COCHLEAR IMPLANT HISTORY: THE FIRST YEARS

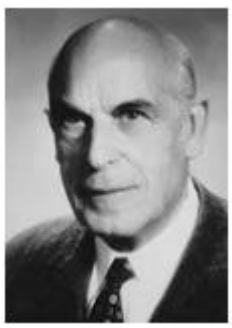
André Djourno was born in Algeria in 1904, where he studied to be a doctor, and he moved to Paris in 1935, where he worked as occasional teacher at the Faculty of Medicine in the University of Paris. His main field was the innovation in the physiologic research and the applications of electricity.

André Djourno

He experimented fitting little coils in animals. These coils consisted of a central ironed base with a wire firmly affixed around it. One or both ends of the wire were in contact with the nerve or muscle that he wanted to stimulate, and then the skin was stitched up, making recovery quicker. Using the principle of the electric induction, he placed another coil, which was connected to the electricity, on the implanted coil. The current that pierced this external induction coil generated an electromagnetic field through the skin and the tissues and inducted a current in the implanted coil. The goal of this technique was to stimulate the nerve to activate the diaphragm's muscle and thus provide easy and extracorporeal ventilation that facilitated breathing in people with paralysis by poliomyelitis. Djourno implanted these coils in frogs and rabbits, and he collected testing data about the capacity of the body to tolerate the presence of implants, and the capacity of the nerves to bear electric stimulus in the long term. Besides, Djourno had the idea of using this technique to stimulate the cochlear nerve in deaf patients.

French Academics securely kept their notes and documents about research in a "cachété de pli" (a sealed envelope) in the French Academy of Sciences to avoid copies or theft of inventions and discoveries, and thus demonstrate that they were the pioneers. Djourno did this in 1953, with his idea about a cochlear prosthesis.

Four years later, in 1957, **Charles Eyriès** visited Djourno. Eyriès was an excellent otologist and he had a patient with complications related to a cholesteatoma in both ears. Ten years earlier, this patient went through a radical mastoid surgery in the left ear, losing all the hearing in this ear and with all his left-side face paralyzed. In 1957, the situation repeated itself, but this time in the right side, with same results.



Charles Eyriès

So, the patient, a 50 year-old man, lost all the hearing in both ears and had his face totally paralyzed. He went to Eyriès because of his good name. First of all, Eyriès explored the right inner ear with local anesthesia, trying to repair the facial nerve. During this first operation, Eyriès had used an electric diathermy (diathermy means "electrically induced heat": the use of high-frequency electromagnetic currents as a form of physical or occupational therapy and in surgical procedures) while he was exploring the inner ear. The moments when the diathermy was used, the patient said he had the sensation of hearing. Later, the patient, who was an engineer, called Eyriès' attention telling him about the sensation of hearing when the diathermy was used and asked him if it would be possible to find a technique to help him with his hearing. Eyriès knew Djourno's work thanks to other colleagues and he visited him. Djourno decided to help him. He, along with his assistant Danièle Kayser, built an appropriate coil, which it was put in resin of epoxy and sterilized.

The first article which describes a cochlear implantation was published in the Comptes Rendus of the Societé de Biologie of Paris in March 9th 1957. The article was signed by Djourno, Eyriès and Vallencien, and it mentions the technical assistance of Danièle Kayser. It speaks about the previous experiences with animals that Djourno carried out, and goes on saying: "a patient who had suffered a great damage in both ears asked if it could be possible to make him free, even partially, from the complete deafness to which he was condemned". This desire was so strong and, despite the fact that they warned him that it was highly possible that the procedure would fail because it was experimental, they decided to implant him with the coil during surgery to graft his facial nerve, which took place on February 25th. "After we inserted a facial nerve graft of 5cm., we found such an extensive destruction that at first we hesitated to implant the coil. However, eventually, we went on; partly due to obvious psychological reasons and also because we were able to identify a little stump of the nerve, which was only a few millimetres long, but accessible enough to place it in contact with the electrode in a safe way for the patient (this probably meant that there were not opening of the inner auditory meatus)".

And the article also explained that "the wire was isolated with polythene at one end and placed it in contact with the little worn-out stump of the nerve. The other end, which was not isolated, was joined with the coil in muscle of the temporal bone".

Three days after the surgery the first tests took place. The external coil was connected to an amplifier which was previously built by Djourno to stimulate the phrenic nerve in rabbits. This amplifier gave 15-20 contacts per minute of AC at 100 Hz. When the external coil was placed at a distance from the head, the patient said that he could hear a sound similar to crickets. When they brought the coil closer to the head, the sound became noisier and he described it like a squeaky wheel.

This report was submitted only eight days after the surgery. Five months later they submitted a second report, this time in the journal "Medicale", with more details and tests. The patient was able to distinguish various frequencies of stimulation, although all of them sounded the same to him: like a strident but not unpleasant sound. The induction coil was connected to a microphone and, although the patient wasn't able to understand the whole message, after a while he was able to identify words from a little closed list which include "mum", "dad" and "allo" ("hello" in French). Occasionally he guessed correctly some other words like "bravo".

Unfortunately, after a month went by, the wire forming the electrode broke and the device stopped working. Eyriès re-implanted a new coil. This one worked just the same. The patient was delighted to hear. He trained using the device with his family and he liked hearing the conversations that took place around him and even hearing the sound of doors opening and closing. He regained some functional facial movement. He hadn't unwanted stimulus of the facial nerve neither aches as long as the device was working. The second device (probably for the same reason as the first one) stopped

working too. In 1959, Eyriès decided not to risk with a new surgery, due to the patient's health conditions. In fact, the patient died because a heart attack, twenty months after the first surgery.

At that time, Djourno and Eyriès argued about the potential commercial value of the implant. Djourno had a very clear position: as a matter of principle, the scientific advances should be of public domain, so he refused to patent the device.
He built another device that was used by the surgeon Rogelio Maspetiol. But this time the election of the patient wasn't correct. She was a young Vietnamese woman who lost her hearing because of the streptomycin that was prescribed to cure tuberculosis. The device gave her the sensation of hearing, but she wasn't properly informed about what to expect from the implant. Six months after the surgery, she went back to Vietnam. They reported that she described the electric stimulus that she heard as the sound of the blowing wind.

In 1958, Djourno described the use of the stimulus of the promontory with a transtympanic needle to check the cochlear nerve's integrity. Meaning that it was 9 years before Portmann, Lebert and Aran did theirs. Djourno also preceded House and Brackman in 16 years doing the first description of the use of electrode to stimulate electronically the promontory.
Djourno continued with his experimental work. He admitted the need for better frequency discrimination, differentiating the sounds in various frequencies and sending them by separated electrodes. He built a machine which identified the diverse frequencies of speech and he made the analysis of the frequencies of speech in real time, including vocals, using an oscilloscope. The various frequencies were fitted within different electrodes: a prototype with all the characteristics of a multi-channel cochlear implant.

So, before 1959, Djourno and his team had a dozen publications, two patients and a lot of experimental data. However he needed more funds to hire an engineer to continue his investigations. But they rejected the awarding of grants, and it has been indicated that he wasn't willing to enter in commercial implications. That's why he had to stop these research lines and he dedicated his time to others. He expressed that he had already done all he could in this field, making the results available to public domain and he hoped others Scientists continue his work.

Bibliography

1. Djourno A : Excitation électrique induite localisée à distance. Real Académie des sciences, France 1953

2. Djourno A, Kayser D. : La méthode des excitations induites à distance. Société française d'electroaudiologie médicale. June, 1954

3. Djourno A., Eyriès C. : Prothèse auditive par excitation électrique à distance du nerf sensoriel à l'aide d'un bobinatge inclus à demeure. La Presse Médicale, 65, nº 63, 1957

4. Djourno A., Eyriès C., Vallencien B.: De l'excitations électrique du nerf cochléaire chez l'homme, par induction à distance, à l'aide d'un micro-bobinage inclus à demeure. CR de la société de biologie. Mars, 1957

5. Djourno A : Premiers essais d'excitation électrique du nerf auditif chez l'homme, par micro-appareils inclus à demeure» pàg. 481-483. 2 de juillet, 1957

6. Euro-CIU Newsletter, Special Edition on the International Cochlear Implant Day, January 2016

7. Eyriès C. : Experience personnelle. Les Cahiers d'ORL pages 679-681, nº 7, 1979

8. Jacob A. : Introducción a la historia de los implantes cocleares, en Manrique M y Huarte, A.: Implantes Cocleares, Capítulo 1, MASON, Barcelona, 2002