African Vision and Eye Health
ISSN: (Online) 2410-1516, (Print) 2413-3183

Optical coherence tomography in the management of diabetic macular oedema in sub-Saharan Africa

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Dates:
Received: 11 Jan. 2024
Accepted: 29 Apr. 2024
Published: 28 June 2024

Background: Accurate and objective diagnosis of centre-involving diabetic macular oedema (ci-DMO) requires the use of optical coherence tomography (OCT). There is limited data on the availability and rate of utilisation of OCT for the management of DMO in sub-Saharan Africa (SSA).

Aim: To assess the availability and rate of utilisation of OCT for the management of DMO in SSA.

Setting: Retina-practising ophthalmologists in 18 countries across SSA.

Methods: In this cross-sectional survey, a structured questionnaire was distributed among ophthalmologists treating patients with retina diseases in SSA. Data were collected using Google Forms by sharing a link to the Google data sheet with participants via email. The responses were analysed, summarised and presented using proportions and frequency tables.

Results: A total of 42 ophthalmologists participated in this study. The proportion of diabetic retinopathy patients with DMO seen on a monthly basis was ≤ 20% among 24 (57.1%) participants and ≥ 40% among 14.3% participants. Thirty-eight (90.5%) participants had access to an OCT facility in their area of practice and 85.7% of them had Spectra Domain OCT. Twenty-five (64%) participants performed 1 to 50 OCT scans monthly and 34% performed > 50 OCT scans monthly. Important factors influencing OCT use in DMO patients were: the availability of OCT in the facility, patients' insurance coverage and the severity of DMO.

Conclusion: Optical coherence tomography is readily available although there is wide variability in its use in SSA.

Contribution: This survey uncovers the need for standardising practice patterns and usage of OCT in the treatment of DMO in SSA.

Keywords: optical coherence tomography; diabetic macular oedema; diabetic retinopathy; improving access to care; retina survey; anti-vascular endothelial growth factors; sub-Saharan Africa.

Introduction

Diabetic macular oedema (DMO) is a common cause of visual loss in patients with diabetic retinopathy.[1] Although there is limited data on the magnitude of DMO and associated visual impairment in sub-Saharan Africa (SSA), it is expected to increase because of the increasing prevalence of diabetes mellitus (DM) and associated metabolic risk factors.[2,3] The global incidence of DM has been increasing progressively over time, with a more significant increase across Africa.[4]

Furthermore, about 69% of adults with DM in Africa are estimated to be undiagnosed.[5] The increasing prevalence of DM, the high proportion of undiagnosed or poorly controlled DM, in association with hypertension and hyperlipidemia in SSA coupled with inadequate health care facilities, contribute significantly to the higher risks of vision-threatening diabetic retinopathy (DR) and a threat to visual impairment in SSA.[4,6,7]

Diabetic macular oedema results from the accumulation of fluid in the central retina because of increased permeability of capillaries around the macular caused by vascular endothelial growth factor (VEGF).[8,9] Anti-vascular endothelial growth factor (anti-VEGF) agents are the standard of

How to cite this article: Abaidoo B, Bernard A, Sedhom JA, et al. Optical coherence tomography in the management of diabetic macular oedema in sub-Saharan Africa. Afr Vision Eye Health. 2024;83(1), a918. https://doi.org/10.4102/aveh.v83i1.918

care for the treatment of centre-involving diabetic macular oedema (ci-DMO).[10] Centre-involving DMO occurs when there is a thickening of the central subfield zone of the macular in the retina.[10]

The diagnosis of ci-DMO requires the use of optical coherence tomography (OCT), which is a fast, safe, non-invasive and non-contact imaging modality for the evaluation of macular disorders.[10,11] Optical coherence tomography provides a more accurate and objective measure of DMO than a clinical examination or use of monocular fundus photographs and is further used in monitoring the outcome of treatment of DMO using intravitreal injection (IVI) of anti-VEGF agents.[11,12]

While OCT machines are widely available among retina practices in developed countries, the situation may not be so in low-resource settings such as SSA. Okonkwo et al.[13] have reported on the low rate of utilisation of OCT for monitoring the treatment of retinovascular disorders in a single centre in Nigeria. There is limited data on the availability and rate of utilisation of OCT for the management of DMO in low-resource settings such as SSA although spectral domain OCT (SD-OCT) is readily available with a high rate of utilisation among retina specialists in developed countries.

We sought to determine the availability and rate of utilisation of OCT among retina specialists or general ophthalmologists who manage patients with DMO in SSA. Such information is relevant in forming the basis for further studies on the magnitude of DMO in SSA using OCT. It will also help in identifying areas needing resources for diagnosis and management of DMO in SSA and guide the allocation of such scarce resources.

Research methods and design

This was an online cross-sectional study conducted in December 2023 aimed at evaluating the use of OCT technology specifically in SSA. Sub-Saharan Africa is chiefly composed of Central Africa, East Africa, Southern Africa and West Africa, which lie south of the Sahara with a population of about 1.2 billion in 2022 and a current growth rate of 2.5% according to the United Nations.[14]

Study participants were retinal specialists or general ophthalmologists with retina practice in SSA. Retinal specialists who practice outside SSA were excluded from the study. General ophthalmologists in SSA who do not have a retina practice were also excluded from the study. The membership of the African Retina Society (ARS) includes retina specialists and general ophthalmologists with interest in retina practising in SSA, retina specialists of SSA heritage practising outside Africa and honorary members outside of SSA. Currently, the ARS consists of about 120 members.

Total population sampling was used. An initial feasibility study was carried out by contacting the entire membership of ARS. In the feasibility study, short, structured questions using Google Forms were posted on the WhatsApp platform of the ARS to ascertain the eligibility of members and secondly obtain their individual email addresses to enable the study team to send them a link to the main study individually. We obtained 65 responses in the feasibility study. Of these, seven members were excluded from the main study because three were retina specialists of SSA heritage practising outside of SSA and four were general ophthalmologists with interest outside of retina (i.e. glaucoma or paediatric ophthalmology). A structured questionnaire was used for the data collection. The questionnaire together with the consent forms and the participant's information sheet was designed using Google Forms, and the link to the questionnaire was shared individually among the 58 eligible participants via email. Both closed ended with a set of responses and open-ended questions were used. The first section described the participant's practice setting. The second section had questions on access to OCT and OCT use within the participant's facility, and the third section was about clinical guidance of OCT use. Quality control measures taken included, ensuring anonymity of participants by telling participants not to provide their names, age and sex. Pre-testing of the questionnaire was performed by ophthalmologists at Korle-Bu and Komfo Anokye Teaching Hospitals in Ghana. Feedback from the pretesting phase was subsequently incorporated into the final questionnaire.

Data analysis

SPSS version 25 was used in analysing the data. An initial summary of the data in the form of mean (standard deviation), proportions, pie charts and bar charts were presented descriptively. The proportion of retinal practitioners with functional OCT in SSA was calculated and presented in percentages (%). The rate of utilisation of OCT for the diagnosis and monitoring treatment of DMO in SSA was calculated and presented as percentages (%). The proportions of the different types of anti-VEGF used in the treatment of DMO in SSA were analysed and presented as percentages (%). The chi-square test was used in examining possible associations in the data. *P*-values less than 0.05 were described as statistically significant.

Ethical considerations

Ethical approval to conduct the study was obtained from the Institutional Review Board of Korle-Bu Teaching Hospital (KBTH-IRB/000233/2023). The study was conducted in accordance with the tenets of the Declaration of Helsinki on Human Subjects 1964 and its later amendments. Consent was obtained from all participants. The anonymity of participants was ensured by telling participants not to provide their names, age and sex.

Results

Background characteristics of participants' practice

A total of 42 retinal practitioners from 18 SSA countries participated in this study. Respondents were based in the

following countries: Benin, Cameroon, Democratic Republic of Congo, Ethiopia, Eswatini, Ghana, Kenya, Liberia, Malawi, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Uganda and Zimbabwe. Participants from Ghana (10, 23.8%) and Nigeria (8, 19.0%) were the majority. Participants practising in private settings were slightly higher compared to those in public settings (19 [45.2%] vs. 18 [42.9%]). Most (33, 78.6%) participants had retina as their sub-specialty. More than 40% (18, 42.9%) of the participants see about 100 to 299 patients per month. Seventeen participants (40.5%) see up to 20 patients with DR per month, while 12 (28.6%) see more than 40 patients with DR per month. Of the patients with DR seen monthly, the majority of the participants said 1% – 20% had DMO, compared to those seeing 21% – 39%, and ≥ 40% of DR patients with DMO monthly (i.e. 57.1% vs. 28.6% vs. 14.3%) (Table 1).

The two most common methods of diagnosis of DMO used by most participants were the slit lamp biomicroscopy (38, 90.5%) and the OCT (41, 97.6%). All (42, 100.0%) of the participants use intravitreal anti-VEGF agents in the treatment of DMO in their current practice. Eighteen participants (42.9%) in addition used grid laser photocoagulation and six (14.3%) used intravitreal steroid implants for the treatment of DMO. The most (39, 92.9%) preferred method for treating DMO was IVI of anti-VEGF. Of the patients with DMO treated with IVI of anti-VEGF agents, 27 (64.2%) of respondents said over 70% of their patients receive intravitreal bevacizumab, 32 (76.2%) respondents said ≤ 10% of their patients receive intravitreal ranibizumab or aflibercept and 34 (81%) of respondents said they had never used IVI of ziv-aflibercept while 8 (19%) respondents said ≤ 10% receive IVI of ziv-aflibercept. Ten (10, 23.8%) had biosimilar intravitreal anti-VEGF in their country of practice.

TABLE 1: Practice setting and management of diabetic macular oedema among participants.

Characteristics	*n*	%
Current practice setting		
Private	19	45.2
Public	18	42.9
Quasi-government	5	11.9
Sub-specialty		
Retina	33	78.6
General ophthalmology	9	21.4
Number of patients seen monthly		
< 100	3	7.1
100–299	18	42.9
300–499	10	23.8
≥ 500	11	26.2
Proportion of patients seen with retina diseases monthly		
≤ 20	17	40.5
21–39	13	30.9
≥ 40	12	28.6
Patients seen with DR monthly		
≤ 20	16	38.1
21–39	11	26.2
≥ 40	15	35.7
Proportion of DR patients with DMO seen monthly		
≤ 20	24	57.1
21–39	12	28.6
≥ 40	6	14.3

DMO, diabetic macular oedema; DR, diabetic retinopathy.

Access to an optical coherence tomography facility

A total of 38 (90.5%) participants had access to an OCT facility in their area of practice. Most (*n* = 36, 85.7%) participants have the spectra domain OCT as the common type of OCT machine available (Table 2).

Utilisation of an optical coherence tomography facility by participants

Most (25, 64.1%) participants do 1 – 50 OCT examinations monthly. More than half (23, 56.1%) of the participants always use OCT in their practice for evaluating DMO. Thirteen (31.0%) of the participants occasionally encounter OCT-related problems while 21% frequently encounter OCT-related problems (Table 3).

Factors influencing optical coherence tomography use

Participants identified several factors influencing the use of OCT in DMO patients including the availability of OCT facility, patients' insurance coverage, the severity of DMO and other responses such as OCT is the best diagnostic modality, it has the capacity to enhance clinical examination, it is the recommended thing to do and its capacity to aid in quantifying macular oedema. A total of 27 (64.3%) participants

TABLE 2: Accessibility to optical coherence tomography (OCT) facility and type of OCT machine available in current practice.

OCT facility	*n*	%
Accessibility		
Yes	38	90.5
No	4	9.5
Type of OCT machine available		
Time domain OCT	5	11.9
Spectra domain OCT	36	85.7
Swept-source OCT	1	2.4

OCT, optical coherence tomography.

TABLE 3: Utilisation of optical coherence tomography for evaluating macula disorders among participants.

Utilisation	*n*	%
Number of OCTs carried out per month		
1–50	25	64.1
> 50	14	35.9
Frequency of OCT use		
Always	23	56.1
Frequently	15	36.6
Occasionally	2	4.9
Rarely	1	2.4
Frequency of OCT-related problems		
Always	2	4.8
Frequently	9	21.4
Occasionally	13	31.0
Rarely	12	28.6
Never	6	14.3

OCT, optical coherence tomography.

TABLE 4: Factors influencing optical coherence tomography use and its importance in diabetic macular oedema management.

Factor	*n*	%
Availability of OCT	29	69.0
Patients' insurance coverage	6	14.3
Severity of DMO	3	7.1
Others	4	9.5
Importance of OCT use:		
Extremely important	27	64.3
Very important	14	33.3
Important	1	2.4

OCT, optical coherence tomography; DMO, diabetic macular oedema.

said OCT was extremely important in the management of DMO (Table 4).

Discussion

The increasing prevalence of DM in Africa has raised concerns regarding the potential rise in DMO.[4] However, limited data on the incidence of DMO in this region accentuate the necessity for comprehensive research to understand and address this growing health concern. The survey conducted among 42 retinal practitioners across 18 sub-Saharan African countries provided a valuable snapshot of the state of DMO management in SSA, offering significant observations regarding the availability and utilisation of OCT and the treatment landscape for DMO.

A substantial portion of practitioners in SSA (97.6%) had access to an OCT facility in their practice areas, including access to a spectral domain OCT machine (85.7%). These findings suggest that the infrastructure for advanced diagnostic tools is at least reasonably well established among retinal practitioners in this region. However, despite the availability of OCT machines, a significant majority (90.5%) relied on slit lamp biomicroscopy for diagnosing DMO. This observation could suggest a reliance on traditional clinical methods despite the availability of advanced imaging tools. Another notable observation from the study data is the low number of OCT examinations performed with as many as 64.1% participants doing 1 – 50 OCT examinations per month. The low frequency of OCT examinations may be related to the cost of the procedure as many patients pay out of pocket.[8,13] Optical coherence tomography examination is key to the diagnosis and monitoring treatment of DMO with anti-VEGF. In a retrospective study of 742 eyes with retinovascular and macular diseases who had treatment with ant-VEGF at Eye Foundation Hospitals in Nigeria, 99 (74.4%) of 133 eyes with DMO had OCT examination prior to initial IVI of anti-VEGF and 52 (39.1%) had post-treatment OCT.[13] The authors concluded that the rate of utilisation of OCT pre- and post-treatment of retinovascular and macular diseases with intravitreal anti-VEGF was below the desired level.[13] They suggested the following reasons for the low rate of utilisation of OCT: the prohibitive cost of the investigation as it is not covered by the national health insurance scheme, non-availability of OCT machine in the health facility, breakdown of the OCT machine and lack of knowledge on the usefulness of OCT for the management of retinovascular and macular diseases.[13] Our study revealed that the availability of OCT in the facility, patients' insurance coverage and the severity of DMO were factors influencing the decision of retinal specialists to use OCT in SSA. In addition, 21% of our respondents experience frequent problems with the use of their OCT machine. OCT machines currently in commercial use are quite expensive.[15,16] There is an urgent need for the development, regulatory approval and introduction of low-cost OCT devices for commercial use.[15] The availability of low-cost OCT devices to retinal practitioners in SSA will help drive down the cost of investigation to the patient and thus improve the rate of utilisation of OCT for the diagnosis and monitoring outcome of treatment of ci-DMO with IVI of anti-VEGF.[13,15] The cost of OCT examination per patient could be reduced further by increasing the number of OCT scans carried out monthly. For the cost of a new OCT machine of approximately 5000 United States Dollars (USD) and a lifespan of 10 years, by performing 937 OCT examinations annually (78 examinations per month), the estimated cost per patient examined was 6.42 USD.[16] Although this cost excludes administrative, technician and grading costs, it is below the amount charged per OCT examination in many public facilities in SSA where the cost of technicians and consultants is borne by the state health ministry.

Our survey clearly indicates that IVI of anti-VEGF was the preferred treatment method for DMO among the majority of participants (92.9%). This aligns with global trends and established standards in managing DMOs. [10,17] The preferred treatment of DMO when the initial baseline BCVA was 20/50 or worse was aflibercept based on observation of the Diabetic Retinopathy Clinical Research Network (DRCR.net).[18] The choice of aflibercept for the treatment of DMO is more relevant in SSA as many patients with DMO present with a more severe form of the disease with worse visual acuity.[8] In a retrospective study of 25 eyes with DMO treated with anti-VEGF in Ghana, their median BCVA was 20/80 (6/24) and 88% had an initial BCVA of 20/50 (6/15) or worse.[8] In the American Society of Retina Specialists 2022 global preferences and trends (PAT) survey, retinal specialists were asked about their first-line intravitreal anti-VEGF for DMO where cost (payer access) is not a concern; 58.2% preferred aflibercept, 35% preferred bevacizumab, 5.4% preferred ranibizumab and 1.4% preferred other anti-VEGF molecules.[17] In contrast, 64.2% of the respondents in our survey use intravitreal bevacizumab for the treatment of DMO in over 70% of their patients. Off-label use of compounded intravitreal bevacizumab has been found to be cost effective compared to aflibercept and ranibizumab.[19] The cost of the anti-VEGF agent can be a significant factor in the initial choice of anti-VEGF for the treatment of DMO in SSA. Although the single most important factor in the initial choice of anti-VEGF was the efficacy and safety of the drug, the 2022 global PAT survey shows that drug cost is a significant factor in the initial choice of anti-VEGF treatment among retinal specialists in the Africa and Middle East region, followed Asia and/or Pacific region and Latin Americas, whereas insurance mandates play a significant

role in the initial choice of anti-VEGF in Europe and the United States of America.[17]

The 2022 global PAT survey noted that 35.2% of 198 respondents in the Africa and Middle East region said 11% – 25% of their patients on intravitreal anti-VEGF for clinically significant DMO receive additional focal or grid laser compared to other regions where the majority said less than 5% of their patients receive additional focal or grid laser.[17] Our survey also supports the findings that more retinal specialists from SSA add focal or grid laser treatment to patients with DMO on IVI of anti-VEGF. There is an urgent need to increase the availability and cost-effectiveness of intravitreal anti-VEGF agents for the treatment of DMO in SSA populations.

An area of concern highlighted by the study was the limited availability of biosimilar intravitreal anti-VEGF injection drugs, reported by 23.8% of the participants. Biosimilars are molecules with similar efficacy and safety to the innovator (reference) drug although they may not be exact copies of the reference drug.[20] Razumab is a biosimilar used in India and has been found to have comparable efficacy with ranibizumab.[21] Biosimilars tend to be cheaper than the reference drug because of the lower cost of manufacturing.[20] This could lead to a reduction in the cost of treatment of DMO should they be made readily available to retinal specialists in SSA.[20] The scarcity of these alternative drugs could impact treatment options, potentially affecting patient care and treatment outcomes in cases where the primary intravitreal anti-VEGF agents are inaccessible or expensive to patients.

There are some limitations to this study that should be addressed. Foremost, the study is limited in its survey nature, limiting access to the population of concern and incurring respondent bias. Additionally, respondents were limited to Africa Retina Society members and did not exclusively include retinal specialists, as this would have generated a small sample size given the lack of specialists in the region of study. Furthermore, the over-representation of the responses from ophthalmologists in West Africa may be a reflection of the membership of the ARS.

Careful consideration should be made to address and avoid these concerns in future studies.

Conclusion

Optical coherence tomography is readily available although there is wide variability in its use in SSA. Addressing the technological disparities, enhancing OCT usage and access, and driving advancements in diagnostic and treatment technologies will significantly improve the accuracy of DMO diagnosis and management, ensuring better patient outcomes and advancement to health care equality in SSA.

Acknowledgements

The authors are grateful to members of the African Retina Society for their support and participation in this study.

Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

I.Z.B., B.A., A.N. and A.E.A. were responsible for the study concept and design. I.Z.B. conducted the study. I.Z.B. and B.A. retrieved and analysed the data, interpreted the data and prepared the manuscript. I.Z.B., B.A., A.N., A.B., A.E.A., J.A.S., P.Y. and S.B. were involved in the critical review of the manuscript and manuscript approval and were accountable for all aspects of the work.

Funding information

This work was supported by a research grant from HCP Cure Blindness. HCP Cure Blindness had no role in the study design, data collection, data analysis, decision to publish or preparation of the manuscript.

Data availability

The data that support the findings of this study are available on reasonable request from the corresponding author, I.Z.B. There is no data repository in Ghana.

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