Architectural analysis of subconjunctival oblique limbus incision techniques in manual cataract extraction surgery by optical coherence tomography imaging

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The purpose was to assess the profile of subconjunctival oblique limbus incision (SCOLI) design by using anterior-segment optical coherence tomography (AS-OCT) and try to emphasize the proper technique of wound construction. The structural dimensions and integrity of the wound were acquired from the patients, who had undergone manual small-incision cataract surgery with SCOLI techniques, using a Canon OCT anterior-segment imaging system on the first postoperative day. The use of AS-OCT allowed for an *in vivo* evaluation of SCOLI in high definition. The radial OCT scan image showed three staggered incisions, including conjunctiva incision, scleral entrance, and inner corneal lip. A tangential scan demonstrated that the internal lip is parallel to the curvature of the peripheral cornea. The *en face* image showed an asymmetric 4 arc-shaped configuration rather than a symmetrical one. In conclusion, AS-OCT could be used to analyze SCOLI to determine optimal wound construction and geometry. The results of this study indicated that an asymmetric 4 arc-shaped limbus tunnel incision was superior to the conventional linear equivalent in stability and nucleus delivery.

Key words: Anterior-segment optical coherence tomography, incisional funnel, manual small-incision cataract surgery, subconjunctival oblique limbus incisions

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Previously, we have reported that a modified cataract surgery incision, known as subconjunctival oblique limbus incision (SCOLI), is a suitable incision construction technique to manage mature cataracts.[1] This has been demonstrated in over 30,000 cases, in which using a SCOLI was shown to be an effective and safe method, superior to the conventional manual small-incision cataract surgery (MSICS). Although SCOLI has been described 8 years ago, it has not gained popularity worldwide, partly because of its relatively complicated wound construction and need for the highly demanded skill of the surgeon.[1-3]

The introduction of anterior-segment optical coherence tomography (AS-OCT) has allowed an *in vivo* evaluation of wound architecture in high definition. AS-OCT technology was the most commonly used method for evaluating clear corneal incisions in phacoemulsification cataract extraction.[4,5] Here, we examine the features of SCOLI architecture *in vivo* by using a Canon OCT anterior-segment imaging system. The purpose of the present study is to demonstrate the architectural features and the dimensions involved in wound construction in SCOLI and try to demonstrate the proper technique of wound construction.

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Surgical Technique

All participants involved in the study were provided an informed consent form to be involved in the imaging. This study was approved by the Kunming University of Science and Technology Sciences Subcommittee for the Protection of Human Subjects and the Institutional Review Board.

In the current study, we employed a surgical technique that was previously described.[1] In brief, a 3.0 mm keratome was used to create a transconjunctival limbus tunnel [Fig. 1a], whose extent was next lateralized with a 2.8 mm crescent blade. The extent of the initial tunnel (external and internal lip) was propagated with gentle lift and titling movements [Fig. 1b and c] upon translating the blade to the right side. Depending on the size of the nucleus, an intrascleral extension was created upon leftward movements of the blade by lifting and lateral swiping movements repeated 1–3 times [Fig. 1d]. Finally, pulling allowed to form an enlarged scleral pocket and an "L" conjunctival pocket by withdrawing the blade backward and laterally [Fig. 1e and f; Videos 1 and 2].

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Imaging technique

In this study, the radial section of SCOLI was visualized using a SD-OCT system with the addition of a corneal adapter module. For this purpose, we used an anterior-segment SD-OCT three-dimensional dataset of 100 B-scans, each containing 512 A-scans, obtained on the first SCOLI postoperative day. Processing with proprietary software was used for the reconstruction of an *en face* image of the temporal limbus based on the dataset of 100 B-scans. During this process, patients were asked to look straight to the opposite of the incisions. Afterward, a complete transverse scan was obtained, and high-definition images were recorded.

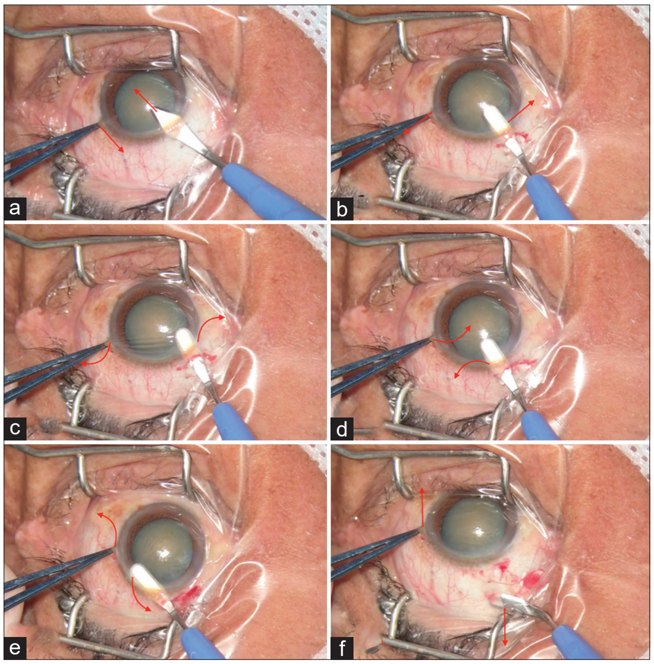

Figure 1: A composite photograph of making a subconjunctival oblique limbus incision: (a) A transconjunctival sclerocorneal tunnel was fashioned with a 3.0 mm keratome, placed 1.25 mm behind the conjunctival limbal insertion. (b) The dissected pocket was extended to the right by moving the blade to the right followed by tilting the blade side direction (c and d) The tunnel was extended to the left, by pushing the blade to the left, lifting it, and spinning it backward. (e and f) A 5 mm opening of an inverted "L" conjunctival pocket was created by pulling the blade backward and laterally

Results

An anterior segment SD-OCT three-dimensional dataset was acquired on postoperative day 1 from a subconjunctival oblique limbus incision from a 75-year-old woman who underwent uncomplicated cataract extraction by SCOLI technique. The scan dataset consisted of 100 B-scans, which allowed for the reconstruction of an en face image of the limbus using proprietary software.

In the images of radial OCT scan, three staggered incisions were shown in middle of the tunnel [Fig. 2],while similar arcuate architecture presented itself in the right and left edges of the SCOLI [Figs. 3 and 4]. A tangential scan demonstrated that internal lip was parallel to the curvature of the peripheral cornea[Fig.5].In the en face image, an asymmetric 4 arc-shaped incision was shown. [Fig.6].

Discussion

Wound construction is of importance in manual cataract extraction, in which everything about the wound has to be carefully planned because the ease of delivering the nucleus and the ultimate outcome is dependent on incisional architecture.[1,6,7] In this study, we examined the profile of SCOLI using the AS-OCT system. This technology has allowed the first view of the clear corneal incision for phacoemulsification cataract surgery in the living eye in the early postoperative period.[4,8] To our best knowledge, this is the first study that investigates an *in vivo* wound architecture of the MSICS using an OCT imaging system.

Fig. 2 is an image of the radial OCT scan, aligned in the middle of the initial 3 mm-width tunnel, which shows a curvilinear shape of a subconjunctival limbus incision but not a straight one. This arcuate incision was considerably longer than the chord length originally estimated for the incision length. The architecture of the incision allowed for a tongue-and-groove paneling-liking fit by adding a measure of stability to these incisions while limiting the probability of sliding their surfaces over the other.[9]

Figs. 3 and 4 have been aligned to the right and left edges of the SCOLI, respectively. The image of the OCT scan shows a sclero-corneal incision with a similar arcuate architecture and adequate apposition at the endothelial side on the first postoperative day.

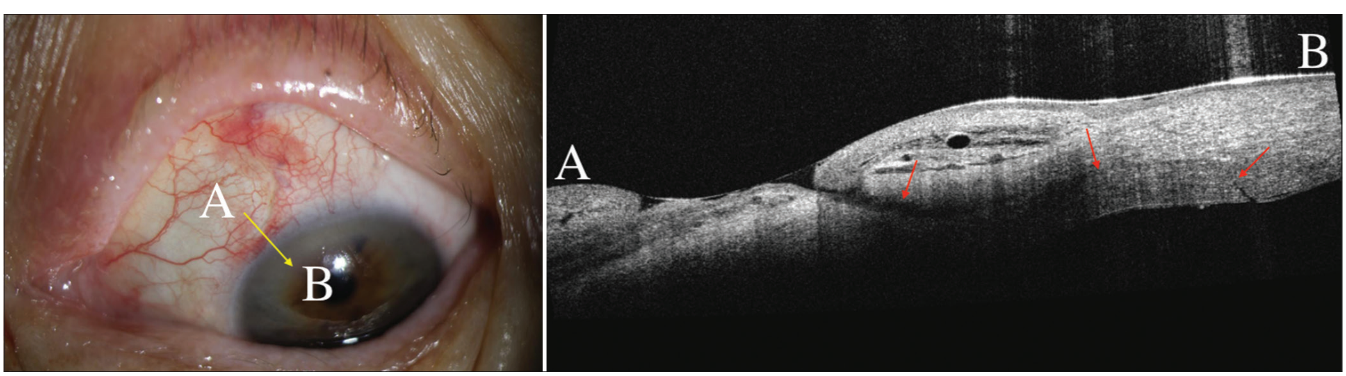

Figure 2: The image of radial OCT scan that was aligned to the middle of the 3 mm-width tunnel showing three staggered incisions: conjunctival incision, limbal entrance, and inner corneal lip. The red arrow indicates the curvilinear shape of the incision; the conjunctiva has seemed to cover the scleral exit

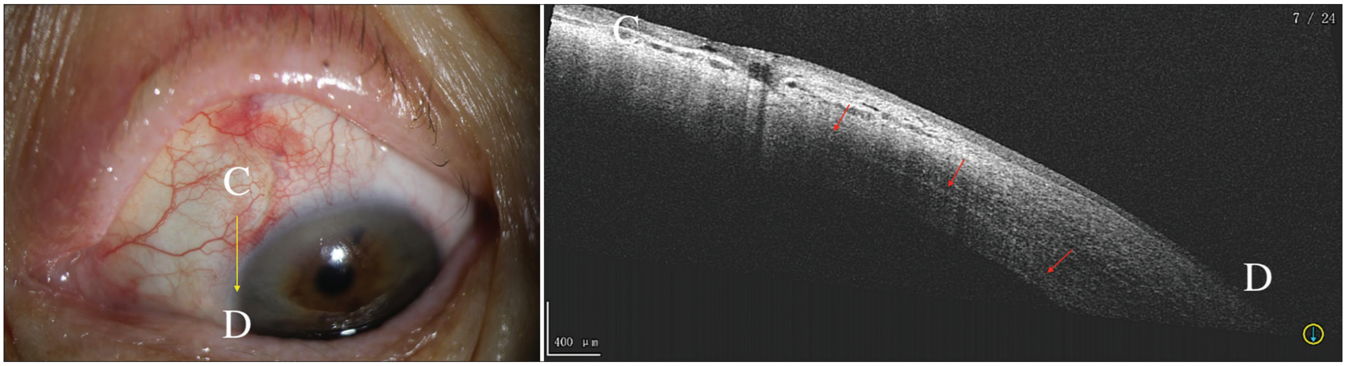

Figure 3: The image of the radial OCT scan that was aligned to the right of the SCOLI showing an adequate apposition of the epithelial edges between the corneal anterior and limbal posterior lips of the incision

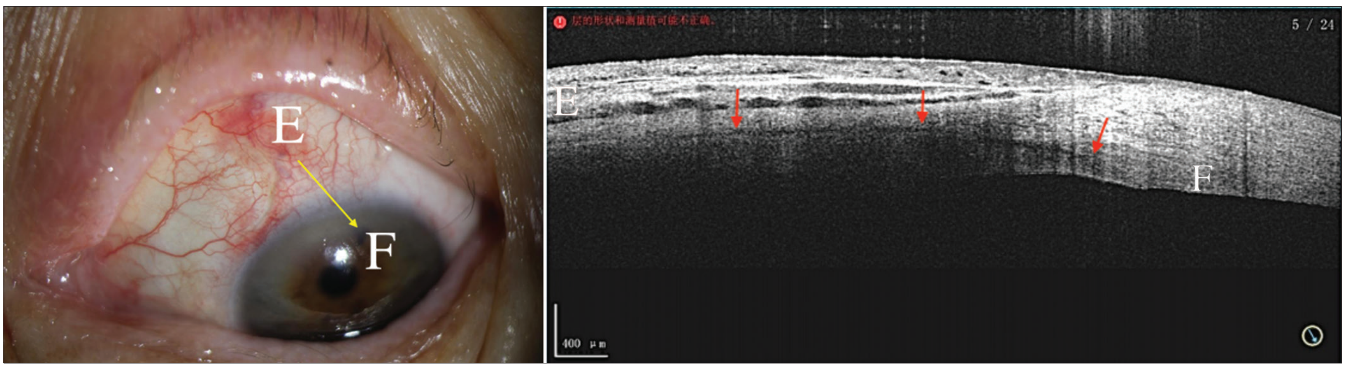

Figure 4: The image of the radial OCT scan that was aligned to the left in the width of the SCOLI showing anterior lips lying in the clear cornea

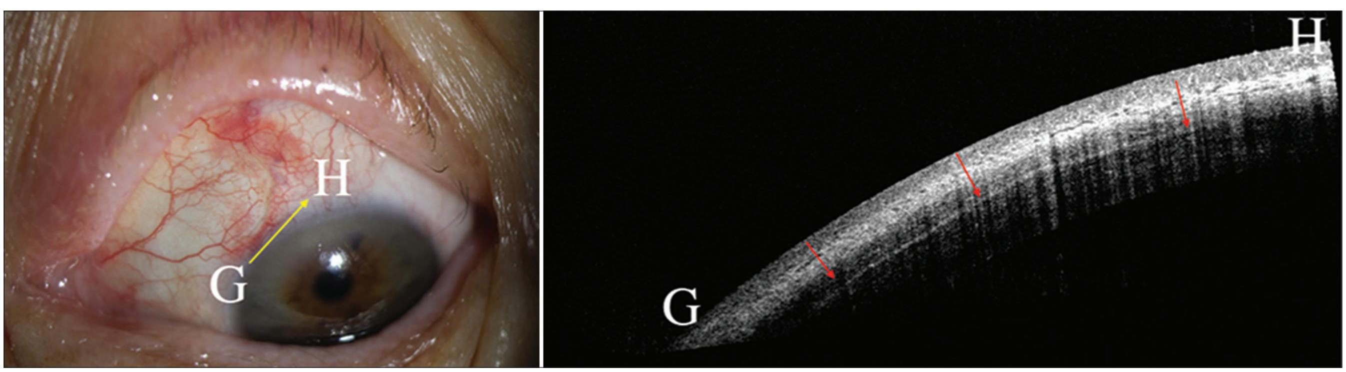

Figure 5: The image of the OCT scan that was aligned tangential to the limbus showing that the internal lip seems to be parallel to the curvature of the peripheral cornea but not a straight horizontal line

One of the findings in the recent study was demonstrating that the limbal tunnel was parallel to the curvature of the peripheral cornea [Fig. 5]. To achieve a longer inner lip extension (GH), tunnel enlargement should always be made by moving the tilt of the blade along and equally to the contour of the globe while avoiding a tendency of peripheral extension of the inner lip close to the limbus. This created an arcuate incision with a chord length whose width was considerably smaller than the arcuate incision in the dimension tangential to the limbus itself, adding a greater degree of stability.

Another important finding of this study was demonstrating that the inner lip is parallel to the limbus, resulting in the arch length of the incision being greater than the chord length. This would allow stretching the pocket to accommodate a bigger nucleus [Fig. 7]. Compared to conventional MSICS, a shorter tunnel in SCOLI would also help in the safe and efficient delivery of the large nucleus,[1,10] thereby demonstrating that SCOLI architecture was designed for the smooth delivery of a larger nucleus.

The *en face* OCT image of the SCOLI [Fig. 6] has shown a four arc-shaped geometry profile: an arch-shaped inner corneal lip (B′F′) and external scleral incision (A′E′), a lateral edge in the left (E′F′), and an arc plane (GH). It must be emphasized that the proximal and the distal portion of the scleral incision are 1 mm and 4 mm from the limbus, respectively. The backward extension part of the cut might contribute to less SIA, which might be explained by the distance from the limbus and the radial orientation.[11]

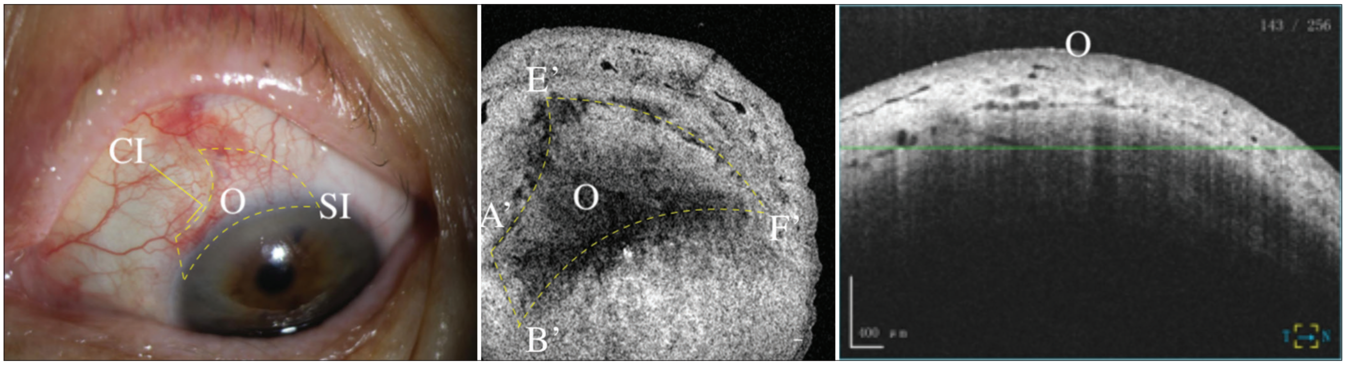

Figure 6: The geometry of SCOLI. Incision configurations were demonstrated by AS-OCT on the first postoperative day. (a) A photograph of a subconjunctival oblique limbus incision. The solid line indicates the conjunctival incision (CI), whereas the dotted line range (SI) represents the sclerocorneal tunnel incision. (b,c) An asymmetric 4 arc-shaped incision shown by the en face image on the first postoperative day. The dotted line indicates the four edges of the incision. With the O point as the apex, the deep section of the SCOLI has been analyzed by AS-OCT, starting from the surface of the corneal margin. The dotted range labeled as A'B'E'F' represents the approximate range of the corneal tunnel

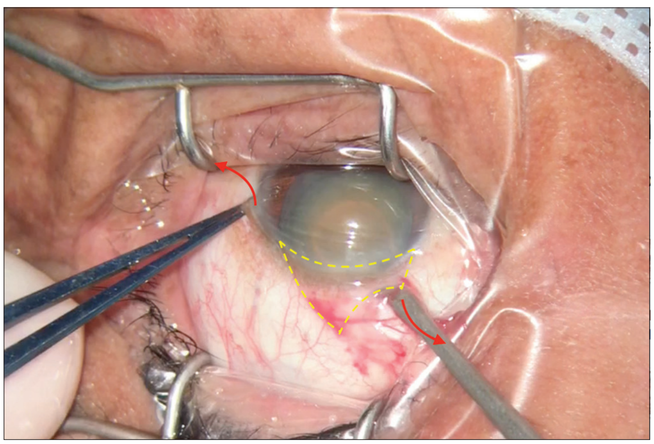

Figure 7: The picture demonstrates a procedure of the opening of the external foramen of the tunnel followed by the nucleus bulk passing through the pocket. The downward pressure of the Vectis heel was in a slightly rotating fashion.

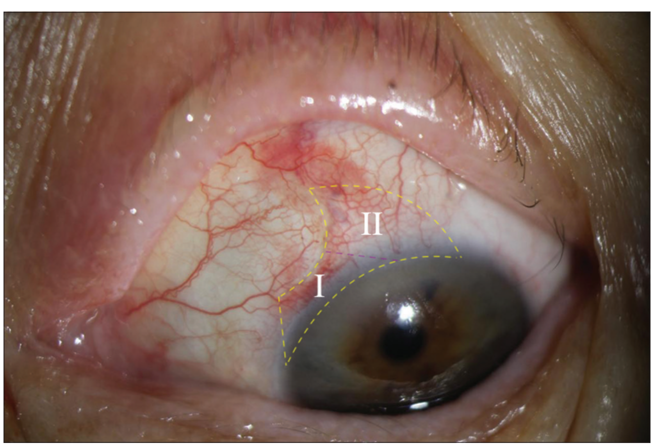

Figure 8: Zone I: Predominant zone causing surgically induced astigmatism (SIA). Zone II: Secondary zone responsible for SIA and main passage for nucleus delivery.

When adding an imaginary line, the SCOLI design seems to combine the symmetric tangential incision (zone I) with an asymmetric enlarging component (zone II) [Fig. 8]. Zone II represents an enlarged scleral pocket, which opens toward the anterior chamber, allowing the removal of a nucleus of any size in a slightly rotating fashion. In addition, it can be speculated that following an architectural enlarging component would acquire both mechanical (wound stability) and optical (astigmatism) properties, thereby allowing the wound to become independent of the amount of enlargement.

The asymmetric arch-shaped wound designs offer several advantages when compared to symmetric line-shaped ones, especially in precision, reproducibility, and convenience. Additionally, the healing surface of the overall tunnel is significantly larger than the others with straight designs, which also limits the postoperative wound slide and promotes healing.[12]

Conclusion

The stability of the wound directly depends on the appropriate architectural design and well-designed construction of the wound. In contrast to conventional MSICS, in which the wound is created outside inward, in this study, the SCOLI wound is made inside out. This needed a great deal of surgical expertise. Although difficult, it gave clean edges and is very quick in the hands of the expert. Therefore, a good understanding of the technique, as well as using appropriate materials (sharp instruments) and adhering to the standard operative procedures in every case, will undoubtedly benefit the surgeon in achieving great reproducibility and stability of the SCOLI wound.

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Conflicts of interest

There are no conflicts of interest.

References

1. Yang J, Lai P, Wu D, Long Z. Manual cataract extraction via a subconjunctival limbus oblique incision for mature cataracts. Indian J Ophthalmol 2014;62:274-8.
2. Yang J, Lai P. Author reply to comment on subconjunctival limbus oblique incision for mature cataracts. Indian J Ophthalmol 2015;63:361-2.
3. Yang J, Lai P. Reply to comment: Conventional manual small-incision cataract surgery. Indian J Ophthalmol 2015;63:804.
4. Can I, Bayhan HA, Celik H, Bostancı Ceran B. Anterior segment optical coherence tomography evaluation and comparison of main clear corneal incisions in microcoaxial and biaxial cataract surgery. J Cataract Refract Surg 2011;37:490-500.
5. Doeller B, Hirnschall N, Fichtenbaum M, Nguyen PM, Varsits R, Findl O. A randomized study of the impact of a corneal pre-cut during cataract surgery on wound architecture and corneal astigmatism. Ophthalmol Ther 2021;10:313-20.
6. Rajappa SA, Bhatt H. Minimizing surgically induced astigmatism in non-phaco manual small incision cataract surgery by U-shaped modification of scleral incision. Indian J Ophthalmol 2020;68:2107-10.
7. Bernhisel A, Pettey J. Manual small incision cataract surgery. Curr Opin Ophthalmol. 2020;31:74-9.
8. Teixeira A, Salaroli C, Filho FR, Pinto FT, Souza N, Sousa BA, Allemann N. Architectural analysis of clear corneal incision techniques in cataract surgery using Fourier-domain OCT. Ophthalmic Surg Lasers Imaging 2012;43 (6 Suppl):S103.
9. Fine IH, Hoffman RS, Packer M. Profile of clear corneal cataract incisions demonstrated by ocular coherence tomography. J Cataract Refract Surg 2007;33:94-7.
10. Haldipurkar SS, Shikari HT, Gokhale V. Wound construction in manual small incision cataract surgery. Indian J Ophthalmol 2009;57:9-13.
11. Hennekes RL, Van den Dooren KA. Asymmetric L-shaped corneal no-stitch tunnel incisions for cataract surgery. J Cataract Refract Surg 1999;25:550-5.
12. Bang JW, Lee JH, Kim JH, Lee DH. Structural analysis of different incision sizes and stromal hydration in cataract surgery using anterior segment optical coherence tomography. Korean J Ophthalmol 2015;29:23-30.