

Step-by-Step Guide to Retinal Implant Surgery

Surgical pearls for this complex implantation procedure.

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Retinitis pigmentosa (RP) is a group of inherited diseases that cause retinal degeneration. Patients with RP experience a gradual decline in visual acuity caused by the death of photoreceptor cells. Thanks to advances in science and technology, these patients may regain some functional vision with a retinal implant (Argus II Retinal Prosthesis System, Second Sight Medical Technology). This device delivers electrical stimulation to the retina to induce visual perception and is generally implanted in the eye with worse visual acuity. The implanted device consists of extraocular and intraocular components. A receiver and transmitting coil and a case containing electronic components is fixed to the scleral surface. The epiretinal electrode array that stimulates the photoreceptor cells is fixed to the retinal surface with a tack. The procedure is performed under general anesthesia and takes approximately 4 hours. Following are some tips we have found helpful in the implantation of the Argus II.

PREPARATION

First, a limbal peritomy is performed, and the rectus muscles are isolated. At the start of the procedure, long suture tags are placed on the conjunctival edge to help identify the edge at the end of the procedure. It is critical that the implant be well covered by the conjunctiva to prevent erosion in the long term. It is also important to avoid cautery at the intended sclerotomy site temporally.

Pearl: *If necessary, make only a nasal relaxing incision and avoid cutting the temporal conjunctiva. The temporal conjunctiva and Tenon capsule should remain intact to cover the bulk of the implant, which will be placed temporally.*

Pearl: *Take extra care to protect the cornea from drying, which would make the intraocular and tacking portion of the procedure much more difficult. Keep the cornea well lubricated and consider using a corneal protector.*

EXTRAOCULAR PLACEMENT

Once the peritomy has been performed and the rectus muscles have been isolated, the surgeon begins placement of the extraocular components by positioning the band under all the rectus muscles and securing the device to the sclera.

Pearl: *Using scleral tunneling nasally will minimize sutures, thereby lessening the long-term chance of suture erosion.*

Place the receiving coil under the lateral rectus muscle, pass the inferior portion of the band under the inferior and medial rectus, then pass the superior portion of the band under the superior rectus.

Pearl: *Placing the coil under the lateral rectus can be challenging because it is relatively large. To avoid the risk of damaging the coil with a metal instrument, a fingertip can be used to manipulate the coil. This allows the surgeon to titrate the level of force.*

Pass the band through the scleral tunnels or suture it nasally and connect it with a Watzke sleeve in the superonasal quadrant.

Pearl: *Allow slack in the buckle so it has positioning flexibility as the eyelet tabs are sutured to the sclera.*

At a Glance

- The conjunctiva must fully cover a retinal implant to prevent long-term erosion.
- The array should cover the macular center at approximately 45°.
- In preparation for the tacking procedure, raising the patient's intraocular pressure to between 60 mm Hg and 80 mm Hg will minimize bleeding.

This allows mobility and flexibility of the electronics case during eyelet suturing, which is important for accurate placement in the middle of the superotemporal quadrant.

The electronics package and coil are secured with 5-0 nylon or polyester fiber (Mersilene, Ethicon) sutures at designated locations posterior to the limbus. Second Sight provides a nomogram for the placement of the sutures based on the axial length of the eye. The eyelet markings around the metal electronics case should be superotemporal, midquadrant, and radially oriented in relation to the center of the cornea. The accurate placement of the electronics case is critical, as errors in the distance measurements will ultimately determine the length and orientation of the cable when the array is tacked to the retina. The coil tab is sutured with 5-0 nylon or polyester fiber at the same distance from the limbus in the inferotemporal quadrant.

Pearl: Take bites from anterior to posterior, and back the needle through the suture tabs to avoid damaging the silicone tabs.

Do not over-tighten the band, as doing so can cause scleral indentation. If the eye is indented, there can be a change in axial length, which can make tacking more difficult.

Pearl: It is helpful to protect the delicate microelectrode array until its insertion into the eye. It can be covered with a nonlatex glove tip, but a phaco sleeve has the added benefit of being transparent, allowing the surgeon to see the array and ensure it is not damaged during the procedure.

INTRAOCULAR PLACEMENT

Begin intraocular placement of the array with a pars plana vitrectomy. It is helpful to place the ports at midline (3 and 9 o'clock) to improve access to the superotemporal quadrant of the vitreous cavity and aid in complete removal of the vitreous.

Lens management depends on the lens status of the patient. If the patient is aphakic, remove all residual lens capsule. If phakic, the crystalline lens must be removed. In this case, either clear corneal cataract surgery or phacolytic lensectomy can be performed with complete capsule removal. If the patient is pseudophakic, it is acceptable to leave the intraocular lens (IOL) in place as long as it is sufficiently stable. IOLs with pseudophakodonesis should be explanted because of the risk of dislocation.

Perform a core vitrectomy to ensure that all vitreous is removed over the macula, verifying that posterior vitreous detachment is either present or induced. Perform a

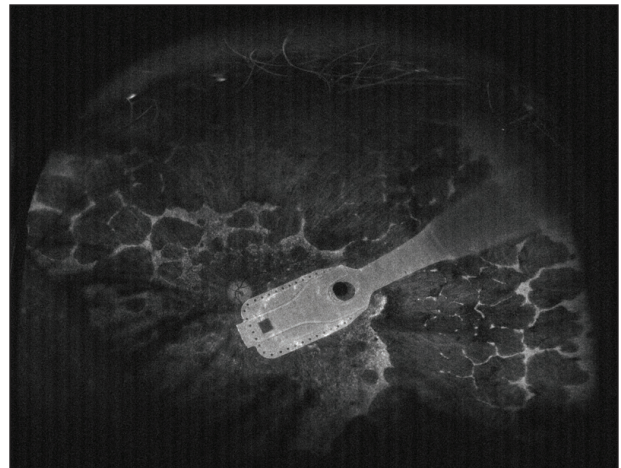


Figure 1. Wideangle fundus autofluorescence photograph of an eye with an Argus II implant. Note the cable extending from the array superotemporally on its path to exit the sclera.

complete vitrectomy near the sclerotomy site superotemporally and near midline ports where the array and tacks will be introduced.

Pearl: Complete vitreous removal can be aided by chandelier illumination to allow scleral depression with close vitreous base shaving. Vitreous staining with triamcinolone is useful to aid visualization.

If a significant epiretinal membrane (ERM) is present, peeling may be required to enable the electrodes to stimulate the inner retina. A significant ERM may keep the array from close proximity to the retina. Preoperative optical coherence tomography imaging can help determine the presence of a significant ERM. Many eyes with advanced RP have some degree of ERM. Because of the delicacy of the macular area and the necessity of nerve fiber layer integrity for function of the device, avoid peeling an ERM unless it is significant. Peeling of the internal limiting membrane is not recommended.

SCLEROTOMY

Mark the center of the sclerotomy to allow natural cable positioning. Measure the precise distance and setback along the cable axis depending on the eye's axial length. The width of the sclerotomy should be at least 5.2 mm, perpendicular to the cable axis, to accommodate the widest part of the electrode array. Cut the sclerotomy with a blade perpendicular to the sclera so as to ensure full-thickness incision into the eye. The sclerotomy can be opened gently with forceps to ensure a full-thickness pass through the entire length of the sclerotomy. If full thickness is not achieved, the

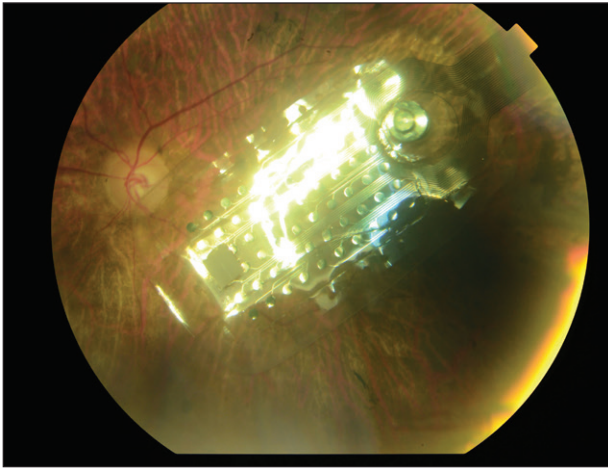


Figure 2. Fifty-degree color fundus photograph of the same eye as shown in Figure 1 with an Argus II implant. Note the position of the array with respect to the macula and optic nerve.

array can cause a choroidal detachment as it enters the eye, which is problematic.

Pearl: *Err on the side of caution by making the sclerotomy slightly wider than 5.2 mm, although less than 5.5 mm. It is critical that the array does not get caught upon entry.*

Pearl: *This step is similar to placing a 0.59-mg fluocinolone acetonide intravitreal implant (Retisert, Bausch + Lomb).*

ARRAY INSERTION

Using 20- or 23-gauge Eckhart forceps (Synergetics), grasp the array by the small silicone knob or “handle” on the device and insert it into the sclerotomy. Open the sclerotomy slightly using toothed forceps to accommodate smooth entry of the array. Insert the array perpendicular to the sclera, taking care not to macerate the sclera with the instruments or the array. If the array becomes caught in residual vitreous, additional vitrectomy may be required.

Once the array has been inserted, the edges of the sclerotomy must be closed just enough to accommodate the cable width and to ensure watertightness. Close using polypropylene (Prolene, Ethicon) or coated polyglactin (Vicryl, Ethicon) sutures. When performing this step, take care not to pierce the cable with the needle.

Pearl: *Do not place the sutures too close to the array cable, as this can cause cable compression and puckering, which may prevent the sclerotomy from closing completely. This may lead to hypotony from egress of fluid postoperatively.*

INTRAOCULAR TACKING

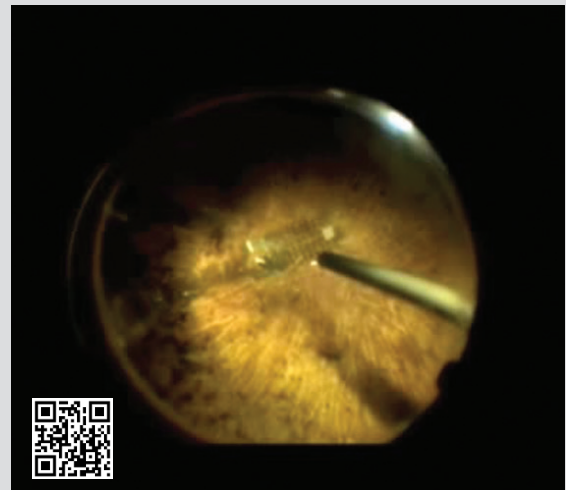
Position the array with the Eckhart forceps to assess its location on the macula. Ensure that there is no twist in the cable. If the array appears tilted when placed on the fovea or there is substantial twist in the cable, relocate the extraocular portion of the device to change the cable angle entering the sclerotomy.

The array should be centered over the macula at approximately 45° and should not cover the optic nerve, although some overlap is acceptable in the area that is electrode-free (Figures 1 and 2). Remove the superior trocar corresponding to your dominant hand and enlarge the wound with a 19-gauge microvitrectomy blade inserted parallel to the limbus to accommodate the 19-gauge tacking forceps. Engage the tip of the tack into the tack ring, which is a small hole near the area of cable insertion, and steer the array with the tack to the desired location, taking care not to scratch the retina, before pressing the tack into the retina to permanently secure the array to the retina and choroid (Video; eyetube.net/?v=urele.)

Pearl: *It is helpful to practice loading and inserting the tack prior to the procedure. Chandelier illumination is also helpful here, as it allows the surgeon to use a bimanual technique, if desired.*

Pearl: *In preparation for the tacking procedure, raise the intraocular pressure (IOP) to between 60 mm Hg and 80 mm Hg to minimize bleeding. The duration of high IOP should be brief, and IOP should be reduced gradually once it is determined that the tack is in place and there is no bleeding.*

Video: Argus II Implantation



The tack should pierce the posterior ocular layers (the retina and choroid) and be embedded in the sclera. It can be challenging to judge how much force is needed. With too little force, there is risk that the array can loosen. With too much force, there may be excessive tissue compression and damage. The surgeon generates the force to tack the device. Prior to surgery, practice tacking on a silicone surface. In surgery, look for retinal blanching to determine if you are using adequate force.

CLOSURE

Place a 9-0 polypropylene mattress suture over the cable surface to flatten it, again taking caution not to pierce the cable. Test for leaks with a cellulose (Weck-Cel, Beaver-Visitec International) sponge.

Ensure that the suture tabs of the external device are covered to prevent conjunctival erosion and minimize risk of endophthalmitis. Application of grafting material over the sclerotomy and suture tabs (for both the case and coil) is recommended. In fact, any area that has a potential for conjunctival exposure should be covered. Tutoplast (Tutogen Medical) or corneal patch grafts such as VisionGraft (Tissue Banks International) work well. Polyglactin sutures are used to affix the graft material.

The conjunctiva and Tenon capsule are pulled forward and sutured at the limbus. Thorough conjunctival closure is critical to long-term success, as with glaucoma drainage implants.

Performing retinal prosthesis implantation incorporates several techniques familiar to the vitreoretinal surgeon. Retinal tacking, however, is novel to most surgeons. The surgical pearls offered here by the authors are those they share with vitreoretinal surgeons performing their first retinal prosthesis surgeries. ■

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