

1 **Safety net suture for aphakic Descemet membrane endothelial keratoplasty**

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18 **Conflicts of interest**

19 None

20

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31 **Keywords:** Descemet's membrane endothelial keratoplasty; aphakia; corneal endothelial

32 failure.

33

34 **Purpose:** To describe a low-cost, accessible method for reducing the risk of posterior donor
35 dislocation in Descemet membrane endothelial keratoplasty (DMEK) performed in eyes with
36 aphakia and a large iris defect (unicameral eyes) – the ‘safety net suture’.

37

38 **Methods:** We review 3 cases of aphakic bullous keratopathy in unicomeral eyes treated
39 successfully using DMEK aided by a simple technique to create a temporary, partial barrier
40 between the anterior and posterior chambers. The safety net suture technique is based on a
41 continuous 10/0 Polypropylene suture placed across the anterior chamber in a cats-cradle
42 pattern anterior to the trabecular meshwork. At the end of surgery, after air tamponade of
43 the DMEK donor, the 10/0 Polypropylene suture is removed.

44

45 **Results:** All 3 cases were completed with no intraoperative posterior dislocation. A partial
46 postoperative detachment in one case was successfully treated with repeat air tamponade.
47 The corneas remain clear in early follow-up, 1 to 10 months post-surgery.

48

49 **Conclusion:** The safety net suture is a simple, low-cost method of reducing the risk of
50 intraoperative posterior dislocation for DMEK in unicomeral, aphakic eyes.

51

52 Descemet membrane endothelial keratoplasty (DMEK) has a lower rejection risk than other
53 keratoplasty modalities, estimated at <3% in the first 5 years after surgery.^{1 2} This is
54 approximately three times less than the rejection risk for Descemet stripping automated
55 endothelial keratoplasty (DSAEK).² Other advantages include a 2.4mm self-sealing incision
56 architecture, rapid rehabilitation, and relative freedom from surgical trauma – facilitating
57 repetition in the event of graft failure.

58

59 Aphakic eyes with a large iris defect may have risk factors for corneal transplant rejection
60 including chronic inflammation and glaucoma.^{3,4} Based on rejection risk, DMEK would be
61 the rational therapeutic choice for the treatment of corneal endothelial failure in these
62 eyes, but DSAEK with a safety suture is commonly preferred in order to reduce the risk of
63 posterior dislocation.⁵⁻⁷

64

65 Here we describe an adaptation of the safety suture concept to DMEK as a simple, low-cost
66 method for reducing the risk of posterior dislocation in unicameral eyes.

67

68

69

70 **Surgical Technique**

71

72 To maintain a firm intraocular pressure before each suture pass, we placed a single 1.5mm
73 self-sealing paracentesis incision in the peripheral cornea to accommodate a Simcoe
74 irrigation and aspiration canula for rapid refilling of the eye with balanced salt solution.

75

76 We then passed a double-armed, 10/0 Polypropylene suture, across the cornea in a
77 continuous pattern immediately anterior to the plane of the trabecular meshwork to create
78 the safety net suture (Figure 1ab).

79

80 We completed entry site construction after safety net suture placement, using a standard
81 pattern comprising a 2.4mm main entry site and two further small paracentesis incisions, all
82 placed at the junction of limbus and clear cornea.

83

84 After a Descemetorhexis under air, we injected the DMEK donor carefully into the anterior
85 chamber on top of the safety net suture using a 2.4mm Geuder canula (Geuder AG,
86 Heidleberg, Germany) prior to DMEK unfolding and air tamponade.

87

88 To complete the surgery, we cut the 10/0 Polypropylene suture at several points to facilitate
89 suture removal, and injected 0.1ml of Cefuroxime 125mg/ml into the anterior chamber,
90 leaving the anterior chamber with a 100% air fill at a firm, physiological intraocular pressure.

91

92 We reviewed the patients prior to discharge after 1 hour posturing face-up-to-ceiling, and
93 prescribed Dexamethasone 0.1% hourly by day for 1 week, reducing to four times daily for
94 one month, then to once daily over 3 months after surgery. We also prescribed
95 Chloramphenicol 0.5% four times daily for one week.

96

97 A video summary of the safety net suture technique is available at:

98 <https://www.youtube.com/watch?v=ZmZyNHIDxVs>

99 (last accessed June 3rd 2021).

100

101 **Clinical Cases**

102 **Case 1:** A 64-year-old male with aphakic bullous keratopathy, a large fixed pupil, previous
103 glaucoma tube drainage surgery was referred because of poor vision and persistent
104 discomfort. He had previously had a severe blunt injury in the affected (left) eye, and had
105 corrected distance visual acuity (CDVA) reduced to perception of light by secondary
106 glaucoma with advanced glaucomatous optic neuropathy. The contralateral eye was normal
107 (CDVA = 20/15). He was using preservative free Latanoprost 0.005% and Timolol 0.5% eye
108 drops in the left eye prior to surgery. His treatment aims were to restore any remaining
109 vision, to restore comfort, and preserve cosmesis in the left eye.

110

111 He had uncomplicated left DMEK surgery under local anesthetic using the safety-net suture
112 technique described above.

113

114 At review 1 week after surgery, the DMEK donor was fully attached, and the corneal
115 oedema was resolving. 9 months after surgery (Figure 2a), his left CDVA was hand
116 movements, not improving with a contact lens. The endothelial cell density was measured
117 at 2628 cells/mm² and the central corneal thickness was 490µm. The intraocular pressures
118 were 11mmHg and 19mmHg in the right and left eyes respectively.

119

120 **Case 2:** A 37-year-old male with large congenital bilateral colobomas and a past history of a
121 right vitreolensectomy and Silicone Oil tamponade after a blunt injury presented with
122 aphakic bullous keratopathy and low-grade band keratopathy. His main complaint was

123 reduced vision in the right eye. His contact lens corrected CDVA was 20/125 in the right eye
124 and 20/60 in the amblyopic left (contralateral) eye. His intraocular pressures were normal.

125

126 We removed the central epithelium and performed an ethylene-diamine-tetra-acetic acid
127 (EDTA) chelation for band keratopathy, then proceeded with right DMEK surgery using the
128 safety-net suture technique under local anesthetic. Residual Silicone Oil was removed from
129 the anterior chamber during surgery. Surgery was otherwise uncomplicated.

130

131 At review 1 week after surgery, the DMEK donor was fully attached, and the corneal
132 oedema was clearing. 4 months after surgery (Figure 2b), his right contact lens corrected
133 CDVA was 20/40. The corneal endothelial cell count was 2562 cells/mm² and the central
134 corneal thickness was 432µm. The intraocular pressures were 11mmHg in both eyes.

135

136 **Case 3:** A 90-year-old male with a history of chronic idiopathic bilateral uveitis, bilateral
137 advanced secondary glaucoma, and bilateral intracapsular cataract surgery with broad
138 iridectomies performed in the 1970s was referred with aphakic bullous keratopathy in the
139 left eye. CDVA was reduced to 20/400 in the left eye, and was 20/40 in aphakic spectacles in
140 the right eye.

141

142 He had uncomplicated left DMEK surgery under local anesthetic using the safety-net suture
143 technique described above.

144

145 At review 1 week after surgery, the DMEK graft was partially detached inferiorly. He was re-
146 bubbled at the slit-lamp microscope, but the DMEK graft was still partially detached at week

147 2 review. A second re-bubbling procedure, lying prone in the operating room was
148 successful. 6 weeks after surgery (Figure 2c), the DMEK graft was fully attached, the left
149 CDVA was 20/60, and the central corneal thickness was 549 μ m. The intraocular pressures
150 were 8mmHg and 5mmHg in the right and left eyes respectively.

151

152 **Discussion**

153

154 The concept of using a safety suture to prevent posterior donor dislocation in endothelial
155 keratoplasty is not novel. Masket and Fram⁸ originally described a 'safety-basket' technique
156 in which a 10/0 Polypropylene suture is placed in a square 'tic-tac-toe' pattern through the
157 pars plana to centralize and stabilize the optic of an intraoperative lens as an aid to scleral
158 fixation during either secondary intraocular lens implantation or revision surgery for
159 intraocular lens dislocation. Behshad et al,⁵ and later Newman and Rosenwasser,⁷ adapted
160 this approach to helping prevent postoperative posterior dislocation of the donor in DSAEK.

161

162 Postoperative donor detachment is normally complete after DSAEK, but partial after DMEK
163 (Case 3). We therefore remove the safety net suture at the end of surgery, and describe the
164 safety net suture technique primarily to prevent *intraoperative* DMEK donor dislocation into
165 the posterior chamber in unicameral eyes. This is achieved by creating a temporary, pre-
166 placed barrier between the anterior and posterior chambers. The main departure from
167 previously described 'safety-basket' techniques is to create a denser cats-cradle pattern,
168 with 3-5 suture passes horizontally and vertically (Figure 1ab). Note that this does not
169 provide complete protection from posterior dislocation, since a DMEK donor is routinely
170 delivered in a scrolled conformation through a 2mm internal diameter glass cannula, and

171 could therefore slip through the net during surgery. Care is required during DMEK donor
172 injection and unfolding. Although we did not encounter any problems in the cases we
173 describe, we would recommend keeping fine-gauge blunt forceps on stand-by to rescue
174 partial posterior escape of the DMEK donor through the safety-net during donor unfolding.
175 Where donor material selection is possible, we would also recommend selecting an older
176 donor to reduce the risk of unfolding problems associated with a tight donor scroll.

177

178 We previously described the use of an ICL as a temporary barrier between the anterior and
179 posterior chambers for DMEK in a unicameral eye.⁹ The safety net suture is much lower
180 cost. It also avoids the technical challenge of removing both the implant and associated
181 ocular viscosurgical device (OVD) whilst maintaining DMEK donor attachment. We found the
182 suture was easy to remove at the end of surgery with little disturbance to the air
183 tamponade.

184

185 As with the ICL technique,⁹ we found that the effective shallowing of the anterior chamber
186 provided by the temporary barrier created by the safety-net suture facilitated DMEK donor
187 unfolding. We would therefore recommend a complete safety net suture pattern even for a
188 sectoral iris defect.

189

190 Trifold techniques¹⁰ in which the DMEK donor is fixated with pull-through forceps during
191 unfolding may be a viable alternative to temporary barrier techniques for DMEK in
192 unicameral eyes. But these trifold techniques rely on catching the donor in transition
193 between the endothelium-in and the endothelium-out donor scroll conformation. This may
194 be more difficult where no anatomical or surgically created barrier is present to protect

195 from donor scroll conformation reversal. Trifold techniques may also require both
196 specialized instrumentation ¹¹ and input from a skilled surgical assistant.

197

198 The safety-net suture technique is a simple, low-cost solution for extending the application
199 of DMEK to the treatment of endothelial failure in unicameral eyes. As illustrated by Cases 1
200 and 4, it can be a useful alternative to a Gundersen flap in a non-sighted eye, avoiding the
201 technical problems inherent in conjunctival dissection after glaucoma tube drainage surgery
202 (Case 1) or retinal surgery with scleral buckling, and providing good cosmesis. In sighted
203 eyes (Case 2 and Case 3), the safety net suture technique is a low-risk alternative to a more
204 extensive anterior segment reconstruction (DMEK plus secondary intraocular lens and iris
205 prosthesis implantation); but patients must be prepared to wear contact lenses or an
206 aphakic spectacle correction.

207

208

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210

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243

244

245

246

247 **Figure legends**

248 **Figure 1**

249 The safety net suture is a continuous 10/0 Polypropylene suture placed comprising 3-5
250 horizontal and vertical passes across the full width of the anterior chamber just anterior to
251 the plane of the trabecular meshwork (a). It forms a temporary barrier (b) to reduce the risk
252 of posterior dislocation in DMEK for aphakic bullous keratopathy in the presence of a large
253 iris defect. An odd number of vertical and horizontal suture passes is required to ensure that
254 the continuous suture starts and finishes in the same place before tying the knot.

255

256 **Figure 2**

257 Cases 1-3 (a-c respectively) at postoperative review 1-9 months after surgery showing the
258 large iris defect in each case.

259

Safety-Net Suture









