Reduction in admissions of patients with acute primary angle closure occurring in conjunction with a rise in cataract surgery in Taiwan

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ABSTRACT.

***Purpose*: Using 8 year nationwide administrative data, this study sets out to investigate the relationship between the total number of cataract operations undertaken in Taiwan and admissions for acute primary angle closure (APAC).**

***Methods*: Monthly cataract surgery and APAC admission rates, per 100 000 of the population, were provided by 1997–2004 inpatient and outpatient data obtained from the Taiwanese National Health Insurance Research Database. The 3814 cases of APAC and 503 687 patients who had undergone cataract operations were categorized by age groups (40–49, 50–59, 60–69 and ≥70 years) and by gender. Spearman rank correlation coefficients were used to examine the direction and strength of the relationships.**

***Results*: Throughout the study period, the admissions for APAC showed a steady decline from 630 cases in 1997 to 351 cases in 2004, while the number of cataract operations revealed a gradual increase from 26 600 in 1997 to 77 924 in 2004. The Spearman rank correlation coefficients showed significant inverse relationships between monthly APAC admission rates and monthly cataract operation rates for the total group ($r = -0.407$, $P < 0.001$), males ($r = -0.330$, $P < 0.001$), females ($r = -0.444$, $P < 0.001$), 40–49 year olds ($r = -0.335$, $P < 0.001$), 50–59 year olds ($r = -0.497$, $P < 0.001$) and 60–69 year olds ($r = -0.417$, $P < 0.001$). No significant inverse relationship was observed for the ≥70 age group.**

***Conclusion*: Significant inverse relationships were noted between the monthly APAC admission rates and the monthly cataract operation rates. We recommend that data should be collected from other regions and ethnic groups to determine the inter-relationships.**

Key words: acute primary angle closure – cataract – intraocular pressure

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Introduction

A number of prior studies on patients with primary open-angle glaucoma have demonstrated that long-term intraocular pressure (IOP) control is largely unaffected by cataract surgery alone (Wishart & Atkinson 1983; Radius et al. 1984; Savage et al. 1985; McGuigan et al. 1986). However, amongst patients with primary angle-closure glaucoma (PACG) who subsequently undergo cataract extractions – either by means of traditional extracapsular lens extraction or by modern phacoemulsification – there is evidence of deeper anterior chambers and better postoperative IOP control, even when preoperative IOP controls are inadequate (Greve 1988; McKibbin et al. 1996; Acton et al. 1997; Yang & Hung 1997; Gunning & Greve 1998; Hayashi et al. 2000; Ge et al. 2001; Di Staso et al. 2002; Jacobi et al. 2002; Kubota et al. 2003; Yoon et al. 2003). For this reason, we postulate that for those patients with cataract and narrow angle structures who have undergone prior cataract surgery, there will be a consequential reduction in the risk of angle-closure attacks.

By examining the total number of cataract operations year by year in Taiwan, as well as the hospital admissions for APAC, we should be able to

determine the relationship between cataract surgery and overall occurrences of APAC. This study therefore sets out, using 8 year population-based data on Taiwan, to investigate the relationship between cataract operations and admissions for APAC amongst different age and gender groups between 1997 and 2004. To the best of our knowledge, this is the largest population-based study ever to have explored the relationship between cataract operations and APAC admissions.

Materials and Methods

Dataset

This study used an administrative dataset, covering the years from 1997 to 2004, obtained from the Taiwanese National Health Insurance Research Database (NHIRD) published by the National Health Research Institute in Taipei. The NHIRD is one of the largest and most comprehensive population-based healthcare databases currently available anywhere in the world, providing primary diagnoses from the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) and up to four secondary diagnoses.

The database covers all inpatient and outpatient medical benefit claims for over 96% of the Taiwanese population of approximately 23 million people, and includes registries of contracted medical facilities, board-certified physicians, catastrophic illness patients, monthly summaries for inpatient and ambulatory care claims, details of inpatient and ambulatory care orders and all expenditure on prescriptions dispensed at contracted pharmacies.

Study sample

Those patients who were admitted to hospital with PACG as their principal diagnosis were selected as our study sample, along with those patients who had undergone cataract operations, either in ambulatory or inpatient settings. The sample period ran from 1 January 1997 to 31 December 2004. The sampled patients were identified from the database either by a principal diagnosis of PACG (ICD-9-CM code 365.2) or a principal procedure code of cataract operation (ICD-9-CM codes 13.1–13.5).

In order to ensure a clear focus on the sampled patients with APAC, those patients who had been diagnosed as having chronic angle-closure glaucoma (ICD-9-CM code 365.23) or being at the residual stage of angle-closure glaucoma (ICD-9-CM code 365.24) were excluded from the sample. Patients below the age of 40 years were also excluded, essentially because APAC is known to occur primarily amongst older patients. Ultimately, our study sample comprised 3814 cases of admissions for APAC and a total of 503 687 patients who had undergone cataract operations in Taiwan between 1997 and 2004.

Population data

The Population Affairs Administration, Ministry of the Interior, releases population data annually to the public. The monthly APAC admission and cataract operation rates were defined in this study as the proportion (fraction) of the total monthly APAC admissions and cataract operations for the entire island's population. This study used the nationwide data on population registrations to calculate the APAC admission and cataract operation rates per 100 000 of the population.

Statistical analysis

Monthly APAC admission rates and cataract operation rates per 100 000 of the population were calculated for 96 months, by age groups (40–49, 50–59, 60–69 and ≥70 years) and by gender. We also used the Spearman rank correlation coefficients to examine the direction and strength of the relationships between monthly APAC admission rates and cataract operation rates for each age and gender group.

Descriptive statistical analyses, including the frequency, percentage, mean and standard deviation (SD), were performed on all of the identified variables. Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS 12.0 for Windows; SPSS, Chicago, Illinois, USA). All P-values of <0.05 were considered to be statistically significant.

Table 1. Demographic characteristics of acute primary angle closure inpatients and cataract operations in Taiwan, 1997–2004.*

	Acute primary angle closure admissons*		Cataract operations†	
Variable	Total no.	%	Total no.	%
Age group (years)				
40–49	242	6.4	16 409	3.3
50–59	795	20.8	54 315	10.8
60–69	1483	38.9	175 003	34.7
≥70	1294	33.9	257 960	51.2
Gender				
Male	1374	36.0	237 453	47.1
Female	2440	64.0	266 234	52.9
Year				
1997	630	16.5	26 600	5.3
1998	643	16.9	54 152	10.8
1999	605	15.9	58 779	11.7
2000	481	12.6	68 536	13.6
2001	405	10.6	74 187	14.7
2002	392	10.3	75 158	14.9
2003	307	8.1	68 354	13.6
2004	351	9.2	77 924	15.5

*A total of 3814 admissions for treatment of acute primary angle closure.
†A total of 503 687 patients who had undergone cataract operations.

Results

Our sample comprised a total of 3814 patients with APAC and 503 687 patients who had undergone cataract operations in Taiwan between 1997 and 2004. A summary profile of the sampled cases is provided in Table 1; this reveals that, compared to those patients who had undergone cataract operations, those who were admitted for the treatment of APAC were more likely to be female ($P < 0.001$). The mean age for patients treated for APAC was 65.2 (±9.6) years, while the mean age for those who had undergone cataract operations was 69.0 (±9.2) years. We also found that over half of the patients who had undergone cataract operations were aged 70 years or above.

Throughout the period of this study there was a gradual increase in the total number of cataract operations undertaken: 1997 (26 600 cases), 1998 (54 152), 1999 (58 779), 2000 (68 536), 2001 (74 187), 2002 (75 158), 2003 (68 354), 2004 (77 924). However, the total number of admissions for APAC showed a steady decline over the same period: 1997 (630 cases), 1998 (643), 1999 (605), 2000 (481), 2001 (405), 2002 (392), 2003 (307), 2004 (351).

Table 2. Monthly mean values of cataract operations and acute primary angle closure in Taiwan, 1997–2004.

Variable	Mean	SD	Min.	Max.
Acute primary angle closure per 100 000 of the population				
By age groups (years)				
40–49	0.0737	0.0539	0.0000	0.2449
50–59	0.4318	0.2447	0.1211	1.3036
60–69	1.0790	0.4002	0.2687	2.0841
≥70	1.0899	0.5057	0.2747	2.4508
By gender groups				
Male	0.3514	0.1540	0.0448	0.7792
Female	0.6433	0.2697	0.2037	1.2664
Total	0.4951	0.1897	0.1238	0.9061
Cataract operations per 100 000 of the population				
By age groups (years)				
40–49	4.8461	1.6496	1.5359	8.8706
50–59	27.2315	9.3498	7.4068	47.2336
60–69	125.8002	42.3628	33.1293	198.3859
≥70	208.3283	57.4443	72.6519	305.4084
By gender groups				
Male	58.9512	14.6792	20.8025	78.9868
Female	67.3998	20.0917	18.2086	96.2141
Total	63.1302	17.2670	19.5371	87.5316

SD, standard deviation.
*Total sample number = 507 501.

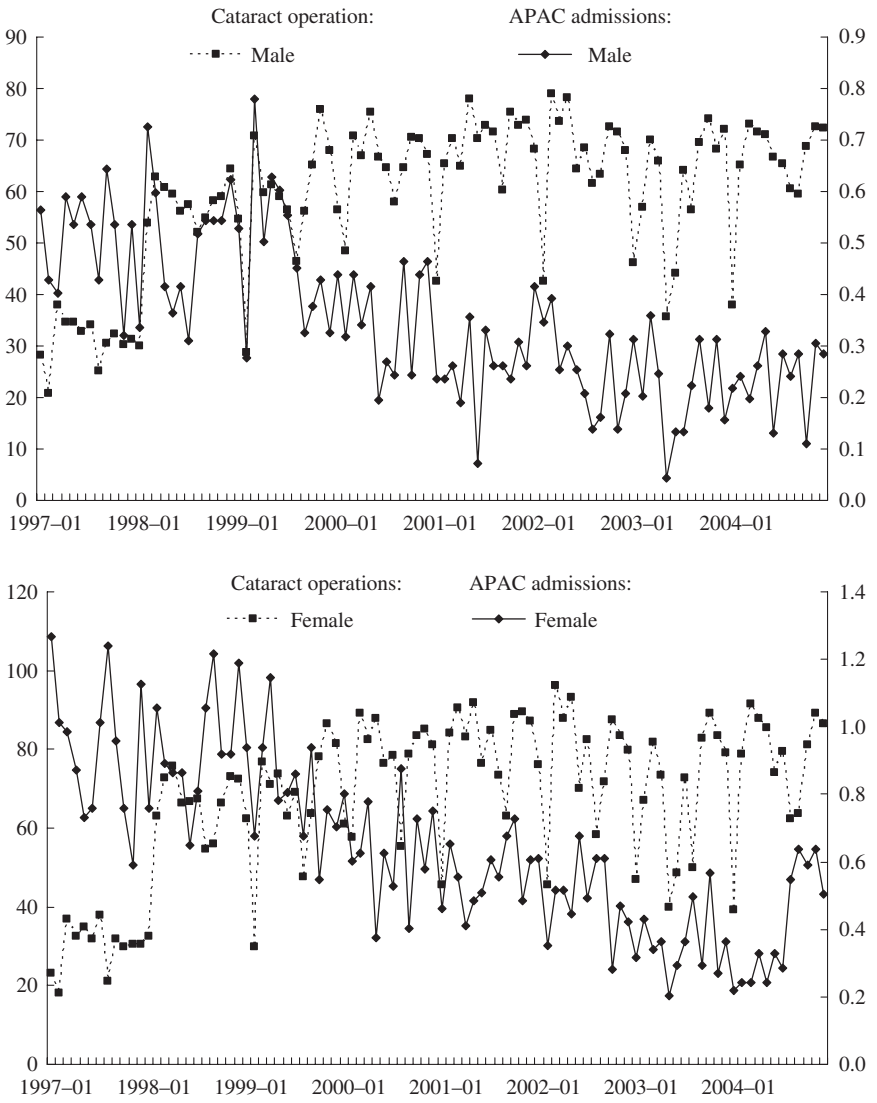

Fig. 1. Mean monthly cataract operation and acute primary angle closure (APAC) admission rates, by gender, 1997–2004.

Details of the mean monthly values of APAC admissions between 1997 and 2004 (per 100 000 of the population) are provided in Table 2, by both age and gender. Throughout the period of this study, the monthly APAC admission rates per 100 000 of the population ranged from a high of 0.9061 in January 1997 to a low of 0.1238 in May 2003, with a mean of 0.4951 and SD of 0.1897. The mean monthly APAC admission rates were 0.3514 for males and 0.6433 for females; 0.0737 for the 40–49 age group, 0.4318 for the 50–59 age group, 1.0790 for the 60–69 age group and 1.0899 for the ≥70 age group.

Table 2 also summarizes the monthly mean values, across the entire study period, of cataract operations per 100 000 of the population, by age and gender. The monthly mean cataract operation rates per 100 000 of the population ranged from a low of 19.5371 in February 1997 to a high of 87.5316 in March 2002, with a mean of 63.1302 and SD of 17.2670.

The monthly mean cataract operation rate for females was demonstrably higher than that for males; with increasing age, there was a corresponding steady rise in the monthly mean cataract operation rate. The monthly mean values of admissions for APAC and cataract operations carried out between 1997 and 2004 by gender groups and per 100 000 of the population are illustrated in Fig. 1.

The Spearman rank correlation coefficients between the monthly APAC admission and cataract operation rates are provided in Table 3, by age and gender groups. Significant inverse relationships were identified between the monthly APAC admission and cataract operation rates of the total sample ($r = -0.407$, $P < 0.001$), males ($r = -0.330$, $P < 0.001$), females ($r = -0.444$, $P < 0.001$), 40–49 year olds ($r = -0.335$, $P < 0.001$), 50–59 year olds ($r = -0.497$, $P < 0.001$) and 60–69 year olds ($r = -0.417$, $P < 0.001$). No significant inverse relationship was observed for the ≥70 age group.

Discussion

With the single exclusion of 2003 (the year of the SARS outbreak in Taiwan), from the time of the introduction of the National Health Insurance system in Taiwan the total number of cataract extractions has increased steadily amongst older patients: from 26 600 cases in 1997 to 77 924 cases in 2004.

However, as opposed to any abnormal rise in incidences of cataracts amongst the population, this may be more attributable to one of two factors: (1) the reduction in economic barriers for those of low socioeconomic status, which would thereby

Table 3. Spearman's rank correlation coefficients between monthly acute primary angle closure rates and cataract operation rates in Taiwan, 1997–2004.†

APAC admissions per 100 000 of the population	Cataract operations per 100 000 of the population						
	By age groups (years)				By gender groups		
	40–49	50–59	60–69	≥70	Male	Female	Total
By age groups (years)							
40–49	−0.335***	−0.264**	−0.228*	0.063	−0.123	−0.103	−0.105
50–59	−0.520***	−0.497***	−0.480***	−0.139	−0.402***	−0.396***	−0.400***
60–69	−0.421***	−0.433***	−0.417***	−0.106	−0.345***	−0.344**	−0.344**
≥70	−0.522***	−0.490***	−0.473***	−0.042	−0.363***	−0.339**	−0.348**
By gender groups							
Male	−0.489***	−0.499***	−0.443***	−0.012	−0.330***	−0.284**	−0.297**
Female	−0.578***	−0.549***	−0.546***	−0.135	−0.446***	−0.444***	−0.445***
Total	−0.590***	−0.558***	−0.533***	−0.084	−0.419***	−0.401***	−0.407***

APAC, acute primary angle closure.
*$P < 0.05$; **$P < 0.01$; *** $P < 0.001$.
†Total sample number = 509 274.

have enabled them to receive cataract operations; and (2) the introduction and prevalence of newer technologies such as small incision phacoemulsification and foldable intraocular lenses.

PACG, which is the most common form of glaucoma in Taiwan, occurs most frequently in eyes that have a particular anatomical configuration. Such eyes invariably have a shallow anterior chamber and also tend to be hypermetropic, with a short axial length, increased lens thickness and steep anterior lens curvature (Hillman & Turner 1977). Admissions for APAC demonstrated a steady decline throughout the study period, from 630 admissions in 1997 to 351 admissions in 2004. The statistics also revealed certain major characteristics of angle-closure glaucoma, i.e. the predilection for episodes amongst females and older patients.

As expected, our analyses using the Spearman rank correlation coefficients demonstrated significant inverse relationships between monthly APAC admission rates and cataract operation rates for each of the age and gender groups (with the exception of the ≥70 years group). This implies that for some of the more susceptible narrow-angle patients, prior cataract operations may well preclude the occurrence of APAC.

Very encouraging results, in terms of long-term IOP control, have been found following operations for cataract extraction with intraocular lens implantation amongst patients with acute PACG (McKibbin et al. 1996; Acton et al. 1997; Jacobi et al. 2002; Kubota et al. 2003; Yoon et al. 2003) and those with chronic PACG (Wishart & Atkinson 1983; Acton et al. 1997; Gunning & Greve 1998; Kubota et al. 2003). Jacobi et al. (2002) reported that acute PACG was well controlled in 72% of patients in the primary phacoemulsification and intraocular (PPI) lens implantation group, and in 35% of the patients in the conventional surgical ididectomy (CSI) group.

The mean preoperative IOP in the Jacobi et al. study was 40.5 ± 7.6 mmHg for the PPI group and 39.7 ± 7.8 mmHg for the CSI group; after a mean follow-up of 10.2 ± 3.4 months, the mean postoperative IOP was 17.8 ± 3.4 mmHg for the PPI group and 20.1 ± 4.2 mmHg for the CSI group. The mean number of postoperative ocular hypotensive medications was 0.18 ± 0.45 for the PPI group and 0.45 ± 0.62 for the CSI group. Additional surgery was, nevertheless, necessary in 11.5% of the cases in the PPI group and in 63% of those in the CSI group (Jacobi et al. 2002).

For patients with no glaucoma, several studies have revealed a significant reduction in IOP following cataract surgery (Hansen et al. 1995; Kim 1996; Issa et al. 2005); however, other studies have reported no significant postoperative changes in IOP (Dimitrov et al. 2001). Hansen et al. (1995) also found that 7 years after extracapsular cataract extraction and the implantation of intraocular lens, the mean IOP value was 1.3 mmHg lower than the preoperative mean value for patients with no glaucoma.

Furthermore, according to the study by Issa et al. (2005), the reduction in IOP following cataract surgery was found to have a positive correlation with preoperative IOP and an inverse correlation with preoperative anterior chamber depth (ACD); the study by Kim (1996) demonstrated that there was some postoperative IOP reduction in both the extracapsular cataract extraction (ECCE) and phacoemulsification groups, although there were no significant differences in the overall amount of the reduction between the two groups.

Dimitrov et al. (2001) reported that in both glaucoma and non-glaucoma groups there were corresponding increases in IOP in non-operated eyes with increasing age. However, following cataract surgery, there were significant reductions in IOP amongst those patients with glaucoma, although there were no significant changes amongst the non-glaucoma participants.

Several biometric and image studies have added to our understanding of the way in which cataract surgery can lower postoperative IOP (Congdon et al. 1997; Yang & Hung 1997; Hayashi et al. 2000; George et al. 2003). Compared to normal, unaffected eyes, those with angle-closure glaucoma and occludable angles have significantly shorter axial lengths, shallower anterior chambers and greater lens thickness (George et al. 2003). Furthermore, the radius of the corneal curvature is significantly smaller amongst Chinese patients, who generally demonstrate PACG rates that are as much as 10–15 times higher than those for White people (Congdon et al. 1997).

Following cataract extraction and IOL implantation, through the use of Scheimpflug video photography, the width and depth of the anterior chamber angle in eyes with PACG have been found to increase significantly and to become similar to those of normal eyes, thereby explaining the reduction in IOP observed in the postoperative period (Hayashi et al. 2000).

Yang & Hung (1997) reported that the preoperative mean ACD in the PACG patients group was 2.04 ± 0.29 mm prior to cataract surgery, whereas the postoperative mean

was 3.44 ± 0.16 mm. Again, using Scheimpflug image processing subsequent to surgery, the anterior chamber angle was found to have been widened significantly in relation to the superior, inferior, temporal and nasal quadrants.

PACG and cataracts are both age-related disorders, with the disproportionately enlarged lens predisposing cataract patients to the development of angle-closure glaucoma as a result of the enlarged lens pushing the lens–iris diaphragm forward, narrowing the anterior chamber angle and creating the pupillary block. This further narrows the anterior chamber angle, thereby leading to angle-closure attacks.

We assume in this study that many attacks of symptomatic angle closure may have been prevented by timely, successful cataract surgery amongst the older age groups in Taiwan. As to the reason why the oldest group (those aged ≥70 years) did not demonstrate any significant inverse relationships between monthly cataract operation rates and monthly APAC admission rates, we postulate that at this age, the preventive effects of cataract surgery may well be largely offset by the total number of cases of age-induced APAC attacks.

In addition, it was suggested that the reduction in admissions of angle closure may be caused by an increase of day-case care for angle closure. However, our data (not shown in tables) have shown that there was a decreasing trend in the annual number of cases of day-case care for angle closure during the study period. Therefore, the reduction in the admissions of angle closure is unlikely to be caused by the increase of day-case care for angle-closure cases.

However, there are several limitations of this study that must be considered. Firstly, of those cases identified for the study sample, there is likely to have been a mixture of glaucoma cases, including APAC, as well as chronic PACG patients undergoing elective surgery. The numbers will, nevertheless, be quite small, as a result of our exclusion of all chronic PACG cases and the fact that most elective filtering operations in Taiwan are now undertaken as day cases.

Secondly, the APAC admission rate used in this study was drawn from NHIRD inpatient medical benefit claims. The APAC admission rate reported here may, therefore, have underestimated the actual figures of symptomatic angle-closure attacks because it is assumed that a small proportion of the patients would have been treated as outpatients. In a study undertaken in Singapore, it was estimated that hospital discharge databases were likely to underestimate symptomatic angle-closure attacks by as much as 5.2% (Wong et al. 2000).

Thirdly, all of the APAC diagnoses in our study were totally reliant upon claims data reported by either physicians or hospitals; this may be less accurate than diagnoses carried out individually through a standardized procedure and could, of course, compromise the findings. The NHI Bureau does, however, undertake a random sample of a fixed percentage of claims from every hospital in Taiwan each year in order to verify both the diagnoses and the quality of care through a chart review undertaken by an independent peer group. In addition, any hospital with outlier charges, or unusual patterns of care for any diagnostic group, faces the risk of audits and heavy penalties should any discrepancies or overcharging be subsequently discovered by the Bureau.

Conclusions

Our population-based analysis found an inverse relationship between cataract operation rates and APAC admission rates, particularly for females and for the 50–59 and 60–69 age groups. This is a very important finding from the point of view of public healthcare prevention of PACG, particularly amongst certain ethnic groups – such as Chinese or Eskimos – amongst whom angle-closure glaucoma is the most common form of glaucoma.

It is also an important finding for several countries in which there are lengthy waiting periods for elective cataract surgery; indeed, it could be argued that some cases of lens-induced glaucoma may well be prevented if the waiting periods were shorter (McKibbin et al. 1996). We recommend that future studies should be conducted in other regions, and amongst other ethnic groups, to explore the relationships existing between cataract surgery and incidences of APAC in order to further clarify this issue.

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