Artificial Retina

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There are 2 types of retinal degenerative diseases:

- Retinitis Pigmentosa (RP) ~ This disease affects the light sensing cells of the retina. It reduces the retina's ability to sense an initial light signal, causing a loss of most of a persons peripheral vision resulting in tunnel vision. This is a hereditary disease and mainly affects people early in life.
- Age-related Macular Degeneration (AMD) ~ This is a disease that progressively decreases the function of the cells in the macula. It causes a loss of central vision. It does not however cause total blindness because it does not affect peripheral vision. Mostly affects the elderly. It is the most common cause of vision loss in people 50 and over.

Retinal disease affects 6 million Americans and this number is expected to double by the year 2020.

The artificial retina is a microchip with an array of about 16 electrons that is designed to stimulate damaged retinal cells. This will allow the cells to send image signals to the brain as they should. The chip is made out of silicon and is 2mm in diameter and 25 microns thick.
It is composed of about 5,000 microscopic solar cells that convert light energy from images into electrical impulses that stimulate the remaining functional cells of the retina in patients with AMD and RP. It helps patients to distinguish shapes and regain some limited vision.

The microchip is surgically implanted under the retina in the subretinal space. Patients wear glasses that have a tiny camera embedded in the lens. The camera captures images and sends the data to a microprocessor which is concealed in the side of the glasses which converts the data to an electronic signal. An antenna in the lens transmits the signal to a receiving antenna in the eye. The signal then travels along a tiny wire to the retinal implant. The chip produces visual signals similar to those produced by the photoreceptor layer. From their subretinal location, these artificial signals from the microchip are in a position to induce biological visual signals in the remaining functional retinal cells which may be processed and sent to the brain through the optic nerve.

The implantation procedure consists of a standard operation called a vitrectomy and a retinotomy plus implantation of the chip itself. Three tiny incisions are made in the white part of the eye. Through these incisions the vitreous gel in the middle of the eye is replaced by saline. Then an opening is made in the retina through which fluid is injected. This fluid lifts up a portion of the retina from the back of the eye and creates a small pocket in the subretinal space where the microchip is placed. Air is then used to gently push the retina back into place. After 1-2 weeks the air bubble is absorbed and replaced by fluids created in the eye. This procedure takes about 2 hours.
The microchip is still being tested in clinical studies and is not yet commercially available. Ten patients have had the device implanted in clinical trials since January 2000. So far, no patient has shown signs of implant rejection, infection, inflammation, erosion or retinal detachment. The durability of the chip in the retina and the long-term safety of this procedure are yet to be determined. Visual function improvements occurred in all patients and included unexpected improvements in retinal areas distant from the implant. Some improvements included improved perception of brightness, contrast, color, movement, shape, resolution, and visual field size. "The first patient to receive a prototype implant in 2002 described what it was like being able to "see" large letters and to differentiate between a cup, a plate, and a knife after being blind for over 50 years."
The next prototype is in clinical trials. It will have 50-100 electrodes. In the future they are hoping for a "next generation" device that will have 1000 electrodes and will allow patient to see images. They also hope to develop a completely implanted system that will not need use of glasses, and to have the procedure available to patients within 5 years.

References

http://www.optobionics.com/index.asp?pageid=4
http://doemedicalsciences.org/abt/retina/art-retina.shtml
http://www.theretinasource.com/news/articles/ArtificialRetina_0402.htm
http://currents.ucsc.edu/04-05/10-18/retina.asp
http://archopht.ama-assn.org/cgi/content/abstract/122/4/460