

The history of Spanish neuroradiology

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ABSTRACT

Background. This study describes the development of neuroradiology in Spain. It has not been presented either totally or partially at any of the Annual Meetings held by the Spanish Society of Neurology (SEN), or at any similar meetings held prior to the founding of that society in 1949. Both authors specialised in using imaging techniques to study neurological disorders. I. Pascual-Castroviejo studied neuroradiology as a diagnostic tool, and J. Víaño did so to acquire a more in-depth knowledge of the aetiology and pathogenesis of neurological diseases.

Development. Both authors observed the evolution of complementary techniques and especially neuroimaging techniques when these began to emerge. Neuroimaging was employed to obtain more precise aetiological diagnoses that would thus be followed by more appropriate treatments. The present study has received no funding of any kind.

Conclusions. The authors relate 50 years of experience attending the annual meetings of the SEN and witnessing the changes brought about by the advent of different techniques. In addition to becoming less uncomfortable for patients, neuroimaging techniques have delivered better diagnostic, therapeutic, and combined approaches. These changing methods have helped resolve a sizeable percentage of different brain and spinal cord diseases. Today, diagnostic approaches in neuroradiology have grown more complex not only because of instruments and systems, but also because of the experts needed to perform the scans and interpret results.

KEYWORDS

Neuroradiology, imaging, SEN, SENR, computed tomography, magnetic resonance imaging

Background

It would be unfair not to acknowledge the contributions of French neuroradiology, especially the schools of Strasbourg and Paris, to the development of neuroradiology in Spain. Many Spanish neurosurgeons and neurologists, mainly hailing from Barcelona and Madrid, attended French schools of neurology and learned the importance of understanding and practising certain relatively novel techniques in order to obtain an aetiopathogenic diagnosis of diseases affecting the brain and spinal cord. Ventriculography, accidentally discovered and later performed by neurosurgeons, usually during surgery, was of no great interest to neurologists. However, we should highlight that neurosurgeons were active and influential participants in the scientific congresses held by the Spanish

Society of Neurology (SEN) in the first two decades after it was founded, a collaborative situation explained by the lack of neurology departments at that time. The few neurology units existing before the second half of the 1960s were set up within neurosurgery departments and depended entirely on the head neurosurgeon. Nevertheless, the SEN had already been founded in Barcelona in 1949 thanks to the efforts of a group of Catalan neurologists, most of whom had been trained as neurologists in France¹; it had no neurosurgeons among its members.

In the course of their training, several budding neurologists and neuroradiologists learned such techniques as pneumoencephalography, cerebral angiography (via the carotid and the vertebral arteries), and myelography, usually using air (air myelography) but some-

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times employing iodinated contrasts (lipiodol, pantopaque, etc.). These pioneers included Alberto Gimeno, Juan Viaño, and J.M. Alfonso, who were trained at La Salpêtrière-La Pitié under Ruggiero and Metzger; and many others, including Juan Solé Llenas, Manuel Subirana Cantarell, Ignacio Pascual-Castroviejo, and Luis Escudero, who specialised in neuroradiology at Hôpital Civil de Strasbourg under the great professor August Wackenheim. In Madrid, it was Alberto Gimeno who first demonstrated the utility of neuroradiology in performing a neurological diagnosis. A true theorist, Gimeno was more adept at interpreting results than at conducting the studies themselves in the X-ray room, and he authored a treatise on neuroradiology which was sponsored by the Sandoz pharmaceutical company. However, he was not an active member of the SEN's neuroradiology group, nor did he attend any international congresses on imaging techniques.

The first figure to promote neuroradiology during the early years of the SEN was Juan Solé-Llenas; he suggested that an official neuroradiology group be created, and his proposal was finally approved by the SEN's general assembly in 1963. Few members attended the neuroradiology group's scientific meetings in its formative years. Some of the most dedicated members were J. Solé-Llenas, M. Rovira Molins, M. Subirana Cantarell, and I. Pascual-Castroviejo.²

Development

The members of the neuroradiology group met independently, although they also participated in the SEN's annual meetings from 1964 onward. Their meetings were quite modest as they were attended only by the four members listed above, plus a handful of neurosurgery and neurology residents with an interest in neuroradiology. Participants presented their clinical findings at these meetings, which rarely exceeded twenty attendees. Most of their patients had been diagnosed using what the specialists had learned from *Diagnostic neuroradiology*,³ an excellent reference published by Taveras and Wood in 1964. Most of the neurologists who performed neuroradiological studies purchased this treatise even though it was written in English, a language that very few of them had mastered; furthermore, the book cost 3500 *pesetas*, an exorbitant price in those days. As time passed, other specialists (V.G. Queimadelos, M. Trujillo Peco, J. Mercader, C. Parera,

O. Torrent, L. Escudero, and L. Pons, among others) began to gravitate toward the neuroradiology group meetings: they were mainly general radiologists and radiologists who had worked in neuroradiology or ORL radiology units, normally in cooperation with neurosurgery departments. However, very few of these neuroradiologists continued to practice neurology as well –only Pascual-Castroviejo and M. Subirana– and imaging studies necessarily had to be carried out in radiology departments. In light of those facts, members of the neuroradiology group supported the creation of another society that would be independent from but functionally associated with the SEN. This society was founded in 1971 and its annual meetings were held alongside the SEN's meetings in Barcelona. Group members who worked in radiology departments were considered full members of the Spanish Society of Neuroradiology (SENR), while those not meeting that requirement were regarded as associate members. Time and PubMed have both shown that the contributions of these neuroradiologists to international neuroradiology were rather scarce, with a few rare exceptions, and their visibility at international scientific congresses could also have been more pronounced.

One of the greatest challenges in the early years of neuroradiology was the lack of good equipment for performing cerebral angiography and serial pneumoencephalography studies, especially those requiring lateral or sagittal and frontal views in the latter case. In the late 1920s, after a number of lengthy and laborious experimental studies, Portuguese neurologist Egas Moniz finally developed a technique for visualising cerebral arteries and veins.⁴ Percutaneous injection of solution into the carotid and especially the vertebral arteries had to be performed by a very skilled professional. This was especially difficult for Prof. Moniz, who had certain motor limitations in his hands due to his gout; however, he was assisted by his countryman and student Almeida Lima, a neurosurgeon. For many years, Egas Moniz's valuable contribution was widely used in diagnosing brain and spinal cord vascular disorders (thrombosis, embolism, malformations, vascular tumours, etc.), whether arterial or vascular in origin, and whether congenital or acquired.

Although the SENR's meetings frequently coincided with the SEN's for a period of several years, the SENR soon broke away completely from the activities organised by the SEN. Nevertheless, a large number of

communications presented at the SEN's annual meetings did address neuroradiological issues, and many of these presentations focused on imaging techniques. Since communications were organised by topic, they were given in their own specific sessions. Traditionally trained neurologists with an interest in neuroradiology (I. Pascual-Castroviejo, A. Pou Serradell, A. Oliveros, C. Hernández-Lahoz, J. Berciano, etc.) were joined by strict neuroradiologists (J. Viaño, F.J. Romero) and a promising younger generation including J. Álvarez-Linera and D. Quiñones (who trained in the USA), J.L. Munuera, and Bosquet, as well as clinical neurologists (C. Oreja and others) who regarded neuroradiological imaging techniques as essential means to an aetiopathogenic diagnosis. But then something happened that would change the imaging scene forever. Godfrey Newbold Hounsfield, an English electrical engineer, developed a computerised system that enabled diagnosis by displaying pathological findings as real anatomical images, not as images of the disease's distorting effects on anatomical structures (ventricles, cisterns, arterial and venous vessels, etc.). This technique was named computed tomography (CT). The earliest CT scanners, manufactured by the English company EMI, only produced axial slices, so the technique was first known as computed axial tomography (CAT). The pioneer studies were presented in the United Kingdom in late 1971, although clinical use of

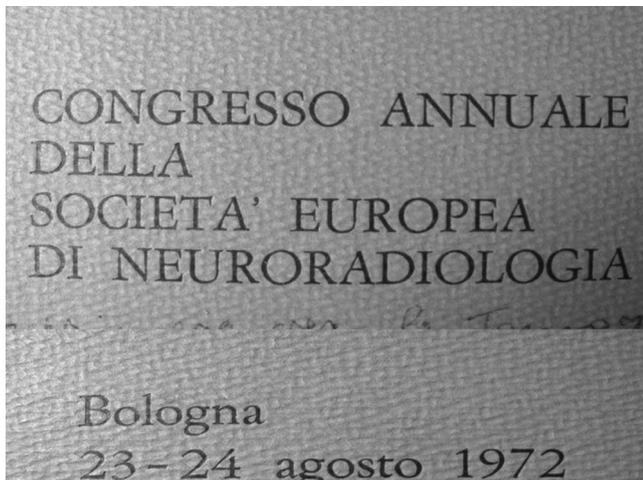


Figure 1. Programme from the Third Congress of the European Society of Neuroradiology, held in Bologna (Italy) in August 1972

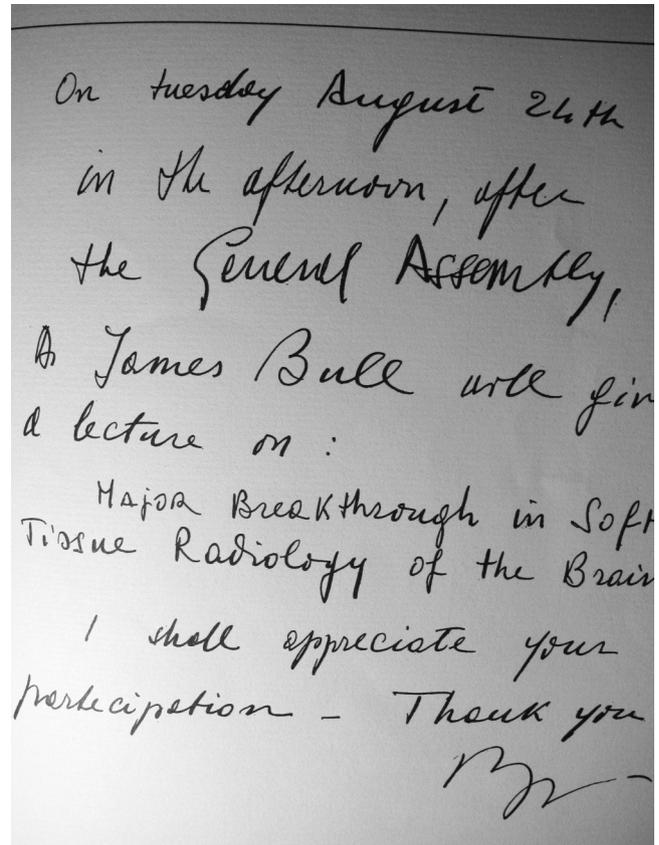


Figure 2. Title of the conference presenting CAT technology at the Third Congress of the European Society of Neuroradiology

CT would not be described until 1973.⁵ CAT was officially unveiled at the Third Congress of the European Society of Neuroradiology (Figure 1), held on 23-24 August 1972 in Bologna, Italy, in a special conference given by Prof. James Bull, head of the neuroradiology department at Queen Square Hospital in London. The title of the lecture, which provided a provisional name to this new imaging technique, was 'Major breakthroughs in soft tissue radiology of the brain' (Figure 2). The programme listed the attendees by country; the Spanish participants are shown in Figure 3. Everyone who attended the conference concluded that pneumoencephalography had become obsolete and arteriography was following the same path. Another conference on the same subject was held in Madrid in May 1973; this was the first time that CT was discussed in Spain. Also presented by James Bull and bearing the same title, it was included in an international workshop

NORVEGIA	Einar Aksnes, Per Amundsen, John Ludwig Larsen.
OLANDA	Ruben Hekster, Lourens Penning, J. Valk, T. Thoenes, Georges Ziedses Des Plantes.
SVEZIA	Örn Arnaldsson, Ulf Bergvall, Torgny Greitz, Bengt Liliequist, Anders Möller.
SVIZZERA	Peter Huber, Robert Oberson.
SPAGNA	Ignacio Pascual Castroviejo, Juan Solé-Llenas, José Mercader, Mariano Rovira, Manuel Subirana.

Figure 3.List of the Spanish neuroradiologists who attended the Third Congress of the European Society of Neuroradiology where CAT was mentioned.

organised by Dr Pascual-Castroviejo at the La Paz children's hospital (Figure 4). By this time, the resulting images were significantly clearer. In 1971, Dr Pascual-Castroviejo published *Diagnóstico clínico-radiológico en neurología infantil*.⁶ This book on the radiological diagnosis of paediatric neurological disorders was an international success, but it was based on simple radiography, pneumoencephalography, cerebral angiography, and myelography studies (Figure 5). Dr Bull himself recommended that the book be translated into English and even contacted a translator and a publishing company: Heinemann of London. The first Spanish-English translator failed to complete the task, and the other translators who took charge of the assignment two years later did not do a fully satisfactory job. As time passed, traditional neuroradiology became obsolete while CAT continued to gain ground. Given this climate, Pascual-Castroviejo reached an agreement with Heinemann to cancel publication of his book in English (Figure 6), and assumed the translation fees that the publishing company had already paid, as was to be expected.

Another technique that radically transformed the field of radiology was magnetic resonance imaging (MRI). This type of imaging is based on research conducted in the mid-1960s. Stejskal and Tanner (1965)⁷ discovered that MRI could be used depict molecular mobility. This technique was also developed in England. The first prototype scanner was installed in Hammersmith

Hospital in London in 1981 and successfully obtained three-dimensional images, thereby proving itself superior to CAT, which could only deliver axial images. In 1986, Le Bihan et al.⁸ obtained contrast-enhanced images of human brain tissue, while the neurologists at Hammersmith Hospital could now boast of their experience with findings from their first thousand MRI scans. The first MRI scanner to be installed in Spain was made by the CETIR group in Barcelona in 1984; Dr J. Gili was the technical director. It was not until two years later that another scanner (0.5T) would be installed, this time in Madrid, at Sanatorio San Francisco de Asís under Dr Juan Viaño. That doctor later had a 1.5T scanner installed at Hospital Nuestra Señora del Rosario, and more recently, a 3T digital MRI device.

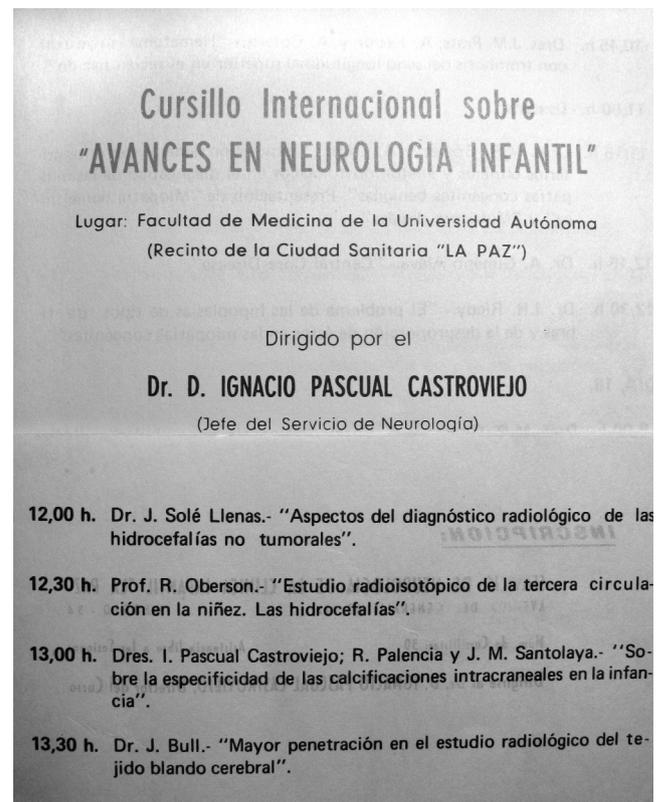


Figure 4.Flyer announcing the international workshop held at Hospital Infantil La Paz in May 1973 and the lecture in which Dr Bull first presented CAT technology in Spain

The advent of CAT and MRI scanners in Spain, and the improvements made to the earliest models, permitted doctors to study virtually all types of diseases located in any part of the body, a prospect that has dramatically increased the diagnostic potential of imaging techniques whose possibilities still seem endless. The development of diagnostic neuroradiology following the implementation of CAT and MRI scanners can be divided into three different stages:

Anatomical stage. Based on anatomical and morphometric images, the anatomical stage (1989) was associated with advances in electronics.

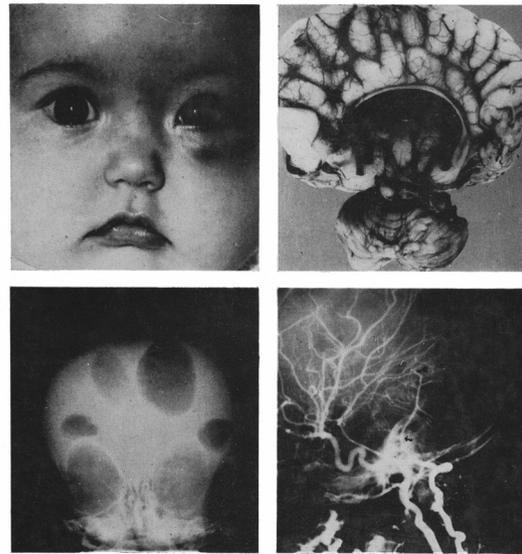
Physiological stage. Starting in 1990 when new software became available, imaging studies of capillary permeability, oxygenation-hypoxia, and metabolic studies (spectroscopy) were developed.

Molecular images. Starting in 2000, the molecular stage was characterised by designer chemistry and technological advances in MRI studies, with the development of biomarkers for genomics and proteomics studies. This stage ushers in an era of preventive medicine since disease processes often precede symptoms, and specific therapies may be designed to treat disease before it even becomes symptomatic. These changes herald a huge step forward for neurology, and at the same time, a return to the close relationship between clinical neurologists and neuroradiologists that existed in the 1970s and 1980s before CAT and MRI tools appeared.

Diagnosing vascular disease was revolutionised by CAT and MRI, but that process had previously been aided by another tool in interventionist neuroradiology: angiography studies via the femoral artery, as described by Seldinger (1953). That technique made it possible to visualise brain and spinal cord blood vessels in order to correct potential defects, and it was pioneered by René Djindjian in Paris and Servinenko in Moscow. Several Spanish neurologists who had been trained in France (L. Guimaraens, J. Viaño, L. López Ibor, and others) mastered these techniques and introduced them to their colleagues at the SEN's annual meetings.

In view of the high demand for neuroimaging methods, their increasing sophistication, and their usefulness in the diagnosis and treatment of neurological disease, the neurologists who had expressed continued interest in neuroradiology and published articles in Spanish and

Diagnóstico Clínico-Radiológico en Neurología Infantil



Dr. I. Pascual Castroviejo



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Figure 5. Cover of *Diagnóstico clínico-radiológico en neurología infantil*, by Dr Ignacio Pascual-Castroviejo

international scientific journals requested that the SEN create a neuroimaging group. This group was established in 2002 and Dr Pascual-Castroviejo was nominated as its first coordinator. Since then, the neuroimaging group ('neuroradiology group' never stuck, unfortunately) has organised specific meetings at the SEN's official events as well as conferences in many Spanish cities on the use of imaging techniques to study neurological diseases.

Although several years passed before MRI would undergo significant advances, it was hardly at a standstill. The development of devices with more teslas and featuring new accessories brought about new benefits

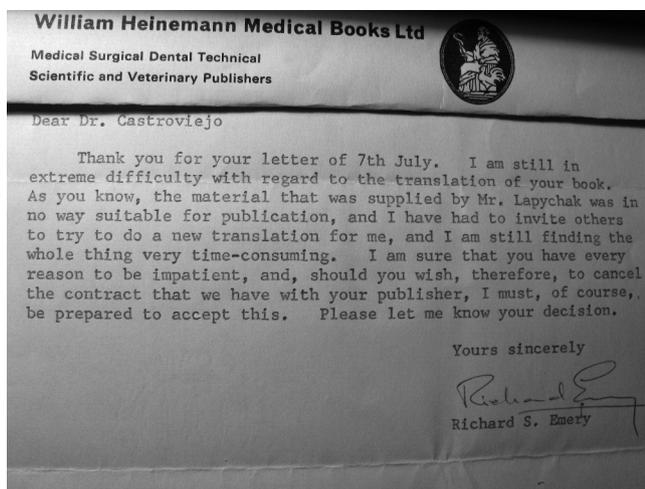


Figure 6. Letter from the Heinemann company in London, in which they agree to cancel the publication of Dr Pascual-Castroviejo's book due to the delays in translating the original version.

these studies tend to use the traditional name of 'neuroradiology'.

Neuroradiological studies are increasingly more convenient, physiologically representative, reliable, comfortable, and brief. Likewise, their image quality is better. Although neuroradiology has now become a separate discipline, close collaboration between neurologists and neuroradiologists is essential if we are to provide more accurate diagnoses and more suitable treatments.

and greater image quality. In the meantime, angiography MRI, spectroscopy MRI, and functional MRI appeared.

The tesla unit (T) was named after the eminent Croatian researcher Nikola Tesla (Figure 7), who revolutionised the field of electricity with his discovery of alternating current. Unfortunately, as happens all too often in the unscrupulous world of research, many of his discoveries were unfairly appropriated by other authors.

Conclusions

Neuroradiology in the SEN emerged almost at the same time as the SEN itself, and it evolved from the need to identify the aetiology and pathogenesis of different clinical processes.

Although only a few neurologists promoted this emerging discipline, their aetiological findings were beneficial for many.

The increasing complexity of imaging tools forced the vast majority of traditional neuroradiologists to further specialise in the field. Today, imaging tests are performed in specialised units staffed not only by healthcare professionals but also chemists, physicists, biologists, and others. Although the term 'neuroimaging' is gaining ground, the specialists who perform

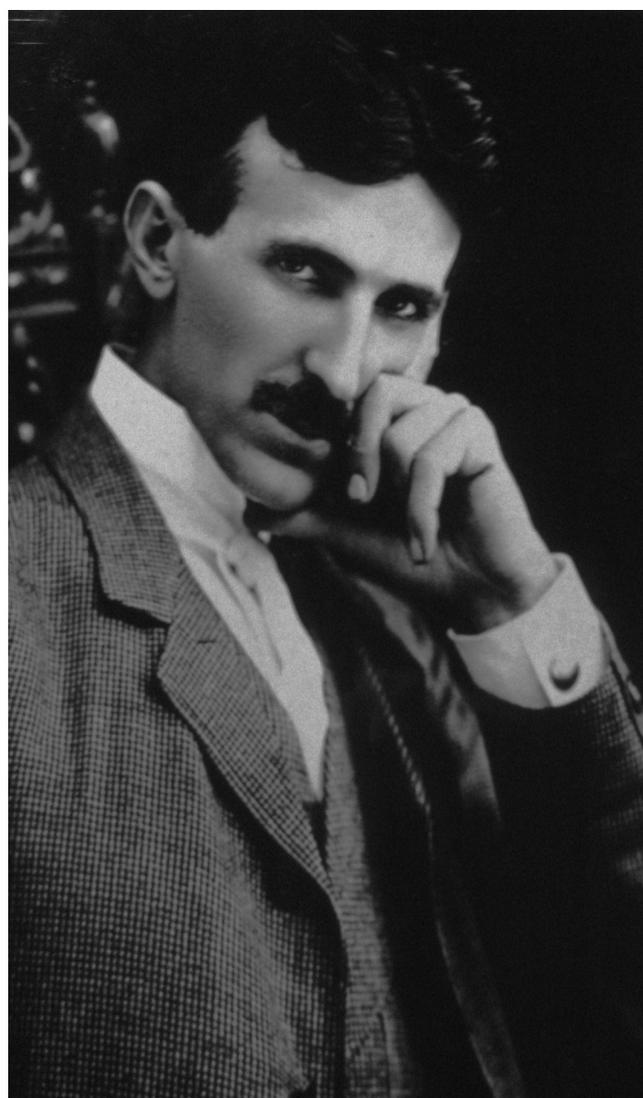


Figure 7. Tesla at the peak of his career

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