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A comparative review between the updated models of Brazilian, United Kingdom and American eye banks and lamellar transplants

Uma revisão comparativa entre os modelos atuais de bancos de olhos e transplantes lamelares do Brasil, Reino Unido e Estados Unidos

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ABSTRACT

The corneal transplantation (CT) is the most commonly performed type of transplant in the world and the Eye Banks are organizations whose capture, evaluate, preserve, store and distribute ocular tissues. With the evolution of surgical techniques and equipment for CT, the BOs had to evolve to keep up with these requirements. This evolution goes from tissues capture techniques, donating money and clarification to the patient (e.g. internet-based), use of current equipment for more adequate tissues supply for the most current surgical techniques, integration of BOs of certain country and real-time management of stocks of ocular tissues, and adequacy of laws that manage the entire process. This review aims to make a comparative review between the updated models of Brazilian, United Kingdon and American Eye Banks. Like, check what the trend towards lamellar transplants in these three countries.

Keywords: Cornea; Corneal transplantation; Laser; Health services administration; Benchmarking; Brazil; United States

RESUMO

O transplante de córnea (CT) é o tipo de transplante mais realizado no mundo e os Bancos de Olhos (BO) são organizações que capturam, evoluem, preservam, guardam e distribuem tecidos oculares. Com a evolução das técnicas cirúrgicas e equipamentos para o CT, os BOs precisaram evoluir para acompanhar estas necessidades. Esta evolução vai desde técnicas de captura de tecidos; doação de dinheiro e esclarecimento ao paciente (baseadas na internet, por exemplo); utilização de equipamentos modernos, para fornecimento mais adequado de tecidos para técnicas cirúrgicas mais atualizadas; integração dos BOs de determinado país e gerenciamento em tempo real dos estoques de tecidos oculares, e adequação das leis que gerem todo este processo. Esta revisão tem como objetivo fazer uma comparação dos modelos atualizados de BOs brasileiro, inglês e americano, além de avaliar a tendência dos tipos de CT nestes países e sugerir melhorias ao modelo de BO brasileiro.

Descritores: Córnea; Transplante de córnea; Laser; Administração de serviços de saúde; *Benchmarking;* Brasil; Estados Unidos

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Introduction

Eye Banks

The Eye Banks are nonprofit organizations whose capture, evaluate, preserve, store and distribute ocular tissues. Anywhere in the world through local legislation, these organizations were created, are regulated and inspected.

Lamellar Transplants

The lamellar transplantation (LT) was first performed by Von Hippel in 1888[1]. This technique is more difficult to do and used to provide less visual acuity than the penetrant keratoplasty (PK). For these reasons, especially, the LT until about a decade ago, was done mostly for tectonic and/or cosmetics purposes, and the PK used for optical purposes, where wanted best final visual acuity, even if the patient needed to replace only part of the cornea, anterior or posterior[2]. With the development of Eye Banks, surgical techniques and equipment as the artificial anterior chamber, microkeratome and femtosecond lasers, LT was more refined and technically reproducible, thus getting significant improvement in final visual acuity[2-10]. Thus, LT (anterior or posterior) is becoming the technique of choice in conditions in which it is only necessary to exchange a part of the cornea (anterior or posterior)[2,3,9,10], as keratoconus and endothelial dysfunction. These two diseases remain among the top three causes of transplants in world[9,10].

This review aims to make a comparative review between the updated models of Brazilian, United Kingdon and American Eye Banks. Like, check what the trend towards lamellar transplants in these three countries.

In Brazil

Transplants

Brazil ranks second in the absolute number of transplants performed annually worldwide. If we consider the relative number of transplants and GDP (gross national product), Brazil ranks third, favored by investments made in this area and the stimulus given to its increase[11]. Table 1 shows the evolution of the types of transplants in Brazil between 2001 and 2011.

The importance of corneal transplantation (CT) for Brazil can be observed, both by popular demand as the state investment, as represented 63.42% of all transplants performed in Brazil in 2011. In 2009, the MS invested about R$ 900 million in transplants[12]. Despite the increase in the number of corneal transplants in Brazil, can be seen in Table 2 the great difference in numbers of transplants in several Brazilian States over the years, which reflects the inefficiency in generating a model of Eye Banks efficient nationwide.

Can be observed that there are states that do not perform any CT in 2011, another did not perform CT between 2001-2009, and that there are more developed states having fewer transplants than other less developed. On the other hand, only the State of São Paulo was responsible for 37.39% of corneal transplants performed in Brazil in 2011.

Lamellar Transplants

Of these nearly 15,000 CT held in Brazil in 2011, do not know for sure how many were LT and how many were PK, because there isn't this kind of statistical control in Brazil.

In United Kingdon

Like in Brazil, if no wish has been expressed in life then specially trained healthcare professionals should approach the family for their authorization to proceed, based on their knowledge of the potential donor (opt-in)[13]. Currently there are 14 European nations operating under a system of opt-out or 'presumed consent': Austria, Belgium, Czech Republic, Finland, France, Greece, Hungary, Italy, Luxembourg, Poland, Portugal, Slovak Republic, Spain, Sweden[13]. In UK, 16.124.871 people (The total at 31 March 2009) registered on the NHS Organ Donor Register[13] (a web based database).

Transplants

Figure 1 shows the evolution of the number of corneas donated and the number of corneas grafted in the UK between 2002 and 2012[14].

Figure 2 shows the evolution, in a decade, of the numbers of LT for keratoconus, preserving the patient's healthy endothelium and changing only the corneal stroma[9].

Table 1

Evolution of the types of transplants in Brazil between 2001 and 2011

Ano	Órgãos sólidos							Tecido ocular	Células	Total
	Coração	Fígado	Pulmão	Rim	Pâncreas	Rim/Pâncreas	Fígado/Rim	Córnea	TMO	
2001	143	542	25	2672	39	105	6	6.193	703	10.428
2002	149	654	36	2.714	57	161	5	6.556	871	11.203
2003	181	794	43	2.911	53	203	9	7.556	972	12.722
2004	200	914	39	3.126	94	201	10	8.394	1.197	14.175
2005	181	939	42	2.903	112	108	8	9.970	1.307	15.570
2006	155	978	55	2.961	88	125	12	10.382	1.032	15.788
2007	159	971	50	3.040	78	116	33	11.419	1.439	17.305
2008	205	1.110	53	3.154	43	127	26	12.825	1.446	18.989
2009	201	1.322	59	4.259	39	119		12.723	1.531	20.253
2010	167	1.404	60	4.660	44	87		12.923	1.695	21.040
2011	159	1.496	49	4.939	54	130		14.838	1.732	23.397

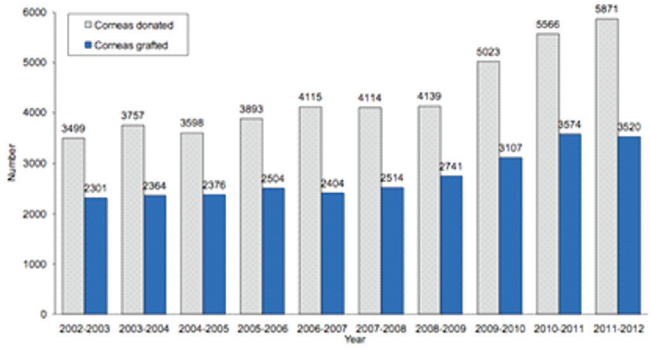
Source: http://aplicacao.saude.gov.br/portal/public/transplantes/destaque/dest5. Accessed on 04/21/2012

Table 2

Annual change in the number of corneal transplants by Brazilian State (2001-2011)

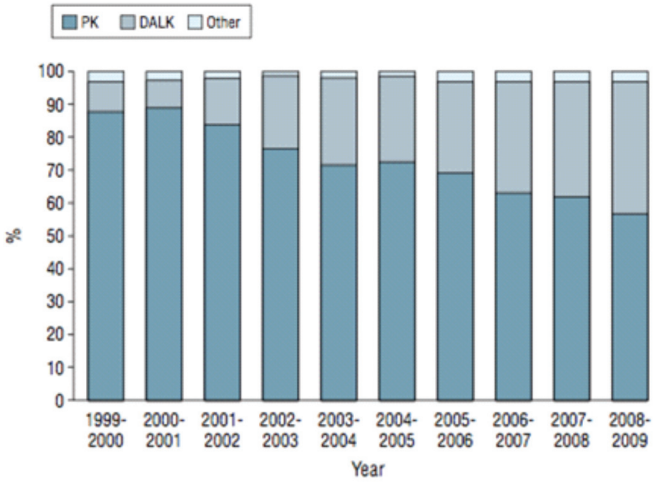
UF	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Acre	0	0	0	0	0	0	0	0	0	19	18
Alagoas	8	8	10	10	26	18	7	51	82	63	117
Amazonas	0	0	6	19	35	68	88	118	95	119	139
Bahia	40	41	43	57	87	98	168	258	209	198	228
Ceará	113	181	240	325	310	227	400	473	420	475	788
Distrito Federal	124	105	158	185	298	276	289	299	390	369	327
Espirito Santo	57	108	117	100	120	91	69	122	131	159	323
Goiás	542	584	585	757	862	795	443	403	404	403	796
Maranhão	6	8	1	4	11	58	60	79	129	128	119
Mato Grosso	24	43	30	31	42	39	147	162	117	41	285
Mato Grosso do Sul	74	56	118	165	13	90	183	173	180	177	180
Minas Gerais	840	541	948	1226	956	632	1033	1478	1446	1328	1437
Pará	98	151	80	69	82	79	97	104	135	135	160
Paraíba	66	186	132	184	154	143	123	135	202	171	154
Paraná	448	443	483	606	461	615	885	1000	947	752	1298
Pernambuco	215	217	311	336	391	522	494	632	671	502	661
Piauí	25	46	39	44	61	39	46	37	126	160	170
Rio de Janeiro	114	205	257	157	141	77	54	78	88	145	294
Rio Grande do Norte	0	102	97	138	128	125	128	89	171	194	278
Rio Grande do Sul	508	604	527	352	632	805	605	595	607	759	918
Rondonia	0	0	0	0	0	0	2	30	0	3	0
Santa Catarina	210	171	207	210	240	285	281	241	414	496	462
São Paulo	2623	2714	3100	3331	4888	5255	5762	6209	5655	6037	5547
Sergipe	58	42	67	88	32	45	55	59	104	90	139
Brasil	6193	6556	7556	8394	9970	10382	11419	12825	12723	12923	14838

Source: http://aplicacao.saude.gov.br/portal/public/transplantes/destaque/dest5; accessed on 04/21/2012



Source: http://www.organdonation.nhs.uk/statistics/transplant_activity_report/archive_activity_reports/

Figure 1: Evolution of the number of corneas donated and the number of corneas grafted in the UK between 2002 and 2012[14]



Source: Trends in the Indications for Corneal Graft Surgery in the United Kingdom: 1999 Through 2009. Arch Ophthalmol. 2012;130(5):621-628

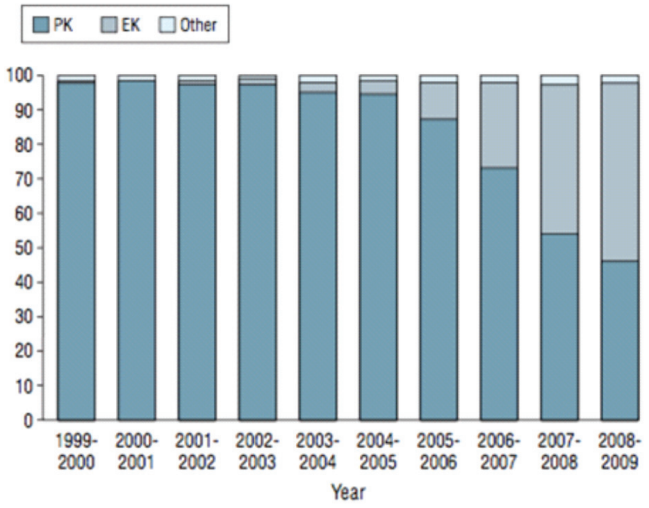
Figure 2: Evolution, in a decade, of the numbers of LT for keratoconus. PK: Penetrant keratoplasty, DALK: Deep anterior lamellar keratoplasty[9]

Figure 3 shows the evolution, in a decade, of the numbers of LT for endothelial failure, preserving the patient's healthy stroma and changing only the corneal endothelium[9].

In the UK it is possible to request and receive from Eye Bank a corneal donor lamella with specific thickness and diameter to the realization of LT. As in Brazil, the patient dosen't pay to the donnor cornea.

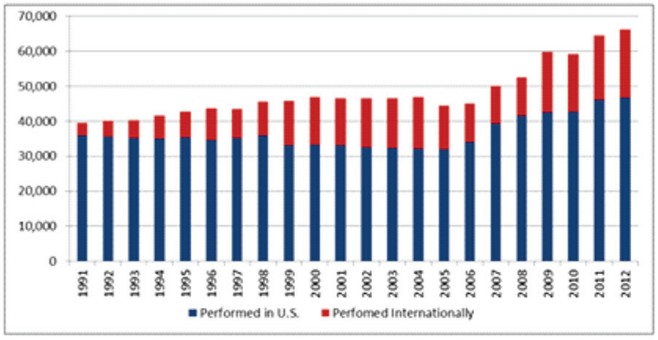
In United States

Currently, there are 84 Eye Banks in the U.S. In 2013, the Eye Bank Association of America (EBAA) published the statistical report for 2012[10]. Since 2011, the EBAA began a new monthly collection methodology for the Statistical Report using EBAA CONNECT, a real-time, web-based statistical reporting and analytics engine designed specifically for the EBAA by Transplant



Source: Trends in the Indications for Corneal Graft Surgery in the United Kingdom: 1999 Through 2009. Arch Ophthalmol. 2012;130(5):621-628

Figure 3: Evolution, in a decade, of the numbers of LT for endothelial failure, preserving the patient's healthy stroma and changing only the corneal endothelium[9]; PK: Penetrant keratoplasty; EK: Endothelium keratoplasty



Source: Eye Bank Association of America. 2012 Banking Statistical Report

Figure 4: Shows the annual number of corneal transplants supplied by U.S. Eye Banks (US and exported)[10]

Connect©[10]. In this study, the data reported were from 80 Eye Banks. Prior to 2008, all keratoplasties were counted as "penetrating keratoplasty". From 2008, pre-cut and uncut tissue utilization was stratified into penetrating grafts (PK), endothelial keratoplasty (EK), anterior lamellar keratoplasty (ALK), keratolimbal allografts (KLA), and tectonic grafts (TK). Keratoprosthesis (K-Pro) as a specific utilization was added in 2009. Before 2009, domestic and international data from U.S eye banks were combined. In 2009 and 2010, stratified data was only collected for tissue distributed and used within the U.S. For 2011 and beyond, tissue provided by U.S. eye banks was stratified and separated into domestic and international use. International use of tissue sent from U.S. eye banks was generally not included in statistical analysis before 201[10].

Year	Total provided by U.S.	Performed in U.S.
1991	39,515	35,831
1992	39,973	35,525
1993	40,215	35,173
1994	41,539	35,022
1995	42,740	35,300
1996	43,711	34,668
1997	43,492	35,209
1998	45,579	35,861
1999	45,765	33,020
2000	46,949	33,260
2001	46,532	33,035
2002	46,440	32,559
2003	46,436	32,240
2004	46,841	32,106
2005	44,329	31,952
2006	45,035	33,962
2007	50,122	39,391
2008	52,487	41,652
2009	59,784	42,606
2010	59,271	42,642
2011	67,590[3]	46,196
2012	68,681[2]	46,684

Source: Eye Bank Association of America. 2012 Banking statistical report

Figure 5: Number of corneas available and how these have been used for transplants in the USA between 1991-2012; in 2011 and progressing, long-term preserved corneal tissue is included in the total[10]. [3]Until 2010, corneal grafts total did not include long-term preserved corneal tissue

Beginning in 2012, eight international banks began using the EBAA Connect data system[10].

Transplants

In the U.S., tissue supplied by U.S. Eye Banks for all keratoplasty procedures types in 2012 was 68,681. Of these tissues, 46.684 were used to transplants in US and 19,546 corneas were exported internationally[10]. The Figure 4 shows the annual number of corneal transplants supplied by U.S. Eye Banks (US and exported)[10].

Figure 5 shows annually, the number of corneas available and how these have been used for transplants in the USA between 1991-2012[10].

Lamellar Transplants

Figure 6 shows the annual number of surgeries by type of cornea transplant between 2005-2012[10].

It can be seen that since 2011 the number of LT (anterior and posterior) is greater than the number of PK, and that in 2012 the number of posterior LT alone was greater than the number of PK.

In the United States all Eye Banks provide donor corneal lamellae. The current cost of a corneal donor (lamella or not) varies on average between US$ 1,949.00 to US$ 2,449.00[15].

Comments and suggestions

Although the penetrating keratoplasty indications were similar in the world[9,10,16-20], management of eye banks model have improved in Brazil[21] and the Brazilian corneal surgeons perform the most updated techniques of CT, it can be seen

Domestic surgery use	2012	2011	2010	2009	2008	2007	2006	2005
Penetrating Keratoplasty	21,422	21,620	21,970	23,269	32,524	34,806	37,776	42,063
Endothelial Keratoplasty	23,049	21,555	19,159	18,221	17,468	14,159	6,027	1,398
Anterior Lamellar Keratoplasty	883	932	1,041	774	1,072	950	806	641
Keratolimbal Allograft	80	69	130	120	173	207	138	175

Figure 6: The annual number of surgeries by type of cornea transplant between 2005-2012[10].

that there is an inefficiency of the Brazilian system at the national level by the huge discrepancy in the number of transplants in several Brazilian states. In 2010, only São Paulo made 1.7 times more CT than all UK did in 2012. In 2011, Brazil made 4.2 times more CT than all UK did in 2012. In the other hand, in 2011, the EUA performed 3.11 times more CT than Brazil in the same year. In this same period, the US exported more corneas than the number of CT across Brazil. Thus it is important to consider whether the Brazilians Eye Bank are following trends and best practices of other major Eye Banks in the First World. The three countries use the opt-in system for cornea donation.

Clearly, it is observed that in the United States (since 2011) and the UK (since 2009) are performed more posterior LT (endothelial) than PK. There is also a significant number of anterior LT in these countries. In this issue specifically, in Brazil the vast majority of Eye Banks as corneal surgeons do not have equipment (microkeratome, artificial anterior chambers, femtosecond lasers) for manufacturing their own donor corneal lamellar (anterior or posterior) from the donor corneal-scleral button. Thus, the number of LT performed in Brazil is a tiny fraction of the total CT. So, despite being a global trend, the LT is not encouraged by the Brazilian Eye Bank System, where there is practically no supply of donor corneal lamellae by Eye Banks, as in England or the United States have.

Suggestions

1. Investment in national awareness campaigns, guidance and fundraising (donations, web-donations with CBO help);
2. Specific guidance program to improve patient's knowledge about the main causes of CT and its treatments[22];
3. Developing a specific guidance program on protocols related to the importance, capture and donation of organs and tissues for TC, intended for all physicians and key stakeholders such as: CNCDOs, Intra-Hospital commissions, State and Municipal Health;
4. Investment for the 24 hours system of communication, transportation and collection nationwide;
5. Allow Eye Banks operate outside hospitals;
6. Partnership between the MS and the Brazilian Council of Ophthalmology (CBO) to develop and implement, in all national Eye Banks, software for on-line management, supervision and control of donated tissues and all types of cornea transplants;
7. Investment in equipment, material and human resources in Eye Banks for the possibility of making donor corneal lamellae;
8. Possibility to enrollment lamellar transplant (anterior and posterior) on Eye Banks;
9. Creating a web based database for the population could enroll as organ donors and tissues, as well as be able to make financial donations.

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