ONE CENTURY OF URORADIOLOGY IN EUROPE: 1896 – 1996
Section 1: the time of progenitors

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I'm looking for an honest man!" Diogenes of Sinople.

Pasteur said *"Chance smiles on well-prepared brains"*. Wilhelm C Roentgen and his immediate followers [1,2,3,4,5] had to be expert in three associated technologies - photography, physics and medicine - to obtain a picture of an anatomical volume irradiated by an X-ray beam which had been produced by a glass Crooke's tube excited by a power battery (Fig 1). Information about Roentgen's brilliant but serendipitous discovery spread rapidly throughout the world after January 5th, 1896. In Europe, urolithiasis was then a common disease and looking for calculi became one of the first radiological challenges everywhere [6,7].

THE FOREFATHERS OF URORADIOLOGY: FERNAND-JOSEPH CHAUVEL AND JOHN MACINTYRE.

Uroradiology was born on April 21st 1896, when Félix Guyon [8] presented the radiological appearance of urinary and biliary stones, seen as a *"black spot"* in surgical specimens, noted by his resident, François-Joseph Chauvel, and a physicist, James Chappuis, at the *Académie Nationale de Médecine* (Fig. 2&3). Chauvel and Chappuis, with Varnier and Fünck-Brentano, already had performed the first French radiography of a foetus at the Clinique Baudelocque that was announced on March 10th, 1896, by Pinard [9]. A clinical case report of a renal calculus came several months later from John Macintyre of Glasgow, Scotland [10]. Three years later, the first similar French clinical case was reported by Albarran and Contremoulins [11], who had refined their

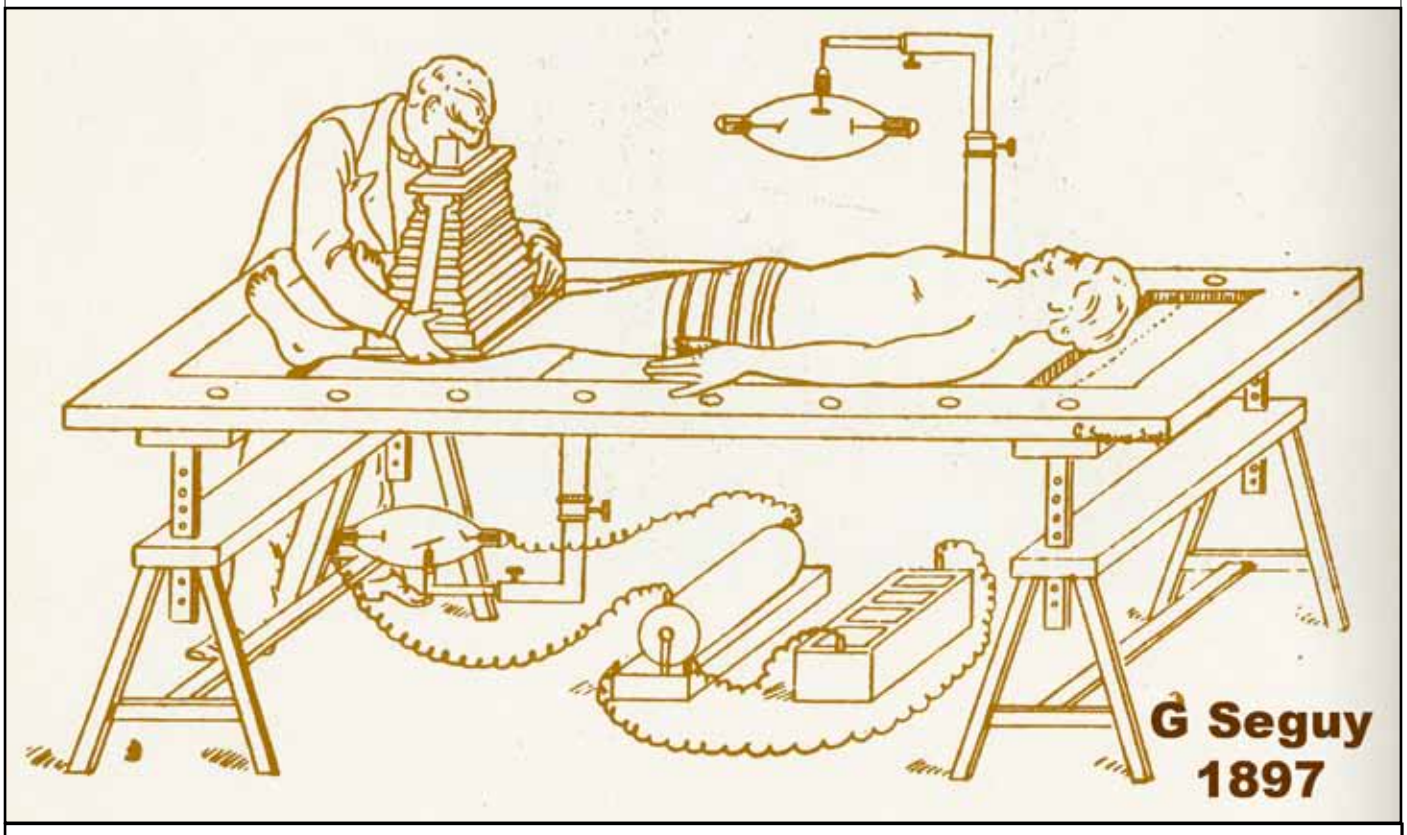


Fig 1. Radiology in 1897. (Drawing by G Seguy, by courtesy of *Bibliothèque du Centre National des Arts & Métiers*, Paris)

technique of X-Ray production after showing the effects of different degrees of heating of the X-Ray tube during production of the X-Rays. In 1902, Albers-Schönberg [12] of Hamburg suggested a compression device to avoid pitfalls caused on plain films by intestinal gas.

FIRST STAGE (1896-1931): URORADIOLOGY WAS A UROLOGIST'S HOBBY.

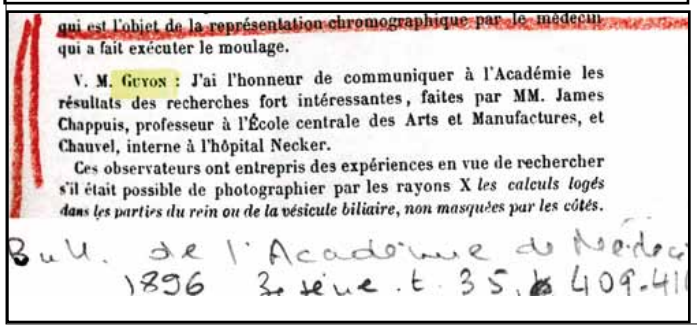
For almost half a century, the development of uroradiology was a part of pure urological research, first at the Hôpital Necker in Paris, and later in Hamburg and Berlin [7]. In 1897, the first four radiological laboratories were created in Paris, in new hospitals or buildings already equipped with electricity [3,4]. Antoine Béclère [3] moved from Hôpital Tenon to the new laboratory at Hôpital Saint-Antoine. The renowned professor Félix Guyon (1831-1920) installed a large and sophisticated laboratory in the Clinique Urologique at the Hôpital Necker [6]. It was designed and directed by the first official French «radiographer», Gaston Contremoulins (1867-1950), who had previously been the photographer for the physiologist Etienne-Jules Marey, a pioneer of chronophotography and of cinematography [13].

A major literature review in 1995 by the American uroradiologist Howard Pollack [7] suggested that the surgeon Théodore Tuffier [14] was the first to pass a radiopaque catheter through the ureteral orifice in the bladder into the ureter (Fig. 4). However, Tuffier was indebted to Guyon's cystoscopist Janet who was expert at ureteral catheterisation [15].

Joaquin Albarran (1860-1912) may well be the professional uroradiologist's first ancestor [6,16] (Fig. 5). Born in Cuba, where he has become a national hero, and then trained in Barcelona, he spent his professional life at the Hôpital Necker under Guyon's chairmanship. In 1897, he invented a revolutionary cystoscope (*Albarran's level*). He also stimulated local radiological research facilitated by Contremoulins' laboratory and the chemical investigations of Marcel Guerbet, a young pharmacy resident. Albarran was nominated for the Nobel Prize in 1912 but he died just before the election. The first ureteric catheters were radiolucent and mounted around a lead wire and later the catheter walls were made of radiopaque compounds. In 1914, the urologist Pasteau invented a catheter which included

Fig 2. Félix Guyon (in black) and his staff (Albarran and Legueu at his right) at the Hôpital Necker. (by courtesy of Photothèque de l'AP-HP, Paris)

Fig 3. First communication from Guyon, Chappuis & Chauvel (Facsimile, by courtesy of the Académie Nationale de Médecine, Paris.)



qui est l'objet de la représentation chromographique par le médecin qui a fait exécuter le moulage.

V. M. Guyon : J'ai l'honneur de communiquer à l'Académie les résultats des recherches fort intéressantes, faites par MM. James Chappuis, professeur à l'École centrale des Arts et Manufactures, et Chauvel, interne à l'hôpital Necker.

Ces observateurs ont entrepris des expériences en vue de rechercher s'il était possible de photographier par les rayons X *les calculs logés dans les parties du rein ou de la vésicule biliaire, non masquées par les côtés.*

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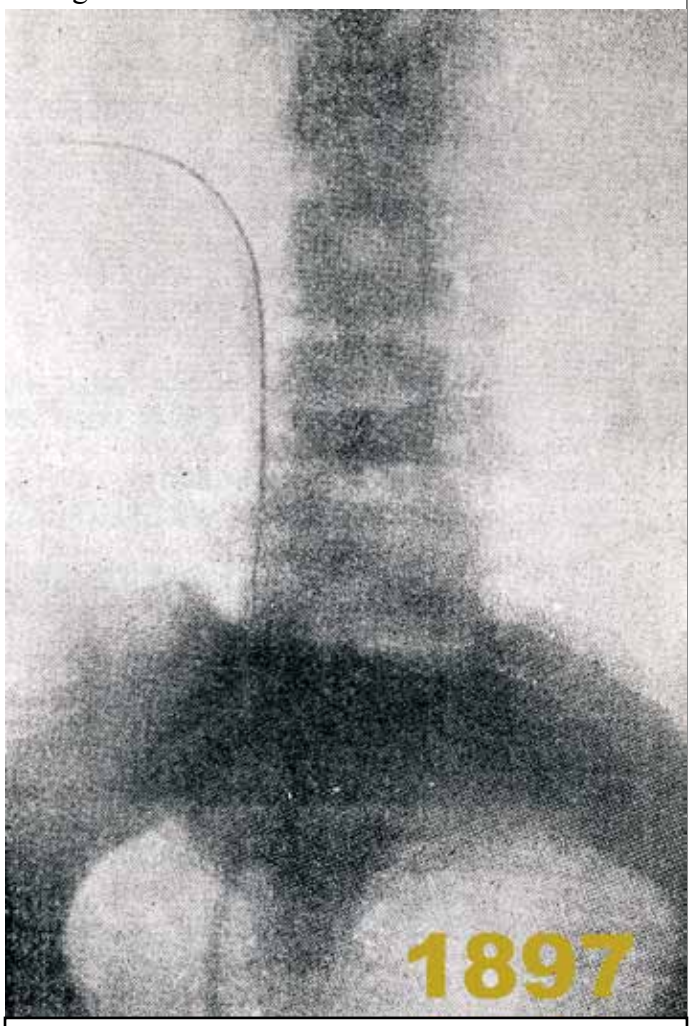

Fig. 4. First radiopaque catheterism of the ureter by Tuffier (by courtesy of Masson & Cie)

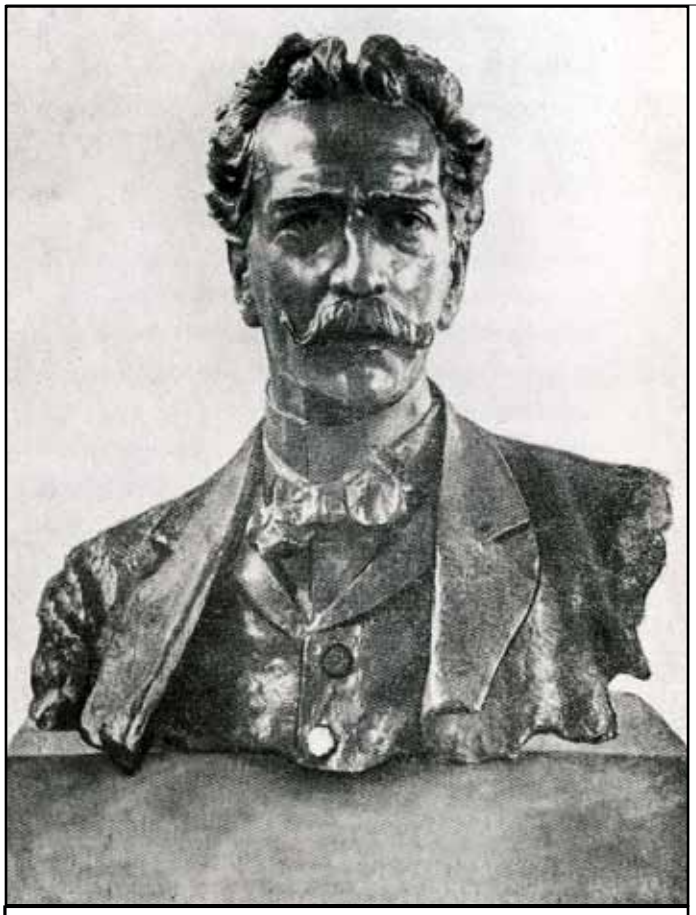

Fig 5. Joaquin Albarran

a semi-opaque centimetre scale to localise stones precisely [17] (Fig. 7).

At the beginning of the last century, urologists developed surgical treatments for prostatic adenoma. They also had to treat stenoses of the urethra caused by urethral infections, which were common, and by urethral trauma. Uroradiology pioneers therefore undertook radiography of the lower urinary tract using a variety of media some of which look rather alarming to modern eyes [7].

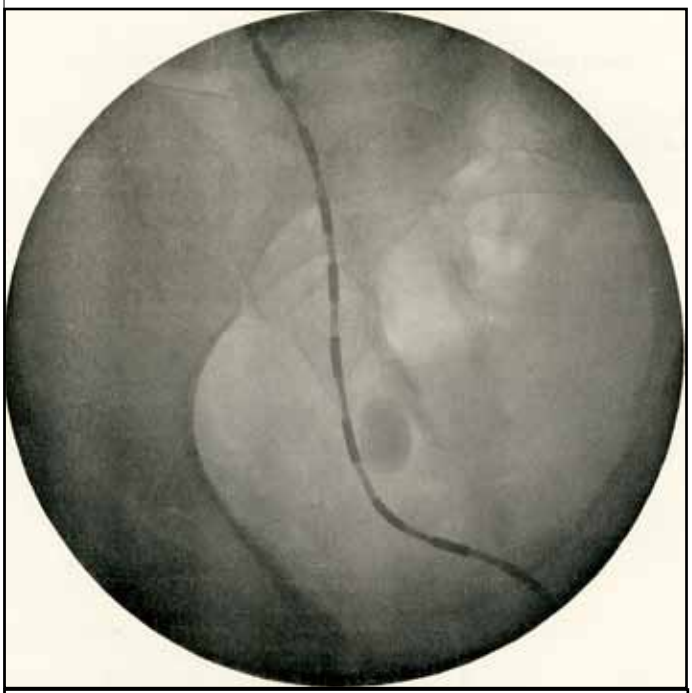

Fig. 6. Localisation of a calculus with Pasteau's graduated catheter. (1914, by courtesy of Masson & Cie, Paris)

Gas (air, oxygen and carbon dioxide) was used in radiology throughout the twentieth century. According to Pollack [7], in 1903 Wittek injected air into a bladder to visualize a calculus. In 1905, Wulff - who was against air injection - and Albers-Schönberg of Hamburg first used air and bismuth for cystography. Injection of gas into the peritoneum and the retroperitoneal space were used for many years until CT-scanning became available. In 1920, Robert-Théophile Coliez's medical thesis [18] was on artificial pneumoperitoneum which had been suggested in 1914 by Rautenberg [7]. In 1921, Carelli and Sordelli [19] of Buenos Aires, Argentina, suggested gas injection into the retroperitoneum to obtain a better view of the renal outlines.

From 1906, the German urologists Voelcker, von Lichtenberg and his pupil Czerny investigated bladder opacification with a variety of radiopaque compounds: bismuth, lithium, silver (Collargol®) and then thorium in 1914 [7]. Under their influence, Albarran developed retrograde pyelography to improve his surgical operations [20]. Albarran's successor Félix Legueu (1863-1939) and Papin worked with a radiologist, Maingot, to publish the first French book dedicated to the radiological evaluation of the urinary tract [21]. In the same year, another radiologist, André Lomon, published a book on general radiology which included a good radiograph of a calculus of the pelvic ureter, but he had to use an exposure time up to one minute to obtain an interpretable film [22]. Radiography was improved when World War 1 and the American army brought the powerful and more reliable Coolidge X-ray tube and, later, the Potter-Bucky to Europe [3,4,5].

1920-1928: A disruptive decade when the saga of Iodine started serependitously.

The halogen iodine had been used since the nineteenth century to prevent and to treat atherosclerosis and rheumatism. Marcel Guerbet, a French chemist and pharmacist at the Hôpital Necker, who was looking for a non-toxic iodinated compound which could be injected safely, was inspired by a German oily compound (Iodipin®, Merck Darmstadt) which combined iodine and chlorine [23]. He synthesized an iodinated oily ester, patented as Lipiodol®, in 1901. Jean-Athanase Sicard (1872-1929), neurologist at the Hôpital Necker, suggested that this compound could be used for radiological opacification [24]. His resident, Jacques Forestier (1890-1978) first showed

this serependipitously in 1921 by injecting Lipiodol into the lumbosacral paravertebral space in a arthritic patient who by chance had a plain film soon after [25]. Instead of a fixed opaque spot Forestier saw a mobile collection of radiopaque globules in the subarachnoid space (Fig 7). This observation led to the birth of modern neuradiology. Lipiodol bronchography, hysterosalpingography and fistulography were also successfully used for several decades. In the urinary tract, Lipiodiol was used for retrograde urethrography but, since it was a fatty emulsion, it was unsuitable for intravenous urography [26].

Fig. 7. Jacques Forestier performing intradural injection (by courtesy of Masson & Cie (21).
Fig. 8. Forestier lecturing in 1926 for three months in the USA promoting Lipiodol spoke in Denver Colorado. (by courtesy of J. Arlet (20)).

However the universal success of Lipiodol (Fig. 8) led to an intensive search for a watersoluble iodinated compound which could be injected intravascularly. Sodium iodide was already known as a contrast medium [7]. In 1923 at the Mayo Clinic, Rochester, Minnesota, the pharmacist Rowntree discovered, also serependipitously, the first faint excretory cystogram in a syphilitic patient who had been treated with sodium iodide and had a radiograph of the pelvis taken shortly after the injection. Osborne *et al.* at the Mayo Clinic conducted a trial in a series of similar patients but failed to obtain satisfactory renal images after a 200ml-IV-injection of sodium iodide [27]. In 1924, Graham and Cole, influenced by Osborne's work, used iodinated phenolphthalein, which was much better tolerated than the bromide phenolphthalein used previously, for intravenous cholecystography [28].

During the same decade the Portuguese school of radiology at the University of Coimbra, led by the future Nobel Prizewinner, Egas Moniz, did the first carotid angiograms with sodium iodide [3,4,]. In 1928 Reynaldo Dos Santos (1876-1970) introduced translumbar aortography [29] (Fig. 9). Both of them soon changed to Thorotrast® until its carcinogenic properties were recognised in the 1950s.

Urologists were not satisfied with a single static picture of the urinary tract obtained using by retrograde techniques. Legueu *et al.* in the 1920s developed a method of taking a dynamic sequence of radiographs of the pelvicalyceal system when it had been opacified with sodium iodide [30]. However, their *pyeloscopy* still required catheterisation of the ureter at cystoscopy (Fig. 10).

The synthesis of watersoluble iodinated organic compounds was finally achieved in Berlin during 1928-1929, the worst years of the century from an economic standpoint, with the Deutschmark being massively devalued every day. Moses Swick (1900-1985) and Alexander von Lichtenberg (1880-1949) were the winners of the race for Intravenous Pyelography, but not without some controversy [7] (Fig. 11 and 12).

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SPECIAL MEETING

Denver County Medical Society

Monday, January 11th, 1926

at 8:00 P. M. sharp

THE USE OF LIBIODOL.

By Dr. J. Forestier, of Paris, France

Dr. Forestier will talk upon the use of Libiodol in various lung conditions for the injection of the nasal accessory sinuses, the spinal cord and the uterine cavity. His talk will be in English and will be illustrated by lantern slides. Dr. Forestier is a distinguished internist of Paris and is a pioneer in this work.

Entered as second-class matter March 9, 1911, at the post-office at Denver, Colorado, under the act of July 16, 1894

1928-1931: Starring Intravenous Pyelography.

In 1928, a young American urologist, Moses Swick, was doing a research fellowship studying antibacterial

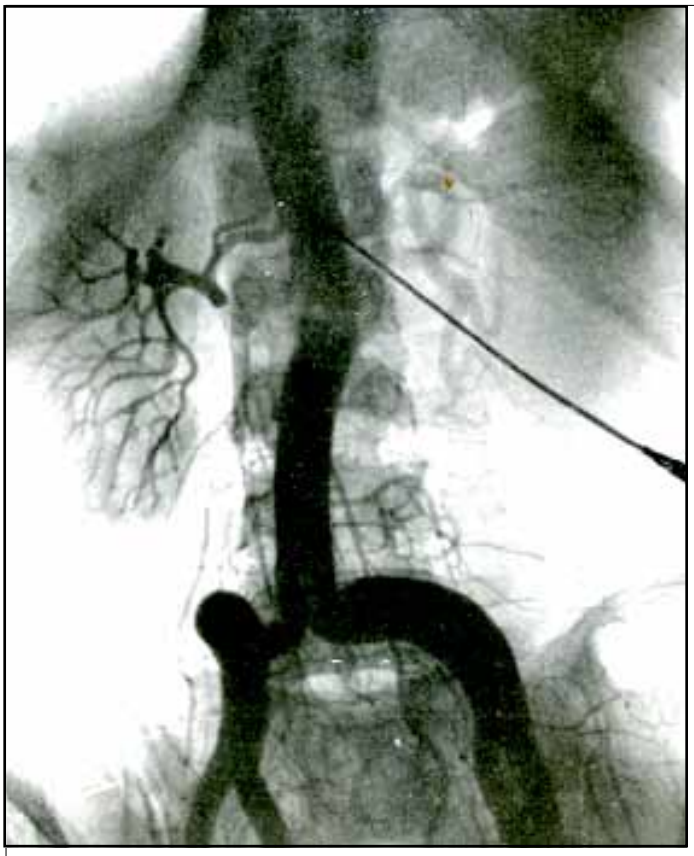


Fig 9. Translumbar aortography in a patient presenting with a left renal sarcoma treated by Legueu at the Hôpital Necker in 1931. (author's collection).

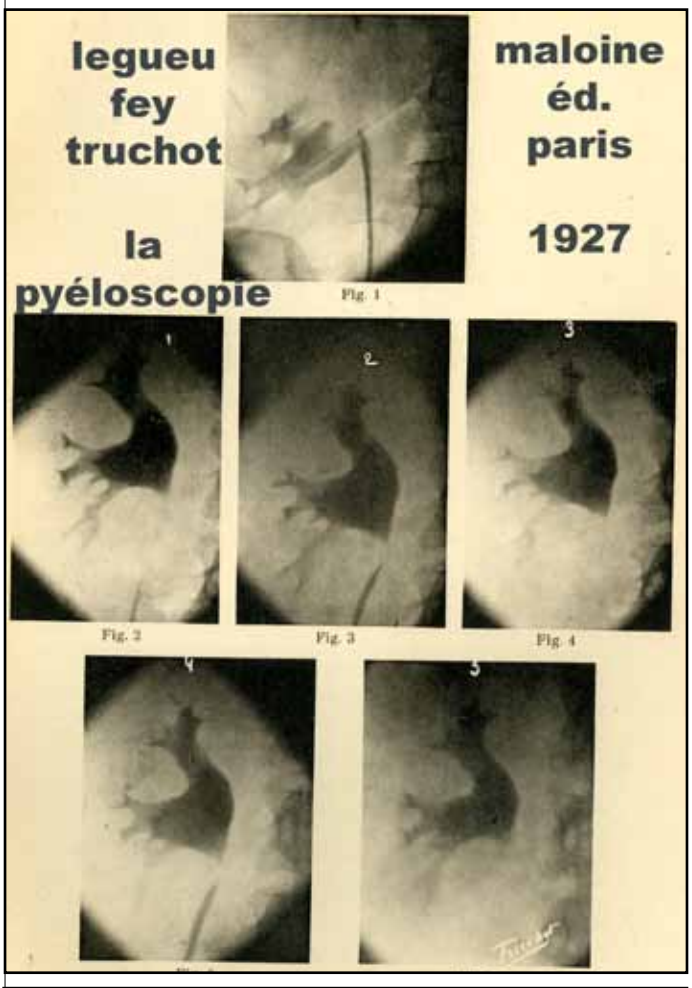
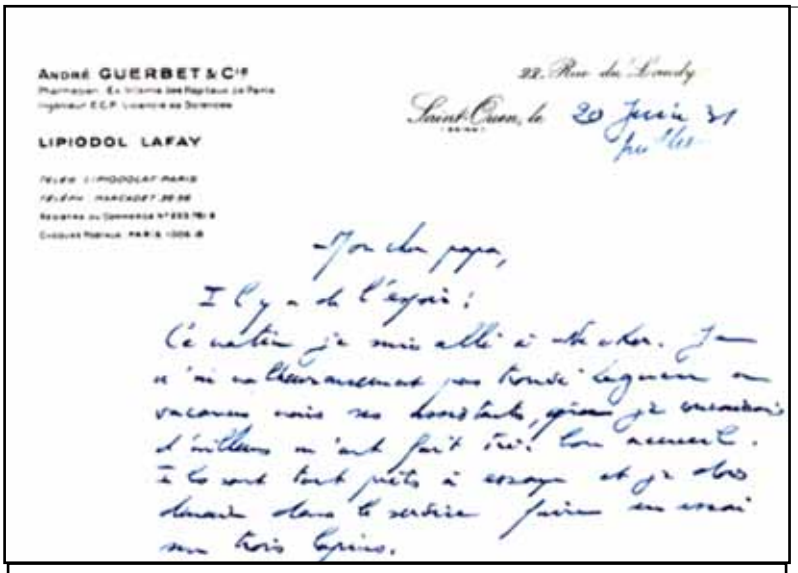


Fig 10. Pyeloscopic sequence by Legueu *at al*. at the Hôpital Necker. (author's collection).

Fig. 11 & 12. Moses Swick and Alexander vonLichtenberg. http://urologichistory.museum/content/collections/uropeople/

drugs at the internist Leopold Lichtwitz's Clinic in Hamburg, Germany [7]. Lichtwitz advised him to move to Berlin where the chemists Binz and Rath were synthesizing new benzoic acid molecules containing atoms of iodine. While evaluating the first compound (Selectan neutral®) in rabbits, Swick shrewdly obtained radiographs which showed urograms. His chairman Alexander von Lichtenberg was lecturing in the USA so Swick alone took the responsibility of giving several injections of Selectan to patients and intravenous pyelography (IVP) was born [31]. This led to an immediate conflict with von Lichtenberg who was the powerful chairman of the largest urology department in the world, which had recently opened at the St.-Hedwig-Krankenhause in Berlin. Alexander von Lichtenberg was a Hungarian aristocrat who had become fascinated by


André GUERBET & Cie

LIPIODOL LAFAY

22, Rue du Landy

Saint-Ouen, le 20 Juin 31

Fig. 13. Letter dated on June 20th, 1931, from André Guerbet to his father (by courtesy of Dr Michel Guerbet).
«Dear Dad,
«This is a day of hope!
«This morning I went to the Necker. I couldn't meet with «Legueu who was in holydays but I was warmly welcomed «by his assistants whom I know by the way. They're «ready to try [Ténébrix]*and I have to go to-morrow in «the department with three rabbits…»* (author's translation)

opacification of the urinary tract since he worked on opaque cystography with Voelcker in Heidelberg in 1905. He had also been involved in the introduction of silver suspension to delineate the pelvicalyceal system. He found it difficult to accept that a young American alone should take the credit for discovering intravenous pyelography. Von Lichtenberg started an official study of what he termed *Excretory Urography* using Uroselectan [32]. This new technique was immediately accepted in the Western world as a major advance.

Within two years, the German chemical industry introduced the family of diiodinated benzoic acid molecules: Schering AG: Uroselectan B®, soon replaced by Diodone; Bayer: Abrody®. Marcel Guerbet and his son, André, invested the fortune earned from Lipiodol into the synthesis of their own diiodinated molecule, Tenebryl®, just in time to be available in 1931, a crucial year for uroradiology

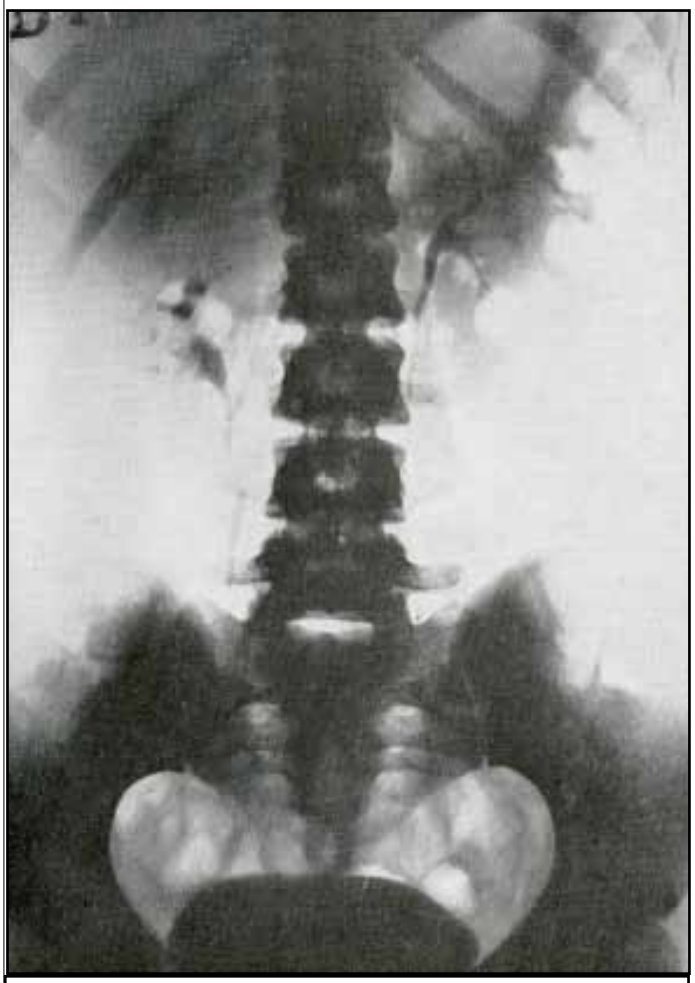


Fig 14. Normal intravenous urography by Tendoja[35]. (by courtesy of *Centre Antoine Béclère*)

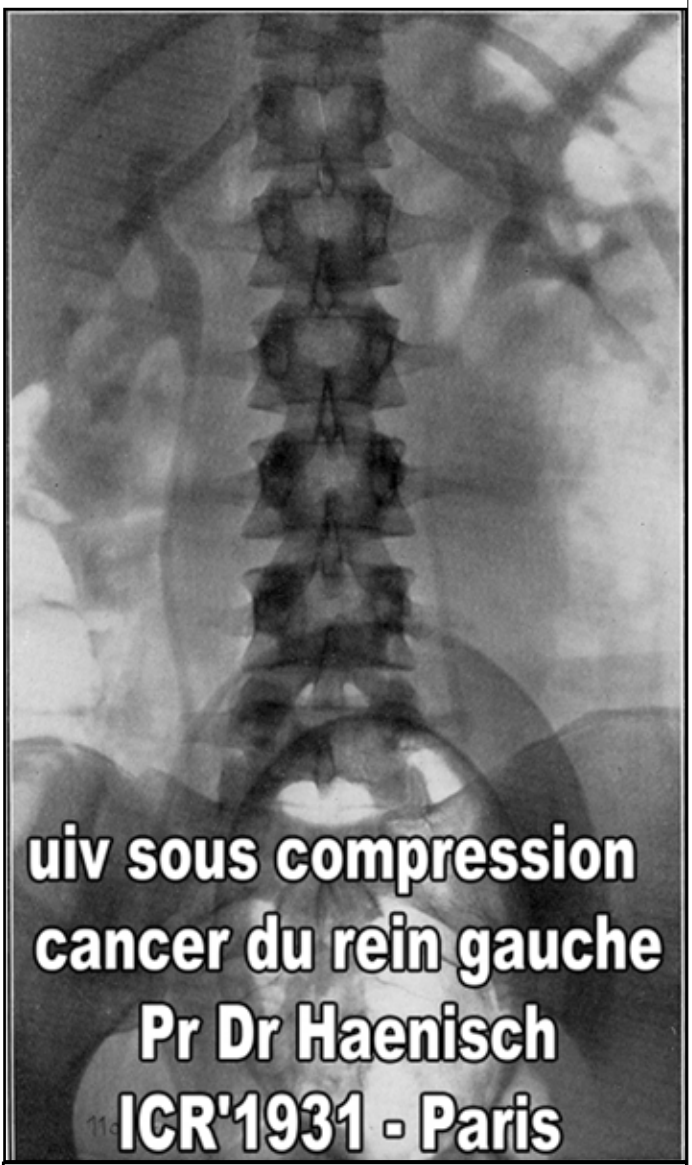


Fig 15. Excretory urography with ureteric compression by Haenisch[32]: tumour of the left kidney.
(by courtesy of *Centre Antoine Béclère*)

[33] (Fig 13).

In 1931 Antoine Béclère, president of the IIIrd International Congress of Radiology in Paris, selected *Urography by excretion* as one of two hot topics for the diagnostic program [34] (Fig 14,15,16). Germany was still handicapped by the sequelae of the economic crisis and all but three German radiologists were unable to attend the congress. Although von Lichtenberg could not be present, his abstract based on 2000 examples of excretory urography with seven different media was printed in the proceedings without figures [35]. Fedor Haenisch of Hamburg reported 17 examples of excretion urography with Abrodyl, most of which are still interpretable [36]. Paul Rosenstein [37] of the Judischen Krankenhaus, Berlin, described seven studies of similar quality, one of which was actually a rectal urogram obtained with an Abrodyl enema! (Fig.17) and Tandoja [38] of Naples presented good images from five patients obtained with Uroselectan B. Although Legueu *et al.* expressed their interest in excretory urography, they still favored routine pyeloscopy [39]. In 1931 von Lichtenberg published a paper titled "*The principles of Intravenous Urography*" in the Journal of Urology (Baltimore) [40]. Despite the breakthrough that these early reports represented, they also showed that diiodinated molecules could not produce dense urograms. In 1930 Coliez got the idea of a compression device when he saw ureteric dilatation in a pregnant woman [41]. Rosenstein credited his radiologist, Zeigler, with the same invention [37].

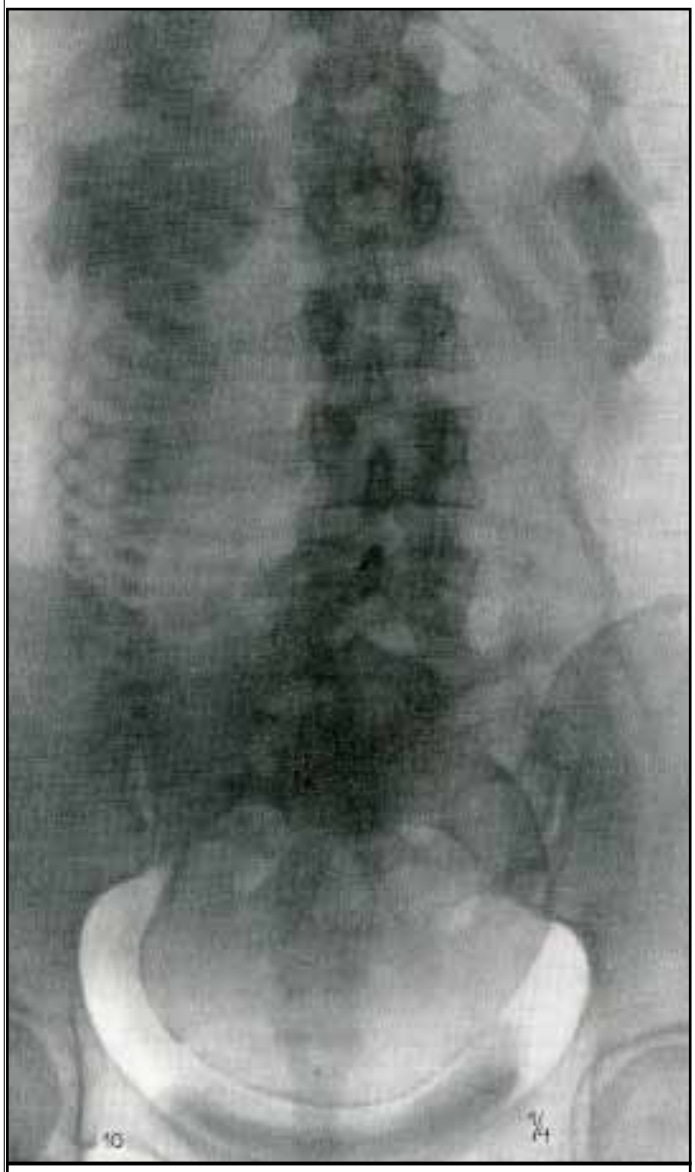


Fig 16. Urography by excretion in a pregnant woman, by Haenisch[32]. (by courtesy of *Centre Antoine Béclère*).

SECOND STAGE (1931-1960): URORADIOLOGY INVOLVED A UROLOGIST, WITH OR WITHOUT A RADIOLOGIST .

In the 1930s the Hôpital Necker was challenged by the new Clinique Urologique at the Hôpital Cochin, Paris, created by Maurice Chevassu (1877-1957) [16] (Fig 18). This also led to the decline of Guyon's school of urology because of disagreements after Albarran's premature death between his three pupils, Legueu, Marion and Chevassu. Excellent urology and uroradiology departments developed throughout

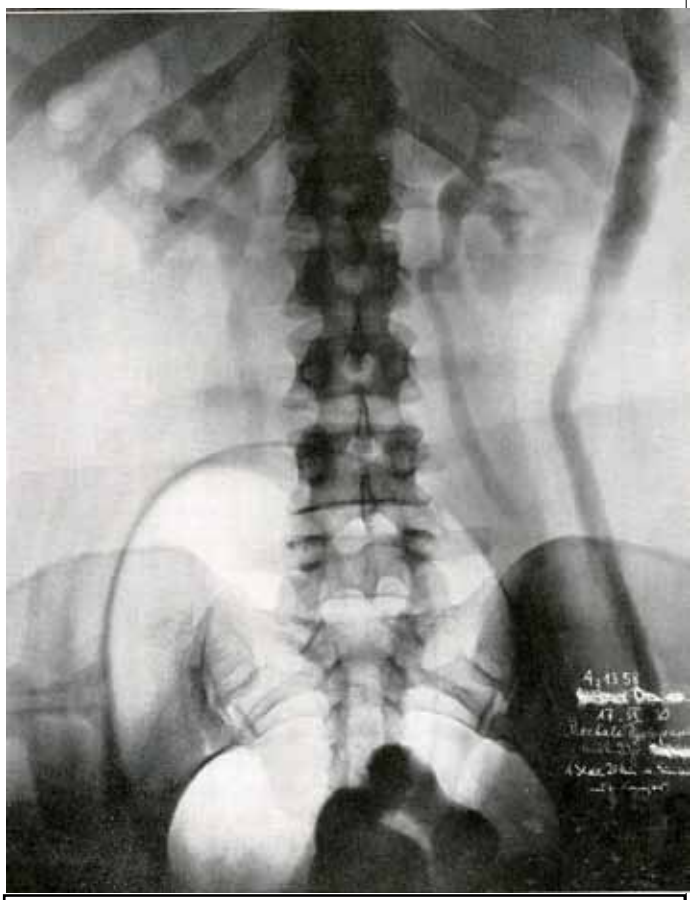


Fig. 17. Rectal urography by Rosenstein and Ziegler[33] presented at ICR'31 (20ml-enema with Abrodyl). (by courtesy of Centre Antoine Béclère)

Europe and also in the USA mainly at the Mayo Clinic, under William Braasch and Johns Hopkins Hospital in Baltimore under Hugh Young [7].

Retrograde UreteroPyelography (RUP).

From 1928 to 1932, Maurice Chevassu, using his olive tipped catheter, the so-called *sonde-bouchon*, at the Hôpital Cochin, improved the technique of retrograde ureteropyelography catheterisation [42]. This type of catheter remains in clinical use (Fig. 19).

IVP or RUP?

Even after WW2, many urologists preferred

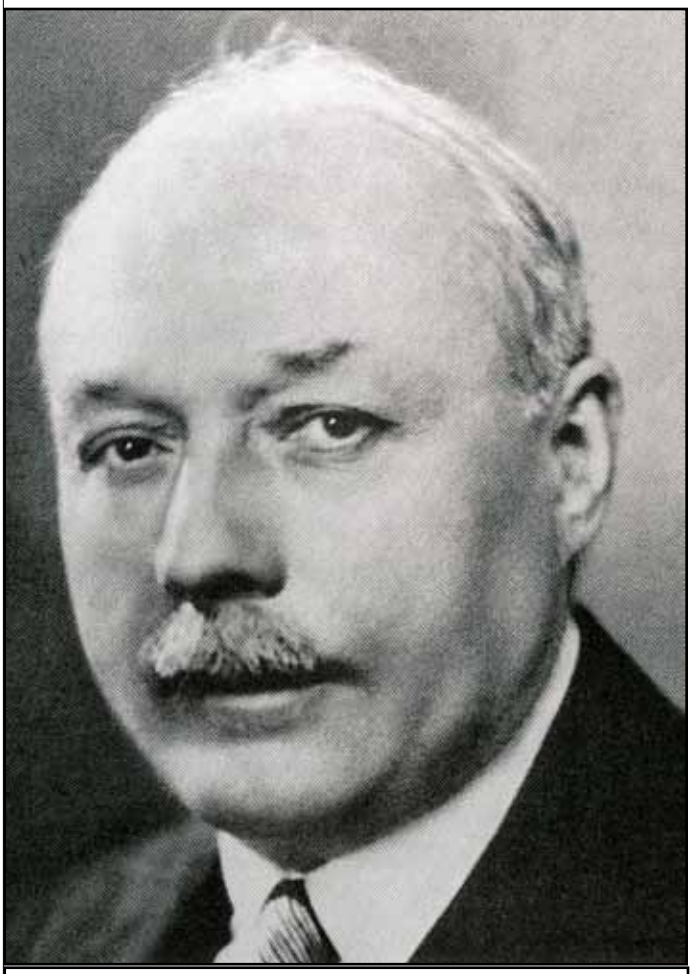


Fig. 18. Maurice Chevassu.
(by courtesy of Photothèque de l'AP-HP, Paris)

cystoscopy and RUP to IVP. HM Pollack, who was a urologist before he turned to uroradiology, noted this dispute was also current in the USA [7]. There was even disagreement in the European countries where there were new companies dedicated to the manufacture of contrast media, e.g. France, Germany and Italy [2,3,4]. There were more arguments against IVP than RUP . Intravenous urography (IVU) at that time was usually called intravenous pyelography (IVP) because the excretory nephrograms and cystograms usually were not dense enough to be diagnostic. Injection of diiodinated molecules produced unpleasant side-effects, especially venous pain, vomiting and a sensation of heat [43]. More and more patients complained of pain and vasoactive symptoms caused by abdominal balloon compression which had been applied too firmly [44]. More serious cardiovascular reactions, including collapse and sudden death, also occurred. The reputation of the IVP suffered and there were medicolegal consequences. When the author started his training in the 1960s, he still met internists who disliked IVU

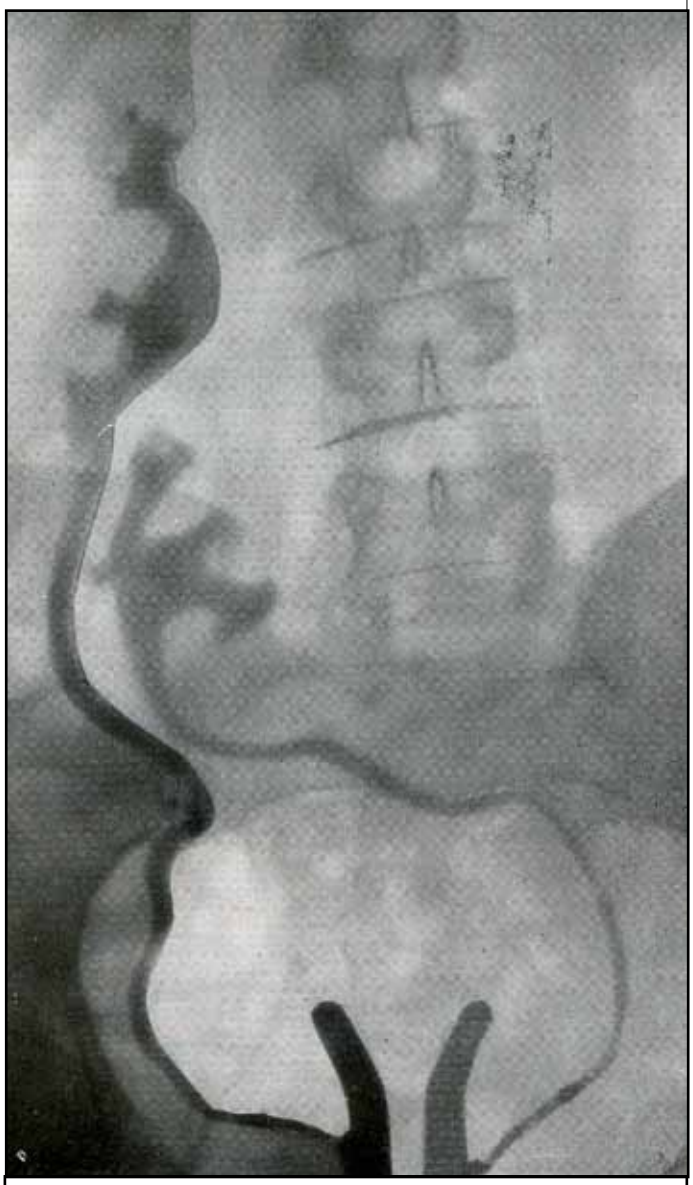


Fig. 19. Retrograde ureteropyelography by Chevassu (1934). (by courtesy of Dr P. Léger).

enough to refuse its use even in situations where it could potentially affect the diagnosis significantly. The first surveys on adverse events after injection of contrast media led to IVP being avoided in patients who had an allergic history and/or a positive iodine skin test. The use of diodinated media was also limited by their low excretion threshold and cases of oliguria and anuria were reported, some in patients with myeloma. Proteinuria and azotemia>0.80g/l

were considered to be contra-indications to IVP and arteriography. However, cystoscopy and RUP were invasive examinations, with a significant rate of traumatic and infectious complications. Because they were performed by the urologist himself with limited radiological input, potentially helpful radiological involvement in the diagnosis often did not occur. An IVP requested in 1935 by a modern urologist saved one normal kidney of the author's father-in-law, which an older colleague wanted to remove because on clinical examination a huge Pott's abscess of the psoas muscle mimicked a pyonephrosis (Fig. 20).

Looking for Uroradiologist's Grand-Fathers.

Most of the treatees dealing with diagnostic radiology of the urinary tract at that time seldom were written by pure radiologists only. In Spain,

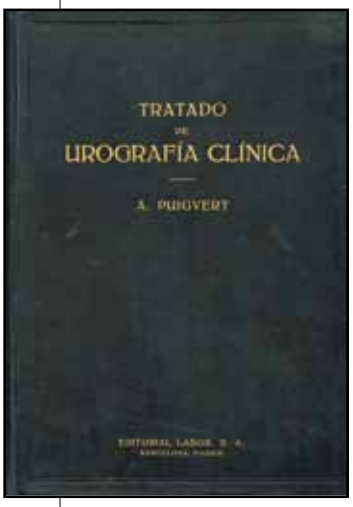


Fig. 20. Antoni Puigvert

Antoni Puigvert (1905-1990) of Barcelona didn't mention nor acknowledged any radiologist in his book on IVU [44] (Fig. 20). The American urologists Braasch and Emmett edited their famous *Clinical urography* twice without a radiologist coauthor until Witten joined the latter in 1971 [45]. In France both chairmen at the Hôpital Cochin, Fey, and the Hôpital Necker, Gouverneur, associated their radiologists but in second position on the cover page of their books [46,47].

Even if the author's European literature survey has not been exhaustive yet, he states that, at least in France, the urodiology grand-father is the outstanding electroradiologist, Robert-Théophile Coliez (1893-1983) (Fig. 21). From 1920 to 1979, he published multiple papers on diagnostic and therapeutic genito-uroradiology, including his early work on pneumoperitoneum and ureteric compression device for IVU, and a famous report on urographic study of ureteric obstruction [48]. He took the chairmanship of the department of radiotherapy at the new Centre des Tumeurs created at the Hôpital Necker in 1927 but still worked on uroradiology mostly in his private practice since he wasn't supposed to replace Maurice Gilson, the official chairman of the department of diagnostic radiology deserving the Clinique Urologique. Coliez was a strong radiologist's union leader who undertook the first national inquiry on the accidents observed during IVP procedures [48,49]. He was the honorary orator invited to open the

Fig. 21. Robert-Théophile Coliez and Maurice Tubiana in 1952 at the Hôpital Necker (by courtesy of Professor Bernard Pierquin).

session dedicated to the 50th anniversary of the IVU in 1979 at the Congrès Européen de Radiologie de Culture Latine à Paris.

A study of the authors of chapters in radiological textbooks is a way of finding some of the other radiologists who were involved in uroradiology. Shanks and Johnstone coauthored a uroradiology chapter in the second edition of Shanks and Kerley's famous British textbook published in 1950 [50]. Probably because uroradiologic practice was strictly limited to urologists in German-speaking

countries, the Swiss radiologist Schinz of Zurich used a Swedish author, Nils Edling, to provide the radiological contribution to his monumental textbook reedited in 1952 [51].

1940-1960: Sweden is the Radiology Mecca.

Like the greatest European pioneers, Antoine Béclère in France, Thurstan Holland in Great Britain and Hans Schinz in Switzerland, Gösta Forsell (1876-1950) in Sweden created an excellent school of radiology at the Karolinska Institute in Stockholm [52]. There Edling developed uroradiology and Sven Ivar Seldinger, (1921-1998) (Fig. 22) invented the revolutionary transfemoral abdominal angiographic technique in 1953 [53,54] (Fig. 23, 24a, 25a). After World War 2 the Swedish government funded social welfare very generously, enabling several other famous departments of radiology to do innovative research in science and technology (A. B. Stille-Werner©, Kifa©, Elema-Schönender©). In 1956 Per Ödman developed preshaped selective catheters in Norköpping with Kifa©, and Seldinger and Edholm's paper on this topic followed that of Ödman in the same Acta Radiologica issue [55,56] (Fig. 24b, 25b). The same teams pioneered interventional uroradiology. However, at least in the English-speaking radiological world, the true godfather of modern Uroradiology is undoubtedly Olle Olsson (1911-1999), who in 1949 founded the second great school of Swedish radiology at the University of Lund near Malmö [57] (Fig. 26). He was both a uroradiology expert and an angiographer and wrote the chapter on renal angiography in the first edition of Abrams' «Angiography» in 1961 [58,59,60]. Erik Boijsen, his pupil and successor, started his scientific career with a major report on renal angiographic anatomy in 1959 [60] (Fig. 27).

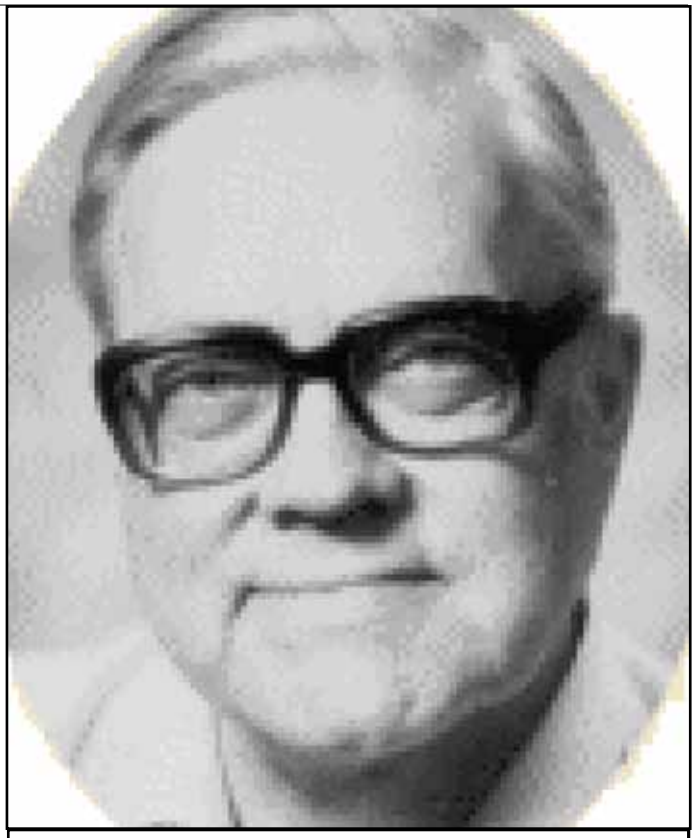


Fig. 22. Sven Ivar Seldinger (http://www.sfmr.se/sok/seldingersvenivar.htm)

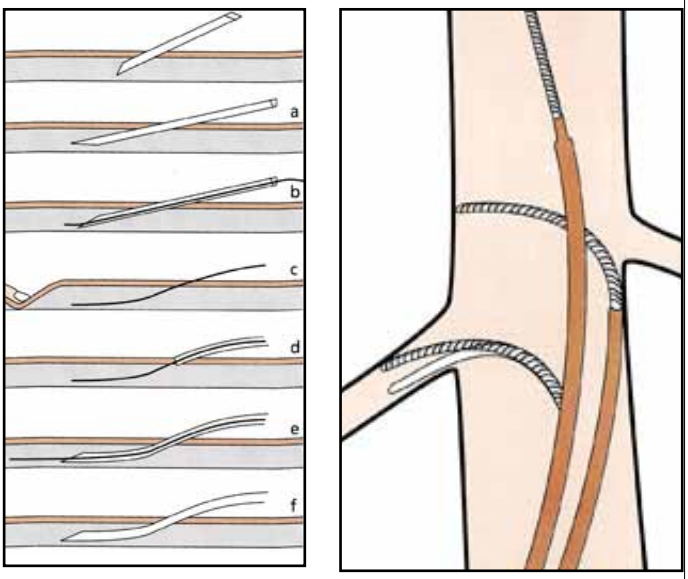


Fig. 23. Technique of percutaneous femoral artery (a) and selective renal artery catheterism (b) drawn by Seldinger (46,49). (by courtesy of Acta Radiologica)

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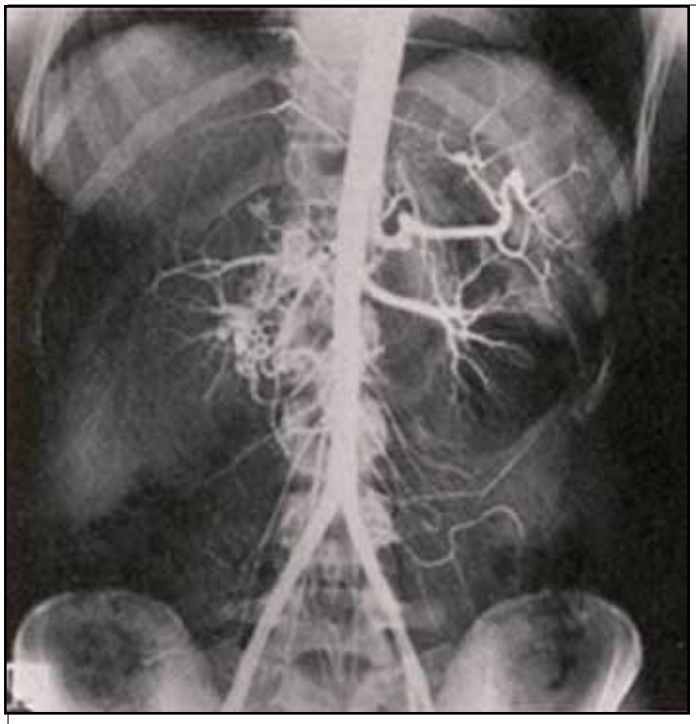

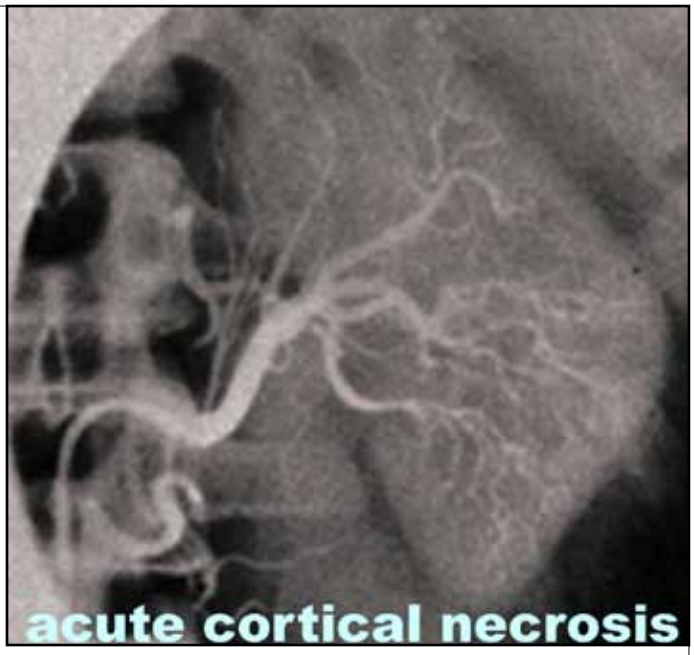

Fig. 24 a and b. Seldinger's aortography (left) and Odman's selective renal arteriography (right) in an anuric patient (author's collection).

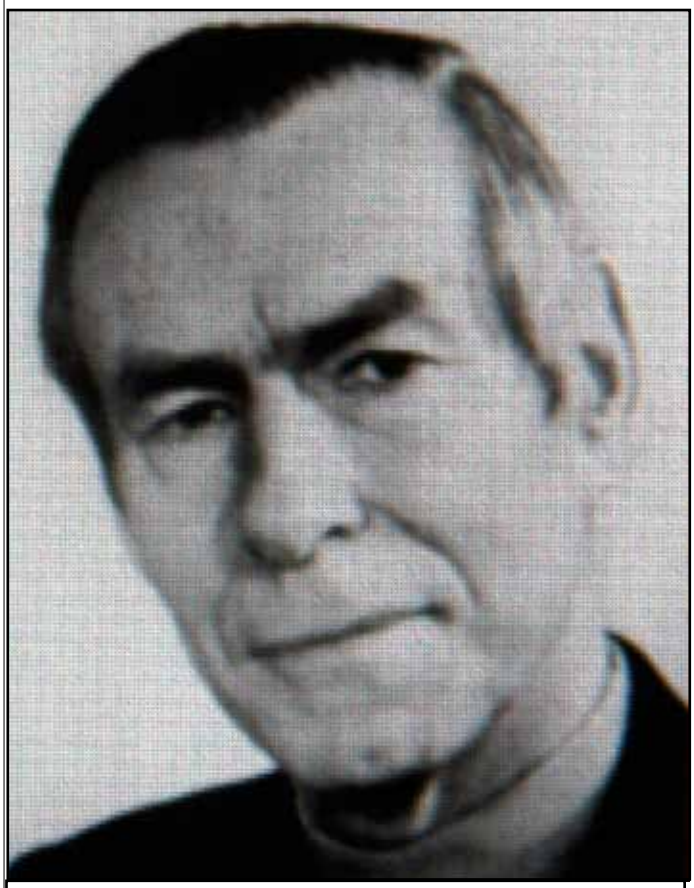

Fig. 25. Olle Olsson.
(by courtesy of *Radiology* (20).

Fig. 26. Erik Boijsen. (http://www.sfmr.se/sok/sel-dingerhedersmedlem.htm)

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