History

Polish radiology in the 19th and 20th centuries

“Polish radiology in the 19th and 20th centuries” (authors: Andrzej Urbanik, Stanisław Leszczyński) – book abreviation

At the time Roentgen made his historic discovery Poland had not existed as a state (since the end of the XVIII century), divided among the neighbouring Austria, Russia and Prussia. The following cities were the main academic centres: in the Russian partition – Warszawa (Warsaw) and Wilno (Vilnius), in the Prussian partition – Poznań (Posen) whereas in the Austrian one – Kraków (Cracow - where the Jagiellonian University had incessantly functioned since it was founded in 1364) and Lwów (Lvov). The Poles, although deprived of their own state institutions, retained their language, religion and national tradition. Despite the partitions, Polish art, literature, music as well as science and economic life flourished. The Poles would take any opportunity of regaining independence. They engaged in the Napoleonic wars or organised insurrections themselves. Thanks to their determination and taking advantage of the political situation Poland regained independence towards the end of World War I in 1918.

The first news about Konrad Wilhelm Roentgen's great discovery were published by Kraków-based "Czas", by Lwów-based Gazeta Lwowska and Warszawa-based Słowo, as early as January 8, 1896; the information from Vienna-based „Die Presse” of January 5, 1896 was quoted. In a short note the methods of obtaining the X-rays and their hypothetical applications were presented. It also stated that "*the problem, although it seems an All Fools' Day joke, is seriously considered in serious circles*".

Shortly after that many articles on that subject matter appeared in the Polish press, both in dailies and weeklies and scientific magazines. On January 1896 Roentgen's first report was translated into Polish by dr Stanisław Srebrny and published as a booklet.

Soon first experiments with X-rays were started. In Kraków, at Jagiellonian University, between January 8 and 20, 1896 the professor of chemistry Karol Olszewski (the man who was the first one, along with W. Wróblewski, to liquefy air) took various experimental pictures using a Plücker tube (Olszewski’s X-ray unit is in Jagiellonian University Museum), including that of a bronze lizard-shaped paper weight (the first Polish X-ray picture) and that of a human hand. Those pictures were found in the Jagiellonian University Archives, Kraków. The information about those experiments was published by "Czas" on January 21, 1896.

At the same time, in the first half of January 1896 in Davos, Switzerland, successful X-ray images were obtained by a Pole Adam Władysław Alexander Rzewuski; these were the first X-ray images in Switzerland.

Lwów was a strong scientific center where physicists conducted experiments with cathode rays. Prof. Franciszek Dobrzyński on July 9, 1890 found that "*electromagnetic waves obtained using Hertz's method permeate wood despite the fact that it is an insulator*"; he realised that "*the waves have the effect on a photosensitive plate as the normal light does; the exposition, however, took about 3 hours*". Dobrzyński presented his findings at the meeting of the Academy of Arts and Sciences in Vienna and published them in the minutes entitled „Ueber die photographische Wirkung der elektromagnetischen Wellen”; his work was also published in English in 1891 in „Philosophical Magazine".

On January 28, 1896 at the meeting of the Lvov Medical Society, prof. Jan Zakrzewski delivered a lecture on X-rays on which he demonstrated his own x-ray image of the compass.

In 1896, in Lwów a monograph on X-rays was published: "Dark light rays, especially roentgen rays in theory in practice". Its author was the physicist professor Zygmunt Korosteński.

On February 18, 1896 the physicist from Warszawa, prof. Wiktor Biernacki, delivered a lecture on X-rays at the meeting of the Warsaw Medical Society illustrated with his own X-ray pictures taken on January 25, 1896. Drawing from his own experiments, Biernacki suggested the use of collimators in the roentgen device.

Prof. Karol Olszewski and his assistant dr. Tadeusz Estreicher took the first Polish X-ray picture out of clinical indications (in a patient referred by the surgeon prof. Alfred Obaliński). On the basis of that picture elbow joint dislocation was diagnosed. On February 11, 1896 "Czas" reported that fact and on the same day prof. Olszewski discussed his experience with X-rays at the meeting of the Naturalist Society in Kraków.

The first polish scientific article on X-rays ("On the use of roentgen rays for diagnostic purposes") in a Medical Magazine was published in Kraków by the surgeon prof. Alfred Obaliński.

At the beginning of February 1896 the first Polish X-ray laboratories were established. In Warszawa, the first one was a private laboratory belonging to dr. Mikołaj Brunner. In Kraków the first X-ray laboratory was established in the University Clinic; it was headed by prof. Walery Jaworski (he was an eminent gastrologist and discoverer of *Helicobacter pylori*). He had considerable achievements using radiological investigations in internal diseases. The most spectacular fact, placing him among the pioneers of the world radiology, was the description of the bile concrements and the first stomach examination with the use of a contrast media - carbon dioxide.

Jaworski presented his conclusions: "*The bile concrements produce shadows only when they are composed of calcium compounds or blood pigment"...*

„In order for the stomach to be well visible we will distend it strongly with soda water or lathering powder. The bright place on the screen corresponding to the stomach will become enlarged and take a shape of a distended bladder".

In the pioneer period of the Polish radiology an important figure was dr. Mikołaj Brunner from Warszawa. He had an excellent medical and physical backgrounds, particularly in the field of electricity. In the co-operation with the engineers Paweł Lebiedziński and Bogdan Zatorski, he made many inventions and improvements (an amplifying screen, a new construction of the tube, static devices and a mercury circuit breaker, a kind of cap and others).
Especially important was the fact of inventing the amplifying screen in 1896 by the engineer Piotr Lebiedziński. The experiments with the use of that invention were presented by Brunner on May 19, 1896 at the meeting of the Warsaw Medical Society: "*I would like to add that the application of those fluorescing substances - cyanogen with barium and platinum or potassium and platinum - onto a plate considerably accelerates the process of obtaining a good picture That discovery was first made by the chemist P. Lebiedziński and slightly later by Prof. S.P. Thompson in London*".

Brunner constructed a cap by means of enclosing the tube in tinfoil, which made it possible to better direct the beam, shorten exposition time and improve the picture sharpness. He also made some innovations of the X-ray tube according to his own design. His numerous publications and lectures on the use of X-rays popularised the high level of radiology of that time.

It was in Kraków, too, that the first Polish textbook of radiology was published in 1900 by dr. Mieczysław Nartowski (Nartowski M.: Roentgen rays and their application for diagnostic and therapeutic purposes. Published by A. Krzyżanowski).

On May 24, 1901 the radiological laboratory in the Warsaw Holy Spirit Hospital started radiological examinations for patients of a paediatric centre (Zakład Leczniczy dla Dzieci, Warsawa) thus initiating the history of Polish paediatric radiology.

In 1907 a rule of isometrics was published, which was a breakthrough in stomatological radiology that which was coming into being; it made it possible to take real-size X-ray pictures of teeth. It was developed by the Pole dr. Antoni Cieszyński in Stomatological Institute of Munich. In 1907 he developed the first atlas of stomatological radiology in the world.

In the following years Cieszyński became a professor of stomatology at the Lviv University. He was the author of many technical innovations, including a X-ray cassette for stereoscopic pictures, a holder for extraoral pictures, holders for intraoral pictures, a measurement device for direct reading the distance between the film and the focus, a cap with a plate making it easier to adjust the main beam for typical pictures of the skull. Cieszyński's activity laid the foundations of stomatological radiology. In 1926 he published his own textbook of stomatological radiology.

A considerable contribution to the development of the world radiology was made by prof. Bronisław Sabat. Initially, he worked in Lwów, and then in Warszawa. He was a precursor of new techniques. In 1911 he developed the method of roentgenokymography that made it possible to record the mobility of internal organs, particularly that of the heart and great vessels. He obtained a patent for it. He described the kymograph of his invention as follows: "*two parallel tape-like metal strips a couple of millimetres apart, having the appropriate thickness so as not to let X-rays through, e.g. lead plates 1 mm thick, one of which is cut transversely in the middle of its length in the direction perpendicular to its longitudinal dimension, are connected in a movable way at the edges in such a way that both halves of the strips can be freely moved apart. A rectangular-shaped gap of any width can be obtained between those two halves by means of moving them over the uncut strip. There is a tape*

of film or photographic paper between those strips which can, using a clock device, be moved at any speed between those strips in the longitudinal direction by means of unwinding them from one cylinder and winding tchem onto the othe other one".
Another method invented by Sabat (in 1929) was endoradiology. In the introduction to his article he described the new method as follows: "*This work is a provisional report on the new roentgenographic method that I have developed, which is based on the fact that a roentgen picture is taken on films that are inserted, using special holders, to the lumen of organs, such as the rectum, stomach or oesophagus*"
Sabat received a thorough education; he studied in Munich under the supervision of W.K. Roentgen and then worked in Henryk Bequerel's, Maria Skłodowska-Curie and Pierre Curie's laboratories in Paris. He obtained a specialisation degree in radiology under the supervision of Guido Holzknecht, one of the pioneers of the world radiology.

From the beginning, the X-ray tube was the heart of every X-ray apparatus, and the quality of the image obtained depended on its quality. The key moment in the development of radiology was the introduction in 1913 of a new type of X-ray tube, constructed by the American physicist William Coolidge. This lamp has become the basis of modern radiology. An innovative solution introduced by Coolidge was the use of high vacuum in the tube and the use of a heated cathode as an electron source. This gave stability of work and the ability to control the amount of electrons emitted. Coolidge filed for a patent for a "hot cathode" lamp on May 9, 1913. At a similar time (even earlier) Julius Edgar Lilienfeld (Polish-Jewish origin) constructed an X-ray tube with a filament that emits electrons. He filed a patent application in 1912 but did not pay the fee. The appearance of a similar type of lamp on the market caused a direct conflict between Lilienfeld and Coolidge (considered the father of the X-ray tube). The Lilienfeld lamp was more complicated and its production ceased.

In 1914 dr Karol Mayer presented the principles of making images using a tomography technique. In his book (Mayer K.: Radiological differential diagnostics of the heart and aorta diseases with the consideration of my own examination methods) in 1916 in Kraków he described the principles and practical uses (tomography images) of that technique, being considerably ahead of the world radiology. Unfortunately, that was not noticed in the scientific world.

In 1914 Mayer patented in Germany his own roentgen tube having two or more anodes

Prof. Karol Mayer was the first Polish radiologist who became a professor. In 1921 he obtained the position of the head of the Chair of Radiology in Poznań University.

At that time in Paris a Pole Maria Skłodowska-Curie (born in Warsaw, on November 1867) was active. She was one of the first women scientists to win worldwide fame. She had degrees (Sorbonne University, Paris) in mathematics and physics. Winner of two Nobel Prizes for Physics in 1903 (with her husband Pierre Curie) and for Chemistry in 1911 (alone), she performed pioneering studies with radium and polonium and considerably contributed to the understanding of radioactivity. She is a truly remarkable figure in the history of science and perhaps the most famous of all women scientists (the first woman in Europe to receive doctorate in sciences, the first woman to win a Nobel Prize for Physics, the first woman lecturer, the professor and head of a laboratory at the Sorbonne University of Paris, the first person ever to receive two Nobel Prizes, the first Nobel-Prize laureate mother of a Nobel-Prize laureate, the first woman who has been laid to rest under the famous dome of Pantheon in Paris).

When World War I broke out she left her laboratory and research work to dedicate herself to radiological diagnostics on the battlefield. The great daughter of the Polish nation wrote letter to the War minister of France, Langvin: "*As I cannot serve my motherland, I will serve my country of adoption*". She established a front-line radiological service which she directed and in which she worked. She organised a network of 200 permanent radiological laboratories as well as 20 mobile car-borne ones, in which about 1,1 million radiological examinations were performed. She organised numerous training courses for doctors and technicians. Skłodowska's activity was of tremendous significance during the war, but it also contributed to the common application of X-rays in French medicine.

Skłodowska has organized radiological courses for American Army radiologists. She was the first woman to receive a Gold Medal from the Radiological Society of North America in 1922, and the American College of Radiology in 1931.

Maria Skłodowska-Curie became an honorary president of III International Congress of Radiology. As the first person she obtained the title of an honorary member of the Polish Medical Society of Radiology.

With the technical progress the number of doctors with radiological experience was becoming increasingly larger. They started to create organisations, circles and societies. The Polish Medical Society of Radiology was established during the XII Congress of Polish Doctors and Naturalists (13-15 July 1925) in Warszawa. Prof. Karol Mayer became its first president.

In 1926 the Society started to issue the scientific magazine "Polish Radiological Review". The first editor-in-chief was professor Zygmunt Grudziński, an outstanding Polish radiologists. He developed a unique method of localising foreign bodies in the eyeball that has been used until now.

In 1927 a uniform specialization training program in radiology was introduced. It was also agreed that a specialist diploma could be obtained after three years of work at an X-ray laboratory and passing the exam. From 1928, compulsory teaching of radiology at medical universities

was also introduced.

Towards the end of the 1920s prof. Adam Elektorowicz from Warszawa started trials with arteriographic examinations. Initially, he performed them in dogs. He used 30% sodium iodide or 50-60% abrodil and thorotrast as the contrast medium. He performed percutaneous puncture of the aorta or the puncture of prepared femoral arteries under general anaesthesia.
At the beginning of the 1930s Oleński, Kieturakis and Szczerbo performed the first cerebral arteriography in Poland in a patient with a brain tumour. It was done in the Stefan Batory University Clinic of Surgery in Wilno.

In 1931-1939 prof. Stanisław Hornung from Lwów introduced radiological diagnostics as routine in the diagnosis of tuberculosis. There, he also organized the mobile unit, which traveled to villages near Lwów with a X-ray machine.

The first Polish devices generating X-rays were assembled with elements from the equipment of physical or chemical laboratories. At the turn of the 19th century mass production devices were started to be purchased, mainly those manufactured by German companies, and later by French and American ones. With the development of X-ray diagnostics attempts to improve and manufacture the devices were made in the Polish territory, too. In 1912 in Warszawa the production of portable devices (Induktor-Progress) was assumed by the company Trojanowski i Markson. A small X-ray device was constructed in 1925 in the company Woźniak. In 1934 in Warszawa a large factory Rurix producing X-ray tubes was established. A number of smaller factories produced roentgen devices, too like that of Jan Babicki, the Borkowski brothers, Zygmunt Lisiecki and Feliks Walkowski.
Besides, in several Polish companies foreign-invented devices were assembled.
There was a number of companies producing accessories of elements of X-ray devices. Many of the products were designed by Polish doctors or engineers. The most interesting ones were the following:

- in 1913/14 prof. Antoni Cieszyński developed a number of devices facilitating radiological stomatological examinations;
- in 1914 dr. Henryk Wachtel developed a localiser used in the case of double picture with the film shift, whereas in 1917 - a bathycopsometer, or a vertical depth scale for X-ray procedures (removing foreign bodies);
- in 1922 Henryk Golberg developed a device for ion tube regeneration;
- in 1925 prof. Zygmunt Grudziński developed a modification of the so-called Peltason's screen that protected the radiologist against the patient coughing during the X-raying;
- in 1925 dr. Józef Jaxa Chania-Dębicki developed a design of a device for radiological examinations in veterinary medicine; the design was presented at the International Congress of Radiology in 1925 in London;
- in 1926 the engineer Jan Bajoński developed a tube designed for high-voltage devices;
- in 1926 the engineer Tadeusz Skrzywan developed a good modification of roentgen transformer; the design was purchased by the company Siemens;
- in 1927 dr Franciszek Woźniak developed a device for the examination of the duodenum;
- Zygmunt Lisiecki's company produced cassettes for X-ray films, a stand for Metalix lamps and a device called pointgraph (it reduced by four times a scheme drawn on the pane of the X-ray screen with a dermatograph);
- in 1935 the radiologist prof. Stanisław Januszkiewicz obtained a for the method of limiting the ionising radiation beam using the visible light, which is now commonly used in the X-ray collimators;
- in the years 1936-39 the grid designed by the engineer Gustaw Choroszczak surpassed foreign constructions in terms of quality.

The first factory of photographic paper in the Polish lands was established by Piotr Lebiedziński in 1888 in Warszawa. Photographic paper used for radiological examinations was manufactured there, too. In 1933 the factory was restructured and modernised (it was called FOTON) - films and reagents used in radiography were produced in it. In 1933-36 in Warszawa the factory FOTO came into being (based on the tradition of the factory of upholstery and paper Franaszek that had existed since 1829), which produced photographic materials.

In the years 1923-24 a chemical factory based in Kalisz produced barium sulphate used as a contrast medium for the alimentary tract examinations. Since 1927 the production was resumed in the company Spies in Warsaw (the preparation called Gelobaryna). That company also produced another agent called Tetracontrast.
In the 1930s the firm Nasierowski i Ska produced contrast agents lipiodol and tenebryl (for urography).

In the 1930s an important role in the development of the Polish radiology was played by prof. Witold Zawadowski in Warszawa. His work „The accompanying paracostal shadows” introduced his name into the world medical literature and became a classical source referred to in many textbooks of radiology world-wide.

In 1931 Polish radiologists were offered a comprehensive and modern textbook „An outline of roentgenology - a textbook for doctors and medical students” by dr. Stanisław Rubinrot.

In 1932 the "Polish Medical Dictionary of Radiology and Phototherapy" edited by prof. Zygmunt Grudziński was published in Warsaw (in Polish, German, French and Latin). It played an important role because it unified the terminology used in everyday work of radiologists as well as didactic and research work.

A very important moment in the history of radiology, and almost unnoticed by historians, was the patented in 1935 by Stanisław Januszkiewicz from Wilno of the original, now widely used in every X-ray apparatus, the collimator with illumination of the examined field.

During World War II, Poland experienced the unprecedented terror of the German occupier. Despite this Poland was subject to underground state structures were established, including secret administration and army. Education, including medical student training, was not excluded from the activity. Secret medical courses were arranged in Warszawa. There were three centres:

Dr Jan Zaorski's Private Vocational School for Auxiliary Medical Personnel. The name not denoting its university character was supposed to mislead the Germans.

Warsaw Secret University,

Western Lands Secret University founded by professors displaced from Poznań.

Radiological laboratories of most university hospitals in Warszawa as well as a number of radiologists were engaged in radiology teaching. The total number of over 3000 students were involved in secret medicine teaching in Warszawa during the war. After the Warsaw Uprising the Western Lands Secret University continued its activity in Kraków. Radiology was taught by prof. Karol Mayer. Having left Poznań, he spent the war time in Kraków where he worked on a project of a "great power missiles".

Another important medical teaching centre during the World War II was the Polish Medical Department of the Edinburgh University, founded in 1941. Radiology was taught by prof. Adam Elektorowicz and dr. Jan Kochanowski, who got there with the Polish army.

The tragedy of Holocaust was not avoided by Polish radiologists of Jewish origin. The example was dr Natan Mesz. Since 1918 he had been the head of the (established by himself) radiological department of the Jewish Hospital in Warsaw. In 1940 he moved with the hospital to the ghetto. In extremely harsh conditions, he kept working until its end doing the diagnostics and teaching students of the Jewish origin who participated in the courses led by the Warsaw University prof. Julian Zweibaum.

During the Second World War radiological laboratories in Poland often had an unexpected role. Owing to their specific character (darkrooms) they were important placed for the resistance movement.

The radiologist dr. Stanisław Matulewicz wrote down the unusual pages of history. Together with another doctor, Sławomir Łazowski, they fought a "private immune war" with the German occupier. During the war, Germans were afraid of infectious diseases, especially typhus. To protect the inhabitants of Rozwadów from being deported to Germany for forced labor, both doctors injected the Proteouse OX-19, a harmless dead strain of bacteria that caused the immune system to produce antibodies indicating typhoid infection, which resulted in a positive Weil and Felix test and disqualified before leaving. In this way, both doctors saved about 8,000 people from being sent to forced labor.

A great blow to Polish radiology was dealt by the Second World War. Many radiologists, including eminent ones, lost their lives. Technical equipment was destroyed and radiological centres were ruined. The losses were evidenced by the fact that of the 200 radiologists working before the outbreak of the war, only 50 remained. During the bombings in September 1939, the FOTON factory was destroyed. Some of her staff took up work in the FOTO factory, where photographic materials were produced during the war. At the same time, false documents were produced on a large scale for the resistance. During the Warsaw Uprising, the Nazis murdered, in the factory courtyard, part of the crew and hundreds of nearby residents, and the factory was almost completely destroyed.

An additional problem after the war was the fact that as a result of the Allied agreement in Yalta, Poland found itself behind the „Iron Curtain” in the area of Soviet influence. Limited contact with world science and lack of access to modern equipment significantly hindered the development of Polish radiology. Nevertheless, it developed as well as possible.

In post-war reality, the radiology service had to organize itself again. The most important task was to fill in the shortages of equipment and staff as soon as possible.

Prof. Witold Zawadowski played a huge role in the post-war history of Polish radiology, who created a training center for doctors specializing in

radiology in Warszawa. It was possible based on the created in 1946, Radiology Chair of the Medical Faculty of the University of Warsaw, of which he became the head. Already in 1947 he organized the first course for radiologists from all over Poland. Thanks to the courses that took place in subsequent years, in 1954 there were already over 500 radiologists in Poland, and in 1959 the number increased to over 600. Among them were 6 professors and 5 associate professors. Acting as a national specialist, Zawadowski contributed to the creation of Chairs of Radiology at all medical universities. A two-stage specialization system has also stabilized, lasting six years in two three-year cycles.

In 1951, prof. Ksawery Rowiński created the Chair of Pediatric Radiology at the Medical University of Warsaw, the first institution of this type in Europe. Pediatric radiology developed in Poland thanks to Rowiński's activities (among others, he organized courses for radiologists).

An important task of the post-war years was to equip radiology laboratories with appropriate equipment. Initially, X-ray machines from the available parts were repaired and assembled on their own. Deliveries via UNRRA (United Nations Relief and Rehabilitation Administration) that reached Poland in 1945-1948 became a breakthrough.

One of the most important health problems in post-war Poland was the tuberculosis epidemic, which reached such proportions that it became a real social disaster. According to statistical data for 1945 and 1946, 39 thousand died of tuberculosis in Poland and 234 thousand people were sick. This has become a real challenge for both Polish pulmonology and radiology. To control the situation, a network of anti-tuberculosis outpatient clinics was organized, of which there were about 650 in 1947, but only 143 facilities at that time had X-ray laboratories. 14 so-called moving groups for mass, 35mm lung examinations were also organized. Special railway wagons with 35-mm x-ray machines were also installed. Dr. Alexander Schreiber played an important role in this respect. In 1950/1951, 35mm chest flourography became mandatory.

Although radiological examinations for the purposes of neurology or neurosurgery were carried out before 1939, yet the origin of Polish neuroradiology is associated with the activity of prof. Stanisława Spettowa. During her 26 busy years of work (since 1946) in the Kraków University Hospital she created the Polish school of neuroradiology. She introduced to the world bibliography, along with the neurosurgeon prof. Adam Kunicki, the term "brain medial area tumor".

In 1949 dr. Edward Matuszek from Warszawa presented his method of obtaining "layer films of any desired curvature or the refraction of the cross-section area" (he started this method at the end of the 1930s. but the war delayed his studies). He presented tomograms of the curvatures of the plaster model of the facial skeleton taken with the use of a device of his own construction. In his device the object investigated and the X-ray film were movable, whereas the source of radiation was immovable. His disease made it impossible for him to continue his studies; as a result, dr Matuszek withdrew from professional activity; he died in 1952. Unfortunately, his disease as well as the difficulty in foreign contacts at that time („Cold War") resulted in the fact that his achievements failed to be commonly applied, whereas they were ahead of the introduction of pantomography by Paatero from Finland in the 1950s.

In 1949, in Warszawa, the reconstruction of the destroyed FOTO factory was completed, which was named FOTON Warsaw Photochemical Works. X-ray film production began there. Production of the contrast media, ion intravascular agent Uropolinum and agents for the examination of the alimentary tract – Baryt, began, too.

In 1954 the FAREL (later FARUM) X-ray and Electromedical Apparatus Factory was established. The production of x-ray machines of Polish construction started there. At that time, radiological laboratories were also equipped with apparatus produced in East European countries (East Germany - TUR, Hungary - Medicor, and Czechoslovakia – Chirana).

Organizing a dose measurement system was extremely important from the point of view of both the safety of patients and the staff of the radiology laboratories - taking into account the different quality of X-ray machines at the time. This was possible thanks to the activities of Cezary Pawłowski, who had been working at the Faculty of Electrical Engineering since 1946, and later at the Faculty of Communications of the Warsaw University of Technology where he managed the Department of Radiology. The Medical Electrical Engineering Section he created was one of the first in the world to educate in techniques used in medicine. Pawłowski organized the Central Laboratory of Radiological Measurements.

In the years 1947-81 the head of the Department of Radiology of the Institute of Oncology, in Warszawa was prof. Janusz Buraczewski. He established the Polish school of oncological radiology. Along with dr. Dąbska, he was the co-author of the first work on the symptomatology of aneurysmal bone cyst in the world (Dąbska M., Buraczewski J. Aneurysmal bone cyst -pathology, clinical course and radiologic appearances. Cancer 1969, 23:371).

In the early 1960s Buraczewski started xerographic examinations. They were performed using the Xerofot-Piast device, constructed along with the staff of the Chair of Physics, the Warsaw University of Technology. In the 1975 he introduced xeromammography. He was the editor of the monograph "Radiodiagnostics of neoplastic lesions".

In the 1950s in Warszawa, dr. Janusz Bowkiewicz created the first centre for angiographic examinations in Poland. From 1959 he organised training courses for radiologists.

The next stage was interventional radiology. In 1967 dr. Zygfryd Wawrzynek performed in Katowice, as the first one in Poland, the restoration of patency of the femoral artery using Dotter's method with the use of his own set of instruments. The results were published in 1968; it was the first publication on that subject matter after that by Charles Dotter.

Ultrasound examinations were performed in Poland as early as the 1960s (mainly in obstetrics and gynaecology). A considerable contribution to the world ultrasonography was made by team headed by prof. Leszek Filipczyński from Warsaw. In 1966 a Polish ultrasound machine was produced. In 1969 the first ultrasound imaging of the eye was performer. Filipczyński was a precursor of the Polish school of ultrasound applications in medicine and biology. Under his leadership both the first in the world ultrasound of the eyeball was performed as well as ultrasound measurements of arterial blood flow. He was also the undisputed global authority in his field. He has received a number of prestigious awards such as the "Pioneer of Ultrasound in Medicine" (World Society of Ultrasound in Medicine and Biology), honorary membership of the American Institute of Ultrasound in Medicine and honorary membership of the International Academy of Engineering in Medicine and Biology.

In the years 1972-1973 the "Techpan" experimental group of the Institute of Fundamental Technological Research of the Polish Academy of Sciences in Warszawa and its branch in Puławy was established. Design and small-lot production of ultrasound equipment with the main focus on medical equipment was started. In 1977, the first ultrasound machine (with a pantograph arm) was created; in the following years more and more technologically advanced units were constructed.

In the 1970s the then state-of-the-art angiography units were purchased for the main university centres. That resulted in the development of angioradiology and interventional radiology. In 1972, at the Medical University of Lublin, at the initiative of prof. Marian Klamut, the first independent Interventional Radiology Department in the country was established. This institution played an important role in popularizing this branch of radiology in Poland.

The first computed tomograph in Poland was installed in the Department of Radiology at Poznań Medical University in 1979. The new technique immediately found recognition, and Polish radiologists mastered it very quickly, both in clinical practice and as a tool for scientific activity.

The prototype of the mathematical theory used in computed tomography software was developed in 1917 by the Austrian mathematician Johann Radon. However, Cormack (one of the creators of computed tomography) was also based on a method (algorithm) of finding an approximate solution of systems of linear equations with a large number of variables (iterative algorithm), whose creator was, in 1937, the Polish mathematician Stefan Kaczmarz.

In 1989, there was a political, social and economic breakthrough in Poland. As a result of the reform called the "Balcerowicz Plan", the official dollar (and other currencies) exchange rate was adjusted to market value. This stabilized the economic situation in Poland and allowed the transformation of the Polish economy into a free market system, which opened the way to easier purchase of equipment from any global manufacturers. The world also opened up to the Poles, when passport restrictions were lifted, soon everyone could have a passport in their own drawer. Moreover, a number of countries have begun to abolish the obligation to have visas for Poles. The greater accessibility of the world has made it easier to contact global radiology, and has also allowed the world to see the achievements of Polish radiologists. In 1991, prof. Bogdan Pruszyński from Warszawa, received an honorary membership of the Radiological Society of North America.

In 1991 two MR systems were installed in Warszawa as first ones (Departments of Radiology at Railways Hospital and Neuropsychological Institute) in Poland. It is worth mentioning here that prof. Andrzej Jasiński and his group at the Department of Radiospectroscopy at Institute of Nuclear Physics in Kraków started MR research in Poland by building first experimental MR system in 1985. The system was based on a 0.6 T permanent magnet with a gap of 60mm with a home built MR console in CAMAC standard, interfaced to a minicomputer with a software system developed in house. First good quality MR images of plants and small animals were obtained in 1986. The system was upgraded in 1992 to a MR microscope based on a 6.3T/53mm vertical bore superconducting magnet.

An important technique that had just begun to develop was DWI (magnetic resonance diffusion). Jasiński has made great contributions in its development. His group received the main prize (Magna cum Laude) at the European Congress of the Magnetic Resonance in 1997 in Brussel.

The path that enabled the emergence of a magnetic resonance imaging method using imaging diagnostics was initiated by Isidor Isaac Rabi who received the Nobel Prize in 1944 for developing a method that allows measuring the magnetic properties of atomic nuclei. Rabi was born in Rymanów, a small Polish town

In 1995, at the centenary of the discovery of X-rays the 34th Congress of the Polish Medical Society of Radiology was held in Łódź. On that occasion a reprint of Roentgen's first report, translated into Polish by dr. Stanisław Srebrny and published (January 30, 1896) as a booklet, was issued.

In 1996 the centenary of the Polish radiology was celebrated (it came into being in January 1896 in Kraków) by the organisation of an exhibition in the Jagiellonian University Museum in Kraków.

Polish engineers Sławomir Szwed, Jerzy Goździk and George Grabowski made an interesting contribution to the history of radiological technology. In 1997, they designed a new solution for the angiograph movement. In the known and widely used design of the floor positioner for the lamp-image intensifier set, called LC, the arm L was cut at the base and a swivel joint was installed at this point. In this way, an additional degree of freedom of movement was obtained. Thanks to computer control of rotational movements, the linear movement was precise and repeatable. The authors called the new solution a „scissor”. The prototype of the angiograph with the new type of positioner was presented in 1997 at the exhibition accompanying the international cardiological conference in New Orleans. In 2001, George Grabowski created a separate company (International Medical Design) in which two angiographs of new design were produced. In 2003, one of them went to the angiographic workshop of the Institute of Psychiatry and Neurology in Warszawa, where it successfully worked for several years. Despite the success, the designers did not submit a new solution to the Patent Office. In 2007, Toshiba Company introduced to the market an angiographic apparatus with an LC positioner with an analogous design as used in the "scissor". For this solution, it received the prestigious award of the Frost & Sullivan organization for the most innovative solution of the year.

In 1998 the first teleradiology and RIS systems (soon upgraded with PACS) in Poland were installed at the Department of Radiology - Kraków University Hospital.

In 1999 a thorough reform of the specialisation training system in radiology was implemented (among other things, a unified central exam, and since 2003 a practical exam by means of computer monitors presented images).

In 1999 the Polish Radiology website - www.polradiologia.org - was created.

The 20th century ended the monograph "The history of the Polish radiology against the background of the world radiology" edited by prof. Stanisław Leszczyński from Warszawa.