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# A Study on the Improvement of Visual Acuity and Refractive Power According to General Characteristics of Cataract Surgery Patients

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## Abstract

For 299 patients who had undergone cataract surgeries we investigated the difference in visual acuity and refractive power before and after cataract surgery and the clinical change of the visual acuity and the refractive power according to age, gender, hospital visit time and specific medical history. We found the factors affecting preoperative and postoperative outcomes of the cataract patients in metropolitan hospitals by input, process, and outcome and analyzed medical characteristics and patient characteristics as the input variables. T-test and ANOVA have been performed for statistical analysis of functional status, and general status and the technical characteristic as the process variable and the outcome variable of diagnosis. Visual acuity improved significantly in patients who had undergone cataract surgery. However, the change in refractive power did not show a statistically significant difference but only a slight difference. The improvement of male patients was greater than that of female patients. The difference in age was more effective in patients under 50 years old and the effect of cataract surgery was relatively high in patients without the presence of specific medical history. Cataract surgery did not seem to help all of the patients, but it is more effective in improving visual acuity and refractive power. We conclude that simultaneous cataract surgery in both eyes is reasonable in order to have at least the better effect.

**Key words:** Cataract surgery, visual acuity, refractive power, statistical analysis, improving visual acuity and refractive power

## 1. Introduction

Today is a highly developed information age. The information age is characterized by the use of sight through the development of various print media and image media. This causes the sudden loss of visual acuity due to reading, close-range work, watching TV in harmful radio waves, and longtime computer work under artificial lighting. <sup>[1]</sup>

Especially, the tendency to appeal to refractive error due to decreased visual acuity of Korean adults is increasing. As an example Cho reported that in the measurements of the refractive error of eyes in the residents of Chonnam the ratios of emmetropia, myopia and hyperopia were 32%, 56.6%, and 11.4% respectively. <sup>[2]</sup> In addition, it is reported that the visual disturbance of the cataract patients is great due to lenticular opacity, but the improvement effect of visual acuity and refractive power by the cataract surgery is not constant

Cataract is the most common cause of blindness, and it is relatively easy to avoid blindness through surgery. Currently, it is reported that 17 million blindness in the world is caused from cataract. <sup>[16]</sup> Most of these are

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occurred in developing countries, with only 20% of patients receiving cataract surgery. [17] In the United States, cataract surgery is the most important cause of blindness. In order to reduce vision deterioration and dysfunction caused by cataracts, more than 1 million cataract surgeries are performed annually for Medicare recipients. It is reported that cataract surgery can arouse the difference in visual acuity and refractive effect according to patient conditions

In a study of the refractive power and visual acuity of the corrective lens, Park et al. measured the change of visual acuity in anthropomorphic myopia and reported that the change in visual acuity at the low visual acuity was significant only in the greater refractive change of the corrective lens but at high visual acuity the change was also significant even in the smaller refractive change of the corrective lens. [3]

In addition, Choi argued that errors can be reduced by maintaining records that focus on patient outcomes for proper judgment and evaluation of surgery in cataract surgery. [5] Lee also emphasized the importance of visual prognostic factors in the management of diabetic patients by recognizing the increased change in visual prognostic factors. Park et al. [6-8] suggested that visual acuity can be improved simply by correcting the glasses of patients with refractive amblyopia. [4]

This is also supported by the results of a foreign study, which advances at the domestic level and measures each element of the optical system to develop the cause of the refractive error or predict the stage. Smith et al. [9] also established an equation for the relationship with ametropia, pupil size and uncorrected visual acuity.

Although there have been various attempts to improve visual acuity and refractive power, there has been a growing interest in the prognosis of cataract surgery in cataract patients. However, despite the recent surge in cataract patients, the majority of patients and their families have increased their anxiety due to the lack of a clear difference in the prognosis and the change in visual acuity before and after surgery. Therefore, as the clinical contents of the preoperative and postoperative changes are analyzed in various aspects, the prognosis for the surgical changes will be helpful to the patient and the practitioner as well as the financial gain as the service is provided to the patient or the family. [10-15]

Therefore, in this study the differences in visual acuity and refractive power before and after surgery of 290 patients who underwent cataract surgeries were analyzed according to age, gender, hospital visit time and medical history to investigate the improvement and correlation of these factors.

## **2. Object and method**

### **1) Research subjects**

The subjects of this study were 300 patients who agreed to the purpose of this study among patients who underwent ultrasound emulsion aspiration and posterior capsule implantation due to cataract in the ophthalmology department of general hospitals in the metropolitan area from January 2016 to June 2017 And data of 290 persons excluding 10 persons who were not suitable for the survey were used for analysis.

### **2) Analysis data and items**

The analysis method for this study is for the patients who have undergone cataract surgery in the hospitals in the metropolitan area. The analysis method is divided into the input, process and outcome of the medical treatment that may affect the result of the treatment. The medical characteristics and the patient characteristics were analyzed as the input variables of the treatment. The technical characteristics as the process variables and the clinical results, the functional status, and general status as the outcome variables of the patients and the medical care were analyzed by T-test.

As a basic investigation for the patients who have undergone cataract surgery the differences in the postoperative visual acuity improvement, refractive power improvement, co-relation of visual acuity and refractive power, gender, age, hospital visit time and medical history were analyzed with preoperative ophthalmic medical history. ANOVA variance analysis was carried out for the improvement of visual acuity and refractivity, and Duncan analysis was used for post-test.

## **3. Results**

**1) General characteristics of patients with cataract surgery**

Cataract surgery patients were 104 men (35.9%) and 186 women (64.1%). The patient numbers according to onset age were 20 (6.9%) under the age of 50, 76 (26.2%) in the 60s and 70 (51.7%) in the 70s and 44 patients (15.2%) were in their 80s or older. The mean age was 71.7 years. 61 (21.0%) patients have specific illnesses and 229 (79.0%) does not have any specific illnesses, Also, 269 (92.76%) patients were unemployed in the occupational group of cataract surgery patients. The jobs of the patients were farmers 13 (4.49%), office workers 4 (1.38%), fisheries 3 (1.03%) and house wives 1 (0.34%). Hospital visit time is less than 1 month for 117 (40.3%), less than 2 months for 149(51.4%) and more than 2 months for 24(8.3%). The mean duration of visit was 38 days. Table 1 showed General characteristics of patients with cataract surgery.

**Table 1. General Characteristics of Cataract Surgery Patients**

|                          |                    | N   | %     |
|--------------------------|--------------------|-----|-------|
| Gender                   | Male               | 104 | 35.9  |
|                          | Female             | 186 | 64.1  |
| Age                      | younger than 50's  | 20  | 6.9   |
|                          | 60's               | 76  | 26.2  |
|                          | 70's               | 150 | 51.7  |
|                          | older than 80's    | 44  | 15.2  |
| Peculiar Medical History | Yes                | 61  | 21.0  |
|                          | No                 | 229 | 79.0  |
| Occupational Group       | Agriculture        | 13  | 4.49  |
|                          | Unemployed         | 269 | 92.76 |
|                          | Office Job         | 4   | 1.38  |
|                          | Fisheries          | 3   | 1.03  |
|                          | Housewives         | 1   | 0.34  |
| Hospital Visiting Period | 1 month or less    | 117 | 40.3  |
|                          | 2 months or less   | 149 | 51.4  |
|                          | more than 2 months | 24  | 8.3   |
| Total                    |                    | 290 | 100.0 |

**2) Changes in visual acuity and refractive power in patients with cataract surgery according to general characteristics**

**(1) Changes in visual acuity and refractive power according to gender**

To investigate the changes in visual acuity and refractive power after cataract surgery according to gender, a t-test was conducted for each group. The mean visual acuity for the male patients was  $0.29 \pm 0.18$  before cataract surgery and  $0.59 \pm 0.28$  after cataract surgery, which indicated a significant change ( $t = -12.153, p < .05$ ), and the mean refractive power was  $1.11 \pm 2.31$  before cataract surgery and  $-0.68 \pm 1.14$  after surgery,

which also indicated a significant improvement ( $t = -2.190, p < .05$ ).

On the other hand, in female patients with cataract surgery, mean visual acuity was significantly changed from  $0.27 \pm 0.17$  before cataract surgery to  $0.52 \pm 0.25$  after surgery ( $t = -14.037, p < .05$ ) and the mean refractive power was changed from  $-0.59 \pm 2.61$  before cataract surgery to  $-0.67 \pm 1.21$  after surgery, which did not indicate a meaningful change ( $t = 0.519, p < .05$ ). Table 2 shows changes in visual acuity and refractive power in cataract surgery patients according to general characteristics.

**Table 2. Change of Visual Acuity and Refractive Power According to Gender**

| Classification   | Surgery | Mean   | Standard Deviation | t        |
|------------------|---------|--------|--------------------|----------|
| Visual Acuity    | Male    | Before | .29                | -12.153* |
|                  |         | After  | .59                |          |
|                  | Female  | Before | .27                | -14.037* |
|                  |         | After  | .52                |          |
| Refractive Power | Male    | Before | -1.11              | -2.190*  |
|                  |         | After  | -.68               |          |
|                  | Female  | Before | -.59               | .519     |
|                  |         | After  | -.67               |          |

\* $p < .05$

## (2) Comparison of cataract surgery effect by gender

Independent sample t-test was performed to determine whether the difference in visual acuity and refractive power improvement of cataract surgery was affected by gender. The results showed that there was no statistically significant difference in the improvement of visual acuity between males and females ( $t = 1.601, p > .05$ ). In the degree of improvement of refractivity, the average improvement was 0.429 in males and 0.084 in females, which indicated a significant difference ( $t = 2.020, p < .05$ ) between the two groups as shown in Table 3.

**Table 3. Difference in the Effect of Surgery According to Gender**

| Classification   | Effect Mean | Standard Deviation | t      |
|------------------|-------------|--------------------|--------|
| Visual Acuity    | Male        | .304               | 1.601  |
|                  | Female      | .254               |        |
| Refractive Power | Male        | .429               | 2.020* |
|                  | Female      | .084               |        |

\* $p < .05$

These results show that the visual acuity improved to the same level for both men and women according to the cataract surgery, and the effect of improving the refractive power could be seen only in men. The standard

deviation of refractive power also showed a very large deviation from 2.3 to 2.6 before surgery, but the standard deviation after surgery was much more stable, from 1.1 to 1.2. These results suggest that cataract surgeries should not be used to improve the refractive power, but to investigate whether the cataract surgery has the effect of converging to a certain level.

**(3) Changes in visual acuity and refractive power according to age**

To determine the changes in visual acuity and refractive power after age-related cataract surgery, a corresponding sample t-test was performed. The average visual acuity of patients under 50 years of age increased from  $0.29 \pm 0.22$  to  $0.60 \pm 0.38$  after surgery ( $t = -4.246, p < .05$ ). For the patients of 60s it also increased significantly from  $0.29 \pm 0.18$  preoperatively to  $0.58 \pm 0.27$  postoperatively, with a statistically significant difference ( $t = 10.285, p < .05$ ). There was a statistically significant difference ( $t = -12.741, p < .05$ ) between the preoperative average of  $0.28 \pm 0.17$  and the postoperative average of  $0.54 \pm 0.24$  in the patients of 70s. For the patients of 80s it showed a significant difference from  $0.22 \pm 0.67$  to  $0.48 \pm 0.24$  with ( $t = -10.285, p < .05$ ).

On the other hand, in the case of refractive power for the patients under 50s, there was a significant difference between the preoperative mean of  $-1.68 \pm 2.12$  and  $-0.53 \pm 0.67$  after surgery ( $t = -2.51, p < .05$ ) but there was no significant difference for the patients over 60s ( $p > .05$ ).

In general, all patients in each age group showed a synergistic effect after cataract surgery. The refractive power was improved only in the 50s or younger group, but not in the 60s or older (Table 4).

**Table 4. Change of Visual Acuity and Refractive Power According to Age**

| Classification   |           | Surgery | Mean  | Standard Deviation | t        |
|------------------|-----------|---------|-------|--------------------|----------|
| Visual Acuity    | Under 50s | Before  | .29   | .217               | -4.245*  |
|                  |           | After   | .60   | .376               |          |
|                  | 60s       | Before  | .29   | .181               | -10.285* |
|                  |           | After   | .58   | .271               |          |
|                  | 70s       | Before  | .28   | .175               | -12.741* |
|                  |           | After   | .54   | .241               |          |
|                  | Over 80s  | Before  | .22   | .146               | -7.734*  |
|                  |           | After   | .48   | .238               |          |
| Refractive Power | Under 50s | Before  | -1.68 | 2.125              | 2.510*   |
|                  |           | After   | -.53  | .668               |          |
|                  | 60s       | Before  | -.60  | 2.349              | .108     |
|                  |           | After   | -.63  | .751               |          |
|                  | 70s       | Before  | -.73  | 2.803              | .389     |
|                  |           | After   | -.80  | 1.452              |          |
|                  | Over 80s  | Before  | -.83  | 1.864              | -1.545   |
|                  |           | After   | -.41  | .897               |          |

\*p<.05

**(4) Comparison of age-related effects of cataract surgery**

ANOVA was performed to determine the difference in visual acuity and refractive power between before and after cataract surgeries depending on age groups. Duncan 's post - test was used to compare groups. The results showed that there was no statistically significant difference in the improvement of visual acuity between the ages ( $F = 0.367$ ,  $p > .05$ ), and there was no significant difference in the degree of improvement of the refractive power between the ages ( $F = 2.359$ ,  $p .05$ ). However, as a result of the post test, the improvement of the visual acuity was observed in one group, while the degree of improvement of the refractive power was one group in the under 50s and the over 80s and another group in the 60s and 70s. And those over 80 years of age showed relatively higher improvement than those in their 60s and 70s.

**Table 5. Difference in the Effect of Surgery According to Age**

| Classification   | Age       | Effect Mean | Standard Deviation | F     | Duncan  |
|------------------|-----------|-------------|--------------------|-------|---------|
| Visual Acuity    | Under 50s | .307        | .316               | .367  | a,b,c,d |
|                  | 60s       | .289        | .243               |       |         |
|                  | 70s       | .260        | .246               |       |         |
|                  | Over 80s  | .266        | .220               |       |         |
| Refractive Power | Under 50s | .272        | .246               | 2.359 | b,c<a,d |
|                  | 60s       | 1.15        | 2.049              |       |         |
|                  | 70s       | -.027       | 2.234              |       |         |
|                  | Over 80s  | -.069       | 2.170              |       |         |

\* $p < .05$

Therefore, there was no difference in visual acuity improvement between cataract surgery according to the ages. The visual acuity in all ages increased about  $0.26 \sim 0.3$  after cataract surgeries and there was no difference in refractive power according to ages. In the case of refractive power, it converged to about  $-0.675 \pm 0.05$ , similar to the change according to gender. In the 50s or younger group, the effect of improving the refractive power was very large. In the 60s and 70s, the refractive power rather decreased slightly. over 80s the refractive power increased again by cataract surgery. Comparison of age-related effects of cataract surgery is shown in Table 5.

##### (5) Changes due to specific medical history

This study was designed to investigate the effect of cataract surgery on visual acuity and refractive power after cataract surgery depending on the presence or absence of specific history including corneal opacity, liver surgery, high myopia, glaucoma, diabetes mellitus, blood pressure, scaly syndrome, strabismus, kidney, liver, heart, left facial palsy, uveitis, T-test was used to determine the change in refractive power according to individual corresponding group samples. Patients with a specific medical history showed a statistically significant difference in mean visual acuity between  $0.26 \pm 0.15$  preoperatively and  $0.49 \pm 0.27$  postoperatively ( $t = -7.232$ ,  $p < .05$ ). Patients without a specific medical history showed a statistically significant difference between  $0.28 \pm 0.56$  preoperatively and  $0.56 \pm 0.26$  postoperatively ( $t = -17.157$ ,  $p < .05$ ) as well.

On the other hand, the mean refractive power of patients with a specific medical history was  $-0.94 \pm 0.29$  preoperatively and  $-0.68 \pm 1.68$  postoperatively ( $t = -0.998$ ,  $p > .05$ ). which was not significant and in the case of patients without any medical history it was  $-0.73 \pm 2.41$  preoperatively and  $-0.68 \pm 1.02$  postoperatively ( $t = -0.397$ ,  $p > .05$ ), which was not significant as well (Table 6).

**Table 6. Change of Visual Acuity and Refractive Power According to Specific Medical History**

| Classification   | Medical History | Surgery | Mean | Standard Deviation | t       |
|------------------|-----------------|---------|------|--------------------|---------|
| Visual Acuity    | Yes             | Before  | .26  | .150               | -7.232* |
|                  |                 | After   | .49  | .267               |         |
|                  | No              | Before  | .28  | .183               | 17.157* |
|                  |                 | After   | .56  | .258               |         |
| Refractive Power | Yes             | Before  | -.94 | 2.917              | -.998   |
|                  |                 | After   | -.68 | 1.684              |         |
|                  | No              | Before  | -.73 | 2.412              | -.397   |
|                  |                 | After   | -.68 | 1.016              |         |

\*p<.05

**(6) Comparison of surgical effect according to specific medical history**

We analyzed the difference in cataract surgery effectiveness according to the presence of specific medical history in cataract surgery patients. As a result of the analysis, there was a statistically significant difference in the surgical effect according to the specific history in the improvement of visual acuity ( $t = -2.048, p < .05$ ). In contrast, there was no difference in the degree of improvement in refractory power according to the presence of specific history ( $p < .05$ ) (Table 7).

**Table 7. Comparison of the Effect According to Specific Medical History**

|                                 | Medical History | Mean | Standard Deviation | t       |
|---------------------------------|-----------------|------|--------------------|---------|
| Improvement of Visual Acuity    | Yes             | .233 | .252               | -2.048* |
|                                 | No              | .282 | .243               |         |
| Improvement of Refractive Power | Yes             | .262 | 2.052              | .686    |
|                                 | No              | .057 | 2.170              |         |

\*p<.05

**4. Discussion and Conclusions**

The results of this study are summarized as follows: First, pre-post-cataract surgeries according to gender showed that average improvement of 0.304 in male patients and 0.254 in female patients were improved, It seemed that the improvement of male patients is higher than that of female patients. However, statistical analysis showed no significant difference. Therefore, the average improvement in visual acuity may be different according to gender, but it is not certain that gender differences in visual acuity improvement effect are considered when considering the difference in visual acuity and individual difference before surgery. Therefore, in order to recover the visual acuity of cataract patients, surgical treatment should be actively recommended. However, there is a significant difference in some gender, but there is a clear tendency of the improvement of visual acuity in high refractive power rather than in low refractive power as a whole. Hence,

the visual acuity improvement should be approached in various ways. This suggests that the improvement of visual acuity and refractive power is better in high refractive power than in low refractive power and the improvement of visual acuity is more effective than that of the correction lens proposed by Park<sup>[3]</sup> and Choi.<sup>[4]</sup>

Second, in the case of refractive power, the average preoperative refractive power was -1.11 in male cataract surgery patients, whereas the female preoperative value was -0.59, which indicates that the difference was large before cataract surgery. It was confirmed that the all values converged to -0.68. In addition, the standard deviation of refractive power showed a very large deviation of 2.3 ~ 2.6 before surgery, but the standard deviation after surgery was much more stable as 1.1 ~ 1.2 level. These results suggest that cataract surgeries should not be used to improve the refractive power, but to investigate whether the cataract surgery has the effect of converging a certain value.

Third, the visual acuity after surgery compared to before surgery improved in average by 0.307 in patients under 50 years, 0.289 in patients in their 60s, 0.26 in patients in their 70s, and 0.266 in patients over 80s. This means that cataract surgery is relatively effective in patients younger than 60 years or elderly patients older than 80 years. This is because the retinal status or other visual function is relatively better in patients younger than 60 years. However, it is not yet known whether visual acuity improvement and refractive power improvement effect of larger surgery in older patients aged 80 years or older is greater than that of 60 or 70 years old, suggesting that further study is needed.

Fourth, preoperative and postoperative visual acuity according to the presence of specific medical history it showed 0.282 in visual acuity improvement in patients without specific history and 0.233 in visual acuity improvement in patients with specific history ( $t = 2.0480$ ,  $p < .05$ ), which was statistically significant ( $p < .05$ ). Overall, these results support that cataract surgery is effective for the visual acuity and refractive power of the patients, which is also supported by previous studies.<sup>[16-19]</sup>

The percentage of cataract patients over the age of 40 years old was 42.1% in Korea and the prevalence rate increased gradually with patients age such as the age of 65 years, 37.9%, 32.0% and 45.4%, respectively. This means that early cataract surgery more effective for the cataract patients.<sup>[20]</sup> However, since many patients still have poor patient conditions to undergo surgery, the prognosis of surgery is not as satisfactory to all people as expected.<sup>[21]</sup> In particular, by finding out factors that cause cataract include the function to protect the lens from ultraviolet and oxidative stresses known to date except for age, the deficiency of vitamins and the like, exposure to radiation, gender, education and socioeconomic level, concomitant diseases such as race, hypertension and diabetes, Glaucoma, severe dehydration, nearsightedness, body mass index (BMI), drinking and smoking it is necessary to find out the relationship that these may have with cataract surgery effect.<sup>[22]</sup>

In particular, the risk of cortical cataracts in women is 1.7 times higher and such high risk in women was reported in other studies. Therefore, it is necessary to study the reason for that.

In recent years, according to health insurance statistics released by the Health Insurance Review and Assessment Service,<sup>[23]</sup> the number of patients hospitalized for the treatment of cataracts in the 60 ~ 70 age group has been increasing, The more frequently the frequency increases. Therefore, aggressive cataract surgery is recommended in consideration of the prolongation of life expectancy and the recent trend of cataract patients. Yoon et al, reported that cataract causes a decrease in visual acuity due to the presence of opacity on the lens area. In this case a close area that is temporarily invisible may be well visible, or overlapping objects appears when viewed with one eye.<sup>[24]</sup> Therefore, preventive education should be important for not leaving it as an aging cataract due to aging because it can be caused by any eye injury or strong ultraviolet rays.

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