First-ever human head transplant is now possible, says neuroscientist

thinking ahead

As face transplants become common, will head transplants be next? *AP/Gail Burton*

Technical barriers to grafting one person's head onto another person's body can now be overcome, says Dr. Sergio Canavero, a member of the Turin Advanced Neuromodulation Group. In a recent paper, Canavero outlines a procedure modeled on successful head transplants which have been carried out in animals since 1970.

The one problem with these transplants was that scientists were unable to connect the animals' spinal cords to their donor bodies, leaving them paralyzed below the point of transplant. But, says Canavero, recent advances in re-connecting spinal cords that are surgically severed mean that it should be technically feasible to do it in humans. (This is not the same as restoring nervous system function to quadriplegics or other victims of traumatic spinal cord injury.)

As Canavero notes in his paper:

> "The greatest technical hurdle to [a head transplant] is of course the reconnec-

tion of the donor's (D)'s and recipients (R)'s spinal cords. It is my contention that the technology only now exists for such linkage…. [S]everal up to now hopeless medical connections might benefit from such a procedure."

It's worked before, in animals

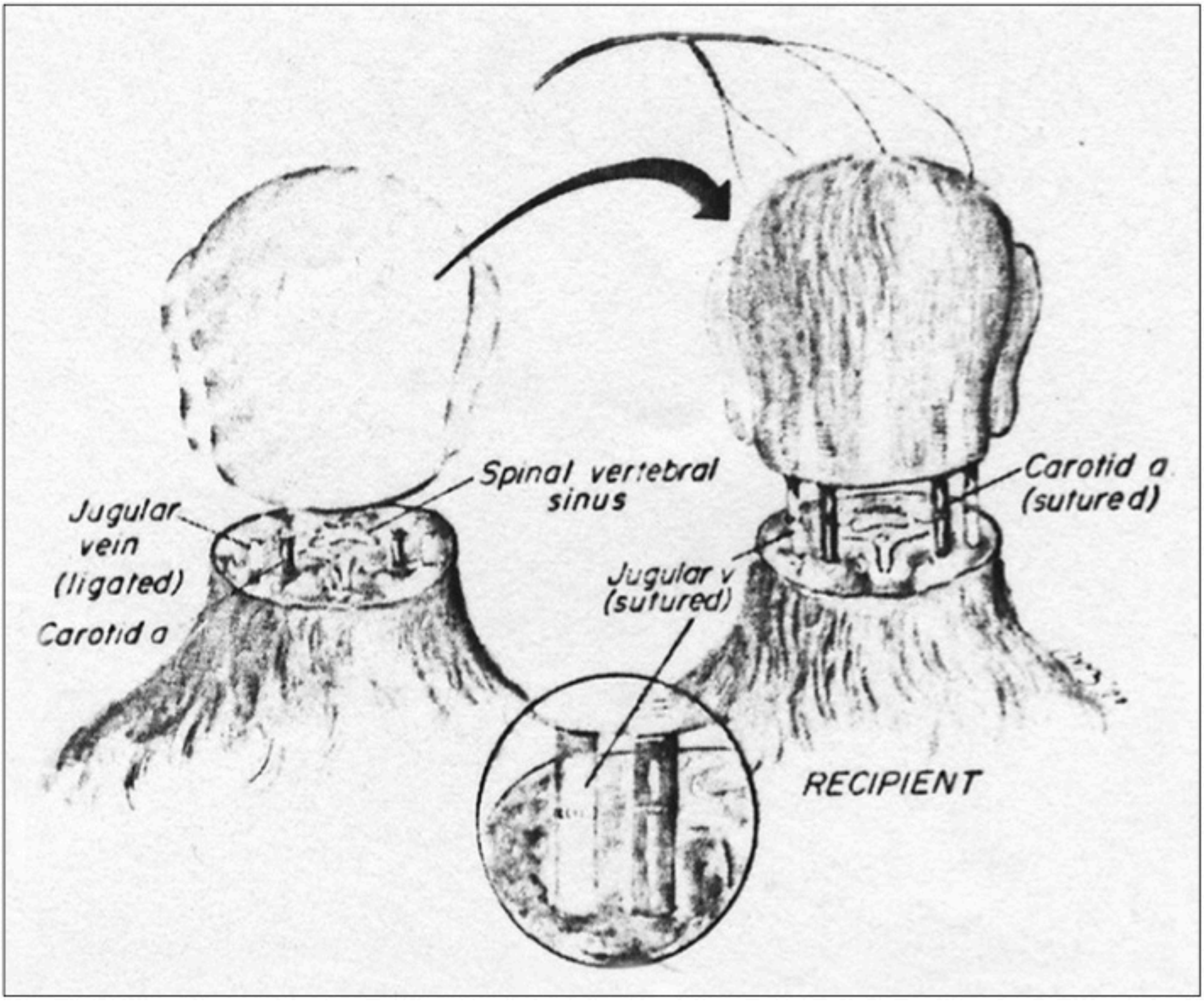
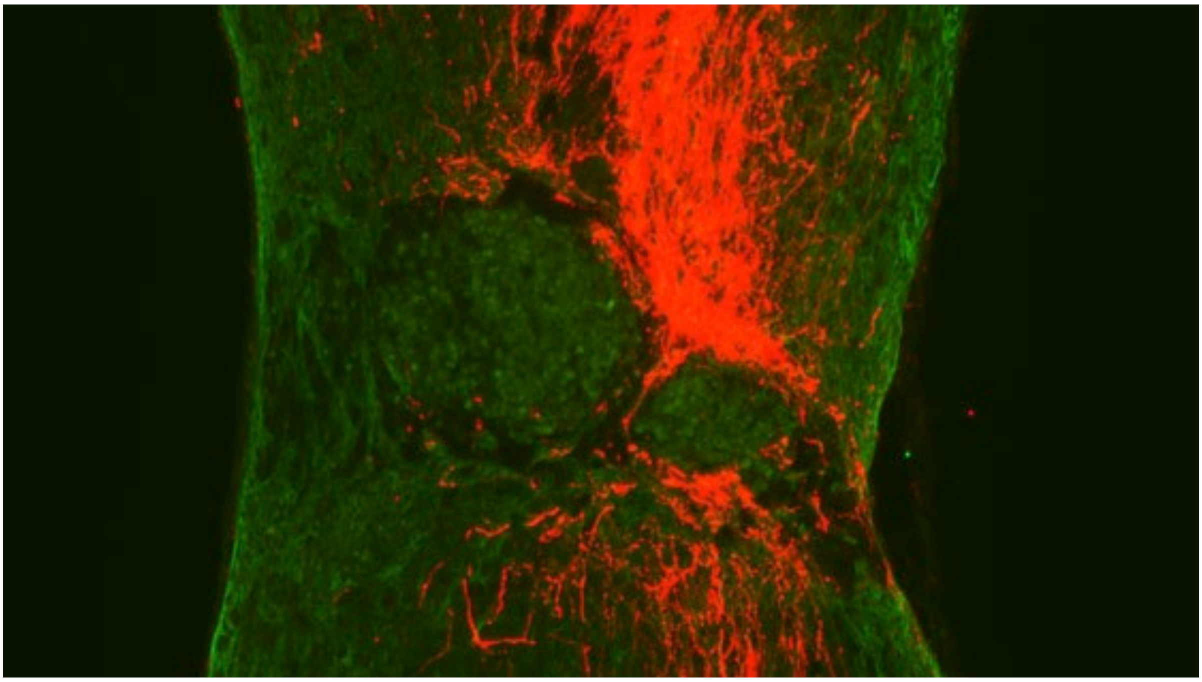


Illustration of the first-ever head transplant in a monkey.*White et al. 1971*

The procedure Canavero outlines is very much like that used by Robert White, who successfully transplanted the head of a rhesus monkey onto the body of a second rhesus in 1970. First, both patients must be in the same operating theater. Then the head to be transplanted must be cooled to between 12°C and 15°C (54.6°F and 59°F). Moving quickly, surgeons must remove both heads at the same time, and re-connect the head to be preserved to the circulatory system of the donor body within one hour. During the reconnection procedure, the donor body must also be chilled, and total cardiac arrest must be induced.

Once the head is reconnected, the heart of the donor body can be re-started, and surgeons can proceed to the re-connections of other vital systems, including the spinal cord.

Connecting the spinal cord is the final barrier



Spinal cords have been re-connected in animals using a number of technologies, and with varying degrees of success.*Oswald Steward, UC Irvine*

Connection of a spinal cord from the head of one creature to the body of another has never been attempted even in animals, so Canavero's paper must be taken as an exercise in speculation. However, the severing and re-connection of spinal cords in the same animal has met with limited success in the past. Just this week, scientists at Case Western Reserve University and the Cleveland Clinic were able to restore limited connectivity between the two severed halves of spinal cords in rats.

The re-connection of spinal cords can be accomplished through the encouragement of the body's natural healing mechanisms, which are at work even in the severed spinal cord. But Canavero's proposal is different: By cutting spinal cords with an ultra-sharp knife, and then mechanically connecting the spinal cord from one person's head with another person's body, a more complete (and immediate) connection could be accomplished. As he notes in his paper:

> "It is this "clean cut" [which is] the key to spinal cord fusion, in that it allows proximally severed axons to be 'fused' with their distal counterparts. This fusion exploits so-called *fusogens/sealants*….[which] are able to *immediately reconstitute (fuse/repair) cell membranes damaged by mechanical injury*, independent of any

known endogenous sealing mechanism."

Canavero hypothesizes that plastics like polyethylene glycol (PEG) could be used to accomplish this fusing, citing previous research showing that, for example, in dogs PEG allowed the fusing of severed spinal cords.

Huge implications for some disorders, at a cost

Paraplegics with qualifying injuries (i.e., enough spinal cord left intact to allow for a head transplant) could in theory regain the full use of a (donor) body. Likewise, patients with muscular dystrophy could be given whole new lives. Aside from the enormous technical challenges a head transplant would present, another potential barrier is cost. Canavero estimates that the total cost of a head transplant would be at least €10 million euros ($13 million.)

The bioethics of such a procedure are also extremely controversial.