Suprachoroidal Buckling Technique

A novel, less-invasive treatment option for rhegmatogenous retinal detachment and vitreoretinal interface pathologies.

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Scleral buckling is a common surgical procedure for repairing uncomplicated rhegmatogenous retinal detachment (RRD). The basis of therapy is to form a chorioretinal adhesion around the retinal break in conjunction with releasing the vitreoretinal traction force by the use of the scleral buckle, thus preventing access of intravitreal fluid to the subretinal space via retinal breaks.[1,2] Although scleral buckling can be indicated for most primary RRDs, it may result in some vision-threatening complications due to the direct depression of the sclera with the buckle and/or the size and location of buckle placement, such as mechanical ocular motility disturbance secondary to an extraocular muscle imbalance, corneal contour changes, and chorioretinal circulatory disturbances.[3-5]

Because the therapeutic concept of scleral buckling is to bring retina into contact with treated choroid around retinal tears, the sclera itself may not necessarily be involved in the indentation. Based on this idea, we have developed a novel technique called suprachoroidal buckling, which uses a specially designed catheter to inject and place suprachoroidal filler (long-lasting hyaluronic acid solution) in the suprachoroidal space, indenting the choroid alone to close the retinal tear through the suprachoroidal space. This filler, which indents the choroid and creates a suprachoroidal buckling effect to close tears or support the retina, can be used instead of suturing a scleral buckle.

Suprachoroidal buckling is performed by making a small peritomy followed by a 3-mm scleral incision and guiding the catheter beneath the tear, avoiding all potential difficulties of scleral buckle placement. The indentation effect achieved with the suprachoroidal approach can also be used as an alternative to episcleral macular buckling for managing challenging myopic traction maculopathy (MTM). In this article, we introduce the procedure details and preliminary outcomes of suprachoroidal buckling for treating uncomplicated RRDs and challenging MTMs complicated with large staphylomas.[6,7]

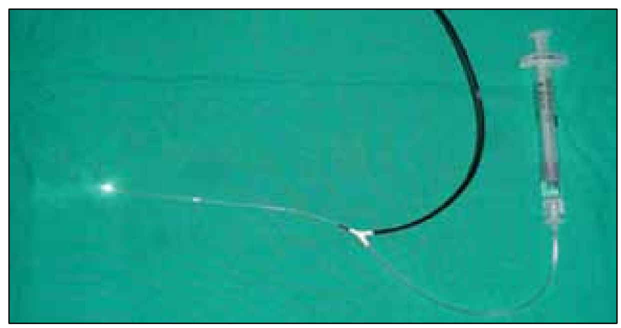

Figure 1. Suprachoroidal catheter for suprachoroidal filler injection. A 450-µm catheter (MedOne Surgical, patent pending) showing the 2 arms of the Y connector, 1 arm to the light source and the other to the filler injector ampule. It can be connected to a regular bright illumination light source that illuminates a 31-gauge optic fiber in the catheter for identifying the tip of the inserting cannula when placed in the suprachoroidal space.

SURGICAL DEVICES AND MATERIALS FOR SUPRACHOROIDAL BUCKLING

Our technique uses a 450-µm catheter (MedOne Surgical, patent pending; Figure 1). This catheter has a dual injection/illumination capability. It can be connected to a regular bright illumination light source that illuminates a 31-gauge light fiber when placed in the suprachoroidal space for identifying the tip of the inserting cannula. The other end of the Y connector on the catheter is connected to high-pressure tubing to deliver stabilized (natural entangled) long-lasting hyaluronic acid solution (Healon GV or Healon V, Abbott Medical Optics Inc.; or Restylane Perlane, Q-med) to the injection port of the catheter when placed in the suprachoroidal space. Recently, as an alternative to the illumi-

Figure 2. Curved cannula for suprachoroidal buckling for peripheral breaks. A nonilluminated 20-gauge curved cannula with an olive-shaped tip for injecting the filler and creating a suprachoroidal buckling effect for peripheral breaks.

nated tip catheter, we successfully used a nonilluminated 25-gauge curved cannula with an olive-shaped tip for injecting the filler and creating a suprachoroidal buckling effect (Figure 2).

EXPERIMENTAL USE

An experiment in rabbit eyes was carried out to evaluate the safety and feasibility of the newly developed device for suprachoroidal buckling in advance of clinical use. Under intravenous anesthesia, a total of 10 rabbit eyes received suprachoroidal injections of long-acting hyaluronic acid solution (Healon GV). The 10 fellow eyes were injected with balanced salt solution as controls. Intraoperative video recording and histologic examinations of the retina and choroidal tissues were conducted at 1 and 3 months postoperative.

After creating a small peritomy, a 3-mm scleral incision was made for insertion of the prototype suprachoroidal catheter tip (Figure 3A). The insertion of the catheter can be easily monitored under the surgical microscope illumination or identified by the inner illumination feature in the catheter (Figure 3B).

Choroidal elevation was successfully created with hyaluronic acid solution via the prototype suprachoroidal catheter in all rabbit eyes without any complications, such as choroidal rupture, retinal penetration, or intraocular hemorrhage. Intraoperative video recording and histologic examinations of the retina and choroidal tissues conducted at 1 and 3 months postoperative suggest that choroidal elevation was maintained for up to at least 3 months after injection without any observed tissue destruction in both retinal and choroidal layers (Figure 3C). Although further investigation is warranted before widespread use of this new technique, the favorable results obtained from the animal experiments encouraged us to conduct a preliminary clinical trial to explore the safety, feasibility, and efficacy of using this less-invasive procedure to treat human eyes with uncomplicated RRDs and refractory myopic MTM.

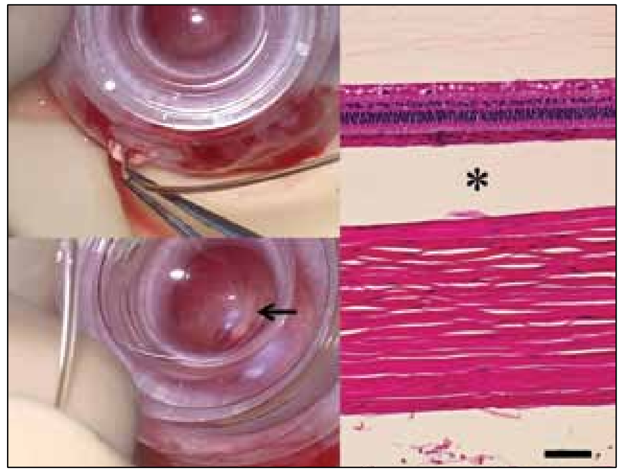

Figure 3. Suprachoroidal buckling in rabbit eyes. Suprachoroidal catheter inserted into the suprachoroidal space through a 2-mm scleral incision (A). The illuminated tip (black arrow) of the catheter can be seen underneath the retina through a magnifying contact lens (B). Histologic examination 3 months after surgery demonstrates clear separation of the choroid from the sclera (asterisk) with intact morphology in the chorioretinal layer (C). Bar = 50 μm

SUPRACHOROIDAL BUCKLING WITH A 25-GAUGE ILLUMINATED SUPRACHOROIDAL CATHETER

By Ehab N. El Rayes, MD

Suprachoroidal catheter for suprachoroidal buckling with and without vitrectomy to treat uncomplicated rhegmatogenous retinal detachment.

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SUPRACHOROIDAL BUCKLING WITH AN OLIVE-SHAPED 25-GAUGE CANNULA

By Ehab N. El Rayes, MD

Suprachoroidal cannula for suprachoroidal buckling with vitrectomy to treat peripheral-break-induced rhegmatogenous retinal detachment.

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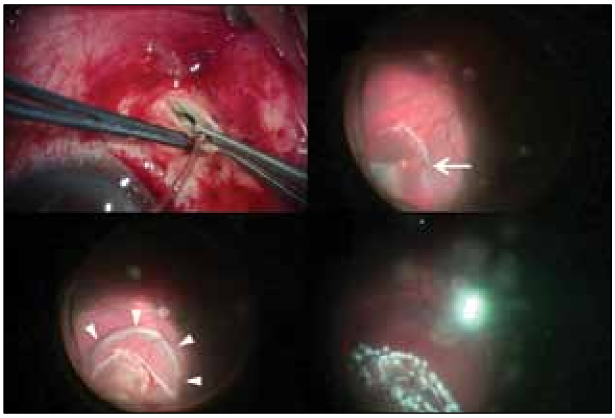

Figure 4. Intraoperative view of suprachoroidal buckling in a case with primary RRD. A suprachoroidal catheter is inserted into the suprachoroidal space through a 3-mm scleral incision (A). The illuminated tip (white arrow) of the catheter inserted underneath the retinal break can be seen to adjust the location for filler injection under the chandelier endoillumination (B). A choroidal buckle (white arrowheads) is successfully created to cause a retina-RPE re-attachment by the injection of the long-acting HA filler into the suprachoroidal space (C). Laser photocoagulation is then applied to create retina-RPE adhesion as in a usual procedure (D).

SUPRACHOROIDAL BUCKLING FOR RHEGMATOGENOUS RETINAL DETACHMENT

Suprachoroidal buckling can be performed with or without vitrectomy. In most cases, a chandelier light (25 gauge or smaller) is placed at the 12 o'clock position or in any other quadrant if the tears are at 12 o'clock; then we use an operating microscope combined with a wide-angle viewing system for fundus examination. The tear site can easily be identified and marked under wide-angle fundus viewing with direct illumination from the chandelier. The wide-angle system is then removed. The conjunctiva in the quadrant of the tear is incised, and a 3-mm circumferential sclerotomy is created 4 mm from the limbus to expose the choroid. We then displace the choroid by injecting some viscoelastic to form a 1-mm to 2-mm pocket to create a space for the introduction of the suprachoroidal catheter (Figure 4A). The catheter is then threaded through the sclerotomy into the suprachoroidal space in the direction of the tear location, pushing against the scleral wall in the suprachoroidal space. The wide-angle system is then flipped again to see the fundus with the chandelier light and the location of the tip of the catheter in relation to the tear (Figure 4B). Once the light from the catheter is under the middle of the tear, the injection of the hyaluronic acid solution is initiated, causing a controlled choroidal indentation that expands in height and direction depending on the desired location and height, similar to the process of adjusting the location and height of an episcleral buckle (Figure 4C). Typically, 0.2 mL to 0.5 mL of suprachoroidal gel, accompanied by an anterior chamber paracentesis or subretinal fluid drainage, is necessary to adjust the intraocular pressure (IOP). The collection of hyaluronic acid solution in the suprachoroidal space causes the light tip to dim, but the use of the catheter helps in targeting posteriorly located breaks irrelevant to the anterior location of the sclerotomy. If 1 or more tears are close to each other (1 to 2 clock hours), these can be buckled using the same entry site. Once the tear is closed by the suprachoroidal buckle, the catheter is withdrawn from the sclera and the sclerotomy is closed with sutures. The conjunctiva is closed with sutures, and the chandelier is removed from the eye. The tear can then be treated by indirect laser ophthalmoscopy (Figure 4D). Another treatment option to create chorioretinal adhesion is cryoretinopexy, which should be performed in advance of the suprachoroidal buckling. The IOP is rechecked and adjusted by another paracentesis if necessary. (Note: this step is not essential if the buckling process is part of a vitrectomy procedure.) An air or SF_6 gas bubble may be used depending on the site, size, and location of the break.

SUPRACHOROIDAL MACULAR BUCKLING FOR MYOPIC TRACTION MACULOPATHY

MTM is a descriptive term for the schisis-like thickening in the outer layers of highly myopic eyes with posterior staphyloma, also known as myopic foveoschisis. In addition to the schisis thickening, findings may also include inner retinal fluid, foveal detachment, and lamellar or even full-thickness macular holes followed by progressive retinal detachments.[8-10] Management of MTM has focused on eliminating epiretinal traction forces by means of vitrectomy with or without internal limiting membrane (ILM) peeling in previous reports.[11-15] Macular buckling is a well-established technique for supporting the posterior scleral wall, releasing the tractional forces on the vitreomacular interface (VMI) in the area of the staphyloma, and it has been used for treating challenging MTM cases refractory to the above-mentioned surgical approaches. Several authors have reported favorable results of macular buckling in managing MTM. However, there is a long learning curve and challenge in proper localization and fixation of the episcleral macular buckle in the cases with extremely thin sclera and deformed staphyloma, despite several modifications to the designs and materials of episcleral macular buckles.[16-19]

The suprachoroidal buckling technique can bypass the difficulties of conventional scleral buckling in the macular area by direct controlled delivery of a buckle-like effect (indentation) from the suprachoroidal space in the area of staphyloma. The choroidal indenting effect at the macula relieves all forms of traction at the VMI. In macular buckling,

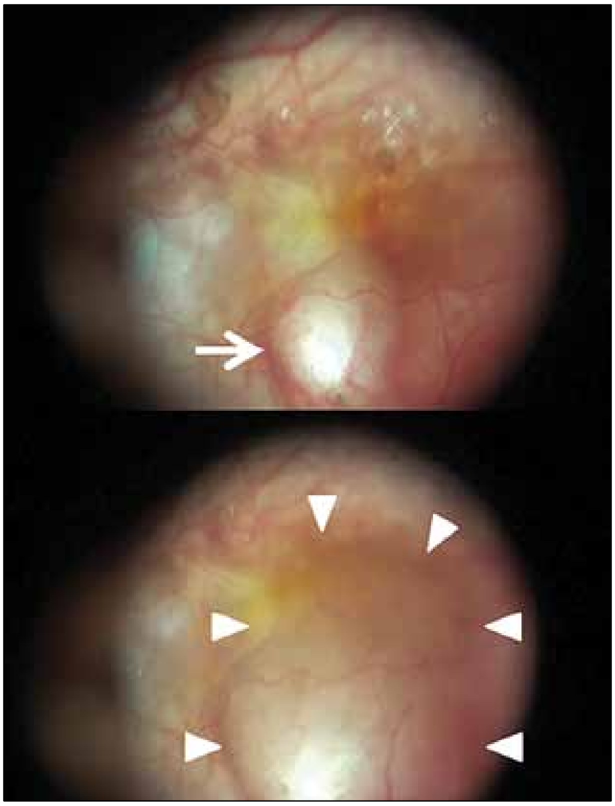

Figure 5. Intraoperative view of suprachoroidal macular buckling in a case with myopic foveoschisis. The illuminated tip (white arrow) of the suprachoroidal catheter inserted into the suprachoroidal space around the macula (A). A dome-shaped choroidal buckle (white arrowheads) is clearly created at macula with an injection of the long-acting HA filler into the suprachoroidal space (B).

the surgical procedure for all patients is a standard 3-port, 25-gauge pars plana vitrectomy (PPV) and dissection of the posterior hyaloid. Suprachoroidal buckling, as previously described for RRD, is then employed. Care must be taken, however, while attempting to cross the edges of the posterior staphyloma because the choroid is extremely thin, particularly at the superior edge of the staphyloma. Prior to crossing this site, a small amount of hyaluronic acid solution is injected to dissect and lift the choroid at the edge prior to pushing the catheter into the posterior staphyloma. Once the tip of the catheter is placed in the suprachoroidal space underneath the target tissue (foveoschisis or macular hole), we inject the hyaluronic acid solution to dissect the thin choroid toward the retina, creating an indentation effect (Figure 5). This effect restores the normal contour of the choroid or even indents it to a convex configuration supporting the retina. The illuminated tip of the catheter is seen with ease in patients with foveoschisis and in patients with macular holes associated with shallow posterior pole detachment. Fluid/air exchange is used prior to hyaluronic acid solution injection, if the subretinal fluid is extensive enough to obscure the catheter tip light.

PRELIMINARY OUTCOMES

In a preliminary clinical trial, a consecutive series of 28 patients (5 with uncomplicated RRDs and 23 with MTMs) who underwent suprachoroidal buckling at 2 institutional facilities in Cairo, Egypt, were followed and enrolled into the data analysis. Of the 5 eyes with uncomplicated RRDs, all retinal breaks were sealed with suprachoroidal buckling, including 2 eyes treated simultaneously with vitrectomy for inferior retinal breaks. Retinal attachment was achieved in all 5 eyes without any intra- and postoperative complications over the 6-month follow-up period. Of the 23 eyes with MTMs, retinal structural restoration was achieved in the 11 eyes with myopic foveoschisis. Of the other 12 eyes with macular hole retinal detachment, 10 eyes (83%) showed successful hole closure with the resolution of retinal detachment; 2 eyes showed retinal reattachment and flatting of the edges of the macular holes but with incomplete closure. No recurrence of retinal detachment was observed in any study eyes over the 12-month follow-up period. Surprisingly, based on optical coherence tomography examination, the indentation effect in some cases has been persistent over the 12-month follow-up period.

CONCLUSIONS AND FUTURE PERSPECTIVES

The concept of suprachoroidal buckling was first reported by Poole and Sudarsky in 1986 as suprachoroidal implantation for treatment of peripheral retinal breaks in retinal detachment.[20] A direct injection of 1% sodium hyaluronate with a 27-gauge cannula was successful in 14 patients with RRDs with peripheral breaks. However, the concept of suprachoroidal buckling failed to be widely accepted, possibly because of the technical difficulties and instability of the initially reported procedures. In contrast to this study, we have succeeded in establishing a secure technique for suprachoroidal buckling by injecting long-lasting hyaluronic acid solution into the suprachoroidal space with a suprachoroidal catheter, which was originally developed to inject drugs into the suprachoroidal space to treat macular edema and exudative age-related macular degeneration.[21]

Based on the favorable results obtained from animal experiments and preliminary clinical trials, we believe that the suprachoroidal buckling procedure with a suprachoroidal catheter is technically safe and feasible. Because the physiologic adhesion between the choroid and sclera is loosened, no serious complications related to the insertion of the catheter and injection of the hyaluronic acid solution into the suprachoroidal space was encountered. This technique is apparently less invasive than a conventional scleral buckling procedure to treat a single tear or a group of tears in 1 clock hour independent of their location (superior or inferior), and to close reopened retinal breaks in cases of inferior recurrent retinal detachment under silicone oil. Certainly, posteriorly located breaks are good indications in which to use the catheter to reach these breaks to avoid long radial episcleral buckles. Additionally, retinal detachments in young phakic patients with myopia are reasonable cases to consider for this procedure, to avoid the refractive changes that can occur with conventional episcleral buckling.

In our experience, a suprachoroidal approach to macular buckling is promising, both anatomically and functionally, for treating MTMs. A suprachoroidal approach may be more reliable in terms of reaching the target area and achieving the desired buckle height than a conventional episcleral macular buckle technique. In addition, this technique may change our therapeutic approach for refractory MTMs from the goal of restoring the normal contour of the choroid to separating the choroid from the sclera and thus releasing the traction on the retinal layers. Using this novel technique, the choroidal indentation separation from the sclera lasted up to over 1 year, supporting the chorioretinal adhesion at the macula. There were no ischemic changes at the choroidal indentation, possibly due to the gentle sloping elevation created via the suprachoroidal approach, which may have created less mechanical pressure and effects on the choroidal circulation compared with conventional episcleral macular buckling.

In summary, the results of 2 pilot studies, in conjunction with data from animal experiments, encourage us to conclude that suprachoroidal buckling with or without PPV may be a promising less invasive treatment option for uncomplicated RRDs and refractory MTMs. A prospective multicenter clinical trial will be started in Japan soon. Further study is recommended to evaluate the choice of fillers for suprachoroidal buckling according to the pathology and desired length of indentation. ■

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