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Population Based Incidence of Macular Holes

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Abstract

Purpose—To determine the incidence of full thickness macular holes in Olmsted County, Minnesota.

Design—Population based retrospective chart review (cross sectional study).

Participants—94 eyes of 85 patients who were residents of Olmsted County, Minnesota.

Methods—A population based retrospective chart review was performed for all diagnoses of macular hole between 1992-2002 among residents of Olmsted County, Minnesota. Yearly incidence rates for each given age and sex group were determined by dividing the number of cases within that group by the estimated total Olmsted County resident population of the group for that given year.

Main Outcome Measure—Documented clinical diagnosis of a macular hole.

Results—Idiopathic macular holes occur at an age and sex adjusted incidence in 7.8 persons and 8.69 eyes per 100,000 population per year in Olmsted County, Minnesota. The female to male ratio was determined to be 3.3 to 1, and bilateral idiopathic macular holes occurred in 11.7% of patients and accounted for 20.9% of the affected eyes.

Conclusion—This study uniquely determined the incidence of macular holes in a predominantly Caucasian population.

Idiopathic macular holes have long been a cause of central vision loss, especially in the elderly population. Since the early 1990s, surgical repair of macular holes has evolved allowing a previously blinding condition to be repaired with excellent potential visual outcome.[1]

To date there has been no study determining the incidence of macular holes. The prevalence of macular holes has been reported in the Beaver Dam Eye Study,[2] the Baltimore Eye study,[3] the Blue Mountain Eye Study,[4] the Beijing Eye Study,[5] and a study in Southern India.[6] In these reports the prevalence ranges from 0.02% to 0.8%. In our investigation, the occurrence of new macular hole diagnoses was determined to establish an incidence of this condition.

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PRECIS: Idiopathic macular holes occur at an incidence of 8.69 eyes and in 7.8 persons per 100,000 population per year in Olmsted County, Minnesota.

Methods

A population based retrospective chart review was performed for all diagnoses of macular hole between 1992 and 2002 among residents of Olmsted County, Minnesota. Institutional Review Board approval was obtained for this study. Only patients who provided research authorization according to Minnesota state statues were included, and all work was in accordance with the Health Insurance Portability and Accountability Act of 1996 (HIPAA). A search for the diagnosis of macular hole (ICD-9 362.54) was performed in the diagnostic index of the Rochester Epidemiology Project. An initial clinical diagnosis by an ophthalmologist, regardless of diagnostic testing, was used to define an incident case of macular hole.

The Rochester Epidemiology Project (REP) is a medical records linkage system designed to capture data on any patient-physician encounter in Olmsted County, Minnesota. The population of this upper Midwest community of the United States (106,470 in 1990) is relatively isolated from other urban areas, and nearly all medical care is provided to county residents by Mayo Clinic and Olmsted Medical Group and their affiliated hospitals.[7] Patients who were not legal residents of Olmsted County during the study time period were excluded. Records were checked for miscoding, and any patient who was not found to have a macular hole documented in the chart was excluded.

Data collected included the patient's age, sex, visual acuity and lens status. Due to the retrospective nature of this study, no standardized protocol for the recording of visual acuity or other clinical variables was used. However, the best-corrected Snellen visual acuity and available recorded clinical data were used. Data were collected from the date of diagnosis with a macular hole through the last visit in the medical record.

Recorded data underwent double entry, whereby two people entered the same data collected on the data collection forms, followed by verification of the two entries against each other for discrepancies.

Yearly incidence rates for each given age and sex group were determined by dividing the number of cases performed within that group by the estimated total Olmsted County resident population of the group for that given year.

Population figures for 1990 and 2000 came from United States census data, and population figures for the intercensus years were estimated using linear interpolation. Yearly incidence rates were compared to determine overall trends as a function of time. These incidence rates were also age- and/or sex-adjusted to the 2000 census figures for the United States white population, so that our data could be compared to national estimates. Trends over time, age, and between genders were investigated using Poisson regression models.

Results

Ninety-four eyes with macular hole in 85 patients met inclusion criteria for the study. Among these, 86 macular holes (91.5%) in 77 (90.6%) patients were idiopathic. Non-idiopathic macular holes were attributed to the following etiologies: three occurred after retinal detachment repair, two secondary to trauma, one after macular translocation surgery, one after unspecified eye surgery, and one with chronic inflammation (Table 1).

Case characteristics

The mean age of patients at time of idiopathic macular hole diagnosis (n=77) was 68.6 (standard deviation [std] d 9.1, range 47.5 – 89.6; median 68.6) years. The mean age of patients at time of non-idiopathic macular hole diagnosis (n=8) was 45.7 (std 23.4, range 14 – 77.8; median

43.4) years. Females accounted for 76.7% of idiopathic macular hole eyes, and 74.5% of total macular holes. Eighty-three percent of patients were phakic, 16 % were pseudophakic, and 1 % was aphakic. Other baseline characteristics are detailed in Table 2.

Incidence

The overall age-adjusted rate of residents of Olmsted County, Minnesota between 1992 and 2002 who had a macular hole in either or both eyes was 8.5 persons per 100,000 population per year. After adjusting for sex, the rate remained unchanged. Among females the rate was 11.6 persons per 100,000 population per year (Confidence interval [CI] 8.72-14.47) and among males at a rate of 5.0 persons per 100,000 population per year (CI 2.86-7.15).

As expected, an idiopathic etiology was the most common cause of macular hole, which reflects the focus of current literature on macular holes. For this reason, we performed a separate analysis to determine the incidence of idiopathic macular holes. The age-adjusted incidence of idiopathic macular holes in either or both eyes of residents of Olmsted County, Minnesota between 1992 and 2002 was found to 7.8 per 100,000 population per year (CI 6.06-9.57). After additionally adjusting for sex, the rate remained 7.8 per 100,000 population per year. Females were affected at a rate of 10.9 per 100,000 population per year (CI 8.12-13.70), and males at a rate of 4.3 per 100,000 population per year (CI 2.32-6.43).

A second set of analyses was undertaken to determine the incidence of macular holes, regardless if both occurred in the same patient in bilateral cases. The age-adjusted incidence of macular holes of any etiology in Olmsted County, Minnesota between 1992 and 2002 was found to be 9.38 eyes per 100,000 population per year (CI 7.47-11.28). Again, adjusting for sex in addition to age had no effect. The incidence of macular holes among females was 12.89 eyes per 100,000 population per year (CI 9.87-15.92), and in males was 5.41 eyes per 100,000 population per year (CI 3.19-7.63).

The age-adjusted incidence of idiopathic macular holes in Olmsted County, Minnesota between 1992 and 2002 was found to 8.69 eyes per 100,000 population per year (CI 6.85-10.53). Again, adjusting for sex in addition to age had no effect. After adjusting for age and sex, the value remained 8.69 per 100,000 eyes per year. The incidence in females was 12.21 eyes per 100,000 population (CI 9.26-15.16), and in males was 4.78 eyes per 100,000 population (CI 2.65-6.91).

The female to male ratio for idiopathic macular holes was 3.3:1. Bilateral idiopathic macular holes accounted for 20.9% of eyes, and occurred in 11.7% of the patients; 7 of 59 females (11.9%) and 2 of 18 males (11.1%) (p=1.0).

Discussion

The age and sex adjusted overall incidence of macular holes in Olmsted County, Minnesota between 1992 and 2002 was found to be 9.38 eyes per 100,000 population per year. Idiopathic macular holes were found to have an incidence of 8.69 eyes per 100,000 population per year.

Currently available epidemiologic information about macular holes focuses on prevalence and varies widely. In the Beaver Dam Eye Study macular hole prevalence was 2.9 per 1000 (Personal communication: Moss SE and Klein R.). In the Baltimore Eye study a prevalence of 3.3 per 1000 was reported.[3] In the Blue Mountains Eye Study, a prevalence of 0.02% (or 0.2 per 1000) was reported in Australia[4] and a recent study from Beijing reported a prevalence of 0.09% (0.9 per 1000) eyes in a Chinese population.[5] Sen and colleagues reported a prevalence of 0.17% (1.7 per 1000) in southern India.[6] Despite these data on macular hole prevalence, there is no reliable method to estimate incidence from prevalence data.

Consistent with other studies, macular holes were found to be more common in females (male to female ratio of 1:2.4). However, male to female ratios vary widely across studies and ranges from 1:1.2 (India)[6] to 1:7 (China).[5] Additionally, the rate of macular holes occurring bilaterally varies across studies from 8% (India)[6] to 14.3% (China),[5] compared to our finding of 11.7% in this report. The population-based approach in this study may result in more accurate representative estimates.

Although our current study does provide new epidemiological information, it is not without its weaknesses. The incidence rate was determined from data spanning only ten years. Optimally a longer period of evaluation would have provided greater power to our study. However, the reporting of macular holes before 1992 was likely imperfect and variable. Until the advent of a standardized classification system in the late 1980s[8] and successful treatment involving vitrectomy surgery in the early 1990's,[1] macular hole was likely indiscriminately grouped with untreatable conditions of age-related macular disease. Thus, the accuracy and incentive for reporting macular holes as a distinct entity might have been low. However, with the availability of surgical treatment, reporting macular holes became more important, frequent, and expected to be more reliable. Also, it is likely that patients diagnosed in Optometrists' offices which are not part of the REP's indexing, would be referred for possible treatment. Because of these issues, it was decided to focus the chart review on a time period after which reliable reporting of macular holes was thought to be more likely. However, it remains possible that macular holes were not diagnosed or simply missed by eye care providers, both within the providers part of the REP, and by Optometrists.

Another potential weakness of the study is racial homogeneity. Because the ethnic composition of Olmsted County is over 90% white, our results are best extrapolated to the semi-urban white population of the United States and may not be applicable to other more diverse populations or other racial groups. Interestingly, this study corroborates the female to male ratio of macular holes and the rate of bilateral macular holes found previously.[8-20] These latter two points suggest that the data in this study are representative of what is already known about macular hole epidemiology.

It must also be realized that the study period preceded the routine use of ocular coherence tomography (OCT) as a diagnostic aid. At the inception of the current study in early 2006, not all cases from 2003 were available due to a lag in the REP indexing. Therefore there were insufficient years of routine OCT use available to determine an incidence for a case definition of macular hole requiring OCT confirmation. Without the routine use of OCT, early macular holes (stage one), which are easily diagnosed on OCT, may not have been a part of this cohort. In this report, an incident case of macular hole was defined as a clinical diagnosis; the use of OCT or confirmation by a retina specialist was not required. Therefore it is possible, that a case definition requiring the use of OCT or retinal specialist confirmation, or both, to establish a diagnosis may result in a different incidence rate of macular holes. It would be interesting to repeat this study in the era of routine OCT use and have the case definition of macular hole include OCT confirmation. Comparing such a study with the current one may allow assessment of the impact of a diagnostic technology on the determined incidence of a condition.

In summary, this study of idiopathic macular holes determined an incidence rate of 7.8 persons and 8.69 eyes per 100,000 population per year in Olmsted County Minnesota, a community largely comprised of Caucasians of northern European heritage. Females were 3.3 times more likely to be affected than males, while bilateral macular holes occurred in similar frequency among men and women. This incidence information supplements epidemiological knowledge of the estimated prevalence of macular holes.

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References

1. Kelly NE, Wendel RT. Vitreous surgery for idiopathic macular holes. Results of a pilot study Arch Ophthalmol 1991;109:654–9.
2. Klein R, Klein BE, Wang Q, Moss SE. The epidemiology of epiretinal membranes. Trans Am Ophthlamol 1994;92:403–25.
3. Rahmani B, Tielsch JM, Katz J, et al. The cause-specific prevalence of visual impairment in an urban population. Baltimore Eye Survey Ophthalmology 1996;103:1721–6.
4. Mitchell P, Smith W, Chey T, et al. Prevalence and associations of epiretinal membranes. The Blue Mountains Eye Study, Australia Ophthalmology 1997;104:1033–40.
5. Wang S, Xu L, Jonas JB. Prevalence of full-thickness macular holes in urban and rural adult Chinese: the Beijing Eye Study. Am J Ophthalmol 2006;141:589–91. [PubMed: 16490523]
6. Sen P, Bhargava A, Vijaya L, George R. Prevalence of idiopathic macular hole in adult rural and urban south Indian population. Clin Experiment Ophthalmol 2008;36:257–60. [PubMed: 18412595]
7. Melton LJ III. History of the Rochester Epidemiology Project. Mayo Clin Proc 1996;71:266–74. [PubMed: 8594285]
8. Johnson RN, Gass JD. Idiopathic macular holes. Observations, stages of formation, and implications for surgical intervention. Ophthalmology 1988;95:917–24. [PubMed: 3174041]
9. Lewis ML, Cohen SM, Smiddy WE, Gass JD. Bilaterality of idiopathic macular holes. Graefe's Arch Clin Exp Ophthalmol 1996;234:241–5. [PubMed: 8964529]
10. Morgan CM, Schatz H. Idiopathic macular holes. Am J Ophthalmol 1985;99:437–44. [PubMed: 3985081]
11. McDonnel PJ, Fine SL, Hillis AI. Clinical features of idiopathic macular cysts and holes. Am J Ophthalmol 1982;93:777–86. [PubMed: 7091263]
12. Niwa H, Terasaki H, Ito Y, Miyake Y. Macular hole development in fellow eyes of patients with unilateral macular hole. Am J Ophthalmol 2005;140:370–5. [PubMed: 16084790]
13. Causo LA, Scott IU, Flynn HW, et al. Long-term follow-up of unoperated macular holes. Ophthalmology 2001;108:1150–5. [PubMed: 11382645]
14. Hikichi T, Yoshida A, Akiba J, Trempe CL. Natural outcomes of stage 1,2,3, and 4 idiopathic macular holes. Br J Ophthalmol 1005;79:517–20. [PubMed: 7626565]
15. Bronstein MA, Trempe CL, Freeman HM. Fellow eyes of eyes with macular holes. Am J Ophthalmol 1981;92:757–61. [PubMed: 7315926]
16. Trempe CL, Weiter JJ, Furukawa H. Fellow eyes in cases of macular hole: biomicroscopic study of the vitreous. Arch Ophthalmol 1986;104:93–5. [PubMed: 3942551]
17. Akiba J, Kakehashi A, Arzabe CW, Trempe CL. Fellow eyes in idiopathic macular hole cases. Ophthalmic Surg 1992;23:594–7. [PubMed: 1480366]
18. Guy DR, de Bustros S, Diener-West M, Fine SL. Observations on patients with idiopathic macular holes and cysts. Arch Ophthalmol 1992;110:1264–8. [PubMed: 1520113]
19. Ezra E, Wells JA, Gray RH, et al. Incidence of idiopathic full-thickness macular holes in fellow eyes: a 5-year prospective natural history study. Ophthalmology 1998;105:353–9. [PubMed: 9479299]
20. Chew EY, Sperduto RD, Hiller R, et al. Clinical course of macular holes: the Eye Disease Case-Control Study. Arch Ophthalmol 1999;117:242–6. [PubMed: 10037571]

Table 1

Incidence of Macular Holes in Olmsted County, Minnesota (1992-2002), Adjusted for Age and Sex

Mechanism of Hole Formation	N (%)	Incidence of affected eyes per 100,000 population per year (95%CI)
All	94 (100)	9.38 (7.47-11.28)
Idiopathic	86 (91.5)	8.69 (6.85-10.53)
Traumatic	2 (2.1)	0.14 (0.00-0.33)
Other*	6 (6.4)	0.54 (0.10-0.99)

* Three patients following retinal detachment repair, one patient following macular translocation surgery with scleral imbrication, one patient after unspecified eye surgery, and one patient with chronic inflammation.

CI=confidence interval

Table 2

Eye characteristics at time of diagnosis of macular hole

	Idiopathic macular hole cases (n=86)					Secondary* macular hole cases (n=8)				
	Mean	**Std Dev**	**Median**	**Min**	**Max**	**Mean**	**Std Dev**	**Median**	**Min**	**Max**
Sph Equiv	+0.16	1.77	0.00	-3.50	+4.63	-0.56	0.80	-0.56	-1.13	0.00
Va at Dx			20/100	CF	20/30			20/400	CF	20/150
Va Final			20/100	CF	20/20			20/200	HM	20/30
Years of follow up	6.0	4.0	5.4	0	14	4.4	2.9	3.8	1.2	9.0

*Three patients s/p retinal detachment repair, two secondary to trauma, one patient s/p macular translocation surgery with sclera imbrication, one patient after unspecified eye surgery, and one patient with chronic inflammation.

Min = minimum

Max = maximum

Std Dev = standard deviation

Age at Dx = age at diagnosis of macular hole

Sph Equiv = spherical equivalent

Va at Dx = visual acuity at diagnosis of macular hole

Va Final = visual acuity at final documented visit

CF=count fingers

HM=hand motion

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