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LATIN AMERICAN GUIDE TO PRIMARY OPEN ANGLE GLAUCOMA

FOR THE GENERAL OPHTHALMOLOGIST

2019: Editors: Fernando Barría von-Bischhoffshausen MD and Dr. Jesús Jiménez Román MD.

BASIC CONCEPTS:

- Glaucoma is an **optic neuropathy** with progressive loss of ganglion cells, producing irreparable damage to the visual field.
- Primary Open Angle Glaucoma is considered a **"silent thief of vision,"** since it is asymptomatic until its advanced stages.
- It is the **leading world cause of irreversible blindness**, and its prevalence increases with age.
- An increase in intraocular pressure is the main **risk factor;** while it is not the cause of glaucoma, the pressure level determines the damage to the optic nerve.
- To **prevent vision loss and blindness** associated with glaucoma, we must implement early detection strategies and manage cases appropriately, above all those with a highly aggressive rate of progressive damage.
- Although this guide focuses on recommendations for Open Angle Glaucoma, we must also not neglect **angle-closure or occludable angle cases, since this group has a high potential for blockages and blindness due to glaucoma.**

See COMPLETE GUIDE IN

https://paao.org/glaucoma-guide/

https://www.iapb.org/resources/latin-america-guide-to-primary-open-angle-glaucoma/

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I. EXECUTIVE SUMMARY

Glaucoma is a progressive optic neuropathy characterized by specific changes in the visual field associated with the death of retinal ganglion cells. Primary open angle glaucoma (POAG) accounts for 70% of glaucoma cases.

The prevalence of glaucoma increases with age; it is associated with greater longevity, and it requires early detection and timely treatment to avoid irreversible blindness.

The risk of vision loss and blindness is reduced through appropriate ophthalmological testing of at-risk patients. We must carry out **early diagnosis** in order to provide timely treatment, considering that up to 75% of those affected are unaware of their condition (Los Angeles Latino Eye Study, LALES). **The main risk factors are:** ocular hypertension, family history of glaucoma, and age over 60 years.

Vision loss occurs in late stages of the condition, and thus it is crucial to convince patients not to miss checkups or neglect their treatment, in order to avoid irreversible changes leading to blindness. A diagnosis of glaucoma is based on evaluation of the condition of the optic nerve and its correlation with functional damage to the visual field, even if intraocular pressure is within normal limits.

To initiate a successful glaucoma detection program, the following must be considered:

a. **ENSURING AVAILABILITY OF A CLINICAL GUIDE,** with an outline for diagnosis, a simplified classification system and suggested treatments.
b. **SELECTING A SCREENING METHOD FOR THE PRIMARY-CARE LEVEL,** considering the available equipment and human resources.
c. **SETTING UP SECONDARY DIAGNOSTIC CENTERS AND ENSURING THAT THEY ARE PROPERLY MANAGED.**
d. **EDUCATING GLAUCOMA PATIENTS** about the risk of vision loss and blindness without ongoing treatment.

II.a- FROM THE EDITORS

Glaucoma is the second leading cause of blindness in the world, after cataract, and it causes irreversible vision loss, in contrast to cataract which is reversible. The most frequent variants of the disease are open angle and angle-closure glaucoma, with open angle glaucoma being the most common in Latin America. The risk of blindness depends on various factors, including the level of intraocular pressure; direct family history of glaucoma; age at onset; the severity and rapidity of disease progression; and appropriate and timely treatment.[1] Primary open angle glaucoma is a chronic and progressive disease, and thus we must ensure timely diagnosis by identifying individuals in the community with risk factors and undertaking examinations which either confirm or rule out the disease, while considering that mass population screening is not recommended. When a diagnosis is confirmed, ongoing periodic examinations and appropriate case management must be ensured in order to prevent vision loss. This can be a significant challenge, however, in more vulnerable communities where the threat of vision loss is greater due to poor access to health services and specialists, lack of access to medications, high cost of treatment, low adherence to or rejection of treatment, and a lack of patient education. To achieve the

desired results, we must include ophthalmology programs starting at the primary-care level to ensure the timely detection of glaucoma, identifying high-risk cases or those with moderate or advanced damage, and immediately referring them to the secondary or tertiary care level to confirm the diagnosis and ensure effective management of complex or rapidly progressing cases, as well as the rehabilitation of those with visual deficits through low-vision services.[2]

Our aim in creating this guide is to provide an overview of the current situation in Latin America with regard to glaucoma, the prevalence of which has increased in tandem with the life expectancy of the population, as well as to provide an orientation for the general ophthalmologist regarding its diagnosis and management. Many of the recent advances in this area have not resulted in decreased rates of blindness due to glaucoma, in part because of delayed diagnosis, limited access to health services, poor adherence to treatment, and the lack of awareness of the risk of blindness due to this disease.

We must improve our strategies to prevent blindness due to glaucoma, ensuring effective early detection and a management strategy that is accessible and accepted by the community, without neglecting patient education to avoid progression resulting in blindness.

To assist in the fight against blindness due to glaucoma, the efforts were undertaken to create this volume dedicated to the general ophthalmologist. It does not represent a consensus statement, but aims to deliver an overview of the management of the condition, directed above all toward the most vulnerable population groups.

Fernando Barría von-Bischhoffshausen and Jesús Jiménez Román, EDITORS

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II.b- PROLOGUES

QUALITY GLAUCOMA MANAGEMENT: An Imperative for Universal Eye Health Coverage

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Glaucoma is one of the most severe and most complex diseases that ophthalmologists have to deal with. Glaucoma is severe because it may lead to complete blindness, even when treated, and glaucoma is complex because it requires individualized care, making public health approaches very difficult. And yet, universal eye health coverage can only be achieved if all patients in need (and only those in need) receive high quality glaucoma management throughout their lives.

Too often, quality has been perceived as a luxury that only rich countries can afford. In fact, provision of quality eye health services is possible in all communities, regardless of their income level. And quality is of particular importance in glaucoma management because of the chronic nature of the disease: substandard care harms the patient and wastes very significant amounts of resources.

There is growing acknowledgement that optimal health care cannot be delivered by simply ensuring the concurrent availability of infrastructure, medical supplies and health care providers. Improvement in eye care – and especially glaucoma care – requires providing effective, safe, people-centred care that is timely, equitable, integrated and efficient.[i] These seven aspects need to be taken into consideration in order to increase the likelihood of sight preservation:

1.- Effectiveness: adherence to the present guidelines is the best way to ensure effective management of each patient, based on evidence and current scientific knowledge.

2.- Safety: glaucoma treatment, being complex and mostly chronic, is prone to adverse events, including medical errors and medication interactions. Here again, adherence to the guidelines and good patient safety practices are essential. Only treating patients who actually need treatment is a also an important way to increase patients' safety.

3.- Patient-centeredness: the needs and preferences of glaucoma patients need to be systematically taken into consideration. Glaucoma being a blinding disease, patients might understandably be worried and ask many questions. The eye care team need to be prepared to listen and answer in a culturally-sensitive and understandable way. Patients need to be given all the necessary easy-to-understand background so that they can be actively involved when different treatment options are discussed. Monitoring patient experiences and perceptions is also critical to achieve optimal adherence to treatment.

4.- Timeliness: a timely diagnosis and initiation of management is indeed critical to achieve the best possible outcome. In addition, reducing waiting time to access services during the entire course of treatment is key for adherence. Efficient patient flow systems for scheduling or modifying visits and for notifying patients are an essential component of glaucoma services, whether in large hospitals or private practices.

5.- Equity: gaps exist in health care quality everywhere in the world, but they are even more serious for disadvantaged populations. In many countries these gaps are actually increasing, a situation which demands special attention. The quality of care a patient receives should not vary according to personal characteristics such as gender, race, ethnicity, geographical location and socioeconomic status. The services received should be driven by evidence of the potential health benefits of the treatment only, and nothing else.

6.- Integration: the care glaucoma patients receive across facilities and providers needs to be coordinated. With emerging chronic and noncommunicable diseases, more people are living with multiple and complex chronic conditions, including glaucoma, that require coordination of care across all levels and throughout their life course. Continuity of care and care coordination can improve both outcomes and the care experience of people living with such conditions. This is particularly true for diabetic patients.

7.- Efficiency: according to WHO about 20–40% of all health sector resources are wasted.[ii] The leading causes of inefficiency in glaucoma management include inappropriate medicine use – including overprescription, an inappropriate mix of human resources, overuse of equipment and underuse of existing infrastructure. Care should be provided by a cohesive, ophthalmologist-led eye care team, each taking on tasks that match their competencies and able to track previous tests and procedures via an interoperable electronic medical record system, preventing repetition and waste of resources.

In summary, high-quality glaucoma management involves the right care based on the existing guidelines, at the right time, responding to the patients' needs and preferences, while minimizing harm and resource waste. Quality glaucoma management increases the likelihood of preserving sight and contributes to the achievement of universal access to eye health. Regardless of the income level of a country, the quality of glaucoma management can always be increased.

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GLAUCOMA IN THE WORLD AND IN LATIN AMERICA

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It is a great pleasure and privilege to be writing this foreword for such an important series of guidelines of for the management of glaucoma. In March 2017, I had the pleasure of meeting fellow ophthalmologists with an interest in glaucoma at Veracruz. This meeting, which was an alliance of IAPB, PAAO, and PAHO, was an opportunity to discuss the various glaucoma guidelines in different regions of the world and to create a guideline which fitted the particular needs of Latin America. This is what is now before you.

The need is pressing. Working with colleagues in the Americas, we (the Vision Loss Expert Group) estimated that in 2015, 1 in 5 people across Latin American and the Caribbean (LAC) had some degree of vision loss, and that between 2015 and 2020, the number of people with vision loss will increase by 12% to 132 million.[1] In 2020, glaucoma will contribute to 2.2-3.7% of blindness and moderate and severe vision impairment (<6/18 in the better eye) in Latin America which is higher than what we observe globally (2.0%). After cataract and uncorrected refractive error, glaucoma is the next most common cause of blindness in all LAC regions except Southern Latin America, where glaucoma is four times most common after age-related macular degeneration. So, the need to address the burden of glaucoma is clear and we all know that glaucoma causing blindness or vision impairment is the tip of the iceberg. The reality is that there are many more people affected by glaucoma at earlier stages where their binocular vision is less severely affected and there is an opportunity to arrest the disease with treatment. In many regions of the World the fragmentation and segmentation of eye health systems between and within countries may explain why disparities in visual health status exist. This is all the more reason for producing guidelines on glaucoma management so that there is standardization in the approach to patient care and the opportunity to measure the effectiveness of our interventions.

Grant and Burke in 1982 asked 'Why do some people go blind from glaucoma.'[2] Susanna asked again in 2015 'Why do some people (still) go blind from glaucoma' in an excellent update.[3] Grant suggested that a third are undiagnosed, a third are not treated properly, and a third are not compliant with therapy. While I am sure that these proportions will vary wherever you happen to be working in Latin America (or indeed the rest of the world), these remain real considerations. Glaucoma care guidelines offer the opportunity to correct the proportion undiagnosed by improving surveillance systems, the accuracy of referral of suspected cases, and recognition of glaucoma by healthcare providers. Guidelines also improve the quality and effectiveness of treatment, for example by assisting the clinician in stratifying their glaucoma patients by risk and thereby concentrating resources on detecting and protecting those at greatest risk of deterioration.

Thirteen years ago I wrote an Editorial for the British Journal of Ophthalmology called 'Worldwide Glaucoma through the Looking Glass,'[4] in which I wrote "There is no doubt that glaucoma suffers from an 'image problem'…the fact that it is irreversible, difficult to detect, and difficult to treat means that it is often viewed as less of an urgent

issue, particularly in nations where other more remediable disease such as cataract are more prevalent." I still believe this to be the case but since then there have been some major steps forward in awareness of glaucoma, understanding of effective and cost-effective treatments, and better strategies for detection. I am convinced that these guidelines will play an important role in continuing these advances to counter this public health concern.

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GLAUCOMA IS A REGIONAL PRIORITY IN VISUAL HEALTH: An Action Plan to Prevent Blindness and Vision Loss

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For the year 2015, it was estimated that there were 2.34 blind persons in Latin America, and 12.46 million with moderate or severe visual deficits. The main cause of blindness was cataract, and the leading cause of visual deficits was refractive errors.[1] Although prevalence has been decreasing with respect to the 2010 estimate,[2] it is necessary to strengthen prevention programs to reduce the absolute numbers of persons with blindness and visual deficits due to preventable causes.[1] However, the increase in the population and its aging[3] represent a challenge, since the demand for services will increase in the future. In response to this situation, in 2013 the World Health Assembly approved the 2014-2019 action plan for the prevention of avoidable visual disability and blindness, "Universal eye health: a global action plan[4] for 2014-2019." It calls upon the Member States to consolidate their efforts by integrating eye health into their national health systems, in order to reduce blindness.[4] The 2014-2019 Strategic Plan of the Pan-American Health Organization is an action plan for the prevention of blindness and visual deficits,[5,6] representing an updated version of the Plan approved by the Directing Council of the WHO in 2009, which places priority on eye health and provides guidelines for concrete initiatives to address priorities specific to the region in the area of blindness prevention.

In Latin America, **the prevalence of blindness** in persons over age 50 varies from 1% in urban areas with high levels of socioeconomic development to more than 4% in rural and marginalized areas. The main cause of blindness is cataract,[7,8] along with diabetic retinopathy and glaucoma.[7] In the Caribbean, cataract and glaucoma cause 75% of the cases of blindness.[9] In the majority of countries there are sufficient ophthalmologists to cover the existing need, but there is an imbalance in distribution, with a higher concentration of professionals in zones with higher per capita gross domestic product, as has been previously documented in some countries.[10] During the past decade, access to services has successfully been expanded, as demonstrated by rising averages in the rates of cataract surgery.[11,12] Observing that visual disability is a significant problem in the region and one which is associated with poverty and social marginalization, and that the majority of causes of blindness are avoidable, it must be noted that current treatments are among the most cost-effective of all medical interventions.

In Latin America, **the prevalence of glaucoma varies between 1% and 3.4%** in persons over age 50, and it accounts for between 15% and 20 % of the cases of blindness in countries with greater African heritage.[7] In the Caribbean, the prevalence of open angle

glaucoma in persons over age 40 exceeds 7%, and it represents a significant cause of vision loss and the main cause of irreversible blindness.[9,13] There are countries with information, communication and education programs with respect to glaucoma, but the rates of glaucoma surgery in the region are very low.[14] The general aim of the Plan is to reduce avoidable visual disability as a public health problem, and to ensure access to rehabilitation services for the visually disabled, improving access to ophthalmological care as an integrated part of public health systems, and increasing political and financial commitment with respect to eye health. The objectives of the Plan are a combination of treatment, promotion, prevention and rehabilitation, which must be focused on populations who are not served by the health systems; the primary-care system for eye health must be strengthened in order to detect and refer persons with visual deficits, encourage diabetic patients to have annual retinal exams, and remind patients over age 40 with risk factors for glaucoma to have regular ophthalmological checkups. Objective 3.3 is to reduce the incidence of blindness due to open angle glaucoma through detection and treatment, especially in high-risk groups such as persons of African descent, the Caribbean population, those over age 40, and those with a family history of glaucoma. A concurrent aim is to ensure that blind and visually disabled persons have access to rehabilitation programs and educational opportunities, in accordance with universal agreements such as the Convention on the Rights of Persons with Disabilities.

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1.- INTRODUCTION

Dr. Fernando Barría von-B.

In recent years, the prevalence of the entire spectrum of pathologies related to aging has increased, due to demographic changes in the population. Primary open angle glaucoma is one of these pathologies, and as the number of cases increases, cases of vision loss and blindness will also rise. The ultimate aim for developing this guide is to improve clinical practice in the timely diagnosis and management of primary open angle glaucoma, and thus to reduce the rates of vision loss and blindness, which on the world level continue to be estimated at some 12%.[1] Because of this, it is necessary to create strategies to reconcile the general clinical guidelines for open angle glaucoma with considerations associated with local capacities such as the availability of human and financial resources, as well as cultural factors. There is no single method of diagnosis, and there is great variation in medical practice with regard to management, contributing to a situation where there is underdiagnosis of glaucoma, with at least 50% of those affected remaining unaware of their condition, combined with overtreatment, considering that many cases which are merely glaucoma suspects are receiving treatment.[2]

The ultimate aim of a guide is to ensure that medical actions are based on scientific data, by providing recommendations focused on improving medical practice, optimizing decision-making based on a systematic review of the best scientific evidence deriving from properly conducted research, and evaluating the risks and benefits of the various alternatives for diagnosis or treatment, with the ultimate aim of optimizing health care for patients. There is currently an epidemic of meta-analysis, which only complements medical experience, and it is necessary to do away with the supposed paradigm that evidence-based medicine only seeks to reduce the costs of medical practice. This will require integrating the scientific evidence obtained from individual clinical experience, as well as the values and preferences of patients, in decision-making. This guide does not aim to be a textbook for the glaucoma specialist; instead, it is dedicated to the general ophthalmologist and other health professionals. A clinical guide on the Latin American level must cover the following topics:

1.- **The epidemiology of glaucoma** on the world level and in Latin America, to assist in the development of management strategies, considering the magnitude of the problem.

2.- **Early detection at the primary-care level in the community,** directed at effectively identifying glaucoma cases, and including three phases: a.- Identifying patients with glaucoma risk factors; b.- Determining which stages to detect, in order to develop screening programs at the primary-care level, and deciding how to implement these programs; and c.- Determining how to diagnose glaucoma on the secondary level, which requires specialized equipment.

3.- **Effective and timely management of glaucoma**, presenting recommendations with respect to medications, laser treatment or surgery. At this stage it is crucial to identify the patient's degree of progression, as well as existing risk factors for blindness.

4.- Finally, **patient education** is of fundamental importance, considering that glaucoma is an asymptomatic condition with associated low adherence to topical treatment. It is considered a disease that is poorly understood by patients, the community, and governmental authorities.

There are two questions that we must answer:

1.- **Why has blindness due to glaucoma not decreased?** Some reasons include the following: a) There is an increase in clinical cases, associated with the aging of the population. If we estimate a prevalence in Latin America of 3.4% of the population over age 40,[3,4] as the older population increases, clinical cases and the risk of blindness will also

increase. b) In 56 to 75% of cases, glaucoma remains undiagnosed.[5,6,7] c) There are low rates of adherence to topical treatment; it is estimated that some 30 to 50% of patients do not use their eye drops in the manner prescribed.[8] This is associated with the low level of knowledge about the disease and the damage it can cause, and thus education is needed, although clear evidence is lacking that treatment is effective at a very early stage. And finally, d) Most patients in the region are in developing countries and members of vulnerable population groups without access to effective diagnosis or treatment.[2]

2.- **Why do patients become blind?** In general, they become blind because of: a) Late diagnosis. A study by Moorfields Hospital[9] estimated that nearly 90% of patients who progress to legal blindness entered the hospital with moderate or advanced damage from glaucoma (visual field MD > 6 dB) in at least one eye. Many patients obtain store-bought eyeglasses without an eye exam, with false confidence that their vision is good, which delays the detection of visual pathologies, including glaucoma. Even in developed countries, it is recognized that early detection of glaucoma remains a problem that needs to be addressed. Open angle glaucoma is most frequent, but angle-closure glaucoma is underdiagnosed due to the lack of gonioscopy. b) Accelerated rate of progression: After a diagnosis of glaucoma, it is necessary to analyze the rate of the progression of damage to the visual field[10] in order to detect rapidly advancing damage, given that those cases present a greater risk of blindness. This functional loss can be evaluated by comparing successive visual fields, analyzing the indices of the visual field (IVF) or using progressive analysis, which produces a physiological curve of functional loss of vision with age, highlighting progression caused by glaucomatous damage. It is very important to consider this rate of progression as part of the framework of clinical management of a patient, since treatment must be much more aggressive when the rate of progression is higher, also taking into account family history, the level or fluctuation of intraocular pressure, gonioscopy or corneal thickness, as well as life expectancy. Other clinical factors to consider include the presence of pseudoexfoliation; pigment dispersion; the current state of damage to the optic nerve; and the presence of any systemic illnesses. c) Other Causes: Lack of awareness of the disease, considering that many patients do not understand the seriousness of their condition, and thus they exhibit low adherence to treatment and fail to attend their medical checkups. There can also be barriers impeding access to appropriate therapy, such as the high cost of treatment or inadequate medical controls that do not include follow-up exams to evaluate the progress of the condition and adjust the treatment plan.

Because of all of the above, this text aims to be a systematic support guide for the general ophthalmologist and other health professionals.

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2.- THE EPIDEMIOLOGY OF GLAUCOMA

2.a THE GLOBAL PREVALENCE AND IMPACT OF GLAUCOMA

Dr. Van C. Lansingh

Glaucoma is a form of optic neuropathy, and it is the second leading cause of blindness in the world, responsible for between 6.6% and 8% of cases of blindness.[1,2] A recent systematic review of 50 population-level studies, evaluating glaucoma cases among 252,894 individuals, estimated that the world prevalence of glaucoma is 3.54%, affecting 64.26 million people;[3] however, its impact varies greatly among different populations.[2-4] The largest population with glaucoma is found in Asia, where it affects 39 million people (3.4% of the region's population), but the prevalence is higher in Africa and Latin America (4.79% and 4.51%, respectively).[3] Considering that Asia is the world's most populated region, and its population is aging, that continent represents 60% of the world's cases of glaucoma. The authors have projected that the number of people with glaucoma in the world will increase to 76.0 million by 2020 and to 111.8 million by 2040, with aging populations in Asia and Africa most strongly affected. Another recent systematic review estimated the world prevalence of primary open angle glaucoma (POAG), identifying it as responsible for 3 out of 4 cases of glaucoma.[4,5] The authors were more inclusive with diagnoses of glaucoma, basing them on visual field data rather than intraocular pressure. Surveys of parameters of the optic disc to define abnormalities,[4,6] where the visual field cannot be assessed, are very variable and cannot be directly compared.[7] The methodology of the Rapid Assessment of Avoidable Blindness (RAAB) detects glaucoma only in a terminal stage with vision loss[8] and does not include cases of early glaucoma. The international ophthalmological epidemiology organization carried out a systematic review of 81 studies, covering 5,266 identified cases among 216,214 participants, and thus greater than that estimated in previous reviews,[3,4] and concluded that there were 57.5 million people with POAG in 2015, which will rise to 65.5 million by 2020.[4]

It is difficult to conceptualize the impact and burden of glaucoma in terms of the number of people affected, because during the early stage of the condition, patients may be asymptomatic. In epidemiological studies in developing countries, between 82% and 96% of persons with glaucoma had not been previously diagnosed.[9-11] Even in developed countries, between 50% and 85% of persons with glaucoma do not realize that they have the condition, with differences observed among racial and ethnic groups.[12-15] For example, in the United States, African-Americans have a 4.4-fold greater probability of having undiagnosed glaucoma compared to Caucasians, and Hispanics have a 2.5-fold greater probability than Caucasians.[14] Among patients who were unaware that they had glaucoma, 33% were already in an advanced stage of the disease in at least one eye.[16] In Singapore, 56.0% had significant damage to their visual field;[13] and in rural communities in Ghana, 34% with a new diagnosis of POAG were already blind.[17] Studies have reported that one out of every 5 or 6 patients with glaucoma are blind.[15,18,19] For this reason, knowing the number of people with vision loss caused by glaucoma can be a more useful epidemiological data point than the general prevalence of glaucoma, for the purposes of planning prevention and treatment programs. It has been estimated that in 2010 there were 2.1 million blind persons in the world (0.1% of the global population) and 4.2 million people with visual deficits due to glaucoma;[2] however, there was significant geographical variation. In tropical Latin America, the prevalence of blindness caused by glaucoma was 0.3%, contributing 15.5% of the cases of blindness in that region.[2] Numerous factors can explain the great differences in the rates of blindness and visual impairment caused by

glaucoma. Studies have reported that the age and state of vision at the onset of the condition; the rate of progression of the illness; higher levels of intraocular pressure; lack of access to services and/or low quality of those services; low adherence by the patient to exams and treatment; a lack of knowledge about glaucoma; and poverty are all **risk factors for becoming blind due to glaucoma.**[20-42] Additionally, it has been reported that glaucoma tends to affect people of African heritage earlier and more aggressively;[3,20,43-51] and for this reason, blindness may be more common among people of African descent because the overall duration of the glaucoma is longer.

With respect to the **risk factors for glaucoma**, many studies report gender as a risk factor,[2-4,9,11,15.52-55] concluding that men have a higher risk of suffering from glaucoma than women.[3,4] This association may be related to the fact that men have a higher risk of comorbidities such as cardiovascular disease.[4,56] Similarly, patients with African and Asian heritage are more susceptible to systemic illnesses, including diabetes and heart disease, than Caucasians, [4,57-60] and these illnesses are clearly associated with glaucoma.[4,60,61] High blood pressure,[62-64] and possibly also low blood pressure, are additional risk factors, while the evidence is not conclusive with respect to obstructive sleep apnea.[65-69] Eye-related risk factors include myopia and high intraocular pressure.[3,7,9,15,53,54,70-73] Studies have concluded that greater age is a risk factor for glaucoma,[4,15,54,73] although this varies according to race and ethnicity. For example, a systematic review found that the prevalence of POAG is higher (12.2%) among patients of African descent who are 80 years of age; however, the increase in glaucoma risk by decade of age was greater among Hispanics and lower among Asians, possibly attributable to genetic factors.[20,74-77]

The costs of glaucoma are sobering. In the United States, the direct annual cost of glaucoma is between US$3 and $6 billion.[78-81] The main financial burden arises from the cost of medications,[78,82,83] which in Europe range between 42% and 56% of direct costs, depending on the stage of the disease.[83] In Mexico, where the national laboratories produce glaucoma medications, prices can be more affordable, with an annual cost per patient of between US$4.97 (for timolol) and US$675.39 (for brimonidine);[84] nevertheless, for low-income patients, the cost of glaucoma treatment represents an average of 61.5% of monthly expenses.[85] In fact, people with glaucoma in less-developed countries may spend between 20% and 50% of their monthly income on their glaucoma treatment.[85-88] The lack of access to health insurance is significant in less-developed countries; in India, it was found that 92% of patients did not have insurance.[87] Thus, early diagnosis and proactive treatment may be very influential in reducing the costs of glaucoma.[78,88]

Living with glaucoma and its consequences aside from the economic burden, such as vision loss, pain, and side effects of treatment, negatively impact quality of life.[89-103] Patients with glaucoma are more likely to report depression, anxiety, burns, falls, and difficulties in walking, driving and reading, among other limitations affecting daily life.[90,93,103-135] Although quality of life becomes diminished with the severity of the illness,[90,136,137] even patients at an early stage of glaucoma and with normal visual acuity report a lower quality of life.[90,138-141] Simply having a diagnosis of glaucoma is enough to reduce quality of life, which can be lower than the quality of life with other eye conditions that cause blindness.[90,142] It must also be taken into account that the time required for regular checkups and associated examinations also affects the patient's quality of life.

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2.b GLAUCOMA EPIDEMIOLOGY IN LATIN AMERICA: Global and Latin American Evidence

Drs. Jaime Soria, João M. Furtado and Van C. Lansingh

Glaucoma is the second leading cause of blindness on the world level and the leading cause of avoidable blindness.[1] For 2020, it is estimated that the total number of

persons diagnosed with glaucoma in Latin America (LA) may reach 8 million (CI 95% possibly reaching 13.6 million),[2] representing 12.9% of the global total.[3] The regional prevalence of glaucoma in LA for persons over age 40 is calculated at 3.6% (CI 95% 2.08 – 6.31).[3] This prevalence and incidence of glaucoma in the Hispanic world is recognized as being lower than in African populations, but greater than in non-Hispanic white populations. It is expected that the prevalence of this condition will increase in LA,[4] although it varies among the different Latin American countries, with a range from 1% to 3.4%.[5,6] The impact of glaucoma on vision is difficult to measure, and the RAAB studies report that low vision in persons over age 50 varies greatly among the different countries of the region, from 2% in El Salvador to 43% in Cuba,[7] with glaucoma being responsible for 15 to 20% of the total cases of blindness.[5]

Compared with cataract, glaucoma has a low cost-effectiveness ratio in diagnosis and treatment.[5] Up to 75% of people with glaucoma are undiagnosed[8] and studies carried out in Brazil report a best corrected vision at first appointment less than or equal to 20/200 in the worse eye in 53.6% of cases, and in the better eye in 13.4% of cases, and a cup-to-disc ratio of between 0.8 and 1 in the worse eye in 67.7% of cases, and in the better eye in 58.8% of cases.[1] Thus, it is important to strive for early detection and the timely management of non-complicated cases by ophthalmologists at the primary-care level, referring advanced, complex or surgical cases to specialists.[1]

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2.c ADHERENCE TO GLAUCOMA TREATMENT

Drs. Jaime Soria, João M. Furtado and Van C. Lansingh

One important problem is the **lack of adherence to treatment**, which is associated with ethnic group, socioeconomic status and level of education.[1,2] The opinion of specialists is that the cost of medications affects patients' quality of life (96%), and also makes treatment less accessible for most patients (72%), and thus it is the main cause of poor adherence to treatment, which affects nearly 50% of patients, whether the medications are generic or non-interchangeable bioequivalents (81.6%).[3] In addition, members of vulnerable population groups also face difficulties in attending ophthalmological checkups, which affects fulfillment of the treatment.

Nearly 98% of glaucoma specialists in Latin America prefer **medication over surgery as a first-line treatment**. According to their responses, prostaglandins lower intraocular pressure more than beta-blockers (100%), have fewer systemic effects (90%) and tend to be the first option for 97% of glaucoma specialists.[3] In LA the most commonly used medications are prostaglandin analogs and beta-blockers.[2] There is ongoing debate

about results which suggest that the therapeutic response might be different among specific Latin American population groups.[1,4,5] In any case, adherence to treatment and monitoring of the progression of glaucoma are extremely important.[6,7]

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2.d RATES OF SURGERY FOR GLAUCOMA: Are they sufficient?

Drs. Jaime Soria, João M. Furtado and Van C. Lansingh

Surgery can be an alternative to reduce intraocular pressure, where limited resources are available for the ongoing use of medications.[1] In 2013, Mansouri and collaborators created an index called the Glaucoma Surgical Rate (GSR), defined as the number of glaucoma surgeries per million persons per year.[2] There is no ideal number of glaucoma surgeries to be performed, but the authors have found a higher GSR in countries with more abundant resources and a larger number of ophthalmologists. On the world level (in a sample of 38 countries), the average rate is 139.2 glaucoma surgeries per million inhabitants per year, but with great variation. Among the countries of the Americas included in the study, Canada has the highest GSR (174), while fewer surgeries than average are performed in Chile (103), Colombia (63.5), Puerto Rico (43.1), Paraguay (31.5), Bolivia (29) and Brazil (16.9). The authors also note that trabeculectomy is the most common surgery for glaucoma, and the overall trend is toward a reduced number of glaucoma surgeries, especially in developed countries, such as France (declined by 47% to 365.3 in 2000), Holland (declined by 45% to 85.2 in 2000), and Australia (declined by 57,3% between 1997 and 2003, to a rate of 183.3), possibly due to the advent of new types of pressure-lowering drugs.

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3.- BASIC DIAGNOSTICS FOR GLAUCOMA:

How to identify "glaucoma suspects"

Glaucomas may be primary or secondary. The type ("first name") of glaucoma is determined by gonioscopy (open, closed, secondary or congenital, among others) and the stage of progression ("last name") is determined by the observed damage to the visual field (ocular hypertension; early or incipient damage; moderate, advanced or end-stage damage).

Knowing the type and the stage of progression of the glaucoma, we can identify the best possible treatment for each case.

CONSENSUS[1]

DIAGNOSIS OF GLAUCOMA:

• The loss of retinal ganglion cells determines the disease.
• A suspicion of glaucoma arises in the presence of one or more high-risk factors.
• For the diagnosis:
  - Elevated intraocular pressure is not required.
  - The optic nerve must be evaluated, mainly considering the increase in vertical excavation.
  - A functional (computerized) visual field and/or structural examination must also be carried out.
• A case of **monocular glaucoma** should be considered, in principle, a secondary glaucoma.

1. Consensus of the Grupo Mexicano de Investigación en Glaucoma and the Colegio Mexicano de Glaucoma: Dr. Jesus Jimenez

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3.a RISK FACTORS: What to look for

Jesús Jiménez- Román, Carlos Chau Ramos and Miguel Moreno Marín

There are risk factors related to the condition which are common among the majority of patients with POAG, such as **ocular hypertension and/or direct family history** of glaucoma, and the disease has also been associated with reduced central corneal thickness, as well as Hispanic ancestry.[1] Multivariable studies identify ocular hypertension, a vertical increase in optic disc cupping, myopia, advanced age and family history as risk factors for developing glaucoma.[3,4] Thus, the risk factors to look for are as follows:

A) High risk factors for open angle glaucoma

1.- **Ocular hypertension:** IOP elevated above 24 mmHg. High intraocular pressure is the **most frequent risk factor, and the only one that is modifiable** in glaucoma treatment; it is also a risk factor for the progression of the disease.[5] Pressures above 20 mmHg, taking corneal thickness into account, are considered to be **suspicious intraocular pressure** in the absence of structural or visual field damage, and even pressures close to this level can be considered suspicious if associated with other risk factors such as increased optic disc cupping, optic disc asymmetry, or positive family history. **Fluctuation of intraocular pressure** is a risk factor for the **progression of glaucoma**, although it is subject to debate.[6] Graphing changes in pressure over time is useful in glaucoma suspect cases as well as with glaucoma patients.[13] This allows identification of variations in IOP, upper and lower limits, and target pressures in the case of glaucoma. An average IOP of 19 mmHg in a patient without structural or visual field damage, or fluctuations greater than 4 mmHg, are warning signs. The water drinking test is an alternative to the daily pressure curve (Dr. Remo Susanna, Jr.).

2.- **Family history of glaucoma:** Some 10 to 20% of patients with glaucoma have a first-degree relative with the condition. We must ask about a family history with glaucoma as well as family members with blindness. The condition arises 3.7 times more often among individuals with family members with a positive diagnosis of glaucoma.[8,7] It is known that glaucoma can be hereditary, and its prevalence is estimated at five to 20 times greater with a positive history of glaucoma in the family.[8]

3.- **Increase or asymmetry in optic disc excavation** (cup-to-disc ratio)**:** Exploring the optic nerve through direct ophthalmoscopy, it is necessary to evaluate its characteristics, taking into account the **size of the optic nerve**, its coloration, **vertical and horizontal excavation**, **the thickness of the neuroretinal rim** (the ISNT rule, which is applicable to discs of normal size and shape), notches, localized or generalized pallor, the type and degree of peripapillary atrophy, and the visibility (or not) of the lamina cribrosa, among others. The presence of splinter-like hemorrhages in the absence of systemic diseases such as diabetes mellitus, high blood pressure or vasculitis is a relevant sign of glaucoma,[9] particularly in normal-pressure glaucoma, in which it can be seen in up to 21% of cases. Optic nerve hemorrhages are associated with the progression of glaucoma, along with an increase in excavation in older patients.

4.- **Age:** The prevalence and incidence of glaucoma increase by 4 to 10 times in individuals over age 60.

5.- **Central Corneal Thickness:** If below 545 microns in the central area, it must be considered in glaucoma suspect cases and patients with glaucoma when the IOP is evaluated. However, it is not possible to define the exact impact of the thickness on IOP readings, and thus the algorithms offered for the correction of IOP and corneal thickness lack consistency. There are other relevant factors, such as the curvature and elasticity of the cornea, and all of these biomechanical factors generate variations in IOP readings, as seen when Goldmann-type applanation tonometry (GAT) is used. Because of this, this factor must be considered in the diagnostic process with glaucoma suspect cases and patients with glaucoma, but its practical utility must be weighed.[10]

6.- **Humphrey Visual Field**, full-threshold 30-2 with standard deviation greater than 1.98 dB, after a normal baseline. 24-2 perimetry is the most commonly used pattern, and the 10-2 strategy is used most frequently with the aim of earlier diagnosis. In the **glaucoma suspect patient the visual field is normal**, without field defects typical of glaucoma, which does not rule out the presence of the disease. Defects in the nerve fiber layer precede alterations in the visual field, even years before they appear in an examination, and thus with a glaucoma suspect case it is necessary to carry out structural examinations such as optical coherence tomography (OCT), Heidelberg Retinal Tomography (HRT) or scanning laser polarimetry.

7.- **African or Hispanic ancestry**: Persons of African descent have a greater risk of developing POAG,[11] and it has been shown that the prevalence for Hispanics lies between that of African-Americans and Caucasians.[12]

B) Lower risk factors

1.- **Vascular Factors: Systemic arterial hypertension;** Cardiovascular disease. Vascular factors have been linked to the development and progression of glaucoma. Low systolic or diastolic pressure, or a history of cardiovascular disease, are associated with the progression of primary open angle glaucoma.[14] There are circulatory abnormalities of the optic nerve in subjects with glaucoma, with a reduction of up to 25 % of blood flow in the neuroretinal rim compared with control groups.

2.- **Myopia:** Myopia greater than -6 D is a risk factor associated with glaucoma, in which one finds a large disc area, broad excavation and a rotation of the disc (oblique papilla), making a detailed examination more complicated. These difficulties oblige the clinician to carry out a painstaking exploration of the optic disc and to use additional structural methods.

3.- **Migraine**

GOALS OF EVALUATION: Evaluation of a patient with suspected glaucoma requires:

1.- A detailed clinical history.

2.- A complete and meticulous ophthalmological examination.

3.- Functional documentation: Achromatic perimetry, FDT.
4.- Structural documentation: photography of the optic nerve, structural analysis of the head of the optic nerve and of the nerve fiber layer with Optical Coherence Tomography (OCT) and/or Heidelberg Retinal Tomography (HRT).

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3.b EVALUATION OF THE HEAD OF THE OPTIC NERVE

Jesús Jiménez Román, María del Pilar Alfaro Goldaracena and Jorge Gamiochipi Arjona

Evaluation of the optic disc is crucial in the diagnosis of glaucoma, and the general ophthalmologist must be able to recognize its clinical changes, as well as associated risk factors, since the disease is asymptomatic in its initial stages.[1-4]

OPTIC DISC EVALUATION

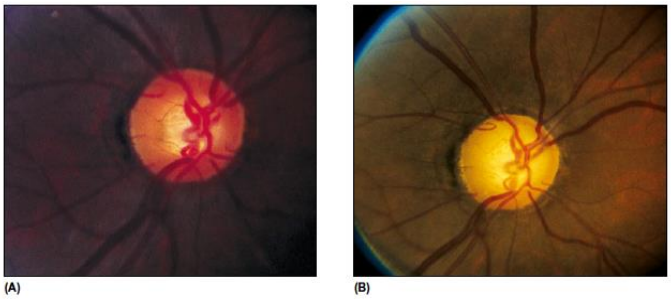
Size and form of the optic nerve: The optic disc has an oval shape, being a bit longer in its vertical extension, in contrast with the cup, whose horizontal diameter is greater. Within the refractive range of -5 to +5D, the size of the disc shows little variation; however, patients with hyperopia above +5D have smaller discs, and those with myopia greater than -5D have larger discs. Larger nerves, macrodiscs or megalopapillae (twice the average of the studied population, with values greater than 2.5 to 3 mm^2), can be divided into primary asymptomatic (without morphological defects), primary symptomatic (pitted, "morning glory" syndrome, among others) and secondary, which continue to grow from birth and correspond to patients with high levels of myopia. Small nerves, microdiscs or micropapillae, are associated with pseudopapilledema, drusen and non-arteritic ischemic optic neuropathy, and those of statistically normal size with arteritic ischemic optic neuropathy, retinal vascular occlusions and glaucoma. In the macro- or microdisc it is more difficult to identify glaucomatous damage.

Size and shape of the neuroretinal rim: In a disc of normal size and shape, the rim is wider in its inferior portion, followed by the superior and the nasal sectors, and thinnest in its temporal portion (the ISNT rule). With the progression of glaucoma, the rim tends to lose its form first in the infero- and superotemporal zones, which correlates with the defects found in perimetry.

Cup-to-disc ratio: The cup-to-disc ratio in normal eyes is greater on the horizontal plane, compared with the vertical. In patients with glaucomatous damage, the vertical aspect increases more rapidly, so that the coefficient of the horizontal-vertical ratio becomes less than 1. An asymmetry greater than 0.2 between one eye and another is very rare, and thus it is suggestive of damage, with the exception of cases with an existing asymmetry in the size of the optic disc between the two eyes, for example in anisometropia.

Configuration of the excavation: Damage may begin with an increase in the physiological excavation; however, there is some portion which is lost before the rest, and it appears as a notch, or more rarely, as a pit. Axon loss of up to 40% can occur without evident visual field defects as seen in Goldmann perimetry.

Position of the central retinal vessels and their branches: The location of the central retinal vessels may be associated with the loss of fibers due to glaucomatous damage,



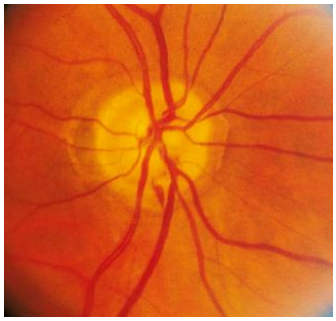
(A) Initial photo of a patient with primary open angle glaucoma.
(B) Photo of the same patient 12 years later: concentric increase in excavation and thinning of the superotemporal neuroretinal rim.

Taken from: Campbell DG, Netland PA: Stereo atlas of glaucoma, St Louis, Mosby, 1998.

associated with losses in the neuroretinal rim. As the excavation increases, the vessels which usually pass in a perpendicular orientation above the disc change their direction and take on a more vertical position. This change in the configuration of the vessels is a sensitive indicator of changes in the optic disc, and it must be monitored. The vessels which pass circumferentially on the temporal side of the excavation are called "circumlinear" and are common in glaucoma.

PERIPAPILLARY DATA

Peripapillar hemorrhages: Splinter-like hemorrhages around the optic nerve are very rare in normal eyes, but they are seen in 4-7% of patients with glaucoma. They are more common in normal-tension glaucoma, and they have been associated with losses to the nerve fiber layer and defects as seen in perimetry exams. They tend to be present for intervals of 2 to 35 weeks.



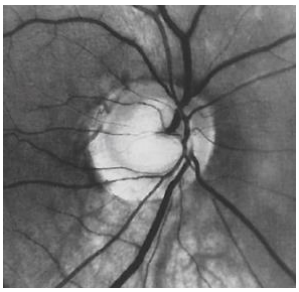
Hemorrhage in the inferior section of the optic nerve.

Taken from: Campbell DG, Netland PA: Stereo atlas of glaucoma, St Louis, Mosby, 1998.

Defects in the nerve fiber layer: These represent the loss of optic nerve axons due to any cause of optic atrophy. There are two patterns of fiber loss: 1. Localized, in a wedge-shaped pattern, which occurs in approximately 20% of patients with glaucoma, although it can also arise from other causes of optic atrophy. 2. Diffuse, which is more difficult to detect and can coexist with the previous form. Evaluation of the nerve fiber layer can be carried out using various techniques. Defects in the nerve fiber layer have a sensitivity of 84-94% and a specificity of 3-17% for glaucomatous damage.

Diameter of retinal arterioles: Narrowing of the arterioles in the head of the optic nerve is a non-specific indicator of optic atrophy, either of glaucomatous or non-glaucomatous origin.

Peripapillar choroid atrophy: Traditionally, two zones of peripapillar atrophy are distinguished: the beta (central) and the alpha (peripheral). To these, the gamma and delta zones have recently been added. **Alpha zone:** A peripheral region of irregular hypo- and hyperpigmentation due to partial atrophy of the pigmentary epithelium of the retina and thinning of the overlying chorioretinal layer. It appears with a frequency of 15-20% in healthy eyes. **Beta zone:** A central region which represents marked atrophy of the pigmentary epithelium of the retina and the choriocapillaris; the sclera and the choroid vessels are visible, and there is a diminished number of photoreceptors. It is less frequent in healthy eyes, and thus it is more indicative of some kind of pathological process. We also find the **gamma zone:** a region between the edge of the scleral channel of the optic nerve and the termination of Bruch's membrane. **Delta zone:** Central part of the gamma zone in which there are no cups of at least 50µm in diameter and 300µm in length. These last two zones (gamma and delta) are useful in differentiating peripapillar atrophy of glaucomatous origin versus that occasioned by severe myopia. Peripapillar atrophy in the alpha zone represents a relative scotoma, while atrophy in the beta zone is an absolute one. It is important to note that optic atrophy of non-glaucomatous origin is not associated more strongly with peripapillar atrophy than in normal eyes; thus, the presence of progressive atrophy can help us distinguish glaucomatous versus non-glaucomatous damage.



Glaucomatous optic disc with diffuse thinning of the inferior neuroretinal rim and total atrophy of the pigmentary epithelium of the retina and the choriocapillaris (beta zone).

Taken from: Airaksinen PJ, Tuulonen A, Werner EB: Clinical evaluation of the optic disc and retinal nerve fiber layer. In: Ritch R, Shields MB, Krupin T, editors: The glaucomas, 2nd ed., St Louis, Mosby, 1996.

SUMMARY: Evaluation of the optic disc is fundamental in the diagnosis of glaucoma. A normal disc has a vertical excavation less than 0.4 and a pink neuroretinal rim (ISNT rule) (Figure 1). Evaluate the size of the disc with a stereoscopic lens, from macro >3mm to microdisc <1.2 mm. One of the first signs of glaucomatous damage is an **increase in excavation** through the thinning of the neuroretinal border. Variations exist in the vessels of a glaucomatous cup, such as bayonet vessels. Loss to the rim may be visible in the form of a **notch,** most frequently in the inferior sector (Figure N 2). Also to be considered is a vertical **asymmetry of the excavation** greater than 0.2, but if there is a diffuse loss of axons, the excavation enlarges concentrically due to marked loss of the neuroretinal rim in all sectors (Figure N 3 and 4).

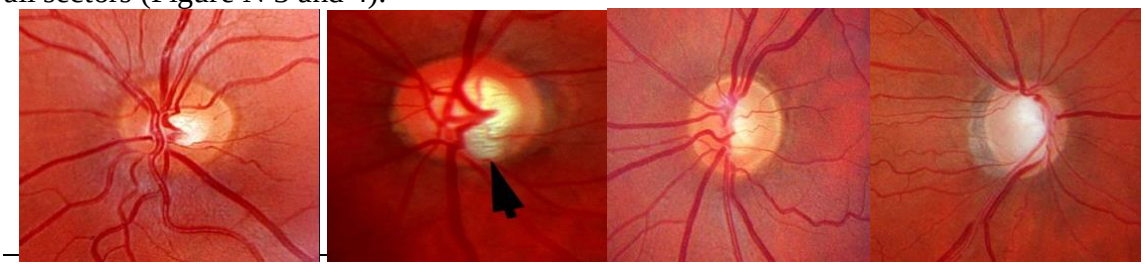


Figure 1 ***Figure 2*** ***Figure 3*** ***Figure 4***

Figure 1: Normal optic disc with a central cup of diameter 0.4 and a pink neuroretinal rim.

Figure 2: Loss of the neuroretinal rim can be observed in the inferior sector (arrow), with the lamina cribrosa visible.

Figure 3: One of the first signs of glaucomatous damage is an increase in vertical diameter, with violation of the Inferior Superior Nasal and Temporal (ISNT) ratio in the neuroretinal rim (NR).
Figure 4: With advanced damage, there is marked loss of the neuroretinal rim in all sectors, whether diffuse or localized. Peripapillary atrophy in the beta zone also appears.

There are **optic nerves which are difficult to evaluate** for glaucomatous damage, due to their form and configuration, and to intrinsic characteristics of the disc. These include the macrodisc (Figure 5), as well as myopic discs (Figure 6), because they have a large, oblique optic disc, and it is difficult to define the borders of the neuroretinal rim. In cases of significant chorioretinal damage or micropapilla (Figure 7), it is difficult to evaluate the optic cup because it is occupied by neuroretinal tissue. Also, difficult to evaluate are the oblique disc and situs inversus of the optic disc.

Figure 5

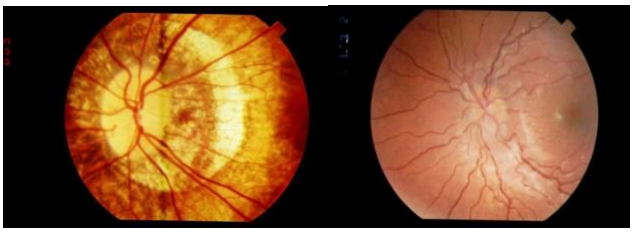


Figure 6 ***Figure 7***

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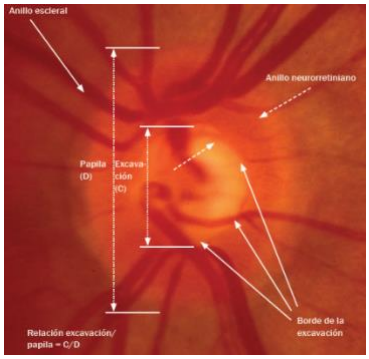
3.c WHAT TO LOOK FOR IN AN OPTIC DISC WITH SUSPECTED GLAUCOMA

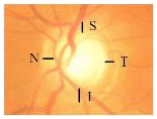
Fernando Barría von-B, Eugenio Maul de la P. and Luis Peña G.

¿HOW TO EVALUATE AN OPTIC DISC?



NORMAL OPTIC DISC*: Oval in shape, with a pink neuroretinal rim, vertical excavation less than 0.4 and a well-differentiated border

ISNT RULE: In normal cases, the inferior border is thickest



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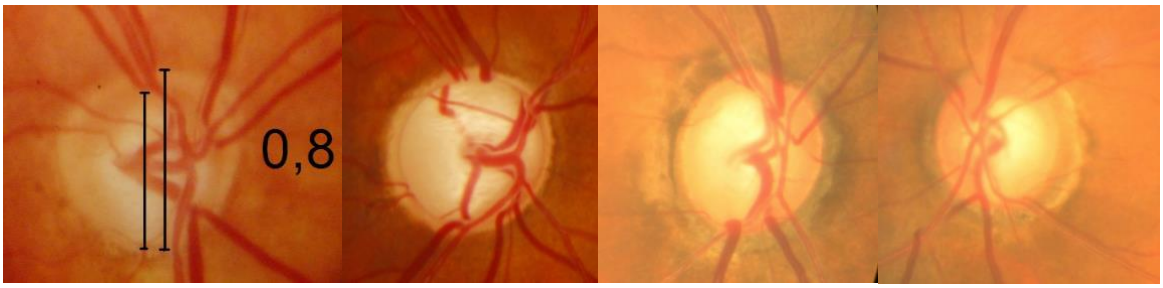
Temporal thinner / progression / total excavation

SUSPECTED GLAUCOMA: Multiple risk Factors: Family history, IOP>21, age over 65 years, unilateral Blindness Pseudoexfoliation syndrome, Myopia, others.
INCREASED EXCAVATION: Thinning of the neuroretinal rim, localized or generalized. Consider excavation greater than 0.65 in the vertical direction ($p<5\%$, less than 5% of the normal population has this degree of excavation). An excavation of 0.8 is normal in less than 2.5% of the population ($p<2.5\%$).



Excavation of 0.8/0,9. Bayonet vessel **OPTIC DISC ASYMMETRY** Generalized thinning of the rim (excavation 0.9 vs 0.6), greater on inferior rim. OD bayonet vessel and atrophy.

OTHER SIGNS OF GLAUCOMA: In association with other optic disc alterations

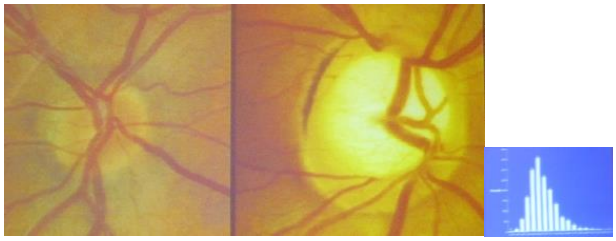
a) Notches in the optic disc border, especially the inferior segment

b) Optic disc hemorrhages (8% glucoma): Of short duration, but they suggest progression

c) Asymmetry of the vertical excavation greater than 0.2

d) Peripapillary atrophy in the beta zone: Choroid vessels and sclera visible (more frequent in glaucoma).

c) Evaluate the size of the optic disc: with a 90 D lens (x1.3) great variability, Macro >3, Micro <1.2 mm, in relation to the neural rim.



Optic disc hemorrhage. Peripapillary Atrophy Optic disc side (mm) related nerve fibers

References:

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CONSENSUS[1]

EXAMINATIONS ASSOCIATED WITH A DIAGNOSIS OF GLAUCOMA:

Examination of the Optic Nerve: There is no pathognomonic sign of glaucoma.

Consider:

- Increase in excavation (>0.6 on the vertical axis) or progression of damage
- Violation of the ISNT rule with thinning of the neuroretinal rim
- Asymmetry greater than 0.2
- Splinter hemorrhages
- Polar notches or pseudopits
- Peripapillary atrophy in the beta zone

1. Consensus of the Grupo Mexicano de Investigación en Glaucoma and Colegio Mexicano de Glaucoma: Dr. Jesus Jimenez

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3.d WHAT STAGE OF GLAUCOMA SHOULD WE AIM TO DETECT?

Fernando Barria von B. and Jesús Jiménez- Román

One of the first objectives to define is: **What stage of glaucoma should we detect at the primary-care level in Latin America?** Given the complexity of the diagnostic process in the initial stages of glaucoma and the difficulty of obtaining the necessary technology for timely diagnosis, the consensus is that strategies must be created at the primary-care level so that moderate or advanced damage from glaucoma can be identified among the most vulnerable population groups and those with greater risk of blindness, in order to provide managed treatment compatible with the local community's cultural considerations and available economic resources.

Detecting early glaucoma is difficult and requires costly high-technology equipment, and it is not possible to detect all cases or to generate a comprehensive strategy for their management, since for the uninformed patient the disease appears to be a trivial problem. In the early stages of glaucoma, patients do not perceive it as a dysfunction, generally rejecting treatment with eye drops when these cause any sort of eye discomfort. This does not mean that early diagnosis should not be emphasized; on the contrary, publicity campaigns are aimed at detecting glaucoma at an early stage, when treatment has better long-term expectations, but this is not the primary objective. Patients with moderate and advanced glaucoma have a more rapid rate of progression in general and a greater risk of blindness.

3.e SCREENING AT THE PRIMARY-CARE LEVEL: IS IT POSSIBLE?

Fernando Barria von-B.

To prevent blindness from glaucoma, we must **establish a diagnostic process at the primary-care level**, identifying any patient with moderate or advanced glaucoma damage, taking into account the existing consensus with respect to glaucoma detection and management:

1.- The first is to identify the **patient with high-risk factors** for glaucoma,[1,2] since screening should only be carried out within these **high-risk groups**. What are these groups? Persons older than age 65, those with a direct family history of the condition, and those of African descent.[3] In the Los Angeles Eye Study, it was also determined that Latino individuals are also more susceptible to this disease. Among the clinical risk factors are unilateral blindness or afferent pupillary defect, intraocular pressure above 24 mmHg, and other lesser factors such as myopia, pseudoexfoliation syndrome (Vogt) or thin cornea, among others[4] (see section 3.a).

2.-**How should screening be performed at the primary-care level?** There is no single universal test at the primary-care level for the diagnosis of glaucoma in the community, which would accurately identify established cases of glaucoma and distinguish them from normal cases. Nevertheless, what screening test could be considered for identifying a glaucoma suspect?

i.- **Intraocular pressure** is not the most appropriate test to be used for screening, since it has low sensitivity for detecting the condition. In the Baltimore studies, only 50% of glaucoma patients had elevated intraocular pressure at their first examination.[5] In addition,

it does not measure the functional state of the eye, nor any visual field damage. However, a measurement of more than 28 mmHg can be taken into account as a possible case affected by glaucoma until the contrary is demonstrated.

ii.- **Examination of the optic disc** is possibly the most important test, although it is not easy to quantify morphological changes, such as an increase in excavation (>0.6 on the vertical axis in less than 5% of the normal population, and >0.8 in less than 2%), asymmetry of the excavation, the presence of a focal notch, optic disc hemorrhage or peripapillary atrophy, for a diagnosis of glaucoma or glaucoma suspect (sections 3.b and 3.c). The challenge is to provide continuing medical education so that general ophthalmologists have access to uniform diagnostic criteria and can quickly refer patients to the next level when necessary.

iii.- **Perimetry is necessary to evaluate glaucoma-related damage. Frequency doubling perimetry** allows the detection of moderate or severe glaucoma damage with 95% sensitivity.[6] A study[7] concluded that the presence of eight defects in its C-20 mode identified moderate or advanced glaucoma damage with 99% sensitivity; however, it has only 41% specificity, generating many false positives, and thus it must be complemented by analysis of the optic disc. The advantage of this exam is that it is done with portable, low-cost equipment, and it does not require lenses except in cases of severe ametropia; it has a quick learning curve; and it is rapid, taking only one minute per eye in its C-20 screening mode. The computerized white-on-white visual field test is a higher-cost technology, requiring specialized human resources and more time to carry out the exam; however, it is crucial for an accurate diagnosis of glaucoma.

iv.- **Analysis of the nerve fiber layer** with technology such as optical coherence tomography (OCT) allows the detection of changes in the nerve fiber layer, but these are high-cost pieces of equipment. This examination has 90% sensitivity and 68% specificity for moderate and advanced glaucoma damage,[8] and it detects advanced loss of the visual field associated with losses in the nerve fiber layer.

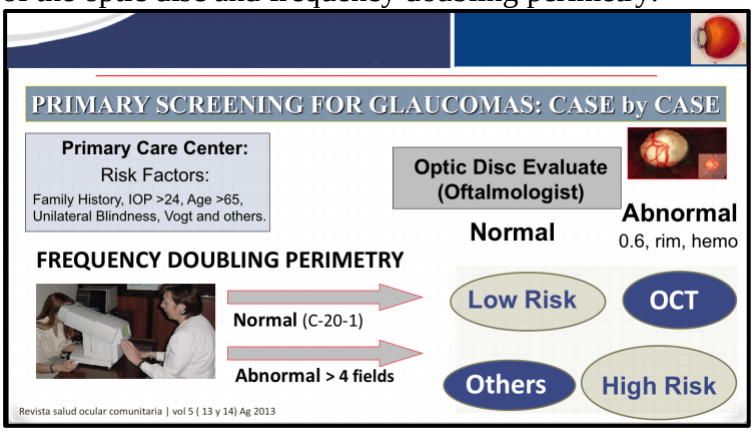
For a screening test to be considered, it must have high sensitivity, in order to detect all cases, but for the purposes of cost-effectiveness, a high-specificity test is also required, so that only true cases of glaucoma are identified. Unfortunately, there is no test which is 100% sensitive and 100% specific in glaucoma detection, unless the patient is already in an advanced stage.[9] Some meta-analyses have shown that the tests with greater sensitivity include ophthalmoscopy with a photo of the optic disc, some kind of examination of the nerve fiber layer, and frequency doubling perimetry with a C-20 tracking strategy. Thus, all of these technologies are useful for detecting moderate or advanced glaucoma, but is it possible to carry out screening at the community level? Although there is no single best strategy, there are some initiatives that may be considered, as follows:

2a.- **Telemedicine** permits the identification of an advanced case of glaucoma by detecting abnormalities in the optic disc. A theoretical flow would be to evaluate the optic disc at a reading center, using a standardized photo to be judged as normal or abnormal.[10,11,12] If suspicious changes are detected, the next step must be a visual field test or optical coherence tomography (OCT) of the optic disc, or if the disc is highly altered, the case should be referred for further evaluation,[9] while always appropriately informing and educating the patient. A study involving the diabetic retinopathy screening program in England[13] concluded that images of the optic nerve may be used as a screening strategy to detect cases of advanced glaucoma in the diabetic population. From a total of 11,565 images, 216 (1.8%) suspicious cases were derived, with 170 (1.4) referred for a complete

study, confirming a diagnosis of glaucoma in 113 (0.9). It is evident that we must also consider the costs associated with the false positives which are referred to the next level for examinations. Another study[14] carried out at the primary-care level to determine the usefulness of retinography as an early detection tool for chronic open angle glaucoma in persons with risk factors found a very low sensitivity level (21%, CI 95%: 0-43%) and thus it should not be chosen as the only test for the early diagnosis of glaucoma.

2b.- A second strategy is to detect glaucoma suspect cases during an **ophthalmological examination** of patients with risk factors. This would involve **analysis of the optic disc**, ideally with stereopsis (90 D lens), in addition to a complementary exam with **frequency doubling perimetry** (C-20) to classify the patients (Figure N 1). Those cases with a normal optic disc and perimetry showing no changes are recommended to continue with periodic checkups, but if perimetry shows alterations, an evaluation process is added to rule out other pathologies. Patients with abnormal optic discs but normal perimetry receive an additional OCT exam. If frequency doubling perimetry shows alterations, the patient is classified as a glaucoma suspect and must undergo further studies to confirm the diagnosis. A study[15] described this strategy for glaucoma screening on the primary-care level and estimated that among the referrals for suspected glaucoma, 55% had no damage and were able to continue their checkups at the primary-care level. Where glaucoma or another pathology was suspected, they were referred to the secondary level.

Figure N 1: Glaucoma Screening Strategy at the primary-care level, including evaluation of the optic disc and frequency doubling perimetry.



2c.- A third possibility is to have all of the **high-tech equipment** (computerized visual field and/or OCT) available at the primary-care level, to test all patients with risk factors, and then to have the results evaluated by an ophthalmologist in a consultation or via telemedicine, to confirm or rule out suspected glaucoma on a case-by-case basis. The main barrier to this strategy is that this equipment is costly and difficult to transport, and it requires specialized human resources to operate. In general, these technologies are used to confirm a diagnosis of glaucoma, or for glaucoma tests in developed countries, rather than as screening tools at the primary-care level. However, successful telemedicine programs have been developed in various parts of Latin America (see section 3.g)**. Public education is key, since no benefits are obtained from glaucoma screening in patients who are currently asymptomatic and have good vision if they do not understand the risk of blindness.**

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3.f PRIMARY GLAUCOMA SCREENING: An unfulfilled need

Eugenio Maul F. and Fernando Barría von-B.

Glaucoma is among the leading causes of irreversible blindness,[1] with the root of the problem being late detection and the abandonment of regular exams and treatment by diagnosed patients. This issue was already described 40 years ago,[2] and a recent publication confirmed that we continue to face the same situation.[3] Given that the **great majority of individuals with glaucoma are unaware that they have the disease**, and it is estimated that less than 10% of patients in Latin America are aware of their condition,[1] a screening process is necessary to achieve earlier detection and to avoid blindness. The problem is that there is no specific method for detecting glaucoma in the general population. It is estimated that the Latino population has a greater prevalence of glaucoma than the European population, estimated at between 3% and 4% of those over age 40.[4] A low prevalence combined with a low-specificity exam results in a large quantity of false positives, which in addition to creating anxiety among healthy individuals, overloads the health system, making it an intervention with a low level of cost-effectiveness. An additional argument is that visual field tests have lower effectiveness in populations at lower socio-educational levels, due to false positives arising from the learning effect, which on average is greater than 5 visual fields (Dr. Jimena Schmidt, Congreso Chileno de Oftalmologia 2012). Thus, **the most significant outcome of community screening for glaucoma is simply to create awareness of the disease** and its impact on the population.

The first factor to consider is that we must **concentrate on groups at higher risk,** such as those over age 65, considering that the prevalence increases with age (those over age 75 have rates of glaucoma close to 10%[5]) or those with a family history of the condition (the prevalence is 10 times greater in first-degree relatives[6]). In these high-risk groups, a screening process can be cost-effective. The best tool for detecting glaucoma is an

examination of the optic disc by an experienced doctor, concentrating on the neuroretinal rim more than the excavation, and taking the diameter of the optic disc into account in the interpretation of the findings. We must educate patients about the importance of coming in for thorough ophthalmological exams, and we must also train ophthalmologists to carry out the exams, considering a study[7] which showed that nearly half of patients diagnosed with glaucoma had been previously evaluated by a visual health professional during the past year. There are some **protocols** which combine different exams, including visual acuity, air puff tonometry, non-mydriatic fundus photography, Optical Coherence Tomography (OCT), and visual field tests, which would improve sensitivity and specificity, but at a high cost. In spite of improvements in technology, to date there is no evidence that supports their effectiveness and cost-benefit relationship. One suggested option is to detect only more advanced cases of the condition, for instance by screening for unilateral blindness (glaucoma is a bilaterally asymmetrical condition), or for a highly excavated optic disc. Telemedicine is already playing a role in screening for diabetic retinopathy, through photographs which allow the identification of a highly excavated optic disc, and this modality will likely continue to improve gradually over time.

For now, **we must focus on raising awareness in the community** that glaucoma is an disease capable of causing blindness, and thus it is extremely important to have periodic ophthalmological checkups at the intervals recommended by the American Academy of Ophthalmology;[8] furthermore, if a patient has risk factors for glaucoma, this must be mentioned to the ophthalmologist so that a more specific examination can be performed. With regard to screening, if it is carried out, it must be oriented toward population groups at greater risk, with an emphasis on creating expeditious referral channels to confirm or rule out the condition, and on equipping the health care system to effectively manage these cases.

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3.g A TELEOPHTHALMOLOGY PROGRAM TO DETECT OCULAR PATHOLOGIES: A great help for "isolated communities."

Juan Carlos Rueda et al. *

*Based on posters presented at the World Glaucoma Congress in Helsinki, 2017 and at the ARVO annual meeting, Baltimore, USA, May 2017.

Emerging countries, such as Colombia, have **limited resources for specialized care in rural or underserved areas.** Thus, government-financed telemedicine programs in ophthalmology have shown themselves to be ideal tools to provide vision care in outlying regions. An example of this is the eye care program for the **indigenous population** of

Guainia, an area of the Amazon forest bordering Venezuela and Brazil. After more than 20 years of experience in prevention and detection programs for patients with glaucoma, we decided in 2015 to **carry out screening among high-risk population groups**, which would provide an improved cost-benefit ratio. We selected the population older than age 50, with hypertension or diabetes and a family history of glaucoma or blindness. At first we carried out screening with FDT campimetry and intraocular pressure, resulting in a very high number of false positive cases. I would like to emphasize the **evaluation of the narrow angle**, since it is a highly prevalent pathology among Hispanic patients, especially in women of short stature over age 50.

METHOD: 1.- A **public awareness program about eye diseases** and the opportunity to participate in a detection campaign was financed and publicized by the local authorities several weeks before the planned activity. 2.- A trained visual health team **(optometrists and nurses) worked in a mobile clinic with technological capacities** to send information derived from a clinical evaluation (including visual acuity, Goldmann applanation tonometry, gonioscopy with Sussman lens, fundus with a 90D lens) to a reading center in the capital of Santander. **Suspected glaucoma was defined as**: **IOP> 21 in at least one eye, cup> 0.6.** Positive cases were subjected to **photography** of the nerve, **OCT, FDT** (complete matrix of the 24-2 program), **pachymetry** and photographs of the anterior/posterior segment. These data were also sent to the reading center. **A definition of the disease** was established in order to refer positive cases to a specialist center and provide the basis for definitive diagnosis and treatment.

RESULTS 1.- In rural areas of Colombia: During a four-month period, in 51 municipalities (58.6%) of Santander, Colombia, a total of **7,234 participants** (4,510 women) were evaluated by the mobile teams, with an average age of 64.7 years (SD = 13.8), of whom 4,468 (60.3%) were visually healthy. **Table 1** shows the diagnoses identified among the participants who were examined.

Table 1. **Conditions identified during the teleophthalmology campaign in the Department of Santander, Colombia**.

	SEX			
DIAGNOSIS	**Female**	**Male**	**Total**	**Percentage**
Cataract	610	289	899	12.2
PACS-PAC*	602	251	853	11.6
Pterygium	358	186	544	7.4
Glaucoma Suspect	253	84	337	4.6
Glaucoma	154	52	206	2.8
Diabetic Retinopathy	19	8	27	0.3

Absolute numbers (total and by gender) and the percentage are shown. *PACS = primary angle closure suspect; PAC = primary angle closure.

Agreement with regard to the diagnoses between the mobile teleophthalmology team and the reading center was 91%. All of the cases (853) of **primary angle closure suspect (PACS) and primary angle closure (PAC) underwent an iridotomy with Nd: YAG laser**.

RESULTS in the indigenous population of Guainia: During a five-month period, **3,545 participants** (1,785 women) were evaluated, with an average age of 58.3 years (SD= 11.9).

Seventy-three percent of the participants were visually healthy. The main diagnoses (table 1) were: **closed irido-corneal angles (398 cases), pterygium (243), glaucoma suspect (204), glaucoma (56 cases) and cataract (69 cases).** 488 subjects (13.8%) had more than one diagnosis. No cases of diabetic retinopathy were found.

Table 1. **Conditions/diseases identified during the teleophthalmology campaign in the Department of Guainia, Colombia.**

	SEX			
DIAGNOSIS	Female	Male	Total	Percentage
PACS-PAC	230	168	398	11.2
Pterygium	160	83	243	6.8
Glaucoma Suspect	153	51	204	5.7
Cataract	37	32	69	1.9
Glaucoma	36	20	56	1.5

The diagnosis of specific eye diseases was well-correlated between the mobile teleophthalmology teams and the reading center (89%). Eighty-six percent of the participants who were positive for eye diseases were treated. **A doctor carried out a bilateral Nd:YAG laser iridotomy in all of the PACS and PAC cases**. All of the patients confirmed to have glaucoma initiated medical treatment.

CONCLUSIONS

1.- **The significantly high figures for angle closure suspect, glaucoma suspect, and glaucoma** can be explained by a number of reasons, due to the manner in which the campaign was promoted and the **broad definition** of the conditions.

2.- It is possible that many people who did not participate in the detection campaign might have relevant eye diseases, and this would call for more effective communication strategies when a teleophthalmology project is being planned.

3.- The teleophthalmology program used among the indigenous participants in Guainia, Colombia, **showed good performance** in identifying eye pathologies and referring patients to a specialized ophthalmological care center.

A mobile teleophthalmology program is a viable option to detect eye diseases in rural communities in Colombia and elsewhere in Latin America. Confirmation of diagnoses and timely, specific treatment can improve eye health standards among any Colombian population group.

THE CURRENT PROTOCOL: An examination is carried out by trained technical assistants, including vision tests with pinhole occluder**,** intraocular pressure by Goldman applanation, non-mydriatic photography of the optic disc, Van Herick angle evaluation and gonioscopy. A patient is considered a **glaucoma suspect** in the presence of intraocular pressure ≥24 mmHg and/or excavation ≥0.6, and **further examinations are carried out**: visual field, pachymetry, posterior OCT (optical coherence tomography) to measure the thickness of the retinal nerve fiber layer, and anterior OCT to detect narrow angles (< 15 degrees, but it has been necessary to evaluate false positives in many cases). This information is sent for evaluation via teleophthalmology to a specialized center to diagnose glaucoma or another ocular pathology and to determine the treatment approach to be taken. In summary, it can be concluded that **simple strategies such as**

teleophthalmology have an effective cost-benefit profile, and they can have very high social and economic impact in our region, above all in areas without medical care. We are also currently working with a systems engineering department on **computerized image analysis** for the early detection of these pathologies.

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3.h THE USE OF IMAGES IN GLAUCOMA DETECTION: Present or Future?

*Dr. Juan Carlos Rueda et al.**

*Based on a work pending publication: **GLAUCOMA DETECTION USING FUNDUS IMAGES OF THE EYE:** Carrillo J, Bautista L, Villamizar J, Rueda J and Sanchez M.

Glaucoma is the leading cause of irreversible blindness, and it is estimated[1,2] that in developed countries, half of patients with glaucoma are not aware of their condition; this situation is assumed to be even worse in developing countries. It is estimated that by 2020, more than 11.1 million people in the world will be blind due to primary glaucoma,[3,4] and the rising economic cost of treating glaucoma in its advanced stages has been reported.[3] In Colombia, the Ministry of Health estimates that there are 296,000 blind persons due to various causes, and glaucoma has a prevalence of 3.9% in persons over age 40 in Bucaramanga.[5,6] There exist **various tests which can be carried out in glaucoma suspect cases**, such as tonometry, gonioscopy (open or closed angle), optical coherence tomography (to measure the **thickness of the retinal nerve fiber layer**) and images of the fundus of the eye to view the retina and the optic nerve. These images are easily taken, whether or not the retina is healthy,[7] and there is portable equipment for detection campaigns in populations without access to medical care.

Various projects have been carried out to provide **automatic glaucoma detection** based on color images of the eye fundus,[8] in which the main difficulty is **estimating the cup-to-disc ratio (CDR), which is the ratio between the size of the disc and the excavation**. A method has been proposed for disc segmentation[9] through the detection of borders, recognizing the problem of peripapillary atrophy which alters the borders of the disc. To segment the cup, a threshold is used of one-third of the intensity of the gray scale. However, the distance between the pixels of the disc and the cup is not always the same,

which complicates the segmentation in different individuals. Segmentation of superpixels[10] is also used to analyze both the disc and the cup, with a sensitivity of 88% and precision of 90.9%. This has the drawback that when the excavation grows in the nasal-temporal direction, the cup is hidden due to the presence of blood vessels. Another segmentation technique using color models[11] achieves 92% precision, but it does not consider that the vascular system covers the entire disc, which interferes with the precision of detecting the correct pixels of the disc. Segmentation has also been implemented with an ellipse adjustment algorithm,[12] **In our work, a computational tool is presented for the automatic detection of glaucomas using eye fundus images**, with an improved method for segmentation of the cup and disc. These algorithms have been tested using images supplied by the Center for Glaucoma Prevention in Bucaramanga, Colombia. Here we present the methods for the segmentation of discs and blood vessels and measurement of the cup-to-disc ratio (CDR).

2. MATERIALS AND METHODS In practice, doctors make a visual estimation of the CDR (area of the cup/area of the disc), by observing the fundus of both of the patient's eyes, which takes one to three minutes for a trained specialist. However, it is susceptible to subjective interpretation, which may increase during a detection campaign, in which each specialist has hundreds of images to read. **If the CDR ≥ 0.6, the case is a glaucoma suspect**. To carry out automatic glaucoma detection, the first step is to obtain the segmentation of the disc and the cup, separating the images of the right and left eyes using a filter, whereby it is obligatory to segment the blood vessels, since the curvature of the vessels helps in detecting the border of the cup in the nasal (N), superior (S) and inferior (I) quadrants of the disc, eliminating the macula, which is an artefact.[13]

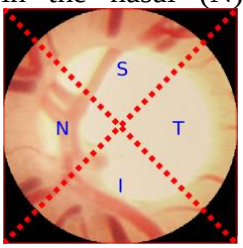

Figure 1. Quadrants of the Disc

The ISNT rule applies in dividing the optic disc into four segments (Figure 1), using the limits of the blood vessels within the cup.[14] Once the disc and the cup have been segmented correctly, we can proceed to measure the cup-to-disc ratio (CDR). A geometric measurement is used to obtain the average ratio; if it is greater than 0.6, the case is classified as a glaucoma suspect and submitted for diagnostic analysis by a specialist.

Results: Tests were carried out on fundus images, and the precision obtained for the segmentation of the disc using the proposed algorithm[10] was 92%. In addition, test measurements were taken using fundus images from both healthy and non-healthy eyes, with ophthalmologists providing estimates of CDR. The results of our algorithm were compared with these reference estimates, generating an absolute error rate of 8.6% and a relative error rate of 19.2%, with a success rate of 88.5% in the detection of glaucoma cases.

In conclusion, we can state that the cup-to-disc ratio (CDR) is a strong indicator of glaucoma, and we present a computational tool that can be used for the automatic detection of glaucoma, based on eye fundus images, using an innovative method for segmenting the cup via thresholding, with a method which utilizes the vessels and the intensities of the cup. The results were obtained using eye fundus images in collaboration with the Center for Glaucoma Prevention in Bucaramanga, Colombia, where the success rate in the detection of glaucoma was 88.5%. A

future paper will cover a study in which we obtain more fundus image data and carry out a more in-depth test of the algorithm.

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3.i THE GLAUCOMA SUSPECT

Jesús Jiménez R., Miguel Luis Moreno M. and Carlos Chau Ramos

In 2003, the Glaucoma Symposium of the Congress of the American Academy of Ophthalmology[1] (AAO) in 2010 and the European Glaucoma Society[2] (EGS) defined **a glaucoma suspect as an individual who presents one or more risk factors and a clinical finding** associated with the development of primary open angle glaucoma (POAG). **The clinical findings** that must be considered for an open angle patient are:

1.- Examining the **characteristics of the optic disc**[1]: the appearance of glaucomatous damage to the optic disc, asymmetry of the cup-to-disc ratio, notch/narrowing of the neuroretinal rim, defects in the nerve fiber layer (NFL) and hemorrhage of the disc. These last three clinical findings are controversial, and in a strict sense they must not be considered as risk factors, but as characteristics of established damage or progression.[3] A splinter hemorrhage may appear in cases of diabetic retinopathy, branch retinal vein occlusion, or occlusion of the central vein of the retina.

2.- Evaluating the **functional characteristics in the visual field;** it has been shown that signs of established glaucomatous damage, in the absence of other clinical signs and other neuropathies, are: arcuate defect, Bjerrum scotoma, nasal step, paracentral scotoma, altitudinal defect, or a pattern of elevated standard deviation.

At the abovementioned AAO Glaucoma Symposium,[1] criteria were established for a glaucoma suspect patient, who may present consistently elevated **intraocular pressure (IOP)** associated with a normal appearance of the optic nerve, normal visual field and normal NFL. In contrast with the AAO consensus, the EGS[2] defines a glaucoma suspect case as: peak IOP readings > 21mmHg and < 30mmHg without treatment, with normal visual field, optic disc and NFL. This lack of rigor in the definition produces **an overlap of the diagnoses of glaucoma suspect and glaucoma in its initial stage**.

Regarding risk factors, both the AAO Symposium and the EGS agree that the following factors increase the probability of developing glaucoma:

1.- Ocular hypertension: This has been established as a risk factor for the development and progression of glaucoma. In contrast with IOP fluctuations, the Advanced Glaucoma Intervention Study (AGIS) associated it with deterioration in the visual field, although the Early Manifest Glaucoma Trial (EMGT) determined that IOP fluctuations are not significantly associated with the risk of developing glaucoma or its progression.[4]

2.- **Advanced age**.

3.- **Low ocular perfusion pressure**: Low arterial pressure together with elevated IOP reduce the perfusion pressure of the head of the optic nerve, reducing blood flow in eyes with vascular dysfunction and causing ischemic damage to the ganglion cells.[5] It is also known that diastolic arterial pressure decreases during the night and is elevated during the day in subjects with POAG, compared to healthy subjects. The Baltimore Eye Survey study concluded that subjects with DPP < 30 mmHg have a six times greater risk of developing POAG in comparison with subjects with values >50 mmHg.

4.- Family history of glaucoma is a strong risk factor for developing glaucoma, multiplying the probability of developing glaucoma by a factor of three.[6]

5.- **Increased cup-to-disc ratio**.

The EGS also points to additional factors, such as a difference in IOP of >4 mmHg between the two eyes, or Afro-Caribbean ancestry, as indicating greater risk.

According to the African Descent and Glaucoma Evaluation Study (ADAGES), subjects with African ancestry have **anatomical differences in the optic disc, retinal nerve fiber layer and other clinical characteristics** compared to those of European descent.[7] These are:

a. Broader optic discs, by some 12%, as shown through Heidelberg (HRT) and optical coherence tomography (OCT). Increase in the size of the pores of the **lamina cribrosa** at the superior and inferior poles.

b. Greater volume of nerve fibers and area of the rim, except in the temporal area (through HRT). Thicker **retinal nerve fiber layer (OCT**) in the superior and inferior zone, but thinner in the temporal zone.

c. The implications of central corneal thickness (CCT) **and corneal hysteresis** (CH), as well as their variation among ethnic groups, have been documented.[8] These studies focus on the finding that CH is lower in those of African descent (8.7mmHg), compared with Hispanic (9.4 mmHg) and Caucasian (9.8 mmHg) subjects. The CH represents a biomechanical difference in the cornea among these groups, and it would be a preferable measurement for evaluating the risk of the onset and progression of glaucoma.

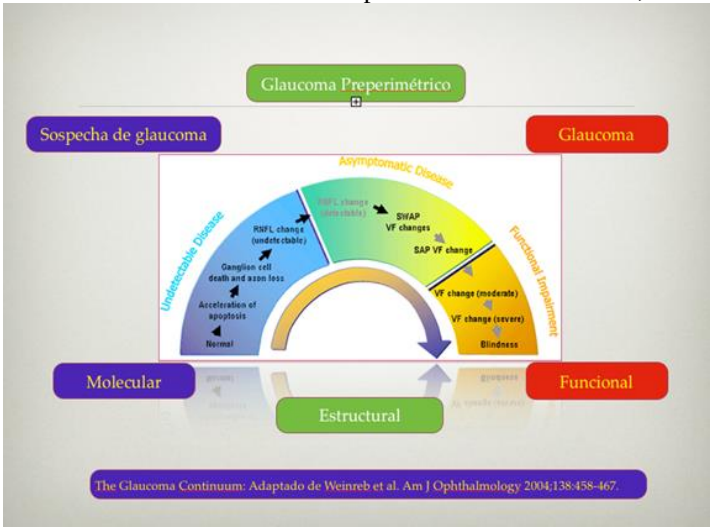
d. Increased **standard deviation** of the pattern.

THE TERM "GLAUCOMA SUSPECT" MAY CAUSE CONFUSION FOR THE PATIENT AND EVEN FOR THE DOCTOR; however, it is necessary to recognize that it is part of the spectrum of the illness, and it can be defined as **any suspicious optic nerve**, **with the presence of at least one risk factor,** with a normal visual field and in the absence of demonstrable structural damage.[9] When the risk factors are weighed, ethnic group must also be included as a factor for susceptibility to the development of glaucoma,[9] and thus the following should be considered: 1.-Age over 60 years 2.-Ocular hypertension, taking ethnic group into account, and 3.- Corneal thickness, taking ethnic group into account.

As we can see, identification of a glaucoma suspect **represents the first step**, in which a number of factors come together that can lead to the development of glaucoma, and **if the conditions for this development are sufficient,** the progress of the damage will become evident (Figure N 1), passing through the phases of the disease and terminating in blindness, which will

occur if we do not diagnose the patient with risk factors in a timely manner, and if we are not able to provide ongoing follow-up for the patient who is a glaucoma suspect.

Figure N 1: Natural History of Glaucoma (preperimetric suspect Glaucoma/ molecular functional structural) The Glaucoma Continuum: Adapted from Weinreb et al., Am J Ophthalmology 2004; 138:458-467.



Clearly establishing a diagnosis, within this broad spectrum, will permit us to discern whether a patient **requires only monitoring and follow-up;** if he or she is a **glaucoma suspect requiring treatment**, taking into account the individual's risk factors; or whether it is a case of **early glaucoma**, in which therapeutic management is essential, as well as evaluation of the prognosis. Today the challenge is to establish an early diagnosis, with the aim of initiating timely treatment. This first step of the illness, that of a glaucoma suspect with sufficient risk factors, is the stage where we find the best opportunity to exercise preventive medicine, leading to early diagnosis of a disease which can be incapacitating. Thus, our knowledge of the risk factors, detailed questioning of the patient and diligent clinical exploration provide the critical route which brings together the necessary elements to successfully establish a diagnosis and appropriate treatment.

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3.j SCREENING: Some final reflections

Fernando Barria von-B. and Eugenio Maul F.

There is currently a problem, and it is that there are **many undiagnosed cases of glaucoma in the community, who arrive at their first examination already in an advanced or end-stage phase.** Because of this, it is necessary to carry out glaucoma screening for early diagnosis on a community level. However, there is no optimal method for detecting glaucoma in the general population, with the strongest argument being the lack of evidence to support its effectiveness and its cost-benefit ratio. Screening the population for elevated **intraocular pressure (IOP) is neither sensitive nor specific** from any standpoint, and it generates excessive costs for a complete examination of those with a positive result. Many detection programs using IOP have been ineffective in finding sufficient cases of glaucoma to justify their cost and the effort involved. Thus, screening programs function more as a tool for public education rather than an effective means to detect glaucoma.

Our first area of concentration must be the **at-risk population**, such as older adults, those with genetic predispositions (those of African descent or with family members who have glaucoma), or those with untreated ocular hypertension, which allows us to undertake cost-effective screening. In these high-risk groups, the prevalence of glaucoma is significant, 6-10% according to age group, and "detection" can produce a significant rate of identified cases.

The best tool for detecting glaucoma is the **examination of the optic disc** by a trained doctor, but many only assess the excavation and do not look at other signs of glaucomatous damage. We must always educate patients about the importance of having a complete ophthalmological exam. Other detection tools include **visual field tests**, which have greater sensitivity and specificity than IOP measurement, but they require equipment, experienced perimetrists and expert interpretation, and, for example in the case of frequency doubling perimetry, as mentioned above, may generate many false positives. **Telemedicine protocols** have been developed as an independent program, which are very sensitive for advanced glaucoma, but they must include visual acuity tests, non-contact IOP, optical coherence tomography (OCT) and non-mydriatic photos of the anterior and posterior segment to improve their sensitivity and specificity. A final option is to complement other tests with OCT, but this equipment is expensive, and it is not always possible to implement it on the primary-care level. All of the above allows only a first filter of cases with risk factors, referring those cases with a well-founded suspicion of glaucoma to the secondary or tertiary level to confirm the diagnosis. Finally, we must consider the **costs of carrying out complementary examinations** to confirm the diagnosis, for those cases which emerge as positive from the screening process.

4.- CONFIRMING THE DIAGNOSIS OF GLAUCOMA: "The End of the Path"

4.a GONIOSCOPY: A necessary examination

Marla Álvarez Padilla and Jesús Jiménez-Román

Gonioscopy is a technique used to evaluate the iridocorneal angle, given the fact that it cannot be directly visualized, since the angle of incidence of light exceeds the critical angle of the water-air interface and causes total internal reflection; thus it is necessary to use a goniolens to evaluate this structure.[1] While this guide addresses open angle glaucoma, it is necessary also to diagnose occludable angle and primary angle closure suspect cases, since the lack of diagnosis

and treatment causes the majority of cases of blindness due to glaucoma. There are two types of gonioscopy:

a. **Direct gonioscopy**: A direct visualization of the angle is obtained, and mirrors are not needed to obtain the image. The patient is placed in a supine position, with an external light source (e.g. Barkan illuminator) and microscopy, to obtain the image. This type of lens is the type generally used in the operating theater for procedures and for evaluation of the angle in explorations under anesthesia. Examples include the Koeppe or Barkan goniolens.[1,2,6]
b. **Indirect gonioscopy:** This is carried out using a goniolens with mirrors or prisms, which reflect the light and allow visualization of the contralateral angle. One advantage of this type of gonioscopy is that it can be carried out with a slit lamp.[1] Examples of lenses of this type are the Goldmann lens (1.2 and 3 mirrors), Zeiss lens and Sussman lens.[1,2,3,4]

TECHNIQUE: Indirect gonioscopy is the most commonly used in everyday practice, since it does not require the patient to assume a supine position, and it can be carried out with a slit lamp. It is performed with low ambient illumination, and a topical anesthetic is used. The patient is asked to look upward, and the goniolens is put into place (applying methylcellulose in some lenses which require it, such as the three-mirror Goldmann lens). The patient is asked to look straight ahead; the width and height of the slit beam are lowered in order to avoid contraction of the pupil; and the eye is examined by quadrants.[1,8] For the horizontal quadrants (nasal and temporal), it is necessary to place the slit lamp horizontally and tilt the illumination arm. Dynamic or indentation gonioscopy is carried out with lenses of a smaller diameter than that of the cornea; pressure is applied on the cornea, displacing the aqueous humor and in turn displacing the irido-crystalline diaphragm toward the rear. With closed angles, this allows us to determine whether the closure is appositional or due to synechiae (does not open with pressure).[1,3,8]

USEFULNESS: Gonioscopy is an important part of a complete ophthalmological examination; it is indispensable for the classification, diagnosis and treatment of glaucoma. In addition, it permits us to recognize the risk of angle closure and to detect certain congenital or acquired abnormalities in the iridocorneal angle.

ANGULAR STRUCTURES: The following must be examined:

Schwalbe Line. This is the anteriormost structure in gonioscopy. It represents the scleral septum and forms the termination of the Descemet membrane. It is visualized as a thin, translucent-white line, which can be more or less pigmented according to the pathology.[1,2,5]

Trabecular meshwork. This follows the Schwalbe line and appears as a grayish or brown line, according to the level of pigmentation. Its inferior portion is more highly pigmented.[1,2,5]

Scleral spur. This is the extension of the sclera, where the longitudinal ciliary muscle is inserted. It is seen as white and opaque beneath the trabecular meshwork.[1,2]

Ciliary body band. This is the part of the ciliary body which is seen in the anterior chamber. It is seen as a gray-brown line below the scleral spur. The thickness depends on the insertion of the iris into the ciliary body.[1,2]

ANGULAR PATHOLOGY

Shaffer Classification. This describes the iridocorneal angle according to the number of structures visible, to evaluate the risk of angle closure.[1,2,5]

Grade 0: ANGLE CLOSURE. No structure is visible. Angular opening 0º.

Grade 1: PROBABLE CLOSURE. Schwalbe line is visible. Angular aperture less than 10º.

Grade 2: POSSIBLE CLOSURE. Schwalbe line and trabecular meshwork are visible. Opening is 10-20º.

Grade 3: NO ANGLE CLOSURE RISK. Schwalbe line, trabecular meshwork and scleral spur are visible. Angle opening is 20-35º.

Grade 4: NO ANGLE CLOSURE RISK. All structures are visible. Angle opening is 35-45º.

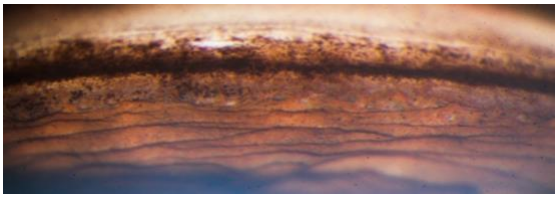
PIGMENTATION. There can be different degrees of pigmentation, and it can occur at different levels. Pigment in the Schwalbe line occurs in the form of a wave, and it is also seen in pseudoexfoliation syndrome; an increase in pigment in the trabecular meshwork is observed in pigmentary dispersion syndrome, as well as in traumas; however, we must seek other data to provide an orientation, such as asymmetry between the two eyes, cyclodialysis, angular recesses, and ruptures of the iris sphincter, among others. Patches of pigment, above all in the Schwalbe line, can be observed when there is iridotrabecular contact in angles closed by apposition (Figure N 1).

IRIS PROCESSES. These are extended projections of the iris which generally run up to the scleral spur (short iris processes) or reach above the trabecular meshwork (long iris processes). It is always necessary to differentiate these from synechiae (Figure N 2).

NEOVESSELS. These vessels cross perpendicular to the scleral spur and the trabecular meshwork. They can be secondary to neovascular glaucoma, venous occlusions or some types of uveitis. They can cause peripheral anterior synechiae and angle closure, and it is necessary to differentiate them from the normal vessels of the iris, which are radial, circumferential and trabecular, but none of them cross the scleral spur.[2,5,7]

Figure N 1: Increase in pigmentation of the angle.

Figure N 2: Iris processes in the angle.



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4.b FUNCTIONAL AND STRUCTURAL EXAMINATIONS

Jorge Gamiochipi and Jesús Jiménez-Román

Evaluation for the diagnosis and management of the patient with glaucoma requires both functional and structural examinations. The **functional analysis of glaucomatous damage is carried out using the visual field**, by evaluating its range and sensitivity. The achromatic or white-on-white (SAP) form is the most popular strategy, establishing criteria for the diagnosis and prognosis of the patient with glaucoma, although there are some limitations, such as the fact that the appearance of visual field defects is observed only once some 25 to 50% of the ganglion cells have been lost. Multiple theories have been put forth to explain why achromatic visual field tests have low sensitivity in patients with very early damage; one of the most important is based on the existence of a redundant visual system and the capacity of multiple groups of ganglion cells to perceive light signals through the superposition of the receptor fields of each cell. Recently, new functional diagnostic strategies have been established which could detect

glaucomatous damage at an earlier stage through the examination of individual groups of ganglion cells, thus avoiding the problem presented in the achromatic strategy by allowing for less redundancy among these cell groups.[1,2] The human retina includes three subpopulations of cones, which have synapses with ganglion cells through the bipolar cells. The information received by the ganglion cells is processed through two systems, one chromatic (red-green and blue-yellow) and one achromatic. In turn, there are approximately 30-50 subtypes of ganglion cells, which are classified according to their projection toward the lateral geniculate body. The anatomical and functional characteristics of the groups[3] are described in Table 1.

Table N 1: Anatomical and functional characteristics of the ganglion cells

Anatomical and functional characteristics of the ganglion cells			
Subtype	Parasol	Midget	Bistratified
Projection to LG cells	Magnocellular	Parvocellular	Interlaminar
Function	Sensitivity to contrast and movement perception	Red-green opposition and central visual acuity	Blue-yellow opposition
Percentage	10%	90%	10%

Diverse strategies have been investigated for the specific evaluation of the various groups of ganglion cells. Among the most currently relevant are: Blue-yellow campimetry, which evaluates the bistratified cells through a blue stimulus on a yellow field; FDT (frequency doubling technology) campimetry, which analyzes the magnocellular cells; and the achromatic strategy or white-on-white, which evaluates all of the cell groups.[3] **White-on-white campimetry** is currently considered the gold standard for diagnosing glaucoma and for assessing the stability or functional progression of the case. There are criteria previously described by Anderson-Patella, designed to **establish the diagnosis of glaucoma**: three points which are not located contiguously on the border of the visual field, with a $p < 5\%$ and at least one of them with a $p < 1\%$ (arch location), pattern deviation < 5% and abnormal glaucoma hemifield test. The presence of two out of these three criteria provides a sensitivity of 95.3% for a diagnosis of glaucoma.[4]

A diagnosis of glaucoma is also carried out through the identification of **structural damage to the head of the optic nerve**, the nerve fiber layer and the complex of ganglion cells, **and their correlation with glaucomatous defects in perimetry**. However, a loss of 50% of ganglion cells must occur previous to the presence of visual field defects as seen in manual kinetic (Goldmann) perimetry, compared to a loss of some 25-30% in white-on-white perimetry (SAP), and thus the diagnosis of glaucoma is made late, with severe alterations already present. This justifies **structural diagnostic methods** for the head of the optic nerve, the lamina cribrosa, the vasculature of the head of the optic nerve, and that of the complex of ganglion cells, in order to detect early damage due to glaucoma. The **first neurons affected are the ganglion cells of the retina** and their axons. Their density is maximal in the fovea, where approximately 50% of the total of these cells are located. For many years, the technology has focused only on studying the head of the optic nerve and the thickness of the nerve fiber layer for the diagnosis of glaucoma and assessment of its progression. Previous studies have demonstrated that time-domain **Optical Coherence Tomography (OCT)** is capable of identifying macular thickness and volume, which is useful in the diagnosis of glaucoma. The new generation of tomography has also incorporated spectral-domain technology, which offers greater resolution and speed in acquiring results. This has permitted the use of computer programs which measure two new complexes: the ganglion cell complex (CCG), obtained through segmentation of the internal layers of the retina, including

the nerve fiber layer, the ganglion cell layer, and the inner plexiform layer; and the ganglion cell-inner plexiform layer (GCIPL).[5] Two new parameters can be obtained through this software, which are the loss of global volume and the loss of focal volume; these provide a quantitative value for the changes in the volume of ganglion cells. Numerous advantages can be obtained in carrying out this exam for the analysis of the **thickness of the nerve fiber layer (TNFL)** and the **optic nerve head (ONH)**. Tomographic analysis of the macular region is simpler than that of the optic nerve because of its location, allowing less time for the exam and better quality of the analysis. Additionally, multiple studies have shown that for some patients, glaucomatous damage in early phases occurs initially in the central region, and thus analyzing this area can offer an earlier diagnosis under some conditions. In a study by Mwanza and collaborators, the diagnostic potential of the GCIPL was evaluated, through analysis of the ganglion cells with Cirrus-HD optical coherence tomography to differentiate healthy eyes and those with early glaucoma, compared with the analysis of TNFL and ONH with the same machine. The parameter with a ROC curve with greater value for the GCIPL is the minimum thickness, with a value of 0.959, which is greater than any value from the analysis of the NFL. The study concluded that the diagnostic capacity is high, and similar to that of any parameter of analysis of the NFL and ONH, so that the exams can be complementary.[6]

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4.c ANALYSIS OF THE VISUAL FIELD: ¿What to evaluate in a visual field?

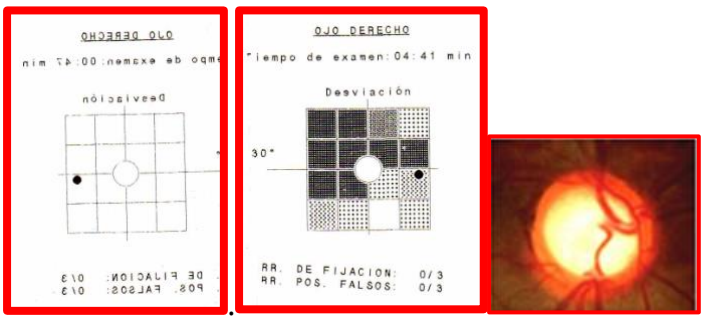
Fernando Barría von-B., Eugenio Maul de la P. and Luis Peña G.

GLAUCOMA SUSPECT: Rule out moderate or advanced glaucoma damage (uni or bilateral)

1.- **FREQUENCY DOUBLING PERIMETRY** in C-20 screening mode

NORMAL FDP: Rule out moderate or advanced glaucoma damage

ALTERED FDP: 8 or more fields altered: suspicious damage

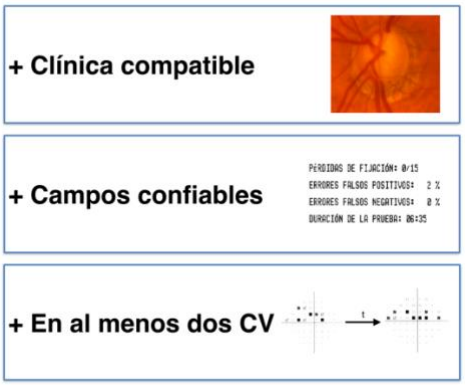


FDT Normal Abnormal (>4) Several Damage (Optic Disc)

2.- HUMPHREY CC-120: 16 points not seen at 4/4 or 8 in a single quadrant
(Criterion: Baltimore Eye Study)

Flowchart:
GLAUCOMA SUSPECT: Refer to a specialized center (diagnosis/treatment)
LOW RISK OF GLAUCOMA: Monitor on the primary-care level (normal optic disc and visual field)

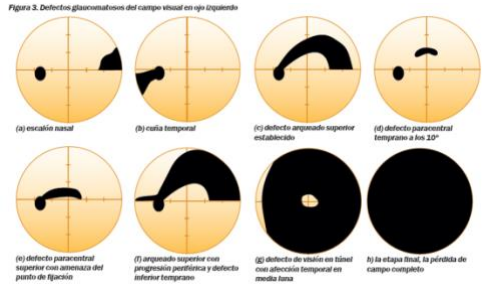
DIAGNOSING GLAUCOMA: Correlation between optic disc and visual field!!
HUMPHREY: Use white-on-white visual field, SITA 24-2 (gold standard)
DIAGNOSIS CRITERIA: Combine clinical findings/reliable visual field tests/repeatable defects

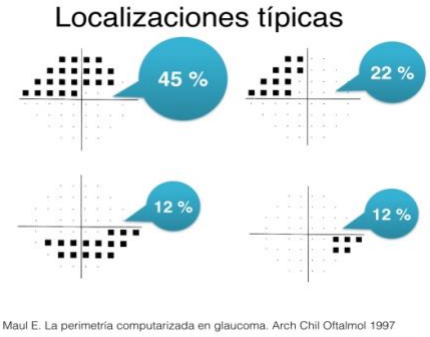


VISUAL FIELD W/W Sita 24-2
92% Sensibility (82% for initial damage)
82% Specificity
(Takahashi el al: Comparison of algorithms for Interpretation of SITA. Clinic 2008)

Use Anderson criteria: 24-2 Humphrey
Model Deviation (MD): P<5%
Model: ≥3 points P<5% at least one P<1%
Hemifield Test (PHG): Outside normal limits
(Walsch Visual Fields examination and interpretation, AAO 1996)

¿WHAT DEFECTS TO LOOK FOR?
Nasal / Paracentral Step
Arcuate Defects





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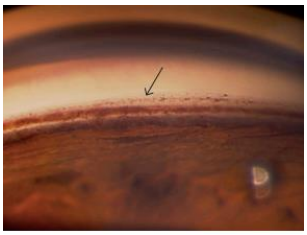
4.d Basic Elements in the Diagnosis of Glaucoma

María José Oportus Z. and Alejandra Varas C.

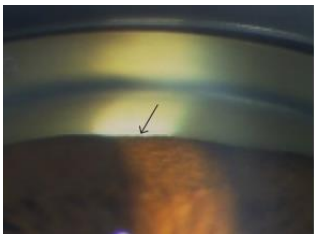
A basic evaluation in order to reach a diagnosis of glaucoma:[1]

- CLINICAL HISTORY: Family history of glaucoma, history of ocular contusion or associated pathology.
- VISUAL ACUITY: This is only affected in advanced stages of glaucoma, but it also aids in differential diagnosis.
- Autorefractometry: evaluate myopia (risk factor for POAG) or hypermetropia (PACG).

- Biomicroscopy: Rule out Vogt, evaluate state of the lens, depth of the anterior chamber (periphery), signs of active or past inflammation. Evaluate corneal edema (high acute or chronic IOP) and red eye (drug allergy).
- Evaluate pupil: light reflex: pupillary defect gives asymmetric or advanced glaucoma.
- TONOMETRY, Goldmann or Shiotz tonometry previous to dilatation or gonioscopy.
- GONIOSCOPY, Goldmann or Zeiss/Posner: evaluate iridocorneal angle (contact of the iris with the trabecular meshwork with indentation) as well as neovessels or pseudoexfoliation. Rule out anterior synechiae.



Open angle



Angle closure

- EXAMINE THE DISC with a 78 or 90 diopter lens: also, direct ophthalmoscopy.
    - Look for: excavation ≥ 0.5; focal defects RNFL, focal defects of the rim, increased vertical excavation, cup/disc asymmetry, focal excavation, disc hemorrhage, changes to the ISNT rule, among others.
    - Advanced damage includes excavation greater than 0.7 and disc hemorrhage.
- VISUAL FIELD: localize and quantify loss of the field (annex N 1).
    - Defects typical of glaucoma, useful for diagnosis and follow-up.
    - Computerized: White-on-white gold standard, 24-2 for follow-up.
    - Also: Frequency doubling technology, short-wavelength automated or Goldmann perimetry
- Pachymetry[2]: with lesser thickness of the central cornea, IOP readings are underestimated, and with greater central corneal thickness, IOP is overestimated.
- STRUCTURAL EXAMINATION:
    - Photography of the optic disc:
    - Image analyzers for the optic nerve: useful in the initial stage.
        - Confocal scanning laser ophthalmoscope
        - Optical coherence tomography
        - Scanning laser polarimetry

DIAGNOSIS OF POAG OR PACG

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4.e WHEN TO REFER TO A SPECIALIST

Jimena Schmidt C.

Glaucoma has an approximate prevalence of 2 to 3% in persons over age 40, and it increases with age, with a prevalence at age 80 of approximately 10% of the population. Thus, with the aging of the population, the disease will increase. If all glaucoma suspects and patients with glaucoma were to be seen at the highly complex tertiary care level, these centers would not have the logistical capacity to provide thorough and timely health care. Thus, we face the challenge of prioritizing ophthalmological care, so that low-risk patients are examined by an ophthalmologist, not by an assistant, in primary care centers. Studies show that among patients referred to tertiary care, only 10% are ultimately diagnosed with glaucoma, which points to inadequacies in the referral criteria.[1,2] On the other hand, we also face the challenge of preventing blindness due to glaucoma, especially in the face of underdiagnosis, which can reach up to 50% in developing countries; at the time of diagnosis, from 10 to 39% of glaucomas are already in a later stage.[3,4] On the other end of the scale, we also have the problem of overdiagnosis and overtreatment: in many cases, due to a lack of knowledge or thoroughness, ongoing hypotensive treatment is prescribed to individuals who do not benefit from this therapy, with the corresponding economic consequences and adverse effects.

In the case of a **glaucoma suspect**, a complete medical history must be taken, seeking factors such as ocular contusion due to trauma, the use of topical or systemic steroids, pathologies associated with higher cardiovascular risk, and family history. An examination must be carried out, including gonioscopy, refraction and dilated eye fundus, specifically seeking signs of pseudoexfoliation and defects in the nerve fiber layer. It is important to evaluate the depth of the interior chamber with the Van Herrick technique, but this does not replace gonioscopy, an exam which must be repeated during follow-up. The diagnosis of primary angle closure suspect depends on gonioscopy, and it does not require confirmation with images of the iridocorneal angle, nor a dark-room test or positive provocative test, which may be requested in cases of doubt, but are not necessary to confirm the diagnosis.

Faced with a reading of **elevated intraocular pressure**, measured with the air puff or applanation method, we must take serial measurements with Goldman or Perkins applanation tonometry, to verify if this high reading is isolated or ongoing, and to assess the peak level of pressure it reaches. There is general consensus that if ocular pressure by applanation is not greater than 24 mmHg, and the examination of optic nerve is normal, the patient does not need to be referred to tertiary care, and the need for treatment will be determined according to risk factors such as a family history of glaucoma, a thin cornea, the presence of pseudoexfoliation, etc.[5] With intraocular pressures of 28 mmHg or greater, it is advisable to initiate hypotensive treatment independent of the state of the optic nerve, since in this case there is also the risk of retinal thrombosis. One must be rigorous in the **evaluation of optic discs** of different sizes, due to the risk of underdiagnosis with small optic nerves (less than 1.5 mm in vertical diameter), where an excavation of some 30% may be compatible with glaucoma and visual field damage; and of overdiagnosis and overtreatment with optic nerves of increased size (larger than 2.2 mm in vertical diameter), where an excavation of 80% may be of physiological origin, and the visual field perfectly normal. When **ordering a visual field test** for an investigation of glaucoma, we must

consider the learning effect, so that if the first visual field shows abnormalities, it is highly recommended to repeat the exam. In the Ocular Hypertension Treatment Study (OHTS), up to 88% of initial visual fields showed improvement in successive trials. If alterations in the visual field continue to be observed upon repetition, it must be evaluated whether the pattern of the defect is clinically compatible with the damage to the optic nerve, for example if there is a notch-type narrowing of the inferior neuroretinal rim associated with a superior Bjerrum scotoma.

There are many glaucoma suspects and patients with glaucoma whose cases can be controlled safely at primary care centers as long as they possess the necessary equipment, including applanation tonometry, refraction, slit lamp, gonioscopy, pachymetry and computerized visual field. It is highly recommended to take photographs of the optic nerve to document its characteristics and provide ongoing follow-up.

The suggestions would be:

I.- The following patients **can be served at the primary-care level:**

1. Family history of glaucoma
2. Monitoring of the optic discs of glaucoma suspects, if the capacity is present to evaluate changes.
3. Ocular hypertension with IOP up to 24 mmHg
4. Mild to moderate open angle glaucomas without visual field progression

II.- The following patients **must be seen by a specialist at a tertiary care center:**

1. Angle closure glaucoma
2. Glaucoma secondary to pseudoexfoliation
3. Pigmentary glaucoma
4. Traumatic glaucoma
5. Afro-American patients with glaucoma
6. Glaucoma in one eye
7. Childhood glaucomas
8. Neovascular glaucoma
9. Uveitic glaucoma
10. Post-surgical glaucomas
11. Glaucoma in a patient with severe myopia in which progression is difficult to detect
12. Glaucomas with mean defect greater than 20 dB, independent of etiology
13. Glaucomas with rapid progression (greater than 1 dB/year): to identify these patients, we must order at least six visual fields during the first two years of glaucoma monitoring.[6,7]

The most common errors in **patient referral** to tertiary centers result from incomplete clinical examinations, with the overdiagnosis of glaucoma frequently seen in individuals with large optic nerves. On the other hand, it is very serious to fail to diagnose or refer patients with angle-closure glaucoma and/or pseudoexfoliation, due to the aggressiveness of these types of glaucoma, which may involve significant fluctuations in ocular pressure and a rapid deterioration in visual function. There is also the risk of failing to detect rapidly progressing glaucomas, which are seen in approximately 6-7% of all patients; this occurs when insufficient visual fields are requested during the first years after diagnosis. In recent years, **telemedicine** has shown itself to be highly useful as a **diagnostic tool**. By sending the patient's clinical data to specialists, including 3D photographs of optic nerves, visual fields, optic disc OCT, ocular pressure curves and pachymetry, a clear diagnosis can be

reached in 95% of glaucomas and 83% of cases of ocular hypertension. This permits a rapid resolution of doubtful cases and optimizes the limited resource of the glaucoma specialist, who can examine the more complex cases in person through referral.[8,9]

Without a doubt, we are facing **a public health challenge in prioritizing the screening, diagnosis and treatment of patients with glaucoma**, especially in countries with limited resources and growing older populations, and we must implement the necessary measures to ensure that this condition will not cause a deterioration in the visual health of our population.

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CONSENSUS[1]

EXAMINATIONS ASSOCIATED WITH THE DIAGNOSIS OF GLAUCOMA:

Intraocular pressure:

• Determines control and follow-up of glaucoma, **not its diagnosis.**

• Ocular hypertension is the most significant risk factor for developing glaucoma.

• IOP fluctuation is a risk factor for the progression of the disease.

• The target level of intraocular pressure is an individualized and dynamic estimate, and it is determined in order to avoid progression of the glaucoma.

Pachymetry:

• Must be carried out in glaucoma suspects and patients with glaucoma, because it aids in the management of a patient with glaucoma. **There is no validated conversion algorithm.**

Gonioscopy

• Gonioscopy classifies the type of glaucoma (open angle or angle closure) and aids in its management. The angle changes over the years, and thus this examination must be repeated.

Perimetry:

• It is fundamental for diagnosis as well as follow-up of patients with glaucoma.

• At least three reliable exams are required to establish a baseline diagnosis of damage, along with periodic follow-up exams, depending on the damage and treatment plan.

• If a white-on-white test is normal, it can be complemented with a structural exam or blue-yellow campimetry, and/or matrix FDT for early diagnosis.

• Carry out visual fields every three months in patients with advanced glaucoma to evaluate progression.

Structural Examinations:

• Diagnostic equipment: OCT III and HRT III are used to detect early structural alterations in the glaucoma suspect or patient with preperimetric damage.

1. Consensus of the Grupo Mexicano de Investigación en Glaucoma and Colegio Mexicano de Glaucoma: Dr. Jesus Jimenez

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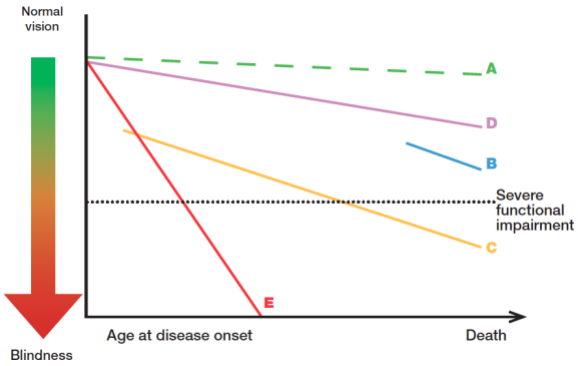
5.- MANAGING GLAUCOMA: Avoiding vision loss: our greatest challenge.

5.a RATE OF PROGRESSION: The vision loss curve and blindness risk

Adapted from the Glaucoma Guide of the European Glaucoma Society[1]

The visual field is bilateral, and thus the visual field of the better eye determines the patient's quality of life. However, the rate of progression for each eye must be evaluated to determine the treatment for the individual patient. The **rate of ganglion cell loss,** that is, the speed of the deterioration called the **rate of progression** is different in each patient, and quality of life is reduced only when the defects in the visual field are severe.[1] Line A shows the effect of aging (Table N 1). In a patient with glaucoma, the loss of visual function is more rapid, and in a diagnosed case in an older patient, line B shows a lower risk of severe visual loss than in a young patient with the same level of damage and progression, as shown by line C. A slow rate of progression, associated with treatment, is shown by line D, while rapid progression requires aggressive treatment with a lower target intraocular pressure, and this is shown by line E (Terminology and guidelines for glaucoma, Chapter 3, p. 132, www.eugs.org/eng/guidelines.asp).

Table N 1: Varying curves of progression of vision loss in a healthy eye and an eye with glaucoma



The rate of progression is generally linear, and it determines the target pressure and the intensity of the treatment, in order to limit the progression of the damage as much as possible. In visual fields, progression can be evaluated with the MD or VFI indices, which are corrected for age, so that a normal eye does not show age-related deterioration over time.

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5.b PROGRESSION IN GLAUCOMA: How to evaluate it

Jorge Gamiochipi and Jesus Jiménez-Román

Glaucoma is the leading cause of irreversible blindness on the world level.[1] Numerous epidemiological studies have shown that the only way to slow the rate of progression is to reduce intraocular pressure. One of the most significant questions in recent years has been how to differentiate those patients who will have a "benign" course and whose visual field who will not suffer significant damage due to the nature of their illness, and those with **more aggressive subtypes of glaucoma**, which can rapidly lead to blindness. It has been reported that 3 to 17% of patients with glaucoma will have aggressive courses, progressing toward significant visual field loss in spite of medical treatment. This group of patients, with visual field loss of some -1.5 dB annually,[2,3] are known as rapid progressors.

Monitoring of glaucoma progression has classically been based on examinations of the visual field over time, although other techniques also exist. One of the classic studies, which defined criteria to identify patients with progressive visual field loss, was the EMGT (Early Manifest Glaucoma Trial).[4] In this study, which analyzed the rate of progression, patients with untreated glaucoma progressed at a rate of approximately -0.4 dB/year,[5] while visual field loss associated with aging was approximately -0.06 dB/year.[6] Taking these theoretical data into account, a patient would require 20 years without treatment to suffer significant vision loss, close to -12 dB.[7] As mentioned, however, a not insignificant percentage of patients are rapid progressors, who have a high probability of progressing to blindness. With the aim of identifying this group of patients at an early stage, international guides recommend that three visual field tests be carried out per year during the first two years.[8]

During the 1980s and 90s, studies were carried out to gain a better understanding of visual field damage progression among patients with glaucoma, in order to evaluate methods for changing the trajectory of the disease, such as the use of hypotensive medications, and to establish criteria for analyzing these changes over time in an objective manner. The most influential study was the EMGT (Early Manifest Glaucoma Trial),[4] which showed that the consecutive loss of sensitivity at three contiguous points during three consecutive visual field evaluations, with a probability of less than 5%, was sufficient to establish a tendency toward progression. These criteria have been useful in standardizing methods to manage glaucoma, and the **GPA (Glaucoma Progression Analysis) software**, used by the Zeiss company, is based on these criteria. However, evaluation of the visual field alone has **low sensitivity in the early phases of the disease**, and it delays the diagnosis of the progression of glaucoma. Multiple factors can explain this low sensitivity for the early detection of progression. Initially, the current strategy evaluates points separated by 6º, and thus the redundancy of the visual system can compensate for losses in these spaces. There is also inter-exam variability, which makes it difficult to identify

definitive changes. The evidence shows that losses of ganglion cells may occur up to 8 years before repercussions in the visual field are evident.[9]

New strategies for detecting progression in its early phases have been developed in recent years, with the most important technological advance being the advent of **Optical Coherence Tomography** and the development of spectral-domain technology. These tools permit precise evaluation of the **thickness of the ganglion cell layer** and the behavior of these cells over time. Some criteria have been developed to determine whether a loss is significant, but to date they are not generalizable for all ethnic groups and all patients.[10] The current use of OCT has great relevance for **diagnosis and early follow-up** of patients with glaucoma and can even be superior to campimetry at these stages. Unfortunately, because of the "floor effect," in highly advanced stages of the disease, the capacity to detect further reductions in the thickness of the nerve fiber layer is very limited.[11]

In the future, with regard to clinical follow-up of the patient with glaucoma, the focus will be on several factors, even before the start of treatment: **risk factors associated with rapid progression, negative responses to hypotensive medications, and target intraocular pressures.** All of this will be carried out in a personalized manner, taking into account genetic, ethnic and demographic factors. Kalman filters are currently being used, fed with data from observational studies of large cohorts (AGIS, CIGTS), to determine the rates of progression in various patients and their responses at different target pressures. These strategies are based on incorporating artificial intelligence to make decisions with a higher degree of clinical evidence and greater certainty.[12] The visual field is the strategy most commonly used to evaluate the type of progression of glaucoma, rapid or slow, and OCT is a diagnostic aid in earlier phases of the disease. **The combination of these tests makes monitoring of the progression more sensitive** in the different phases of the disease. However, in stages with moderate or severe damage, the rate of progression is evaluated through automated perimetry.

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5.c PRINCIPLES OF FIRST-LINE MEDICAL TREATMENT OF GLAUCOMA

Alfonso García López, Jesús Jiménez Román and Carlos E. Chau R.

The objectives of treatment for patients with primary open angle glaucoma (POAG)[1] are: 1. Control of IOP within the target range; 2. Stable optic nerve and nerve fiber layer; and 3. Stable visual fields.

To date, it has been demonstrated that the only modifiable factor for **slowing the rate of glaucomatous progression is reducing intraocular pressure** (IOP), through medications and/or laser therapy as a first-line therapeutic option. Incisional surgery for glaucoma is reserved as a second therapeutic option, when the first two treatments have not significantly reduced IOP due to functional glaucomatous damage in the patient. The degree of reduction in IOP is a personalized parameter for each patient, and it depends on various factors such as: age (life expectancy), family history (glaucoma, blindness), comorbidities, baseline IOP, visual field damage, and damage to the optic nerve and nerve fiber layer. All of these factors considered together lead us to determine a target IOP. Before initiating treatment, whether medical or surgical, it is important to **establish an effective doctor-patient relationship** in order to communicate to the patient that glaucoma is a chronic and asymptomatic disease, which requires continuous and monitored treatment for life, and that all of the topical hypotensives have local and systemic side effects. We must stress that therapy is aimed at reducing IOP in order to preserve the visual field for the longest possible time and avoid reductions in quality of life, but it will not improve visual acuity. Appropriate treatment requires adherence to therapy, which is frequently not achieved; studies identify low rates of compliance with treatment.[2-5] Side effects and the need for multiple daily doses can have an impact on adherence to therapy.[6,7] When we refer to **target IOP,** it is the range within which there is a lower probability of progression and/or losses to the nerve fiber layers and ultimately the visual field. When the decision is made to initiate treatment, we assume that the range of measured pressures prior to therapy (baseline IOP) have contributed to damaging the optic nerve, and thus our objective must be a reduction far below this level. It has been demonstrated that a reduction of 25% in baseline IOP slows the progression of POAG,[8-13] and thus it is justified to choose lower values of target IOP if there is more advanced damage to the optic nerve, if the damage is progressing rapidly, or if there are other risk factors such as a family history of glaucoma.

Medical therapy is the most common initial intervention to reduce IOP. There are a variety of medications, and the choice among them is a function of potential side effects, dosing, necessary reduction in IOP, and cost (Annex N 1). Prostaglandin analogs are the most frequently used hypotensive eye drops, because they are highly effective, well-tolerated, and used only once per day.[14-16] As a safe option, they are considered the first line of treatment.[17-19] Other hypotensive eye drops include beta-blockers, parasympathomimetics, alpha-2 adrenergic agonists, and oral and topical carbonic anhydrase inhibitors.[20,21] As a rule, when the target IOP has not been reached with a single medication (monotherapy), a change in medication must be considered (if the first medication does not produce a reduction in IOP), or another medication should be added (if the effect is insufficient). Additional hypotensive eye drops from the same pharmacological group should not be added to the treatment. In summary, if monotherapy is not effective in reducing IOP, or the target pressure is not reached, in spite of good adherence to treatment,

combined therapy may be appropriate,[22] or the medication must be replaced by an alternative agent until effective medical control is achieved, whether through monotherapy or a combination of medications. Fixed combinations (eye drops containing two or three hypotensives from different pharmacological groups) can improve the patient's adherence by reducing the number of drops required for the therapy. Proper application of the drops is difficult for many patients, and skill in applying them may decrease with age, comorbidities and the progression of the disease.[23,24] Repeated instructions and advice about appropriate techniques in the use of the medication, including waiting at least five minutes between drops in the case of multiple regimens, along with a clear written regimen for the prescribed medication and follow-up telephone calls or recordings with intelligent phone systems, may improve adherence to the therapy.[25-27] The **cost of treatment** may also be a factor in adherence, especially when multiple medications are prescribed.[27] Oral and written instructions for patient education, and informed participation in therapeutic decisions, can improve adherence[26] and the effective management of glaucoma in general. Once a treatment has been established, **the patient must be monitored for local ocular and systemic effects, toxicity** (interactions with other medications) and potentially life-threatening **adverse reactions**. To reduce systemic absorption, patients must be instructed about punctal occlusion to close the lacrimal punctum when applying the hypotensive eye drops.[28]

Annex N 1: TOPICAL HYPOTENSIVES FOR THE MANAGEMENT OF GLAUCOMA

CLASSIFICATION	ACTION MECHANISMS	REDUCTION IN IOP	ADVERSE REACTIONS	CONTRA-INDICATIONS	PREGNANCY CATEGORY†
Prostaglandin analogs	Increase in uveo-scleral and/or trabecular outflow	25%-33%	**-Increase and misdirection of eyelash growth** -Periocular hyperpigmentation -Conjunctival injection -Allergic conjunctivitis - Contact dermatitis - Keratitis -Possible activation of herpes virus -**Increase in iris pigmentation** - Uveitis -Cystoid macular edema - Periorbitopathy -Migraine-like headache -Flu-like symptoms	-Macular edema -History of herpes keratitis -Active uveitis	**C**
Beta-receptor antagonists (Beta-blockers)	Decrease in aqueous humor production	20%-25%	-Allergic conjunctivitis /contact dermatitis -Keratitis -**Bronchospasm** (non-selective) - Bradycardia - Hypotension -**Congestive Heart Failure** (they are used as a first-line treatment in CHF) -Reduced exercise tolerance -Depression - Impotence	-Chronic obstructive pulmonary disease (non-selective) - Asthma (non-selective) - CHF - Bradycardia - Hypotension - Major first-degree heart block	**C**

Alpha-adrenergic agents	-Non-selective: improves outflow of aqueous humor - Selective: reduction in aqueous humor production; reduction of episcleral venous pressure or increase in uveo-scleral outflow.	20%-25%	-Allergic conjunctivitis / contact dermatitis - Follicular conjunctivitis - Dry mouth and nose -Hypotension - Headache -Fatigue - Sleepiness	-Users of monoamine oxidase inhibitors -Babies and children younger than 2 years	**B**
Parasympatho-mimetics	Increase in trabecular outflow	20%-25%	-Increased myopia -Diminished vision - Cataract -Contact dermatitis - Allergic conjunctivitis - Conjunctival retraction -Keratitis -Paradoxical angle closure -Retinal detachment -Eye pain -Increased salivation -	-Need for regular fundoscopic evaluation -Neovascular, uveitic or malignant glaucoma	**C**
Topical carbonic anhydrase inhibitors	Decreased aqueous humor production	15%-20%	-Allergic conjunctivitis / contact dermatitis - Corneal edema - Keratitis -Metallic taste	-Sulfa allergy -Kidney stones - Aplastic anemia - Thrombocytopenia -Sickle-cell disease	**C**
Oral carbonic anhydrase inhibitors (systemic use).	Decreased aqueous humor production	20%-30%	-Stevens-Johnson syndrome - Decreased well-being, anorexia, depression - Electrolyte imbalance - Kidney stones - Dyscrasias (Thrombocytopenia anemias) - Diarrhea, abdominal cramps	- Sulfonamide allergy -Kidney stones	**C**
Hyperosmotic agents	Dehydration and reduction in vitreous volume	No data	-Headache -Heart failure -Nausea, vomiting, diarrhea -Kidney failure -Diabetic complications - Mental confusion	-Kidney failure - Congestive heart failure	**C**

*** Data from**: Heijl A, Traverso CE, eds. Terminology and Guidelines for Glaucoma. European Glaucoma Society. 4th ed. Savona, Italy: PubliComm; *2014:146-51.* Available at: http://www.icoph.org/dynamic/attachments/resources/egs_guidelines_4_english.pdf

† **FDA Category B during pregnancy**: Animal reproduction studies have failed to demonstrate risk for the fetus, and there are no adequate controlled studies in pregnant women. **Category C**: Animal reproduction studies have shown some adverse effects on the fetus, and there are no adequate and controlled studies in humans, but the potential benefits may justify the use of the medication in pregnant women, in spite of the potential risks.

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5.d THE COSTS OF GLAUCOMA TREATMENT

Tulio Reis and Joao Furtado

Glaucoma treatment may involve eye drops, laser therapy or surgery, with the aim of reducing intraocular pressure.[1] Treatment is ongoing for life, and it is costly for the patient and for the public health system in countries which provide or subsidize medical care. In Brazil, for example, health insurance coverage in 2018 was only 24.4%,[2] and thus the remainder of the population depends on assistance provided by the state.

Glaucoma is the world's leading cause of irreversible blindness.[3] People who are already blind due to glaucoma do not need hypotensive medications in most cases, but they have associated secondary costs, and in general they are not working, or their productivity is reduced.[4] A method of estimating **the financial impact of blindness** was proposed by Eckert and collaborators on the basis of the minimum wage or per-capita Gross National Product.[4] Using the minimum salary as an estimate, the study concluded that in 2011 the cost of blindness in Brazil was 1.5 billion dollars, with glaucoma responsible for 0.17 to 0.30 billion of the total.[4,5,6] With the aging of the world population, it is expected that the

prevalence of the disease and its effects will increase. A 2015 study found that there were 36 million blind persons in the world, with glaucoma responsible for 2.9 million cases, and this number is projected to rise by 2020 38.5 million blind persons, with 3.2 million associated with glaucoma.[7]

The majority of patients are **treated clinically with eye drops** from the four classes of available hypotensive drugs[1]: prostaglandin analogs (bimatoprost, latanoprost, travoprost); beta-blockers (timolol, betaxolol); carbonic anhydrase inhibitors (dorzolamide, brinzolamide) and alpha-agonists (brimonidine). According to the seriousness of the illness, it may be necessary to combine medications, which further raises the cost of treatment for the patient. The following table shows the price in dollars of a bottle of eye drops in selected countries of the Americas. This data was collected between January and March 2018 by glaucoma specialists and members of the respective national blindness prevention committees for VISIÓN 2020. Currency conversion was carried out using March 2018 historical rates from the U.S. Treasury Department.[8]

Table1: Prices of eye drops in USD* by medication class

	Prostaglandin analogs	Beta-blockers	Carbonic anhydrase inhibitors	Alpha-agonists
Argentina[a]	23.6	5.6	19.3	20.7
Brazil[b]	27.9	1.5	13.0	14.2
Chile[c]	41.5	19.5	29.8	46.4
Colombia[d]	46.6	9.0	26.9	33.9
Ecuador[e]	29.0	8.0	19.0	19.0
Guatemala[f]	37.8	29.0	35.9	20.3
Mexico[g]	35.8	5.1	28.7	39.6

*Exchange rates: Bureau of the Fiscal Service[8]
Researchers who provided the data: a- María Eugenia Nano; b- Tulio Frade Reis; c- Fernando Barría von Bischhoffshausen; d- Fernando Yaacov Peña; e- Jaime Soria Viteri; f- Mariano Yee Melgar; g- Van Charles Lansingh.

As can be observed in the table, the price of eye drops varies greatly according to the class of medication chosen for the treatment, and the cost of the same medication also varies significantly among the countries surveyed.

Table 2: Percentage of the minimum monthly salary in 2017, in dollars,[a] dedicated to buying eye drops for glaucoma, assuming one bottle/month.

COUNTRY	Minimum salary	Price of monthly treatment/Minimum salary in %			
		1 eye drop	2 eye drops	3 eye drops	4 eye drops
Argentina	440.6	5.4	6.6	11.0	15.7
Brazil	283.5	9.9	10.3	15.0	20.0
Chile	447.5	9.3	13.6	20.3	30.7
Colombia	264.2	17.6	21.0	31.2	44.1
Ecuador	375.0	7.8	9.9	14.9	20.0
Guatemala	360.9	10.5	18.5	28.5	34.1
México	145.8	24.6	28.1	47.7	74.9

a- Exchange rates: Bureau of the Fiscal Service[8]
Sources of minimum salaries: Argentina- Ministério Del Trabajo [9]; Brazil- Instituto de Pesquisa Econômica Aplicada[10]; Chile- Ministério del Trabajo[11]; Colombia- Banco de la República[12], Ecuador- Ministério del Trabajo[13], Guatemala- Ministério del Trabajo[14]; Mexico- Secretaría del Trabajo y Previsión Social.[15]

In the preparation of Table 2, prostaglandin analogs were considered as the first-line drugs of choice, and when other drugs were needed, the order of selection was: beta-blockers, carbonic anhydrase inhibitors, and alpha-agonists. It was also assumed that one bottle of each type of eye drop would be used during one month. As can be seen in Table 2, considering only the clinical treatment, a large portion of the patients' monthly income is dedicated to the use of the eye drops. This is without counting the costs of consultations, additional examinations and potential laser or surgical procedures. Thus, it would be of great importance to the population to ensure that all countries have public policies in place to finance this treatment, in addition to developing the most cost-effective possible strategies at the national and international levels to avoid worsening of the condition and thus to reduce glaucoma-related cases of blindness.

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5.e GLAUCOMA AND OCULAR SURFACE DISEASES

Carlos Ríos and Jesús Jiménez-Román

Glaucoma produces irreversible blindness, and intraocular pressure is the most significant risk factor; it must be treated on an ongoing basis, and thus adherence to therapy is crucial.[1] Numerous topical medications have been used to control the disease, and in spite of their effectiveness, they are not free of side effects, whether due to their active ingredient or the preservatives.[2] These adverse effects include alterations to the ocular

surface, which provoke inflammation and dysfunction of the conjunctival epithelium, causing dry eye and blepharitis.[2] Ocular surface disease is a common pathology with a broad spectrum of symptoms, from red-eye to the sensation of a foreign body, with a complex pathogenesis that increases the osmolarity of the tear film, resulting in inflammation of the eye.[3] As a result, the patient's discomfort may lead to poor adherence to treatment, failure of the therapy, and ultimately to the progression of the disease.

The prevalence of ocular surface disease increases with age,[3] which we must also associate with the prolonged treatment of glaucoma patients. Some preservatives, especially benzalkonium chloride, found in many kinds of drops that are used to lower intraocular pressure, are known to provoke or aggravate ocular surface disease.[3] Currently there are few options for preservative-free drops, and thus doctors face the challenge of analyzing each case individually to provide the best treatment for the patient, which will be effective but with the fewest possible adverse effects. In many cases, intraocular pressure is not controlled with just one kind of eye drop, and one must resort to using multiple medications to achieve the desired pressure. For this reason, ocular surface disease associated with the treatment of glaucoma has become a topic of vital importance for the continuity of ongoing treatment and adherence to therapy. The use of multiple eye drops for the same patient has the disadvantage that it requires a greater number of applications, causing adherence to decrease.[1] Preservatives tend to cause discomfort to the patient and provoke symptoms such as dry eye, so it is necessary to add lubricant drops to the treatment, thus increasing the cost of the treatment and exposing the patient to a larger number of drops.[1]

Recently, companies have begun to produce eye drops with preservatives other than benzalkonium chloride, and good results have been observed with these, under the theory that benzalkonium chloride is the main substance responsible for ocular surface disease in patients undergoing glaucoma treatment.[3] It has been observed that patients who change their medication from drops with preservatives to preservative-free drops, or to drops with preservatives other than benzalkonium chloride, use fewer lubricant drops[3] and are able to improve the quality of their tear film, making cases of dry eye less frequent and increasing adherence to treatment.

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A STUDY EVALUATING TRABECULOPLASTY AS A FIRST-LINE TREATMENT OPTION (LIGHT):[1]

1 Gazzard G[1], Konstantakopoulou E[2], Garway-Heath D[2], Garg A[2], Vickerstaff V[3], Hunter R[4], Ambler G[5], Bunce C[6], Wormald R[7], Nathwani N[8], Barton K[2], Rubin G[9], Buszewicz M[4]; LiGHT Trial Study Group. Selective laser trabeculoplasty versus eye drops for first-line treatment of ocular hypertension and glaucoma (LiGHT): a multicentre randomised controlled trial. Lancet. 2019 Apr 13;393(10180):1505-1516. doi: 10.1016/S0140-6736(18)32213-X. Epub 2019 Mar 9.

5.f TREATMENT WITH TRABECULOPLASTY: WHEN?

Laura Ramirez G., Jesús Jiménez R., María del Pilar Alfaro G. and Jorge Eduardo Gamiochipi A.

International guidelines recommend therapy with topical medications as the initial treatment for glaucoma; however, **laser trabeculoplasty represents an alternative** from a cost-benefit standpoint, especially in countries where there are economic barriers to ongoing treatment with medications.[1,2] A selective trabeculoplasty can be considered as a first-line therapy in selected patients,[3,4,5] or as an alternative for patients who are at high risk for non-adherence to medical treatment, because they cannot or will not use the medications due to cost, memory problems, difficulty with application or intolerance to the medication. Laser trabeculoplasty reduces IOP by improving the exit flow of the aqueous humor, and it can be carried out using an argon or diode laser, or a double-frequency neodymium yttrium-aluminum-garnet (Nd-YAG) laser.[6,7] The reported effectiveness is an approximately 20% reduction in intraocular pressure in 80% of patients during the first year of treatment, and the incidence of adverse effects is low. The technique has even been recommended as a first-line therapy in multiple studies, since its effectiveness in reducing intraocular pressure (IOP) is similar to that of prostaglandin analogs, and it can be carried out by general ophthalmologists.[8]

Laser trabeculoplasty is indicated in subjects with **primary, pigmentary, pseudoexfoliative or secondary open angle glaucomas** as a first-line therapy in patients who do not tolerate medication, or those using maximal medical therapy who continue to show progression of the disease, and who do not desire surgery or are not candidates for filtration surgery. Selective laser trabeculoplasty (SLT) can be used with patients who do not respond to argon laser trabeculoplasty (ALT).[9] It can also be used as a supplemental tool in medical management when IOP is poorly controlled with topical therapy, or as a step prior to surgical intervention.[10,11] Trabeculoplasty can reduce the number of topical medications, reducing toxicity and secondary ocular surface disease, and thus it represents an excellent therapeutic alternative considering its results, reproducibility and costs.[12]

Initially, trabeculoplasty was carried out with an **argon laser** (ALT), however, there are new technologies utilizing different wavelengths, such as **selective trabeculoplasty** (SLT) or **micropulsed laser** (MLT) which have shown themselves to be equally effective and with fewer side effects than ALT[13,14] (Annex N 1), considering that a poorly implemented ALT treatment may end in closing the angle. The action mechanism involves the disruption of the endothelial cells of the trabecular meshwork, in addition to liberating chemotactic factors which recruit monocytes which, in turn, act phagocytically on the liberated pigment granules.[14] The effect of the laser increases the inter-trabecular spaces, thus improving the exit flow of aqueous humor.[15,16,17] In contrast to ALT, SLT and MLT offer the advantage of not producing coagulative damage to the trabecular tissue, so that repeated treatments can be carried out safely.[12,13] It is important to mention that the pulse must be applied upon the trabecular meshwork, applying a goniolens in order to adequately visualize the angular structures (Photo N 1). In the case of SLT, it is necessary to **focus on the pigmented portion of the trabecular meshwork,** and a Nd:YAG laser is used with the following parameters: 532 nm wavelength, duration 3 ns, spot size 400 μm and initial power 0.8 mJ (to be adjusted within a range of 0.4 to 1.7 mJ).[9] The observation of the characteristic **champagne bubble sign** indicates that the energy used is adequate; if this sign is not observed, the power can be increased gradually until the phenomenon is seen. It is recommended to treat from 90-180º, and if there is no improvement in IOP six weeks

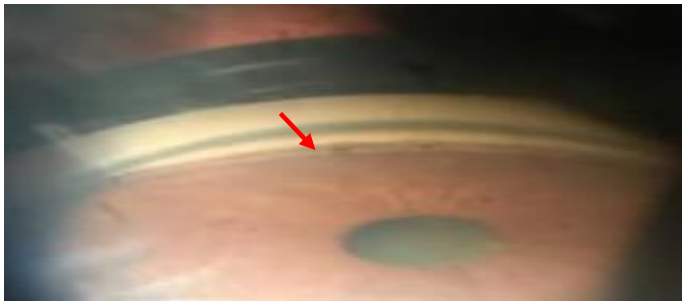
post-treatment, the remaining 180º can be treated. The rate of complications reported with SLT is 4.5%, while with ALT it can reach up to 34%.[2] The most common side effects observed are **hypertensive peaks** during the first four hours post-treatment; their frequency is less than 10 %, and in general prolonged ocular hypertension figures are not observed that threaten the trajectory of the disease. One recommendation for preventing this situation is to apply α-2 adrenergic agonist (brimonidine) drops immediately after the treatment, and to ensure that the power of the laser is correctly regulated.[9,18] Another complication is inflammation of the anterior segment, which is usually minimal and responds well to management with anti-inflammatories, whether steroidal or non-steroidal.[9,12] Blurred vision, corneal edema and corneal lesion have also been reported as adverse reactions, although these are very rare.[19] Contraindications for the use of laser trabeculoplasty are: chronic angle closure glaucoma, neovascular glaucoma, uveitis, post-traumatic glaucoma or congenital glaucoma.

We conclude that the use of SLT represents a **safe and effective tool for the management of the patient with glaucoma**, as a first-line treatment or as a secondary tool to reduce the number of medications. The safety and effectiveness of this procedure make it highly useful in the management of our patients. It must remain clear that SLT does not cure glaucoma, but only aims at lowering intraocular pressure, and thus the patient must continue with regular exams and additional treatment if necessary. In addition, angle-closure patients can benefit from SLT, always given that the angular structures are visible.[20]

ANNEX N 1: Characteristics of the various laser trabeculoplasty treatments

	ARGON ALT	**SELECTIVE SLT**	**MICROPULSE MLT**
Type of laser	Argon blue/green light	Neodymium-YAG green 532 nm	Diode 810 nm
Power	40-70 mJ	0.2 – 1.2 mJ	0.6 mJ
Spot	50 mcs	400 mcs	300 mcs
Time	0.1 seconds	3 nanoseconds	0.2 seconds
Application cycles	50 pulses 180° x2	50-100 from 180° to 360°	50-100 pulses 180°
Reduction in IOP	30%	20-30%	20%
Lens	3-mirror Goldmann lens	Latina lens	Latina lens
Effect	**Photocoagulation** Bubble formation	**Photodisruption** "Champagne bubble" or microbubble formation	**Thermal photostimulation** No anatomical alteration of the tissue

PHOTO N 1: Zone for laser pulses in trabeculoplasty



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5.g SURGICAL TREATMENT: When to perform surgery

Eugenio Maul F. and Fernando Barría von-B.

The factors associated with the decision to operate are complex, and they include the current state of the disease, the projected impact of the disease on the patient, and the risk of the procedure under consideration. A publication of the International Association of Glaucoma Societies reported that glaucoma surgery is indicated when the preferred treatment with medication and/or laser have failed to sufficiently reduce intraocular pressure; when there is local or systemic intolerance to the medication; or when the patient

does not have access to medical treatment or does not adhere to it.[1] The most frequent type of surgery continues to be trabeculectomy,[2] due to its strong hypotensive effect and the increased probability, compared to other surgeries, that it will leave the patient medication-free while achieving the target pressure. The rates of trabeculectomy have declined since the introduction of prostaglandins,[3] but in many developing countries, access to medications is a significant barrier for patients. Some considerations are:

1.- Previous training in glaucoma surgery and experience gained over time are very important. The first consideration when planning a surgery is the experience of the surgeon, since glaucoma surgery has a high rate of complications, even when performed by an expert. A study of tube-shunt surgery versus trabeculectomy reported a rate of complications of 37% among patients undergoing trabeculectomy over a period of five years, and all of them were operated on by glaucoma specialists in the United States and Europe.[4] The rate of re-operation was 22%. The CIGTS study, which evaluated the outcome of trabeculectomy versus medication as an initial treatment for glaucoma, reported a rate of 12% for complications related to the operation.[5] There is evidence showing that doctors performing low volumes of trabeculectomy procedures have a greater rate of complications and poorer results.[6] Since glaucoma in general is a disease which progresses slowly, if a doctor does not have sufficient experience or training for surgery, it is preferable to make every effort to refer the patient to a specialist center.

2.- The diagnosis is one of the most important factors in the treatment decision. Angle closure glaucoma is one of the leading causes of blindness on the world level, and because doctors do not routinely perform gonioscopy in their patients, this condition is underdiagnosed. Today there is evidence that patients with angle closure glaucoma and chronic angle closure with elevated intraocular pressures benefit more from a lensectomy with implantation of an intraocular lens than from other medical or surgical treatments, with a high probability of altering the trajectory of the disease,[8] considering that it is currently easier to find an ophthalmologist skilled in phacoemulsification than in glaucoma surgery, although this is a matter of dispute. Primary open angle glaucoma must be categorized according to the presenting intraocular pressure, the presence or absence of pseudoexfoliation, and the level of existing damage. In more hypertensive glaucomas (i.e. presenting pressure above 30 mmHg) and pseudoexfoliative glaucoma, the probability of progression of the disease is greater,[9] and thus more aggressive treatment is recommended along with greater vigilance, with a lower threshold for considering surgery. Normal-tension glaucoma is a very slowly progressing pathology in general,[10] and even if the target intraocular pressure is not achieved with the available treatment, a wait-and-see approach is preferred, deferring surgery for cases in which progression of the disease is documented.[11] Thus, two key elements as we plan treatment for our patients are **knowing the baseline intraocular pressure without treatment, and performing gonioscopy**. In cases of patients under treatment, suspension of the treatment for 48 to 72 hours is justified in order to evaluate the intraocular pressure and categorize the patient. Pseudoexfoliation tends to be associated with very high and fluctuating intraocular pressures, but analyses report that it is an additional risk factor at an elevated level of intraocular pressure.[9] In my experience, these patients may suffer very rapid deterioration, for example within six months, and thus they deserve the effort of more frequent exams and a lower target intraocular pressure.

3.- The level of damage to the visual field is another key factor at the time when treatment decisions are made. Patients with more advanced damage are closer to reaching the point of blindness or visual disability, and thus the target IOP is stricter. There is some

evidence that these patients with more advanced glaucoma can benefit more from trabeculectomy than from entry-level medication therapy,[12] but this debate remains unresolved. There is a randomized study underway that will provide information to help us better advise our patients.[13] The factor that tips the balance is the presenting intraocular pressure, and in the collaborative study of normal-tension glaucoma where the patients on average had advanced damage, more than half of the patients observed for 5 to 7 years did not have changes in the visual field, nor loss of visual acuity, in spite of remaining untreated.[14]

4.- Technical considerations once the decision to operate has been made: If after reading this section, you have decided to operate on a patient, there is some advice which can help you improve your results: Glaucoma surgery is slow surgery. If you take 20 minutes to perform a trabeculectomy, you are probably not doing it well. Also, early hypotonia must be avoided to reduce complications. For this, it is helpful to: a. Manipulate the conjunctiva with great care. b. Make a thick scleral flap. c. Carry out the trabeculectomy as cornea-anterior as possible, below the flap. d. Apply the mitomycin in as diffuse an area as possible, avoiding very high concentrations, and after the set time period, rinse abundantly. e. Take all the time in the world to evaluate the tension of the sutures in the scleral flap, seeking an equilibrium pressure of the filtration by injecting saline through paracentesis at 10-15 mmHg in the intraoperative space, emphasizing the use of sutures with a longer run in the sclera, since this avoids the loss of tension in seating them or during the early postoperative period, and making a hermetic seal in the conjunctiva.

To watch a **video of a surgery** with this and other suggestions, refer to the following link. (https://www.youtube.com/watch?v=-SBzC1a6uI0)

5.- Alternatives to trabeculectomy: The use of **drainage implants** has greatly increased,[3] but a randomized study recently showed that trabeculectomy continues to be a preferred option for surgery in patients without previous surgeries.[15] Another option which has been evaluated is **cyclophotocoagulation**, since it is a simple technique and an extraocular surgery. However, this procedure has complications related to vision loss which are higher than with trabeculectomy. One interesting option in development is the **micropulse laser**, which is applied to the ciliary body; this technique can have fewer complications, but current evidence is insufficient to be able to recommend this procedure as a first-line surgery for glaucoma.[16]

Summary: In open angle glaucoma, the factors that suggest greater risk of progression of the disease, and thus of blindness, are **highly elevated intraocular pressure at presentation, pseudoexfoliation, and more advanced damage** (i.e. mean deviation worse than -12 dB) In these cases, especially if treatment with medication is not available or is not adequately followed by patients, a surgical option must be considered. However, in the event that an **experienced glaucoma surgeon** is not available who regularly performs this type of surgery each month, all possible efforts must be made to refer the patient to a center with the appropriate resources and more highly trained personnel. **Phacoemulsification** also plays an important role in the management of angle closure glaucoma, changing the trajectory of the disease, so it is crucial to use gonioscopy to reach a diagnosis.

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5.h FINAL INDICATORS FOR SURGERY: When is surgery indicated?

Jimena Schmidt C.

The only proven method for reducing progressive damage in all types of glaucoma is to reduce the intraocular pressure. This can be achieved through treatment with medications, laser trabeculoplasty or incisional surgery. Each of these has different indications, risks and benefits. **Topical medications** offer minimal and reversible risk, achieving sufficient reduction in intraocular pressure as a first-line treatment in many cases of glaucoma. **Laser trabeculoplasty** offers a slight to moderate reduction in intraocular pressure without significant adverse effects, although there can be significant rises in pressure post-procedure, and in general its effect is transitory. **Incisional surgery**, whether trabeculectomy or implantation of tube shunts, offers a significant and ongoing reduction in intraocular pressure, without fluctuations, although with unavoidable short- and medium-term risks which must be considered when decisions are made.

The short-term **complications of filtration surgery** are infection, external drainage, transitory hypotonia, hyphema and narrowing of the anterior chamber, while the long-term risks are cataracts, erosion of the bleb, infection and loss of the drainage function of the bleb. All of these complications and their implications for quality of life must be discussed with the patient when making the decision for a filtration surgery. A skilled technique reduces the risk of complications, and any complications that arise must be identified and addressed in a timely manner in order to obtain better short- and long-term results from surgery. Some conditions in which filtration surgery is recommended are:

1.- When **the target intraocular pressure is not reached** with medication therapy, and there is a threat of deterioration of the visual field.

2.- When the hypotensive treatment **is not tolerated by the patient**, or it cannot be sustained **due to economic or logistical considerations;** for example, with patients who live alone and have difficulty administering eye drops.

3.- **Poor adherence to hypotensive treatment** in association with deterioration of the visual field. The patient must be well-informed about the risks of glaucoma as well as the risks and expectations of surgery.
4.- Where there is **confirmed progression of the glaucoma** in spite of the maximum tolerated hypotensive treatment, surgery is also a recommended next step, even if measured intraocular pressure values are low. It is possible to stabilize the visual field in this manner, possibly due to a reduction in diurnal fluctuations in intraocular pressure which is achieved through the surgery.
5.- Some **types of glaucoma** are very aggressive, and they frequently require incisional surgery, as in the case of congenital glaucoma, neovascular glaucoma, traumatic glaucoma or glaucoma associated with silicone oil emulsification.
6.- In patients with **monocular blindness due to glaucoma,** the progression of glaucoma in the eye which still has vision must be controlled, because there is a greater probability of needing filtration surgery if deterioration is detected. If this happens, it is essential to identify the need for surgery in time and avoid further visual field deterioration in the single eye.
7.- Patients with **advanced glaucomas**, with a remaining visual field of less than 10º, mean visual field defects less than or equal to 20 dB, or with visual acuity of 0.1 or less attributable to glaucoma, must be carefully monitored to evaluate any further deterioration in their visual function. In general it is accepted that their intraocular pressure must be maintained at a level close to 12 mmHg, representing a reduction of some 30 to 50% compared to baseline pressure without treatment. If the visual field deteriorates or it is difficult to maintain desirable pressure levels, the need for filtration surgery must be considered to avoid damage to the remaining visual capacity.
8.- Another relative indication for surgery is the patient who is **stable in the visual field,** but with **highly elevated intraocular pressure**, which places visual function at long-term risk. In this case, the decision should be made together with the patient and family members, considering life expectancy. This is relevant when pressures of approximately 30 mmHg are achieved with maximum tolerable medical treatment, since here the short-term risk of vascular occlusions is added to the long-term risk of progression of the glaucoma, which can dramatically change the prognosis for the patient's vision.

Finally, it is important to note that in all cases, the decision to perform filtration surgery must be made on an individualized basis with each patient, carefully evaluating the risks and benefits of the surgery as well as the risks of failing to perform it when it is indicated. An effective doctor-patient relationship, in which the necessary time is dedicated to explain the treatment plan and answer questions, will be greatly beneficial as decisions are made.

CONSENSUS[1]

MEDICAL TREATMENT OF GLAUCOMA:

• In a suspected case of glaucoma with high risk, one should start with topical monotherapy.

• In patients with ocular hypertension (>25 mmHg) and known high-risk factors, treatment with medication should be considered.

• In every patient with a diagnosis of glaucoma, a target IOP should be determined, according to the existing damage and life expectancy, and medical treatment should be initiated and periodically evaluated.
• According to studies such as OHTS, EMGT and AGIS, we must seek reductions in IOP greater than 30% (see algorithms).
• Every therapy is started as a MONOTHERAPY with first-line medications; prostaglandins and beta-blockers are considered first during this phase.
• As a first-line treatment, a medication should reduce IOP more than 25% compared to baseline, while second-line treatments show a reduction in baseline IOP lower than 20%.
• A reduction in pressure of more than 20% in a patient can be considered a good response to therapy.
• If a reduction of more than 30% is required, or the patient does not respond to or tolerate treatment with prostaglandins, it is necessary to consider a fixed combination eye drop. The maximum level of medication therapy is the stage prior to surgery.

Majority consensus

• Prostaglandin analogs are considered the treatment of first choice in treating primary open angle glaucoma. The main benefit of these agents lies in their hypotensive effectiveness and minimal systemic side effects.
• Conjunctival hyperemia, photophobia and abnormal eyelash growth are adverse reactions which, when associated with non-reversible hyperpigmentation of the iris, can abort the treatment.
• Contraindications in the use of timolol are congestive cardiac insufficiency, asthma and chronic obstructive pulmonary disease.

Adherence to Treatment:

• Patient education is fundamental for therapeutic compliance, considering that this therapy involves following a treatment plan for life and returning for regular checkups, to avoid irreversible vision loss in a disease which is asymptomatic.
• The level of adherence is related to the number of applications per day, the side effects of the medications, and the complexity of the patient's daily life.

1. Consensus of the Grupo Mexicano de Investigación en Glaucoma and the Colegio Mexicano de Glaucoma: Dr. Jesus Jimenez-Román

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6.- PATIENT EDUCATION AND WEEL-BEING: A "forgotten necessity"

6.a FUNDAMENTALS OF EDUCATION: IS IT NECESSARY?

Fernando Barria von-B.

Patient education is fundamental in a glaucoma suspect or diagnosed glaucoma patient, in order to improve adherence to examinations, eye drop treatment and medical testing. Public activities which promote knowledge about the disease, such as World Glaucoma Day, help educate both patients and the community, taking advantage of the opportunity to share a message through the communications media. As part of this

education, we must provide clear information; for example: Glaucoma is an asymptomatic disease, but one which produces progressive damage to the optic nerve, which is difficult to detect and poses the risk of blindness. In addition, people need to be informed that: a.- In order to detect a potential case of glaucoma, they need to have regular eye exams; b.- The condition can affect anyone, but its prevalence increases with age, and thus the older the person, the greater the risk of developing glaucoma; c.- If there is a suspicion or diagnosis of glaucoma, exams and treatment must never be abandoned, because there is a risk of vision loss and the person may become blind. The most relevant aim is to promote adherence to the overall management of glaucoma, since it is an asymptomatic disease, not noticeable to the patient in its early phases; and d. Prescriptions for eyeglasses are part of a complete ophthalmological exam which also serves to detect pathologies such as glaucoma, and thus simply buying eyeglasses from vendors or in shops, without an eye exam, can hinder the management of these diseases.

SUMMARY:

- **Asymptomatic / Adherence to checkups and eye drop treatment**
- Glaucoma is an **asymptomatic disease** which produces progressive damage and which is not detected by the patient in its initial stages, because it does not affect vision until very advanced phases, when vision loss is irreversible.
- **It can affect any person,** although it is more prevalent after age 45, and it must be taken into account that the risk of developing glaucoma increases with age.
- For its detection, **regular eye exams are necessary,** especially for those with a family history of glaucoma.
- A person with a diagnosis of glaucoma **must never skip exams or stop using the prescribed treatment.** A patient without appropriate management can lose vision, even leading to blindness in some cases.
- The most important consideration is to **promote adherence to treatment** for glaucoma, since it is an asymptomatic disease, often imperceptible to the patient in early stages.
- Finally, we must also educate the immediate family members of the patient with glaucoma.

6.b COMMUNITY EDUCATION: World Glaucoma Day

Dr. Jesús Jiménez-Román

Glaucoma has a great impact on daily functioning and quality of life for individuals affected by this disease. This generates a high socioeconomic cost for society, since more than 60.5 million people in the world have been diagnosed with glaucoma, a number that is expected to rise to 80 million by 2020. 4.5 million people are bilaterally blind due to glaucoma, with a projected increase to 11.2 million by 2020. Thus, 6.7 million people may be at risk of losing their vision due to glaucoma without realizing it. Blindness due to glaucoma can be prevented in 90% of cases, and this fact was the main motivation behind the creation of what was originally World Glaucoma Day, and later **World Glaucoma Week**.

World Glaucoma Day was born in 2008, promoted by the **World Glaucoma Association,** to inform the community, through various activities, about the importance of

glaucoma as a public health problem and the incapacitating nature of the disease if it is not detected and managed appropriately. These initiatives are aimed at sharing **information about the characteristics of the disease** and raising public awareness about it. Similar efforts have been carried out in many Latin American countries, including detection campaigns which are publicized throughout all levels of society through the mass media. The media seem to be the weapon with greatest penetration, acting as permanent sources of ongoing information about diverse aspects of the condition, ways to ensure timely detection, and the possibility of maintaining effective vision for the longest possible time, if appropriate management is carried out. With the advent of social networks as an additional tool to educate people about the condition, noteworthy examples have arisen such as the Facebook pages Glaucoma Colombia and Glaucoma Mexico, "Para verte siempre" ["To See You Always"], this last with around 80,000 followers. Using diverse and multiple types of digital content is an effective strategy today to inform the population about the prevalence of the disease, opportunities for timely diagnosis, and the need for early treatment in the face of the risk of blindness from this disease. In many Latin American countries, diverse efforts are being carried out to publicize the facts about glaucoma and respond to the need for the community to understand this condition and its most serious complication: blindness.

World Glaucoma Week, a joint initiative of the World Glaucoma Association and the World Association of Glaucoma Patients, will be held this year from March 10 to 16, 2019. Support from all is needed so that it will be successful and help expand awareness about glaucoma. Many publicity initiatives about glaucoma are underway around the world, which can be found on the website https://www.worldglaucomaweek.org/. The most frequent types are detection fairs at health centers; conferences with patient support groups; and participation in radio and/or television programs, as well as publication of information in the print media. The **objective is to educate the population,** emphasizing the importance of glaucoma as a public health issue, early diagnosis of patients at risk, and the need for timely treatment to avoid the risk of blindness. There is an international association of patients with glaucoma (*https://www.glaucomapatients.org/* o *https://www.worldgpa.org/)* which provides valuable information. The greatest difficulty in glaucoma detection campaigns has been ensuring follow-up with cases of suspected glaucoma, and thus we believe that using communication strategies to publicize this disease and provide community education will result in better opportunities for timely diagnosis, particularly in patients with risk factors. Various actors must also be added to these efforts: an alliance among the pharmaceutical industry, government health authorities and civil society is crucial to effectively publicize this message and make progress in the fight against this disease.

6.c THE IMPACT OF ADVANCED GLAUCOMA ON QUALITY OF LIFE: An underappreciated factor

Fernando Gomez G, Luz C Martinez and Santiago Arias G

Glaucoma is the main cause of irreversible blindness on the world level,[1] and because it is a chronic condition posing a high risk of blindness, a diagnosis of glaucoma has a great impact on the patient. Glaucoma leads to progressive loss of the visual field, which impairs visual function, and as it advances it affects numerous aspects of patients' lives. Understanding how this condition affects a patient's quality of life allows us to achieve better adherence to treatment, as well as to select therapeutic options which improve its long-term prognosis.[2] The psychological effects of the diagnosis, which may include anxiety, depression, the fear of blindness, and concerns affecting other family members, are some of the consequences of the disease, as well as limitations on mobility, driving, reading, recognizing faces and identifying objects. Deficits in the visual field and visual acuity, adverse effects of medications and/or surgical treatment, the financial costs of medical appointments and medications, and loss of income due to missed work also affect the patient's quality of life.

ASSESSING EFFECTS ON QUALITY OF LIFE: The quality of life of patients with glaucoma can be evaluated using subjective questionnaires such as **NEI-VFQ25** (National Eye Institute 25-Item Visual Functioning Questionnaire),[3,4,5] which asks about various aspects (physical, social and psychological) which can affect the patient in his or her daily life. Another questionnaire is **GQL-15** (Glaucoma Quality of Life Questionnaire 15), which is a specific instrument for glaucoma, including questions related to the severity of the glaucomatous pathology and its repercussions on the patient's quality of life.[5,8,9,10]

CHANGES IN QUALITY OF LIFE

Changes related to space and mobility: The degradation of visual functionality interferes with numerous activities of daily life, such as leaving the home, walking, night vision, recognizing faces, identifying objects, and color vision. Among the most frequent complaints are changes affecting close-up and central vision, which have an impact on activities such as reading. However, defects in the paracentral and lower peripheral areas of the binocular visual field have the greatest overall impact on quality of life, since they affect the functions necessary for successful mobility, such as walking down stairs, perceiving objects on the ground, and driving a vehicle, among others. This explains the increase in the risk and incidence of falls, with their associated long-term consequences. On the other hand, the presence of superior defects leads to difficulties with activities related to near vision: reading, locating objects on shelves, and recognizing street names and names of businesses, among others.[3,2] Various studies using the GQL-15 questionnaire to evaluate patients' quality of life have found that **the subjective alterations most often cited are those related to adaptation to different intensities of light.** Issues related to outdoor mobility are in second place for these patients' most incapacitating symptoms.[8,11] When subjective surveys and objective visual field tests are compared with regard to the deterioration of vision, it is found that the presence of a stable visual field in at least one eye masks the perception of the deterioration of the other eye. As might be expected, in patients with deterioration in both eyes, a significant decline in quality of life is seen in both subjective and objective assessments.[9]

Binocular Campimetry: Monocular visual fields are essential for the diagnosis, evaluation and follow-up of glaucoma. During the 1980s, in order to evaluate visual disability in individuals, a standard, objective method was implemented to obtain the patient's "real" visual field: the binocular visual field. This came about at the request of various governmental and institutional authorities such as the military, driving schools, social security offices, low-vision clinics, etc. Although **binocular visual fields do not have diagnostic value, they provide relevant results in terms of functional limitations,**[7,11] and thus they are appropriate for evaluating a patient's visual disability in the socio-medical environment.[9,10] The Esterman binocular visual field was initially used for manual perimetry and later adapted as an algorithm for automated campimetry; it is used in Humphrey campimetry.[13] The template for binocular campimetry is the result of the superposition of the right and left monocular visual fields, using 120 light stimuli which evaluate more than 130° of the visual field. This exam places more weight on zones of greater functional importance in the visual field, which correspond to the central and inferior field. It evaluates the total binocular field based on function, assigning higher values to the areas of greater functional significance, following the points system proposed in 1967 by Esterman, which was initially used in monocular fields.[14] On the one hand, the binocular visual field offers the advantage of providing information about the patient's visual function without any type of occlusion. On the other hand, the binocular field presents an "amplification effect" of the response in certain areas, due to the fact that the superposition of the visual fields "duplicates" the response of retinal receptors, increasing the probability of seeing the stimulus. In the binocular visual field of patients with advanced glaucoma, it is common to observe the phenomenon of "amplification," which is observed in normal subjects to occur with less frequency in the central field at -20° from fixation.[13-15] As additional benefits, binocular campimetry is a complete test and easily reproducible, and one that is universally applicable as a standard for all patients, since it is available in the majority of campimetry systems in circulation (Figure 1).[16] It can be carried out independently of the standard monocular visual field, since the binocular field does not consider detailed central vision nor the blind spots of the person examined. Problems with this test include the fact that it has a supra-threshold stimulus, producing an increase in false negative stimuli, as well as issues with respect to correlation with other campimetric exams due to the lack of uniform standards for the intensity of the stimulus (Figure 2).[12,9]

FIGURE 1: Esterman point system for visual fields

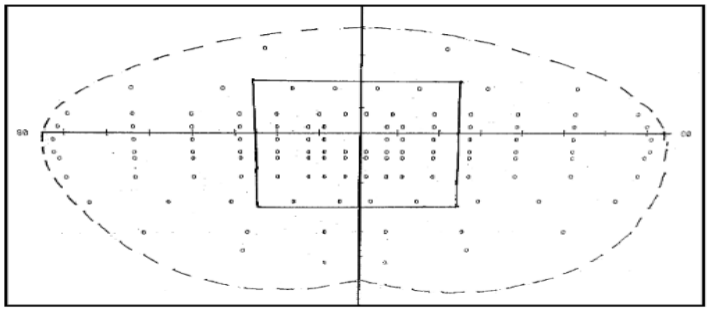

Photo: Dr Fernando Gomez

FIGURE 2: Correlation of the monocular 24-2 computerized visual field and the binocular Esterman visual field in two patients with advanced glaucoma. **A.** This patient presents severe superior and inferior arcuate defects in both eyes, with nearly the entire binocular visual field affected, with a 2% level of effectiveness. **B.** Patient with an inferior arcuate defect in the right eye

and a mild paranasal inferior defect, affected predominantly in the left inferior hemisphere as shown in binocular Esterman, with a level of effectiveness of 84%.

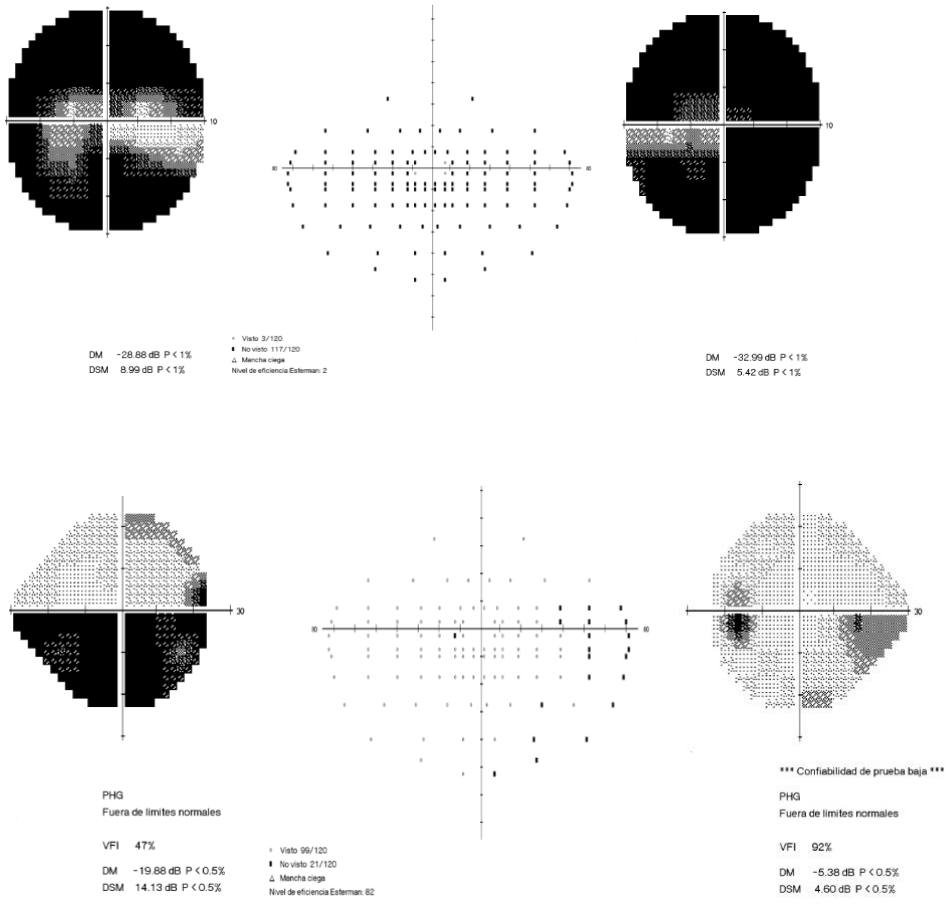

Photo: Fernando Gomez

Psychosocial changes: The psychosocial alterations most often associated with glaucoma are depressive and anxiety disorders, with prevalence levels up to 13%, so that glaucoma is considered a risk factor for developing these conditions. These disorders can also be a confounding factor when the impact on the patient's quality of life is evaluated using subjective scales. A correlation has been found between age and the presence of these psychological pathologies: the younger the patient when receiving the diagnosis, the greater the incidence of anxiety disorders, while the opposite occurs with depression, with a marked increase in incidence with advanced age.[17,18,19]

Diseases of the ocular surface: Ocular surface disease (OSD) is a frequent comorbidity in patients with glaucoma. OSD is found in some 15% of the general population of older adults, and it is reported in 60% of glaucoma patients under medical treatment. OSD is characterized by inadequate tear volume and instability of the tear film, accompanied by symptoms such as irritation, foreign body sensation, photophobia and fluctuations in visual acuity. Among the main predisposing factors are advanced age, a previous history of ocular surface disease, increased intraocular pressure, and a history of changing a topical hypotension medication due to intolerance of the same.[20,21] Because of its effects, ocular surface disease affects quality of life, and it is a barrier to appropriate adherence to

treatment for glaucoma or ocular hypertension. Due to its high prevalence, it must be assessed as part of the case management of these patients.

The quality of life of patients with glaucoma is affected starting from the moment that they recognize the seriousness of the condition, and in addition to economic and social repercussions, there are additional factors which degrade quality of life, such as functional limitations, psychological disorders and ocular changes associated with the use of medications. Diagnosis and treatment are crucial in this condition, but we must also consider the aspects mentioned here, which affect the patient's quality of life and the appropriate management of the disease.

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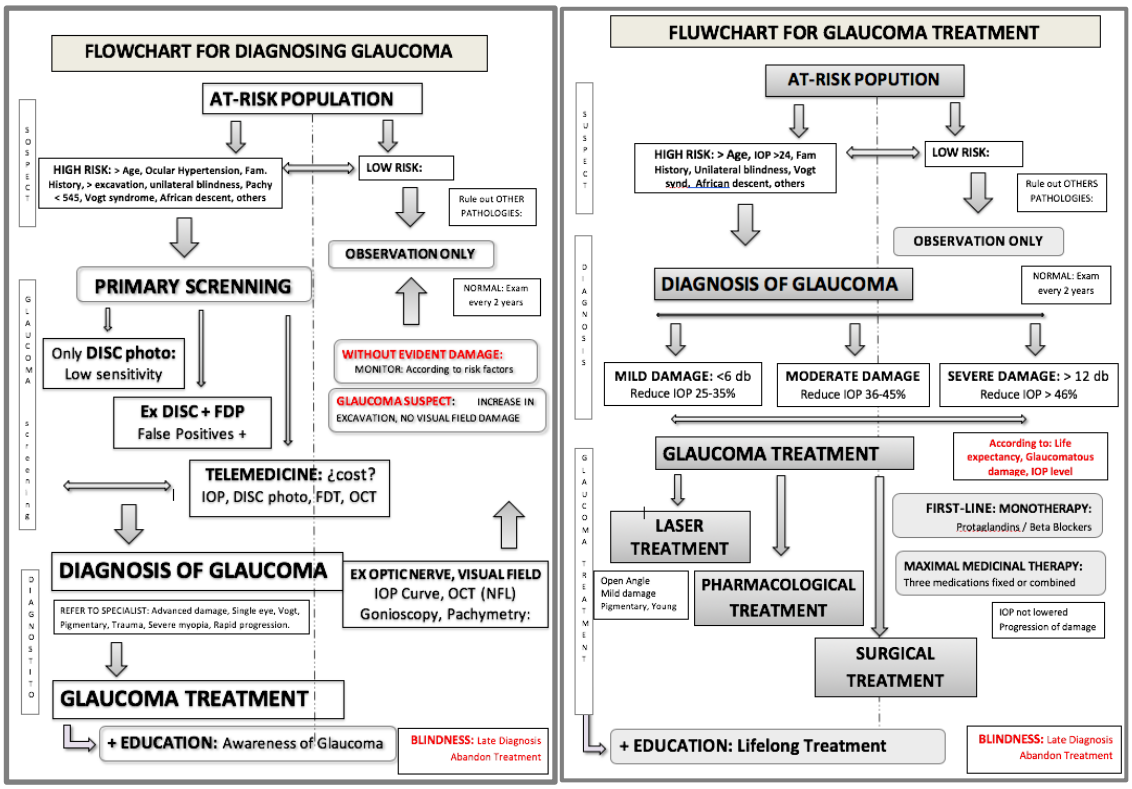
7.- SUMMARY

7.a FLOWCHART: Diagnosis and Treatment of Glaucoma

Dr. Fernando Barria von-B.



7.b A GLAUCOMA PROGRAM ACCORDING TO AVAILABLE RESOURCES: Planning

Dr. Fernando Barría von-B.

Within the Latin American region, some countries have greater access to resources, allowing them to have state-of-the-art technology and qualified professionals, while other countries have fewer resources at their disposal. At the same time, many countries exhibit this diversity within their own territory, associated with different cultural environments or discrepancies between urban and rural areas, thus generating clusters of more vulnerable populations who require other strategies that are often more basic (Table 1).

Table 1: A Program for Diagnosis, Monitoring and Management of Primary Open Angle Glaucoma, according to available resources.

OPHTHALMOLOGICAL RESOURCES	**LOW RESOURCES** **Basic Technology**	**INTERMEDIATE RESOURCES**	**HIGH LEVELS OF RESOURCES** **State-of-the-art Technology**
PREVALENCE	Low (population over age 65 is small)	Possibly 3.6% of those over age 40	3.6% (CI 95% 2.08–6.31) in those over age 40 Latin American estimate[1]
SCREENING	**PRIMARY CARE** Evaluate Optic Disc+ Telemedicine? (low sensitivity) REFER	**PRIMARY-CARE CLINIC OR DOCTOR** Optic disc + gonioscopy Telemedicine? - Frequency Doubling Perimetry? (false +s) – OCT?	**MEDICAL EXAM:** Optic Disc - Visual Field - Gonioscopy - OCT plus Pachymetry
GLAUCOMA SUSPECT	Control vs. Refer	Control vs. Risk Factors for treatment	Consider treatment according to risk factors
TREATMENT EARLY CASE	Single-drug therapy If uncontrolled: surgery?	Laser vs. Drugs, use combinations	Use combinations vs. laser or surgery
ADVANCED CASE	REFER	Surgery according to capacity	Strict control vs. surgery

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8.- FINAL COMMENTS

Because glaucoma is a condition that is on the rise, due to the aging of the population, and one that is difficult to diagnose because of the absence of symptoms, it is vital that patients at higher risk be evaluated in a timely manner, with the aim of obtaining an early diagnosis and timely treatment. **Early diagnosis is the best opportunity** to successfully preserve vision; however, it requires state-of-the-art technology which is not always accessible for vulnerable populations. Thus, with this guide we have attempted to offer simple strategies for improving diagnosis and management at the primary-care level. Our efforts must be focused on diagnosing glaucoma at the earliest possible moment, and on **identifying rapidly progressing cases** which pose a greater risk of blindness. Patients with moderate or severe glaucoma may retain functional vision for the rest of their lives if they receive appropriate treatment, but rapidly progressing or end-stage glaucomas must be referred to glaucoma centers for specialized care. Given the conditions that prevail in our region, however, this is a very difficult challenge to achieve due to the associated costs as well as the lack of awareness among patients and health professionals about its importance and the risk of blindness posed by glaucoma.

The **aim of creating this guide** is to provide an orientation for the diagnosis and treatment of glaucoma to the general ophthalmologist and other health care professionals. This guide is directed at the primary-care level, to present the risk factors for the disease, the importance of classifying suspected cases of glaucoma as high or low risk, how to choose follow-up measures for high-risk patients to determine how to manage their cases, and how to recognize the characteristics of a moderate or severe case of glaucoma and its rate of progression. Reviewing this guide, you will be able to find the fundamentals of primary care for a glaucoma suspect or a patient with glaucoma and determine the necessary strategies for their follow-up and control, as well as appropriate referral, always with the aim of avoiding blindness.

Drs. Fernando Barría von-Bischhoffshausen and Jesús Jiménez Román, EDITORS