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Head Transplant Surgeries and Brain Cooling Technique: A Pictorial Review

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Abstract

The aim of this review is to see the development of head transplant surgeries over time and highlight the big obstacle in the way of this neurosurgery to succeed which seem very difficult at the time of publishing this paper.

Keywords: Head transplant, Body transplant, Cephalosomatic anastomosis, Brain cooling technique, Surgical experiment

Introduction

If you have a ship made of wood and every day you change one wood. After a while you will have a new ship. Likewise, human bodies change their cells since day of birth with a few exception like the auditory cells. Human body itself change every day and regenerates new cells. Some experimental methods have been used as a preservation techniques of the brain and the body by cooling the body temperature below 110 degrees in liquid nitrogen-filled tanks. During head transplantion surgery on monkeys, lowering the blood temperature helped in protecting the brain tissue from damaged using this technique which is known as therapeutic hypothermia. Neurons in the brain die in the hippocampus which results in losing a memory (1). When neurons are generated by stem cells, omnipotent cells (i.e. using transcription factors), brain tissue engineering could generate a new brain tissue, but it could become a new person with no memory or different personality with no experience. The experience has been wiped out when the old neurons changed. The brain is functioning during all day even during sleep. That's how the brain works. Simulating the brain with depth electrodes to give the neurons a signal might keep these cells functioning to avoid losing the function or the experiences. Our neurons shaped by our experiences or what is known as neuroplasticity. After 15 minutes of death, the brain will have an irreversible damage due to lack of oxygen. Many cases of death due to being frozen in the ice and undergo brain scans showed that these cases have no hemorrhage, but there are no sulci seen as in lissencephaly (i.e. flat brain surface).

Head Transplant Surgeries

Head transplants surgeries are done depending on cooling technique that allows the brain tissue stay intact with low blood temperature. This surgery is done on a human head by transplanting the head onto another living body during head transplant surgery, sometimes referred to as a whole-body transplant or cephalosomatic anastomosis. A Soviet surgeon named Yevgeny Chazov suggested the idea of a head transplantation at the beginning of the 20th century. According to Gkasdaris et al., (2) the first surgery was done in 1908, which was a head transplant surgery on a dog was done by Charles Guthrie to make a dog with two heads which was a bizarre useless surgery (Figure 1). The second surgery was made

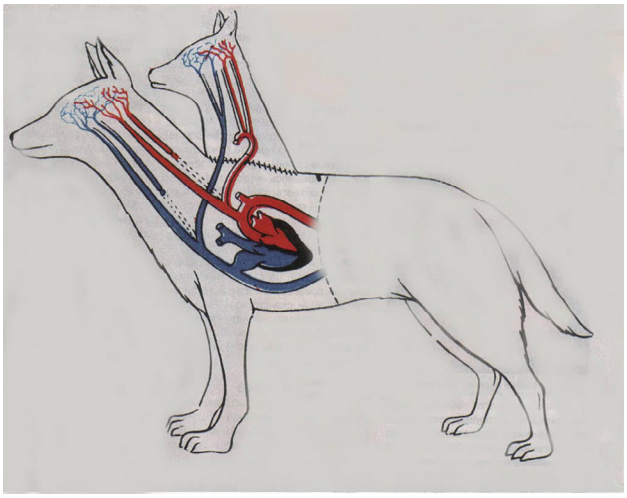

Figure 1: The surgery that was done by the Russian surgeon.

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by the Soviet Surgeon Demikhov in 1959 according to (the daily mail, 2021). This surgery was done to attach two dogs, one with the full body and another one just his head and paws (Figure 2). After that, head transplant surgery was done on monkeys in 1970 by Dr. Robert White, a Neurosurgeon (3,4). This surgery was successful for 8 days (Figure 3-5). Dr. White thought he could keep monkeys' brains working outside the skull with blood supply and electrical stimulation which was wrong then he turned to head transplant surgery. The donor's body is cooled then the neck's blood arteries are painstakingly cut to be joined with the new body to receive enough blood. When the spinal cord is cut in the donor then it will be attached by a substance called polyethylene glycol. Then different groups were successful in performing a head transplant on rats (2). Then an Italian Neurosurgeon named Sergio Canavero attempted to do the operation in the twenty-first century (5). And in 2016, the Italian neurosurgeon claimed that another surgical research group in China followed the footsteps of Dr. White by doing a head transplant surgery on monkeys. Then in 2017, a cephalosomatic anastomosis procedure was done on a cadaver by (6).

Figure 2: The soviet surgeon Demikhov and his two attached dogs.

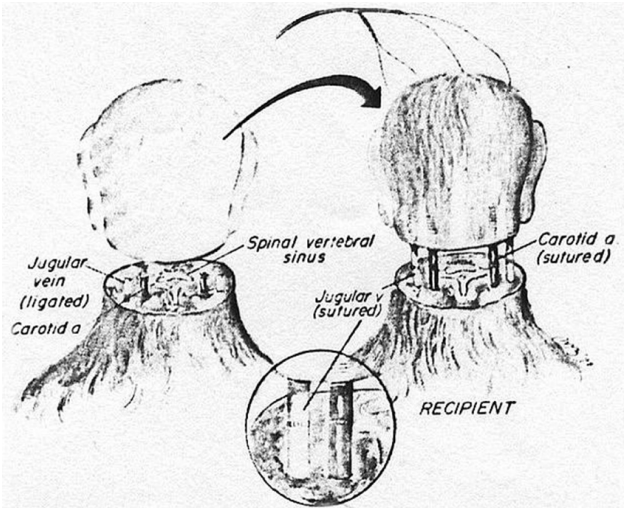

Figure 3: Dr. White's sketch of how the surgery will be done.

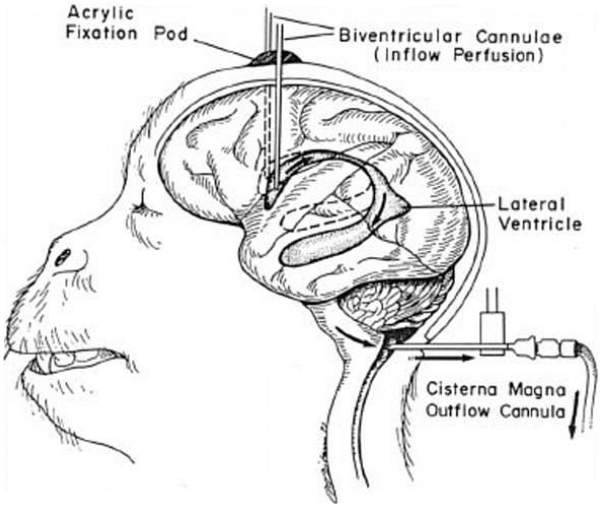

Figure 4: Another sketch by Dr. White for the brain cooling technique.

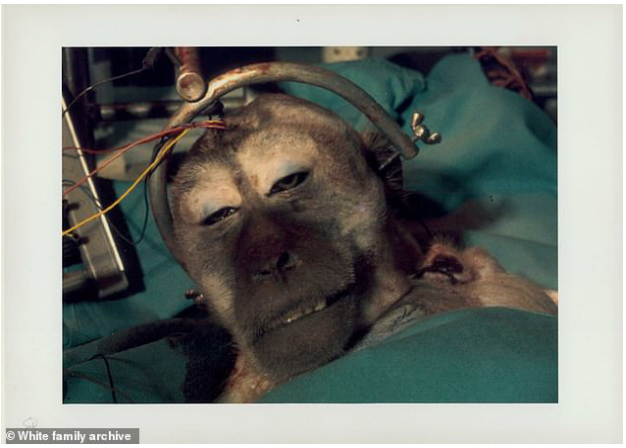

Figure 5: Dr. White's monkey who died 8 days after the surgery due to rejecting of the transplanted head by the body.

The patient who has a damaged brain can use a new head of a donor that something bad happened to his body, but his head is intact. The reason of doing a head transplant surgery, not a brain surgery, is because the brain is difficult to take out due to having many blood vessels and being attached to meninges. The head transplant is

easier by taking the whole box and its contents (the skull and the brain). But the patient face will change to someone else and his brain will be for the previous person. It is well known that heart transplant surgery makes the recipient have feelings and personal traits of the donors. They see dreams of people that they do not know, which presented in many cases in the literature (7). The person will have that person ideas and memories. If this surgery is done one day, the brain will have irreversible damage in 15 minutes, but by cooling the brain, the time can be extended and the damage is delayed. The cooling occurs by cooling the blood in the neck's vessels. And Dr. White used the brain cooling technique to allow the transplant to be done. Another issue in the transplant is cutting the spinal cord which will make the patient quadriplegic.

Such surgery has an ethical issue, psychological issues (i.e. personality, memories, personal preferences of the donor's, etc.), the long-term complications, social issues (i.e. having the face of the donor and not being recognized by family and friends), etc. Is the recipient of the head will remain the same person? Or the recipient will be more similar to the donor? Or a mix of both? Nobody knows. Is our consciousness, perception, selfhood, thoughts, and the way of thinking will change? There are many philosophical difficulties that needs to be answered. As well, how from a surgical and immunological point of view, is this surgery is possible? There a re serious c omplications a fter th e surgery that include: rejection of the transplanted head, paralysis, infection, and death. The nerve regeneration and function recovery were seen in animals, but is it the same in humans? To sum up, head transplant surgery is a brave and uncharted territory for the medical industry. Although there are many exciting potential benefits to such a process, there are also significant ethical, technical, and practical concerns that need to be carefully considered. For example, the consent and autonomy are another ethical issue for this high-risk surgery. Can criminals get a new head that will help them to be more productive and less trouble maker? Do they still get the punishment after literally changing their heads?

The t echnical i ssues i n t he s urgery i s t he s ize o f t he skull, the weight of the head, the circumference of the neck of the donor's to fit with the neck of the recipient, the color of the skin matches between the donor and recipient, etc. Also, the fixation method of the skull on the neck or on the vertebral column, needs to be able to take hits and not fall off with a minor trauma.

In order to make the surgery successful, many tasks need to succeed first. These tasks are; reattachment of the spinal cord, stopping the immune reaction, increase nerve regeneration, and improve the surgical techniques. The long-term effects post-surgery that needs to be highlighted are the psychological care and the physical therapy. In addition, there is a need for rules who can and who can't undergo the surgery. The cost and health insurance for such surgeries need to be addressed. Such a surgery seems hard to be achieved now, but with advancement in surgical techniques and new immunology medications, it might be possible in near future just like any other surgery.

Conclusion

This surgery seems difficult to achieve, but with development of surgical techniques and immune suppression medications, it might work. The success of such surgery will start a revolution in psychology, philosophy, medical ethics, and the medical field in general.

Conflict of Interest

Authors declare no conflict of interest.

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