Brazilian Journal of TRANSPLANTATION

https://doi.org/10.53855/bjt.v26i1.507_ENG

OPINION ARTICLE

Why a Technique of the Beginning The XIX Century is Important in the Organ Transplantation Development?

Ana Terezinha Guillaumon[1,*]

1. Universidade Estadual de Campinas – Faculdade de Ciências Médicas – Campinas/SP – Brazil.

*Corresponding author: atguillaumon@gmail.com

Section Editor: Ilka de Fátima Santana F. Boin

Received: Mar. 20, 2023 | Accepted: Apr. 18, 2023

How to cite: Guillaumon AT. Why a Technique of the Beginning the XIX Century is Important in the Organ Transplantation Development. BJT. 2023.26 (01):e1623. https://doi.org/10.53855/bjt.v26i1.507_ENG

ABSTRACT

The author presents a singular view of th Alexis Carrel importance in the elaboration the vascular anastomosis, technical principles and organ preservation. His ingenious mind developed an innovation vascular suture technic. The experimental works showed technical details with good method with applicability in unlike characteristic vascular anatomies and vessel caliber. The operatories principles developments were based the transplantations surgery and it's were applied until today

Keywords: Anastomosis; Artery; Vein; Organ Preservation; Organ Transplantation.

Porque uma Técnica do Início do Século XIX é Importante no Desenvolvimento dos Transplantes de Órgãos?

RESUMO

A autora apresenta uma visão peculiar da importância de Alexis Carrel na elaboração dos princípios técnicos das anastomoses vasculares e preservação de órgãos. Sua genialidade desenvolveu técnicas de suturas vasculares inovatórias. Seus trabalhos experimentais apresentaram detalhamento técnico bem metodizado com aplicabilidade nas diversas características anatômicas vasculares e calibre dos vasos, que permitiram o avanço das cirurgias envolvendo vasos. Os princípios operatórios traçados alicerçaram as cirurgias de transplantes e são até hoje empregadas.

Descritores: Anastomose; Artéria; Veia; Preservação de Órgãos; Transplante de Órgãos.

INTRODUCTION

The success of organ transplants is closely linked to the technique of suturing the vessels of the target organs. That was the first argument sustained by a young student at the University of Lyon, Alexis Carrel, when observing the death of the French president with a portal vein injury that was not repaired since, at the time, the techniques for suturing vessels were not known.

Thus begins his journey with his experiments, and he soon gains local notoriety.

Alexis Carrell was born in 1873 in Lyon, southern France. He received his primary education at home from his mother, Anne Ricard, and then studied at the Saint Joseph de Lyon school. In 1889 Carrel obtained a Bachelor of Letters at the University of Lyons; and, in 1890, in sciences, having received the degree of Doctor in 1890. He graduated in medicine in 1900, continued his work as a physician at the Hospital de Lyons, and concomitantly taught Anatomy and Surgery at the University in the department of Professor Testut. While still in Lyon in 1902, he showed his interest in vascular sutures and organ transplantation by performing them experimentally, publishing several scientific articles between 1902 and 1905.[1]The science of vascular anastomoses and organ transplants was born.

In 1912 he received the Nobel Prize in Medicine and Physiology.

INTELLECTUAL DEVELOPMENT METHOD

Carrel worked to develop a balance between science and art, logic and imagination, with conviction and a disciplined and constant method to achieve his goals in operative medical science. He was the forerunner of the technique of anastomoses and vascular sutures.

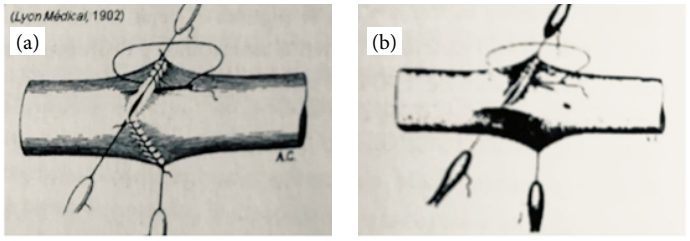
He worked with art to imitate life and with life to hone it with science...

Was Alexis Carrel a technician, a doctor, a visionary magician or an artist? As a technician, he worked hard on his experiments, and in 1902, he published the operative technique of vascular anastomoses.[2–4] and organ transplantation.[5–7]

In 1904 he went to Chicago, fascinated by Rudolf Matas's experiments in treating aneurysms and in 1905 began his experiments in the transplantation of kidneys in animals. At the same time, he worked in the Department of Physiology at the University of Chicago with Professor Stewart. In 1906, he joined a group of medical researchers at the Rockefeller Institute of Medical Research in New York, studying extracorporeal tissue conservation techniques and tissue culture. He increasingly worked on perfecting arterial suturing techniques with widespread end-to-end anastomosis in 1907.

In 1908 he successfully transplanted arteries that had been frozen for weeks. He also demonstrated the method of transplanting all organs like ears, thyroid, kidney and spleen. His experimental works began in Lyon, and after migrating to the United States, he continued his studies and, in six months, published 21 works with his collaborators. He studied cellular aging, cell and organ cultures, and today's medicine. He was a visionary. Later he studied the histology and physiology of preserved homografts.

He was a restless and dedicated researcher. In addition to dedicating himself to anatomy studies, he developed the technique of vascular sutures, end-to-end, end-to-side, side-to-side, the Carrel triangulation technique (Figs. 1 and 2), the "patch" and its use in anastomoses of small caliber vessels and visceral vessels in transplantation, the rubber patch (Fig. 2). He sought to study the entire line of research in an experiment, including in his studies the physiology and behavior of the vessels, the pathology with the analysis of a biopsy of the vessel wall at the site of the parietal perforation produced by the suture needle.



Source: Obtained from Carrel (1902).[8]

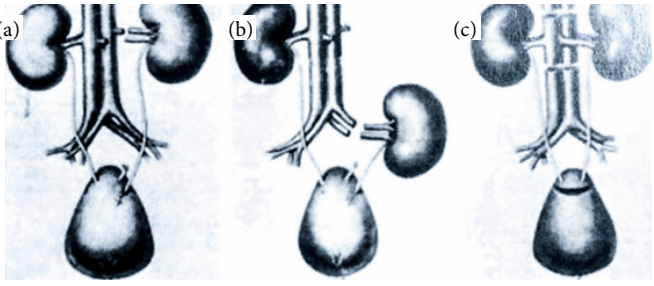
Figure 1. (a) End-to-end anastomosis; (b) Triangulation, a suturing technique for small vessels.

Source: Taken from Carrel and Guthrie (1905)[9] and Carrel (1902).[8]

Figure 2. (a) Schematic drawing of the suture by triangulation; (b) Patching anastomosis.

Homologous, autologous and conserved vascular grafts led to the development of methods for preserving vessels and organs at low temperatures and preservation media. In 1910, he demonstrated that vases withstand long periods of frozen storage.

All of Carrel's studies and research had a practical humanistic objective, so he devoted a good portion of his time to experiments with organ transplants (kidneys) (Fig. 3).



Source: Taken from Carrel and Guthrie (1906)[10] and Carrel (1908).[11]

Figure 3. (a) Renal reimplantation; (b) Renal implantation in iliac vessels and ureter in bladder; (c) En bloc renal transplantation.

He was a man ahead of his time... He worked continuously to preserve tissues and save lives due to his remarkable humanitarian characteristic. In recognition of his work in developing living-to-living blood transfusion and linking donor and recipient vessels, he was awarded the Nobel Prize in Medicine in 1912.

In 1914-1919, during the First World War, he returned to France to serve in the army in the medical corps as a Major. He then developed the antiseptic known as Carrel-Dakin to treat war wounds, which was widely used for several years.

Continuing his studies, he developed a machine to preserve organs removed from the body, the basic principle of the perfusion pump, having subsequently released the book: The Culture of Organs, autologous and Homologous (Fig. 4).[12]

Source: Obtained from Carrel (1908).[13]

Figure 4. Transplantation of front limbs between dogs.

Following came a sequence of publications, such as: "Man, The Unknown", a philosophical book with humanist refinement, and a technical and practical book on treating infected wounds.

His unshakable curiosity for world events and his ability to gather scholars made him work in several areas of science; he performed successful valvotomy with Theodore Tuffier and sarcoma cell culture with Burrows. This genius did not stop and studied different aspects of the field of oncology, valuing other aspects of tumor cell reproduction. He insistently experimented and surveyed, with his thoughts focused on the improvement he could provide patients, a humanistic characteristic that accompanied him throughout his life. In 1908 he performed his first transplant of forelimbs between two dogs (Fox Terrier breed), news received in the scientific world with astonishment (Fig. 4).

Carrel received several awards and commendations: Doctor of Medicine from the University of Lyon (1900); Doctor Honoris Causa from the University of Belfast (1919), Columbia (1913), Brown and Princeton (1920), New York (1937), Manhattan College (1938), University of California (1936); Doctor of Arts and Letters (1936); Doctor Honoris Causa in Sciences from New York University (1939); Nord-hoff-Jung Cancer by tissue culture and repercussions and recognition of malignant tumors (1931); Saint Michael and Saint George Distinctions; in addition to numerous medals and distinctions in England, Spain, Sweden, France, Belgium, Italy and the USSR. He participated in several European scientific societies: France, Spain, Russia, Sweden, Holland, Belgium, Vatican City, Germany, Italy and Greece.

He received the Nobel Prize in Medicine in 1912 for his research and standardization in vascular suturing, which were the basis for developing an operative technique, both curative and therapeutic, very advanced for its time.

A DOCTOR

Carrell, the Doctor, worked hard on the purposes that guided his life of humanism; he studied for the good of humanity with each discovery he made and said: "Intelligence is almost useless to those who only and only have it". Always ahead of his time, he acted as a disciplined physician in all his studies, that converted to practical applicability in his path of dedication. Thus, the principles of vascular surgery, heart surgery and organ transplantation were born.

He possessed a humility inherent in privileged minds when he bowed to the miracle of a patient cured of cancer when visiting Lourdes. Since then, he abandoned atheism and returned to Catholicism without losing the clarity and transparency of the limitation of science.

Although he was well adapted to life in New York, with the outbreak of the First World War, he decided to return to his native country. He did hard work treating war wounds. He considered that the time taken to transport the injured person was fundamental in the occurrence of infection, so he developed "Carrel's ambulance". He establishes care protocols, debridement of wounds and removal of dead tissue. New antiseptic solutions are created with the support of the Rockefeller Foundation

by sending the English chemist Henry Drysdale Dakin; the Carrel-Dakin solution appears, a new concept in treating wounds. At first, it was heavily criticized for bringing new approach criteria to treating wounds, but later the criticisms were reconsidered, and success was recognized internationally.

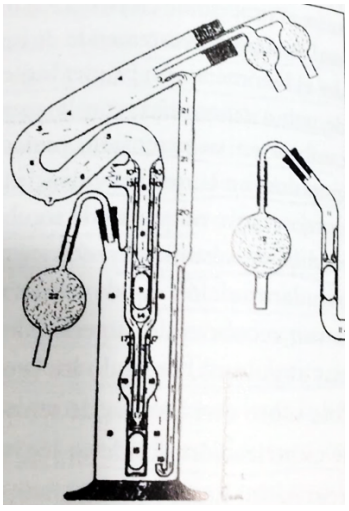
The systematic, precise, disciplined and meticulous work contributed globally to developing studies on infectious agents. His moral stature again grants him fame and a pilgrimage of renowned surgeons to his laboratory to know and analyze, admitting the success of the applied method.

A VISIONARY MAGICIAN

As a visionary, the clinical significance of the basic principles developed by Carrell was only later understood, and so were the techniques of vascular surgery applied in various areas of medicine, such as vascular sutures and organ transplants. In the 19th century, he envisaged performing organ transplants and performed them in kidneys,[10,11]thyroid gland, adrenal gland, ovary, intestine, heart and spleen, as well as the studies that outlined and supported the current transplants. In 1905 Carrel and Guthrie[9]they performed extremity transplants in dogs (Fig. 4), and in 1910, they transplanted the heart and lung together in an animal.[14] In 1921, Carrel and Ebeling performed a corneal transplant. His surgical aptitude has always been a determining factor in his life, as well as his moral integrity, persistence and discipline.[7]

The next journey was the study, conservation and culture of tissues and organs for planning transplants and studying the behavior of neoplastic tissues.[15] Carrel cultivated a fragment of embryonic chicken heart tissue, evaluating the temperature, plasma culture medium, composition, and interference of microorganisms; the tissue remained alive for 34 years, creating the false interpretation of immortality by laypeople; he envisaged the development of substitute organs.[12]

And his bright life went by in leaps and bounds from 1931 to 1935; Carrel and Lindenbergh[16] developed equipment ("artificial heart") to maintain tissue perfusion and viability, a machine capable of nourishing, oxygenating and keeping tissues alive (Fig. 5), starting the modern era of organ preservation and transplantation, whose physiological foundations constituted Carrel studies.



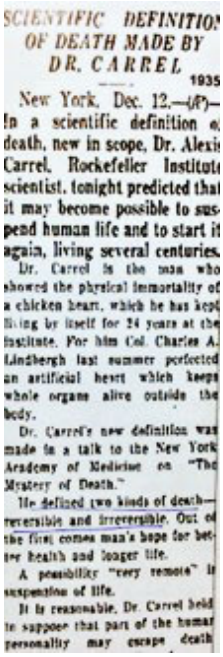
Source: Taken from Lindbergh (1931).[16]

Figure 5. Scheme of the Carrel-Lindberg artificial heart (current perfusion machine).

It was a restless and hardworking mind pursuing new challenges and theories but constantly elaborating, as a whole, the set to be studied in detail at each stage: experimental techniques, inadmissible for the time, physiology, inclusion of pioneering concepts and questioned by eminent researchers of the time. He was a visionary ahead of his time.

He left for a future life that was not recorded in monuments but what amalgamated the lives of those who lived with him and succeeded him, left an infinite path of the primordial principles of the treatment of the sick, bequeathed us the cornerstone of sutures, transplants of organs, tissue preservation, anatomical and physiological principles, in short, a set of knowledge that underpinned the surgery of our century with the development of anastomosis techniques, conservation and treatments for patients uniquely and incomprehensibly at the time. He has contributed to developing transplants and worked on kidney and limb autotransplantation (homologous) kidney transplantation between cats, thyroid, ovaries, and visceral and limb implants.

Carrel advanced further in his research and realized he needed to evolve in his studies, starting tissue cultivation. New methodologies have been improved to fulfill your restless mind in obtaining effective treatment for human beings. The lay press publishes a discussion about the reversibility and irreversibility of life (Fig. 6).



SCIENTIFIC DEFINITION OF DEATH MADE BY DR. CARREL

1935

New York, Dec. 12.—(AP)—In a scientific definition of death, new in scope, Dr. Alexis Carrel, Rockefeller Institute scientist, tonight predicted that it may become possible to suspend human life and to start it again, living several centuries.

Dr. Carrel is the man who showed the physical immortality of a chicken heart, which he has kept living by itself for 24 years at the institute. For him Col. Charles A. Lindbergh last summer perfected an artificial heart which keeps whole organs alive outside the body.

Dr. Carrel's new definition was made in a talk to the New York Academy of Medicine on "The Mystery of Death."

He defined two kinds of death—reversible and irreversible. Out of the first comes man's hope for better health and longer life.

A possibility "very remote" is suspension of life.

It is reasonable, Dr. Carrel held, to suppose that part of the human personality may escape death

Source: New York press release (1935).

Figure 6. Note from the press about Carrel's death code.

One of his most relevant works was the study of the transmissibility of characters linked to genetic inheritance, studies carried out in animals.

AN ARTIST

Carrel was a brilliant researcher. However, his artist's soul burned when he elaborated theories of well-performing experimental operative procedures in animals or humans when he put his dreams into execution.

The end of the 19th and 20th centuries was permeated by remarkable evolution in science and society, with Marxist theory and art with the splendor of impressionism, but his talent did not succumb to the storms of his time; he had great patience, which is peculiar to artists, originality that is an effort of will and intense observation that generated his work and life.

Surgery is like art: there is arid work in which the spirit is agitated because you have to think about a thousand things simultaneously in a single moment, but Carrel did not give up on the intention of building a human masterpiece. Just as clay for a sculpture comes from the human being, the colors in painting come from the nature of God, and humanism comes from building character. That's what matters in life... It doesn't matter what you do; the important thing is to develop human nature with pleasure, method and respect.

Working from sunrise to sunset makes human beings better if we can rationalize without losing our dream, aim without losing the nuances of the path, being responsible for the divine work. We need to learn to work and make each medical procedure a new masterpiece. That's why we return to the mass we were made of and dedicate ourselves to the elaboration of new technical principles of knowledge without losing humanism. Our art is present in each suture, in each new technique, and in each new path. That is the surgeon's goal.

In 1935, after 33 years of Rockefeller Center service, he retired along with the director of the research center due to social deterioration with financial constraints for the institute's experimental research. He returned to France in 1939, where he found "a decadent society with corrupt politicians, with obsolete and even ignorant medicine." He suffered a lot for his beloved homeland, which humiliated him and triggered a series of heartaches that led to his death.

Carrel was the youngest researcher to receive the Nobel Prize in Medicine in October 1912, a Frenchman who was welcomed and worked on the American continent. Other awards and commendations came, but humility did not allow him to forget his primary role in life: maintaining moral, religious, technical integrity, honesty, getting rid of individuals who cultivated slander, maleficence, lies, rudeness and selfishness, as these disintegrate the human being and will never build an egalitarian and dynamic society in valuing the individual.

He was gone in the middle of the 20th century (1944). He is gone, but he left a legacy that guides the vascular procedures used in various areas of operative knowledge, the evolution of operative techniques and organ transplants and the treatment of infected

war wounds. He was tormented by WWII, in which he participated as a member of a special commission of the Ministry of Health. His disciples accompanied him on his deathbed and stayed with their master until his passing.

DATA AVAILABILITY STATEMENT

All dataset were generated or analyzed in the current study.

CONFLIT OF INTEREST

Nothing to declare.

FUNDING

Not applicable.

ACKNOWLEDGEMENT

Not applicable.

REFERENCES

1. Carrel A, Guthrie CC. Functions of a Transplanted Kidney. Science. 1905;22(563):473. https://doi.org/10.1126/science.22.563.473.a
2. Carrel A, Morel B. Anastomose bout a bout de la jugulaire et de la carotide primitive. Lyon Medical. 1902;99:114-6
3. Carrel A, Morel L. Presentation d'un chien porteur d'une anastomose arterioveineuse. Lyon Med. 1902;99:153.
4. Carrel A. The surgery of blood vessels, etc. Bull Johns Hopkins Hosp. 1907;18:18-28.
5. Carrel A. The transplantation of organs: a preliminary communication. JAMA 1905;XLV(22):1645-6. https://doi.org/10.1001/jama.1905.52510220031001i
6. Carrel A, Guthrie CC. Extirpation and Replantation of the Thyroid Gland with Reversal of the Circulation. Science. 1905;22(565):535. https://doi.org/10.1126/science.22.565.535.a
7. Carrel A. Suture of blood-vessels and transplantation of organs. In Nobels Lectures, Phisiology or Medicine 1901-1921. Amsterdam: Elsevier Publishing Company; 1967.
8. Carrel A. La technique opératoire anastomoses vasculaires et la transplantation des viscères. Lyon Méd. 1902;98:859-64.
9. Carrel A, Guthrie CC. The transplantation of veins and organs. Am Med. 1905;10:1101-2.
10. Carrel A, Guthrie CC. Successful Transplantation of Both Kidneys from a Dog into a Bitch with Removal of Both Normal Kidneys from the Latter. Science. 1906;23(584):394-5. https://doi.org/10.1126/science.23.584.394
11. Carrel A. Transplantation in mass of the kidneys. J Exp Med. 1908;10(1):98-140. https://doi.org/10.1084/jem.10.1.98
12. Carrel A, Lindbergh CA. Culture of Whole organs. Science. 1935;81(2112):621-3. https://doi.org/10.1126/science.81.2112.621
13. Carrel A. Results of the transplantation of blood vessels, organs and limbs. J Am Med Assoc. 1908;51(20):1662-7. https://doi.org/10.1001/jama.1908.25410200010001b
14. Carrel A. Experimental surgery of the aorta e heart. Ann Surg. 1910;52(1):83-95. https://doi.org/10.1097/00000658-191007000-00009
15. Carrel A, Burrows MT. Culture de substance rénale en dehors de l'organisme. CR Soc Biol. 1910;69:298-9.
16. Lindbergh CA. Apparatus to circulate liquid Under constant presue in a closed system. Science. 1931;73(1899):566. https://doi.org/10.1126/science.73.1899.566.a