

Is combined cataract surgery associated with acute postoperative endophthalmitis? A nationwide study from 2005 to 2014

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ABSTRACT

Purpose To assess the incidence of acute postoperative endophthalmitis (POE) after cataract surgery combined with corneal, glaucoma or vitreoretinal surgical procedures from 2005 to 2014 in France.

Methods In this cohort study, acute POE occurring within 6 weeks after surgery was identified by means of billing codes recorded in a national database in patients operated for cataract extraction with phacoemulsification, or corneal, glaucoma or vitreoretinal surgical procedures, either combined or stand-alone.

Results From January 2005 to December 2014, up to 6 260 477 eyes underwent phacoemulsification cataract surgery as a single procedure and 115 468 eyes underwent phacoemulsification combined with corneal, glaucoma or vitreoretinal surgical procedures. The crude incidence of acute POE after stand-alone or combined cataract surgery was 0.102% and 0.149%, respectively. In multivariate Poisson analysis, combined surgery taken as a whole was at higher risk than cataract stand-alone surgery, with an adjusted incidence rate ratio (IRR) (95% CI) of 1.38 (1.11 to 1.70; $p=0.0054$). Glaucoma surgeries were associated with a lower acute POE incidence compared with phacoemulsification, conversely to vitreoretinal surgical procedures: IRR 0.63 (0.47 to 0.85; $p<0.001$) and IRR 1.78 (1.58 to 2.01; $p<0.001$), respectively.

Conclusion A higher incidence of acute POE after combined cataract surgery than after cataract surgery done as a stand-alone procedure was observed based on the French nationwide medical-administrative database. The incidence of acute POE after combined surgery was related to the type of surgery performed simultaneously with cataract extraction.

INTRODUCTION

Although professionals involved in eye care have striven to combat the advent of acute postoperative endophthalmitis (POE), this complication of ocular surgery remains a major concern for the operating team and a fear for patients. Various studies have shown that the incidence of acute POE after cataract surgery is declining over time. A report from Sweden noted a decrease in POE incidence after cataract surgery from 0.048% in 2002–2004 to 0.029% in 2005–2010.¹ Similarly, a recent series using big data in France from 2005 to 2014 showed an overall incidence of acute POE decreasing from

0.145% to 0.053% during the study period.² A similar trend was observed in the USA among Medicare beneficiaries.³

The identification of risk factors for acute POE through large cohorts allows epidemiologists and clinicians to identify which patients are at risk and therefore to develop effective strategies to better prevent acute POE. In the literature, older age, male gender, diabetes and perioperative complications such as posterior capsule rupture have been associated with a higher acute POE incidence.^{1,4,5} In a recent analysis of more than 6 million eyes undergoing cataract surgery during a 10-year period, combined cataract surgery was recognised as a risk factor for acute POE, with an adjusted incidence rate ratio (IRR) of 1.77 (95% CI 1.53 to 2.05).² To the best of our knowledge, this risk factor has not yet been clearly identified in the literature. Therefore, we undertook this new evaluation to first explore the trends for combined cataract surgery in France from 2005 to 2014. Second, we aimed to identify which types of surgery (corneal, glaucoma or vitreoretinal), when combined with cataract extraction, were associated with a higher acute POE incidence compared with phacoemulsification as a stand-alone procedure. Finally, we evaluated whether the incidence of acute POE in corneal, glaucoma or vitreoretinal surgeries differed when performed as a stand-alone or a combined procedure.

METHODS

The present study is part of the French Epidemiology and Safety collaborative programme aiming at assessing the epidemiology and safety of interventions in ophthalmology.⁶ This was a retrospective study based on a nationwide database with data collected between 2005 and 2014.

The architecture of this database has been described previously.⁶ Briefly, a national administrative database (Programme de Médicalisation des Systèmes d'Information) was created in France in 1991 and extended in 1997 to the 1546 French hospitals, both public and private.² The information collected is anonymous and gathers both medical and administrative data. Diagnoses are recorded by physicians during the hospital stay and are coded according to the 10th Edition of the International Classification of Diseases (ICD-10). All procedures performed during the hospitalisation are coded following the French Common Classification of



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Medical Procedures (CCAM), which was created in 2005. All the data are compiled at a national level.

We considered all patients who were admitted to hospitals from 1 January 2005 to 31 December 2014 for phacoemulsification cataract surgery. For each patient, cataract surgery was identified by the CCAM code BFGA004 corresponding to ‘cataract extraction performed by phacoemulsification with intraocular lens implantation in a capsular bag.’ We did not include other modalities of cataract extraction such as manual extracapsular or intracapsular extraction because it was shown that the incidence of acute POE for these procedures is much different from phacoemulsification.⁷ We also took into consideration corneal, glaucoma or vitreoretinal procedures as stand-alone procedures or combined with phacoemulsification. The CCAM codes of these surgical procedures are displayed in [table 1](#). Seeking acute POE, we identified all hospitalisations within 42 days of cataract surgery⁸ with a billing code of endophthalmitis (ICD-10 code H440 or H441). In France, endophthalmitis is only treated in hospitals, either public or private. There is no opportunity to perform intravitreal injections of antibiotics in the office because the vitreous tap is performed in the operating room and the preparation of intravitreal antibiotics requires the skills of a trained team. Additionally, eye surgeons can be sued if POE treatment is not delivered according to the official guidelines.

Statistical analysis

Incidence corresponded to the number of eyes presenting with acute POE during a 42-day period after surgery (recurrences during this period were excluded) divided by the number of operated eyes. Each variable was included as the

Table 1 Billing codes for cataract, corneal, glaucoma and vitreoretinal surgeries retained for analysis

Codes used in the study	Description
Cataract surgery	
BFGA004	Cataract extraction using phacoemulsification
Corneal surgery	
BDMA002	Deep lamellar keratoplasty
BDMA003	Penetrating keratoplasty with lens extraction
BDMA008	Penetrating keratoplasty
Glaucoma surgery	
BEFA008	Trabeculectomy
BGFA014	Deep sclerectomy
Vitreoretinal surgery	
BGFA001	Posterior vitrectomy without endodiathermy
BGFA005	Posterior vitrectomy with internal limiting membrane peeling and gas tamponade
BGFA006	Posterior vitrectomy with retinal trans-scleral coagulation without tamponade
BGFA009	Posterior vitrectomy with endodiathermy or endolaser photocoagulation without tamponade
BGFA010	Posterior vitrectomy with retinal endodiathermy and non-lasting tamponade
BGMA001	Vitreoretinal surgery with scleral indentation and at least four of the following manoeuvres: endodiathermy, vitrectomy, endolaser photocoagulation, retinotomy, tamponade, fluid–gas exchange, retinal dissection
BGMA002	Vitreoretinal surgery with at least four of the following manoeuvres: endodiathermy, vitrectomy, endolaser photocoagulation, retinotomy, tamponade, fluid–gas exchange, retinal dissection, retinectomy
BGPA002	Epiretinal membrane dissection

only explanatory variable in a Poisson regression analysis and tested for significance using log-likelihood ratio statistics. The number of surgeries was used as a population offset. We also studied factors that may be associated with endophthalmitis following surgery. For each variable (combined surgery, type of surgery, year of surgery, age ≥ 85 years and gender), IRRs were estimated using Poisson regression. For 1212 procedures, more than one procedure among glaucoma, cornea and retina surgeries was coded. These procedures were not taken into consideration for Poisson regressions. Multivariate Poisson regression analyses were then performed. Analyses were performed with the SAS V.9.4 software (The SAS Institute). All the tests were two sided and p values < 0.05 were considered significant.

RESULTS

Before extraction of the cohort, 0.76% of hospital stays for cataract surgery were excluded for analysis because of patient identification errors. During the 2005–2014 period, 3 986 754 patients were admitted to a healthcare facility for cataract surgery by phacoemulsification according to the national database (PMSI). In the meantime, surgeries combined with cataract procedures accounted for 115 468 procedures. [Table 2](#) shows the number of stand-alone and combined surgeries for corneal, glaucoma and vitreoretinal surgical procedures. The ratio for combined surgery versus cataract surgery as a stand-alone procedure was 1.84%. Glaucoma surgical procedures were more often combined with phacoemulsification than corneal or vitreoretinal surgeries (40.6%, 15.2% and 13.6%, respectively, $p < 0.0001$). The incidence of acute POE after phacoemulsification alone or after combined surgery is given in [table 2](#).

For 1212 procedures, more than one procedure among corneal, glaucoma or vitreoretinal surgeries was coded. Therefore, there is a difference between overall stand-alone or overall combined surgery and the sum of the type of surgery, whether corneal, glaucoma or vitreoretinal.

The incidence of acute POE after phacoemulsification alone decreased during the study period from 2005 to 2014 but not after combined surgery (0.144% to 0.050% and 0.128% to 0.118%, $p < 0.0001$ and $p = 0.92$, respectively). In [table 3](#), the incidence of acute POE is given by type of surgery.

In multivariate analysis ([table 4](#)), combined surgery was at higher risk for acute POE than stand-alone surgery (corneal, glaucoma, vitreoretinal or phacoemulsification) without taking into account the type of surgery (IRR 1.38; 95% CI 1.11 to 1.70; $p = 0.0054$). The association of acute POE with overall combined surgeries was also statistically significant after adjustment on the type of surgery (IRR 1.27; 95% CI 1.01 to 1.60; $p = 0.042$). In these analyses, the type of surgery was indeed associated differently with the occurrence of acute POE. Glaucoma surgeries (ie, stand-alone and combined procedures) were associated with a lower acute POE incidence than stand-alone phacoemulsification (IRR 0.63; 95% CI 0.47 to 0.85). By contrast, vitreoretinal surgery was associated with an increased risk of POE, whether or not it was combined with cataract extraction (IRR 1.78; 95% CI 1.58 to 2.01, $p < 0.001$). Women were less subjected than men to acute POE and a decrease in acute POE was observed during the study period in the three analyses.

Leaving phacoemulsification as a reference for POE incidence, procedures were not associated with a higher occurrence of acute POE, whether corneal, glaucoma or vitreoretinal surgeries were performed simultaneously with phacoemulsification or as stand-alone procedures ($p = 0.68$, $p = 0.16$ and $p = 0.18$, respectively).

Table 2 Number of stand-alone and combined surgical procedures and incidence of acute postoperative endophthalmitis in France from 2005 to 2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Phacoemulsification as a stand-alone procedure, n	487 708	531 732	555 019	575 259	616 308	648 419	675 828	704 401	720 839	744 964	6260 477
Overall combined surgery,* n	8615	10 575	10 468	10 896	11 296	11 618	12 420	12 808	13 227	13 545	115 468
Overall stand-alone surgery,* n	31 466	36 426	38 799	41 350	43 221	44 962	47 696	49 150	50 184	51 769	435 023
Corneal stand-alone surgery, n	1647	2976	3037	3206	3421	3716	3969	4307	4550	4785	35 614
Corneal combined surgery, n	615	577	551	564	575	629	635	655	736	823	6360
Glaucoma stand-alone surgery, n	6773	8840	8973	9249	8818	8913	8982	9151	8985	8992	87 676
Glaucoma combined surgery, n	5960	7363	6805	6643	6323	5915	5696	5402	5115	4634	59 856
Vitreoretinal stand-alone surgery, n	23 168	24 725	26 904	29 022	31 076	32 464	34 844	35 779	36 752	38 069	312 803
Vitreoretinal combined surgery,* n	2060	2656	3130	3705	4404	5089	6099	6761	7389	8101	49 394
Acute POE after combined surgery, n	11	15	13	16	19	24	16	24	18	16	172
Acute POE incidence after combined surgery, %	0.128%	0.142%	0.124%	0.147%	0.168%	0.207%	0.129%	0.187%	0.136%	0.118%	0.149%
Acute POE after phacoemulsification as a stand-alone procedure, n	703	756	752	748	773	729	618	512	400	371	6362
Acute POE incidence after phacoemulsification as a stand-alone procedure, %	0.144%	0.142%	0.135%	0.130%	0.125%	0.112%	0.091%	0.073%	0.055%	0.050%	0.102%

*Corneal, glaucoma and vitreoretinal surgeries.
POE, postoperative endophthalmitis.

DISCUSSION

In this study, we found a higher incidence of acute POE for surgical procedures combined with phacoemulsification when taking stand-alone cataract surgery as the reference. When considering the different surgical procedures concomitant to phacoemulsification, it appeared that only combined cataract surgeries performed with vitreoretinal procedures were associated with a higher incidence of acute POE. On the other hand, when taking corneal, glaucoma or vitreoretinal procedures as the reference, concomitantly adding a phacoemulsification procedure did not increase the incidence of acute POE. In France, according to the data reported herein, the overall rate of combined cataract surgeries increased by 57.2% from 2005 to 2014. This is about the same magnitude as phacoemulsification performed as a stand-alone surgery in the cohort studied: 52.7% during the same time period. This trend, at least for cataract surgery performed alone, is similar to several countries^{9,10} and is probably related to the increasing life expectancy of individuals and to surgical technique refinements.⁷ The decrease of acute POE after cataract surgery observed herein is in line with the published literature.^{1,11} However, for acute POE after combined surgeries considered as a whole, we did not observe this trend during the study period.

Combined surgeries remain a matter of debate and their acceptance among eye surgeons is highly variable. Indeed, the ratio of combined surgeries versus stand-alone phacoemulsification was low (1.84%) in our study. A number of technical advances have helped in performing combined surgery. For instance, the availability of microincision cataract surgery with a

sub-2 mm clear corneal incision has led to better tightness of the anterior chamber, encouraging combined procedures given the better control of surgical manoeuvres.¹² Also, when considering age-related diseases such as glaucoma and retinal diseases such as epiretinal membranes (ERM) or macular holes (MH), many patients present with a concomitant cataract. As an example, it has been estimated that about 20% of patients operated on for cataract have concomitant glaucoma.¹³ To the patient's advantage, combined surgery avoids a second mid-term hospitalisation for subsequent cataract surgery with all the expenses related to a hospital stay.¹⁴ The safety of combined surgeries is also a matter of concern and several studies have shown that cataract-combined surgeries for ERM or MH are safe and allow faster visual acuity recovery.^{14,15}

However, some concerns remain on the effectiveness of combined surgery. For instance, some authors have argued that it can be less effective than a stand-alone procedure for glaucoma surgery.¹⁶

For corneal surgery, a recent paper investigated the incidence of acute POE after corneal transplant, cataract surgery and combined surgery in a large Medicare population.¹⁷ According to the authors, this study was the first to report on endophthalmitis after concurrent corneal transplant and cataract surgery; a higher acute POE incidence was found in the corneal transplant group and the combined surgery group versus cataract surgery performed as a single procedure (0.420%, 0.351% vs 0.127%, respectively, $p < 0.0001$).¹⁷ A study conducted in the UK over a 7-year period on a sample of 11 320 penetrating keratoplasties reported an overall rate of endophthalmitis of 0.67% and a

Table 3 Incidence of acute postoperative endophthalmitis in France after combined or stand-alone corneal, glaucoma or vitreoretinal surgical procedure from 2005 to 2014

Type of combined surgery	Combined surgeries, n	Acute POE after combined surgery, n	Stand-alone surgeries, n	Acute POE after stand-alone surgery, n	Acute POE incidence after combined surgery (%)	Acute POE incidence after stand-alone surgery (%)
Corneal	6360	9	35 614	48	0.142	0.135
Glaucoma	59 856	53	87 676	61	0.089	0.070
Vitreoretinal	49 394	110	312 803	596	0.223	0.191

POE, postoperative endophthalmitis.

Table 4 Crude and adjusted incidence rate ratios for acute postoperative endophthalmitis after combined versus stand-alone surgery in France from 2005 to 2014, derived from Poisson regression analysis

	Crude IRR (95% CI)	P values*	Adjusted IRR (95% CI)	P values*
Without type of surgery				
Combined versus stand-alone surgery	1.41 (1.21 to 1.64)	<0.001	1.38 (1.11 to 1.70)	0.0054
Age ≥85 years	1.03 (0.95 to 1.11)	0.49	1.08 (0.97 to 1.20)	<0.001
Gender, female versus male	0.69 (0.66 to 0.72)	<0.001	0.68 (0.64 to 0.73)	<0.001
Year of surgery (reference=2005)	0.91 (0.89 to 0.93)	<0.001	0.91 (0.90 to 0.92)	<0.001
With type of surgery				
Combined versus stand-alone surgery	1.41 (1.21 to 1.64)	<0.001	1.27 (1.01 to 1.60)	0.042
Type of surgery†		<0.001		<0.001
Cataract	1		1	
Corneal	1.32 (1.02 to 1.73)		1.25 (0.86 to 1.83)	
Glaucoma	0.75 (0.62 to 0.90)		0.63 (0.47 to 0.85)	
Vitreoretinal	1.90 (1.76 to 2.06)		1.78 (1.58 to 2.01)	
Age ≥85 years	1.03 (0.95 to 1.11)	0.49	1.10 (0.99 to 1.23)	0.077
Gender, female versus male	0.69 (0.66 to 0.72)	<0.001	0.70 (0.65 to 0.75)	<0.001
Year of surgery (reference=2005)	0.91 (0.89 to 0.93)	<0.001	0.91 (0.90 to 0.92)	<0.001

*Log-likelihood ratio statistics from Poisson regression.

†Here the reference noted one corresponds to cataract surgery as a stand-alone procedure. For corneal, glaucoma and vitreoretinal surgeries, both stand-alone and combined procedures were taken into account.

IRR, incidence rate ratio.

0.16% incidence of acute POE within 6 weeks after the surgery.¹⁸ This is very close to our findings, 0.14% for stand-alone corneal surgeries.

In the literature, reported acute POE after glaucoma surgery is within the same range as what is observed after cataract extraction.¹⁹ In our cohort, taking phacoemulsification as the reference, we found a lower rate of acute POE for glaucoma surgeries compared with phacoemulsification (table 3). Similarly, it has been noted that glaucoma surgeries performed with concurrent cataract extraction had a lower rate of late-onset endophthalmitis than filtering procedures as stand-alone procedures.²⁰ There is no clear explanation for this finding. However, we may speculate that aqueous drainage whatever the technique, may impair bacteria invasion, and thus lead to lower rates of acute POE.

Vitreoretinal surgeries displayed a higher incidence of acute POE compared with cataract surgery as a stand-alone procedure (tables 2 and 3). Even though a retrospective series on a limited number of cases showed that phacovitrectomy was more at risk than vitrectomy alone (0.75% vs 0.12%, respectively),²¹ the safety of phacovitrectomy in terms of acute POE has been mentioned in the literature for patients at risk of having more complications, such as diabetics.²² More recently, the debate has focused on endophthalmitis after small-gauge microincision versus the classical 20-gauge vitrectomy. A recent review concluded that the overall incidence of acute POE after vitrectomy was 0.03% and that no differences were observed between the different approaches if a bevelled technique was used for sclerostomies.²³ Unfortunately, we could not investigate this point because our national database does not give such detailed information at the national scale.

Among other risk factors, we found a lower incidence of acute POE after phacoemulsification in female patients which is in agreement with the literature.²⁴ It has been hypothesised that adherence to postoperative recommendations could play a role in this difference between men and women.²⁴ However, some series have found a similar acute POE incidence between men and women,¹ while one paper reported more acute POE in women than in men, 53.6% vs 46.4%, respectively.⁵

We acknowledge several limitations to this study. First, the accuracy of coding is always questioned by experts using big data.²⁵ In France, the National Health Service regularly checks coding accuracy based on samples of patient charts and doctors, and hospitals can be fined when excessive errors are found. Furthermore, these national data are used for hospitals' budget allocation, which improves data quality in terms of coherence, accuracy and exhaustiveness.²⁶ Second, the code for endophthalmitis is common to both culture-positive and culture-negative cases, and it is therefore possible that non-infectious severe inflammations could have been counted as endophthalmitis. Nevertheless, most studies examining endophthalmitis also take into account a clinical suspicion of acute POE.¹ Third, these findings may not apply to other countries since the current practices for the prevention of postoperative ocular infection may vary, as can the number of combined cataract surgeries. Fourth, the codes related to a surgical procedure do not exhaustively describe the surgical technique and do not always provide sufficient detail (ie, type of gauge for vitrectomy). Fifth, important risk factors for acute POE such as posterior capsule rupture or intracameral antibiotic injections were not retained for analysis because they were not reliably recorded in the national database. This would require a third number code and most surgeons only mention two codes because the third code is not taken into consideration by the payers (National Health Service and insurance companies). Sixth, we cannot exclude indication bias, that is, eyes that required combined surgeries had more severe condition, such as infection or trauma, leading to higher risk of POE.

The strengths of this report come from the high number of surgical procedures at the scale of an entire country. However, the use of big data requires careful analysis and interpretation, as has already been pointed out in the literature, and we acknowledge that the conclusions drawn from such analyses should be taken with caution.²⁷

In conclusion, using big data, we were able to identify combined cataract surgery as a risk factor for acute POE when compared with phacoemulsification as a stand-alone procedure. This only applied to vitreoretinal surgeries combined with

phacoemulsification. These new findings should be taken into consideration to provide fair information to patients.

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