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Visual field decline and restoration following vitamin A therapy for vitamin A deficiency

Richard D. Ten Hulzen [a,*], Isabella V. Wagner [a], Pierre-Yves Decastro [b], John P. Sullivan [c]

[a] Mayo Clinic Florida, Department of Ophthalmology, 4500, San Pablo Rd S, Jacksonville, FL, USA
[b] Clinique Ophthalmologique Spécialisée, Rue Cheriez, Port-au-Prince, Haiti
[c] Southeastern Retina Specialists, 7740 Point Meadows Dr., Jacksonville, FL, USA

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ABSTRACT

Purpose: To present a case of nutritional vitamin A deficiency (VAD) that caused bilateral severe dry eye symptoms and progressive visual field contraction over a 13.5-month span resulting in peripheral blindness and nyctalopia, and to document the patient's rapid visual field restoration following vitamin A therapy (VAT).
Observations: A 34-year-old Haitian woman presented for a glaucoma consultation with the following symptoms in both eyes (OU): painful dry eyes, floaters, nyctalopia, and visual field contraction over eighteen months despite treatment with four anti-glaucoma medications and intraocular pressures (IOP) in the low teens OU. The glaucoma diagnosis was eliminated due to slit lamp examination and OCT imaging, which showed an absence of both optic neuropathy and secondary glaucoma features. The patient's symptoms remained consistent with VAD. The patient's visual field decline was restored with significant documented visual field improvement occurring within only 11 days, and complete visual field restoration within 5.5 months of VAT.
Conclusions and Importance: Our case demonstrates the critical role of vitamin A in maintaining ocular health and visual field preservation. To our knowledge, this is the second reported case documenting a patient's visual field decline due to VAD, as well as visual field restoration following enteral VAT. As visual outcomes of VAT are significantly underreported in scientific literature, it is imperative that ophthalmologists are aware of its effects.

1. Introduction

VAD is a condition with widespread ophthalmologic manifestations such as night blindness, visual field contraction, xeropthalmia, Bitot's spots, and photophobia.[1,2] VAD's main cause has been reported as malnutrition and is known to persist in regions known for nutrient deficiencies.[1] Prior to the works of Dr. Alfred Sommer, VAD and the clinical importance of vitamin A were not well understood. A clinical trial performed in Indonesia by Dr. Sommer exhibited that supplementation of 200,000 IU vitamin A caused a 34% reduction of mortality rates in young children.[2,3] These results sparked controversy and prompted a series of replicate trials to be conducted.[2] Replicate trials produced similar results regarding childhood mortality rates and vitamin A was additionally found to reduce maternal and neonatal mortality rates.[2,4,5] Following these trials, VAT has become the primary method of treatment for individuals with VAD due to the crucial role of vitamin A in increasing resistance to infection severity.[2] Vitamin A supplementation is now recognized as a successful and cost-effective method to treat VAD.[2] Our report documents progressive visual field contraction due to VAD and how VAT can reverse dry eye symptoms and restore severe peripheral vision loss over a short time period.

2. Case report

A 34-year-old Haitian woman was referred to the United States to be seen by a glaucoma specialist for a second surgical opinion regarding her rapidly progressing blindness which was suspected to be glaucoma-induced and being treated as such. The patient presented with the following in both eyes: painful dry eyes, floaters, nyctalopia, and visual field contraction. The patient expressed she had difficulty seeing at night (nyctalopia) and suffered from daily headaches. She had a family history of glaucoma and was first diagnosed 18 months prior to presentation. Review of outside records indicated that the patient had also been previously diagnosed with dry eye syndrome and vitreous floaters. Her past surgical history related to the ovaries and uterus, but she had no past ocular surgical history. Her daily drop regimen consisted of four

* Corresponding author. Mayo Clinic Florida, 4500 San Pablo Rd S, Jacksonville, FL, 32224, USA.
E-mail address: tenhulzen.richard@mayo.edu (R.D. Ten Hulzen).

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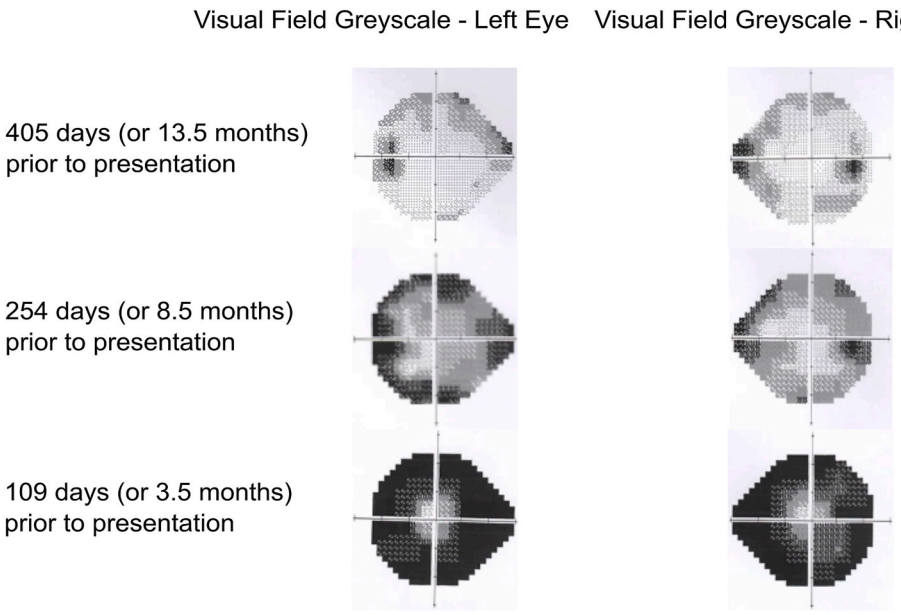

Fig. 1. Visual fields of patient prior to presentation. Outside records document the rapidly progressing visual field constriction OU over a ten-month span.

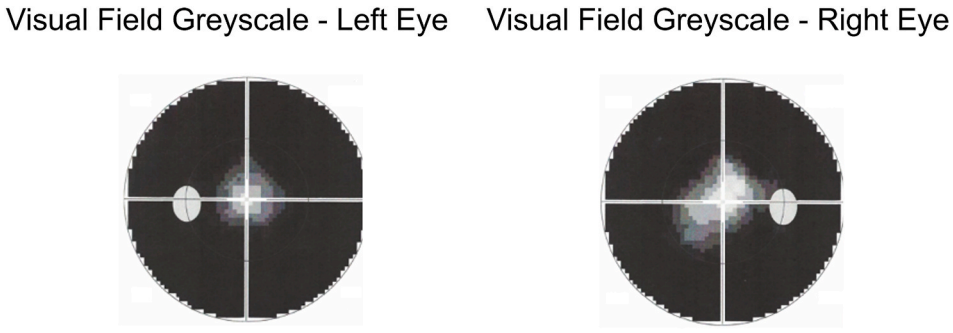

Fig. 2. Visual fields of patient during presentation. Upon presentation for a glaucoma consultation, the previously documented bilateral severe visual constriction was confirmed.

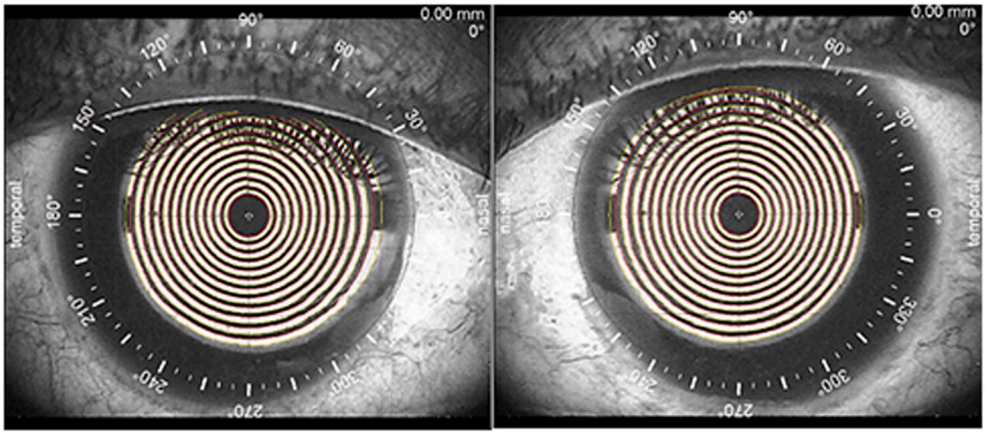

Fig. 3. External photograph with corneal Placido disc image overlay at presentation. Note mild nasal pinguecula OU with irregular sheen and microcystic changes nasally associated with keratinization due to VAD.

glaucoma medications (latanoprost 0.005%, timolol maleate 0.5%, brimonidine tartrate 0.2%, and dorzolamide 2%), cyclosporine 0.05%, and artificial tears; however, she stopped taking all medications 24 hours prior to presentation. The patient also had a history of biannual prophylactic anti-parasitic medication user. Prior to presentation, review of previous records presented findings within normal limits, excluding high C/D ratios of 0.7/0.8, and bilateral progressive visual field contraction as shown in Fig. 1.

Upon presentation, a repeat visual field exam confirmed severe visual field constriction OU (Fig. 2). Slit lamp and fundus examinations

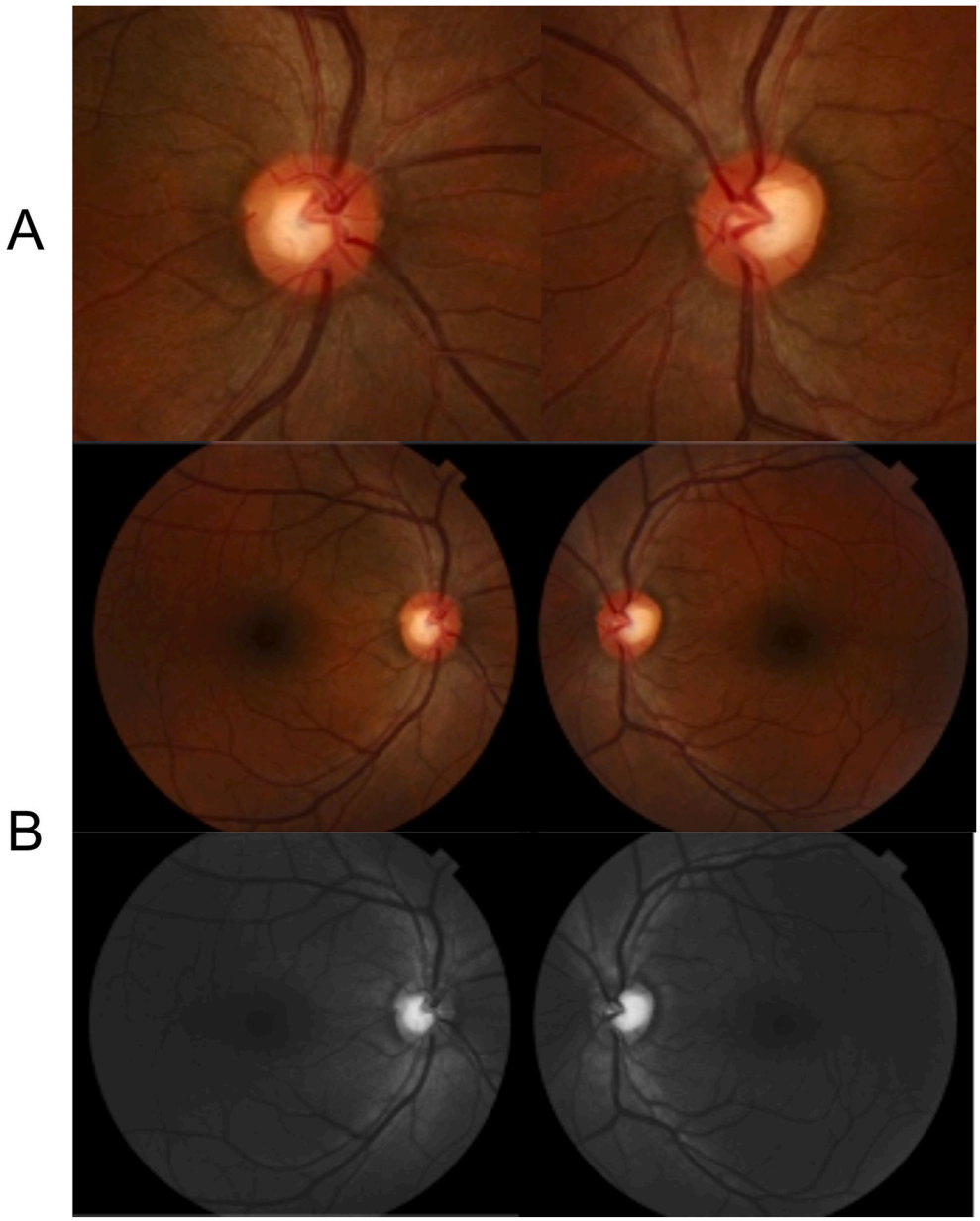

Fig. 4. Disc and fundus photos of patient. (A) Disc photos during presentation. Vitreous, nerve, and C/D findings are all normal OU. (B) Fundus photos during presentation. Macula, vessels, and periphery findings are all normal OU. No signs of optic neuropathy were present.

revealed abnormal findings OU consisting of small puncta, low tear lake, mild temporal and nasal pinguecula, and trace nuclear sclerosis. Regarding the cornea, superficial punctate keratitis involving the inferior quarter of the cornea and pannus along the inferonasal limbus were observed. Interestingly, the nasal pingueculae were noted to appear somewhat dull and keratinized and had a microcystic appearance though no white lesions (Bitot's spots) were seen (Fig. 3). Gonioscopy displayed open angles OU. The fundus exam revealed normal vitreous, optic nerve, a C/D of 0.35/0.45 (Fig. 4A) macula, vessels, periphery, and retinal membrane OU (Figs. 4B and 5). The patient's IOP were normal at 13 mmHg OU despite no use of anti-glaucoma medications in the prior 24 hours.

Visual field testing consistently showed progressive constriction and normal central visual acuity, indicating that the patient's vision concerns arose from a pathological condition. A glaucoma diagnosis was ruled out considering the patient's normal findings (e.g., IOP, optic nerve appearance, OCT) and absence of secondary glaucoma features. Since costs and travel difficulties prevented the patient from receiving diagnostic imaging studies, bilateral occipital infarcts diagnosis could not be excluded, but was considered very unlikely. The combination of preserved central visual acuity and lack of outer retinal layer atrophy on OCT images made a cancer associated retinopathy diagnosis unlikely. Inherited retinal disease and drug toxicity diagnoses were eliminated due to the preservation of the patient's color and central vision. A neurosyphilis diagnosis was excluded, as the patient produced a non-reactive result for rapid plasma reagin (RPR) and fluorescent treponemal antibody absorption (FTA-ABS) tests. Ultimately, the patient's Haitian background and presentation of supporting symptoms and signs, such as night blindness, dry eye, photophobia, and keratinization involving the nasal pinguecula, made VAD the likely diagnosis responsible for her bilateral visual field loss.

The patient was diagnosed with VAD upon her initial visit with the glaucoma specialist and received a treatment plan to stop all glaucoma medications, continue artificial tear drop usage OU, and to incorporate a short one-week course of topical difluprednate ophthalmic emulsion drops 0.05% OU into her regimen. After one week of living in the US, the

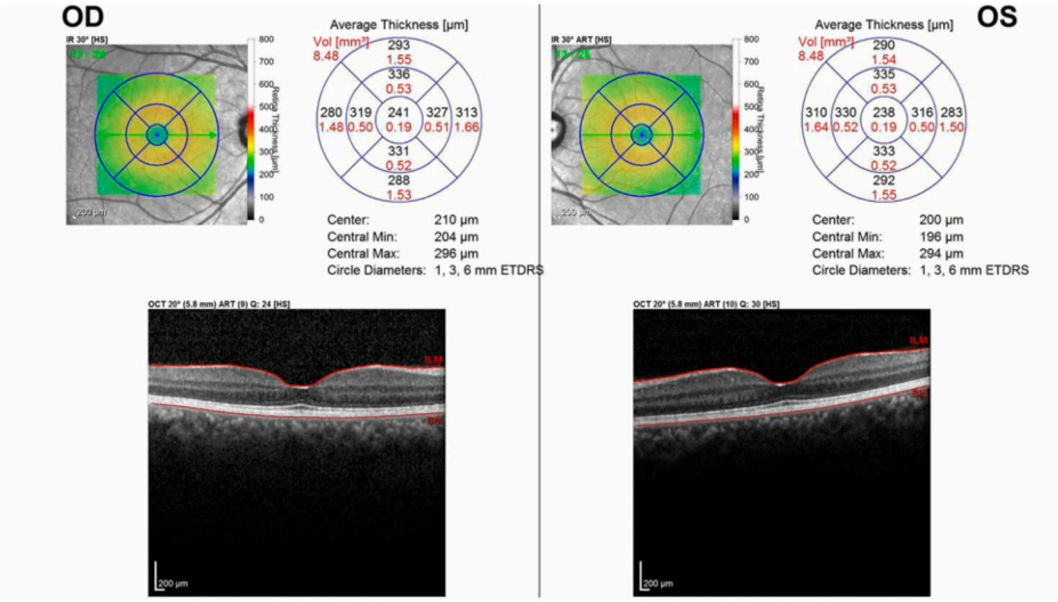

Fig. 5. OCT scans of patient during presentation. The macular thickness and contours were normal.

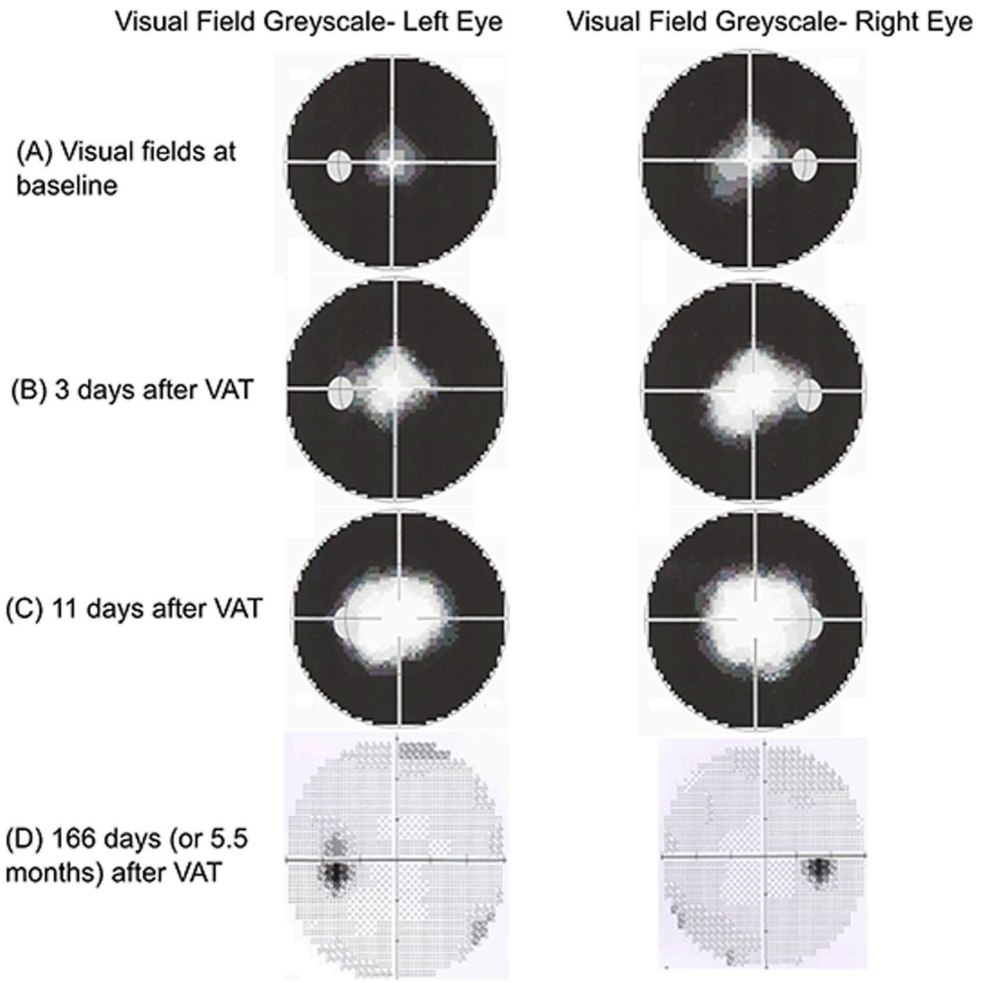

Fig. 6. Progressive visual field improvement following enteral VAT. (A) Visual fields upon presentation. (B) Visual fields on day 3 after initiation of VAT (loading doses of 200,000 IU/day orally on days 1 and 2). The previously documented bilateral visual constriction had improved, as the central isle of vision had expanded OU. (C) Visual fields on day 11 after initiation of VAT. The patient's peripheral vision had markedly improved compared to a week prior, as the central isle continued to expand. (D) Visual fields following 166 days of Vitamin A therapy (8,000 IU daily). Condition of the patient's peripheral vision had been restored and visual acuity was 20/20 OU.

patient's vitamin A serum levels were reported to be 56ug/dL, which likely fell within the normal range due to differences between the diet the patient adopted in the US when compared to their normal diet in Haiti. Regardless, VAD can occur over a large range of serum concentrations, so these findings didn't necessarily negate the VAD diagnosis, which remained.[6] She was advised of her test results and encouraged to

proceed with therapeutic trial of vitamin A therapy.

Five days later, the patient started a therapeutic trial of vitamin A involving palmitate in oil. She started with a loading dose of 200,000 IU/day for two days and returned to the ophthalmology clinic, where she underwent repeat visual field testing and showed improved peripheral vision (Fig. 6B). Her IOP OU after stopping her previous glaucoma medications was normal at 20 mmHg. VAD remained the working diagnosis and the patient was advised to continue the vitamin A therapy with a maintenance dose of 8,000 IU/day, in addition to taking a multivitamin with iron and zinc. Punctal plugs were also placed in both lower lids. One week later, the patient returned to clinic with improved dry eye symptoms and markedly improved visual fields (Fig. 6C). The patient was instructed to continue her current treatment plan. She returned to Haiti the following week. She was lost to follow up until correspondence 166 days (or 5.5 months) later revealed the patient's visual fields had since returned to normal (Fig. 6D). The patient's visual acuity was measured to be 20/20 OU and IOPs were well controlled OU (15 mmHg OD and 16 mmHg OS) on no anti-glaucoma medications.

3. Discussion

VAD is a disease with various ophthalmologic manifestations, including progressive visual field loss, night blindness, dry eye, photophobia, and ocular surface keratinization, all of which were presented by the patient. The side effects of VAD are well understood and have been extensively reported in literature while visual field outcomes of vitamin A supplementation, or VAT, have not. In this report we presented the second case documenting both VAD-induced visual field decline and visual field restoration following VAT.

Our case is unique, as it is the first to depict long-term visual field constriction prior to enteral VAT and the first to depict visual field restoration after a long-term follow-up. Sommer et al. have previously documented visual field constriction and restoration in a patient with VAD over a short five-day period after the patient's initial visit and following onset of enteral VAT.[7] Within our report, visual field constriction was documented over a 13.5-month span prior to the patient's initial visit and onset of enteral VAT. Additionally, our report included a 5.5-month follow-up with visual field restoration imaging, whereas Sommer et al. performed a two-month follow up without inclusion of visual field images, though full restoration was stated to have occurred.[7] Full reversal of VAD complications has also been reported by Bors and Fells over five-months follow-up without inclusion of visual field imaging.[8] Complete omission of vitamin A from the patient's diet led to the development of corneal xerosis, ulceration, and keratomalacia over a four-month span.[8] Interestingly, in our case, the patient did not present with ulceration or keratomalacia over a 13.5-month span, suggesting that her vitamin A stores were slowly diminishing and/or that she was still consuming vitamin A, albeit in sub-optimal amounts.

This case illustrates the detrimental symptoms and visual field effects of clinical VAD while presenting and documenting the progress of a fast-acting and affordable treatment. VAD results in visual decline due to the various roles vitamin A has in ocular surface maintenance and its derivative, retinol, has an integral role in the phototransduction pathway of rods and cones.[9] Night blindness is the earliest VAD symptom due to the rod system's high sensitivity to VAD, while xeropthalmia and Bitot's spots are more typical of long-term VAD.[9,10] During presentation, the patient's ocular symptoms were indicative of short-term VAD. Although the patient was experiencing advanced peripheral blindness, oral administration of vitamin A significantly improved her visual fields in a mere 11 days. Fortunately, the patient's cone system had not yet experienced the effects of VAD, so the central and color vision were preserved. Prior to this case, associations between enteral VAT and visual field improvement have not been vastly studied. Parenteral VAT has been associated with stabilization of nyctalopia symptoms in the past,[11] but documentation of visual outcomes following enteral VAT are scarce in the literature. However, enteral VAT has been reported to be an effective treatment for xeropthalmia, a common symptom of VAD.[12]

The patient developed VAD due to a diet scarce in vitamin A. VAD occurs most frequently in developing countries and is the leading source of childhood blindness.[13] Contributors to VAD incidence in developing countries include poor education, malnutrition, and lack of sanitation.[14] Therefore, it is crucial to educate those in developing countries on their nutritional needs and provide them with access to micronutrient-dense foods. As seen in this case, VAD-induced visual field loss is easily preventable through a balanced diet, or vitamin A supplementation. Malabsorption or problems with liver metabolism can also be associated with VAD. When tested after just one week of eating an American diet, our patient's vitamin A serum levels fell within the normal range. Although no records of vitamin A serum levels from Haiti exist, it is reasonable to assume that systemic stores of vitamin A were nearly depleted, and that the initial values fell below the normal range and rose considerably after the patient consumed fortified and vitamin A-rich foods during her stay in the United States of America. Overall, fortification of food staples with micronutrients and widespread distribution of supplements throughout developing countries are necessary to lower the incidence of VAD.[15]

4. Conclusions

Our report details a case exhibiting the adverse ophthalmologic effects of VAD. VAD has been documented in previous literature to cause bilateral visual field loss, xerophthalmia, and nyctalopia, both of which were exhibited in the case of this patient. The patient had developed VAD due to a nutritionally deficient diet and experienced rapidly progressive visual field constriction and nyctalopia as a result. Fortunately, her visual condition was reversible and eventually returned to normal through enteral VAT. This case report successfully documents the patient's visual field contraction prior to VAD diagnosis, and the rapid restoration of visual fields during VAT treatment. This case illustrates the importance of how a balanced, vitamin A-rich diet is essential to preserve eye health.

Patient consent

This report does not contain any personal identifying information.

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