

THE HUMAN HEAD TRANSPLANT – THOUGHTS FROM THE POSSIBLE REALISTIC SCENARIO

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ABSTRACT

Probably one of the strangest, most unusual, eccentric and impossible ideas – the human head transplantation – has fascinated scientists and normal people alike for hundreds of years. Some of these scientists thought up and executed various experiments that were more and more interesting and crazy for that time; experiments that represented the great goal steps (head transplantation) that could be done today, in the near future or maybe even never. These experiments stirred controversy, fear, curiosity and hope alike; out of these concerns and experiments was born author Mary Shelley's masterpiece Frankenstein (1818). In 2015, numerous publications announced that Italian professor Sergio Canavero wanted to perform the first human head transplant in 2017. Canavero's volunteer is a Russian man suffering from Werdnig-Hoffman disease, an incurable illness that affects his body but leaves his head and therefore his brain intact. Since then, scientists from all over the world have begun to challenge such a procedure, citing reasons such as religion, Italian law, medical ethics, the waste of the donor's organs, the recipient's non-acceptance of the new body, etc. However, the approval and success of this procedure, which is currently at the theoretical, pre-experimental stage, promises a normal life for such patients – after full recovery, both physically and mentally. We can say that this procedure is among the last frontiers that humanity will be able to overcome; if such a procedure is successfully completed at some point in the future. Assuming that in the future, a specialist in the world, will successfully complete the first human head transplant; then the decades to come will raise a lot of questions in areas such as: national legislation of each country, criminal procedures, identity, criminology, ethics, religion, psychology and psychiatry, medicine, etc.

KEYWORDS: head transplantation; body transplantation; criminal procedures; identity.

INTRODUCTION

In September 2014, the Italian doctor Sergio Canavero gives a presentation at the TEDx communications sessions where he talks about human head transplantation and another presentation in March 2015 with the same topic (TEDx Talks/YouTube, 2014; TEDx Talks/ YouTube, 2015). Since 2015, the international press (THE GUARDIAN, 2017; THE TELEGRAPH, 2017; CNN HEALTH, 2015) and even the Romanian press (ȘTIINȚĂ ȘI

TEHNICĂ, 2016; LIBERTATEA, 2017) start to write about Dr. Canavero's plan. Thus different points of view and beliefs are born and scientists around the planet (as well as normal people) are divided into those who believe in Canavero's idea and the new techniques he proposed wishing it to succeed, and those who believe that the Italian doctor wants to create a real and modern Frankenstein's monster and that for this reason Canavero should be stopped. Those who do not agree with the Italian doctor's techniques and idea cite all the reasons to stop him: religion, ethics, psychosocial considerations, etc. (Furr A *et al.*, 2017).

However, ideas such as studying the brain, reanimating the head and even the idea of head transplantation are not new; they are at least 200 years old (19th century) and are promoted by personalities from Italy (Giovanni Aldini), England (Mary Shelley), France (Brown-Séquard, J. B. V. Laborde and Alexis Carrel), Russia (Vladimir Demikhov) and America (Charles Guthrie and Robert White). Apart from Mary Shelley, all the others were scientists who contributed to current knowledge and techniques related to brain, head and transplantation through their work (Furr A *et al.*, 2017; Shelley M, 2010; Roach M, 2018; Parent A, 2004).

STEPS TOWARDS SUCCESS

Giovanni Aldini (Italian scientist, 1762-1834) supports the concept of animal electrical stimulation (galvanism) developed by his uncle Luigi Galvani. After his uncle's death, Aldini switched from experiments on frogs (undertaken with Galvani) (Mary Shelley, 2010; Parent A, 2004) to experiments on birds, lambs, oxen and calves; thus, he obtained positive reactions from several regions following electrical stimulation of an ox's brain in his attempt to determine the relative sensitivity to galvanism of different brain regions. Believing in the therapeutic nature of galvanism, the Italian scientist took the next step and moved from experiments on warm-blooded animals to those on human subjects (human corpses); he therefore managed, with the help of doctors and instruments (a voltaic battery with numerous zinc and copper discs), to apply galvanism to the brain regions of three murderers beheaded in Bologna in 1802 (and who came into the scientist's possession within an hour of the beheading). Following this experiment, Aldini notes that he was able to produce muscle contractions of all kinds following electrical stimulation of various points on the heads and bodies of the three corpses, and that the corpses responded to stimulation up to three hours post-mortem, confirming the results of earlier experiments with Galvani on frogs.

Disappointed that the heart does not respond to galvanism (as voluntary muscles do), Aldini consults Dr Mondini and ends up turning his attention to

stimulating the brain. By stimulating a particular hemisphere of the cerebral cortex, the scientist obtains contractions of the facial muscles on the opposite side of the face; but unfortunately Giovanni Aldini does not continue his research along these lines (Parent A, 2004).

Giovanni Aldini goes on a tour of Europe to promote galvanism and his work. Following a demonstration carried out on the body of an executed murderer who convulsed giving the false sensation of reanimation, Aldini ends up with his experiments in the London newspaper "The Times" (12 January 1803) which reports in detail what happened during the demonstration.

At the same time, scientists were trying to understand and measure the essence of life. Following Aldini's tour, many people (scientists and normal people) began to believe that electricity could be the much sought-after life force, and at the same time began to wonder whether it was possible for electric shocks to bring people back to life. Others went much further and wondered whether it was possible to assemble and bring to life a body made of different component parts. This question came almost naturally if we consider that at that time things were not fully understood enough to know where to draw the line; for this reason all of the above seemed possible. This state of mind then present among humans was excellently rendered in the writer Mary Wollstonecraft Shelley's *Frankenstein* published in 1818 (Shelley M, 2010; Parent A, 2004).

Charles Edouard Brown-Séquard (French physician, 1817-1894) devised and carried out a daring and strange experiment in 1857: he cut off a dog's head to administer arterial blood, thus demonstrating that he could reanimate the head. Eight minutes post-decapitation Séquard begins to administer blood to the head, waits 2-3 minutes and then records movements that appear to be voluntarily directed (movements of the muscles and eyes); thus being able to conclude that something was going on in the brain (inside it) (Roach M, 2018).

Jean-Baptiste Vincent-Laborde (French physician, 1830-1903) makes an agreement with the French authorities in 1884 to provide him with the heads of guillotined people in order to examine their brains, wishing to find out, like other people, whether a severed head can be revived and whether it is aware of the fact that it is guillotined. Laborde's procedure involved drilling holes in the skull and inserting needles through those holes into the brain in an attempt to elicit nervous system reactions. During this time Laborde also applied Séquard's protocol (not forgetting to pump blood into the heads) (Roach M, 2018).

The first decapitated head was supposed to arrive in Laborde's laboratory in 7 minutes, but it arrived after one hour and twenty minutes

because of the law of that time which said that scientists could not take possession of the corpse unless it had passed through the cemetery gate. As expected the brain showed no signs of functionality.

Deciding not to waste so much time on a second head, the doctor is determined to wait for the head at the cemetery gate, which prompts him to set up a mobile laboratory. Laborde takes the head to the cemetery, puts it in a container and his men start work according to the protocol the doctor has drawn up. Using needles in the brain, the French doctor's team introduces electricity and observes movements of the jaw and lips, only to find later that one of the eyes (which seemed to be trying to figure out where it was) is open. Today we know that this is a primitive reflex in fact, given the time that has elapsed since the beheading.

Wishing to minimise the time it takes to get his third head, Jean-Baptiste Vincent-Laborde bribes a town hall official and ends up with the head in the laboratory just 7 minutes after the beheading. Here, the doctor injects oxygenated cow's blood through the arteries on the right side of the back of the head and violates the Séquard protocol by connecting the arteries on the left side to the arteries of a live dog. In this third case Laborde comes closest to restoring normal brain function, managing to see contractions of the eyelid, jaw and forehead muscles.

Today we know that brain death sets in and becomes irreversible after 6-10 minutes; and Laborde's head (the third) was supplied with blood 20 minutes after cutting (Roach M, 2018).

Charles Claude Guthrie (American physician, 1880-1963) and **Alexis Carrel** (French physician, 1873-1944) were the first in the world to master the technique of anastomosis, in 1908; that is tying two blood vessels together so tightly that the blood flowing through them cannot drain out. Having mastered the necessary technique, the two doctors made extensive use of anastomosis and were able to keep kidneys alive outside the body, and even managed to integrate kidneys into the abdomens of animals; and to transplant whole thighs and paws from one dog to another. For this achievement Carrel was awarded the Nobel Prize in 1912 (Furr A *et al.*, 2017; Roach M, 2018).

Also in 1908, Guthrie made the world's first bicephalic dog. He transplanted the head of one dog onto the body of another, attaching the head to the dog's neck and modifying the blood vessels so that the blood followed the route: body, attached head, 'whole dog' neck, 'whole dog' brain and finally back into the body. This bicephalic dog becomes legendary. A picture of this animal was published in Guthrie's book "Blood Vessel Surgery and Its Applications". The American doctor notes that if the time elapsed between the moment of decapitation and the moment when blood circulation is restored

exceeds 20 minutes, then the head, and by implication the brain, does not fully recover its functions.

Some people argue that Guthrie may have been excluded from the Nobel Prize by committee members because of his controversial transplant experiments (Furr A *et al.*, 2017; Roach M, 2018).

Vladimir Demikhov (Russian physician, 1916-1998) is known as the father of heart and lung transplantation as Christian Bernard admits in gratitude for his work, he was the first surgeon to experimentally perform the first coronary artery bypass operation and the first intrathoracic transplant operation. Demikhov performs the bypass operation in the summer of 1953 using blood vessel suturing machines. He had a vision of using his technique on a large scale and so decided to explore the possibility of clinical application. Although the Russian surgeon reaches out and experiments the technique on cadavers, it does not seem feasible for the early 1960s, but rather eccentric and impractical. Vasilii Ivanovich Kolesov undertakes experiments using coronary bypass surgery between 1964 and 1967, acknowledging Demikhov in his publications as the pioneer of the technique (Roach M, 2018; Konstantinov I E, 2009).

In 1954 surgeon Vladimir Demikhov performed the first canine head transplant to see if and how the dog would survive. The transplant is a success because the surgeon minimizes the time the severed head is deprived of blood and oxygen with the help of the blood vessel suturing machine. So Demikhov performs 20 such head transfers (head-shoulders-lungs-front-limb assemblies more correctly) on the bodies of mature dogs. The longest survival of such an animal was 29 days. This news spread so quickly that the newspapers of the time were full of discussion, controversy and various points of view about the surgeon's work, and he was accused of quackery because of the outrage created in the medical world. Demikhov's monograph was published in 1960 in Moscow and was translated in the following years into English, Spanish and German and is considered to be the first book in the world to discuss intrathoracic transplantation (Roach M, 2018; Konstantinov I. E, 2009).

Robert Joseph White (American physician, 1926-2010), through his experiments, extracts the brains of animals and keeps them alive by connecting them to the circulatory system of other animals. Interestingly, the American surgeon found that cooling the brain (used to slow down cellular degradation processes) during the procedure made it possible to preserve most of the organ's functions. Unlike Demikhov, White had the advantage of the advent of the first suppressive drugs, so he benefited from solving the problem of tissue and organ rejection.

R.J. White achieved the incredible in 1971 when he transplanted the head of a monkey onto the body of another monkey after an 8-hour operation. The animals that came out of the operation lived between 6 hours and 3 days due to haemorrhages or rejection of the organisms (the animals were given anticoagulant medication). In the same idea and going a step further, White wants to perform head transplantation in humans but fails to do so because no human wants to volunteer for such a procedure (Roach M, 2018).

Sergio Canavero (Italian doctor, 1964-present) develops two protocols, based on information gathered from his predecessors, that promise to make human head transplantation possible. The procedure called HAVEN ("head anastomosis venture") requires the recipient's head to be placed in a state of hypothermia so as to prevent neurological damage (about 45 minutes at a temperature of 12-15°C). The second procedure/protocol called GEMINI proposes the sudden and careful severing of the spinal cord fibres using an extremely sharp blade to make as precise, fine and accurate a cut as possible, leaving minimal associated tissue damage. After the head is reattached to the new (donor) body, Dr. Canavero will use a PEG (polyethylene glycol) substance that has fusogenic capabilities so as to facilitate the reconnection and remyelination of axons (effects proven *in vitro* and *in vivo* rat studies). And finally, electrical stimulation of nerve fibres will be used to accelerate patient recovery.

Together with his Chinese collaborator Dr. Xiaoping Ren, the Italian doctor conducts a series of experiments on animals and even human cadavers which in the end seem very convincing so that the two doctors conclude that the HAVEN and GEMINI procedures are feasible and can be implemented immediately. Similar or different experiments have been carried out by other researchers, which the Italian doctor seems to have taken into account. However, scientists around the world dispute the feasibility of Canavero's proposed procedures, and others are vehemently opposed to the idea of head transplants, citing religious, ethical, psychosocial, high cost, organ waste, the "Frankenstein effect" and many other reasons. Canavero does not perform a human head transplant until 2023 (Furr A *et al.*, 2017; DownToEarth, 2015; Medical News Today, 2013; Canavero S and Ren X, 2016; Canavero S, 2015; Ren X *et al.*, 2017; Sabino L *et al.*, 2018).

HUMAN HEAD TRANSPLANTATION – PROS AND CONS

We will exclude the part about the surgical procedure itself because it has been discussed many times in numerous articles.

Ethics. Head transplantation is not considered to be ethical for several reasons (Furr A *et al.*, 2017; Gkasdaris G and Birbilis T., 2019):

- The risk taken by both the medical team and the patient is far too great and if something goes wrong during the surgical procedure, the operation will turn from curative to euthanasia.
- Because it is a sensitive and complicated subject, there is not enough data and experiments to prove the success of transplantation. Proponents point to animal experiments conducted in the past that have recorded minutes, hours and even days of post-operative life. Others argue that such animal experiments are themselves unethical.
- Because there are so many variables during the procedure when anything can go wrong, international ethics committees conclude that the operation should not be attempted, at least for the time being.
- It is also considered that the patient in question (who would undergo the transplant) gives his consent in total ignorance; he is blinded by the illusion of a new, normal life. This delusion being amplified and even fuelled by despair, fear and perhaps even shame.

Among those who support the idea of performing this procedure, there are voices that bring to mind the context and history of the face transplant, which has "enjoyed" the same "enthusiasm" from the scientific community. In the beginning, face transplantation was maligned and there were the same ideas that doctors were "playing God". Time has shown the opposite in this case: once the procedure was successfully performed and the results proved to be very good for the patient, research addressing the subject (face transplantation) changed both its view and tone becoming tolerant especially from an ethical point of view (Furr A *et al.*, 2017).

Organ waste. It is no secret that worldwide, for various reasons, the number of people who need and receive a transplant is extremely small, with very long lists of people waiting for a transplant (Furr A *et al.*, 2017; organdonor.gov, 2023). According to organdonor.gov (2023), a website run by the Health Resources & Services Administration (America), 104 234 people (men, women and children) are waiting for an organ, and every day 17 people die waiting for a life-saving organ. The same site tells us that every 10 minutes another person is added to the transplant lists.

The black market for organs has developed most likely because the thought of death frightens most of us, or perhaps some people with money feel that now is not the time to die. Some websites estimate the price of human organs on the black market as can be seen in Table 1 (seeker.com, 2014; sciencealert.com, 2015).

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TABLE 1: Value of human organs on the black market

Organ	Value	Number of people who can be saved
Heart	1 mil \$	1
Liver	557 000 \$	at least 2
Kidney (2)	262 000 \$ x 2	2
Skin	10 \$	at least 2
Eyes (2)	1 500 \$ x 2	1
Cornea (2)	7 500 \$ x 2	1
Lung (2)	103 000 \$ x 2	1 or 2
Total amount	2 305 010 \$	

So, knowing all this information now, it seems at least difficult to choose: do we give all these organs to one man (who will get a nearly whole body after the head transplant) or do we help at least 10 others. So organ waste seems and most likely is one of the most solid and pertinent reasons why human head transplantation should not be seen as a solution that should be routinely implemented. That is to say, if the human head transplant procedure is successfully performed today, tomorrow we should not think that this type of transplant will become so common that we perform one every day.

Cost and logistics. Synthesizing information gathered from several sources (Furr A et al., 2017; vox.com, 2018; CNN HEALTH, 2015; DownToEarth, 2015; Medical News Today, 2013) we can say that at least at the moment such a surgical procedure in its experimental and pioneering phase is considered to be an inefficient expenditure of resources. Why you may ask? Well, because such a procedure would involve 150 doctors and nurses who would have to work non-stop for 36 hours and would involve a huge amount of money. In 2013 this amount was estimated at \$12.6 million (Medical News Today, 2013), and later in 2018 the amount was estimated at \$100 million (vox.com, 2018).

Psychological considerations. The idea that a person who is declared the ideal candidate for a head transplant agrees to the procedure (the person agreeing to undergo the procedure in total ignorance by allowing themselves to be bewitched by the illusion of a new, better life and despair) is the only psychological consideration taken into account by specialists prior to the procedure; with the exception of the patient's family members. Post-procedure the situation changes. Theoretically considering that the head transplant surgery has been successfully performed, scientists propose some sobering ideas such as:

- The transplant recipient may begin to be confused about their new body, even their new identity, and this requires even more attention from psychologists and psychiatrists. There is a possibility that failing to adjust to his or her new physical presence, the patient may suffer a dramatic impact that could most likely lead to insanity and perhaps even suicide (Furr A *et al.*, 2017; Gkasdaris G and Birbilis T, 2019).

*Dr. Canavero argues that these major problems can be avoided or encountered given that the human mind can be manipulated to a greater or lesser extent through techniques such as immersive virtual reality (IVR), hypnosis and brain plasticity modification techniques, as well as through manipulation of gut bacterial flora (which as we know can shape both human behaviour and mental health) (TEDx Talks/ YouTube, 2015; Dinan T G *et al.*, 2015; Hood B, 2012; Cartolovni A and Spagnolo AG, 2015).*

- As there is a possibility that the patient may not leave the operating room alive, family members should be psychologically counseled and prepared for this scenario some time before the procedure, as well as post-procedure (Furr A *et al.*, 2017; Gkasdaris G and Birbilis T, 2019).
- Considering that the surgical procedure was successful and the patient is well, the need for therapy over a long period of time should be considered. Here we are talking about: psychological therapy, physical therapy for the recovery of motor functions especially (physiotherapy), occupational therapy etc (Furr A *et al.*, 2017).

Social services. Social services should provide the patient with: housing throughout recovery, mental support, and extended unemployment (Furr A *et al.*, 2017; Gkasdaris G and Birbilis T, 2019).

HUMAN HEAD TRANSPLANT SUCCESS TODAY – WHAT TO DO TOMORROW?

Assuming that today it was announced that the person who underwent the first head transplant has recovered 100% (psychologically, sensory and motor-wise) we ask ourselves natural questions about what we need to change starting tomorrow.

Or looking at it from another angle, we have to think very carefully about what legal, medical, religious etc. changes will be required when the patient who has come through the procedure, has fully recovered and can work, hold his family in his arms, drive his car, commit crimes etc.

Changes in identity documents. Documents containing information such as height and fingerprints should be updated immediately.

Changes in the laws of the country. The situation can be complicated but even so the State must be far-sighted and take legislative decisions to normalise the quality of life of the patient who has undergone such

a procedure. This raises questions such as: "does the recipient inherit the estate of the donor's parents?". "Knowing that if the recipient (the transplant patient) has children, they will have the donor's DNA; will the donor's parents have the right to see their grandchildren?". And if the donor had children, questions such as: "does the recipient have to financially support the children until they reach the age of majority?", "do the children have the right to know who is the recipient of their father's body and will they be able to see him (the recipient)?".

Changes in criminal sciences. Forensic scientists should either demand or start doing genetic studies and experiments themselves in the first place that answer questions such as: "will the recipient's DNA (now found only in the head) be replaced over time by the donor's (body's) DNA?". And if the answer to this question is "yes", then other questions arise such as "will the replacement of the recipient DNA be complete or partial?", "how long will the exchange of genetic material take before the genotype of the new body is definitively stabilised?" (i.e. the recipient's head attached to the donor's body) and many others that follow. Depending on the answers to the questions posed earlier (and others like them), specialists will decide whether it will be necessary to determine and store the DNA profiles of the recipient and the donor. Such a protocol may prove useful in the possibility of cases where the person concerned commits some crime and biological samples are taken from the crime scene.

Changes in the medical world. The new information should be recorded in surgical treatises and new studies in physiology, anatomy, psychology, psychiatry and many other fields should be made. In addition, a new name should be found for this new type of human. Transplant agencies should convene committees to decide on new protocols that will show transparently and objectively the criteria for determining whether the donor body (and therefore organs) will help one person (for a new head transplant) or save 10 lives. These committees must also establish the criteria on the basis of which a ranking will be made to determine which patients should be placed at the top of the waiting list for a head transplant, we need to know which cases are more urgent or more eligible than others.

Transplant agencies must also decide whether donor bodies can be given to patients (recipients) of the opposite sex, thus replacing sex change surgery for transgender people who wish to complete their transition. And if so, then very well thought-out rules and protocols need to be established so that laws and ethical principles are not violated.

Religious changes. From a religious point of view, questions such as "if the donor had a different religion from the recipient, should the recipient be

re-baptised in his religion?", "when this new person dies, will he have a funeral in the religious style of the recipient or the donor?" and many other questions will be asked and will have to be answered by religious commissions.

CONCLUSIONS

The idea of head transplantation has fascinated the world for over 200 years and has inspired authors who have written about reanimating bodies or parts of them (as did author Mary Shelley in 1818), as well as scientists such as Giovanni Aldini, Brown-Séquard, J. B. V. Laborde, Alexis Carrel, Vladimir Demikhov, Charles Guthrie and Robert White.

In 2014 Italian doctor Sergio Canavero gives a presentation at TED Talks in Limassol and presents his wish and the technique he claims will achieve the first human head transplant. Over the years Dr. Canavero has been mentioned in all sorts of news reports, magazines and scientific articles either supporting or lambasting him for his idea. Even so, the Italian doctor set up an international group with Chinese doctor Xiaoping Ren to carry out studies to demonstrate the feasibility of the procedures they proposed: HAEVEN and GEMINI.

Specialists from all over the world have brought to the public's attention the pros and cons of head transplantation, or rather the procedures proposed by Canavero and Ren, among them: ethics, waste of organs, the procedure itself which does not seem feasible according to some specialists, logistics and high cost (estimated at around 100 million dollars), psychological and religious considerations, etc.

However the world needs to be prepared for the possible scenario in which the human head transplant is successful, the patient makes a full recovery and now lives a normal life. Therefore, the whole world must be prepared to modify or change laws, protocols, rights and freedoms in the areas of each country's national (but also international) legislation, ethics, identity, medicine, psychology, religion, etc.

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