

# The beginning of modern kidney transplantation

One hundred years ago, in 1906, Alexis Carrel and Charles Guthrie published a paper in *Science* entitled 'Successful transplantation of both kidneys from a dog into a bitch with removal of both kidneys from the latter'. This marked the beginning of the scientific study of organ transplantation. It established the technical possibility of kidney grafting, principally by the development of a satisfactory method of suturing fine blood vessels. However, another half century would pass before the biological problems of foreign organ rejection were to become first fully understood and overcome.

Carrel had a remarkable, and unique career. He was born in 1873 in a village in the outskirts of Lyon and qualified at the famous medical school of the University of Lyon in 1893. At Lyon he worked under Mathieu Jaboulay, who attempted renal transplantation on two occasions, by grafting a pig's kidney to the vessels at the elbow of a patient in renal failure and a goat's kidney to a girl with advanced renal tuberculosis. Both kidneys failed to function and were removed. Carrel, as a young resident, experimented on the suture of blood vessels, using fine needles and delicate thread obtained from Lyonnaise lace workers, with some success. In 1904 he obtained a research post in the physiology department of the University of Chicago, and was assigned to work with Charles Guthrie, a lecturer in physiology. This resulted in a remarkably fruitful 2-year collaboration, with joint publication of 21 papers.

Their first contribution was to show that a successful vascular anastomosis depended on a meticulous aseptic technique. They developed very fine needles and delicate sutures of silk. Great care was taken to avoid picking up and therefore damaging the edges of the cut vessel with forceps. They devised the triangulation technique, whereby the two ends of the vessel to be sutured were first approxi-

mated by three sutures, spaced at thirds around the vessel circumference. Retraction on each of these sutures in turn held the vessel ends together for far easier insertion of a continuous stitch. As a result the successful suture of arteries and veins, arterio-venous anastomoses and vein patching of arteries were accomplished. Surprisingly, it was not until the 1950s that all these procedures were to be transferred from the dog laboratory to the clinical setting. They even showed that the amputated limb of the dog could be grafted back in place – a procedure that waited until 1962 for its human application, when a 12-year-old boy had his severed arm replanted at the Massachusetts General Hospital in Chicago.

In Lyon in 1902, Carrel transplanted a dog's kidney to its neck, joining the renal vessels to the carotid artery and the internal jugular vein. The ureter was brought out onto the skin of the neck. The kidney functioned for several days but the animal died of infection.

Carrel and Guthrie performed numerous experiments showing that dogs could survive in health if one kidney was transferred to the neck and the other removed. However, transplantation of a kidney from one dog to another would fail in a matter of days. Carrel was clearly aware that he

had overcome the technical problems of organ transplantation, (including ovary, thyroid and even the heart), but he was defeated by the biological problems of grafting from one animal to the other, even of the same species.

Some of his other achievements include his being appointed in 1906 to the Rockefeller Institute in New York, where he remained for the rest of his career. Here he continued his transplant work, but in other experiments showed that he could graft the dog's aorta or inferior vena cava preserved in ice cold saline to replace the aorta of the cat, a procedure not used clinically till after World War II. He experimented with lung resection and endotracheal anaesthesia, carried out direct heart surgery in the dog and predicted that it would be possible to operate on diseased heart valves. He experimented on tissue and organ culture and during the First World War carried out important studies on wound healing and infection in a specially established hospital behind the front line on the Western Front. He was awarded the Nobel Prize for Physiology and Medicine in 1912, and died in 1944. **BJHM**

Carrel A, Guthrie CC (1906) Successful transplantation of both kidneys from a dog to a bitch with removal of both normal kidneys from the latter. *Science* 23: 591

**Alexis Carrel and his fiancée, Anne de la Meyrie Paris, 1913.**



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