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Dallas Glaucoma Registry: Preliminary Results

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Abstract

Background: Although glaucoma is a leading cause of blindness worldwide, yet there are no large databases where risk factors, current management options and outcomes may be evaluated. With this concept in mind, Dallas Glaucoma Registry was established to focus on an ethnically mixed North Texas population.

Methods: This is a retrospective, chart review of 2,484 patients (4,839 eyes) with glaucoma from three clinics. Data collected included: age, race, gender, intraocular pressure, visual acuity, central corneal thickness, cup-to-disk ratio, extent of visual field damage, glaucoma diagnoses, medical and surgical therapies.

Results: The most prevalent glaucoma was primary open angle glaucoma accounting for 44.4% of patients, followed by glaucoma suspect (39.5%), secondary glaucoma (7.2%), angle closure glaucoma (6.8%), normal tension glaucoma (1.7%), and childhood glaucoma (0.5%). The mean (SD) age was 68.7 (13.8) and 41.3% were non Hispanic white, 37.0% were black, 10.4% were Hispanic and 11.3% were of other ethnic origin. Hispanic representation in glaucoma did not match their numbers in general population of North Texas.

Conclusion: Large numbers of patients in the ongoing Dallas Glaucoma Registry do provide adequate data to better understand risk factors, early detection, improved screening targets, treatment options, outcomes and future studies.

Introduction

Glaucoma is a multifactorial disease and is the second leading global cause of vision loss [1]. With an aging population, glaucoma related problems are estimated to expand [2]. Despite its impact, epidemiologic data on glaucoma are limited and outcomes are poor [3]. In order to study the disease in detail, there is a need for a large, ethnically diverse population consisting of all age groups.

With this in mind, the Dallas Glaucoma Registry (DGR) was established in 2005 as a mechanism to collect epidemiologic and management information on patients seen at University of Texas Southwestern Medical Center and its affiliated clinics. The 2006-2008 American Community Survey [4] estimated Dallas' racial makeup to be 56.6% Caucasian (74.3% nationally), 23.2% African American (12.3% nationally), and 20.2% other race (13.4% nationally). Forty-three percent of the Dallas population is described as Hispanic or Latino (of any race) compared to 15.1% nationally. This diversity made Dallas an ideal place to set up the registry.

Methods

Study design and setting

We utilized cross-sectional, medical record review method in obtaining up-to-date patient data between July 2005-July 2007 from the three eye clinics associated with the UT Southwestern Medical Center in Dallas: Aston Clinic (Clinic A, a university based clinic), Parkland Memorial Hospital (Clinic B, a County hospital), and the Dallas Veterans Affairs Hospital (Clinic C). This gives us a unique opportunity to study patients of various ethnicities and socioeconomic backgrounds.

Appropriate Institutional Review Board (IRB) approvals were obtained and the rules and regulations pertaining to patient health data privacy, The Health Insurance Portability and Accountability Act of 1996 (HIPAA), were strictly implemented.

Selection of patients

Enrolled patients had a diagnosis of primary glaucoma, secondary glaucoma, or glaucoma suspicion in one or both eyes and had at least one reliable Humphrey visual field (HVF) test along with adequate demographic and clinical information (see Data Collection) at the time of enrollment. Exclusion criteria were: patients with tertiary diagnosis of glaucoma, patients who were unable to perform HVF, and those with less than three months of follow up.

Data collection

The data collected included: age, race, gender, glaucoma diagnoses, most recent best corrected visual acuity, central corneal thickness (CCT), Intra ocular pressure (IOP), cup-to-disk ratio (CDR), extent

of visual field damage, current glaucoma medications, and types of glaucoma surgery including laser procedures.

Severity of glaucoma was noted from HVF results. Mild, moderate, and severe glaucoma were based on modified Hodapp-Parrish-Anderson classification [5]. Broadly, those with mean deviation (MD) less than -6 dB were considered as having mild glaucoma, patients with MD between > -6 dB and -12 dB were classified as suffering from moderate glaucoma, and a MD > -12 dB were classified under severe glaucoma. VF defects were thus quantified from 0-3 (normal to severe).

Glaucoma suspects were based upon one or more of the following criteria: IOP of > 21mm Hg, suspicious optic disk based on increased or asymmetric CDR or disc hemorrhage, family history of glaucoma, and/or suspicious visual field. Glaucoma procedures and surgeries were further classified among selective or argon laser trabeculoplasty (SLT or ALT, respectively), laser peripheral iridectomy (LPI), trabeculectomy, trabeculotomy, shunt implantation, and cyclodestruction. Glaucoma medications were categorized as: prostaglandin analogues, beta blockers, alpha agonists, topical carbonic anhydrase inhibitors (CAI), systemic CAI, sympathomimetics, and miotics. Combined drug treatments were classified as the individual drug class.

Data analysis

The prevalence of glaucoma and clinical measurements among various races, age groups, and genders were summarized using descriptive statistics. Percentages were used to describe categorical variables. Means and standard deviations (SD) were utilized in characterizing quantitative variables such as IOP and VF defects. Mixed effects linear models were used with patient modeled as a random effect to evaluate differences among various sample groups and adjust for the correlation between eyes. Computer analysis was performed with Microsoft Access and Excel (Microsoft Corporation, Redmond, WA), Sigma Plot 10 (Systat Software Inc.), and SAS v9.2 (SAS Institute, Cary, NC).

Results

A total of 2,484 (4839 eyes) patients with glaucoma, were enrolled in the DGR from July 2005 to July 2007. Table 1 summarizes the demographics, ocular measurements, and treatment approach for each glaucoma type.

Primary open angle glaucoma

POAG (44%) was the most common diagnosis. The average age

Variable		Total	POAG	NTG	Suspect	Secondary	ACG	Childhood
Number (% of total eyes)		2484 (4839 eyes)	2148 (44.4)	81 (1.7)	1912 (39.5)	347 (7.2)	328 (6.8)	23 (0.5)
Age (SD)		68.7 (13.8)	73.3 (12.5)	67.9 (12.0)	64.8 (12.7)	63.6 (17.1)	70.9 (11.6)	31.0 (10.2)
Gender (%)	Male	1509 (60.7)	1288 (60.0)	36 (44.4)	1197 (62.6)	208 (59.9)	177 (54.0)	9 (39.1)
	Female	975 (39.3)	860 (40.0)	45 (55.6)	715 (37.4)	139 (40.1)	151 (46.0)	14 (60.9)
Race (%)	Caucasian	1027 (41.3)	916 (42.6)	43 (53.1)	731 (38.2)	140 (40.4)	151 (46.0)	11 (47.8)
	Black	918 (37.0)	907 (42.2)	16 (19.8)	663 (34.7)	119 (34.3)	88 (26.8)	10 (43.5)
	Hispanic	259 (10.4)	135 (6.3)	14 (17.3)	256 (13.4)	49 (14.1)	41 (12.5)	0 (0.0)
	Other/NA	280 (11.3)	190 (8.9)	8 (9.9)	262 (13.7)	39 (11.2)	48 (14.6)	2 (8.7)
CDR (SD)		0.65 (0.22)	0.74 (0.20)	0.73 (0.19)	0.55 (0.18)	0.69 (0.24)	0.59 (0.25)	0.74 (0.29)
IOP (SD)		16.4 (5.4)	15.9 (5.4)	13.6 (3.4)	16.7 (4.0)	17.2 (9.6)	16.9 (6.2)	16.8 (9.0)
VA*		0.6 (20/80)	0.7 (20/100)	0.4 (20/50)	0.2 (20/30)	1.5 (20/100 - CF)	0.8 (20/125)	1.5 (20/100 - CF)
HVF (SD)		1.3 (1.2)	1.8 (1.1)	1.7 (1.0)	0.5 (0.8)	2.0 (1.1)	1.4 (1.2)	1.7 (1.3)
CCT (SD)		543.5 (43.0)	537.5 (40.9)	536.7 (38.1)	546.6 (37.7)	563.3 (73.2)	548.9 (44.4)	583.6 (47.2)
Medications	Total (%)	3395 (70.2)	2061 (95.9)	76 (93.8)	701 (36.7)	297 (85.6)	247 (75.3)	13 (56.5)
	Mean # (SD)	1.5 (1.3)	2.2 (1.2)	1.5 (1.0)	0.5 (0.8)	2.1 (1.4)	1.6 (1.3)	1.2 (1.3)
No Medications (%)		1444 (29.8)	87 (4.1)	5 (6.2)	1211 (63.3)	50 (14.4)	81 (24.7)	10 (43.5)
Surgery	Total (%)	1446 (29.9)	895 (41.7)	16 (19.8)	61 (3.2)	185 (53.3)	277 (84.5)	12 (52.2)
	ALT/SLT (%)	697 (14.4)	595 (27.8)	12 (14.8)	28 (1.5)	24 (6.9)	38 (11.6)	0 (0.0)
	LPI (%)	416 (8.6)	90 (4.2)	0 (0.0)	30 (1.6)	39 (11.2)	256 (78.0)	1 (4.3)
	TAE (%)	399 (8.3)	296 (13.8)	5 (6.2)	0 (0.0)	56 (16.1)	36 (11.0)	6 (26.1)
	Shunt (%)	202 (4.2)	83 (3.9)	1 (1.2)	2 (0.1)	95 (27.4)	16 (4.9)	5 (21.7)
	Cyclodestruction (%)	35 (0.7)	11 (0.5)	0 (0.0)	2 (0.1)	21 (6.1)	1 (0.3)	0 (0.0)
	Other	27 (0.6)	14 (0.7)	0 (0.0)	0 (0.0)	2 (0.6)	11 (3.4)	0 (0.0)
No Surgery (%)		3393 (70.1)	1253 (58.3)	65 (80.2)	1851 (96.8)	162 (46.7)	51 (15.5)	11 (47.8)

*LogMAR scale
**CDR- cup to disk ratio; IOP- intraocular pressure in mmHg; VA- visual acuity; HVF- Humphrey visual field; CCT- central corneal thickness; ALT- argon laser trabeculoplasty; SLT-selective laser trabeculoplasty; LPI- laser peripheral iridotomy; TAE- trabeculotomy ab externo

Table 1: Patient characteristics in glaucoma on a per eye basis (Total Number, Total Gender, and Total Race on a per patient basis).

	Caucasian (n = 916 eyes)	Black (n = 907 eyes)	Hispanic (n = 135 eyes)	Other/NA (n = 190 eyes)
Age (SD)	76.8 (11.1)	70.4 (13.0)	69.8 (12.8)	72.0 (11.9)
IOP in mmHg (SD)	15.8 (5.1)	16.2 (5.7)	15.4 (6.0)	15.7 (4.5)
CDR (SD)	0.70 (0.21)	0.78 (0.18)	0.76 (0.18)	0.77 (0.19)
CCT in n (SD)	548.7 (39.8)	527.9 (40.7)	533.9 (35.7)	531.0 (38.2)
HVF (SD)	1.6 (1.1)	2.1 (1.0)	2.0 (1.2)	1.6 (1.0)
# OF Medications	2.0 (1.1)	2.4 (1.2)	2.2 (1.4)	2.0 (1.0)

IOP= Intraocular pressure, CDR= cup-to-disk ratio, CCT= central corneal thickness, HVF= Humphrey Visual Field

Table 2: Characteristics of POAG Eyes among Various Races.

of 73.3 years was older than any other group and these patients had thinnest cornea ($p < 0.001$). Only 6.3% of POAG eyes belonged to Hispanics.

The majority (58%) of patients with POAG did not require any type of glaucoma surgery. For those with a surgical history, ALT and/ or SLT were performed in about two-thirds. Patients with history of any glaucoma procedure had an average IOP of 1.0 mmHg less than those without any procedures (16.3 +/- 5.3 vs. 15.3 +/- 5.2 mmHg, $p < 0.001$).Ninety-six percent were on glaucoma drops, and on the average required 2.2 medication drops.

Non Hispanic white were older, had smaller CDR, thicker CCT, and less severe HVF defects relative to other ethnicities ($p < 0.001$). There was no statistical significance between the most recent IOP measurements of non- Hispanic white, black, and Hispanic patients. When comparing black and Hispanic eyes, there was no statistical significance in their age, CDR, CCT, or HVF severity.

Normal Tension Glaucoma (NTG)

NTG as a group accounted for less than 2% of glaucoma cases and there was female (56%) preponderance. But among the Hispanics, males (64%) outnumbered females. Hispanics were also overrepresented (17%) in NTG group compared to their presence in DGR (10%). These patients also had the thinnest CCT (536.7μ). Medical management was the mainstay (94%) with only 20% undergoing surgery.

Glaucoma suspects

Glaucoma suspect (39.5%) was the second most common diagnosis. This group had the lowest CDR (0.55) and the best visual acuity (20/30) among all glaucoma types. Predictably, 97% of suspect eyes required no surgery, and 63% were on no glaucoma drops. More specifically, 62% of the suspect eyes were merely being followed.

Secondary glaucoma

Secondary glaucoma (7.2%) was the third most common diagnosis. These patients had the highest IOP at 17.2 mmHg and the most severe visual field defects. Just over half (53%) underwent some form of glaucoma surgery, the most common being shunt implantation (27%).

Angle Closure Glaucoma (ACG)

ACG accounted for nearly 7% of eyes in the DGR, with an average age of 70.9 years. The disease appears less likely to affect males and blacks. The data revealed a relatively low CDR of 0.59 and a reasonably well controlled IOP of 16.9 mmHg. ACG is overwhelmingly a surgical disease with 85% of eyes undergoing glaucoma surgery of some kind, specifically LPI (78%).

Childhood glaucoma

This group had the smallest sample size but majority were females (61%). These eyes showed large CDR (0.74), poor visual acuity (20/200 to counting fingers), and thickest CCT (583.6μ). Forty four percent were well controlled without medications and over half had required surgery.

Discussion

The DGR provides a snapshot of glaucoma epidemiologic data in the ethnically diverse population of North Texas. This ongoing study contains information on various types of glaucoma, enabling us to 1) evaluate our results of a particular diagnosis with those of the previous studies and 2) to compare and contrast data within the DGR on basis of diagnosis, race, gender, medications and type of surgeries.

Hispanics were least represented in DGR (10.4%) and also displayed the greatest disparity in terms of where they were seen. For example, they accounted for 22.2% of the total patients enrolled in Clinic B, compared to only 7.3% in Clinic A. Fifty-three percent of all Hispanic eyes were diagnosed in Clinic B.

Primary Open Angle Glaucoma

The European Glaucoma Prevention Study Group [6] identified older age, vertical CDR asymmetry, and thin CCT as major risk factors for the development of POAG. In the DGR we found that POAG patient population was the oldest (73.2 years), had the largest CDR (0.74) with thin CCT (537.5μ).

Fifty percent of patients with POAG were African American, highest among all races, agreeing with prior results [7]. As for Hispanic patients, their average age, CDR, severity of visual field defect, and CCT values lie in between the spectrums of whites and blacks, though the differences were not statistically significant from the latter. The CCT relationship between whites and Hispanics in the DGR are in contrast to those reported by Aghaian et al. [8], who found no statistical significance between CCT values of white and Hispanic patients, but a lower CCT among blacks compared to whites, Hispanics, and Asians ($p = 0.03$).

At least one study [9] in the past suggested that rate of open-angle glaucoma in Hispanics did not differ significantly from whites after controlling for age and gender, while Proyecto VER study showed that prevalence is greater than in whites but less than in blacks, particularly among the older segment of the population [10]. The Los Angeles Latino Eye Study [11] demonstrated an even higher prevalence and that the majority of the subjects identified with glaucoma were previously undiagnosed. Considering these reports and the fact that only 6.3% of our Hispanic patients were seen in Clinic A, Hispanic patients in North Texas are clearly less likely to be seen in a private setting compared to Non–Hispanic white patients.

Glaucoma suspects

Independent studies [12,13] have identified five important parameters for POAG development: increased IOP, increased age, optic disk abnormality, family history of glaucoma, systemic vascular diseases and thin CCT. Since our study focused on ocular features, we found that suspicious optic disk and elevated IOP are the first and second most common risk factors, respectively, among glaucoma suspects.

Sixty-three percent of our glaucoma suspects were not on any glaucoma medications and 3.2% had required a glaucoma procedure. These values differ substantially from 85-91% and 0.3%, respectively, as reported by Stein et al. [14]. The differences reflect our broad definition of glaucoma suspicion (see methods). The Ocular Hypertension Treatment Study[15] and the Advanced Glaucoma Intervention Study[16] highlighted the importance of maintaining a low IOP in reducing glaucomatous visual field progression and preventing or delaying POAG, respectively. In the DGR, 54.5% of suspects with no history of glaucoma procedure were on at least one hypotensive medication. An additional 19% of suspects were being treated even without evidence of elevated IOP presumably to improve optic nerve blood circulation.

Normal Tension Glaucoma (NTG)

Our study has found several similarities with the Collaborative Normal Tension Glaucoma Study [17] such as female preponderance, thin CCT and active treatment but NTG comprised only 1.7% of DGR.

Interestingly, Hispanic representation was the most in this group and there were more Hispanic males than females.

Secondary glaucoma

Not only is there scant data regarding the prevalence of secondary glaucoma, the available data is inconsistent. Gadia et al. [18] and Das et al. [19] both in India found secondary glaucoma prevalence of 22% and 7%, respectively. Studies in Finland [20] and Pakistan [21] further confounded the picture and reported secondary glaucoma prevalence of 33% and 35%, respectively. In the DGR, 7% of eyes were diagnosed with secondary glaucoma, similar to the prevalence Das found. The most common etiology of secondary glaucoma (27%) in our study was post surgical. This finding corroborates Gadia's study [18], in which post surgery and trauma were identified as two of the most common causes for secondary glaucoma. Both Gadia [18] and our study showed male predominance.

Angle Closure Glaucoma

There is increased prevalence of primary ACG in Asians, when compared to other races [22]. Patients with ACG in DGR had the highest proportion of "other" race (14.5%). A closer look at these patients revealed that the majority (60%) of these patients were identified as Asian or East Indian, suggesting that the racial profile of narrow angle eyes in the DGR falls in line with prior studies. Other risk factors such as increased age and female gender [23] were also corroborated in DGR.

Childhood glaucoma

Ample childhood glaucoma information exists in children [24] but DGR provides residual evidence in adults. These patients had the thickest CCT, female preponderance and conspicuous absence of Hispanics.

Limitations

This registry is largely a retrospective project. However, since we did not utilize masked readers to interpret the visual fields, a bias may have existed regarding the severity of the visual field scoring.

Some patients who did not have glaucoma as either their primary or secondary ocular diagnosis were not included. Additionally, ocular conditions, such as cataract or diabetic retinopathy, could have amplified the severity of the visual field defects.

Another limitation also lies in the methodology of the data collection process. While we collected most of the ocular features and measurements (i.e. CDR, CCT, IOP, VA, VF, surgery) on a per eye basis, information pertaining to the patients' glaucoma medication(s) was based on a per patient basis. This presented a challenge in our data analysis, particularly among a small number of patients with differing glaucoma diagnoses between the two eyes. In trying to minimize the issue, in certain cases we utilized data only from patients who share the same diagnosis in both eyes.

Conclusion

The DGR is a multifaceted study and can provide a foundation to advance our understanding of glaucoma prevention and treatment. The study will continue to expand in the future, plausibly collaborating with other researchers, institutions, and projects in making the registry even more comprehensive.

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