Vision prostheses

RETINA australia

What are vision prostheses and how do they work?

Vision prostheses, also known as “bionic eyes”, are electronic devices which are implanted into the eye or brain to provide some basic vision to people with severe vision loss. The implants can be put into the eye (on top of, in between, or behind the retina), onto the optic nerve between the eye and brain, or directly into the brain.

In a healthy retina, the photoreceptor cells convert the light entering the eye into electrical impulses, which then travel along the optic nerve to the brain. In inherited retinal diseases, the photoreceptor cells are damaged, but the connecting nerves stay relatively intact.[1] This means that a vision prosthesis can replace the function of the photoreceptor cells, hence returning some basic visual cues.

Whilst all devices have different design features, the similarities are:

- The user will wear a pair of glasses with a small camera embedded into the frame
- The camera will capture images of the person’s surroundings, which are then translated into electrical signals by a small processing unit (around the size of a smart phone)
- The electrical signals are sent to the implant in the eye or brain, which then stimulates the rest of the visual pathway to give perceptions of light (also known as phosphenes)

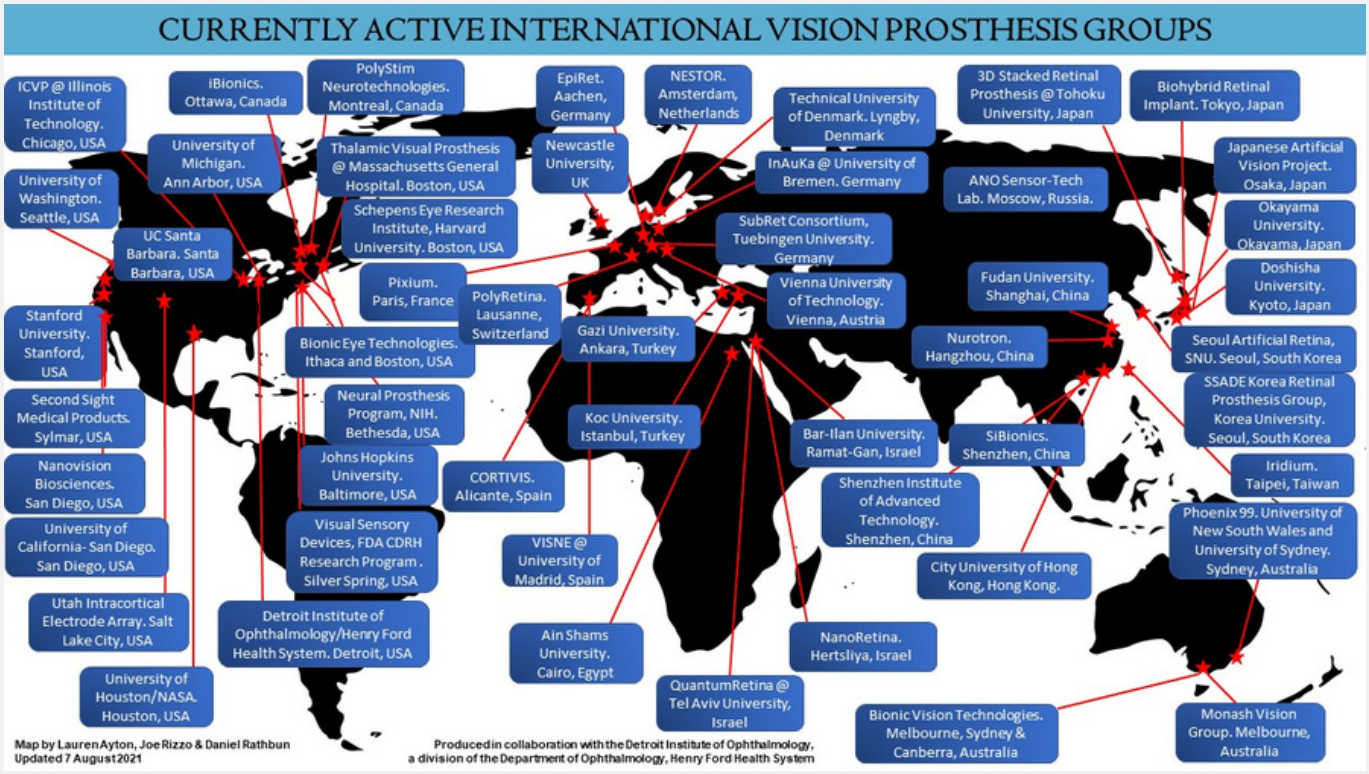
At this stage of development, the devices provide small spots of light only, which the user can interpret to help them identify objects or people. The vision provided is not like normal sight, but with clever software programming and training, can be very helpful in everyday life.

Global developments

There are currently over 40 research groups around the world developing vision prostheses, with most focusing on retinal implants.

To date, there have been three vision prostheses that have received regulatory approval and been available for purchase by patients.

- The Argus II implant by Second Sight (USA)[2] has had the widest reach, with over 350 people receiving the device. The company has now been acquired by



another, who is working on a broader range of medical devices, and there have been no recent updates from their vision prosthesis work.
- The other two devices which have received regulatory approval are the IRIS device from Pixium Vision (France), and the Alpha AMS from Retina Implant AG (Germany) (3) but neither of these are currently available.

As of December 2023, there are no vision prostheses on the market.
For a thorough review of the devices that have been used in clinical trials, please see this paper.

Vision prostheses development in Australia

Australia is a significant contributor to the field of vision prostheses globally. After significant federal government funding for bionic eye research in 2009, four separate programs have developed. Retina Australia was also a proud supporter of this research, providing grants to a number of the scientists in the early years of the program.

1. Bionic Vision Technologies (BVT)

- Arising from research from the Bionic Vision Australia consortium (Centre for Eye Research Australia, the University of Melbourne, the Bionics Institute, the University of New South Wales and NICTA), this company is commercialising a suprachoroidal prosthesis, which is implanted behind the blood vessels at the very back of the eye.

- Led by surgeon Associate Professor Penny Allen at the Centre for Eye Research Australia, seven Victorians have been implanted with this device in two clinical trials (2012 and 2018).
- BVT are currently preparing for an international clinical trial.
- Retina Australia has been proud to fund this group with the following grants:
  - Improving real-world mobility and assessing long-term safety outcomes with a retinal prosthesis ("Bionic Eye"), Associate Professor Penelope Allen – Centre for Eye Research Australia, Melbourne $39,862 (2022)
  - Validation of novel outcome measures for use in vision restoration clinical trials, Associate Professor Lauren Ayton – Centre for Eye Research Australia, Melbourne $39,630 (2014)

2. Phoenix 99

- Another project that came from the initial Australian government funding was the Phoenix 99 suprachoroidal implant. This research program is based in Sydney, (University of Sydney and the University of New South Wales) and is currently developing new technologies involving carbon penetrating electrodes.
- Retina Australia has been proud to fund this group with the following grants:
  - Improving the global acceptance of retinal prostheses: Assessing the influence of different stages of retinal degeneration on selective activation of retinal ganglion cells, Scientia Professor Nigel Lovell – University of New South Wales, Sydney $39,900 (2019)
  - Evaluation of electrical stimulation strategies for selective activation of neurons by a retinal prosthesis, Scientia Professor Nigel Lovell – University of NSW, Sydney $39,405 (2015)
  - Functional optical imaging of the cat visual cortex in response to electrical stimulation of the retina, Professor Nigel Lovell – University of New South Wales, Sydney $30,000 (2006)

3. iBionics

- During the Bionic Vision Australia research program, engineers and material scientists from the University of Melbourne also developed an epiretinal implant (which is implanted on the top of the retina), which is made of diamond.
- As of 2023, this device is being developed through an Australia-Canada collaboration, called iBionics.

4. Monash Vision Group

- The other device that was originally developed through the 2009 federal government funding was a cortical (brain) prosthesis from Monash Vision Group. This team have since been awarded funding from the Medical Research Future Fund and are currently working towards their first-in-human clinical trial.

References

(1) Jones BW, Pfeiffer RL, Ferrell WD, Watt CB, Marmor M, Marc RE. Retinal remodeling in human retinitis pigmentosa. Exp Eye Res. Sep 2016;150:149-65. doi:10.1016/j.exer.2016.03.018

(2) Olmos de Koo LC, Gregori NZ. The Argus II Retinal Prosthesis: A Comprehensive Review. Int Ophthalmol Clin. Fall 2016;56(4):39-46. doi:10.1097/IIO.0000000000000144

(3) Edwards TL, Cottriall CL, Xue K, et al. Assessment of the Electronic Retinal Implant Alpha AMS in Restoring Vision to Blind Patients with End-Stage Retinitis Pigmentosa. Ophthalmology. Mar 2018;125(3):432-443. doi:10.1016/j.ophtha.2017.09.019

(4) Ayton LN, Barnes N, Dagnelie G, et al. An update on retinal prostheses. Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology. Jun 2020;131(6):1383-1398. doi:10.1016/j.clinph.2019.11.029

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