

Keratoplasty in the United States

A 10-Year Review from 2005 through 2014

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Purpose: To report evolving indications and preferred techniques of corneal transplantation in the United States.

Design: Retrospective review.

Methods: Annual reports from the Eye Bank Association of America on corneal graft distribution in the United States from 2005 through 2014 were reviewed.

Main Outcome Measures: Number and percentage of corneal grafts distributed for various types of keratoplasty and their surgical indications in the United States.

Results: The total number of corneal transplants increased from 44 277 in 2005 to 46 513 in 2014. In the past decade, penetrating keratoplasty dramatically decreased (from 95% to 42%) and largely has been replaced by various lamellar keratoplasty (LK) techniques (from 5% to 58%). Descemet stripping (automated) endothelial keratoplasty was the most common (50%) type of corneal transplantation performed in the United States in 2014. The volume of Descemet membrane endothelial keratoplasty (DMEK) has been doubling every year since 2011 and accounted for 11% of total endothelial keratoplasties in 2014. There was a significant shift in indication for corneal transplantation, with Fuchs' endothelial dystrophy (22%) being the most common, followed by corneal edema occurring after cataract surgery (12%) in 2014. Eye banks supplied pre-cut corneal grafts for 68% of LK techniques in 2014.

Conclusions: In the United States, there has been a major shift in preferred keratoplasty techniques over the past decade, with a wide adoption of new LK techniques. *Ophthalmology* 2015;■:1–11 © 2015 by the American Academy of Ophthalmology.

Since the first successful corneal transplant by Zirm in 1905, there has been remarkable progress in keratoplasty techniques. Most advances have come in the last 15 years, with lamellar keratoplasty (LK) techniques in the form of anterior lamellar keratoplasty (ALK) and endothelial keratoplasty (EK).^{1–4} Modern LK was introduced by Melles et al⁵ at the turn of the 21st century with posterior lamellar keratoplasty in Europe and was developed further by Terry and Ousley⁶ with deep lamellar EK in the United States. Since then, various LK procedures have been fine tuned and popularized.^{7–9}

The Eye Bank Association of America (EBAA) is the only accredited organization that monitors nearly all eye tissue distribution in the United States. Their annual reports track donor quality and volume, annual keratoplasty volume, surgical indications, and surgical procedures performed. In 2014, a total of 72 013 corneal grafts were distributed through EBAA and approximately 46 200 tissues were used domestically for transplantation.

The most recent systematic detailed review of corneal transplantation in the United States based on EBAA data was performed 10 years ago, analyzing data from 1980 through 2004.¹⁰ In that report, more than 95% of corneal grafts were used for penetrating keratoplasty (PK), and the major indications for PK were pseudophakic bullous keratopathy

(PBK), keratoconus, Fuchs' endothelial dystrophy, and repeat grafts. However, since then, 3 new LK techniques, deep anterior lamellar keratoplasty (DALK), Descemet stripping (automated) endothelial keratoplasty (DSEK or DSAEK), and Descemet membrane endothelial keratoplasty (DMEK), have been popularized in the United States.^{2–4,11}

These lamellar techniques provide several advantages over PK: reducing the risk for rejection, inducing less astigmatism (especially for DSEK, DSAEK, and DMEK), and expediting visual rehabilitation.¹² Despite their respective learning curves, they have widely replaced PK, when indicated. Improved surgical instruments, techniques, and tissue preparation (pre-cut) from eye banks all have contributed to this trend.

In this study, we reviewed the EBAA annual reports from the past 10 years (2005 through 2014). Tissue distribution for various types of keratoplasties, indications for surgery, and recent developments in tissue processing for LK were evaluated. Our analysis summarizes recent trends and the evolution of lamellar keratoplasty over the past decade.

Methods

The EBAA Annual Statistical Reports from 2005 through 2014 were analyzed and represent a retrospective review of most of the

Table 1. Total Number of Domestic Surgery Uses of Corneal Graft Tissue in the United States from 2005 through 2014

Year	Penetrating Keratoplasty	Anterior Lamellar Keratoplasty	Endothelial Keratoplasty		Keratolimbal Allograft	Keratoprosthesis [†]	Total (No.)
			Descemet Stripping Endothelial Keratoplasty/Descemet Stripping Automated Endothelial Keratoplasty	Descemet Membrane Endothelial Keratoplasty			
2005	42 063 (94.9)	641 (1.4)	1398 (3.2)*		175 (0.4)	NA	44 277
2006	37 776 (84.4)	806 (1.8)	6027 (13.5)*		138 (0.3)	NA	44 747
2007	34 806 (69.4)	950 (1.9)	14 159 (28.2)*		207 (0.4)	NA	50 122
2008	32 524 (63.5)	1072 (2.1)	17 468 (34.1)*		173 (0.3)	NA	51 237
2009	23 269 (54.9)	774 (1.8)	18 221 (43.0)*		120 (0.3)	222 (0.5)	42 606
2010	21 970 (51.5)	1041 (2.4)	19 159 (44.9)*		130 (0.3)	342 (0.8)	42 642
2011	21 620 (48.6)	932 (2.1)	21 211 (47.7)	344 (0.7)	69 (0.1)	332 (0.7)	44 508
2012	21 422 (46.9)	883 (1.9)	22 301 (48.8)	748 (1.6)	80 (0.2)	236 (0.5)	45 670
2013	20 954 (44.4)	951 (2.0)	23 465 (49.7)	1522 (3.2)	91 (0.2)	223 (0.5)	47 206
2014	19 294 (41.5)	914 (2.0)	23 100 (49.7)	2865 (6.2)	80 (0.2)	260 (0.6)	46 513

Data are no. (%).

NA = not available (United States domestic use only).

*Further classification was not available from 2005 through 2010.

[†]Keratoprosthesis data were available from 2009.

corneal transplant activity in the United States. The report describes the number of tissues distributed for various types of keratoplasty and the surgical indications. Of note, significant shares of corneal graft are distributed for international use from United States eye banks. The EBAA segregates international and domestic data for types of keratoplasties (i.e., PK and LK), but combines the data pool for surgical indications. Therefore, this review outlines

global trends in surgical indications. In cases where there were multiple concomitant surgical indications, a single primary diagnosis was entered into the database so that there was a 1:1 indication to tissue match.

The data were analyzed with the Cochran Armitage trend test (SAS software version 9.3; SAS Inc, Cary, NC). *P* values less than 0.05 were considered statistically significant.

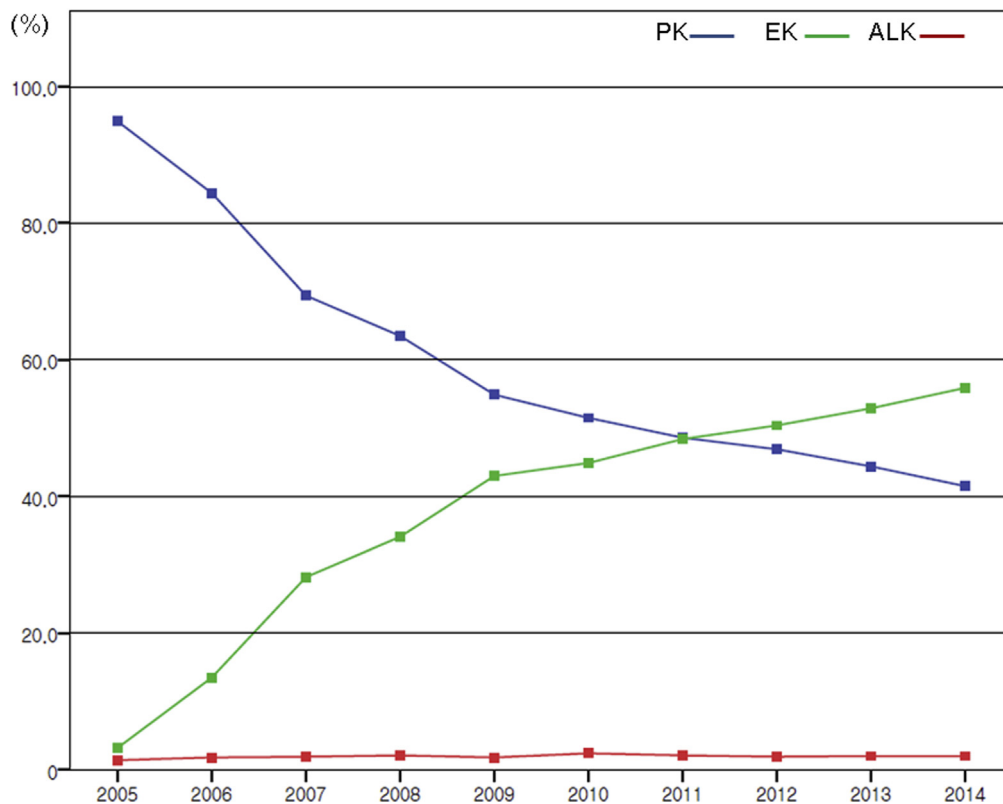


Figure 1. Graph showing the domestic distribution of corneal grafts from 2005 through 2014 according to the Eye Bank Association of America. After 2011, endothelial keratoplasty (EK) surpassed penetrating keratoplasty (PK). Anterior lamellar keratoplasty (ALK) remained constant.

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