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Forward

In our clinical practice and teachings of neuroradiology, we usually focus on the ''here and now'', not the historical underpinnings. As Albert Lyons states in the introduction to his book on the history of medicine, ''the student, practitioner, and public marvel at the contemporary medical scene, with its enlarged scientific understanding, remarkable diagnostic tools, effective therapeutic methods, and broadened attitudes toward the patient. Nevertheless, they are apt to view today's practices as either always having been there or contrarily as if they were unexpected bright meteors suddenly dropped from a dark sky'' (Lyons AS, Petrucelli II RJ, eds. *Medicine. An Illustrated History.* New York: Harry N. Abrams, Inc.; 1987). Similarly, the basis behind the development of contemporary neuroradiologic practice often is forgotten, particularly by the young fellow or practitioner of the specialty.

In this series, I will attempt to highlight and review those 10 neuroradiologic papers that could be considered to have the most significance for our current clinical practice. I stress the word clinical, not to impugn papers of major research interest, but to try to identify the relevant foundations of our day-to-day practice. In order to try to exclude a personal bias, I have chosen some of our more senior neuroradiologic graybeards to help me in my choice. Some of the reviews in this series will be written by them, other reviews by me. I am sure that we will have selected some contributions out of proportion to their real significance, and have ignored others that should have been chosen. For this we apologize. By design I have also chosen not to have articles published later than approximately 1993 in order to assess whether the published information has stood the test of at least 5 years of clinical application.

I would like to thank O. Wayne Houser, Ralph Heinz, James Scatliffe, Norman Leeds, Michael S. Huckman, and Arthur Rosenbaum for their help in developing the list of the ''10 best'' and their contributions that will appear in subsequent issues of the *AJNR*.

Moniz: Pioneer in Cerebral Angiography

Technological advances form the foundation of neuroradiologic practice today. CT and MR imaging have replaced the old techniques of pneumoencephalography and ventriculography. Myelography still plays a minor role in our practice. Cerebral angiography, which some soothsayers predicted would die with the advent of CT and MR imaging, has flourished, particularly with the advent of interventional neuroradiology.

Consideration, therefore, of the 10 most important papers that have been published must include at least one paper on cerebral angiography. The original publication on the technique was published by Moniz in 1927, and the images are extremely primitive by today's standards. Nevertheless, I believe it is justifiable to select this outstanding article as the inaugural review in this series because of its historical significance and application to current practice.

Egas Moniz, whose real name was Antonio Caetano de Abreu Freire, was born in April 1974. The nom de plume that he used in all his writings was that of a gallant 12th-century Portuguese nobleman who played a major role in the separation of Portugal from the Spanish kingdoms of Castille and León (1). Moniz finished his medical studies with a special interest in neurology in 1899 at the age of 25. In 1911, at the age of 37, he came to Lisbon to be appointed to the newly created chair of neurology. His interests, however, were more political than medical and, in 1918, he was appointed Chief of the Portuguese Delegation to the Versailles Peace Conference. He was known as a democrat fighting against monarchy (2) and, after a coup d'etat, brought to power a dictatorial regime. Moniz retired from the political world at the age of 52 and dedicated himself solely to research. His pioneering work on cerebral angiography was published at the age of 53.

Acknowledging that ventriculography is a useful method for the localization of brain tumors, but ''is only achieved in a limited number of cases and with a certain amount of risk'' (3), Moniz felt compelled to develop another technique for the demonstration of cerebral lesions such as brain tumors. Influenced by Sicard's and Forestier's success in the development of lipiodol myelography in 1921, Moniz had the intuition that cerebral blood vessels could be imaged by the use of injectable substances opaque to X-rays and foresaw the possibility of obtaining anatomic and physiologic data important to the understanding of cerebral circulation and its diseases (2, 4). Moniz called cerebral arteriography ''arterial encephalography'', a reference to the term ''pneumoencephalography''. What stands out when reading his article is Moniz's persistence in developing the technique despite what today would be considered to be totally unacceptable risks and a series of nondiagnostic results. After establishing the normal appearances of the carotid arteries in cadavers, and establishing an optimal concentration of a radio-opaque dye with which to visualize the arteries, Moniz commenced to perform arterial encephalography in live persons. The first eight attempts were failures; success was achieved on the ninth try.

It is instructive to review his results. In the first four cases, Moniz attempted percutaneous puncture of the artery. In the next five patients, the internal carotid artery was exposed surgically. A summary of these patients follows:

• Patient 1: A man with general paresis. Seven mL of strontium bromide was inadvertently injected into the jugular vein and the films were diagnostic. The patient survived.

• Patient 2: A violent, painful reaction after the arterial injection of 5-6 mL strontium bromide occurred. The experiment was terminated. No diagnostic films were obtained.

• Patient 3: A patient with Parkinsonism. The patient experienced an unpleasant sensation after injection. The patient developed a Horner's syndrome. No diagnostic films were obtained.

• Patient 4: Extravasation of the contrast medium into the surrounding tissues ensued. The patient developed a fever and a Horner's syndrome.

• Patient 5: A 20-year-old woman with a nonlocalized cerebral neoplasm. After exposure of the internal carotid artery and the injection of strontium bromide, the patient complained and became very agitated. The X-rays were unrewarding, as they were taken too late after the injection. Aphasia, a febrile reaction, and a transient dysphagia lasting 3 days ensued.

• Patient 6: A 48-year-old patient with severe and progressive post-encephalic Parkinsonism. Thirteen to 14 mL of strontium bromide was injected after exposure of the internal carotid artery and the application of a ligature to the common carotid artery to reduce the washout effect of dye by unopacified blood was performed. The second of two films showed what was interpreted as a thrombus in the anterior cerebral artery. The patient died 8 hours later.

• Patient 7: A patient with a cerebral neoplasm. Three mL of 22% sodium bromide solution was injected. Bradycardia ensued and the patient became febrile and dysphagic for 3 days. No arterial images were seen on the films.

• Patient 8: A blind patient with elevated intracranial pressure. Five mL of a 25% solution of sodium iodide was injected that showed the internal carotid artery up to its superior curve (possibly the top of the siphon) but no further arterial opacification. Bradycardia and dyspagia ensued, lasting 3 days.

• Patient 9: In a patient with a suspected pituitary tumor, 5 mL of sodium iodide was injected. Bradycardia and slight dysphagia ensued. The films were successful, showing anterior displacement of the supracavernous internal carotid artery.

Thus, it took Moniz nine attempts to obtain a successful study that confirmed a clinical diagnosis.

Moniz's remarkable tenacity had at last paid off. It is ironic that he was awarded the Nobel Prize in physiology and medicine in 1949 for discovering and performing prefrontal leukotomy, not for cerebral angiography. Possibly this was because psychosurgery was rapidly accepted by the medical community whereas it took many years before cerebral angiography was accepted as a useful diagnostic procedure. The subsequent use of Thoratrast as a contrast agent, with its attendant dangers, may account for the slow acceptance of cerebral angiography. Nevertheless, the two discoveries are closely related, both pertaining to the field of applied medicine (5). Angiography centers on diagnosis for better therapy, and leukotomy centers on therapy. It is also sobering to realize that if cerebral angiography was not discovered in the 1920s, and if Moniz attempted to perform his experiments today, ethical considerations and restrictions imposed by human investigative review committees would have prevented him from making his major contribution to medical science.

Because of gouty arthritis, which prevented Moniz from performing his studies himself, Almeida Lima, a neurosurgeon, actually performed the cut downs and injections.

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