Practice Report

Miami Lighthouse for the Blind and Visually Impaired Case Study: Vision Rehabilitation for the First Florida Resident to Receive the Argus II "Bionic Eye"

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In November, 2014, a totally blind woman became the first person in the State of Florida, and the 10th person in the United States, to receive the Argus II retinal implant, which was developed in California by Second Sight Medical Products (Second Sight, 2014). The device was implanted at Bascom Palmer Eye Institute in Miami (BPEI). The 58-year-old patient became blind at the age of 42 due to retinitis pigmentosa.

The Argus II retinal system provides electrical stimulation of the retina to induce visual perception in individuals who are blind with severe to profound retinitis pigmentosa (Second Sight, 2014). A miniature video camera housed in glasses captures the image. The video is sent to a small, patient-worn, computerized video processing unit (VPU), where it is transformed into electrical impulses that are sent back to the glasses via a cable. These impulses are then transmitted wirelessly to an antenna in the retinal implant. The signals are next sent to the electrode array, which emits small pulses of electricity. These pulses bypass the damaged photoreceptors and stimulate the retina's remaining cells, which transmit the visual information along the optic nerve to the brain, creating the perception of patterns of light (Ho et al., 2015; Second Sight, 2014). After surgery, retinal implant recipients must learn to interpret these visual patterns and integrate the information with visual concepts.

At the inception of the Argus II project, Miami Lighthouse for the Blind and Visually Impaired was chosen to partner with BPEI and Second Sight and to provide vision rehabilitation for retinal implant patients in Florida. In order to train the first recipient in Florida in the use of the implant's highly complicated technical system, Miami Lighthouse professionals developed a vision rehabilitation protocol integrating elements from the Argus II patient training manuals (concerning the technical aspects of the device) with vision rehabilitation therapy. In concert with a consultant from the Second Sight team, existing rehabilitation training strategies were adapted to create a plan tailored to specifically address the skills that are necessary for the successful use of the Argus II system. Unlike patients in traditional low vision rehabilitation therapy, Argus II patients require innovative blindness rehabilitation training as they learn to interpret the new visual input.

Training that provided instruction on how to take full advantage of the device took place both in Miami, Florida, and in the patient's home. After each training session, the patient's achievements were reviewed, progress was documented and future activities were planned. In addition, Miami Lighthouse's certified low vision therapist (the second author) accompanied the implant recipient to California to work on software upgrades at the developer's laboratories.

Synthesis of the Case Reports

Over a three-month period spanning the end of 2014 and the start of 2015, the first and second authors spent 50 hours of training and working with the patient to adjust the device. Six vision rehabilitation sessions totaled 44 hours, and an additional 6 hours were spent in orientation and mobility training and accompanying the patient for device adjustment at BPEI. Also, 60 hours were spent in training in California. Approximately 50 follow-up telephone calls took place to address issues that came up after the initial 6 sessions.

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First session

During the first session, which was five hours in duration and took place December 10, 2014, a check was made of all external components of the Argus II device, including the glasses, the VPU, the VPU pouch, batteries, charger, and cable that connects the VPU with the glasses. When the subject demonstrated her ability to handle these aspects of the device independently, she was seated at a table in front of a half-black, half-white metal board from the ARGUS II instructional kit on which black-and-white objects, lines, and shapes were displayed. The patient expressed frustration and said she only saw only flashing, jumping lights.

A square shape of white felt was placed on the black side of the board, and instructions were given to scan the lines of the shape with "Z" movements known as "micro-scanning" (small-scale scanning within arm's reach). The patient had difficulty with camera alignment, pointing it too high and becoming frustrated at being unable to see a straight line or shape. The low vision therapist recommended that the visual skill of micro-scanning be practiced along with the vertical alignment of the camera with the object (Second Sight, 2012).

After 45 minutes on this activity, working with different settings, the patient reached "saturation" and lost the ability to make even simple black and white distinctions. After a 45-minute break, she could once again differentiate black and white.

A second skill was presented that involved teaching the importance of touching when looking in order to develop visual memory. Development of visual memory through the Argus II system is a process that involves touching the object, then touching and looking at the object, then finally just looking at the object (Second Sight, 2012).

Miami Lighthouse vision rehabilitation professionals developed an individualized care plan that included practicing and exercising eye-head-camera position awareness and movement, micro-scanning, macro-scanning (large-scale scanning of the environment, at 6 to 15 feet), tracking, luminance discrimination (locating a light source), shape recognition, and reinforcing the skill of "touching to look" (Second Sight, 2012).

Second session

In the second session, which was held over a period of eight hours on December 22, 2014, along with micro-scanning, several new skills were introduced, including eye-, head-, and camera-position awareness and movement, plus micro-scanning. The patient continued to exhibit difficulty aligning the camera and complained about a perceived lack of depth perception.

A scanning tube (a clear plastic cylinder six inches long and six inches across) was introduced, with instructions to "look" through the tube while holding it to the face with both hands. The purpose of this training was to keep eyes, head, and shoulders together in a straight line during scanning. Some difficulty was encountered at the beginning of the process, and verbal cues were required to perform the task successfully. The Argus II's VPU beeps when internal and external parts of the system do not align, providing auditory feedback. This exercise was practiced for nearly an hour, after which scanning with the tube—keeping eyes and head in proper alignment—was accomplished.

Camera alignment was also a challenge. The camera is located on the bridge of the nose, making it sometimes difficult to find an object. In order to rectify this problem, instructions were given to tilt the head downward. The skill of "touching to look" was then introduced. A white plate was set on a black placemat, and instructions were given to touch the plate while also looking at it in order to point the camera correctly. After an hour of practice, proficiency was demonstrated in aligning the camera independently to locate objects.

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The training board from the Second Sight instructional kit was used to teach micro-scanning for small-scale light localization skill. The board was held at arm's length with the black side facing up and a white object positioned on it, and instructions were given to find and touch the object. The position of the object was then changed, requiring the subject to move her head from side to side to locate it. Initially, the task was difficult, but it became easier when she moved her head up and down. It was determined that the camera needed to be realigned.

The patient was a quick learner and continued to practice visual skills to facilitate full use of the Argus II system.

Third session

In the third session, another eight-hour session that took place on December 23, 2014, additional visual skills for macro-scanning, tracking, luminance discrimination, and shape recognition were taught. During large-scale light localization, or macro-scanning, the patient was able to locate a light in different positions in a large dark room, then to use micro-scanning in a reduced area. Instructions were given to divide space into four quadrants during macro-scanning, from top to bottom and left to right. Once the object was identified, the micro-scanning began in that particular quadrant, and this activity was completed successfully.

The next skill introduced was tracking, which entailed following a moving flashlight paired with auditory cues, and increasing illumination in the room. Almost immediately the ability to track lights without auditory cues was demonstrated, but sensitivity to the glare from windows, balcony, and ceiling lights was reported. It was recommended that lighting in the home be modified to reduce glare by placing a shade over the kitchen window, closing curtains on a sliding door, and turning off the fan light that was causing glare on the counter top. Luminance discrimination skills were also taught during this session. Two flashlights at two different brightness settings were used with the goal of identifying which was brighter. This activity was performed with no difficulty.

The next exercise was to develop visual memory through shape recognition. Starting with two-dimensional white shapes on the black side of the board, the patient was able to identify the triangle but had more difficulty with the circle, square, and rectangle shapes. The process of pairing two senses (first touching and looking at shapes to identify them) was then introduced, followed by identification by vision alone. Ultimately, all shapes were matched independently. Identification of several objects with colors other than black or white was achieved by the end of the session, but differentiating purple, red, orange, and blue was problematic.

Fourth session

In the fourth session, which was eight hours in length and took place on January 26, 2015, despite an adjustment at BPEI that attempted to decrease light intensity, considerable glare was noted and further adjustment of the setting was requested. The session began with a chalk mat and thick chalk in different colors. Lines in white, yellow, and light green were identified by pointing, and their lengths were noted with 100% accuracy, but light blue, orange, and light red were more difficult.

One-inch magnetic white letters "I," "L," and "J" were identified without touching, but difficulty was encountered with other letters. Also demonstrated was the ability to recognize all the geometric white shapes on the black side of the board, including curved lines and a lollipop shape. Occasionally, excessive glare contributed to confusion.

During these activities the first setting on the VPU was used. The second and third settings were tried, but they did not help. The reverse setting was still not working correctly. When using the reverse setting, black areas

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were reported to be very dim. The use of a task lamp at different distances and angles was attempted but was not successful. In general, the patient accomplished all white-over-black contrast activities involving shapes and some letters using micro-scanning independently with 90% accuracy.

Fifth session

The fifth session, which took place over seven hours on January 27, 2015, involved working with black magnetic shapes on the white side of the board, but there was some difficulty with this activity. The reverse setting was tried and was once again unsuccessful. Second Sight was advised that this setting needed to be realigned. Once the device was adjusted, instruction was provided on the proper use of the reverse setting outdoors so that mobility training could begin.

The patient had made significant progress since starting vision rehabilitation programming; she was very creative and constantly researched the best way to maximize the use of the Argus II system.

She was able to see hands, arms, and legs when performing an activity such as cleaning the surface of a table with a napkin, clapping, and walking on a treadmill. She could see a silver teaspoon but was still unable to differentiate the size of a tablespoon or tell a knife from a fork. She could follow the motion of silverware stirring when cooking, and could see candle lights. In a restaurant, the waiter approaching the table could be seen as well as the location of the napkin, glass of water, bread plate, and the top arch of a white coffee cup.

Prior to the sixth session, the patient came to Miami for a follow-up visit at BPEI. BPEI technicians and a team from Second Sight made adjustments to the patient's Argus II system, and orientation and mobility training under the guidance of Miami Lighthouse's certified O&M specialist subsequently began.

The patient agreed to not use the Argus II device for three days prior to the next session to avoid "saturation."

Sixth session

The sixth session lasted eight hours and took place outside the patient's apartment in Florida on February 23, 2015. Before turning on the device, the functions of each setting, as well as macro and micro scanning, were reviewed. Using the newly aligned reverse setting, the white lines on the pavement and shadows could be seen. Once back inside, using the first setting, the default, it was noted that "light" was dimmer than before the adjustment. Using the second setting resulted in a lack of brightness, making it difficult to find and identify objects. Also, a "black spider web" between the lights was being seen.

The best results were achieved with the third setting, the one that enhances edges. Light was reported as "yellow and soft," which allowed perception of definition of objects and contrast in surroundings. The patient was able to macro- and micro-scan door edges, see the division between the wall and stairs, and identify the mail box.

Summary

Because of the combined efforts of Miami Lighthouse, Bascom Palmer Eye Institute, Second Sight Medical Products (the manufacturer), and the many hours of vision rehabilitation provided by Miami Lighthouse professionals that were adapted for this new blindness technology, the results for this first Florida-based Argus II recipient were deemed very successful. Despite the fact that there were unique challenges, the innovative rehabilitation program developed and carried out by Miami Lighthouse professionals was a crucial part of the positive outcome for this patient. There is no doubt that rehabilitation is an important component in the successful use of the implant by the patient (Dorn, Geruschat, Anaflous, & Greenberg, 2013).

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Nine months after the initial surgery, with the artificial retinal implant and after specialized rehabilitation, the patient was able to read short words with appropriate contrast and size, see steps and exercise equipment, sort clothes, and discern individuals in surroundings. Perhaps the most meaningful activity was the newfound ability to play with a 5-year-old grandson: rolling a ball on the floor, catching it, and rolling it back to him. The patient summarized her experience: "I knew I would need to learn how to use my new eye. Working with Carol and Raquel, along with the developer, Second Sight, they literally walked me through the process from the very first day. It has been a very exciting journey."

References

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