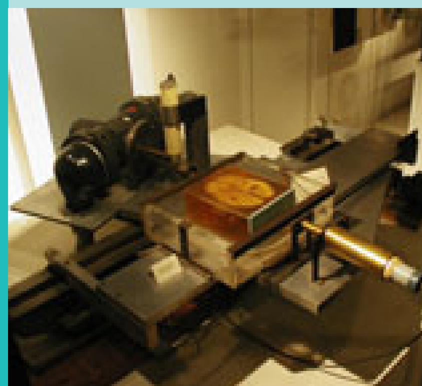
It is difficult for people today to understand what imaging and diagnosis was like 40 years ago.

In the 1960s, imaging was largely x-ray film-based and diagnosis depended largely on the skill and interpretation of the radiologist. Surgeons and other clinicians had to be able to interpret, from plain film x-rays, the actual 3D space within the patient. Neurosurgery was often guesswork, using the clinical symptoms of the patient as one of the few guides as to where to operate.

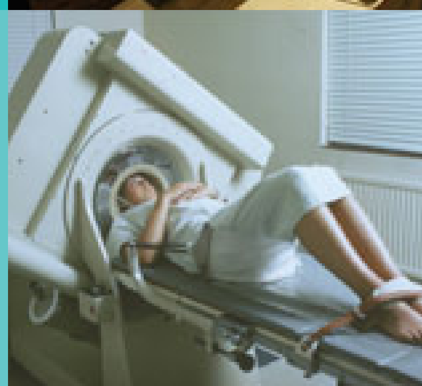
By the early 1970s, relatively little had changed since the original discovery of x-rays by Wilhelm Conrad Röntgen in 1895. Then, on April 20, 1972, Sir Godfrey Hounsfield together with Dr. Jamie Ambrose, a radiologist from Atkinson Morley Hospital in south-west London, presented a paper entitled 'Computerised axial tomography (the new means of demonstrating some of the soft tissue structures of the brain without the use of contrast media)' at the 32nd annual congress of the British Institute of Radiology.

This paper presented the results of the first ever patient examination using CT, which was carried out on October 1, 1971, at Atkinson Morley Hospital. When the first patient images were seen by Hounsfield and Ambrose they reacted like footballers who had just scored a winning goal. The first patient image scan (200.2A) showed a circular cystic tumour in the frontal lobe. The surgeon who subsequently operated on the patient reported that the tumour was exactly where it had appeared on the scan.

Little did anyone realise just how much the medical imaging world would change as a result of the invention of CT. The initial development of CT had been carried out by Hounsfield and his team at the central research laboratories of EMI. His proposal had come as a result of a project that involved trying to recognise characters, which made him think about pattern recognition. This led him to wonder whether he could recognise the contents of a box by taking a large number of readings from all around the box. From this concept and after some preliminary computer experiments he developed a laboratory prototype built on the base of an old lathe, which he had used in an earlier computer memory experiment. These early experiments enabled him to prove the concept of reconstructing an image of a brain using a series of x-ray readings.



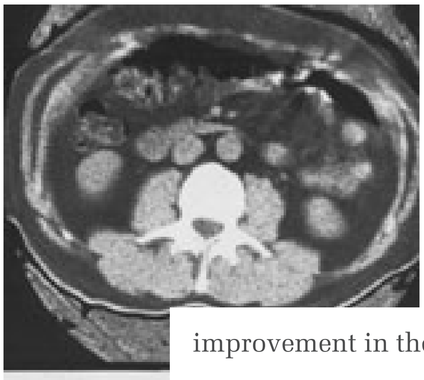
Godfrey performed his early experiments using perspex blocks of varying density, then with pig specimens, and ultimately preserved brain specimens from a museum.



The prototype clinical scanner at Atkinson Morley Hospital was just a head scanner capable of imaging the brain. The small size of the scanner was due to the use of water behind a rubber membrane, which surrounded the head. As experience was gained with the early brain scanners it became possible to remove the water and rubber membrane.

This was replaced by beanbags around the patient's head to keep the target steady and maintain a homogenous beam. Early EMI head scanners were installed in many countries, marking a major

SIR GODFREY HOUNSFIELD'S OWN ABDOMEN, 1975



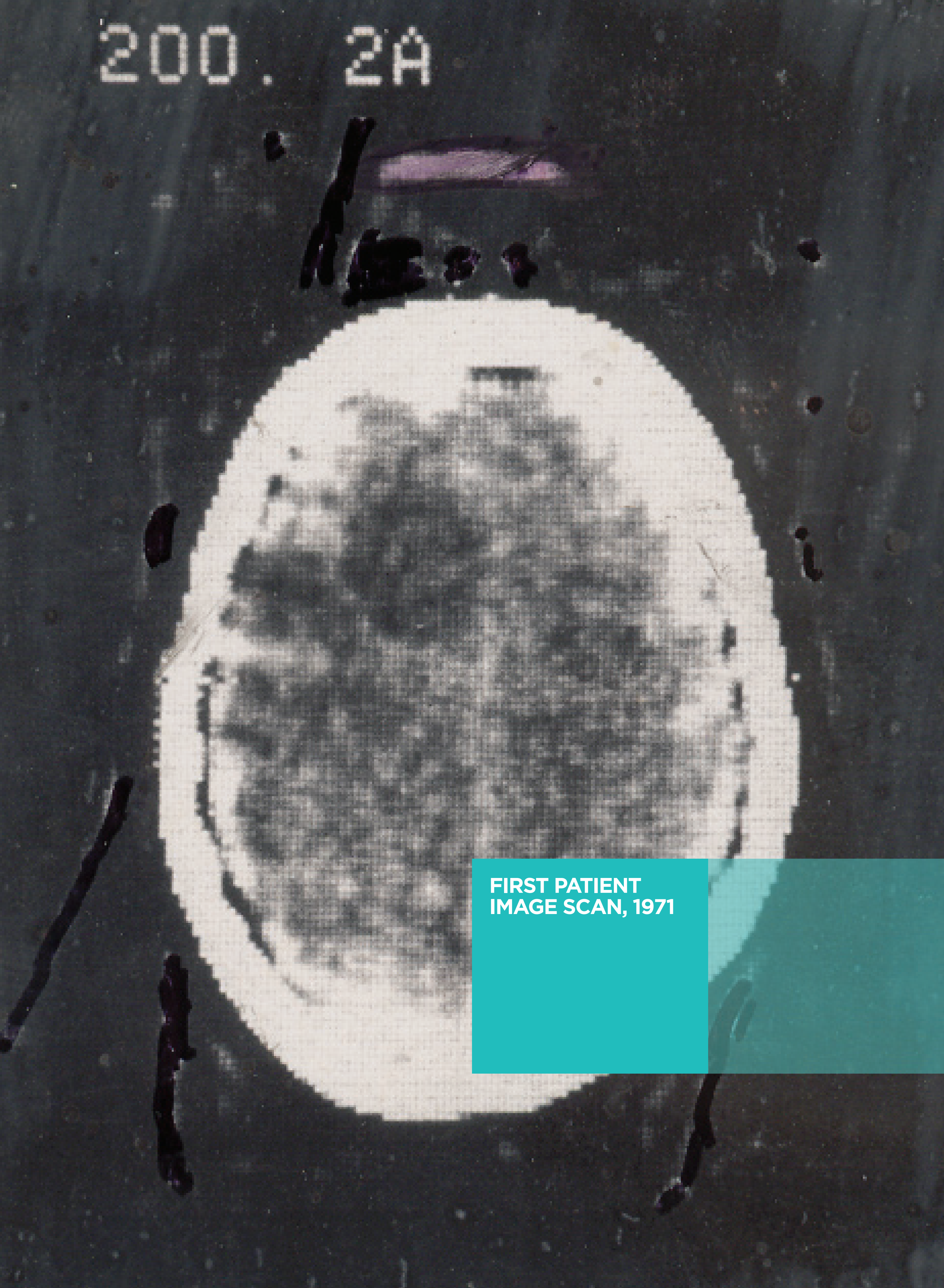
improvement in the ability to image the brain and greatly improving patient management. Subsequently, CT scanners were developed by EMI and other manufacturers with gantry apertures large enough for the body, which allowed imaging of the body as well as the head.

The body scan that was presented at the first International Congress on CT in Bermuda, March 1975, was in fact an image of Godfrey's own abdomen.

The first ever scan of a human body was of one of Godfrey's team, Tony Williams, who was small enough to fit inside the aperture of the head scanner gantry. This ability to image the entire body and produce axial-slice images remarkably similar to anatomical sections amazed the medical profession and revolutionised patient diagnosis and treatment.

The benefit of computer-based images was the ability to zoom into quadrants of images and create a vertical reconstruction by cutting through the stack of CT slices in orthogonal planes and, within a few years, in oblique and angled planes too. This allowed for a more accurate visualisation of a structure over a number of slices.

The use of CT within radiology has developed significantly since the first patient scan in 1972. The number of clinical areas where CT has shown great benefit has grown, providing more accurate diagnosis and disease monitoring. In addition to improved diagnosis, CT has developed as a method for accurate image-guided interventions such as CT image-guided biopsy.



FIRST PATIENT
IMAGE SCAN, 1971

SKULL RECONSTRUCTION

It has become a standard technique for A&E patients and is used in the majority of major trauma cases. CT is the foundation of imaging for many clinical systems including lung, abdomen and spine. It has developed and retains a major role in the imaging of neurological and head and neck conditions. As computer analysis of CT images has developed it has been possible to extract organs of interest from the complete CT data set. In head and neck imaging this has allowed bone to be extracted and used for accurate planning of maxilla-facial reconstructive surgery.

CT images and the information available from them have grown markedly since the first head image in 1972, although the images themselves may look similar. Advances in several different technologies used within CT have all had an impact; from the development of detector technology, to high energy x-ray tubes and significant changes in computer technology and software.

As CT developed, the images could be used for accurate localisation of tumours in radiotherapy planning. The path and effect of the treatment beams and isodose contours could be accurately calculated based upon the attenuation of the low-energy CT (x-ray) beam by the tumour and surrounding structures. Radiation therapy could be planned in order to minimise the dose to sensitive organs while maximising the dose to the tumour. More recently, techniques such as intensity modulated radiation therapy (IMRT) have built on this to provide even more organ sparing and accurate therapy planning.

FLY-THROUGH IMAGE

Many areas of surgery and surgical planning have changed significantly over the last 40 years, due in part to the introduction of CT images. CT images provide an accurate surgical planning tool in areas from hip replacements to reconstructive surgery. The ability of CT images to provide key information on both the diagnosis and anatomical structure enables surgeons to plan their operations more accurately and to anticipate limitations and complications that they might encounter.

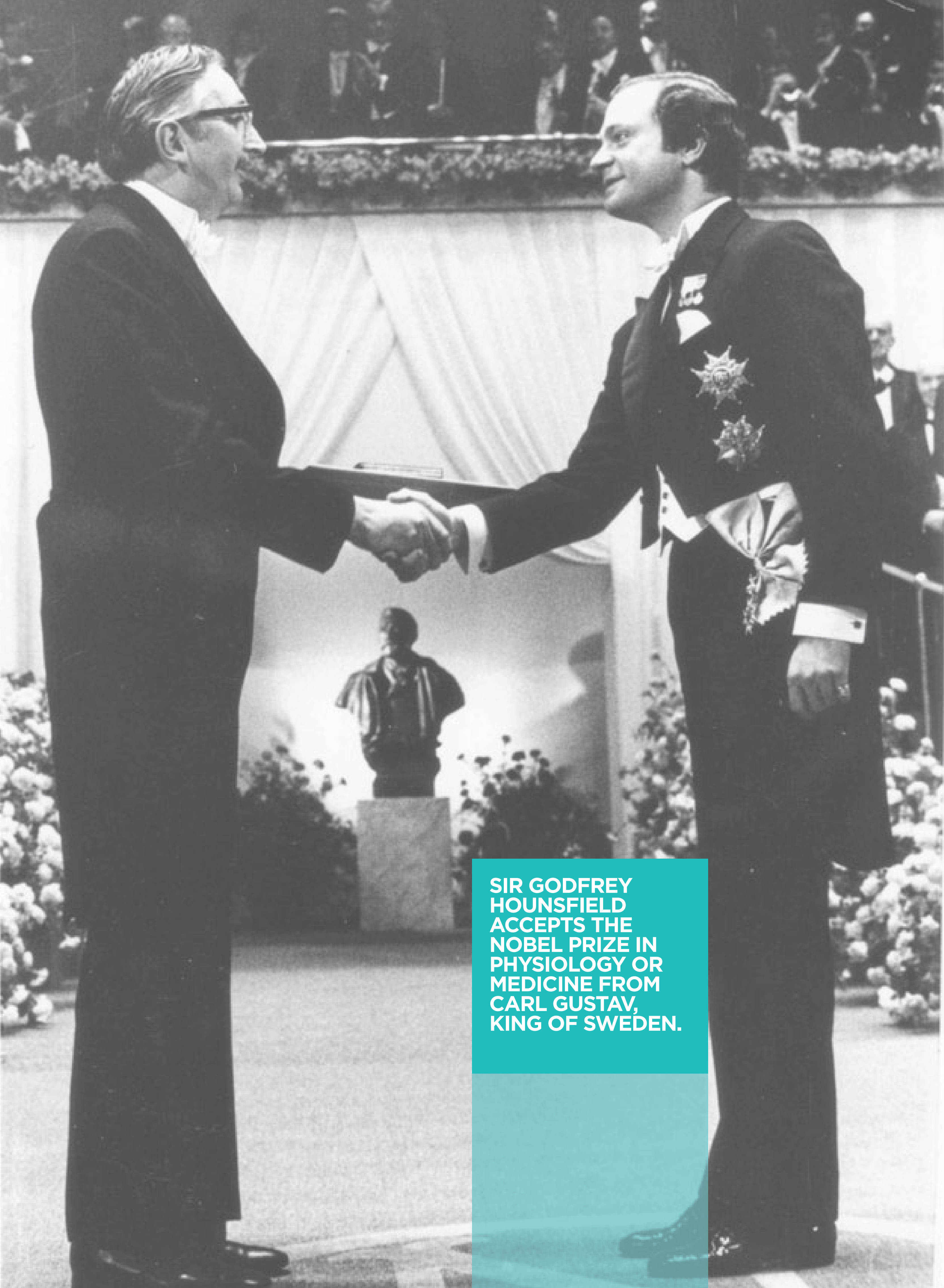
In some areas CT, along with advanced computer programmes, negates the need for invasive surgery or other endoscopic techniques by generating fly-through images. It has also become a major tool for monitoring the progress of disease and the success of different treatments.

The impact of CT over the last 40 years has influenced nearly every branch of medicine. It is hard to imagine where radiology and medicine would be today without Godfrey Hounsfield and his invention.

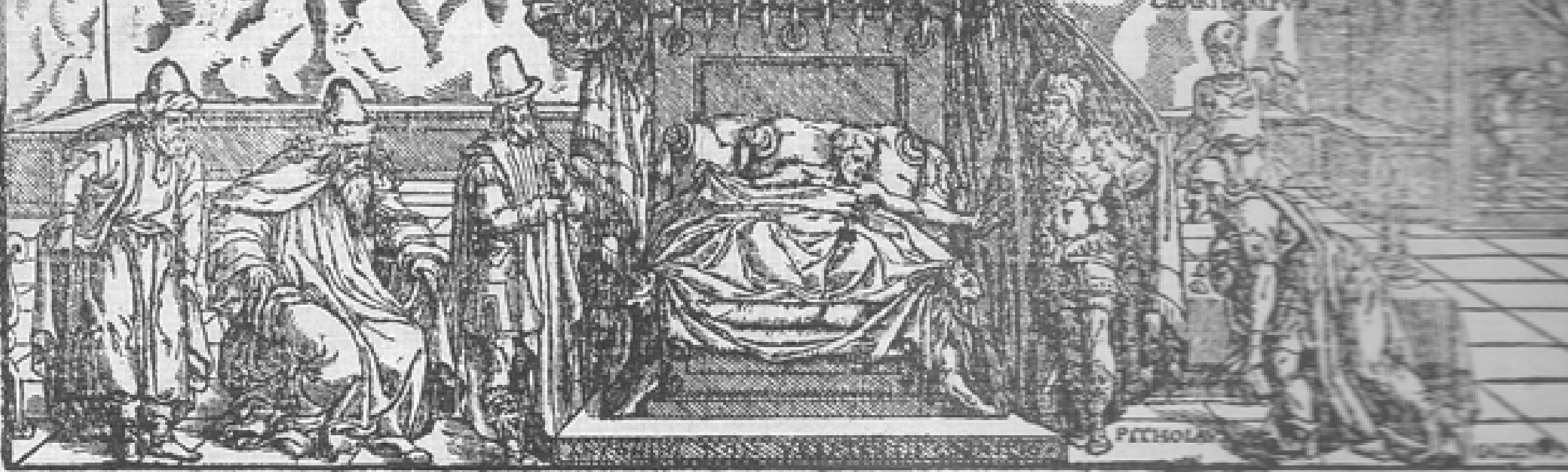
Godfrey Hounsfield was an unassuming British scientist who was born and raised near Newark in England. He was not a high achiever at school, and his school report recorded that his poor work was due to 'intellectual retardation'. Prior to joining EMI in 1949 he worked on aircraft maintenance and radar for the RAF during the Second World War. At EMI he continued his work on radar and then made some major advances in the field of computers. Hounsfield was a fascinating man, who thought in a different way to many people, which made it challenging for those working with him.

He was a fun-loving person, both at work and in his social life, and he was a very sociable character.

In recognition of his development of CT and the significant impact that it had not only on medical imaging, but also in the medical and surgical world, Hounsfield received many awards. These included sharing the Nobel Prize for physiology or medicine in 1979, as well as receiving the British honours of a CBE and a knighthood in 1981.



SIR GODFREY HOUNSFIELD ACCEPTS THE NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE FROM CARL GUSTAV, KING OF SWEDEN.



GALENI
LIBRORVM
QVINTA CLASSIS
EAM MEDICINÆ PARTEM,

quæ ad Pharmaciam spectat, exponens; simplicium medicamentorum, substitutorum, purgantium, antidotorum, componendorum tam per locos, quam per genera medicamentorum, ponderum denique, ac mensurarum doctrinam comprehendit:

NONA HAC NOSTRA EDITIONE

non parum ornamenti adepta: locis pluribus quàm alÿs superi- ribus editionibus, ad græcorum librorum fidem emendatis.

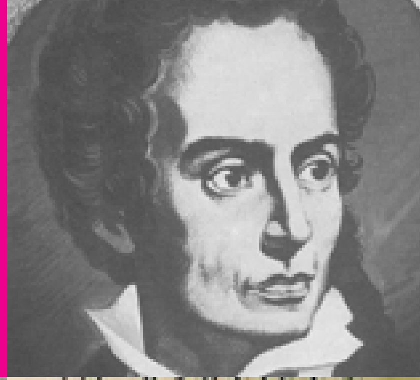
Locis etiam Hippocratis in margine indicatis, quos Galenus sparsim in contextu citat.

Et alÿs etiam annotationibus additis.

Librorum numerus proximo folio continetur.

Τὸ φαρμακευτικόν.

VENETIIS, APVD IVNTAS. MDCXXV.



JO. BAPTISTÆ
MORGAGNI
P. P. P. P.
DE SEDIBUS, ET CAUSIS
MORBORUM
PER ANATOMEN INDAGATIS
LIBRI QUINQUE.
Multiplex præfixus est Index rerum, & nominum accuratissimus.
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DUOS PRIORES CONTINENS LIBROS
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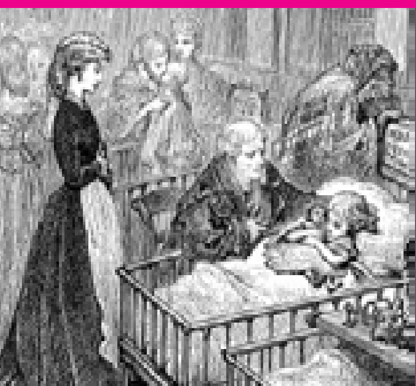
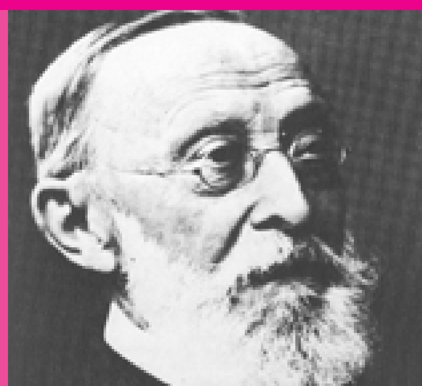
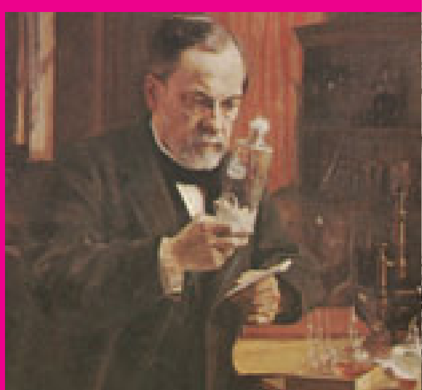


A BRIEF HISTORY OF MEDICINE BEFORE RADIOLOGY

BY
ALFREDO E. BUZZI





MEDICINE IN ANCIENT GREECE

The knowledge accumulated by the Babylonians and Egyptians did not quite reach the standards of modern science. Other cultures like the ancient Chinese, sought non-mythical explanations of natural phenomena, but they did not look for further experimental confirmation of their assumptions; rather they remained in a stage of pure theoretical speculation. Science, in the modern sense of the term, began with the ancient Greeks.

The earliest evidence of Greek science arose in the Ionian colonies in the early sixth century BC. The theoretical speculation of the Ionian philosophers included the belief that nature follows a logical order that can be interpreted through human reason. In this context, medicine could not be understood as a separate science from philosophy, since man is part of nature and is influenced by the same general laws as the rest of the universe.

The medical ideas of the pre-Socratic philosophers included the mechanistic and materialistic doctrines of the Ionians and Atomists, and the mysticism of the Pythagoreans. The events of the material world, whatever they might be, are open to rational explanation: this was the premise adopted by both the Ionians and the Pythagoreans. The Atomists proclaimed that nothing happens without a cause or a reason.

These two trends (deterministic and rational) were introduced to medicine by Hippocrates (460–370 BC). He took magic and supernatural thinking out, arguing that disease occurs only as a result of rational causes and is capable of being identified through the observation

of patients. Understanding medicine as a craft (*téchne iatriké*) was a fundamental event in its history. The great achievement of *téchne iatriké* (medical technique) was to organise symptoms, treatments and disease outcomes according to a rational model.

The Hippocratic writings were gathered in the third century BC in the celebrated library of Alexandria, where they formed the monumental collection now known as the *Corpus Hippocraticum*. The Hippocratic method uses inductive reasoning, which means studying symptoms carefully, keeping track of them and gathering a number of observations large enough to rule out all other possible diagnoses. By doing this, Hippocratic scholars managed to come to rough conclusions about the behaviour of the disease, the most convenient treatment and prognosis. The observation of the patient, without preconceptions and with more focus on the patient than on the disease, was a fundamental premise for the development of this method.

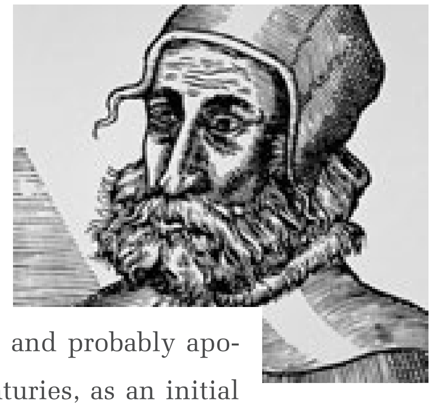
Health depended on the equal distribution of the four elements: air, water, earth and fire, which correspond to the body's four humours: blood, phlegm, bile and black bile. The balance of humours and their qualities (hot, cold, wet and dry) depended on organ function, and this mixture was called *'eucrasia'*. The disruption of this harmony (the *'dyscrasia'*) could be caused by different factors: lifestyle, air, wind, water, miasmas, climate or poison. There were also other causes of dyscrasia produced within the organism itself: retention of secretions or psychological troubles, such as worries or sorrows. The excess or deficiency of the humours would produce diseases, against which the body would respond by trying to restore the balance. They foresaw that the predisposition to an unfavourable humoural mixture can be transmitted from parent to child, recognising hereditary diseases.

The superiority of Hippocrates over his contemporaries was in his method of diagnosis and his principles of therapeutics. To make a diagnosis he carefully observed the patient's general condition, from their position in bed to their mental state. Through palpation he checked their response to pressure, pulse and temperature. He inspected the colour of the skin, secretions and natural orifices, such as the vagina and the ear. For chest diseases, he applied his ear to the chest wall to listen to noises. In sum, we can say that the steps taken by a contemporary doctor to examine patients (interrogation, inspection, palpation and auscultation) were already employed in the Hippocratic technique. Prognosis is also important: only through an exact prognosis is the confidence of the patient gained. And for this, a good clinical examination is critical.

Another exceptional merit of the Hippocratic School was that it invented the clinical record, for the idea of objectively recording a clear and concise description of the clinical case. The Hippocratic treatment was centred on the belief that the physician should help nature towards its tendency to cure. Treatment should primarily be minimal. In addition to rest and tranquillity, the central factor was dietary treatment.

Finally, the Hippocratic works on philosophy and medical ethics, like the famous Hippocratic Oath, should be mentioned. Although

GALEN



apparently written with Pythagorean influence, and probably apocryphal, the oath has persisted through the centuries, as an initial attempt to provide an ethical basis for the medical profession. Hippocrates has become known as the father of medicine because he was the genius behind the Hippocratic method. But, in addition to his scientific attitude, he was a caring soul and said "where there is love for mankind there is love for the art of healing."

In the third century BC a systematic investigation of cadavers by Greek physicians in Alexandria, such as Herophilus (335–280 BC) and Erasistratos (304–250 BC) began. Galen (129–299 AD), a Greek physician from Pergamum, tried to synthesise all the ancient knowledge about anatomy. He acquired his knowledge by dissecting animals and his functional interpretations had anatomical correlates, based on several inaccuracies. Galen summarised and synthesised the work of his predecessors and thanks to him Greek medicine was passed on to subsequent generations. His work was the main source of instruction until the 17th century. His anatomical reports remained uncontested until Andreas Vesalius (1543) and his theory of the physiology of the circulatory system endured until William Harvey (1628).

In the eighth century Arabian culture flourished and its scientists had made considerable contributions to scientific knowledge. This development of scientific thought culminated in the works of the Andalusian Averroes (1126–1198), according to whom, the only way to true knowledge was through logic. He furthered the Greek philosophical tradition in the Islamic world, advocating reason over religion.

EARLY ACHIEVEMENTS IN ITALY AND FRANCE: FROM THE MIDDLE AGES TO THE RENAISSANCE

At the beginning of the 11th century the medical school of Salerno (the oldest in the West) was established, and was widely acknowledged as the centre of medical knowledge in Western Europe, as Alexandria had been in the ancient world. The Benedictine monk and native of Carthage, Constantine the African (1017–1087), arrived at the Abbey of Monte Cassino (100 miles to the north of Salerno). With his knowledge of Arabic, Greek and Latin, he began to translate many of the medical texts from ancient Greece and Rome (including Galen's and Hippocrates') from the surviving Arabic translations into Latin.

This knowledge came into conflict with the prevailing theological dogma, particularly in Paris, where the sciences served theology exclusively. In northern Italy free universities were established without the influence of the church. In Bologna, cadavers were dissected by Mondino di Liuzzi (1270–1326) to examine internal anatomy for the first time in a thousand years, but he maintained several of Galen's inaccuracies. Padua was called 'the Athens of the West'. In its University, the scientific curriculum concentrated on natural sciences, medicine and mathematics, strongly influenced by Averroes' philosophy. The astronomer Nicolas Copernicus (1473–1543) and the physicist Galileo Galilei (1564–1642) were professors in Padua, and the anatomists Andreas Vesalius (1514–1564) and William Harvey (1578–1657) worked there. By the 13th century the medical school at Montpellier began to eclipse the Salernitan school. This new anatomical and physiological knowledge spread from Padua throughout Europe and gradually broke theological dominance at universities.

ANDREAS VESALIUS, AUTHOR OF ‘DE HUMANI CORPORIS FABRICA’, IS CONSIDERED ONE OF THE FOUNDERS OF MODERN HUMAN ANATOMY.

From the 16th century numerous universities were founded, and hospices evolved into hospitals.

In medicine, the Renaissance was a time of anatomical thought. Vesalius challenged the inaccuracy of the Galenic anatomy in his seminal work 'De humani corporis fabrica' (1543).

Surgery was discredited because of the high mortality of surgical interventions. Clinicians had a superior status to that of surgeons, but from this century on, the social status of surgeons rose gradually, initially in France, where Ambroise Paré (1510–1590), a contemporary of Vesalius, introduced several surgical techniques.

The Renaissance also marked the beginning of psychology, with Juan Luis Vives (1493–1540), biochemistry, with Jan Baptist van Helmont (1579–1644) and pathology, with Antonio Benivieni (1443–1502). However, the great figure of pathology, Giovanni Battista Morgagni (1682–1771), belongs to the next century.

During the Renaissance and the Early Modern period, the understanding of medical sciences and diagnosis improved, but with little direct benefit to health care.

SCIENCE IN THE AGE OF ENLIGHTENMENT

During the 17th century Galileo Galilei, Isaac Newton, René Descartes, Francis Bacon and Gottfried Leibniz established the scientific method. The Englishman William Harvey announced, in his 'De motu cordis' (1628), that blood circulates with the heart acting as a pump, breaking with Galen's views. Later, using a microscope, the Dutchman Antonie van Leeuwenhoek (1632–1723) described the capillary system. Also, he observed micro-organisms for the first time in 1676, initiating the scientific field of microbiology. In Italy, Marcello Malpighi (1628–1694) founded microscopic anatomy.

In clinical medicine two new concepts were debated: *iatrophysics* (which attempted to explain physiological phenomena in mechanical terms) and iatrochemistry (which seeks to provide chemical solutions to diseases and medical ailments). There was no further progress until the English physician Thomas Sydenham (1624–1689), often called 'the English Hippocrates', introduced one of the most important ideas in medicine: the ontological concept of disease. Through this approach, diseases were seen as abstract entities, and clinical procedures were established. The concept of 'entity' was reinforced a century later with an anatomical basis in the work of Morgagni and a century later in the era of bacterial agents.

In the 18th century, northern European universities began to excel and the hegemony of the Italian universities disappeared. The most notable achievements of eighteenth-century medicine occurred mostly in the second half of the century, particularly those that emerged from the Enlightenment movement. For the first time the concept of 'social medicine' appeared, and the idea of disease prevention was introduced. The most important development in public health was the introduction, by the Englishman Edward Jenner (1749–1823), of a safe and effective vaccine against smallpox, in 1796.

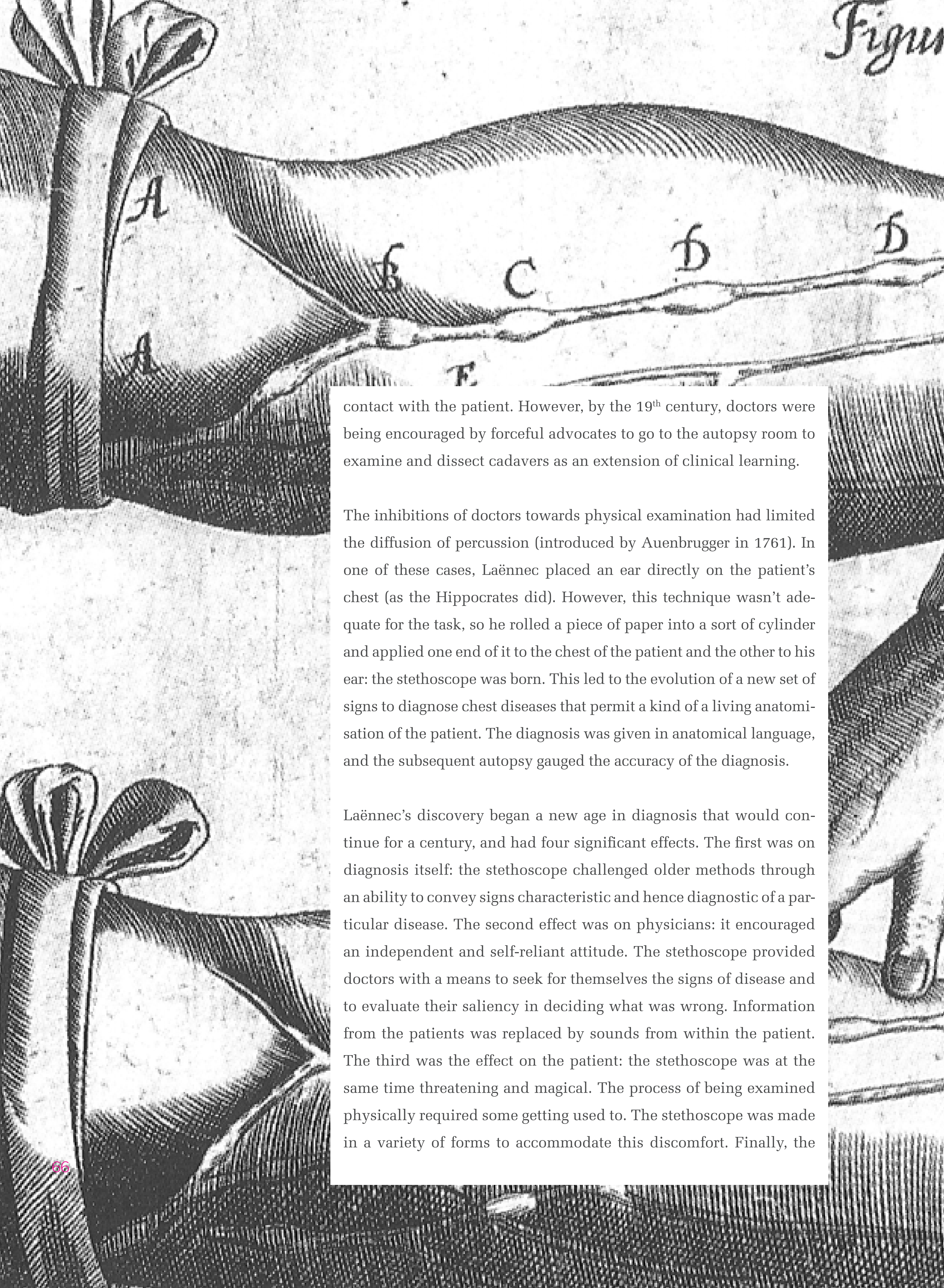
The idea that mental disorders were caused by demonic possession disappeared, along with the miserable conditions that these patients had been subjected to. Under the work of the Frenchman Philippe Pinel (1745–1826) mental disturbances became diseases.

The most prominent clinician was the Dutchman Herman Boerhaave (1668–1738). His favourite pupil, Gerhard Van Swieten (1700–1772), went to Vienna, where he organised the famed Vienna clinic. Van Swieten's pupil Leopold Auenbrugger (1722–1809) introduced percussion to the clinic. But it was Jean-Nicolas Corvisart (1755–1821), physician to Napoleon, who recognised the importance of the method at the beginning of the next century. Although surgeons remained powerless to fight pain and infection, surgery made progress (especially in France and England) thanks to the greater technical knowledge of anatomy.

In 1761, Morgagni published his treatise *The Seats and Causes of Diseases Investigated by Anatomy*. The work had physicians considering the links between symptoms found in the living patient and lesions discovered during autopsy. By invoking the image of site-specific lesions as the hallmark of pathology, Morgagni helped radically transform conceptual thinking about illness from previously dominant thinking. The common medical view about what illness was had been shaped by the humoural concept of physiological function, which had dominated medicine for several millennia. The focus of this theory of health and illness was the whole person. The physiological system of a person and the intricate interlinking of its humoural parts were kept at the centre of medical analysis. The anatomical view of illness caused some to think to the contrary. It made medical observers focus on parts, not wholes; on the site of the illness, not the system it affected. In the half-century between the publication of Morgagni's work and the invention of the stethoscope, anatomical thinking was adopted by a widening medical audience. The doctor was still faced with the problem of understanding the symptoms displayed at the bedside by the patient. These must be compared with their expression as lesions in the body after death to fully comprehend disease.

Completing the revolution promised by anatomical exploration required a complementary revolution in the study of tissues and organ function. Laënnec provided a crucial answer. Laënnec and his contemporaries learned of symptoms and evaluated disease, chiefly through the medium of the patients' subjective accounts of events and experiences connected with their illnesses. Neither physical examination of the patient nor the use of technology to diagnose disease were common in practice.

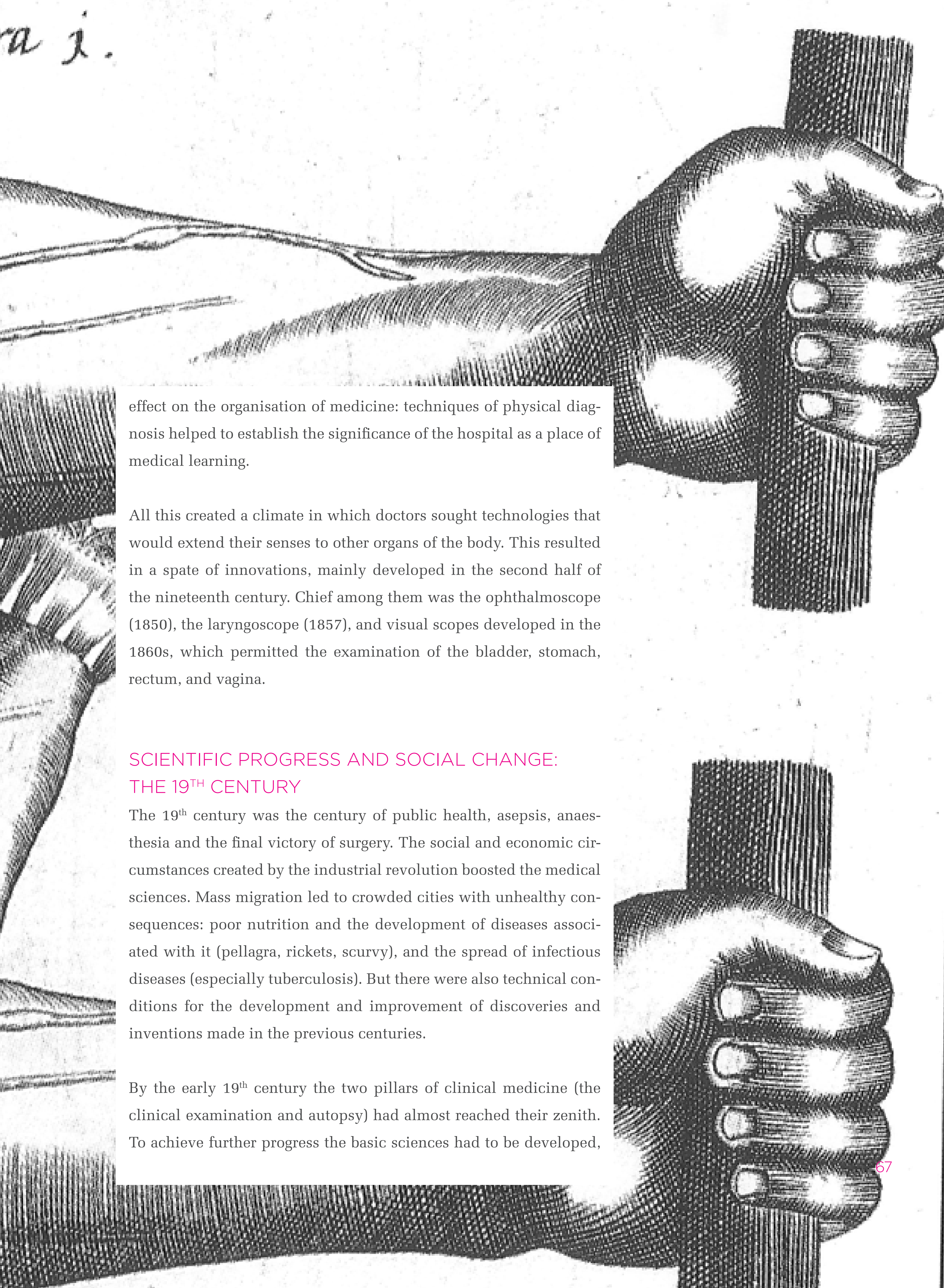
Soon after the establishment of universities in Europe in the 13th century a set of mores developed that viewed manual examination and the use of tools as antithetical to the dignity of a learned doctor. This led to the expulsion of surgery from the medical curricula of universities and the discouragement of physicians from having physical



contact with the patient. However, by the 19th century, doctors were being encouraged by forceful advocates to go to the autopsy room to examine and dissect cadavers as an extension of clinical learning.

The inhibitions of doctors towards physical examination had limited the diffusion of percussion (introduced by Auenbrugger in 1761). In one of these cases, Laënnec placed an ear directly on the patient's chest (as the Hippocrates did). However, this technique wasn't adequate for the task, so he rolled a piece of paper into a sort of cylinder and applied one end of it to the chest of the patient and the other to his ear: the stethoscope was born. This led to the evolution of a new set of signs to diagnose chest diseases that permit a kind of a living anatomisation of the patient. The diagnosis was given in anatomical language, and the subsequent autopsy gauged the accuracy of the diagnosis.

Laënnec's discovery began a new age in diagnosis that would continue for a century, and had four significant effects. The first was on diagnosis itself: the stethoscope challenged older methods through an ability to convey signs characteristic and hence diagnostic of a particular disease. The second effect was on physicians: it encouraged an independent and self-reliant attitude. The stethoscope provided doctors with a means to seek for themselves the signs of disease and to evaluate their saliency in deciding what was wrong. Information from the patients was replaced by sounds from within the patient. The third was the effect on the patient: the stethoscope was at the same time threatening and magical. The process of being examined physically required some getting used to. The stethoscope was made in a variety of forms to accommodate this discomfort. Finally, the



effect on the organisation of medicine: techniques of physical diagnosis helped to establish the significance of the hospital as a place of medical learning.

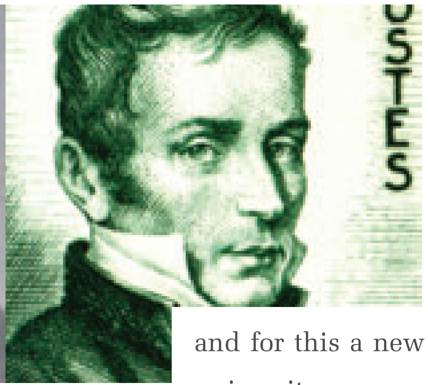
All this created a climate in which doctors sought technologies that would extend their senses to other organs of the body. This resulted in a spate of innovations, mainly developed in the second half of the nineteenth century. Chief among them was the ophthalmoscope (1850), the laryngoscope (1857), and visual scopes developed in the 1860s, which permitted the examination of the bladder, stomach, rectum, and vagina.

SCIENTIFIC PROGRESS AND SOCIAL CHANGE: THE 19TH CENTURY

The 19th century was the century of public health, asepsis, anaesthesia and the final victory of surgery. The social and economic circumstances created by the industrial revolution boosted the medical sciences. Mass migration led to crowded cities with unhealthy consequences: poor nutrition and the development of diseases associated with it (pellagra, rickets, scurvy), and the spread of infectious diseases (especially tuberculosis). But there were also technical conditions for the development and improvement of discoveries and inventions made in the previous centuries.

By the early 19th century the two pillars of clinical medicine (the clinical examination and autopsy) had almost reached their zenith. To achieve further progress the basic sciences had to be developed,

L: RUDOLF VIRCHOW
R: RENÉ LAËNNEC



and for this a new type of doctor was needed. So, a new model of university was required, and this is what appeared in Germany. Wilhelm von Humboldt (1767–1835) conceived the new university from German idealism, basing academic activity on research and teaching. Germany soon stood at the head of Europe in terms of science, and held its place for over a century.

New developments in optics made possible new observations in the fields of cytology, histology and embryology. Matthias Jacob Schleiden (1804–1881) and Theodor Schwann (1810–1882) shaped cell theory. The next steps in the conception of the cellular structure of living beings were taken by Robert Remak (1815–1865), who discovered cell division in 1852, and a few years later by Rudolf Virchow (1821–1902).

In physiology, the works of the Frenchman François Magendie (1783–1855), founder of modern experimental pharmacology, Thomas Young (1773–1829), who formulated a theory on colour vision, Charles Bell (1774–1842), and Johannes Mueller (1801–1858) were all important.

The most celebrated clinicians of the first half of the 19th century were in France and England. The French René Laënnec (1781–1826) invented the stethoscope in 1816, which allowed him to diagnose diseases earlier and more accurately than had previously been possible.
In Vienna, the pathologist Karl von Rokitansky (1804–1878) developed pathology as a discipline independent of clinical medicine, and created several methods of autopsy examination. The German

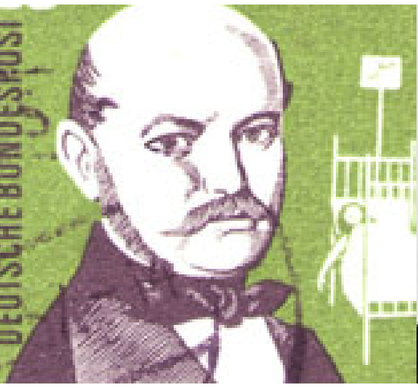
Rudolph Virchow is referred to as 'the father of modern pathology'. He pioneered the modern concept of the pathological process through his 'cellular theory' (1839), which explained the effects of disease in organs and tissues, emphasising that diseases arise not in the organs or tissues in general, but primarily in individual cells. He is also known for promoting public health, and is considered one of the founders of social medicine.

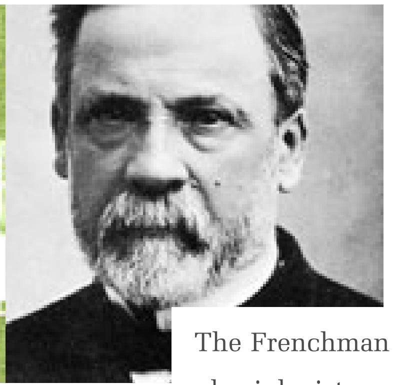
In 1844, the dentist Horace Wells (1815–1848), from Connecticut, successfully used nitrous oxide on a patient. Soon after, the dentist William Morton (1819–1868) asked the surgeon John Warren (1778–1856) of Boston to test this method in an operation. The intervention under general anaesthesia (the removal of a tumour of the jaw) was carried out in 1846 at Massachusetts General Hospital. Crawford Long of Dansville, Georgia, had used ether anaesthesia in 1842, but he had not reported it. Surgery had overcome one of its two major drawbacks: pain. Local anaesthesia was introduced later, at the end of that century.

The Augustinian friar Gregor Mendel (1822–1884) published his books on pea plants in 1865, which would be later known as Mendel's laws. Rediscovered at the turn of the 20th century, they would form the basis of classical genetics.

The great technical advances of that time based on the positivist conception encouraged the development of medical instruments. The classic apparatus for physiological recording were invented: kymograph, spirometer, myograph, miotonógrafo, sphygmograph. Hermann von Helmholtz (1821–1894) invented the ophthalmoscope.

L: IGNAZ SEMMELWEIS
R: LOUIS PASTEUR





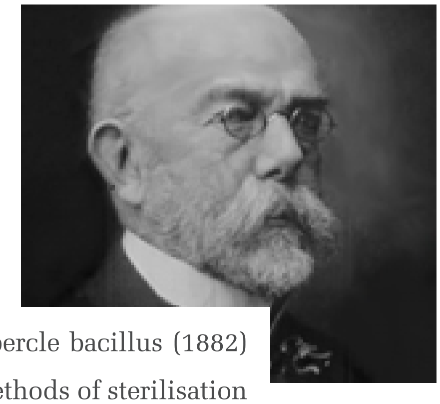
The Frenchman Claude Bernard (1813–1878), probably the greatest physiologist ever, was the founder of experimental medicine. In his classic book ‘An Introduction to the Study of Experimental Medicine’ (1865), he describes what makes a scientific theory good and what makes a scientist important and a true discoverer. He was the first to define the term *milieu intérieur* (now known as homeostasis).

The Hungarian Ignaz Semmelweis (1818–1865) dramatically reduced the death rate of new mothers from childbed fever in 1847 through the simple expedient of requiring physicians to clean their hands before attending to women in childbirth. His discovery pre-dated the germ theory of disease. However, his discoveries were not appreciated by his contemporaries and came into general use only with the discoveries of British surgeon Joseph Lister (1827–1912), who in 1865 proved the effectiveness of antisepsis with carbolic acid in the treatment of wounds.

Semmelweis’s work was supported by discoveries made by Louis Pasteur (1822–1895). Linking micro-organisms with disease, Pasteur brought about a revolution in medicine. His experiments with fermentation led to pioneering research in bacteriology, confirming the germ theory, and he also discovered the principle of sterilisation, which came to be known as ‘pasteurisation’. His discoveries led to the universal practice of surgical antisepsis. He also developed techniques of vaccination to control bacterial infection, as well as a successful vaccine to treat rabies.

Along with Pasteur, the German Robert Koch (1843–1910) founded bacteriology. He first demonstrated the bacterial cause of disease, the

ROBERT KOCH



bacillus anthracis (1876) and discovered the tubercle bacillus (1882) and the cholera bacillus (1883). He developed methods of sterilisation (asepsis), mainly with water vapour, which were better than the antisepsis with carbolic acid that had been introduced in 1867 by Lister. With these methods, surgery overcame its second major obstacle: infection. Koch set out the principles and techniques of modern bacteriology, and developed evidence to prove the bacterial origin of disease.

Medical specialties developed along with the invention of medical apparatus. Surgery and pathology were developing rapidly in the latter part of the 19th century. The introduction of instrumental technology as a basic, common, and significant feature of the diagnosis of disease began in 1816 with the invention of the stethoscope. Before this time, instruments to aid diagnosis were not a feature of diagnostic investigations. The key antecedent circumstances that produced this innovation were the rise of anatomical perspective on illnesses, and flaws in the techniques commonly used to make diagnostic evaluations.

DIFFERENT VIEWS: EXAMINING THE OUTSIDE AND LOOKING WITHIN

The first documented redirection of sunlight into the human body dates back to the 16th century, but the Italian-German Philip Bozzini (1773–1809) was the physician most commonly believed to have been the first to visualise the interior of the body in a novel way in 1806. His apparatus called ‘Lichtleiter’ (light conductor) was constructed from a metal casing which was designed to hold a candle. However, the invention did not gain wide acceptance among medical practitioners. The Frenchman Antonin Jean Desormeaux (1815–1882) replaced the candle with a mixture of alcohol and turpentine to increase the illumination. He conducted the first successful operative endoscopic procedures on patients, and is considered by many as the 'father of endoscopy'. The lighting system was further improved by the dentist Julius Bruck (1840–1902), who was the first to suggest inserting a light source into the human body. In 1867, he installed a platinum wire into a tube surrounded by water which created a safe light source. Maximilian Carl-Friedrich Nitze (1848–1906) was a general practitioner interested in medical examination of the urinary bladder. He was the first inventor to create an endoscope with the light source at its tip. He miniaturised Edison's filament globe and created the first cystoscope in 1877.

By the end of the 19th century, doctors exulted in their power and prestige as investigators and analysts of physical evidence. Other technologies were being developed that would ultimately challenge physical signs as the central feature of diagnosis.

While the earliest thermometer had been invented by Galileo between 1503 and 1597, the absence of a detailed analysis of its application had limited its use in medical practice. In 1868, the German physician Carl Wunderlich (1815–1877) published *On the Temperature in Diseases: a Manual of Medical Thermometry*. He developed views on the physiological movements of body temperature in health, the variations in temperature produced by different diseases, and the meaning of temperature changes in diagnosis, prognosis, therapy, and disease prevention. Thus, Wunderlich had devised a new measure of the course and duration of diseases and the control of therapies for them, based not on a meticulous analysis of symptoms reported by patients or physical signs discovered by doctors, but using numerical results recorded by an instrument.

While physical diagnosis generally detected permanent changes or slowly changing disease phenomena, thermometry provided insight into moment-to-moment disease perturbations. While the other methods focused on site-specific alterations in the body, the thermometer measured the response of the whole body to illness, and thus was a more dependable index of the patient's prognosis.

In the 1870s, the American physician Edward Seguin (1843–1898) classified the techniques of diagnosis into two divisions: those of physical diagnosis such as the stethoscope and ophthalmoscope, which were accessories to and extended the senses, but also reflected the impressionistic aspect of sensory data; and those of positive diagnosis, such as the thermometer and sphygmograph, which were substitutes for the senses, gave automatic results and mathematically analysed and depicted phenomena undetectable to the senses.

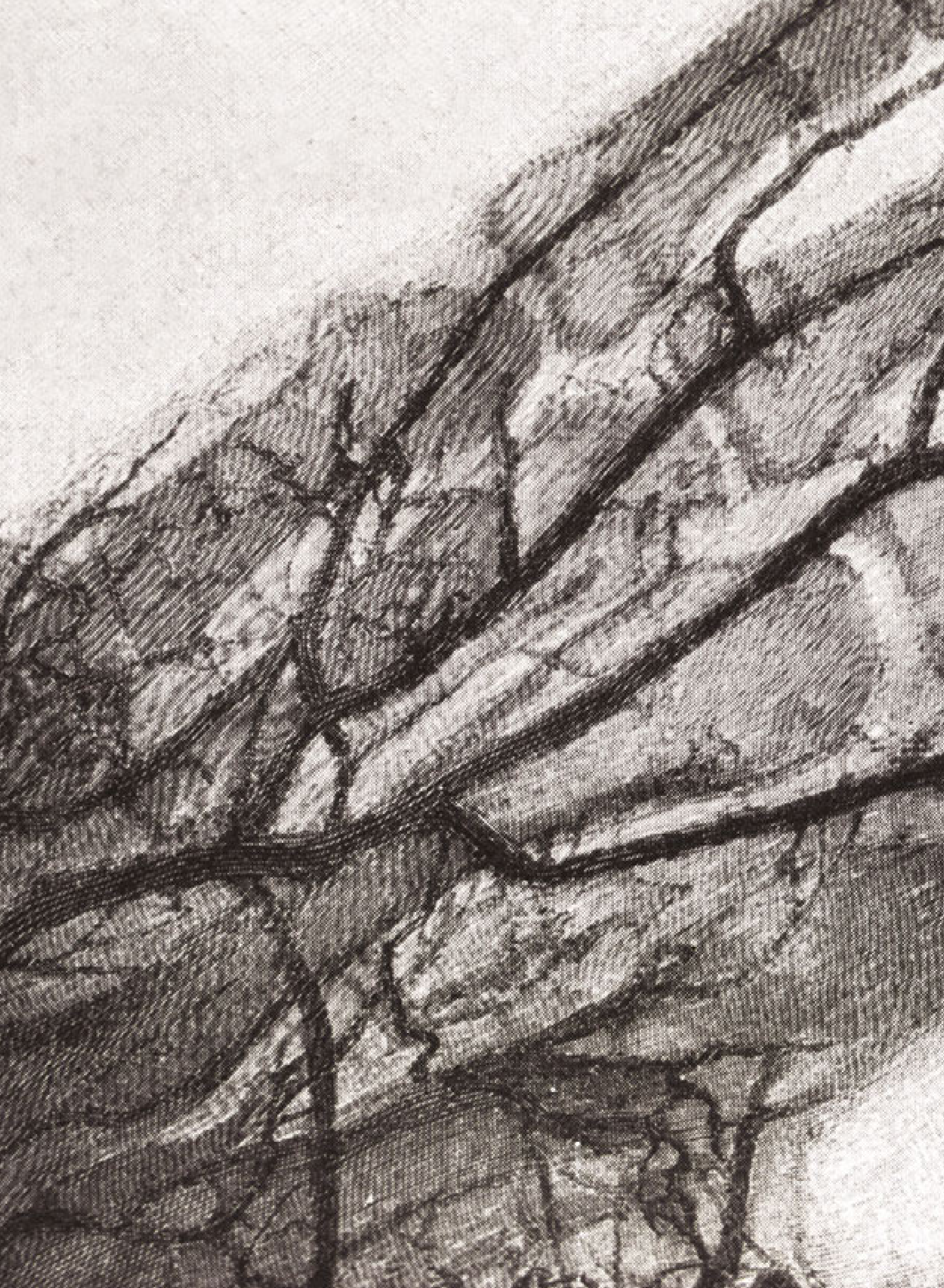
By the end of the 19th century a discovery was made that focused the medical world on a new form of diagnostic data. To be able to see within the human body had a profound impact on both the medical and lay communities, on medical thought and on fundamental ideas about the human body. It is difficult to overestimate the profound impact the discovery of x-rays had on mankind.

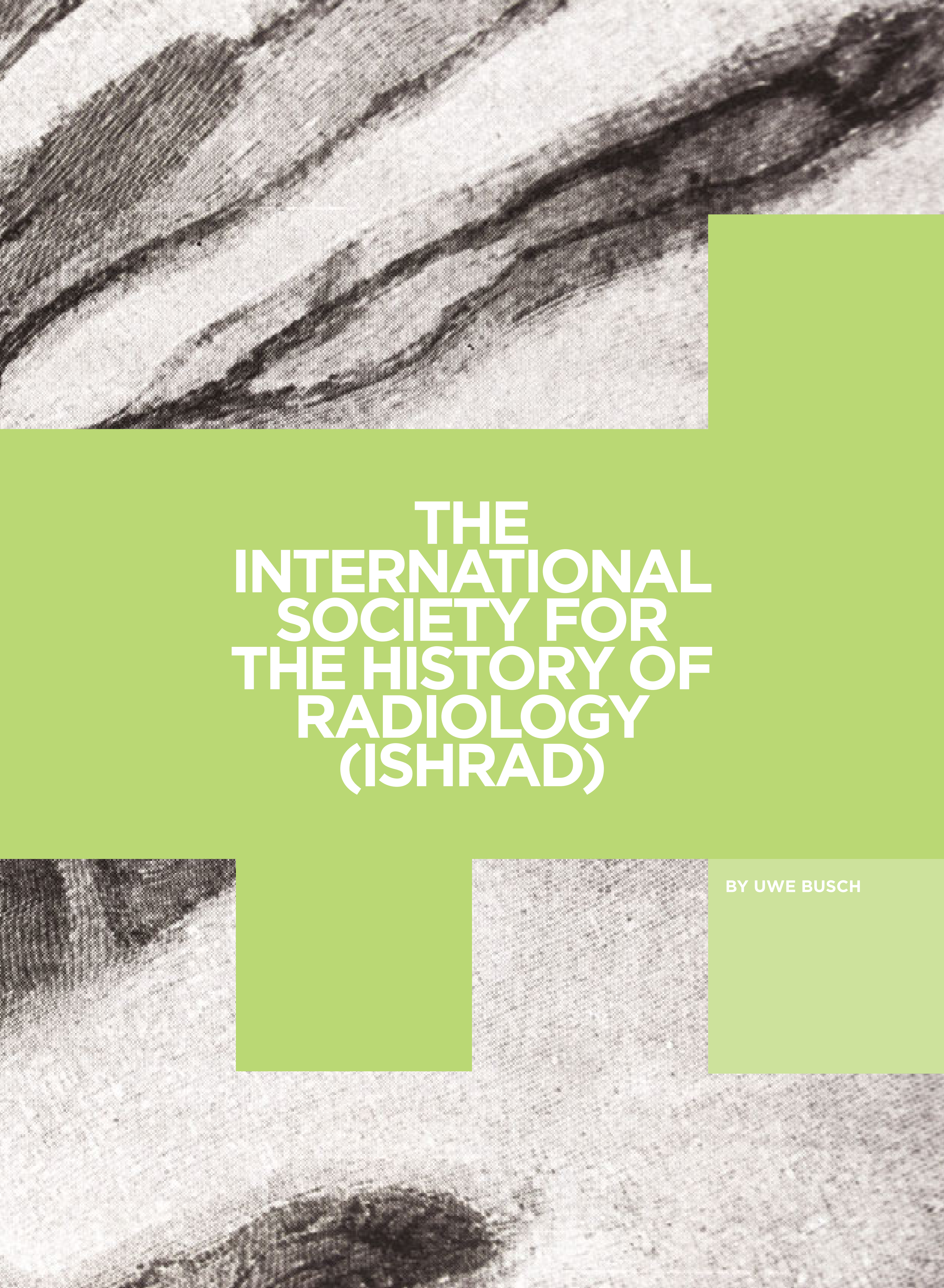
No other innovation in medicine had ever before created the drama and astonishment that x-rays did. A central reason for the rapid acceptance of the use of x-rays was a perception of it as being a type of photography. And a photo is a depiction of reality.

BIBLIOGRAPHY

» Adler RE: Medical Firsts: From Hippocrates to the Human Genome. Wiley Publisher, 2004
» Anderson J, Barnes E, Shackleton E: The Art of Medicine: Over 2,000 Years of Images and Imagination.
» Balint GP, Watson Buchanan W, Dequeker J: A brief history of medical taxonomy and diagnosis. Clin Rheumatol 2006, 25: 132-135.
» Berger D: A brief history of medical diagnosis and the birth of the clinical laboratory. Med Lab Obs. 1999, 31:28-30.
» Buzzi A, Doisenbant R: Evolución histórica de la medicina. Ed. Panamericana, Buenos Aires, 2008
» Bynum WF, Porter R: Companion encyclopedia of the history of medicine. Routledge, London, 1997
» Castiglioni A: History of Medicine. Alfred A. Knopf, Inc., New York, 1941
» French R: Medicine before Science: The Business of Medicine from the Middle Ages to the Enlightenment. Cambridge University Press, 2003
» Gross S, Kollenbrandt M: Technical evolution of medical endoscopy. Acta Polytechnica 2009, 49: 2-3
» Howell JD: Technology in the hospital. The Johns Hopkins University Press. Baltimore, Maryland, 1995
» Lain Entralgo P: Historia de la Medicina. Ed. Salvat, Barcelona, 1982
» Lyons A, Petrucelli RJ: Medicine: An Illustrated History. Harry N. Abrams Publisher, 1997
» Marti-lbañez, F: The Epic of Medicine. Clarkson N. Potter, Inc., New York, 1962.
» Nuland SB: Doctors: The Illustrated History of Medical Pioneers. Black Dog & Leventhal Pubitshers, Inc., 2008.
» Osler W: The Evolution of Modern Medicine. Yale University Press, 1921
» Porter R: The Greatest Benefit to Mankind: A Medical History of Humanity from Antiquity to the Present. Harper Collins, 1997
» Porter R: Blood and guts. W. W. Norton & Company. London, 2004.
» Rosenbusch G, Oudkerk M, Ammann E: Radiology in medical diagnostics. Blackwell Science, Oxford, 1995

HIPPOCRATES
(BY PETER RUBENS)





THE INTERNATIONAL SOCIETY FOR THE HISTORY OF RADIOLOGY (ISHRAD)

BY UWE BUSCH

ISHRAD is the first society specially dedicated to the history of radiology and radiological technology. The aims of the society are to advance scientific research and the exchange of information concerning the history of radiology, radiological technology and radiological practice. These aims are pursued through the collection and presentation of specialist scientific contributions on a new website, through the organisation of exhibitions, scientific congresses and meetings on the history of radiology and radiological technology and practice.

The story began in 1895, when a German physicist discovered a new kind of ray. The development of diagnostic imaging is the result of a fruitful relationship between doctors, radiographers, physicists and equipment manufacturers. New apparatus has spurred on the development of new techniques, and medical needs have, in their turn, encouraged new developments in equipment. Many new techniques have been introduced in recent years.

The principles of CT were first described by Godfrey Hounsfield and the first prototype EMI scanner was installed in 1972, at Atkinson Morley Hospital. Work on magnetic resonance imaging (MRI) progressed in the 1970s and the first human image was obtained in Aberdeen, in 1977. Nuclear magnetic resonance imaging can be used either to produce planar images of anatomy or provide biochemical information through magnetic resonance spectroscopy. Ultrasound started in the 1950s and gained popularity in the 1960s. ‘Real-time’ ultrasound machines were introduced in the late 1970s and ultrasound is now the most commonly used technique, after conventional radiographs. The use of Doppler technology over the last 10 years has allowed blood-flow to be assessed as well as anatomy. These new techniques have displaced many of the older x-ray techniques and this process will likely continue.

In modern radiological practice it is not possible to consider techniques in isolation. An integrated approach is needed, with the various techniques used as appropriate. Often it is better for a complex procedure to be used early in an investigation, since a diagnosis may be reached quickly with minimal inconvenience and risk to the patient. In recent years, the widespread use of percutaneous biopsy techniques, ultrasound, and CT have considerably reduced the need for exploratory surgery. There have been many changes in medicine that influence radiological practice, for example the increasing use of endoscopy has considerably reduced the need for barium meals. Recent developments in diagnostic imaging have considerably influenced the new trend of investigating and treating patients as day cases or as outpatients, with significantly less disruption to the patient's life.

By the 1980s, the techniques needed to store reports and films had changed little since the 1920s. Modern technology has been transforming departments since the introduction of computer management systems and digital image storage. This latter advance will dramatically alter the use of images, with studies being transferred via links between different institutions and offices. The last 100 years have seen many changes and the next 100 will be even more dramatic.

In order to promote the study and conservation of radiological history, the International Society for the History of Radiology was founded in 2011.

We are a very varied group and the one thing that draws us together is our passion for the history of radiology and all aspects of medical imaging and therapy. Medical imaging is changing all the time and is increasingly central to patient management and care. The story of radiology is fascinating and needs to be celebrated and recorded. The idea of an International Society for the History of Radiology was born in Vienna, Austria in 2004 at the European Congress of Radiology (ECR). Today we have 62 members from 15 different countries.

If you are interested in joining us, please find further information on our website: **www.ishrad.org**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THE GERMAN RÖNTGEN MUSEUM

BY UWE BUSCH

The German Röntgen Museum is a museum devoted to Wilhelm Conrad Röntgen, the history of radiology, and the provision of teaching facilities about x-rays for the general public, particularly children. A new plan has been devised for the upgrade and redevelopment of the museum to bring it more in line with modern standards and interactive methods in science and technology.

INTRODUCTION

What can an individual's life tell us about the path towards making ground-breaking discoveries? What part does novel thinking play in the advancement of research? What significance does technology have in our lives and for our health? The questions that Wilhelm Conrad Röntgen brought up are numerous. But they are, above all, extremely pertinent today. That is why our aim is to create a new Röntgen Museum for the future that is relevant to the current era.

RÖNTGEN AS LEGEND

For more than three-quarters of a century now, the German Röntgen Museum in Remscheid has comprehensively explored documents and presented the life, work and impact of Wilhelm Conrad Röntgen. As a forefather of modern, creative and interdisciplinary thinking in the natural sciences, Röntgen has become something of a legend for his scientific research and developments in Germany around 1900. His successes helped establish the phrase 'made in Germany' as a symbol of quality in engineering, technology and industrial production. The award of the first ever Nobel Prize to Röntgen set high standards for future awards.

RÖNTGEN AS A SYNONYM FOR INNOVATION

Wilhelm Conrad Röntgen, born in Remscheid-Lennep, was a world-renowned inventor, researcher, and physicist. His work revolutionised medical diagnostics and paved the way for numerous technological applications in modern science and technology, without which our modern world would be inconceivable. An extraordinary personal and historic achievement, and yet Röntgen's life and work represent much more: a timeless universal message for creative thinking, a positive driving force behind all cultural and social developments as well as technological progress and innovation.

It is on the foundations of this quality that the concept and master plan for the new Röntgen Museum in Remscheid, Germany are based. At the same time its potential should be realised in many respects by creating a museum which will foster Röntgen's spirit of discovery and enquiry, guiding the visitor through an exciting, yet easy-to-understand scientific experience. As a modern educational facility it will follow the hands-on scientific approach, thus allowing fun and interest to develop interactively alongside investigation and experimentation, encouraging potential creative and innovative skills over a long-term basis. In addition, the museum will serve as a cultural and social focal point offering a platform for researchers, industry and the public.

A POSITIVE PARADIGM SHIFT

With this repositioning, a strategic extension of the museum's scope, significance and sphere of influence will take place. This means

that the Röntgen Museum will undergo a transformation from a specialised museum of encyclopaedic character to a modern technical, scientific theme museum. This new orientation and interpretation of the history and diversity of the subject matter will appeal to a broad national and international audience, who will be able to share their interest in applications ranging from those of everyday familiarity to the hi-tech. This will encourage the individual visitor to think about questions of modern scientific research and awaken his or her lasting interest. With this change the museum should complete both its tasks: conservation and renewal.

READY FOR THE FUTURE

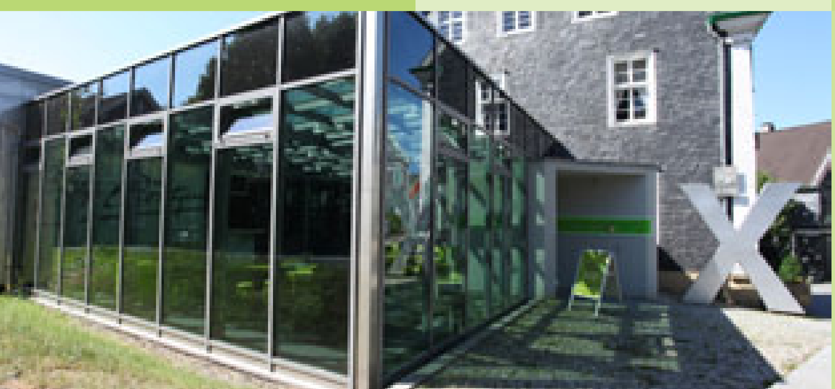
The museum's target groups are school children, students of all ages, and families. Its educational aspect functions through a multilayered presentation of the exhibits, thus achieving maximum accessibility for all age groups and educational backgrounds. Ranging from 'popular science' to 'specialist', the contents are ready and waiting, in various media, to be discovered actively or interactively. In terms of the museum this will be implemented through activities ranging from 'adventure trails' for children, to multimedia archives for the visiting specialist. Ultimately, they all have the same purpose and that is to ignite the spark of enthusiasm and win over new disciples for the heritage Röntgen left us.

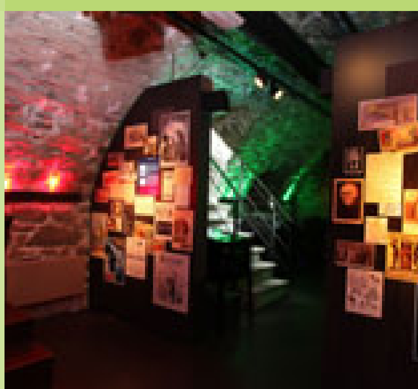
CONTACT

Uwe Busch, PhD
Deputy Director
Deutsches Röntgen Museum
Schwelmer Str. 41
42897 Remscheid, Germany

Phone: +49 (0) 2191/16-3406
Fax: +49 (0) 2191/16-13406
E-mail: buschu@str.de

www.roentgenmuseum.de





ABOUT THE AUTHORS

ARPAN K. BANERJEE

Dr. Arpan K. Banerjee from Birmingham, UK, is treasurer and a founding member of the International Society for the History of Radiology.

He is currently a consultant radiologist at Birmingham Heartlands and Solihull Hospitals. He was president of the radiology section of the Royal Society of Medicine from 2005 to 2007 and continues to serve on the council today. In 2012, he became chairman of the British Society for the History of Radiology. His research interests include MR quantification of obesity, imaging infectious diseases such as HIV, and the history of medicine and radiology.

Dr. Banerjee has also written quite extensively on the subject of radiology, having authored and co-authored six books, including the popular student text 'Radiology Made Easy'.

ELIZABETH BECKMANN

Elizabeth Beckmann from Orpington, UK, is a committee member of the International Society for the History of Radiology.

She is a fellow and former president of the British Institute of Radiology (BIR) and a co-author of the book 'Godfrey Hounsfield: intuitive genius of CT'. Beckmann is a trustee of the British Society for the History of Radiology and honorary secretary of the British Society for the History of Medicine.

Beckmann has worked in the field of Medical Imaging since 1977, working initially for EMI Medical Ltd, inventors of the CT scanner. She launched her own company, Lanmark, in 1989.

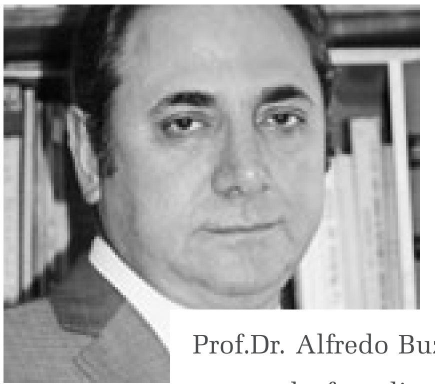
UWE BUSCH

Dr. Uwe Busch from Remscheid, Germany, is honorary secretary and a founding member of the International Society for the History of Radiology.

Dr. Busch is deputy director of the Röntgen Museum in Remscheid, Germany. He is well-known within the field of radiology as a historian of all things x-ray related. He studied nuclear physics at the University of Bochum where he received a diploma and later went on to earn a PhD in medical physics at the University of Erlangen in Bavaria.

Dr. Busch has written three books, over 40 published papers and has delivered over 25 international invited lectures. His other interests include the history of medical physics and physics in the 19^{th} century.

ALFREDO BUZZI



Prof.Dr. Alfredo Buzzi from Buenos Aires, Argentina, is vice chairman and a founding member of the International Society for the History of Radiology.

Prof. Buzzi is currently president of the Argentine Society of Radiology and works at the University of Buenos Aires as a professor of diagnostic imaging and as director of the advanced course for radiologists.

Prof. Buzzi is involved with many other international radiological organisations and is a member of the International Radiology Quality Network. He has also contributed to the discipline on a national level as medical director of the Diagnostico Medico Medical Center, Buenos Aires, and as secretary of the Argentinean Council for Evaluation in Radiology.

ADRIAN THOMAS

Prof.Dr. Adrian Thomas from Bickley, UK, is chairman and a founding member of the International Society for the History of Radiology.

Prof. Thomas is currently chairman of the British Society for the History of Radiology (BSHR). He is also honorary librarian at the British Radiology Institute and has worked as a consultant radiologist for the Sloane Hospital, Kent and Bromley NHS Hospital, London, since 1987.

Prof. Thomas is a member of the British Medical Association and a former president of the Royal Society of Medicine's radiology section. He has also edited a book chronicling the history of radiology, entitled: 'The Invisible Light: 100 years of Medical Radiology'.

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