Pathway Toward Vision Restoration, Artificial Vision, Artificial Retina, Optogenetics

Abstract: Progress in ophthalmology over the past decade moved preclinical data to clinical proof-of-concept studies bringing innovative therapeutic strategies to the market. Diseases such as retinitis pigmentosa (RP) and age-related macular degeneration (AMD) destroy photoreceptors but leave intact and functional a significant number of inner retinal cells. Retinal prostheses have demonstrated ability to reactivate the remaining retinal circuits at the level of bipolar or ganglion cells, after the photoreceptor loss. Recent clinical trials have demonstrated partial restoration of vision in blind people by epiretinal (Second Sight Medical Products, Pixium Vision) and subretinal (Retina Implant AG) implants, in clinical trials and practice now. Despite a limited number of electrodes, some patients were even able to read words and recognize high-contrast objects. Currently, researchers at the Stanford University and Pixium Vision in collaboration with Institut de la Vision develop a wirelessly powered photovoltaic prosthesis in which each pixel of the subretinal array directly converts patterned pulsed near-infrared light projected from video goggles into local electric current to stimulate the nearby retinal neurons. A new asynchronous dynamic visual sensor whose function mimics photoreceptor and retinal cell responses is also under development. Optogenetics (currently under preclinical evaluation in primates) and cell therapy (ongoing first safety and tolerability clinical trials with hESC- and iPSCs-derived RPE) provide alternative approaches for vision restoration in patients with advanced stages of retinal degeneration. Combination of different therapeutic strategies may offer enhanced therapeutic effectiveness and more efficient ways to save vision. These new therapeutic tools call for identification of appropriate patient selection criteria and methods to evaluate treatments’ efficiency and assess the real benefit experienced by the patients.