

Giovanni Aldini and his contributions to non-invasive brain stimulation

Giovanni Aldini e suas contribuições para a estimulação cerebral não invasiva

Fernando Zanela da Silva ARÊAS^{1,2}, Guilherme Peixoto Tinoco ARÊAS³, Roberto MOLL NETO^{4,5}

ABSTRACT

Giovanni Aldini was an Italian physicist interested in propagating Galvanism. With his uncle, Luigi Galvani, he learned techniques of electrical stimulation in humans and helped him to develop them. He later developed his own ideas and created transcranial electric stimulation. This paper presents some of Aldini's personal and professional traits, showing his trajectory and how his performance was important for the development of non-invasive brain stimulation techniques as a whole. Through research on animals and, later, on cadavers, his fundamental discoveries at the beginning of the treatment proposals are used so far.

Keywords: History of Medicine; Medicine; Electrical Stimulation; Transcranial Direct Current Stimulation.

RESUMO

Giovanni Aldini era um físico italiano interessado em propagar o Galvanismo. Com seu tio, Luigi Galvani, aprendeu técnicas de estimulação elétrica em humanos e pode ajudá-lo a desenvolvê-las. Mais tarde, desenvolveu suas próprias ideias e criou a estimulação elétrica transcraniana. Este artigo apresenta alguns traços pessoais e profissionais de Aldini, mostrando sua trajetória e como seu desempenho foi importante para o desenvolvimento de técnicas não invasivas de estimulação cerebral como um todo. Através de pesquisas em animais e, posteriormente, em cadáveres, suas descobertas fundamentais no início das propostas de tratamento utilizadas até o momento.

Palavras-chave: História de Medicina; Medicina; Estimulação Elétrica; Estimulação Transcraniana por Corrente Contínua.

Giovanni Aldini (Figure 1) was born in Bologna, Italy, on April 10, 1762 and died at age 71 on January 17, 1834. He was the nephew of Luigi Galvani, a physician and physicist who conducted one of the first studies on Bioelectricity, helped by Aldini himself³. Aldini later became a professor of Physics in 1798, and his work was mainly focused on Galvanism and its medical applications, including the construction and lighting of lighthouses, as well as experiments for the preservation of human life and material objects against destruction by fire^{1,2}. He wrote in French and English in addition to the Italian, his mother tongue. He donated a considerable amount to the founding of a school of Natural Sciences for artisans in Bologna.

He began his research in animals, studying the behavior not only of muscles, but also of the brain when subjected to



Figure 1. Giovanni Aldini.



¹Universidade Federal do Espírito Santo, Centro de Ciências da Saúde, Vitória ES, Brazil.

²Universidade Federal do Espírito Santo, Departamento de Ciências Fisiológicas, Laboratório de Ciências Cognitivas e Neuropsicofarmacologia, Vitória ES, Brazil.

³Universidade Federal do Amazonas, Instituto de Ciências Biológicas, Manaus AM, Brazil.

⁴Universidade Federal Fluminense, Departamento de História, Campos dos Goytacazes, Rio de Janeiro RJ, Brazil.

⁵Universidade Federal Fluminense, Instituto de Ciência da Sociedade e Desenvolvimento Regional, Niterói RJ, Brazil.

Fernando Zanela da Silva ARÊAS  <https://orcid.org/0000-0002-2068-2606>; Guilherme Peixoto Tinoco ARÊAS  <https://orcid.org/0000-0002-7083-8314>; Roberto MOLL NETO  <https://orcid.org/0000-0001-8763-939X>

Correspondence: Fernando Zanela da Silva Arêas; E-mail: fernandozanela@hotmail.com

Conflict of interest: There is no conflict of interest to declare.

Support: Fundação de Amparo à Pesquisa e Inovação do Espírito Santo — FAPES (21/2018/UNIVERSAL).

Authors' contribution: FZ: bibliographic and written survey. GP: writing; RM: literature review, writing correction and final review.

Received on January 04, 2020; Received in its final form on March 31, 2020; Accepted on May 4, 2020.

electric currents. Investigating in animals, he was the first to observe that stimulation in a cerebral hemisphere produces muscle contraction on the opposite side. In addition, it has been shown that stimulation in different regions of the cerebral cortex produces effects, raising the possibility of electric energy use as a therapeutic tool in humans³.

His most notable work was in relation to the treatment of mental illnesses through the Galvanism method. Despite his unusual experiments as the animation of human and animal corpses, his main proposal was to treat people with mental illnesses, such as schizophrenia and chronic depression, through Galvanism⁴.

By such a feat, he became one of the pioneers in this type of treatment that has been perfected over the years and is still one of the most effective in treating mental illness by offering low health risk⁵.

As mentioned above, Aldini began to study in corpses and, for these studies, corpses of criminals who were executed by decapitation were ceded⁴. Aldini defended the idea, raised by Luigi Galvani, that the animal body, and consequently human, possessed what they called the electric fluid responsible for the nerve stimuli of the muscles^{6,7}.

In the year 1802, Aldini held public demonstrations in the city of Bologna, using bodies of criminals who had been beheaded in less than an hour. In doing so, he demonstrated how the corpses of criminals squirmed when subjected to electric currents. Aldini then begins a journey across Europe to spread Galvanism and convince the scientific community of the existence of animal electricity⁸. The difficulties initially faced by Giovanni Aldini were that the bodies of the criminals were always beheaded, having a great loss of fluids, and not being able to study the behavior of the human brain.

Although Aldini's demonstrations generated distrust of the medical profession, he claimed to have cured two patients with "melancholy" in the city of Bologna in Italy (Figure 2)⁹. One of these patients, named Luigi lanzarini, a 27-year-old farmer hospitalized at the Sant'Orsola Hospital in Bologna, received galvanic stimulation in the head for six weeks, when he was considered cured, and was one of the first reported success cases of transcranial stimulation in Psychiatry^{8,9}.

In 1803, Aldini visited London and Oxford to lecture on Galvanism and held public demonstrations. The most famous took place on January 17, 1803 at the Royal College of Surgeons. There he would have at his disposal the whole body

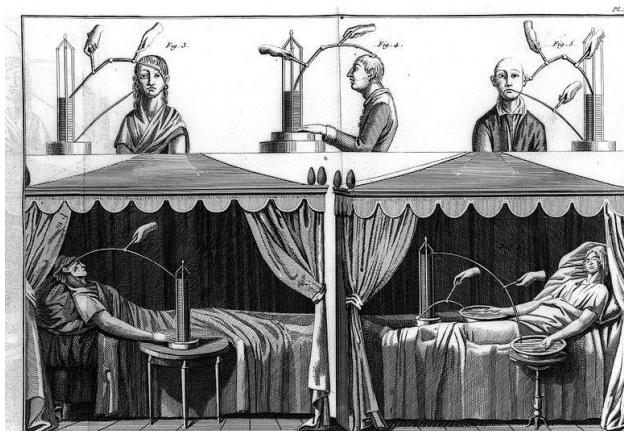


Figure 2. Melancholy.

(as the English hanged criminals) of the criminal George Foster, accused for the murders of his wife and daughter^{3,4}. When Aldini used electricity in Foster's body, all his limbs began to move, as if the criminal were convulsing, thus frightening all the local spectators, who panicked, thinking that he had returned from his death. This event was an inspiration for the writer Mary Shelley to create the famous literary work in which Dr. Victor Frankenstein creates a creature from a dead man who returns to life after being hit by a strong electrical discharge¹⁰.

One of Aldini's destinations in Europe was the Pitié-Salpêtrière Hospital, cradle of modern Neurology, in Paris, trying to convince the famous psychiatrist Philippe Pinel of the beneficial effects of Galvanic stimulation in depressed patients. Aldini published in Paris the work *Essai théorique et expérimental sur le galvanisme*, reporting his experiences with Galvanism; such work was dedicated to Napoleon Bonaparte^{3,4,9}. He was also rewarded for his contributions to the Science, being contemplated with the Order of the Iron Crown of Austria and invited by Napoleon himself to be adviser to the state of Milan, where he moved in 1807, abandoning his academic career⁵. On January 17, 1834, Giovanni Aldini died¹¹ and, through his passion for Galvanism, curiosity and perseverance, he brought to the fore the first hypotheses about non-invasive transcranial stimulation, leaving the legacy to the medical-scientific community, that continues to study and apply this modality of treatment in the patients until the present day.

References

1. Rowbottom CM, Susskind S. Electricity and Medicine: history of their interaction. San Francisco: San Francisco Press, London: MacMillan; 1984.
2. Bresadola M. Medicine and science in the life of Luigi Galvani (1737-1798). Brain Res Bull. 1998 Jul;46(5):367-80. [https://doi.org/10.1016/s0361-9230\(98\)00023-9](https://doi.org/10.1016/s0361-9230(98)00023-9)
3. Nicholson MW. Abstract of the late experiments of Professor Aldini on galvanism. J Nat Philosophy. 1802;3:298-300.
4. Schestatsky P. Introdução e histórico da neuromodulação não invasiva. In: Brunoni AR. Introdução e histórico da neuromodulação não invasiva. São Paulo; 2016. p.17-33.

5. Parent NA. Giovanni Aldini: from animal electricity to human brain stimulation. *Can J Neurol Sci.* 2004 Nov;31(4):576-84. <https://doi.org/10.1017/s0317167100003851>
6. Finger S, Piccolino M, Stahnisch FW. Alexander von Humboldt: galvanism, animal electricity, and self-experimentation part 1: formative years, naturphilosophie, and galvanism. *J Hist Neurosci.* 2013;22(3):225-60. <https://doi.org/10.1080/0964704X.2012.732727>
7. Galvani L, Galvani A. Dell'uso e dell'attività dell'arco conduttore nelle contrazioni dei muscoli. Bologna: S. Tommaso d'Aquino; 1794.
8. Aldini J. De animali electricitate dissertationes duae. Bononiae: Instituti Scientiarum; 1794.
9. Bolwig TG, Fink M. Electrotherapy for melancholia: the pioneering contributions of Benjamin Franklin and Giovanni Aldini. *J ECT.* 2009 Mar;25(1):15-8. <https://doi.org/10.1097/YCT.0b013e318191b6e3>
10. Aldini G. Essai théorique et expérimental sur le galvanisme, avec une série d'expériences faites devant des commissaires de l'Institut national de France, et en divers amphithéâtres anatomiques de Londres. Paris: De l'Imprimerie de Fournier fils; 1804. <https://doi.org/10.5479/sil.166863.39088003171683>
11. Aldini G. An account of the late improvements in Galvanism. London: Cuthell and Martin, J. Murray; 1803. <https://doi.org/10.5479/sil.406997.39088006768360>