

# Comparative Analysis of Two Techniques of Deep Anterior Lamellar Keratoplasty (DALK) - Big Bubble and Layer by Layer Stromal Lamellar Dissection

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## ABSTRACT

**Introduction:** In Deep Anterior Lamellar Keratoplasty (DALK) the affected corneal stroma is replaced and the host endothelium preserved to prevent endothelial rejection. Different techniques have been described for stromal dissection to ensure a smooth and uniform recipient donor interface. The two most popular techniques are the big bubble technique which involves removing a maximal portion of the stroma and the layer by layer stromal lamellar dissection technique which leaves some posterior stroma in place. This study compares the impact of residual corneal stroma on visual outcomes. Objectives of the study were to compare outcomes following the use of two techniques of DALK- big bubble and layer by layer stromal lamellar dissection.

**Material and Methods:** Thirty two eyes of 32 patients with corneal lesions who underwent DALK using big bubble technique were included in this prospective study and divided into 2 groups (1) bare Descemet's membrane (DM) was achieved, (2) stromal lamellar dissection performed because of the failure of big-bubble formation. The best corrected visual acuity (BCVA), spherical equivalent, keratometric astigmatism, contrast sensitivity, endothelial cell density and Intra Ocular Pressure (IOP) were measured postoperatively at 3 and 6 months in both groups.

**Result:** BCVA at 3 months was better in group 1 ( $P=0.034$ ), however at 6 months it was comparable ( $P=0.123$ ). Spherical equivalence, keratometric astigmatism, endothelial density, and IOP were statistically indifferent at 3months ( $P = 0.509, 0.42, 0.22, 0.864$  respectively) and 6 months ( $P=0.983, 0.28, 0.17, 0.864$  respectively). Contrast sensitivity was better in group 1 both at 3( $P=0.038$ ) and 6 months ( $P=0.035$ ).

**Conclusion:** Though visual outcome was better in the big bubble group in the early post operative period, later results were comparable in both groups.

**Keywords:** Deep Anterior Lamellar Keratoplasty, Big-Bubble Technique, Bared Descemet's Membrane, Residual Corneal Stroma.

## INTRODUCTION

Penetrating Keratoplasty (PK) has been the treatment of choice for corneal diseases.<sup>1</sup> During the past decade, however, because of the advancement in surgical techniques, Deep Anterior Lamellar Keratoplasty (DALK) has gained popularity in the treatment of corneal lesions.<sup>2</sup> In DALK we replace affected corneal stroma while preserving healthy host endothelium, so there is less chance of endothelial rejection and the duration of steroid therapy also decreases.<sup>3-4</sup> According to some studies<sup>5-7</sup> DALK is comparable with PK in terms of Best Corrected Visual Acuity (BCVA), whereas a few others<sup>8-10</sup> have documented it as being inferior to PK. One consensus is that irregularity at the donor recipient interface can be responsible for inferior visual outcome after DALK<sup>11</sup>. Therefore different techniques have

been described to separate Descemet's membrane (DM) and endothelium from the stroma, to ensure a smooth and uniform recipient-donor interface, and to prevent interface irregularity and opacity. In 1984, Archilla reported that spatula dissection could be facilitated using intrastromal air injection.<sup>12</sup> Thereafter, in 1997, Sugita described hydrodelamination to dissect DM from the stroma.<sup>13</sup> In 1999 viscodissection was tried with injection of air in to the anterior chamber by Melles et.al.<sup>14</sup> In 2002, Anwar and Teichmann described the big-bubble technique, which is a rapid technique and removes a maximum portion of stroma<sup>15</sup> and yields visual outcomes comparable to PK.<sup>16</sup> Although this technique is reproducible, it has a steep learning curve and success rate is much lower for beginners. In the case of failed air injection, layer-by-layer manual dissection can be done to reach the predescemet level, leaving some posterior stroma in place.

There is no study reported in literature which has evaluated the impact of residual corneal stroma on visual functions and Intra Ocular Pressure (IOP) measurement in cases which have undergone DALK. In this study the visual outcome of cases where big bubble was achieved were statistically compared with cases where surgery was completed by stromal lamellar dissection because of the failure of big-bubble formation.

## MATERIAL AND METHODS

After obtaining ethical clearance from the institutional ethical committee this current prospective study, was done in a teaching hospital from January 2015 to November 2016. It included 32 eyes of 32 adult patients with corneal lesions, like corneal scar, corneal dystrophy and keratoconus which involved stroma but not the DM or endothelium. Patients with history of prior ocular surgery, trauma, pre-existing ocular disease like glaucoma, retinal abnormality, defect in DM causing hydrops, complicated postoperative course like rejection episodes, corneal ulceration, cataract development, and raised intraocular pressure and the cases in which the operation was converted into PK because of extensive tears in DM or double chambers developed postoperatively were excluded from the study.

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Preoperatively complete ocular examination was performed including uncorrected and best corrected visual acuity (BCVA) using the LogMAR chart, slit-lamp examination, tonometry, dilated funduscopy and corneal topography whenever possible. All the patients were explained about the merits and demerits of DALK and informed written consent was obtained.

All the surgeries were performed by a single surgeon under local anaesthesia. Thereafter the patients were divided into 2 groups: in group 1, bare DM was achieved by big bubble formation and in group 2, layer by layer manual dissection was performed because big bubble couldn't be formed.

The surgery began with trephination up to 70 to 80% of stromal thickness with a manual trephine. A 26 gauge needle with air filled syringe was inserted in bevel down position to the corneal stroma at the chosen site which is the clearest area of the cornea. Air was gently injected into the mid stroma until a big bubble was formed extending till the border of the trephination. If the big bubble was not formed after the first attempt, the injection was repeated. In the successful big-bubble group of cases (group 1), superficial corneal stroma was dissected using a crescent blade. Thereafter, a peripheral paracentesis was done to reduce intraocular pressure and the bubble was punctured with a 15-degree knife. Viscoelastic material was injected to keep the DM away from the area of manipulation and the rest of the corneal stroma was completely excised. The viscoelastic material was then completely washed out before proceeding to graft suturing.

In cases where the big bubble could not be formed after several attempts, stromal lamellar dissection upto the DM was progressively performed using a crescent knife (group 2). It was attempted to remove corneal stroma to the extent possible.

In both the groups the donor cornea was held with Lim's forceps and the stromal rim was probed with a dry Weck's cell sponge for creating a small detachment of the outer edge of the DM. Thereafter the donor DM and endothelium was gently stripped off with a forceps. The tissue was then fixed with the host corneal bed with 16 interrupted 10-0 monofilament sutures.

Routine post-operative care and follow up was done and sutures contributing towards graft neovascularisation; or causing a significant amount of foreign body sensation, lacrimation and significant astigmatism were replaced or removed accordingly.

During the 3<sup>rd</sup> and 6<sup>th</sup> month post-operative period the following parameters were documented- BCVA, Spherical equivalent, Keratometric astigmatism, Contrast sensitivity, Endothelial cell density and Intra ocular pressure by Goldman applanation tonometer, Schiottz tonometer and Non contact tonometer.

### STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS software version 17 (SPSS, Inc., Chicago, IL).

To compare the results between the groups, the Mann-Whitney U test was performed.

	<b>Group 1 (Big bubble group)</b>	<b>Group 2 (Stromal lamellar dissection group)</b>	<b>P Value</b>
BCVA (LogMAR)			
03 month	0.302±0.152	0.410±0.111	0.03
06 month	0.275±0.141	0.345±0.094	0.12
Spherical Equivalent			
03 month	4.64±1.79	4.18±1.94	0.51
06 month	4.46±1.56	4.47±1.73	0.98
Keratometric astigmatism			
03 month	4.67±0.83	4.37±1.14	0.42
06 month	4.70±0.89	4.33±0.94	0.28
Contrast sensitivity			
03 month	1.42±0.61	1.30±0.55	0.04
06 month	1.45±0.51	1.35±0.43	0.03
Endothelial cell density			
03 month	2366.67±425.38	2550.73±380.41	0.22
06 month	2242.07±407.69	2438.60±373.41	0.17

BCVA, Best corrected visual acuity; LogMAR, Logarithm of the minimum angle of resolution

**Table-1:** Postoperative BCVA, Spherical equivalent, Keratometric astigmatism, Contrast sensitivity, Endothelial cell density over follow up period in each group.

	<b>Group 1</b>	<b>Group 2</b>	<b>P value</b>
Goldman Applanation Tonometer			
3 Month	15.87±4.43	15.60±4.01	0.86
6 Month	15.20±2.366	15.07±1.83	0.86
Noncontact Tonometer			
3 Month	16.07±4.00	16.20±4.24	0.93
6 Month	14.84±1.44	15.59±1.58	0.19
Schiottz Tonometer			
3 Month	15.86±4.43	16.09±3.88	0.88
6 Month	14.84±1.44	15.59±1.58	0.19

**Table-2:** Postoperative intra ocular pressure by different method over follow up period in each group.

## RESULT

In the study time period 32 eyes were operated and amongst them successful big bubble was achieved in 16 eyes and in the rest of the 16 eyes stromal lamellar dissection (group 2) was performed.

At 3 months postoperative period BCVA in group 1 ( $0.302 \pm 0.152$ ) was better than BCVA in group 2 ( $0.410 \pm 0.111$ ) ( $P=0.03$ ). However, it was comparable ( $P=0.12$ ) at 6 months i.e. group 1 ( $0.275 \pm 0.141$ ) and group 2 ( $0.345 \pm 0.094$ ). There was no significant difference in spherical equivalent between the two groups both at 3 months ( $P=0.51$ ) and 6 months ( $P=0.98$ ). Keratometric astigmatism was also comparable between the two groups at 3 and 6 months after the surgery ( $P=0.42$  and  $0.28$  respectively). Contrast sensitivity was significantly better in group 1 (big bubble group) both at 3 months and 6 months ( $P=0.04$  and  $0.03$  respectively). Endothelial cell count was also comparable in the two groups both at 3 months and 6 months ( $P=0.22$  and  $0.17$  respectively).

This study also showed that at 3 months there was no significant difference in the IOP readings with the use of Goldmannapplanation tonometer ( $P=0.86$ ), Non contact tonometer ( $P=0.93$ ) and Schiottz tonometer ( $P=0.88$ ) in the two groups. Similarly at 6 months there was no significant difference in IOP readings between the two groups by using all three methods ( $P=0.86, 0.19, 0.19$  respectively).

## DISCUSSION

Lamellar keratoplasty has been proposed as an alternative to PK in the management of anterior corneal lesions. But it gained limited popularity because it was a time-consuming and technically demanding technique and had a steep learning curve. It also had a poorer visual outcome compared to PK.

According to different studies, along with graft astigmatism and refractive error, interface scarring and irregular stromal bed after manual dissection are responsible for lower visual outcomes after DALK. Amongst different techniques described in literature, Anwar's big-bubble technique for DALK has the advantage of achieving a smooth recipient-donor interface. But it has a steep learning curve. However, any surgeon who wishes to master it has to pass a series of unsuccessful intra stromal air injections in his initial few cases. Even in cases of unsuccessful big bubble formation, even with the technical complexity, the surgery can be continued by stromal lamellar dissection using a sharp crescent knife leaving a layer of posterior stroma in place. In the current study, the BCVA was better in the big bubble group compared to the stromal lamellar dissection group at 3 months follow-up. However, at 6 months BCVA was comparable in both groups.

Although Sarnicola et al<sup>17</sup> found in their study that visual recovery was faster in the big bubble group as compared to the stromal lamellar dissection, at the end of 30.4 months follow-up there was no difference in outcome. Feizi et al<sup>18</sup> showed that, outcome was significantly better in big bubble group up to one year but in longer follow up outcome was comparable.

In this study also though initially visual outcome was better in the big bubble group, later there was no significant difference. This may be explained by the fact that a few stromal layers are left in the recipient bed, causing interface irregularity and haziness. The Keratometric astigmatism was comparable between the two

groups at 3 and 6 months after the surgery which is corroborative with the studies of Banu Torun Acar et al<sup>19</sup> and Feizi S et al.<sup>18</sup> Therefore, it can be postulated that the lower BCVA observed in the stromal lamellar dissection group at month 3 was not because of refraction but because of interface haziness. Borderie et al<sup>20</sup> explained that there is a loss of keratocytes from the residual stroma remaining in the recipient bed which, may lead to its thinning over time. Another explanation for the stromal lamellar dissection group's delay in visual recovery may be because of the accumulation of fluid, which resolves over time. Marchini et al<sup>21</sup> in their study proposed that in stromal lamellar dissection interface reflectivity in confocal microscopy decreases over time because of absorption of fluid. Borderie et al<sup>20</sup> suggested that anterior lamellar keratoplasty may induce keratocyte loss in the remaining recipient corneal stroma. If this assumption is correct, further thinning of retained recipient stroma can occur over time leading to an increase in visual acuity to the level observed in the big bubble group.

Ardjomand et al<sup>22</sup> reported the importance of residual stromal thickness for the recipient cornea. In their study, they reported that, in the patients with a recipient bed thickness less than 20 mm, BCVA was comparable with that observed in penetrating keratoplasty.

Pelli-Robson contrast sensitivity as a part of subjective measurements of the quality of vision showed that contrast sensitivity is significantly better in big bubble group.

From this discussion it is observed that after a time period both the groups had similar visual acuities, refractive results, and keratometric astigmatism, but contrast sensitivity was significantly better in the big bubble group, which is probably due to interface haziness or interface irregularity. Direct measurement of IOP with a manometric probe is not used due to clinical infeasibility though it is the most accurate method. Goldmann applanation tonometry though considered the gold Standard, its appropriateness is however questionable as its accuracy is severely affected by corneal edema and irregularity and any alteration in corneal thickness and rigidity.<sup>23-26</sup> This study shows that, there is no significant difference in IOP measured by Goldmannapplanation tonometer, Non contact tonometer and Schiottz tonometer both at 3 and 6 months. So in the post operative period any one of these methods can be used.

## CONCLUSION

This study shows that in cases of anterior corneal lesions where deep anterior lamellar keratoplasty is indicated and big bubble formation is unsuccessful, the surgery can be proceeded with by stromal lamellar dissection without having any significant long term differences in outcomes.

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