Cataract Extraction Rates Among Chinese, Malays, and Indians in Singapore

A Population-Based Analysis

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Objective: To describe the rates of cataract extraction among Chinese, Malays, and Indians in an urban population in Asia.

Design: Population-based incidence study using data from a medical savings fund.

Study Population: Chinese, Malay, and Indian residents in Singapore.

Methods: Data on all cataract operations performed for “senile cataract” (International Classification of Diseases, Ninth Revision, Clinical Modification code 366.1) between 1991 and 1996 were retrieved from Medisave, a population-wide, government-administered medical savings fund. The Singapore census was used as a denominator to allow an estimation of age, sex, and race-specific annual rates of cataract surgery.

Results: Between 1991 and 1996, 61,210 cataract operations for “senile cataract” were performed on Singapore residents, which is equivalent to an average rate of 356.4 cataract operations per 100,000 persons per year (95% confidence interval [CI], 353.6-359.2). The average rate was highest for Indians (age-sex adjusted rate of 396.5 per 100,000/year), followed by Chinese (371.2 per 100,000/year), and lowest for Malays (237.2 per 100,000/year). Women had higher rates of cataract extraction than men (age-adjusted relative risk, 1.14; 95% CI, 1.11-1.17), with this pattern consistent across the 3 racial groups. The rate of cataract extraction increased by an average of 40 operations per 100,000/year (95% CI, 28.6-52.8) between 1991 and 1996. Overall, the proportion of cataract extraction without concurrent intraocular lens implantation was low (n=762, 1.2%), but rates still decreased by an average of 0.8 per 100,000 per year (95% CI, 0.03-1.5) during the 6 years.

Conclusions: The rate of cataract extraction in Singapore is consistent with rates seen in developed countries in the West. Racial variation in rates suggests varying predisposition to cataract development and/or threshold for cataract surgery between Chinese, Malay, and Indian populations in Singapore.

Subjects and Methods

Singapore has a stable, multi-ethnic resident population of 3.16 million people, of whom 77% are Chinese, 14% are Malay, 8% are Indian, and 1% is made up of other ethnic groups. The study population consisted of all Chinese, Malay, and Indian citizens and permanent residents in Singapore who are identifiable by a unique identity card number assigned to all Singapore residents. The institutional review board of the Singapore National Eye Center approved this study.

Cataract Surgery Data

The numerators were determined from a national medical savings fund database—the Medisave database, which is managed by the Ministry of Health's Epidemiology and Disease Control Division. The Medisave system is a government-administered medical savings program that is available to all Singapore citizens and permanent residents. In brief, all Singapore working individuals, including self-employed persons, are required by law to contribute 6% to 8% of monthly income to a personal Medisave account. The Medisave account may be used by the individual and his or her family to pay for up to 80% of medical procedures costs in both the public and private sector. As of 1995, there were 2.4 million Medisave accounts (88% of the population). Medisave is linked to 2 other national health financing plans—Medishield, which is a "catastrophic illness insurance," and Medifund, which is a government grant for people without adequate Medisave funds or family support. These 3 plans ensure virtually universal health care coverage, including medically indicated elective ocular surgery, for all Singapore citizens, permanent residents, and their families. Surgical procedures are classified in the Medisave database according to complexity and cost of the operation, with a total of 98 separate billing categories for ocular operations.

For this study, all possible cataract-related surgical procedures from the Medisave database between January 1991 and December 1996 were initially identified. These were categorized into the following 4 main groups of analysis: (1) Cataract extraction with IOL implantation (including extracapsular cataract extraction and phacoemulsification techniques); (2) cataract extraction with no IOL implantation (including intracapsular cataract extraction and lensectomy techniques); (3) cataract extraction combined with glaucoma surgery (including trabeculectomy, filtering shunts, and other forms of glaucoma operations), with or without IOL implantation; and (4) cataract extraction combined with another surgical procedure (including combined cataract extraction with corneal graft, combined cataract and vitrectomy, and other miscellaneous operations).

Next, only operations in which a primary diagnosis of "senile cataract" was made and coded (code 366.1 of the International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]) were included for analysis. Based on this definition, cataract extractions for cases of men, and were highest in Indian, followed by Chinese, and lowest in Malay patients.

After controlling for age and sex, Indians had 1.67 times, and Chinese had 1.56 times higher rates than Malays (Table 3). Women had higher rates than men (with an age-adjusted relative risk of 1.14; 95% CI, 1.11-1.17), with this pattern seen consistently across all 3 groups. Overall, Indian women had the highest race-sex-specific rates of cataract surgery, with 2.24 (95% CI, 2.18-2.30) times higher rates than Malay men.

There was a steady increase in the rate of cataract operations during the 6-year period, rising from 277.4 per 100000 per year in 1991, to 465.0 per 100000 per year in 1996, which is equivalent to an increase of 40 operations per 100000 per year (linear regression coefficients: α = 211.7 and β = 40.7; 95% CI, 28.6-52.8). After controlling for age, the rate of increase was reduced to an average of 35 operations per 100000 per year (Figure 1), suggesting that an aging population partially accounted for the time trend. The excess rates in women, after controlling for age (Figure 2), and in Indian and Chinese patients, after controlling for age and sex (Figure 3), were consistent throughout the 6 years.

Comment

Cataract remains the most common cause of blindness in both developing and developed countries around the world. To tackle this problem, the World Health Organization has set a rate of 350 cataract operations per
congenital cataract (ICD-9-CM code 743.3), infantile, juvenile and presenile cataract (code 366.0), traumatic cataract (code 366.2), cataract secondary to ocular disorders (code 366.3), cataract associated with other disorders (code 366.4), and other miscellaneous forms of cataract (codes 366.5, 366.8, and 368.9) were excluded. Further, operations in which senile cataracts were not coded as the primary diagnosis (but could be coded as secondary diagnoses) were not included. For example, combined cataract extraction and trabeculectomy in which the primary coded diagnosis was “open-angle glaucoma” would not be captured by the case definition. Finally, the case definition did not distinguish between eyes. Thus, a person with bilateral cataract surgery would be counted twice in the numerator.

Quality control measures are conducted by the Professional Medisave Audit Unit in the Ministry of Health to prevent misuse of the Medisave funds, and to ensure accuracy of the data. First, the reimbursement procedure follows strict guidelines. Second, annual audits are carried out to assess the precision of the surgical coding of the Medisave data. Between 5% and 10% of surgical codes are randomly checked against the actual operations and the case records of each hospital during each audit. At the Singapore National Eye Center, recent audits conducted on 100 operations during October 1996, and on 57 operations during September 1997, revealed no discrepancies between patients’ case records and Medisave claims data (P. L. Kwek, MD, written communication, Epidemiology and Disease Control Division, Ministry of Health, Singapore, November 1997).

DENOMINATOR DATA

For the denominator, population data were drawn directly from the 1990 Singapore census and 1993 mid-decade census. Data for all other years in this study (1991, 1992, 1993, 1994, and 1996) were based on projections by the Department of Statistics, Singapore. Ethnic groups were defined in the census according to 1 of 4 main ethnic groups: Chinese (refers to persons of Chinese origin such as Fujian, Guangdong, Hajiya, etc), Malays (refers to persons of Malay or Indonesian origin, such as Javanese), Indians (refers to persons with ancestry originating on the Indian subcontinent), and others (comprising all persons other than the first 3 categories, such as people of European, Eurasian, Middle Eastern, and Japanese ethnicity). Persons of mixed heritage were classified under the ethnic group of their fathers. As the “others” category includes multiple ethnic populations, data on this group were not analyzed.

STATISTICAL ANALYSIS

Annual rates of cataract extractions for each subgroup (10-year age, sex, and ethnic groups) were calculated by dividing the number of cataract extractions by the population of that subgroup for that year. Age-adjusted and age-sex–adjusted rates, and 95% confidence intervals (CI) were calculated by direct adjustment using the appropriate Singapore census population in 1993 to compare rates between sex and race, respectively. Simple linear regression models were constructed to evaluate the effect of time on rates of cataract operations.

Table 1. Average Annual Rate of Cataract Extractions by Type of Surgery (Singapore, 1991-1996)*

<table>
<thead>
<tr>
<th>Type of Surgery</th>
<th>Chinese Patients, Rate per 100 000</th>
<th>Malay Patients, Rate per 100 000</th>
<th>Indian Patients, Rate per 100 000</th>
<th>All Races Patients, Rate per 100 000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>95% CI</td>
<td>No.</td>
<td>95% CI</td>
</tr>
<tr>
<td>Cataract with ICL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49,995</td>
<td>366.3</td>
<td>(363.1-369.5)</td>
<td>4776</td>
<td>199.5</td>
</tr>
<tr>
<td>Cataract without ICL</td>
<td>619</td>
<td>4.5</td>
<td>(4.2-4.9)</td>
<td>82</td>
</tr>
<tr>
<td>Cataract and glaucoma</td>
<td>1503</td>
<td>11.0</td>
<td>(10.5-11.6)</td>
<td>141</td>
</tr>
<tr>
<td>Cataract and others</td>
<td>58</td>
<td>0.4</td>
<td>(0.3-0.5)</td>
<td>4</td>
</tr>
</tbody>
</table>

* CI indicates confidence interval; ICL, intraocular lens implantation; cataract and glaucoma, cataract surgery with simultaneous trabeculectomy or other glaucoma-related procedures; cataract and others, cataract extraction with simultaneous corneal graft, vitrectomy, or other miscellaneous operations.

100,000 population per year as an “ideal” target for developed countries. This target seems to have been met and even exceeded in several economically developed nations. In the United States, cataract extraction rates from 1980 to 1994 averaged 372 per 100,000 per year. In United Kingdom, one study estimated a rate of 270 per 100,000 per year in 1990, while in Scandinavian countries, rates between 350 and 450 per 100,000 per year have been reported. Data from Asia are not readily available. This study therefore provides timely and useful information on the rates of cataract surgery in an urban, rapidly developing country in Asia. An overall rate of 356 per 100,000 per year was observed, within the goal set by the World Health Organization, and consistent with other studies in Western countries. In addition, increasing rates of cataract extraction over time (by approximately 40 operations per 100,000 per year) were seen. This trend has also been noted in other countries, although US rates may have plateaued since the 1993-1994 duration.

What possible factors may explain the increasing rate of cataract surgery in Singapore? Taylor observed 3 factors that determine the number of cataract operations in a population: (1) the age structure of the population; (2) the indications or thresholds for cataract surgery; and (3) accessibility to cataract surgery among those who want or require surgery. These factors, in combination, may contribute to the increasing rate of cataract operations.
The second factor, changing thresholds or increasing "demand" for cataract surgery, seems to be an important additional determinant. Visual function, including visual acuity, is the major criterion in determining the need for cataract surgery. Data from the Visual Impairment Project\(^\text{28}\) suggest that the number of cataract operations increases 2.5 times as the visual acuity criterion changes from less than 20/200 to less than 20/80, and 5-fold if it shifts to less than 20/40. In addition, advances in cataract extraction and IOL technology, a shift toward local anesthesia and day surgery, and greater patient expectation and demand for cataract surgery also contribute to the changing threshold for cataract surgery seen in other countries.\(^{1,2,7,12,27}\) Similar trends in cataract surgery technology evidently involved an IOL implant.\(^{28}\) On the other hand, more than 98% of the operations in this study involved IOL implants, with operations without IOL implants decreasing from approximately 3000 cataract operations in 1982, only 32 reported

Table 3. Age- and Age-Sex-Adjusted Rate of Cataract Extraction (Singapore, 1991-1996)\(^*\)

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Chinese</th>
<th>Malay</th>
<th>Indians</th>
<th>All Races</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>&lt;40</td>
<td>353.8 (347.0-360.6)</td>
<td>363.0 (358.5-400.1)</td>
<td>258.6 (252.8-264.4)</td>
<td>306.1 (301.6-310.6)</td>
</tr>
<tr>
<td>Age-adjusted RR</td>
<td>1.37 (1.33-1.41)</td>
<td>1.52 (1.47-1.56)</td>
<td>1.0</td>
<td>1.13 (1.10-1.17)</td>
</tr>
<tr>
<td>Age- and sex-adjusted rates</td>
<td>371.2 (364.3-378.2)</td>
<td>396.5 (389.3-403.7)</td>
<td>237.2 (231.6-242.7)</td>
<td>396.5 (389.3-403.7)</td>
</tr>
<tr>
<td>Age- and sex-adjusted RR</td>
<td>1.56 (1.52-1.61)</td>
<td>1.67 (1.62-1.72)</td>
<td>1.0</td>
<td>1.67 (1.62-1.72)</td>
</tr>
</tbody>
</table>

\(^*\) Data in parentheses indicate 95% confidence intervals. RR indicates relative risk.
by 0.8 per 100,000 per year throughout the 6 years. In the 1980s, fewer than 15% of cataract operations were performed as day surgical cases; in 1992, this proportion was 95%.28 In 1992, the ratio of phacoemulsification vs extracapsular cataract extraction was less than 1%; in 1996, this ratio was 25%.28 While no data are available, it is not unreasonable to suggest that greater visual expectations in the population and lower visual acuity thresholds for cataract surgery may also contribute to the increasing rate of cataract extraction seen.

The third factor in explaining the increasing rate of surgery in Singapore is increasing accessibility or increasing "supply" of cataract surgery services. In the United States, "supply-side" variables, such as the increasing number of ophthalmologists, seem to be important in determining the number of cataract operations performed.2 In Singapore, the number of ophthalmologists has increased more than 50% in decade; in 1989, there were 53 ophthalmologists (1 per 50,000 persons), but by 1999, this number had risen to 82 (1 per 38,000).

In this study, women were observed to have 14% higher rates of cataract surgery than men after controlling for age, while Indian and Chinese patients had 67% and 56% (respectively) higher rates than Malays after controlling for age and sex. Sex variation in cataract operations has been investigated elsewhere, and it seems to be related to variation in the incidence and prevalence of cataract, threshold and indications for cataract surgery, and access to cataract surgery between men and women.13-17 The modest excess in rates for women in Singapore could be related to any of the above factors.

More interesting, but more difficult to explain, was the variation in cataract extraction rates between Chinese, Indian, and Malay patients. Several explanations are possible. First, racial variation in accessibility to cataract surgery in Singapore, as in other countries, should be considered.13,14 Although not proven, it is believed that overall health care and socioeconomic status may be lower in Malays compared with Indians and Chinese. This is suggested by studies that indicate lower life expectancy in Malay persons,25 and poorer glycemia and blood pressure control in Malay persons with diabetes and hypertension, respectively.30 However, given the magnitude of the variation in cataract surgery rates observed, and the fact that cataract surgery can be paid for by Medisave in 90% of the population (with inexpensive, subsidized operations available for the remaining 10%), accessibility is unlikely the only explanation. A second and more probable explanation is racial variation in indications or threshold for cataract surgery. Studies comparing mortality rates in asthmatic persons in Singapore have suggested that Malays have higher symptom thresholds prior to seeking medical attention.31 It is therefore possible that Malay persons have higher thresholds for cataract surgery than Chinese or Indian patients with similar severity of lens opacity and visual disability. Third, racial variation in incidence and prevalence of cataract has been noted in other countries, and it may be significant in Singapore as well.32,33 No local data are available regarding racial variation in risk of cataract, but previous studies have suggested that Malay persons have lower rates of cataract risk factors such as ocular trauma,22 angle-closure glaucoma,23,34 myopia,35 and diabetes.36 Further studies on the epidemiology of cataract among these 3 groups will provide additional information.
The main strengths of this current study include a population-wide identification of cataract extraction cases throughout a 6-year period, and accurate records. However, there were some important limitations. The possibility of differential underreporting and misclassification of cataract surgery between men and women and racial groups could not be dismissed. In addition, if rates of second eye cataract surgery were high, part of the demographic variation could be explained by variation in rates of second eye cataract surgery.

In conclusion, this study provides data on the rate of cataract extraction in an Asian population. First, an overall rate of 356 cataract operations per 100 000 per year was observed, comparable with rates in other countries in the West. Second, there were variations in rates between sex and race, with an excess of cataract operations among women compared with men, and among Indians and Chinese compared with Malays. In particular, the magnitude of the observed variation suggests differences in risk of cataract and/or threshold for cataract surgery between the 3 ethnic groups.

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REFERENCES