

# Proportion of Glaucoma Types and Surgeries Among Young, Pre-Old, Old, and Oldest-Old Age Groups or Different Sex Groups

Masaki Tanito<sup>1</sup>, Yotaro Matsuoka<sup>2</sup>

<sup>1</sup>Department of Ophthalmology, Shimane University Faculty of Medicine, Izumo, Shimane, Japan; <sup>2</sup>Division of Ophthalmology, Matsue Red Cross Hospital, Matsue, Shimane, Japan

Correspondence: Masaki Tanito, Department of Ophthalmology, Shimane University Faculty of Medicine, 89-1 Enya-cho, Izumo, Shimane, 693-8501, Japan, Tel +81-853-20-2284, Fax +81-853-20-2278, Email mtanito@med.shimane-u.ac.jp

**Background:** We report the real-world distribution of glaucoma types and glaucoma surgeries in each age or sex group in our department.

**Methods:** The department database of Matsue Red Cross Hospital, a tertiary care hospital, for eyes surgically treated to manage glaucoma between April 2014 and March 2018 was searched. Patient age, sex, disease type, and surgical procedure were collected from the database. The age was stratified by  $\leq 64$  years (young), 65–74 years (pre-old), 75–89 years (old), and  $\geq 90$  years (oldest-old or super-old).

**Results:** In the database, 2036 consecutive surgeries ( $70.3 \pm 14.4$  years; 1015 males) were identified. Among all subjects, primary open-angle glaucoma (POAG) (42.7%) was the most frequent identifiable glaucoma type followed by primary angle-closure disease (PACD) (18.8%) and exfoliation glaucoma (17.9%). The glaucoma types differed significantly among the age groups ( $P < 0.0001$ ); POAG was the most frequent type of glaucoma in young and pre-old groups, while PACD and exfoliation glaucoma were the most frequent glaucoma types in the oldest-old group. Among all subjects, trabeculotomy or other goniotomy/gonio-bypass surgery (41.7%) was the most frequent glaucoma surgery followed by long-tube shunt (22.1%) and trabeculectomy (16.2%). The glaucoma surgeries performed differed significantly among the age groups ( $P < 0.0001$ ). The frequency of trabeculectomy was the highest in the young group (27.8%), trabeculotomy was the highest in the pre-old (42.6%) and old (46.6%) groups, and long tube shunt (41.3%) and cataract extraction + goniosynechialysis (32.6%) were the highest in the oldest-old group. The glaucoma type ( $P < 0.0001$ ) and surgeries performed ( $P < 0.0001$ ) differed significantly between sex groups; the rates of PACD and cataract extraction + goniosynechialysis were remarkably higher in female than male group.

**Conclusion:** The types of glaucoma and required glaucoma surgeries differ among the different age groups and sexes. Primary angle-closure disease and exfoliation glaucoma are the major glaucoma types in the old and oldest-old age groups.

**Keywords:** primary open-angle glaucoma, POAG, primary angle-closure disease, PACD, exfoliation glaucoma, trabeculotomy, trabeculectomy, minimally invasive glaucoma surgery, MIGS, cataract extraction

## Introduction

In a previous Japanese population-based study, primary open-angle glaucoma (POAG) was the most frequent type of glaucoma (78% of cases); the frequencies of other types, ie, primary angle-closure glaucoma (PACG), exfoliation glaucoma, and other secondary glaucomas, comprised 12%, 4%, and 6%, respectively.<sup>1</sup> The proportions of the glaucoma types may differ between population- and hospital-based studies since the level of intraocular pressure (IOP) and disease severity differ among the various types. In addition, the ages of the patients should affect the disease type and surgeries chosen,<sup>2</sup> although such an information is difficult to access. We report the real-world distribution of glaucoma types and glaucoma surgeries in each age group or sex group in our department.

## Subjects and Methods

This study adhered to the tenets of the Declaration of Helsinki, and the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan. The Ethics Committee of Matsue Red Cross Hospital (IRB No. 458) reviewed and approved the study protocol, which did not require that each patient provides written informed consent; instead, the protocol was posted at the study institution to notify participants about the study. We searched the department database of Matsue Red Cross Hospital, a tertiary care hospital, for eyes surgically treated to manage glaucoma by one surgeon (MT) between April 2014 and March 2018. Full survey data are available in the [Supplementary file](#). Patient age, sex, disease type, and surgical procedure were collected from the database. The age was stratified based on the proposal of the Joint Committee of the Japan Gerontological Society and the Japan Geriatrics Society, ie,  $\leq 64$  years (young), 65–74 years (pre-old), 75–89 years (old), and  $\geq 90$  years (oldest-old or super-old).<sup>3</sup>

## Results

We identified 2036 consecutive surgeries in the database (mean patient age  $\pm$  standard deviation, 70.3  $\pm$  14.4 years; range, 0–97 years; 1015 males and 1021 females). Among all subjects who underwent surgeries, POAG (42.7%) was the most frequent identifiable glaucoma type followed by primary angle-closure disease (PACD) (18.8%) and exfoliation glaucoma (17.9%) (Table 1). The glaucoma types differed significantly among the age groups ( $P < 0.0001$ , chi-square test); POAG was the most frequent type of glaucoma in young and pre-old groups, while the frequencies of POAG, PACD, and exfoliation glaucoma were similar in the old group, and PACD and exfoliation glaucoma were the most frequent glaucoma types in the oldest-old group (Table 1).

Among all subjects, trabeculotomy or other goniotomy/gonio-bypass surgery (41.7%) was the most frequent glaucoma surgery performed in our hospital followed by long-tube shunt (Ahmed Glaucoma Valve or Baerveldt Glaucoma Implant) (22.1%) and trabeculectomy (including an ExPRESS shunt) (16.2%) (Table 1). The glaucoma surgeries performed differed significantly among the age groups ( $P < 0.0001$ , chi-square test). The frequency of trabeculectomy was the highest in the young group (27.8%), trabeculotomy was the highest in the pre-old (42.6%) and old (46.6%) groups, and long tube shunt (41.3%) and cataract extraction + goniosynechialysis (32.6%) were the highest in the oldest-old group (Table 1).

The mean patient age was older in female (71.5  $\pm$  15.3) than male (69.2  $\pm$  13.3) in our dataset ( $P < 0.0001$ ) (Table 2). The distributions of glaucoma types were significantly different between male and female ( $P < 0.0001$ ). In male, POAG (46.8%) was the most frequent glaucoma type followed by secondary glaucomas other than exfoliation glaucoma (22.2%) and exfoliation glaucoma (19.7%) (Table 2). In female, POAG (38.6%) was the most frequent glaucoma type followed by PACD (28.3%) and exfoliation glaucoma (16.2%) (Table 2). The distributions of glaucoma surgeries were significantly different between male and female ( $P < 0.0001$ ). In both sex groups, trabeculotomy or other goniotomy/gonio-bypass surgery (38.9% in male and 44.6% in female) was the most frequent glaucoma surgery performed in our hospital; this was followed by long-tube shunt (26.3%) and trabeculectomy (19.7%) (Table 2) in male, while by cataract extraction + goniosynechialysis (18.5%) and long-tube shunt (17.8%) in female.

## Discussion

The current proportions of the glaucoma types in this population-based survey differed markedly from previous studies,<sup>1,4</sup> ie, the frequency of POAG was much lower, and those of PACD and exfoliation glaucoma were higher. PACD was associated with a higher risk of visual loss than POAG;<sup>5</sup> and deposition of exfoliation material in the eye was related to high IOP and advanced glaucomatous tissue damage.<sup>6</sup> Generally, more advanced cases tended to require glaucoma surgery. Thus, the difference in disease severity among the glaucoma types likely explains the discrepancy between this and previous population studies. Since the distributions of glaucoma types were affected by age, the difference in age is another explanation. Deposition of exfoliation material is easily overlooked; thus, underestimation of exfoliation glaucoma can be another reason for its low frequency in previous population-based studies.

Recent novel glaucoma surgeries (MIGS) that are minimally invasive, micro-incisional, and a middle indication, ie, a treatment indicated after medication and before filtration surgery, have been reported, and are being performed more

**Table 1** Types of Glaucoma and Glaucoma Surgeries by Different Age Groups

Age Group	≤64 Years (Young, n = 565)	65–74 Years (Pre-Old, n = 568)	75–89 Years (Old, n = 857)	≥90 years (Oldest-Old, n = 46)	All (n = 2036)
Age					
Mean±SD	52.6±13.5	69.8±2.9	81.2±3.9	91.8±1.9	70.3±14.4
Sex, n(%)					
Male	329 (58.2)	310 (54.6)	363 (42.4)	13 (71.7)	1015 (49.9)
Female	236 (41.8)	258 (45.4)	494 (57.6)	33 (28.3)	1021 (50.1)
Glaucoma type, n (%)					
Developmental	43 (7.6)	3 (0.5)	1 (0.1)	0 (0)	47 (2.3)
POAG	288 (51.0)	277 (48.8)	295 (34.4)	9 (19.6)	869 (42.7)
PACD	44 (7.8)	84 (14.8)	237 (27.7)	17 (37.0)	382 (18.8)
Exfoliation glaucoma	36 (6.4)	95 (16.7)	219 (25.6)	15 (32.6)	365 (17.9)
Secondary glaucomas other than exfoliation glaucoma	154 (27.3)	109 (19.2)	105 (12.3)	5 (10.9)	373 (18.3)
Surgical procedure, n (%)					
Trabeculectomy/ExPRESS shunt	157 (27.8)	111 (19.5)	60 (7.0)	2 (4.3)	330 (16.2)
Trabeculotomy/gonio-bypass surgery	200 (35.4)	242 (42.6)	399 (46.6)	9 (19.6)	850 (41.7)
Long tube shunt	119 (21.1)	114 (20.1)	197 (23.0)	19 (41.3)	449 (22.1)
Cataract Extraction + goniosynechialysis	39 (6.9)	61 (10.7)	142 (16.6)	15 (32.6)	257 (12.6)
Other	50 (8.9)	40 (7.0)	59 (6.9)	1 (2.2)	150 (7.4)

**Notes:** The sex ( $P < 0.0001$ ), types of glaucoma ( $P < 0.0001$ ) and glaucoma surgeries ( $P < 0.0001$ ) differ significantly among the four age groups calculated by the chi-square test.

**Abbreviations:** SD, standard deviation; POAG, primary open angle glaucoma; PACD, primary angle closure disease.

**Table 2** Types of Glaucoma and Glaucoma Surgeries by Sex

Sex	Male	Female
Age		
Mean $\pm$ SD	69.2 $\pm$ 13.3	71.5 $\pm$ 15.3
Glaucoma type, n (%)		
Developmental	22 (2.2)	25 (2.5)
POAG	475 (46.8)	394 (38.6)
PACD	93 (9.2)	289 (28.3)
Exfoliation glaucoma	200 (19.7)	165 (16.2)
Secondary glaucomas other than exfoliation glaucoma	225 (22.2)	148 (14.5)
Surgical procedure, n (%)		
Trabeculectomy/ExPRESS shunt	200 (19.7)	130 (12.7)
Trabeculotomy/gonio-bypass surgery	395 (38.9)	455 (44.6)
Long tube shunt	267 (26.3)	182 (17.8)
Cataract Extraction + goniosynechialysis	68 (6.7)	189 (18.5)
Other	85 (8.4)	65 (6.4)

**Notes:** The mean age is significantly older in female than male ( $P < 0.0001$ ) by the unpaired *t*-test. The types of glaucoma ( $P < 0.0001$ ) and glaucoma surgeries ( $P < 0.0001$ ) differ significantly between male and female by the chi-square test.

**Abbreviations:** SD, standard deviation; POAG, primary open angle glaucoma; PACD, primary angle closure disease.

frequently. In this study, MIGS included the iStent, Kahook Dual Blade, Tanito Microhook Trabeculotomy, and gonioscopy-assisted transluminal trabeculotomy.<sup>7</sup> Compared to MIGS, trabeculectomy requires more frequent post-operative procedures, such as laser suture lysis and needling and may be associated with bleb-related complications.<sup>8</sup> Older age and simultaneous cataract surgery might enhance IOP reduction with trabeculotomy<sup>9</sup> or at least not interfere with the IOP reduction with MIGS.<sup>10</sup> In addition, it may be difficult for elderly subjects to travel to hospitals frequently. These arguments may explain why trabeculotomy<sup>11</sup> tends to be the surgery of choice for elderly subjects in our hospital. On the other hand, trabeculectomy/ExPRESS shunt was tended to be chosen for the youngest age group (ie,  $\leq 64$  years), because younger patients require lower target IOP than older patients because of their longer life expectancy, despite the general concerns for stronger scar formation in younger than older patients. Age and glaucoma types differed between both sexes; the most remarkable difference was the much higher rate of the PACD in women than men; these correspond well with the previous reports that the older age and female gender were risk factors for PACD.<sup>12,13</sup> Difference in glaucoma types also explains well with the higher rate of patients who were treated with cataract extraction + goniosynechialysis in female group.

Given that glaucoma surgeries aggregated in this study were performed by one surgeon; the selection bias derived from the single surgeon's preference of surgical procedures needs to be considered when interpreting the results of this study. We found age-dependent differences in the proportions of glaucoma types and the types of glaucoma procedures performed among the subjects who required glaucoma surgery. The information among the oldest-old subjects is especially unique in the literature. Japan currently has the highest aging rate in the world and reached a record high of 28.7% in 2020 (<https://www.stat.go.jp/data/topics/topi1261.html>). Since pseudoexfoliation and PACD are related to aging,<sup>14</sup> we expect that the importance of these glaucoma types will increase in the future in areas of the world where individuals will live to an advanced age.

## Data Sharing Statement

The full dataset for this survey is available as [Supplementary file](#).

## Ethics Approval and Consent to Participate

The institutional review board of Matsue Red Cross Hospital approved the study, which did not require that each patient provides written informed consent; instead, the protocol was posted at the study institution to notify participants about the study.

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## Disclosure

The authors report no conflicts of interest in this work.

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