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Is Minimally Invasive Glaucoma Surgery a Viable Option in Africa?

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ABSTRACT

Glaucoma is a public health challenge in Africa. Many of the affected individuals are not aware and the patients present with advanced disease. The management of glaucoma is also challenging due to a myriad of factors such as poverty, poor drug compliance and limited treatment options.

The major surgical option in Africa is trabeculectomy which is usually reserved for advanced disease. Minimally Invasive Glaucoma Surgery (MIGS) has been found to be efficacious in the management of mild-to-moderate primary open glaucoma and ocular hypertension with minimal complications.

Minimally Invasive Glaucoma procedures are usually expensive and cannot be affordable by average African patients. Low-cost procedures such bent needle goniectomy, Sinskey hook goniotomy and GATT with 5/0 prolene suture have been found to be comparably efficacious like their original expensive counterparts.

Using these low-cost methods and the some the original MIGS procedures for those who can afford will enhance the management of glaucoma in Africa and reduce the reliance on medical therapy. Collaborative partnerships with Industry stakeholders will help in reducing the cost of the devices for MIGS and promote their widespread use in Africa.

Keywords: Glaucoma, Minimally Invasive Glaucoma Surgery, viable, Africa

Introduction:

Glaucoma is a group of eye conditions that damage the optic nerve, often due to high intraocular pressure (IOP). It is a leading cause of irreversible blindness worldwide. The World Health Organization (WHO) predicts that the number of individuals with glaucoma will increase to over 111 million by 2040 due to demographic changes.[1] Chronic eye diseases, such as glaucoma, pose significant public health challenges worldwide and are on the rise due to the increasing size and aging of the population.

Approximately 3-4% of individuals over the age of 40 have glaucoma, with the prevalence increasing significantly among older adults globally.[2,3] In some African countries, the prevalence can be as high as 8-10% in people over 40.[4-6]

Glaucoma is multifactorial and characterised by optic neuropathy evident by loss of retinal nerve fibers and cupping of optic nerve disc with resultant corresponding peripheral visual field defect.[7] Despite extensive research, the exact mechanisms underlying glaucoma remain uncertain; however, accumulating evidence points to several major risk factors associated with this condition. These include elevated intraocular pressure (IOP), advanced age, genetic predisposition, lower diastolic and ocular perfusion pressure, African or Latino ancestry, splinter hemorrhages at the optic nerve head, a thinner central cornea, beta-zone parapapillary atrophy, an increased vertical cup-to-disc ratio of the optic nerve head, systemic vascular factors (such as diabetes mellitus, hypertension, and migraine), eye injuries, myopia, prolonged use of corticosteroids, and smoking. [8-12.] While intraocular pressure is recognized as the primary factor in the death of retinal ganglion cells, glaucoma can occur even when intraocular pressure is within the normal range. In such instances, other risk factors, including abnormally low cerebrospinal fluid pressure, impaired microcirculation, mitochondrial deficits, altered immune responses, excitotoxicity, oxidative stress, or coexisting ocular or systemic diseases, may contribute to the onset and progression of the condition.

The modern classification system categorizes glaucoma into three main groups: (a) primary open-angle glaucoma (POAG; OMIM 137760), (b) primary congenital glaucoma (PCG; OMIM 231300), and (c) primary angle-closure glaucoma (PACG; no OMIM entry).[13]

Evidence indicates that the options for treating glaucoma - medical, surgical, and laser therapies, are constrained by the availability of medications and equipment, insufficient surgical and diagnostic skills, and the high costs associated with treatment. Africa is a low-income region with high rate of poverty. Healthcare financing is majorly out-of-pocket. This article focuses on economics, challenges and limitations in the management of glaucoma with Minimally Invasive Glaucoma Surgery (MIGS) in Africa.

Glaucoma Management Challenges In Africa

When selecting an appropriate medical or surgical therapy for glaucoma, it is essential to consider multiple factors, including efficacy, safety, cost, and patient compliance. The cumulative effect of these factors influences the overall treatment plan and outcomes.

Some reasons for surgical intervention include, the incidental diagnosis of glaucoma during ocular examinations related to that eye's cataract surgery or the surgery for the contralateral glaucoma, relief of angle closure, poor medication adherence due to poor education, lack of motivation, forgetfulness, drop application technique, dementia and cognitive impairment, multiple medication allergies or Ocular surface disease, acute IOP elevation unrelated to PACG[14,15]. It is essential for physicians and caregivers to be aware of these factors, and a personalized approach to patient centered care, starting with initial education, should be implemented.

Studies showed a statistically significant linear trend ($p = 0.018$) that the direct costs associated with treatment for a particular disease escalate as the severity of the disease increases. Specifically, in glaucoma treatment, for each incremental increase in disease severity, the direct cost of treatment rises by an estimated €86. The breakdown of costs reveals that stage 0 treatment costs approximately €455 per person per year, while stage 4 costs approximately €969 per person per year. This demonstrates the increased financial burden on healthcare resources as disease severity increases.[16-18]

Adio found in Nigeria that medication costs play a substantial role in overall treatment expenditures, accounting for 42% to 56% of the total direct costs across all stages of the disease

The average monthly cost of antiglaucoma medication was N6000 (USD 40). When factoring in indirect costs, such as medical laboratory tests, transportation, and care provided by patient escorts, each patient incurred an average monthly expenditure of USD 105.4 (N15,810). A majority of patients (73.3%) covered their own treatment costs, and none opted for the less expensive surgical option, which was priced at USD 275.4 (N41,310). Additionally, 66.7% visited eye clinic on a monthly basis. The direct and indirect economic loss from those who are already blind amounted to USD 3,064,587 annually, which was on top of the USD 4.1 million spent each year on medical treatment for individuals who are visually impaired due to glaucoma.[19]

Research suggests that out-of-pocket (OOP) expenses should not surpass 15-20% of total health expenditure to guarantee that health services remain affordable and accessible for everyone [20].

Advancement of glaucoma treatment should prioritize minimizing the necessity for post-procedure medical therapy and decreasing the incidence of complications following the procedure [21]. The paradigm shift in first line treatment of primary open angle glaucoma from medication to selective laser trabeculoplasty cannot be over emphasised [22].

MINIMALLY INVASIVE GLAUCOMA SURGERY

Minimally Invasive Glaucoma Surgery is a group of interventional procedures that improve the aqueous drainage through its natural course and thus reducing the

intraocular pressure. They are offered to patients with mild to moderate glaucoma. Trabecular outflow accounts for 70% to 95% of the aqueous outflow, and remaining 5% to 30% by uveoscleral outflow.

Minimally Invasive Glaucoma Surgery procedures are designed to reduce intraocular pressure (IOP) by focusing on three distinct outflow pathways: trabecular, suprachoroidal, and subconjunctival drainage.[23]

CLASSIFICATION OF MIGS BASED ON SITE OF ACTION
Schlemm's canal Trabecular bypass
1. Istent
2. Istent inject high frequency deep sclerectomy

Sclemm's dilatation
1. Ab interno canaloplasty- viscocanalostomy
2. Hydrus

Trabeculotomy /Goniotomy
1. GATT
2. Kahook Dual Blade
3. 23g cystotome
4. Excimer Laser Trabeculotomy

Suprachoroidal
1. Intra-Scleral Ciliary Sulcus Suprachoroidal Microtube
2. Ab interno : CyPass (withdrawn) Istent Supra

Subconjuctival space
1. Ab interno : Xen Gel stent
2. Ab externo : Preserflo

Ciliary body
- Ab interno : Endocyclophotocoagulation

IOP still remains the only modifiable factor in the treatment of glaucoma.[24]

In almost all cases of PCG, the traditional first-line surgical options include goniotomy or trabeculotomy.[25,26] Recently, 360° trabeculotomy utilizing a catheter or Prolene suture to open the entire circumference of Schlemm's canal has been reported to yield positive outcomes.[27-29]

MINIMALLY INVASIVE GLAUCOMA SURGERY IN COMBINATION WITH CATARACT SURGERY
Several studies have shown a good outcome in IOP control after cataract surgery and MIGS.[30-32]

Recent trials have indicated that lens extraction via cataract surgery is more effective at reducing intraocular pressure than peripheral iridotomy.[33]

Using this early surgical method, 80% of patients were able to forgo medication after one year while maintaining stable visual fields. Additionally, some patients experienced improvements in their visual fields. This strategy for treating primary open-angle glaucoma (POAG) has demonstrated significant benefits; therefore, experienced surgeons should consider earlier cataract surgery and minimally invasive glaucoma surgery (MIGS) as a primary approach to managing glaucoma.

In resource-limited settings, microinvasive glaucoma surgery can be effectively performed using affordable tools such as a 23-gauge cystotome or a Sinskey hook. Manual small incision cataract surgery (MSICS), a cost-effective alternative to phacoemulsification, is also widely practiced in these regions. Among Black patients who underwent MSICS, intraocular pressure (IOP) decreased in 123 out of 147 eyes (83.67%). For patients with glaucoma, the average preoperative IOP was 23.16 ± 5.68 mmHg, which dropped to 14.5 ± 2.7 mmHg after surgery—a 37.39% reduction. Given its affordability and effectiveness in reducing IOP, MSICS shows strong potential as an alternative to medication, particularly in cases of age-related, lens-induced glaucoma. As surgical techniques continue to advance, cataract surgery is becoming increasingly safe and should be considered earlier in the treatment plan for glaucoma patients to help preserve vision. Further research is warranted to explore the role of early cataract extraction and microinvasive procedures as potential first-line treatments.[34]

ECONOMICS OF MINIMALLY INVASIVE GLAUCOMA SURGERY
High out-of-pocket expenses can impede access to healthcare by discouraging individuals from seeking necessary medical assistance and preventing them from obtaining appropriate treatment.

Research suggests that out-of-pocket (OOP) expenses should not surpass 15-20% of total health expenditure to guarantee that health services remain affordable and accessible for everyone [35].
Only 5 out of 47 countries in the WHO African region reached the benchmark to supporting comprehensive health service delivery aimed at achieving Sustainable Development Goal (SDG 3) with US$249 per capital. Other countries had health expenditures from US$16 to US$236.6

The cost of Istent is about $1195, Preserflow and Xen gel cost about $2000. The GATT and Trabectome may cost between $600 -$1000. However, goniotomy with Kahook Dual Blade, 5/0 Prolene, 23g cystotome may cost less than $100. Tanito ab-interno trabeculotomy micro hook is reusable.[36] These can be used in SSA.

Generally, health financing systems in SSA are characterised by low government spending, under-developed insurance schemes, high out of pocket payments, and high dependence on external donor and funding.

ADVANTAGES OF MINIMALLY INVASIVE GLAUCOMA SURGERY
Minimally invasive devices can be deployed earlier in treatment especially combined with cataract surgery due to their superior safety profile compared to trabeculectomy or tube surgeries.[37] Additionally, the long-term impact of glaucoma eye drops on patients is gaining worldwide recognition, making it essential to explore interventions that either postpone the need for drops or minimize their usage. This concern is especially relevant for patients in Sub-Saharan Africa (SSA), who not only face the challenges of incorporating eye drops into their daily lives but also deal with significantly higher costs, storage difficulties, issues with counterfeit

medications, and irregular supply chains. Therefore, being free from the need for drops is critical in SSA, and the introduction of minimally invasive glaucoma surgery (MIGS) as a viable alternative is much appreciated.

Conclusion

Most Angle -based glaucoma surgical devices may be out of reach for Africa and affordable in Organisation for Economic Co-operation and Development countries, however there are those that can be offered at low cost in the early stage of glaucoma. Early diagnosis and intervention of the disease can be promoted by implementing community-based screening programs that piggyback on cataract detection and surgical initiatives.

A collaborative effort in eye care across Africa, supported by international partnerships with academic leaders, industry stakeholders, and NGOs, holds promise for significant advancements in training and retraining surgeons in skill transfer of advances and innovations in glaucoma management. This can be done in symposium, workshop, wet-lab in new advances in glaucoma surgeries.

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