Original Article

Using the Amsler Grid Test for Age-Related Macular Degeneration Screening

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Abstract

Objectives: To evaluate the use of the Amsler grid test (AGT) in screening for age-related macular degeneration (AMD), one of the most common causes of blindness, in primary healthcare settings.

Materials and Methods: The AGT was applied to 700 eyes of 355 people aged 50 and over who applied to a family health center in Ankara and had no eye complaints. The test was considered positive if the lines on the AGT card were seen as broken or curved, there was a difference in shape or size between the squares, or a color change or blurring was described in any area. An ophthalmologist was consulted if the AGT was positive in one or both eyes. Patients considered suitable by ophthalmologists were evaluated with optical coherence tomography. AGT results were compared with ophthalmologist examination and tomography findings in terms of AMD detection.

Results: The AGT was positive in 97 (13.9%) and negative in 603 (86.1%) out of 700 eyes included in the study. A total of 184 eyes, 79 with a positive AGT and 105 eyes with a negative test, were evaluated by an ophthalmologist. As a result of examinations and tests performed by ophthalmologists, AMD was detected in a total of 67 eyes: 42 of 79 eyes with positive AGT and 25 of 105 eyes with negative AGT but referred to an ophthalmologist for different reasons. In our study, the AGT had 62.7% sensitivity and 68.4% specificity.

Conclusion: The AGT is an inexpensive and easily applicable test. Although moderate sensitivity and specificity were found in our study; further studies are needed to evaluate the suitability of its use for AMD screening in primary care with limited facilities.

Keywords: Amsler grid test, macular degeneration, scanning, specificity, sensitivity

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Introduction

Age-related macular degeneration (AMD) is a disease that damages the central part of the retina responsible for visual acuity, leading to dark spots and shadows in the central visual field, object distortion, and impaired central vision.[1] With the aging global population, AMD is the third most common cause of age-related blindness after cataracts and glaucoma.[1]

AMD is usually asymptomatic in the early stages but can cause irreversible vision loss in the advanced stages. With preventive measures and treatment, it is possible to avoid permanent damage or slow disease progression. By the time visual changes occur, the patient most likely has intermediate or late AMD.[2] Therefore, identifying the risk factors and early findings of AMD, especially in primary health care centers, is important for early diagnosis and slowing the course of the disease.[3]

Metamorphopsia, the most typical symptom of AMD, can be detected by the Amsler grid test (AGT). The traditional AGT, developed by Swiss ophthalmologist Marc Amsler, is a handheld test for identifying areas of scotoma or metamorphopsia.[4] The test is an inexpensive, self-administered, practical method for detecting signs of macular disease and monitoring its progression.[5]

Despite the increasing frequency of AMD, there is insufficient data on screening methods that can be implemented in daily practice, especially in primary health care settings where resources are limited. The aim of this study was to investigate the utility of the AGT for AMD screening in primary health care settings.

Materials and Methods

Our study was carried out in a family health center (FHC) in Ankara with people aged 50 years or older who were all registered with the same family physician. Of the 1222 people

who met this description, the AGT was performed on 700 eyes of 355 volunteers who presented to the FHC for outpatient examination during a period of approximately 1 year and met the inclusion criteria (Figure 1). The family physician obtained the participants' medical history and their electronic health records. After reviewing their past medical records and drugs used, systemic examination and external eye examinations were performed. Individuals having any of the following criteria (including the findings observed by the ophthalmologist for those referred) were excluded from the study:

- Diagnosis of diabetes mellitus (all types)
- History of previous ocular surgery other than cataract (e.g., cornea, vitreoretinal surgery)
- History of cataract surgery in the last 6 months
- Advanced glaucoma
- Impaired central or paracentral vision due to ocular or systemic disease
- History of surgery for ocular trauma
- Presence of corneal structural disorders or scars such as nebula
- Uveitis
- Pathologic myopia
- Optic neuropathy
- Vascular occlusion
- Solar retinopathy
- Poor cooperation during the test

The demographic information of all participants and possible risk factors and exposures related to AMD were recorded.[3] Distance visual acuity was evaluated with the Snellen test in an examination room of the FHC that was illuminated by natural sunlight. For participants with glasses, the Snellen test was repeated with and without their glasses.

For all participants, each eye was tested individually with the AGT by the same physician under the same lighting conditions with the fellow eye covered. The AGT consists of 20 horizontal and 20 vertical white lines arranged in parallel on a black background to form a grid of 400 squares 5x5 mm in size. For the test, the card was shown at a reading distance of 30 cm. Participants with presbyopia were tested while wearing presbyopic glasses. Each participant was asked to fixate on the white spot in the middle of the card with the eye being tested and was asked whether the surrounding lines appeared straight and the squares equal in size, as Amsler[6] described. Describing the lines on the card as interrupted or curved, squares appearing different in shape or size, and discoloration or blurring in any area (presence of metamorphopsia, micropsia, macropsia, or scotoma) was accepted as a positive AGT result.

An ophthalmologist was consulted for participants with a positive AGT result in one or both eyes. Participants with negative AGT were also referred to an ophthalmologist if they had any of the following AMD risk factors: family history of AMD, especially in a sibling; history of parental vision loss (even if this could not be confirmed because most participants' parents were deceased); long smoking history; and history of prolonged ultraviolet exposure, especially outdoor work.[7] In addition, we also referred participants observed to have difficulty focusing in distance vision measurements in their FHC examinations, participants with problems suggesting an ocular pathology, such as decreased reading speed or inability to see relatives clearly, and those who had no ocular signs and symptoms but had not been examined by an ophthalmologist within the last 2 years.

The ophthalmological examination included visual acuity measurement, slit-lamp anterior segment examination, and dilated fundus examination. Participants with findings of drusen, pigmentation suggestive of retinal pigment epithelium anomalies, areas of retinal atrophy, exudate, or hemorrhage on fundus examination underwent further testing. In the literature, drusen smaller than 63 µm (also called druplets) are considered signs of normal aging and not associated with risk of developing AMD. However, eyes with medium-sized drusen (63-125 µm in diameter) and without pigmentary changes are classified as early AMD, eyes with drusen larger than 125 µm or medium-sized drusen with pigmentary changes are classified as intermediate AMD, and the development of geographic atrophy or the neovascular form characterized by hemorrhage and/or exudation is classified as late AMD.[7] In our study, eyes with findings from any stage were accepted as having an AMD diagnosis, and no further staging was performed.

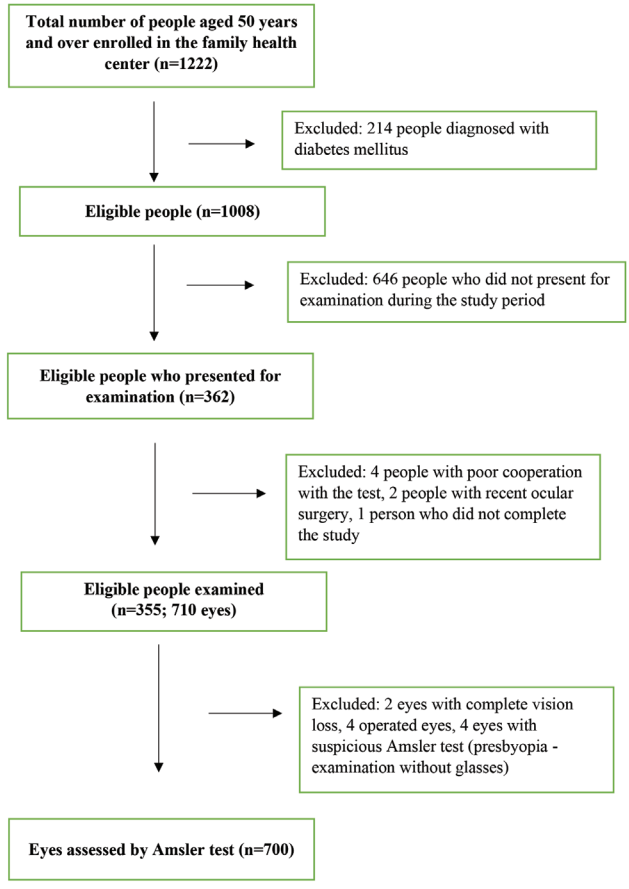

Figure 1. Study sample selection

Selected participants with positive AGT and others for whom it was deemed necessary were referred by the ophthalmologist for optical coherence tomography (OCT) imaging.

In our study, the results of the ophthalmologist examination were used as a reference for the accuracy of AMD diagnosis, and the results of the AGT applied in the FHC were compared with the ophthalmologist's conclusion regarding the presence or absence of AMD. To evaluate the diagnostic performance of the AGT, sensitivity and specificity values, as well as positive predictive value (PPV), negative predictive value (NPV), positive and negative likelihood ratios (LR) were calculated with 95% confidence intervals (CI). Approval for the study was obtained from the Ethics Committee of University of Health Sciences Türkiye, Dışkapı Yıldırım Beyazıt Training and Research Hospital (date: 10.09.2018, decision no: 54/06), and the Research Commission of Ankara Provincial Health Directorate.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics software, version 23 (IBM Corp., Armonk, NY, USA).

Results

A total of 700 eyes of 355 subjects were included in the study. Of the participants, 222 (62.5%) were women. The median age of the participants was 62 years (range: 51-92 years). Of the 93 people referred to and examined by an ophthalmologist, 62 (66.7%) were women and 31 (33.3%) were men. The AGT performed in primary care was positive in 52 (55.9%) and negative in 41 (44.1%) of these 93 patients evaluated by an ophthalmologist.

Overall, the AGT was positive in 97 (13.9%) and negative in 603 (86.1%) of the 700 eyes. Although all individuals with positive AGT were referred to the ophthalmologist, 9 of them were unable to go to the ophthalmologist during the study period for personal reasons (e.g., emergence of other health problems).

Of the total 700 eyes tested in primary care, 184 eyes of a total of 93 people (79 eyes with positive AGT and 105 eyes with negative AGT) were examined by an ophthalmologist (Figure 2). AMD was detected in 67 (36.4%) of the 184 eyes evaluated by an ophthalmologist.

According to the medical data obtained in the ophthalmologist examination (Figure 2, Table 1), AMD was detected in 42 of the 79 eyes with positive AGT. Of the 105 eyes that had negative AGT but were referred to an ophthalmologist for other reasons, 25 had AMD. As a result, the AGT detected AMD of different forms and stages in a total of 67 eyes of 41 people (unilateral in 15 and bilateral in 26).

When the diagnostic accuracy of the AGT was analyzed, its sensitivity was 62.7% (0.51-0.73; 95% CI) and specificity was 68.4% (0.59-0.76; 95% CI). The PPV was 53.2% and NPV was 76.2%. The positive and negative LRs (+LR/-LR) were 1.98 (1.44-2.77; 95% CI) and 0.55 (0.38-0.74; 95% CI), respectively. Thus, the accuracy rate (sum of true positives and true negatives) of the AGT in detecting AMD was 66.3%.

Other pathologies that can cause a positive AGT (e.g., epiretinal membrane, vitreous detachment, vitreomacular traction) were reported by ophthalmologists in a total of 21 eyes. The values obtained upon recalculation after excluding these pathologies were: sensitivity 62.7% (0.51-0.73; 95% CI), specificity 81.3% (0.72-0.88; 95% CI), PPV 70%, NPV 75.7%, +LR 3.34 (2.17-5.43; 95% CI), and -LR 0.46 (0.32-0.62; 95% CI) (Table 2). The accuracy rate increased to 73.7% (0.51-0.83; 95% CI).

Of the participants examined by ophthalmologists, 147 eyes of 74 participants (79.6%) were also evaluated by OCT imaging. OCT was not performed on 37 eyes of 19 people. Only 3 of these eyes had positive AGT (3 eyes of 2 older people could not adapt to OCT). In these eyes, a diagnosis of AMD was not considered in the expert examination. In the other 34 eyes without OCT, AGT was negative. OCT, which is an advanced test, was not performed in these eyes due to both the negative AGT and the absence of AMD findings in the ophthalmologist's examination.

In the analysis using OCT as the gold standard, the accuracy rate of the AGT was 59.9% for the 147 eyes that underwent OCT. The calculated values were: sensitivity 62.7% (0.51-0.73; 95% CI), specificity 57.5% (0.47-0.68; 95% CI); PPV 55.3%, NPV 64.8%; +LR 1.47 (1.08-2.05; 95% CI), and -LR 0.65 (0.44-0.92; 95% CI) (Table 3).

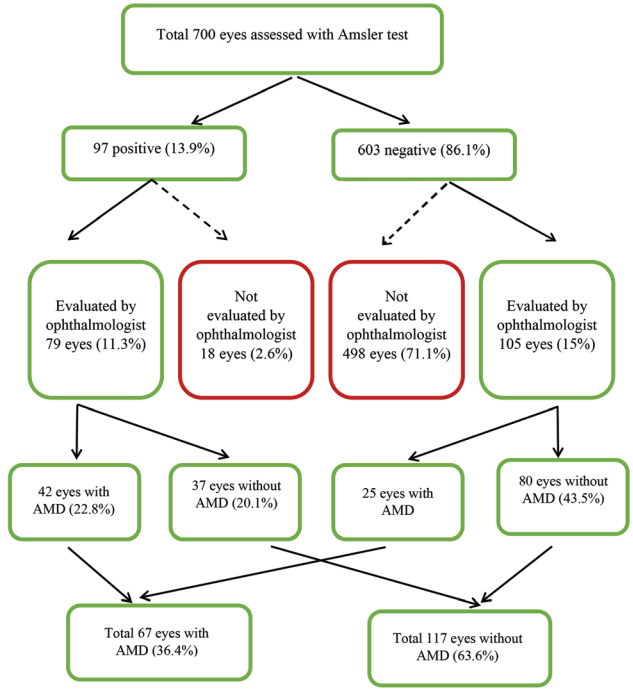

Figure 2. Results of the Amsler grid test and ophthalmologist examination
AMD: Age-related macular degeneration

Table 1. Comparison of Amsler grid test results with ophthalmologist examination results in the diagnosis of age-related macular degeneration

Amsler grid test result	Ophthalmologist evaluation	
	AMD+ n (%)	AMD- n (%)
Positive	42 (22.8)	37 (20.1)
Negative	25 (13.6)	80 (43.5)
Total eyes	67 (36.4)	117 (63.6)

AMD: Age-related macular degeneration

Table 2. Reanalysis of Amsler grid test results in the diagnosis of age-related macular degeneration compared to the results of ophthalmologist examination after excluding eyes diagnosed with other pathologies (n=21 eyes)

Amsler grid test result	Ophthalmologist evaluation	
	AMD+ n (%)	AMD- n (%)
Positive	42 (25.8)	18 (11.0)
Negative	25 (15.3)	78 (47.9)
Total eyes	67 (41.1)	96 (58.9)

AMD: Age-related macular degeneration

Table 3. Diagnostic values of the Amsler grid test in the diagnosis of age-related macular degeneration using optical coherence tomography as a reference

Amsler grid test result	OCT findings	
	AMD+ n (%)	AMD- n (%)
Positive	42 (28.6)	34 (23.1)
Negative	25 (17.0)	46 (31.3)
Total eyes	67 (45.6)	80 (54.4)

OCT: Optical coherence tomography, AMD: Age-related macular degeneration

Discussion

This prospective study investigated the diagnostic value of the AGT for AMD screening in primary health care services and family practice routine examinations. Most of the studies on this subject have been conducted by ophthalmology clinics among people diagnosed with macular disease. To our knowledge, there is no similar study in the literature in primary care and the general population.

Findings of various stages of AMD were detected in 67 (36.4%) of 184 eyes evaluated by ophthalmologists. Our aim was not to classify AMD stages but to enable the early diagnosis and timely treatment of people with suspected AMD using only a screening method that can be implemented in primary health care centers. Therefore, the cases were evaluated as a whole without further staging. Although our study is not an AMD prevalence study, 67 (9.57%) of the 700 eyes screened in primary care received a first-time diagnosis of AMD. Considering that not all eyes with negative AGT were evaluated by an ophthalmologist, this high rate obtained in a relatively young group for the diagnosis of AMD is noteworthy in terms of the need to screen for AMD, given the conditions' prevalence and potential consequences for society.

A previous study showed that a delay of 21 weeks or more in the treatment of AMD increased the risk of visual impairment five-fold compared to a delay of 7 weeks or less.[8] The fact that a delay in treatment increases the risk of irreversible damage is an issue that should be brought to the attention of primary care physicians, especially regarding the importance of AMD screening.

In our study, the AGT had sensitivity of 62.7%, specificity of 68.4%, PPV of 53.2%, and NPV of 76.2% in diagnosing AMD. These data include all results of ophthalmologist-performed fundus examinations and tests in which AMD lesions were observed, without differentiation of AMD type.

Excluding eyes with different pathologies reduced the AGT's number of false positives in recognizing only AMD, thereby increasing its specificity to 81.3%, PPV (rate of catching true positives) to 70%, and accuracy rate (sum of true positives and true negatives) to 73.6%. The possibility that AGT results may be affected by these pathologies, which cannot be diagnosed in primary care, cannot be eliminated. However, this is not a disadvantage in our opinion and suggests that the AGT may also be beneficial in the early diagnosis of other such pathologies.

In a meta-analysis evaluating the diagnostic accuracy of the AGT in AMD screening based on the results of 903 individuals, it was found that the sensitivity of the test ranged from 0.34 to 1.0 and the specificity from 0.85 to 1.0, with a pooled sensitivity of 0.78 (95% CI 0.64-0.87) and a pooled specificity of 0.97 (95% CI 0.91-0.99).[9] The AGT performance values obtained in our study conducted in the primary care setting are consistent with these data.

In their study including a total of 317 patients (mean age: 44±7 years) mainly of Hispanic origin (77%) presenting to an ophthalmology outpatient clinic, Ariyasu et al.[10] screened visual function with 4 different measurements (contrast sensitivity test, AGT, distance and near visual acuity) and detected macular degeneration at a rate of 4.1%. In their patient group, which was younger than in our study, they reported the AGT had 19% sensitivity and 92% specificity but showed poorer performance in patients younger than 40 years of age. Our results support this finding, and because our study group consisted of older individuals, both the rate of macular degeneration and the sensitivity of the AGT were higher. In addition, it can be said that repeating the test over time is important for the diagnosis of AMD due to the increase in AGT positivity with increasing age.

Do et al.[11] evaluate the performance of the AGT compared to fluorescein angiography as a secondary objective in their study investigating OCT sensitivity in detecting conversion to neovascular AMD. For the AGT, they reported low to moderate sensitivity for the detection of new-onset choroidal neovascular membrane (CNVM), with values of 0.42 (95% CI: 0.15-0.72) and 0.50 (95% CI: 0.19-0.81). The AGT was reported to have lower specificity than OCT in the detection of new CNVM due

to the high false positivity rate. In our study, when we reanalyzed the performance of the AGT using OCT as a reference for the 147 eyes evaluated with OCT, we determined its specificity to be 57.5% and NPV as 64.8%. As 34 of the 37 patients who did not undergo OCT were in the AGT-negative group, the statistical values of the AGT in diagnosing this group seem to be low.

Miller and Fortun[12] reported that the traditional AGT was useful for monitoring patients' vision but had limited specificity and sensitivity as a screening tool for neovascular macular degeneration. However, when community screening for AMD is considered, a test that is cost-effective, practical, and repeatable, with the highest diagnostic performance possible is the priority. The sensitivity of the AGT in detecting new CNVM development has been reported be limited to 42% when patients perform the test themselves and increases to 52.6% when the test is applied by a professional.[13] Some researchers who think the AGT is a difficult subjective test for patients argue that it requires patients to describe their perception of their visual defects in other areas of the grid while fixating elsewhere.[14] In our study, we repeatedly warned the participants to keep their eye fixed on the center during the AGT, which we believed improved their adaptation to the test and contributed to the higher specificity and sensitivity of the AGT in this study.

Study Limitations

Being the first study on AMD screening in primary care, our study has various limitations. Testing people with symptoms of disease when investigating the accuracy of a screening test is a common but flawed practice. In contrast, applying these tests in the asymptomatic population enables many people to be tested while identifying those with the disease and allows follow-up to identify actual patients.[15] In our study, 18 eyes with positive AGT and 498 eyes with negative AGT were not examined by an ophthalmologist. However, the proportion of participants who tested positive and did not undergo ophthalmologist examination was low (2.6%). Considering the unwillingness of older people with no ocular complaints to undergo examination for a routine check-up, the study included a considerable number of people evaluated by an ophthalmologist despite a negative AGT.

Although in this kind of study it is preferred to perform one-stop examinations and testing of participants, we gave participants the freedom to choose a physician and a center. However, the examination and AGT performed in the FHC were carried out by a single physician, and the ophthalmologists were informed via the consultation request made by that physician. For all participants, anterior segment and dilated posterior segment examination were performed by ophthalmologists, and all those with positive AGT as well as those deemed necessary by the ophthalmologist were referred for OCT. The same researcher received feedback regarding the procedures conducted by the specialist and the results. OCT was not performed on all eyes of the participants referred to an ophthalmologist. However, OCT was performed in 96.2% (76/79) of eyes that had positive AGT and were referred; only 3 eyes of 2 people could not be examined by OCT. Likewise, OCT was deemed necessary and performed in 67.6% (71/105) of the eyes with negative AGT results. The ophthalmologist did not consider further OCT evaluation necessary for the remaining 34 eyes with negative AGT. In our study, the diagnosis of AMD was taken as a whole, ignoring the prognostic differences between AMD types. Identifying patients with wet AMD and high risk of transformation to wet AMD transformation is of utmost importance to ensure early diagnosis and treatment. This point should be taken into consideration in other studies on the subject.

Conclusion

AMD is one of the most common causes of age-related blindness, and its importance is increasing as the older population grows. Our study was conducted among the general patient population in primary care, and AMD was detected for the first time at a high rate of 9.57% (67 of the 700 eyes tested). Therefore, our findings in terms of the diagnosis of new cases differed from those of studies conducted by evaluating patients diagnosed in eye clinics.

In our study, the AGT had 62.7% sensitivity, 81.3% specificity, and 73.7% accuracy in the detection of AMD when the ophthalmologist examination was taken as a reference. When we reanalyzed the performance of the AGT using OCT as a reference, its specificity was 57.5%.

Although alternative tests are being developed, the AGT appears to be a test that can easily be applied for the detection of AMD. Therefore, although we observed moderate sensitivity and specificity in this study, the utility of the AGT in AMD screening in primary care settings with limited facilities must be evaluated in similar community-based studies designed in reference to OCT, which has been proven to have a high diagnostic value for AMD.

We think that our study will increase awareness of AMD, which is a serious eye disease, both among physicians working in primary health care centers and in the general population, thereby increasing the chance of early diagnosis and treatment.

Ethics

Ethics Committee Approval: Approval for the study was obtained from the Ethics Committee of University of Health Sciences Türkiye, Dışkapı Yıldırım Beyazıt Training and Research Hospital (date: 10.09.2018, decision no: 54/06), and the Research Commission of Ankara Provincial Health Directorate.

Informed Consent: Obtained.

Authorship Contributions

Surgical and Medical Practices: S.A.K.Ü., A.G.K.A., Concept: S.A.K.Ü., A.G.K.A., A.Ö., C.A., Design: S.A.K.Ü., A.G.K.A., A.Ö., C.A., Data Collection or Processing: S.A.K.Ü., A.G.K.A., Analysis or Interpretation: S.A.K.Ü., A.G.K.A., A.Ö., C.A., Literature Search: S.A.K.Ü., A.G.K.A., A.Ö., C.A., Writing: S.A.K.Ü., A.G.K.A., A.Ö., C.A.

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