

# Establishment of a Registry to Monitor Trends in Cataract Surgical Procedures and Outcomes in Israel, 1990–2014

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**ABSTRACT:** **Background:** Cataract extraction is the most commonly performed ophthalmic surgical procedure. There is no registry for documenting cataract surgical procedures and the overall risk of its complications over time in Israel.

**Objectives:** To present trends in the number and type of selected parameters associated with cataract surgical procedures in Israel between 1990 and 2014.

**Methods:** Questionnaires had been sent annually to all surgical centers in which cataract surgery was performed in Israel during the study period. The trends that were investigated included annual rates, surgical sites, surgical techniques, use of an intraocular lens (IOL), and type and rates of postoperative endophthalmitis (POE).

**Results:** A total of 812,112 cataract surgical procedures were reported during the 25 year study period. Responses to the questionnaire increased from 75% in 1990 to 100% in 2006 onwards. The annual number of reported cataract surgical procedures increased from 16,841 (3.5 per 1000) in 1990 to 57,419 in 2014 (6.9 per 1000), representing an increase of 197%. There was a shift from performing the surgery in the public health system to private medical centers. The surgical technique changed from predominantly manual extracapsular cataract extraction (56% in 1999) to predominantly phacoemulsification (98.7% in 2014). POE rates decreased from 0.25% in 2002 to 0.028% in 2014.

**Conclusions:** There was a continuous increase in the rate of surgical cataract procedures, and more were performed in private medical facilities. There was also a major shift towards advanced cataract procedures and a decreased rate of POE.

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**KEY WORDS:** cataract surgery registry, phacoemulsification, postoperative endophthalmitis (POE), extracapsular cataract extraction (ECCE), toxic anterior segment syndrome (TASS), best-corrected visual acuity (BCVA)

Cataract surgery is the most commonly performed ophthalmic operative procedure, with more than 15.6 million performed worldwide in 2009 [1]. It is expected that this number will reach 20 million by the year 2020 [2]. Ongoing progress in technology and surgical techniques have contributed to improved results and postoperative recovery following these procedures [3]. These advances include: (i) transitioning from intracapsular cataract extraction (ICCE) to manual extracapsular cataract extraction (ECCE) and then to phacoemulsification ECCE, (ii) decreasing corneal incision size, and (iii) improving the material and design of the intraocular lens (IOL). In addition, the overall risk of complications is relatively low, and most can be treated effectively with no visual loss sequelae should they occur.

Few countries maintain a national registry for cataract surgical procedures and its complications. Sweden has one of the leading systems [4–6]. The information from such a registry can be of considerable importance for estimating the number of surgeries, the prevalence of complications, and the expected future trends in accordance with changing demographics and economics of a given country.

Cataract surgical procedures in Israel are performed in one of two types of settings – university-affiliated ophthalmology departments and ambulatory surgical centers – representing the public and private sectors respectively. There has never been an official registry of cataract surgical procedures in Israel. We present here the trends in cataract surgery in Israel over a 25 year period that emerged from the analysis of our collected data.

## PATIENTS AND METHODS

Spreadsheet questionnaires had been sent annually since 1990 to all the directors of the university-affiliated ophthalmology departments and the ambulatory surgical centers in Israel where cataract surgical procedures are performed. The questionnaires evolved over time during the first 10 years (1990–1999). We collected basic data, which included the number of surgeries, the surgical technique (manual ECCE or phacoemulsification), and

This paper is dedicated to the memory of the late Prof. Michael Blumenthal who initiated and supervised the first 10 years of the study

**Figure 1.** Number and rate (per 1000) of cataract surgical procedures as reported by Israeli cataract surgical centers between 1990 and 2014



type of IOL used. In 2002, we added questions on postoperative endophthalmitis (POE), including the number of cases and the use of prophylactic antibiotics. In 2005, questions regarding the visual outcome of patients with POE (best-corrected distance visual acuity at the last follow-up) were added, and the questionnaire was further expanded in 2006 to include questions on toxic anterior segment syndrome (TASS), as well as type of anesthesia and the size of the surgical incision. This study was granted an ethics committee waiver for informed consent from the Meir Medical Center institutional review board committee since the study design involved collecting and summarizing general data from each medical center and not direct patient information.

**STATISTICAL ANALYSIS**

Changes over time were assessed using the Spearman correlation. Data were checked for normality using the Shapiro-Wilks test. The Student *t*-test and Mann-Whitney rank sum test were used as appropriate in order to compare overall rates between groups. Statistical analyses were performed using Sigmaplot

software (version 12.5, Systat Software Inc., USA). A *P* value < 0.05 was considered statistically significant.

**RESULTS**

Information was obtained from 75–85% of the centers between 1990 and 2005. Better data collection was subsequently achieved over the ensuing years thanks to better cooperation, and all the centers were fully compliant from 2006 onward.

A total of 812,112 cataract surgical procedures were reported to have been performed between 1990 and 2014. Continuous increases in the number and ratio of the reported cataract surgical procedures were noted over the years: from 16,841 (3.5 per 1000) in 1990 to 57,419 (6.9 per 1000) in 2014 (*r* = 0.988, *P* < 0.0001) [Figure 1]. In 2002, 17,430 (66%) of the reported surgical procedures were performed in university-affiliated ophthalmology departments compared to 8980 (34%) in the ambulatory surgical centers. As of 2006 onward, however, the numbers of the reported cataract procedures were almost evenly distributed between the university and the ambulatory centers: 28,175 (49.1%) and 29,244 (50.9%), respectively.

In 1999, 56% of the surgical procedures were performed by manual ECCE. In 2000, the percentage of the surgical procedures that employed a phacoemulsification technique reached 50%. Since then that technique was rapidly adopted, reaching 98.7% of all surgical procedures in 2014 (*r* = 0.994, *P* < 0.0001).

From 2008 to 2014, there was a significant (*r* = -0.929, *P* < 0.0001) decrease in the clear corneal incision size. In 2008, the incision size was ≥ 3.2 mm in 42% of the surgical procedures compared to only 2.5% in 2014, whereas the incision size was < 2.8 mm in 32.8% of procedures in 2008, rising to 86% by 2014 (*r* = 1, *P* < 0.0001) [Table 1].

**Table 1.** Intraocular lens (IOL) type and incision size reported from 2004 to 2014

Year	Surgeries, n	IOL type						Incision size (mm)			
		Total, n	Rigid	Soft	Soft/foldable			Total, n	≥ 3.2	2.8-3.0	< 2.8
					Hydrophilic	Hydrophobic	Silicone				
2014	57,419	32,867	2.5%	97.5%	60.5%	37.0%	0.0%	45,355	2.5%	11.5%	86.0%
2013	55,398	41,661	2.0%	98.0%	53.9%	43.9%	0.2%	31,229	6.0%	25.0%	69.0%
2012	54,801	42,215	4.0%	96.0%	47.0%	49.0%	0.0%	36,326	5.0%	29.0%	66.0%
2011	51,678	36,787	2.8%	97.2%	51.0%	45.7%	0.5%	26,436	8.0%	42.0%	50.0%
2010	51,762	34,522	5.7%	94.3%	58.9%	34.0%	1.4%	28,279	17.0%	43.0%	40.0%
2009	49,284	34,654	5.0%	95.0%	58.4%	36.6%	0.0%	34,515	12.1%	54.5%	33.4%
2008	49,920	34,558	6.8%	93.2%	60.0%	33.1%	0.1%	22,793	42.0%	25.1%	32.8%
2007	46,608	36,223	6.9%	93.1%	61.6%	31.5%	0.0%	*	*	*	*
2006	45,705	35,702	9.0%	91.0%	66.0%	25.0%	< 1%	*	*	*	*
2005	33,901	25,674	11.4%	88.6%	62.8%	25.8%	< 1%	*	*	*	*
2004	34,126	27,532	18.3%	81.7%	*	*	*	*	*	*	*
2003	31,047	*	*	*	*	*	*	*	*	*	*
2002	26,410	*	*	*	*	*	*	*	*	*	*

\*Not available

**Table 2.** Rates of post-cataract surgery endophthalmitis (POE) and toxic anterior segment syndrome (TASS) from 2002 to 2014

Year	Surgeries, n	POE/ TASS	Cases, n	%	Ratio (1:n)	BCVA, n (total)	BCVA			Postoperative prophylaxis antibiotics					
							≥ 6/12	6/12–6/60	≤ 6/60	n (total)	Cases	%			
2014	57,419	POE	16	0.028%	3589	15	7	46.7%	4	26.7%	4	26.7%	42,129	42,129	100.0%
		TASS	190	0.331%	302	155	80	51.6%	75	48.4%	0	0.0%			
2013	55,398	POE	21	0.038%	2638	17	2	11.8%	7	41.2%	8	47.1%	34,664	34,664	100.0%
		TASS	542	0.978%	102	280	196	70.0%	75	26.8%	9	3.2%			
2012	54,801	POE	18	0.033%	3045	16	4	25.0%	5	31.3%	7	43.8%	36,509	36,509	100.0%
		TASS	211	0.385%	260	195	144	73.8%	40	20.5%	11	5.6%			
2011	51,678	POE	11	0.021%	4698	10	2	20.0%	3	30.0%	5	50.0%	30,543	30,543	100.0%
		TASS	247	0.478%	209	164	110	67.1%	46	28.0%	8	4.9%			
2010	51,762	POE	21	0.041%	2465	17	2	11.8%	7	41.2%	8	47.1%	30,626	30,626	100.0%
		TASS	542	1.047%	96	280	196	70.0%	75	26.8%	9	3.2%			
2009	49,284	POE	24	0.049%	2054	16	2	12.5%	5	31.3%	9	56.3%	43,637	40,718	93.3%
		TASS	258	0.523%	191	92	66	71.7%	25	27.2%	1	1.1%			
2008	49,920	POE	33	0.066%	1513	22	5	22.7%	14	63.6%	3	13.6%	38,909	36,743	94.4%
		TASS	278	0.557%	180	157	127	80.9%	21	13.4%	9	5.7%			
2007	46,608	POE	42	0.090%	1110	24	4	16.7%	9	37.5%	11	45.8%	35,863	32,097	89.5%
		TASS	242	0.519%	193	158	133	84.2%	21	13.3%	4	2.5%			
2006	45,705	POE	47	0.103%	972	32	4	12.5%	13	40.6%	15	46.9%	32,813	26,560	80.9%
		TASS	442	0.967%	103	332	278	83.7%	45	13.6%	9	2.7%			
2005	33,901	POE	47	0.139%	721	30	12	40.0%	12	40.0%	6	20.0%	*	*	*
2004	34,126	POE	44.36	0.130%	769	*	*	*	*	*	*	*	*	*	*
2003	31,047	POE	49.68	0.160%	625	*	*	*	*	*	*	*	*	*	*
2002	26,410	POE	66.03	0.250%	400	*	*	*	*	*	*	*	*	*	*

\* Not available

POE = postoperative endophthalmitis, TASS = toxic anterior segment syndrome, BCVA = best corrected visual acuity

The transition to phacoemulsification through small incisions affected IOL selection, with a corresponding increase in the use of foldable IOLs that reached 97.5% in 2014 [Table 1]. In 2005, we began to collect data on the type of material of the foldable IOLs that had been implanted. It emerged that hydrophilic acrylic IOLs were used in two-thirds of the cases, and hydrophobic acrylic IOLs in the other third. Silicone IOLs were rarely used [Table 1].

Information on the type of anesthesia was available from 2006, and the data revealed that most of the cataract procedures were performed under local anesthesia, ranging from 67% to 96% during the period 2006–2014.

Information on the occurrence of acute POE has been available since 2002. A significant gradual and consistent decrease in the rate of POE was observed during that period ( $r = -0.956$ ,  $P < 0.0001$ ). Specifically, it decreased from 0.25% in 2002 to 0.028% in 2014, representing an 8.9-fold decrease over a 13 year period [Table 2]. The use of postoperative prophylactic antibiotic injections

to the anterior chamber (intracameral) increased from 81% of cases in 2006 to 100% of cases in 2010–2014 ( $r = 0.895$ ,  $P < 0.0001$ ) [Table 2]. The rate of POE between 2002 and 2005, before intracameral antibiotic injection became popular, was significantly higher than the rate for the years 2006 to 2014 when intracameral antibiotic injection had gained popularity: 0.165% (207 of 125,484 surgeries) and 0.050% (233 of 462,575 surgeries), respectively ( $P < 0.001$ ). The best-corrected visual acuity (BCVA) results of patients with POE have been collected since 2005 [Table 2]. Between 2005 and 2014, the rates of patients with a final BCVA of 6/12 or better after POE ranged from 11.8% to 46.7%, and for patients with a final BCVA of 6/60 or worse (legally blind) ranged from 13.6% to 56.3%.

Data on patients with TASS have been collected since 2006. In addition, 52–84% of the reported patients with TASS achieved a BCVA of 6/12 or better, and 0–5.7% had a final BCVA of 6/60 or worse (severe visual loss, legally blind) [Table 2]. The overall risk of having a severe visual loss following TASS between 2006

and 2014 was 3.2% (1:31.3 cases), which was significantly lower than the chance of having a severe visual loss following POE, i.e., 41.4% (1:2.4 cases),  $P < 0.001$  [Table 2].

## DISCUSSION

The information that can be obtained from a registry for reporting data on a given surgical procedure could be important for estimating the load of surgeries, the prevalence of complications, and the expected future trends in accordance with changing demographics and economics of a given country. Indeed, the European Society of Cataract and Refractive Surgeons (ESCRS) study on prophylaxis antibiotics for postoperative endophthalmitis after cataract surgery was based on information extracted from the Swedish registry [7]. There is no such official registry for cataract surgical procedures in Israel. Our annual survey, which was initiated and conducted for the first 10 years by the late Prof. Michael Blumenthal, aimed to identify trends in these procedures in Israel and compare them to international standards.

Not all the surgical centers responded to the survey at the beginning of the data collection process in 1990. Cooperation was usually better from the university-affiliated than the ambulatory centers. By introducing the assurance of confidentiality, we achieved better rates of cooperation and all the surgical centers in Israel have provided complete or partial data since 2006. For that reason, some of the trends/data presented in the current study are relevant for the latter years of the study (i.e., 2006 to 2014).

The ratio of cataract surgical procedures increased from 3.5 to 6.9 per 1000 inhabitants over the last 25 years. The increasing numbers of these procedures can be attributed to improvements in surgical techniques, shortening of surgery time, fewer complications, increasing numbers of ophthalmologists and ambulatory centers, and increasing patient demand for earlier cataract removal. Cataract surgery has now become the most frequent surgical procedure in most European countries [8]. In 2009, the reported number of cataract surgeries per 1000 population in Israel was 6.5, slightly lower than the average rate of 7.3 in Western Europe (range 4.7–9.4) [1].

In 1967, Dr. Charles Kelman started to conduct cataract surgery by inserting a phacoemulsification probe through a small incision. The probe vibrates at ultrasonic frequency to fragment and emulsify the nucleus of the cataract while remaining inside the eye, after which a pump aspirates the lens particles through the tip. The phacoemulsification process allows surgeons to use small incisions, foldable IOLs, and topical anesthesia, all of which result in a lower incidence of wound-related complications, faster healing and more rapid visual rehabilitation than procedures that require larger incisions [3]. This technique gained popularity in the United States during the 1990s, and phacoemulsification has been the pre-

ferred technique in Israel since 2000, comprising 44.0% of all cataract surgical procedures in 1999 and reaching up to 98.7% of those procedures in 2014.

Acute POE, which is a severe infection of the eyeball, is one of the most devastating postoperative complications of cataract surgery. Although this complication is uncommon, poor visual outcome is nevertheless a major concern [9]. The rate of POE is estimated to be 0.04% to 0.3% [9,10]. Reviewing the prevalence of post-cataract surgery infections and inflammations in Israel has some unique advantages. Israel can be considered a “closed system,” in which all surgeries and follow-up care are performed within the same country. Based on the following conditions, we assumed that the prevalence of POE could be accurately extrapolated by surveying and collecting data on endophthalmitis from the university-affiliated centers [11]. Acute POE usually occurs within the first 3–10 postoperative days; therefore, it is reasonable to assume that all patients were operated on, diagnosed, and treated in Israel. It is unlikely that patients who were operated in Israel would travel abroad during the first or second week after surgery. Furthermore, acute POE is always managed as an in-patient emergency in one of the public university-affiliated centers (even if the cataract surgery had been performed at an ambulatory center). In an attempt to explain the change in POE prevalence in Israel over time, we assume that the sharp decline in 2003 (by 0.16%) may reflect the growing acceptance of phacoemulsification. Since the most significant transition to phacoemulsification occurred between 1999 and 2002, it was probably accompanied by more complications associated with the surgeons’ learning curve (such as vitreous loss), which can increase the incidence of POE. In 2003, however, phacoemulsification evolved to become a routine and safe technique. Following the ESCRS reports of providing prophylactic antibiotics for post-cataract surgery endophthalmitis in 2006 [10] and 2007 [7] that demonstrated the importance of intracameral postoperative antibiotics in the prevention of POE, their use in Israel increased from 81% of cases in 2006 to 100% of cases in 2010–2014 ( $P < 0.0001$ ). The rate of POE during the period 2002–2005 (before intracameral antibiotic injections became popular) was significantly higher than the rate in 2006–2014 ( $P < 0.001$ ), dropping to as low as 0.028% in 2014.

TASS is an acute inflammatory process usually starting during the first days after cataract surgery [12]. It is the major differential diagnosis from POE. Many causes for TASS have been suggested, but no definitive mechanism was found in most cases [13]. Interestingly, local outbreaks of TASS have been reported in several countries [12,14,15]. Due to the lack of an ICD-9 code for TASS, the variety of clinical presentations and definitions of the syndrome and the unknown number of unreported ambulatory care cases, it is reasonable to assume that the actual number of TASS cases in our survey was higher than reported, and that the reported cases probably represent those that were more severe. Even so, the rates of TASS were

high, i.e., 0.64% (1:157 cases) between 2006 and 2014. The prognosis of BCVA for TASS patients was significantly better than the prognosis of BCVA for POE patients. It is important to note that we received final BCVA results from only 73% of the POE cases and 60% of the TASS cases, and this could be a source of bias of the results.

The limitations of our study arise mainly from its voluntary registry design, the changes in the type of data collected over the 25 year period, incomplete data, and issues related to the lack of quality control and supervision.

## CONCLUSIONS

This study establishes the foundation of a registry for documenting cataract surgical procedures and the overall risk of its complications in Israel over time. The accumulated data show a continuous increase in the compliance on the part of medical institutions in reporting on the performance, the techniques and the sequelae of cataract surgical procedures. Finally, there was a major shift towards more advanced and safer cataract procedures nationwide over time.

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