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ORIGINAL ARTICLE

Improvement in Activities of Daily Living after Cataract Surgery in the Very Old

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ABSTRACT

BACKGROUND
The benefits of cataract surgery for patients aged ≥90 years in terms of improvements in activities of daily living (ADL) have been poorly evaluated using only limited data. Using a large nationwide administrative database of hospitalized patients, we investigated the improvement of ADL after cataract surgery in the very old (age of ≥90 years).

METHODS
We identified 84,747 patients with cataracts aged 80 to 89 years and 7,253 patients with cataracts aged ≥90 years who underwent cataract surgery in both eyes during hospitalization from April 2014 to March 2015. A retrospective matched-pair cohort study was performed to compare the proportion of patients with improved ADL after cataract surgery. We also compared the length of hospital stay between the two groups.

RESULTS
Patients aged ≥90 years were more likely to be female and have a lower ADL score at admission. In the 1:4 matched-pair analysis with 7,253 versus 29,012 pairs, a lower proportion of patients aged ≥90 years had an improved ADL score (odds ratio, 0.33; 95% confidence interval, 0.29–0.36; $P < 0.001$) even after adjusting for other variables. Patients aged ≥90 years had a slightly shorter length of hospital stay than those aged 80 to 89 years (7.5 vs. 8.2 days, respectively; $P < 0.001$).

CONCLUSIONS
In this large nationwide cohort of patients with cataracts, those aged ≥90 years showed significantly poorer improvement of ADL than did patients aged 80 to 89 years. Cataract surgery before the age of 90 years may be recommended for patients with cataracts.

KEY WORDS
cataract surgery, activities of daily living, very old, elderly, Barthel index

INTRODUCTION

Cataract surgery is the most frequently performed surgical procedure in people aged ≥65 years in the Western world [1]. Major advancements in surgical and intraocular lens technology have led to tremendous increases in surgical volume because of the improved safety profile and visual outcomes.

Populations in developed countries are rapidly aging, and the Japanese population is aging the quickest. Japan's population aging rate, which was <5% in 1950, exponentially increased to 27% in 2015. It is projected to rise to 40% in 2060, which means that 1.0 of about every 2.5 people in society will be ≥65 years of age [2]. The need for cataract surgery among the very old is therefore increasing and becoming an important public health issue.

Although studies have generally supported the benefit of cataract surgery for the very old [3, 4], only two studies have reported the outcome of cataract surgery in terms of activities of daily living (ADL) in patients aged ≥90 years [5, 6]. These previous studies involved only small numbers of patients aged ≥90 years from a single institution with different outcome measures. Therefore, whether the effectiveness of cataract surgery in the very old is comparable with that in younger patients (80–89 years of age) in terms of improvement in ADL remains unclear.

The present study was performed to investigate the effect of cataract surgery in the very old using a large nationwide inpatient database in Japan.

METHODS

STUDY DESIGN AND SETTING

The present study was a retrospective matched-pair cohort study. We used a Japanese national administrative claims and discharge abstract database (the Diagnosis Procedure Combination database). The details of the database and its data have been described elsewhere [7–9]. The database includes administrative claims data and some detailed clinical data for about 7 million inpatients per year in approximately 1,000 participating hospitals. The database includes the following information: patient age and sex; main diagnoses; surgical procedures; comorbidities that were already present at admission and complications that occurred after admission, recorded using International Classification of Diseases, 10th Revision codes; and length of stay. The database has information on 10 components of the Barthel index (BI) [10] for each patient as follows: feeding, bathing, grooming, dressing, bowels, bladder, toilet use, transfer, morbidity, and stairs. Scores of 0 to 3 points are recorded for each component in accordance with the BI scoring system. The individual points of the 10 components are summed to calculate the BI score. The attending physicians are responsible for patient data entry regarding diagnoses and outcomes, including the BI score at discharge. This study was approved by the Institutional Review Board of The University of Tokyo [approval number: 3501-(3) (25 December 2017)]. The requirement for informed consent was waived because of the anonymous nature of the data.

PATIENT SELCTION AND STUDY SETTING

Among patients hospitalized from 1 April 2014 to 31 March 2015, we selected those who underwent cataract surgery in both eyes during hospitalization. We excluded patients who underwent simultaneous surgeries such as vitrectomy and glaucoma surgery. We then classified eligible patients into two groups based on their age: patients aged ≥90 years and patients aged 80 to 89 years.

VARIABLES AND OUTCOMES

We obtained data on the following baseline variables: age, sex, and comorbidities present at admission. Comorbidities were scored according to the updated Charlson comorbidity index [11]. The Charlson comorbidity index, a method of predicting mortality by classifying or weighting comorbidities, has been widely utilized by health researchers to measure burden of disease and case mix. The score is considered to be a quantitative measure of comorbidity burden, in which 0 is the best score and 24 is the worst score. The primary outcome was improvement of the ADL score after cataract surgery. Patients with an improved ADL score were defined as those who had a higher BI score at discharge than at admission. The secondary outcome was the length of hospital stay.

STATISTICAL ANALYSES

We used a matched-pair cohort design to select the case group (age of ≥90 years) and the control group (age of 80–89 years) by means of 1:4 matching. For each patient in the case group, we identified a set of control patients who had the same BI score at admission. We then randomly selected four controls per individual in the case group from the pooled population of controls.

Differences in demographic and clinical characteristics between the groups were compared in the unmatched and matched populations using Fisher's exact probability test for categorical variables and the t-test for continuous variables. Demographic variables included age, sex, Charlson comorbidity index, and BI score at admission. In the matched population, the BI score at discharge after cataract surgery, the proportions of patients with an improved ADL score after cataract surgery, and the length of hospital stay were compared between the ≥90-year-old and 80- to 89-year-old groups using Fisher's exact probability test or the t-test. The proportion of patients with an improved ADL score after cataract surgery was compared between the matched pairs using a multivariable logistic regression model. The length of hospital stay was compared between the matched pairs using multiple linear regression fitted with generalized estimating equations. All demographic and clinical variables used in the univariate analysis were entered into the multiple regression analyses. Because ignoring the matching variables in matched-cohort studies can lead to bias [12], the matching variable (BI score at admission) was included as an explanatory variable. We set the level of statistical significance at $P < 0.05$ for a two-sided test. All statistical analyses were performed using Stata version 15 (StataCorp, College Station, TX, USA).

RESULTS

We identified 283,890 patients who underwent cataract surgery in both eyes during hospitalization. Their mean age was 74.3 years (standard deviation, 9.1 years), and 38.1% of the patients were men. Of the entire cohort, the numbers of patients aged ≥90 years and 80 to 89 years were 7,253 and 84,747, respectively. Pairwise matching created a final study cohort of 7,253 patients aged ≥90 years and 29,012 patients aged 80 to 89 years.

Table 1 shows the demographic and clinical characteristics of the unmatched and matched populations. Before matching, patients aged ≥90 years were more likely to be female and have a lower BI at admission than patients aged 80 to 89 years (85.5 vs. 94.4, respectively; $P < 0.001$). After pairwise matching, the BI at admission was balanced between the groups.

Table 2 shows the unadjusted comparisons of the BI at discharge, the proportion of patients with an improved ADL score after cataract surgery, and the length of hospital stay between the groups in the populations matched with BI at admission. The crude value of the BI at discharge after cataract surgery was significantly lower among patients aged ≥90 years than among those aged 80 to 89 years (86.4 vs. 87.4, respectively; $P < 0.001$). The

Table 1 Demographics and characteristics of patients aged ≥90 and 80 to 89 years undergoing cataract surgery in the unmatched and matched-pair populations

	Unmatched group			Matched group		
	80–89 years	≥90 years	*P* value	80–89 years	≥90 years	p value
Patients, n	84,747	7,253		29,012	7,253	
Age, years (SD)	83.4 (2.6)	91.9 (2.1)	<0.001	85.2 (2.6)	91.9 (2.1)	<0.001
Male sex (%)	29,876 (35.3)	2,047 (28.2)	<0.001	6,281 (21.6)	2,047 (28.2)	<0.001
CCI score (SD)	0.2 (0.6)	0.2 (0.6)	0.43	0.1 (0.4)	0.2 (0.6)	<0.001
BI score (SD) at admission	94.4 (15.7)	85.5 (23.6)	<0.001	85.5 (23.6)	85.5 (23.6)	1.00

SD, standard deviation; CCI , Charlson comorbidity index; BI, Barthel index.

Table 2 Unadjusted comparisons of postoperative outcomes following cataract surgery between patients aged ≥90 and 80 to 89 years

	80–89 years (n = 29,012)	≥90 years (n = 7,253)	p value
BI score (SD) at discharge	87.4 (22.0)	86.4 (23.1)	<0.001
Proportion of patients with ADL improvement, %	96.9	91.4	<0.001
Length of hospital stay in days, mean (SD)	8.2 (5.9)	7.5 (6.9)	<0.001

BI, Barthel index: SD, standard deviation: ADL, activities of daily living.

Table 3 Multivariable logistic regression analysis for ADL improvement and multiple linear regression analysis for length of hospital stay between patients aged ≥90 and 80 to 89 years

	ADL improvement			Length of hospital stay, days		
	Odds ratio*	95% Confidence interval	*P* value	Coefficient*	95% Confidence interval	p value
80–89 years	reference			reference		
≥90 years	0.33	0.29–0.36	<0.001	−0.84	−1.01–−0.67	<0.001

*adjusted for sex, Charlson comorbidity index and BI score at admission
ADL, activities of daily living: BI, Barthel index.

crude proportion of patients with an improved ADL score after cataract surgery was significantly lower among patients aged ≥90 years than among those aged 80 to 89 years (91.4% vs. 96.9%, respectively; $P < 0.001$). The length of hospital stay was significantly shorter in patients aged ≥90 years than in those aged 80 to 89 years (7.5 vs. 8.2 days, respectively; $P < 0.001$).

Table 3 shows the results of the multivariable logistic regression analysis for an improved ADL score after cataract surgery. A significantly lower proportion of patients aged ≥90 years than patients aged 80 to 89 years had an improved ADL score even after adjusting for other variables (odds ratio, 0.33; 95% confidence interval, 0.29–0.36; $P < 0.001$). In the multivariable linear regression analysis for the length of stay, patients aged ≥90 years had a significantly shorter length of stay than those aged 80 to 89 years (difference, −0.84; 95% confidence interval, −1.01 to −0.67; $P < 0.001$).

DISCUSSION

Using a large nationwide inpatient database in Japan, the present study compared ADL after cataract surgery between patients aged ≥90 years and those aged 80 to 89 years, with adjustment for patients' characteristics. The results demonstrated a substantial difference in patients' characteristics between the groups. The proportion of patients with an improved ADL score after cataract surgery between admission and discharge was significantly lower among patients aged ≥90 years than among those aged 80 to 89 years. The length of hospital stay was approximately 1 day shorter in patients aged ≥90 years than in those aged 80 to 89 years.

The findings of previous studies have generally supported the benefit of cataract surgery for the very old in terms of visual acuity, quality of life, and postoperative complications [3, 4, 13]. However, only two studies have focused on improvements in ADL. The goal of cataract surgery is not only to improve visual acuity but also to improve ADL. In a population-based prospective study using one question to assess improvement in ADL ("Has your eye surgery changed your ability to cope with activities of daily life?" Answers: for the worse, no change, slightly improved, or much improved), patients in three age cohorts were surveyed: <84 years (761 patients), 85 to 89 years (92 patients), and ≥90 years (37 patients). The proportion of patients with improved ADL 3 months after cataract surgery was 86% among patients aged <84 years, although it was only 72% among patients aged 85 to 89 years and 79% among patients ≥90 years ($P = 0.03$). The study indicated that there was a significant difference among these three age groups in terms of ADL improvement after cataract surgery without adjusting for other confounders such as the status of ADL before surgery [5]. Another retrospective study investigated improvement of the ADL score after cataract surgery in two age groups: 80 to 89 years (53 patients) and ≥90 years (30 patients). The crude analysis revealed that the mean postoperative ADL scores were significantly better than the preoperative scores in both groups; they were also better in the 80- to 89-year-old group than in the ≥90-year-old group [6]. However, to the best of our knowledge, no study has assessed improvement of ADL after cataract surgery for the very old in a large nationwide cohort of patients with cataracts.

The very old are generally likely to have more limitations in daily activities such as walking, reading, watching television, and household work than younger patients [6], and we therefore adjusted for the ADL score at admission and examined the difference in the outcomes between the two groups. The effectiveness of cataract surgery in the very old was still inferior to that in younger patients in terms of ADL improvement.

In the present study, 91.4% of patients aged ≥90 years and 96.9% of patients aged 80 to 89 years showed an improved ADL after cataract surgery. In accordance with this, a previous study showed that cataract surgery in the very old is beneficial in terms of ADL improvement [5]. However, after adjusting for other covariates, we found that a significantly lower proportion of patients aged ≥90 years had an improved ADL score. Previous studies have demonstrated that age is a significant determinant of the visual outcome [14, 15]. Ocular comorbidities such as age-related macular degeneration and glaucoma have been shown to be associated with poorer outcomes of cataract surgery [14, 16]. Lai et al. reported that age-related macular degeneration (15.9%), glaucoma (10.6%), and myopic degeneration (5.3%) were the three most common ocular comorbidities in a retrospective cohort study of 207 individuals aged ≥90 years [16]. Syam et al. found deterioration of postoperative visual acuity in 11% of patients with cataracts aged ≥96 years; this was attributed to underlying advanced age-related macular degeneration [17]. Surgical complications, such as posterior capsule rupture, zonular rupture, vitreous loss, and retained lens fragments, are associated with poorer post-operative visual acuity [18]. These complications are likely to occur when cataracts are in their advanced stage, such as brunescent, white, dense, and total cataracts, and can lead to worse postoperative visual acuity [19]. These visual outcomes may ultimately lead to a lower incidence of an improved ADL score in patients aged ≥90 years.

Cataracts are the leading cause of blindness worldwide [20], and the prevalence of cataracts increases dramatically with increasing age. Therefore, the dramatic shift toward the extremes of old age in developed countries is associated with increasingly more cataract surgeries in the very old population. In this situation, a proactive policy encouraging cataract surgery earlier when patients' conditions are less severe would be recommended. Cataract surgery is performed increasingly earlier in patients' lifetimes because of growing patient demands regarding visual quality and the improvements in surgical techniques [21]. Earlier surgical intervention is recommended to reduce the risk of capsular complications from more advanced cataracts [22, 23]. Furthermore, a simulation study by Mennemeyer et al. showed that early cataract surgery reduced the number of motor vehicle collisions, fatalities, and motor vehicle collision-related costs by about 21% and reduced total costs by 16% [24]. Moreover, Demir et al. identified non-attendance of surgeries as a serious issue for cataract services and found that proactive management of and communication with patients is as important as the changes to processes and technologies in the UK setting [25]. Cataract surgery is reportedly related to improvement of dementia and depression as well as prevention of falls [26, 27]. It is also clear that cost effectiveness is very high [28]. Taken together with our findings, these data indicate that performance of cataract surgery in an earlier stage of life, at least before the age of 90 years, may be preferable.

Notably, however, a longer life expectancy and earlier cataract surgery result in extended follow-up periods for posterior capsule opacification, which is the most common cause of loss of visual acuity after cataract surgery. Therefore, studies on posterior capsule opacification are becoming increasingly important [21].

In the present study, patients aged ≥90 years had an approximately 1-day shorter length of stay than those aged 80 to 89 years. Patients with dementia in acute-care hospitals are older, have longer hospital stays, and are at higher risk of delayed discharge and functional decline during admission [29], and older patients are reportedly more likely to have dementia after discharge [30]. These findings may be linked to the medical behavior of the attending physicians of patients aged ≥90 years to reduce the length of hospitalization as much as possible.

The main strength of this study was the use of a national inpatient database to involve a large number of patients. In fact, we collected demographic and clinical variables of more than 7,000 individuals. Our findings are thus generalizable to very old patients with cataracts.

However, our study had several limitations. First, we used the BI as an ADL variable; however, the BI score has ceiling effects [31], which makes the outcomes less sensitive to the benefits of intervention. Second, because we excluded patients who underwent simultaneous surgical procedures such as vitrectomy and glaucoma surgery, we could not examine other ocular conditions that may be comorbid with cataracts. Third, although the measured confounders were adjusted by the matched-pair cohort and multivariable regression analyses, the results may still be biased by unmeasured confounders such as the stage of cataracts, ocular complications, and history of other eye diseases. Finally, our results may not be generalizable to patients who undergo cataract surgeries in an outpatient department setting. According to a national database of health insurance claims and specific health checkups of Japan open data [32], 49.4% of the cataract surgeries performed in Japan in 2015 were inpatient surgeries. However, patients with cataracts complicated by many ocular comorbidities generally undergo operations in a hospital rather than in an outpatient clinic. The very old are more likely than younger people to have pseudoexfoliation [5], corneal opacities [33], and anterior chamber narrowing [34], all of which are ocular comorbidities associated with a high risk of cataract surgery. Therefore, cataract surgery for the very old is often performed in the hospital.

CONCLUSIONS

The proportion of very old patients with ADL improvement after cataract surgery was significantly lower than that of younger patients. The present results suggest that cataract surgery before the age of 90 years may be recommended.

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CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

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