Original Article

Manual cataract extraction via a subconjunctival limbus oblique incision for mature cataracts

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Aims: To report the technique and outcomes of sutureless manual cataract extraction via a subconjunctival limbus oblique incision for mature cataracts. **Materials and Methods:** This retrospective study comprised of 112 eyes of 83 patients with mature cataract who all had manual cataract extraction via a subconjunctival limbus oblique incision. A transconjunctival tunnel is fashioned with a 3.0 mm keratome, 0.5 mm behind the limbal vascular arcades. A limbal tunnel, with a transverse extent of 9 mm in the cornea and 7.0 mm in the limbus, is created beneath the conjunctival/Tenon's tissue using an angled bevel-up crescent blade. Outcome measures included visual acuity, intraoperative complications, surgically induced astigmatism, endothelial cell loss rate and surgery time. **Results:** Self-sealing wound was achieved in 112 eyes (98.2%). The nucleus was delivered in whole in 108 eyes (96.4%). Intraoperative complications included hyphema in 3 eyes (2.7%), iridodialysis in 2 eyes 1.8%), posterior capsular rupture and zonular dialysis in 2 eyes (1.8%). At the 3-month follow-up, 91% patients achieved a best-corrected visual acuity of 20/20 or better, the mean of surgically induced astigmatism was -0.62 ± 0.41 Diopters and endothelial cell loss was 4.2%. Average surgical time was 3.75 min per case. **Conclusion:** This subconjunctival limbus oblique incision has the potential to serve as safe and effective technique for mature cataracts.

Key words: Limbus incision, subconjunctival incision, sutureless manual small-incision cataract surgery, wound construction

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Wound construction is of importance in manual cataract extraction, because the ultimate outcome and the ease of delivering the nucleus are dependant on wound architecture.[1-3] In conventional manual small-incision cataract surgery (MSICS), which is gaining popularity in developing countries, scleral tunnel incision, located at 12 o'clock or temporally, is the standard choice. Though the design of the scleral tunnel incision varies from surgeon to surgeon, a common step in this technique involves creating a conjunctiva flap prior to modeling a sclerocorneal tunnel.[2-6] In this procedure, the disconnection of conjunctiva-limbal attachment and free of Tenon's tissue may cause obvious damage to limbal architecture, particularly when a larger conjunctival limbal peritomy is required for cataract with a large nucleus.[4-7]

In addition, to achieve a self-sealing wound, scleral tunnel incision is combined with a long sclerocorneal tunnel (4 mm).[2,3] It is sometimes difficult to deliver a large, hard nucleus through the long tunnel without nucleus fragmentation.[2,6] But in rural area in developing countries, advanced stages of cataracts constitute a significant volume of cataract surgical load.[5-7] Therefore, a novel sutureless self-sealing incision allowing easy delivery of a large nucleus is urgently needed, especially in high volume cataract surgery setting.

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Here, we develop a modified cataract incision called subconjunctival limbus oblique incision (SCOLI). This technique is free of performing a peritomy and the associated trauma/cautery with it. Besides, this incision has greater wound stability and allows easy delivery of a large nucleus. The purpose of the present study is to report this incision construction technique and the surgery results using it for mature cataracts.

Materials and Methods

This retrospective study included 112 eyes of 83 consecutive patients with mature cataracts who all had extracapsular cataract extraction with SCOLI between May and December 2008. A cataract with totally opaque lens matter was considered mature. All surgeries were performed using topical anesthesia (proparacaine hydrochloride, 4 times in 15 min before surgery) by a single experienced surgeon (Jun Yang).

Surgical technique

A 1.0-mm paracentesis is made at 2 o'clock in the limbus with a 15° blade while the eye is stabilized and pushed downward by grasping in the limbus with a 0.12 toothed forceps. [Fig. 1a]. In the next steps, the eye is stabilized by grasping in the paracentesis.

A uniplanar transconjunctival tunnel (oblique plane incision) is fashioned with a 3.0 mm keratome (SHARPOINT, USA), 90° to the right side of the side port (oblique location). The knife is placed parallel to the posterior sclera, 0.5 mm behind the limbal vascular arcades, and pressure is slightly applied to indent the limbus with the knife, pushing forward to begin the transconjunctival tunnel incision [Fig. 1b]. When the knife tip approach 1 mm into clear cornea, the eyeball is rotated slightly backward to enable the knife tip penetrate the Descemet's membrane. The knife is then inserted until the "shoulders" are at the internal corneal incision [Fig. 1c].

Viscoelastic material is instilled in the anterior chamber via the tunnel incision.

A subconjunctival limbal tunnel is subsequently created with an angled bevel-up crescent blade (SHARPOINT, USA) beneath the conjunctival/Tenon's tissue. The dissected pocket should extend temporally and nasally up to, but should not cut the limbal vascular arcades on either side. Its transverse extent is greater in the cornea (9.0 mm) than in the limbal opening (7.0 mm) [Fig. 1d and e].The crescent blade is then used to cut remaining adherent Tenon's tissue in a way perpendicular to corneal limbus to create an inverted "L" conjunctival pocket. With two straight edges being 3 mm and 4 mm in length, the conjunctival pocket has an opening of 5 mm in width. [Fig. 1f]. Thus, a limbal tunnel covered partially by conjunctiva-limbal attachment is created. As only little bleeding occurs, cautery is typically not necessary.

A 7.0 mm capsulorhexis is performed using a pair of capsulorhexis forceps [Fig. 2a]. Hydrodissection is not required with these advanced cataracts. A Sinskey hook is used to extract one pole of the nucleus and rotate in a clockwise direction, until a half of the nucleus is in the anterior chamber [Fig. 2b].

Using toothed forceps to grasp the side incision and rotate the eye downward a little, a vectis may be passed into the anterior chamber and under the half-dislocated nucleus [Fig. 2c]. The external foramen of the tunnel can be opened a little using downward pressure of the 'heel' of the vectis [Fig. 2d]. The bulk of the nucleus can then be lifted and drawn into the tunnel [Fig. 2e]. As the nucleus moves into the tunnel, the eyeball is drawn downward further. When the nucleus is passing through the incision, epinucleus may strip off, or the nucleus may fragment. However, in most cases, the nucleus should be delivered in whole [Fig. 2f].

After cortex is removed, a 5.5 mm 3-piece PMMA lens is implanted in the bag [Fig. 2g]. Final deepening of the anterior chamber (with 500 mg/100 ml vancomycin in Ringer lactate solution) (about 1.0 mg) is done to reach an intraocular pressure slightly higher than normal (T + 1) [Fig. 2h,i], Video 1.

Examinations

Patients were examined preoperatively and on 1-day, and after 3 months postoperatively. The uncorrected and best-corrected visual acuity (BCVA) was measured 3 months after surgery. The central corneal endothelium was examined with a specular microscope (SP 8000 Konan Medical Inc). Surgically induced astigmatism was calculated using the vector analysis method based on the keratometry results of corneal topography examinations (Orbscan III, Bausch and Lomb Inc).[8] Postoperative topographic changes were determined by subtracting the preoperative readings from the postoperative numerical map readings.

Result

The mean age of the 83 patients was 67.2 years ± 9.3 (SD) (range 68 to 86 years). There were 41 male patients (40.2%) and 42 female patients (59.8%). Exclusion criteria were corneal pathologies such as dystrophies and pterygium. Preoperative uncorrected visual acuity in all 112 eyes ranged from light perception to 20/200. In 73 eyes (65.2%), visual acuity was 20/2000 or less. The mean surgical time was 3.75 ± 1.1 min (range 1.5 to 4.5 min).

Sutureless wounds were achieved in all but 2 patients, who required 2 sutures to close the main wound. The nucleus was delivered in whole in 108 eyes (96.4%).

The intraoperative complications included hyphema in 3 eyes (2.7%), irregular conjunctiva tear in 10 eyes (8.9%), iridodialysis in 2 eyes (1.8%), Descemet's membrane detachment in 5 eyes (4.5%), posterior capsular rupture and zonular dialysis in 2 eyes (1.8%).

On the 1 day postoperatively, folds in Descemet's membrane were observed in 13 eyes (11.6%); 9 were moderate corneal edema limited to the incision area (8.0%). A transient increase in intraocular pressure (>25 mm Hg) was observed in 11 eyes (9.8%). Fifteen patients (13.4%) reported a minor superior foreign-body sensation, which resolved within the first 48 h of surgery. No other significant intraocular complications such as endophthalmitis, retinal detachment or epithelial ingrowth occurred in the study.

Postoperative 3-month data were available in 75% (84 eyes) of the cases. There are 67% patients at 1-day and 81% at the 3 months post-operative visit achieved a UCVA of 20/40 or better, 91% patients at the 3 months post-operative visit achieved a BCVA of 20/20 or better [Figs. 3 and 4].Two eyes with a post-operative corrected visual acuity of 20/200 or worse had chorioretinal atrophic changes in the macula [Figs. 3 and 4].

The mean preoperative and postoperative 3 months astigmatism was 0.71 D ± 0.55 D, 1.5 D ± 0.73 D, respectively. The mean (SD) SIA in 25 patients preoperative astigmatism within ± 0.5D was -0.62D ± 0.41D at a mean axis of 135.0 ± 15° calculated using the vector analysis method [Fig. 5].

The mean preoperative endothelial cell density per millimeter squared were 2300 ± 313, 3 months after surgery were 2200 ± 475 ($P < 0.05$). The average number of cells lost per patient was 114 ± 21 per millimeter squared. Therefore, there was a 4.2% loss of endothelial cells after surgery.

Discussion

The present study reports a novel incision technique (SCOLI) and its outcomes in manual cataract extraction for mature cataracts. In this study, 98% eyes (110/112) of the wounds were self-sealing, 81% eyes (68/84) achieved UCVA of 20/40 or better at the 3-month follow-up. There was a low rate (4.2%) of endothelial cell loss, which was compared favorably with endothelial cell loss reported for manual SICS, especially for large and dense cataracts.[6,7] Despite an average surgical time of 3.75 min per case, the surgical complication rate was low, with less than a 2% rate of vitreous loss. Clinical outcomes of this study demonstrated that the SCOLI technique is a safe and effective alternative to MSICS for mature cataracts.

For standard extracapsular cataract extraction (ECCE), the surgical limbus is the primary choice for incision site. However, this entrance approach can't yield a long enough tunnel for a self-closed wound.[9] In MSICS, the external incision is moved to a more posterior location to promote better self-sealing of the wound.[2,3,7] While this incision may be sufficient for cataracts of mild to moderate density, it is sometimes difficult to deliver a large, hard nucleus without fragmentation.[2-4,10] In SCOLI, the location of the external entry has been shifted back toward the limbus approach. The shorter tunnel length (1.5 mm) permits

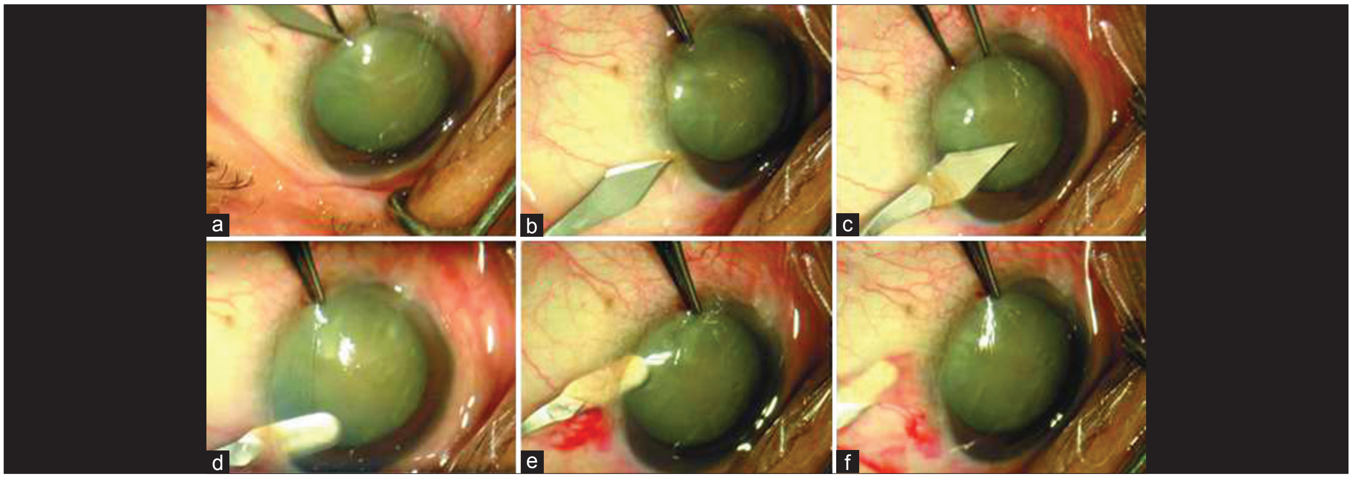

Figure 1: A composite photograph of making a subconjunctival limbus oblique incision, (**a**) A paracentesis is made with a 15° blade, (**b**) The 3.0 mm keratome is placed parallel to the posterior sclera, 0.5 mm behind the conjunctival-limbal insertion, 90° to the right side of the paracentesis, (**c**) A 3.0 mm transconjunctival sclerocorneal tunnel is fashioned with a keratome, (**d**) The dissected pocket is extended temporally, (**e**) The pocket is extended nasally up to the limbus, (**f**) An inverted "L" conjunctival pocket with an opening of 5 mm is created

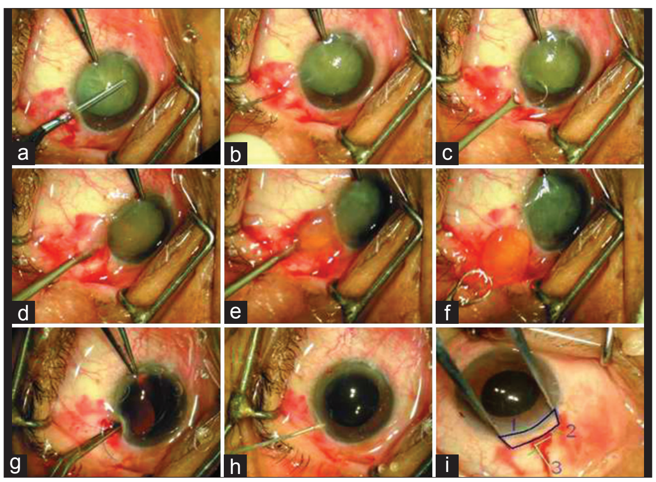

Figure 2: A composite photograph of extracting the nucleus outside the capsular bag and subconjunctival limbus incision, (**a**) 6.0 mm capsulorhexis is performed using a pair of capsulorhexis forceps, (**b**) A Sinskey hook is used to extract one pole of the nucleus outside the capsular bag, (**c**) A vectis is passed into the anterior chamber and under the half-dislocated nucleus, (**d**) The external foramen of the tunnel is opened a little using downward pressure of the 'heel' of the Vectis, (**e**) The bulk of the nucleus is passing through the conjunctival pocket, (**f**) The whole nucleus is delivered from the eye, (**g**) A 5.5 mm 3-piece PMMA lens is implanted into the bag, (**h**) Final redeepening of the anterior chamber is done, (**i**) A limbal incision partly covered by conjunctiva-limbal attachment is created. 1 = corneal lip; 2 = limbal cut; 3 = inverted "L" conjunctival opening

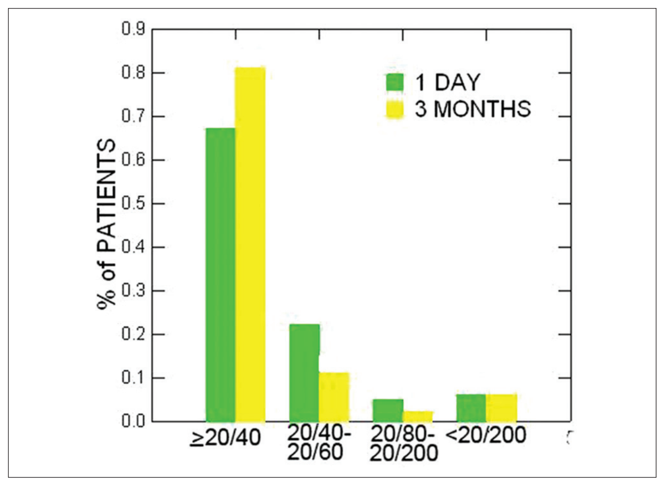

Figure 3: Frequency histogram of UCVA 1-day and 3-mon postoperatively

easy delivery of a large nucleus. In this series, the nucleus was delivered in whole in 108 eyes (96.4%). In 3 eyes, nucleus was broken into pieces in the tunnel. If it is a small fragment, it can be removed by hydroexpression; if it is large, it should be pushed back into the anterior chamber with viscoelastic before reattempting. Only 1 eye may need nucleus fragmentation with the second instrument through the side-port incision. It has been found that the shorter tunnel in SCOLI allows easy delivery of large nucleus safely and effectively using a vectis.

This subconjunctival limbal incision is essentially composed of 3 staggered incisions in alignment as follows: The innermost corneal lip being 9 mm in width; the intermediate scleral-corneal cut being 7 mm in width and the outermost inverted "L" conjunctival pocket [Fig. 2i]. With a smaller conjunctival pocket (5 mm in width), the limbus-corneal tunnel is covered by conjunctive/Tenon's tissue [Fig. 2h and i]. With vector forces being perpendicular to the limbus, the natural elasticity of conjunctival-limbal attachments enhances the wound stability by decreasing sliding between the two lamina of the tunnel. Besides, conjunctival tissue heals quickly, is usually subject to fibrosis/coagulation, and forms rather strong adhesive bonds making the incisions more secure.[11] Thanks to the elasticity of the conjunctival tissue, the smaller size conjunctival opening (5.0 mm in width) does not constitute a barrier to nucleus expression and lens implantation [Fig. 2e and g].

The key step in this technique involves making a tunnel length proportional to the nuclear sclerosis and widening of the limbus tunnel beneath the conjunctival pocket. In MSICS,

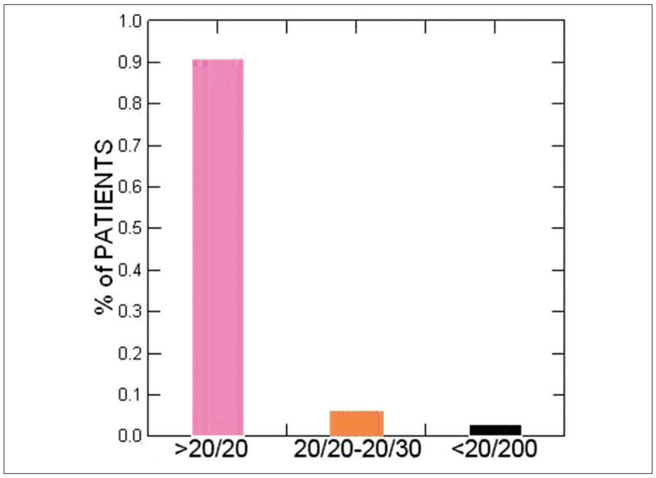

Figure 4: Frequency histogram of BCVA 3-mon postoperatively

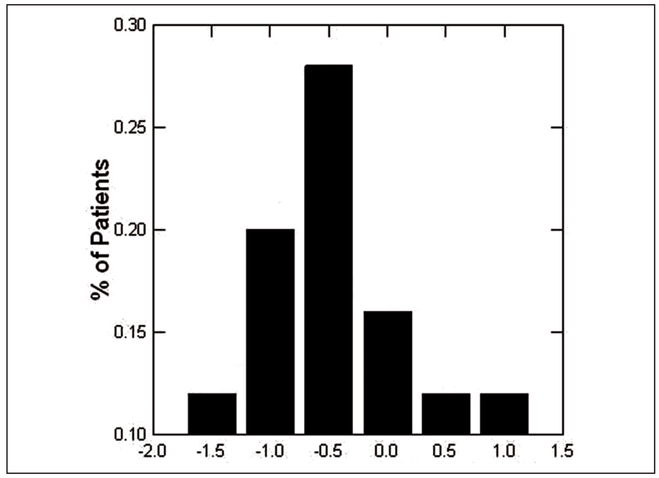

Figure 5: The frequency distribution of SIA by vector analysis at three months postoperatively

the wound is created from outside to inwards. Here we created the SCOLI from inside to out and this needed a great deal of surgical expertise. Though difficult, it gives increased wound integrity and is quick in the hands of experienced surgeon.[2,3] In a high volume setting, this technique allows surgery to be completed in less than 5 min.

The SCOLI, because of its location and its architecture, induces less iatrogenic astigmatism. The super-oblique incision contributes to less surgically induced astigmatism (SIA) than with a superior incision.[6,12] The SCOLI technique is free of cautery, minimizing the damage to sclera and its associated astigmatism. Importantly, as mentioned above, the SCOLI gives increased wound integrity. Where we keep the integrity of tunnel intact, without stretching or tearing of the internal incision, we can minimize SIA.[13] In our series, vector analysis demonstrated a mean SIA of -0.62D ± 0. 41D post-operative 3 months, which is similar to others reports.[14,15]

Local anesthesia is routinely used in MSICS, primarily because of intraoperative pain resulting from trauma/cautery as well as placing a bridle suture for akinesia.[2,4] In SCOLI, less surgical trauma to conjunctive/sclera decrease the peroperative requirements for analgesia. Meanwhile, the side paracentesis enables the surgeon to control the movement of the eyeball using a forceps, decreasing the necessity for a rectus bridle suture. These merits contribute to the less-invasive characteristics and bring the trend toward topical anesthesia.

Flexibility is another advantage of SCOLI over the MSICS. In fact, this limbal incision can be easily extended if conversion to conventional ECCE is necessary. Conversely, by enlarging the incision, we can easily convert phacoemulsification into SCLOL with this technique, especially in eyes with large and hard nuclei.[6,11]

In conclusion, we present here a novel cataract incision technique that allows removal of a large, hard nucleus via a shorter sutureless incision. This SCOLI is free of performing a peritomy and can be performed under topical anesthesia, decreasing operative time and minimizing the damage to limbal architecture. Therefore, this technique has the potential to serve as safe and effective technique for mature cataracts.

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