Use of anterior segment imaging and direct cyclopexy repair of cyclodialysis cleft

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Abstract:
We aim to describe different imaging modalities to localize cyclodialysis clefts and direct cyclopexy repair of cyclodialysis clefts. We reviewed the record of a patient with traumatic cyclodialysis cleft who underwent direct cyclopexy retrospectively. Preoperative and postoperative visual acuity and intraocular pressure (IOP) were recorded. Gonioscopy, ultrasound biomicroscopy (UBM) and 360° swept-source anterior segment optical coherence tomography (SS-ASOCT) were used to localize the cyclodialysis cleft. We concluded that UBM is the current gold standard imaging modality in localization of cyclodialysis clefts, and that SS-ASOCT is potentially useful as alternative imaging modality. Direct cyclopexy is an effective treatment for large cyclodialysis cleft with good IOP control and visual outcomes.

Keywords:
Cyclodialysis cleft, direct cyclopexy, glaucoma

Introduction

Cyclodialysis is defined as separation of the ciliary body from the scleral spur.[1] It can be due to trauma or iatrogenic after anterior segment surgery such as glaucoma filtration surgery.[1-3] The direct communication between the anterior chamber and the suprachoroidal space due to a cyclodialysis cleft can result in significant complications, such as hypotony maculopathy, choroidal effusion, and cataract formation.[1,2] On the other hand, resultant elevated intraocular pressure (IOP) from the closure of a cyclodialysis cleft can lead to glaucoma. The natural history and unpredictable wide spectrum of the condition increase the level of difficulty in the management. In addition, the surgical success of cleft repair is variable, which is partly attributed to the wide range of surgical approaches.[4-6]

The aim of cyclodialysis treatment is to normalize IOP in the long term and prevent complications. Small cyclodialysis cleft can be managed conservatively if the patient is asymptomatic, or the complications are self-limiting. Clinically, small cyclodialysis cleft may close spontaneously or with the use of topical cycloplegic agents that relax the ciliary muscle and promote apposition of the detached longitudinal ciliary muscle fibers to the sclera.[3,4] As for the larger cyclodialysis cleft, various repair techniques have been described. Direct suture closure or direct cyclopexy is one of the procedures that yield satisfactory outcomes in long-term visual prognosis and stable IOP control.[4,5] Several alternative methods include penetrating diathermy,[6,7] argon laser photocoagulation,[1,6,8,9] cryotherapy,[6,10] scleral buckling,[11] and vitrectomy with gas tamponade.[12]

Conventionally, gonioscopy was the only available technique to diagnose and localize the cyclodialysis clefts. However, other examinations such as ultrasound biomicroscopy (UBM),[1,13-15] anterior segment optical coherence tomography
(ASOCT)\(^{[1,13,14]}\) and magnetic resonance imaging\(^{[16]}\) are now available for the diagnosis of cyclodialysis clefts. Slit-lamp gonioscopy can be difficult due to corneal opacity, hyphema, chronic hypotony after globe trauma or obscuration of the cleft by peripheral anterior synechiae. This affects the efficacy of gonioscopy to define the extent of cyclodialysis cleft, which is crucial for surgical planning. Our center routinely uses high-frequency UBM, which is reproducible and highly sensitive in detecting the location and extent of cyclodialysis cleft.\(^{[13,15,17]}\) However, UBM is operator-dependent and contact imaging may distort a hypotonous globe and affect the image quality.

In this case report, we aim to describe a case of large cyclodialysis cleft referred to a tertiary glaucoma unit treated successfully with direct cyclopexy. We also highlight the useful features of noncontact, operator-independent and time-efficient swept-source ASOCT (SS-ASOCT) in the detection, localization and determination of the size and extension of cyclodialysis cleft.

**Case Report**

A 31-year-old female suffered from blunt trauma to the face and left eye in a road traffic accident. Clinical examination showed significant visual acuity (VA) reduction to counting fingers in the left eye due to gross hyphema. IOP was normal and B-scan ultrasonography of the left eye showed no retinal detachment or choroidal detachment. A computed tomography study of the face delineated left orbital floor, lateral, and medial walls fractures. She was treated with topical cycloplegic agent, topical corticosteroid, and open reduction with internal fixation of the orbital fractures at 1-week postinjury. After the reabsorption of hyphema, VA of the left eye remained poor due to ocular hypotony (IOP of 5 mmHg) with maculopathy. Slit-lamp gonioscopy showed cyclodialysis cleft from 12 o’clock to 4 o’clock [Figure 1]. UBM [Figure 2] and SS-ASOCT (Casia, Tomey Corporation, Japan) [Figure 3] were performed and showed similar findings as the gonioscopic study. In view of large cyclodialysis cleft, the patient underwent direct cyclopexy [Figure 4] under general anesthesia.

Postoperatively, there was a transient surge of IOP to 47 mmHg and this was managed with systemic and topical anti-glaucoma medications. Unfortunately, in view of persistent high IOP, she required regular topical anti-glaucoma eyedrops to achieve normal IOP. A gradual improvement of best-corrected VA (BCVA) to 6/12 and IOP of 17 mmHg was observed 1 month and 6 months after the surgery. Postoperative UBM and SS-ASOCT [Figure 5] at 1 month showed complete cyclodialysis cleft closure. At 10-month postoperative review, her left eye BCVA was 6/9 and IOP was 19 mmHg with a single combination topical anti-glaucoma eyedrop.

**Discussion**

UBM has been the gold standard imaging modality used in the diagnosis and follow-up of patient with cyclodialysis clefts.\(^{[13,17]}\) We showed that SS-ASOCT is potentially a useful imaging modality for the localization and determination of the size and extension of cyclodialysis cleft via 3-dimensional and 360° imaging of the anterior segment.\(^{[18]}\) In comparison to UBM, SS-ASOCT is a noncontact, time-efficient imaging device that uses low coherence interferometry to obtain cross-sectional images of the anterior segment. SS-ASOCT has better resolution with full-field view of the whole anterior segment as compared to UBM. It provides clear 3-dimensional images which demonstrate the full extent and location of the cyclodialysis cleft in one single scan. It is also less operator-dependent which makes SS-ASOCT more reproducible compared to UBM. In contrast, UBM only shows parts of the cyclodialysis cleft in respective clock hours and requires multiple repositioning of the probe. We have demonstrated the usefulness of SS-ASOCT in the detection, localization and determination of the size and extension of cyclodialysis cleft. However, the use of SS-ASOCT, similar to other types of ASOCT, is limited to structures anterior to the iris pigment epithelium as optical coherence tomography utilizes light energy which cannot penetrate tissues behind the iris pigment epithelium. On the contrary, UBM allows the visualization of posterior chamber structures, including ciliary bodies, zonules, and lens with high-frequency sound waves. In addition, ASOCT can only be used on eyes with clear cornea, whereas UBM can produce images through an opaque cornea.\(^{[19]}\)
Surgical closure of cyclodialysis cleft is indicated if spontaneous closure failed,[1,3,6] medical therapy with topical cycloplegic agents failed to normalized IOP,[1,3,6] large (> 3 clock hours) cyclodialysis cleft,[14] persistent hypotony (IOP ≤ 5 mmHg) for more than 6 weeks with the reduction in VA secondary to hypotony maculopathy, choroidal detachment, optic disc edema, corneal edema or astigmatism.[1,3,6,14] Surgical treatment should be performed to normalize IOP, reverse associated complications, improve VA and prevent permanent visual loss. The timing of cyclodialysis cleft repair is generally recommended within 3 months after the diagnosis.[1] The most commonly reported surgical option with complete closure of cyclodialysis is direct cyclopexy.[4,5,14,15] Other surgical options such as trans-scleral diode laser therapy,[20-22] anterior scleral buckling,[23] and vitreoretinal procedures with intraocular tamponade[24] were reported on a case-by-case basis with complete closure of cleft. Surgical closure of a cyclodialysis cleft using the haptics of a normal-sized intraocular lens following cataract surgery has demonstrated reattachment of the ciliary body to the scleral spur.[25] Of all the surgical options above, only direct cyclopexy[4,5,14,15] has been widely studied and demonstrated its efficacy and outcome with a good long-term visual prognosis and IOP control.[4,5,14,15] In terms of surgical techniques, direct cyclopexy is the preferred choice of surgical options due to the promising long-term outcome of complete closure, visual improvement, and IOP control.[4,5] Regarding scleral incision during direct cyclopexy, partial-thickness scleral flaps (Naumann and Volcker technique) are superior in terms of the reduced risk of protruding sutures eroding the conjunctiva, whereas the full-thickness flap (Mackensen and Corydon technique) promises a more robust closure by permitting larger scleral suture bites, thereby preventing postoperative dehiscence from extremely high IOP.[14]

Direct cyclopexy is performed under general anesthesia. A miotic agent such as topical pilocarpine 2% is applied before the surgery. A high molecular weight weight
viscoelastic substance is then injected into the anterior chamber to deepen the anterior chamber and raise the IOP of the hypotonic globe. Direct gonioscopy is then used to localized the cyclodialysis cleft and conjunctival peritomy is created according to the location of a cyclodialysis cleft. This is followed by a limbal-based partial thickness scleral flap at 4.5 mm from the limbus. A deep scleral incision is made from the middle to both end of the cleft, at 2 mm posterior and parallel to the limbus. The deep scleral incision is then closed with 10-0 nylon, passing through anterior scleral lip, detached ciliary body, and finally the posterior scleral lip. Finally, the partial thickness scleral flap is sutured with 8-0 nylon and the conjunctiva is closed with 8-0 vicryl. The reported success rates for direct cyclopexy with complete cleft closure were good, ranging from 67% to 96% for the first procedures and improving to nearly 100% with two procedures.\cite{1} Postoperative IOP normalization with VA improvement was reported up to 90% after 6 months of surgery, however, 10% to 16% remained unchanged postoperatively due to posttraumatic posterior segment pathologies.\cite{1,14} The complications of direct cyclopexy include intraocular hemorrhage such as hyphema, suprachoroidal hemorrhage and vitreous hemorrhage, endophthalmitis, cataract, vitreous loss, retinal detachment, wound dehiscence, anterior segment ischemia, and secondary glaucoma due to peripheral anterior synechiae.\cite{4,5} When the cyclodialysis cleft is closed, there may be a period of acute rise in IOP within the first 2 weeks after cleft closure.\cite{4,5,14,24} This increase in IOP is caused by the collapse of the aqueous drainage channels during the prolonged hypotony period and the inability to reestablish drainage after IOP is restored.\cite{24} This transient surge in IOP is treated with topical or systemic anti-glaucoma medications according to the level of IOP and rarely it will require filtering surgery such as trabeculectomy or tube surgery.\cite{14,24} Miotics are generally contraindicated in this condition, as they could re-open or worsen the cyclodialysis cleft.\cite{24}

Figure 4: Direct cyclopexy procedure (a) Intra-operative gonioscopic identification of cyclodialysis cleft; (b) Conjunctival peritomy from 10 o’clock to 6 o’clock; (c and d) Creation of superior and lateral rectus slings with 6-0 silk; (e and f) Creation of partial thickness scleral flap (black arrow) at 4.5 mm from limbus extending from 11 o’clock to 5 o’clock; (g) Deep scleral incision (black arrow) at 2 mm from limbus from 10:30 o’clock to 4:30 o’clock; (h) Closure of deep scleral incision with 10-0 nylon, passing through anterior scleral lip, detached ciliary body and posterior scleral lip; (i) Closure of partial thickness scleral flap with 8-0 nylon, removal of rectus slings and closure of conjunctival peritomy with 8-0 vicryl. (LR: lateral rectus, MR: medial rectus, A: anterior scleral lip, P: posterior scleral lip)
Conclusion

Cyclodialysis cleft is a rare ophthalmic entity that is difficult to diagnose and treat effectively. Gonioscopy and UBM are the currently available techniques in the diagnosis and localization of cyclodialysis clefts. We have demonstrated the potential superiority of SS-ASOCT as an imaging modality in the diagnosis and assessment of cyclodialysis clefts. Direct cyclopexy is a successful and effective treatment for large cyclodialysis cleft. It shows significant postoperative VA and IOP improvement. However, VA may be compromised due to posterior segment sequelae of preceding ocular trauma and long-standing hypotony maculopathy. The surgical outcome of our patient demonstrated direct cyclopexy being a safe surgical approach in cyclodialysis cleft closure with promising primary outcome in restoring normal IOP and secondary outcome of a good postoperative VA.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient has given her consent for her images and other clinical information to be reported in the journal.

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Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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