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SYSTEMATIC REVIEW ON EYE MOVEMENTS AND TREATMENT FOR *VISION SNOW* SYNDROME *SYNDROME*, VSS

Daniela Yoshida
Optometrist, Professor of Optometry at Faculdade RATIO, Fortaleza (CE). Brazil

Maria Marlene Alves Araújo
Optometrist, Professor of Optometry at Faculdade RATIO, Fortaleza (CE). Brazil

Jailzo Maciel
Optometrist, Professor of Optometry at Faculdade RATIO, Fortaleza (CE). Brazil

Abstract: This study is a systematic review on Visual Snow Syndrome (also known as Granulated Vision or *Visual Snow Syndrome* - VSS), with the aim of describing the themes of the main articles that relate this pathology with the most recent findings. VSS is a complex and rare neurological condition, described as a persistent visual disturbance of static in both eyes, appearing throughout the visual field, with flickering spots, similar to the noise of an analog television. This syndrome presents sensory, motor, perceptual dysfunctions, visual and non-visual symptoms related to this undetected condition through ophthalmological and neurological examinations. Studies indicate the existence of a limited number of systematic reviews and the need for new future studies on the topic addressed.
Keywords: Visual Snow, Granulated Vision, Visual Snow Syndrome, VSS

INTRODUCTION

According to the World Health Organization (WHO), in Brazil there are at least 13 million people with rare diseases, among the more than 5 thousand cataloged rare syndromes. A rare, little-known syndrome is " *Visual Snow Syndrome* " (VSS) or Visual Snow Syndrome, which affects up to 2% of the population - estimated at a total of up to 4.3 million Brazilians who may present this Syndrome - with the most common onset between 20 and 50 years of age. VSS is a neurological condition without a defined pathophysiology. The fundamental changes in neurophysiology and its structure remain unknown, despite great research efforts in recent times. The term first appeared in the literature in 1995 as " *Persistent Positive Visual Phenomena* ". (Liu, 1995, Schankin,2014; White, 2018).

Only ten cases had been documented in the literature until 2014, with approximately 200 cases being identified that same year, and since then, a continuous and joint effort in research has sought to better understand this condition. (Schankin,2014; White, 2018). This article will present the main findings about this neurological condition that is being most researched, mainly with the appearance of symptoms and case reports after COVID-19. (Braceros, 2021).

VSS presents as its main symptom the visualization of white, black, transparent or colored dots flashing persistently throughout the visual field as illustrated in Figure 1, showing normal vision on the left and vision with Visual Snow Syndrome on the right. (Brodsky, 2016; Dodick, 2016; Bou Ghannam, 2017).

Other symptoms of VSS are palinopsia, marked entoptic phenomena, photopsia, nyctalopia (impaired night vision), insomnia, migraine with aura (headache), and the most common symptoms being photophobia and continuous bilateral tinnitus. This last symptom is highly prevalent in this syndrome, which suggests a common pathophysiology. (Schankin, 2012; Puledda, 2020; Hans, 2023; Brooks, 2022).

Migraine appears as an aggravating symptom of the clinical phenotype of "visual snow" syndrome, increasing the occurrence of visual symptoms such as: palinopsia, photopsia, photophobia, nyctalopia and tinnitus. "Visual snow" is a visual disturbance distinct from migraine aura, which can be disabling for patients. Migraine is a common combination with VSS, although standard migraine treatments are often useless.

Lauschke et al., (2016) suggest that VSS occurs due to an imbalance between the interaction of the Konio and parvo/ magnocellular pathways that underlies thalamocortical dysrhythmia and cerebral hyperexcitability. This explains the associated features of tinnitus, migraine, and tremor, all

of which have been considered to represent thalamocortical dysrhythmias. The underlying mechanisms causing visual snow syndrome, although not fully understood, may be linked to dysfunctional sensory processing and altered excitability of the occipital cortex.

Over the past three years, clinical and laboratory studies have been conducted that have revealed an unusually high frequency of oculomotor deficits in the VSS. These clinical studies identified that up to 60% of patients presented diagnoses common oculomotor disorders such as convergence insufficiency, accommodative insufficiency, and general oculomotor dysfunction (e.g., saccadic dysmetria). Fortunately, these oculomotor problems can be successfully treated with conventional vision therapy. (Barry, 2024).

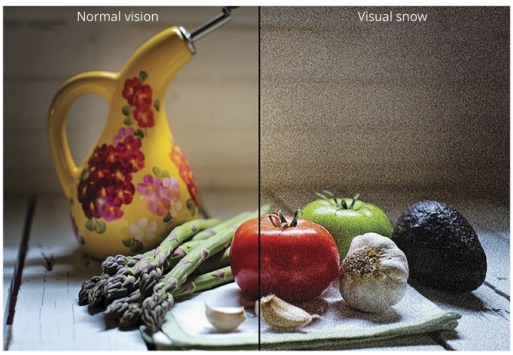


Figure 1. *Normal vision on the left and Visual Snow vision on the right*

Source: https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20m&p=PMC3&id=7136068_NEUROLOGY2019003889FF1.jpg

METHODOLOGY

This study is a systematic review based on a bibliographical survey, with the aim of describing the most recent findings and research on this pathology. For research on the chosen topic, VHL, Web of Science, PubMed and Rayyan were used .

The descriptors (free terms) used and researched, between August 2023 and February 2024, to locate the references were: *"Visual Snow Syndrome (VSS)"; " Visual Snow " and " treatment " and " eye Movement "; " Visual Snow syndrome " and " treatment " and " eye movement"; " Visual snow syndrome" and "treatments" and "movements* eyepieces"; "Grainy vision "treatments" and "eye movements"; "Visual snow "treatments" and "eye movements".

The inclusion criteria and exclusion criteria are described below. The inclusion criteria for analysis were:

1. Type of publication: articles in periodicals.
2. In any language, but with an abstract in English, Portuguese, Spanish or French.
3. Year of publication of articles: period from 2000 to 2023.
4. Articles with abstract.

The exclusion criteria were:

1. Articles without an abstract or with an abstract in a language other than English, Portuguese, Spanish or French.
2. Articles that were duplicates were excluded.
3. Articles that did not directly address the topic of Visual Snow Syndrome in the systematic review.

In total, a total of 142 articles were found in Rayyan, of which: 57 articles in the VHL, 49 articles in Web of Science and 23 articles in PubMed, as shown in table 1 below.

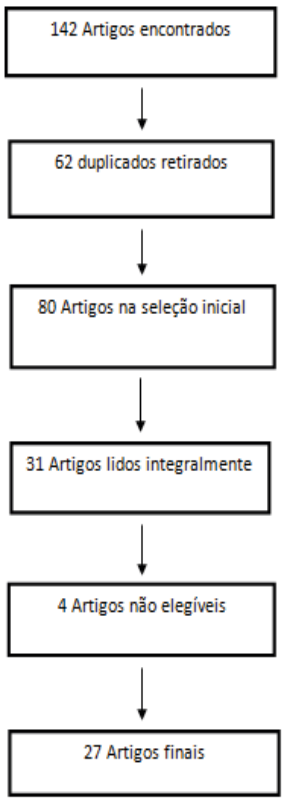
VHL	Web of Science	PubMed	Rayyan
57	49	23	142

Table 1. *Initial selection of articles found*

The selection of the 142 articles found was based on the inclusion and exclusion criteria, with 62 articles being duplicates and, therefore, excluded, leaving 80 articles from which 31 articles were selected, read in full,

to be excluded, 4 ineligible articles, according to the criteria. already mentioned. In the end, 27 final articles were selected in this study, as demonstrated in the flowchart below.

The final selection of articles was carried out simultaneously and conflicts were resolved by consensus by the three authors of this work, in order to avoid research bias. All articles were read by at least 2 authors to reach the final selection of articles.



Flowchart. *Selection of articles with inclusion and exclusion criteria*

RESULTS

The articles found in the literature were as follows: 5 systematic review articles; 1 article citing oculomotor changes in VSS; 7 articles citing migraine with aura or migraine with VSS, 2 articles citing tinnitus and VSS; 1 article related to medication and VSS; 8 articles on VSS pathophysiology; 2 articles citing cerebral hyperexcitability and thalamocortical dysrhythmia ; and 1 article with a case study on VSS, as shown in figure 2. Visual snow is a phenomenon originating in the central nervous system characterized by the perception of an image with continuous visual static, being a visual disorder described as "static", with difficult diagnosis that requires the exclusion of concurrent neurological and ophthalmological disorders.

Visual snow syndrome in relation to tinnitus shows symptoms with static is accompanied by prominent visual symptoms, which often occur simultaneously with migraine, aura and tinnitus, which has been found in 63% of patients reporting continuous bilateral tinnitus (Renze, 2017)

A study on oculomotor changes and VSS showed the importance of evaluating oculomotor changes in patients with VSS, since a total of 77% of patients failed at least one out of three oculomotricity tests performed. (Barry, 2024).

The pathophysiology of VSS remains unclear, with the hypothesis of a lower threshold for the perception of altered images that cannot explain entirely the symptoms reported by patients who present this syndrome. Several signs were associated with the visual snow phenomenon: palinopsia (50%), constant blue field entoptic phenomenon (40%), photophobia (30%), migraine (30%); in 20% of cases an initial toxic ingestion was detected (20%). Therefore, ophthalmologists and neurologists must be able to diagnose VSS, as a quick and adequate diagnosis allows patients to avoid stress and shorten the path to diagnosis (Sampatakakis, 2022; Zambrowski, 2014).

There is a hypothesis that the mechanism related to VSS and its pathophysiology involves the excessive excitability of neurons in the right lingual gyrus and the left anterior lobe of the cerebellum, generating a thalamocortical dysrhythmia which may involve a failure in the inhibitory action of the thalamic reticular

Article	Author (year)	Findings
Clinical reading-related oculomotor assessment in visual snow syndrome, Journal of Optometry	Barry et al., (2024)	A total of 77% of patients with VSS have a high prevalence of oculomotor dysfunctions based on clinical tests, interfering during reading, having failed at least one of the three oculomotor tests performed in the study. More research is needed to discover the neurological mechanisms (e.g., hypersensitivity) and neural substrates (e.g., MT), along with their diagnostics, ramifications, prognoses, and therapeutics.
Visual snow: a potential cortical hyperexcitability syndrome ". Current Treatment Options in Neurology	Bou et al., (2017)	Topiramate is an anticonvulsant approved in the United States and, despite having an unknown mechanism of action, it was well tolerated and effective at follow-up 6 months later in patients with VSS and may be a useful therapeutic option in the treatment of trigeminal neuralgia. Larger controlled studies, including comparative trials against established agents such as carbamazepine, are recommended.
Visual contrast perception in visual snow syndrome reveals abnormal neural gain but not neural noise, Brain	Brooks et al., (2022)	Neurophysiological work indicates that responses are amplified in the primary visual cortex. The first study showed decreased contrast perception in the VSS while a second experiment found neural gain to be increased in the VSS, specifically finding that contrast gain was abnormal and increased in the P (parvocellular) pathway regardless of migraine status. Contrast gain for increments processed in the M (magnocellular) pathway was not affected by VSS. The contrast gain in the off subdivision of the magnocellular pathway was reduced, contradicting the proposal of cortical hyperexcitability. Another area for future research is the link between VSS and tinnitus. The visual discomfort questionnaire provided a more comprehensive assessment of visual hypersensitivity in the VSS than the Leiden Visual Sensitivity Scale. Auditory visual snow tinnitus is highly prevalent in VSS, suggesting a common pathophysiology.
Neuro- optometric treatment for visual snow syndrome: recent advances.	Ciuffreda et al (2023)	-optometric therapeutic advances are promising from the neuro- optometric rehabilitation that benefits most patients, including the use of colored filters and eye movement procedures to reduce the perception of visual snow and some of the other visual effects related to VSS symptoms., such as light sensitivity.
Thalamocortical Dysrhythmia: A Theoretical Update in Tinnitus.	De Ridder et al., (2015)	Tinnitus is triggered by changes in the transmission of the auditory cortical thalamic signal, causing a cortical thalamic arrhythmia. Hyperpolarization of the thalamus causes thalamocortical dysrhythmia, so that deafferentation (interruption of afferent activity) reduces alpha activity to theta activity, which means less external information input. Symptoms of this condition can be easily confused with regular floaters or black spots seen in vitreous and retinal pathologies. In the absence of such pathology, an elaborate history should be obtained and the patient's suffering should be recognized. The patient must also be reassured that this is not a condition that will lead to blindness.
Insights into pathophysiology and treatment of visual snow syndrome: A systematic review.	Eren O. et al., (2020)	Visual Snow Syndrome is not yet fully understood. As for its pathophysiology, it is likely that there is a disorder in visual processing. Lamotrigine is the medication with the greatest pharmacological support for its treatment and can be considered for off-label use. As a non-medicated alternative, patients can benefit from wearing glasses with colored lenses on a daily basis. The only drug that exacerbated the symptoms of Visual Snow Syndrome was amitriptyline.
Historical, Diagnostic, and Chromatic Treatment in Visual Snow Syndrome: A Retrospective Analysis.	Han et al., (2023)	Visual snow was typically constant and monochromatic, being present on average 6.43 years. The most common primary and secondary symptoms were photosensitivity and tinnitus, respectively. The most common etiology was mild traumatic brain injury. Light and dark surfaces were the most provocative/exacerbating/revealing conditions, along with viewing computer screens. There was a high frequency of oculomotor deficits, mainly accommodative and vergence insufficiency (~40 to 50%). Eighty percent of patients were prescribed chromatic tint with subjective visual snow reduction ranging from 15 to 100% (average 45%).
Visual snow: A thalamocortical dysrhythmia of the visual pathway	Lauschke et al., (2016)	The pathophysiology of VSS is an imbalance between the interaction of the Konio and parvo/ magnocellular pathways underlying the thalamocortical dysrhythmia. This explains the associated features of tinnitus, migraine and tremor. Tremor has not been frequently reported in the VSS literature, but was observed in 22% of patients in this study.
Visual Snow: Clinical Correlations and Workup A Case Series	Licht et al., (2017)	The results of this case series confirm what has been observed in previous studies: visual snow is a unique clinical syndrome, often associated with a personal or family history of migraine; visual symptoms differ from migraine aura; the onset of symptoms usually occurs in early adulthood; drug treatment usually does not provide satisfactory relief; and no structural findings are identified on imaging studies associated with this condition.

Visual Snow Syndrome: Proposed Criteria, Clinical Implications, and Pathophysiology.	Metzler AI, Robertson CE (2018)	In addition to pharmacological therapies, there may be a potential role for individualized colored glasses in the treatment of visual snow. The study offered 12 participants with visual snow a variety of lenses to see if a specific color filter improved their symptoms, with 10 of these patients felt that their symptoms were partially alleviated with filters in the yellow - blue spectrum.
Widespread White Matter Changes in Patients With Visual Snow Syndrome	Michels et al. (2021)	Patients with VSS demonstrate heightened excitability of parts of the visual cortex as well as other regions of the brain. However, more research is needed. Changes were observed in the prefrontal cortex, with extension to the inferior fronto -occipital fasciculus (IFOF), temporal and occipital cortex, superior longitudinal fasciculus (SLF) and middle longitudinal fasciculus, changes in the corpus callosum, but not in the sagittal stratum, fasciculus middle longitudinal and occipital WM.
Persistent migraine aura symptoms aka visual snow	Podoll K, (2012)	Visual snow syndrome is caused by anxiety, depression, or taking illicit drugs such as LSD.
Visual snow syndrome: A clinical and phenotypical description of 1,100 cases	Puledda (2020).	The average age of the population with VSS was 29 years and there was no gender predominance. This disorder usually begins early in life and approximately 40% of patients have had symptoms for as long as they can remember. The most common form of manifestation was static black and white visualization. In a considerable number of patients, VSS could begin abruptly and spontaneously; however, this was not necessarily associated with a greater number of disease symptoms.
Localized increase in regional cerebral perfusion in patients with visual snow syndrome: a pseudo-continuous arterial spin labeling study	Puledda, Francesca; Goadsby, Peter (2021).	The results indicate that patients with VSS have significant differences in the brain processing of visual stimuli, confirming the neurobiological basis of the concept.
Snow visual syndrome and its relationship with tinnitus.	Renze, 2017	Visual snow syndrome is a set of symptoms that are highly prevalent in patients who present with visual snow. Although the majority of these symptoms appear to be visual in nature, approximately 63% of patients studied also report continuous bilateral tinnitus.
Visual Snow: A Review on Pathophysiology and Treatment.	Rusztyn (2023)	The data for Visual Snow Syndrome are few and not sufficient to support Visual Snow Syndrome as a medical identity. More investigations are needed.
Visual snow: A systematic review and a case series.	Sampatakakis (2022)	Ophthalmologists and neurologists must be able to diagnose VSS, as a rapid and appropriate diagnosis allows patients to avoid stress and shorten the path to diagnosis.
'Visual snow ' - a disorder distinct from persistent migraine aura.	Schankin, 2014	Headache was the most frequent symptom associated with the onset or worsening of visual disturbance (36%), while migraine aura (seven patients) and illicit drug use (five, without hallucinogens) were rare. Migraine (59%), migraine with aura (27%), anxiety, and depression were common comorbidities over time.
Visual Snow: A New Disease Entity Distinct from Migraine Aura	Schankin (2012)	Of patients with VSS, 92% had no response to medication. Substance abuse was present in 40% of patients, with LSD use found in 5% of the cases studied.
The Relationship Between Migraine, Typical Migraine Aura and "Visual Snow", Headache	Schankin (2014)	Migraine worsens the clinical phenotype of "visual snow" syndrome, worsening some of the visual symptoms such as palinopsia, photopsia, photophobia, nyctalopia and tinnitus.
Visual snow -- persistent positive visual phenomenon distinct from migraine aura	Schankin (2015)	Visual and non-visual symptoms are described in detail and criteria are presented for future studies.
An Integrative Tinnitus Model Based on Sensory Precision	Sedley, (2016)	Although it is currently unknown how visual snow syndrome is related to tinnitus, the high correlation of visual snow syndrome patients presenting with tinnitus suggests that they may share a common underlying pathophysiological mechanism.
Visual snow syndrome and migraine: a review	Silva, 2023	Treating visual snow has been challenging, and efforts have focused on unraveling the biological mechanisms of the syndrome. Recent research on the topic involves neuroimaging, neurophysiological and neurobehavioral studies.

Visual snow syndrome: a review on diagnosis, pathophysiology, and treatment.	Traber (2020)	Visual snow is considered a disorder of central visual processing, resulting in a disturbed perception of bilateral constant flickering or pixelation of the total visual field.
Visual Snow in Migraine with Aura: Further Characterization by Brain Imaging, Electrophysiology and Treatment – Case Report	Unal-Cevik (2015)	Brain MRI revealed left occipital flexion. In the PVE study, there was a potentiation response. After treatment with lamotrigine, the patient no longer had visual complaints, was able to sleep and the migraine frequency decreased to 2 attacks/month, and it was demonstrated that electrophysiologically, cortical hyperexcitability improved. Visual snow and loss of habituation in migraine can be improved with lamotrigine treatment.
Visual Snow: Visual Misperception	White et al., (2018)	The study suggests factors of origin of VSS such as dysfunction in the subcortical network and increased brain activity. Despite the overlap between the symptoms of VSS and migraine syndromes, both neurophysiological investigation and neuroimaging present consistent evidence of distinct abnormalities in processing, supporting them as separate conditions.
The black visual phenomenon	Zambrowski (2021)	This study emphasizes the common symptoms reported by patients experiencing the phenomenon of visual snow, the pathophysiology of which remains elusive. The assumption of a reduced threshold for the perception of entoptic images cannot fully explain the described symptoms. Several symptoms were associated with the visual snow phenomenon in different proportions: palinopsia (50%), constant blue field entoptic phenomenon (40%), photophobia (30%), migraine (30%). In 20% of cases, an initial ingestion of toxic substances was identified.

Figure 2. Synthesis of article, author and main findings, with the distribution of publications (title, author, year, findings), between the years 2000 and 2023, on patients with VSS

Search Theme with VSS	**Amount**	**Authors (Year)**
Systematic review	5	Zambrowski O, Ingster-Moati I, Vignal -Clermont C, Robert M. (2014) White, Owen B. MD, PhD, FRACP; (2018) Sampatakakis SN, Lymperopoulos L, Mavridis T, Karagiorgis G, Papadopoulos C, Deligianni CI, Mitsikostas DD. (2022). Silva EM, Puledda F. (2023). White, Owen B. MD, PhD, FRACP; Clough, Meaghan PhD; McKendrick, Allison M. PhD; Fielding, Joanne PhD. (2018)
Oculomotor changes	1	Barry Tannen, Alina Sample, Kenneth J. Ciuffreda, Noah M. Tannen, (2024)
Migraine with aura/migraine	7	Podoll K, Dahlem M, Haas DC. (2007) Podoll K, Dahlem M, Greene S. (2012) Schankin CJ, Maniyar FH, Digre KB, Goadsby PJ. (2014). Schankin, CJ, Maniyar, FH, Sprenger, T, Chou, DE, Eller, M, Goadsby, (2014) Schankin CJ, Maniyar FH, Digre KB, Goadsby PJ. (2012) Schankin, C.J.; Goadsby, P. J. (2015). Unal-Cevik, I. and Yildiz, F. G. (2015).
Buzz	2	Renze M. (2017) Sedley W, Friston K, Gander P, Kumar S, Griffiths T (2016).
Medicines	1	Haan J, Sluis P, Sluis LH, Ferrari MD (2000)
Pathophysiology	8	Traber GL, Piccirelli M, Michels L. (2020). Eren O, Schank CJ. (2020). Metzler AI, Robertson CE. (2018) Michels, Lars; Traber, Ghislaine R. (2021). Puledda F, Schankin C, Goadsby PJ. (2020). Puledda, Francesca; Goadsby, Peter (2021). Rusztyn P, Stańska W, Torbus A, Maciejewicz P. (2023) Traber GL, Piccirelli M, Michels L. (2020).
Cerebral hyperexcitability and thalamocortical dysrhythmia	two	Bou Ghannam, A; Pelak, V. S. (2017). Lauschke J, Plant G, Fraser C. (2016)
Case study	1	Licht, Joseph; Ireland, Kathryn; Kay, Matthew. (2017).
TOTAL	27 ARTICLES	

Figure 3. *Distribution of publications (VSS Research Topic, number of articles and authors) on VSS. Source: Prepared by the authors.*

nucleus (TRN), and consequently the inability to suppress excitatory sensory information. (Bou Ghannam, 2017; Dodick, 2016). The symptom of tremor has not been frequently reported in the VSS literature, but was observed in 22% of our patient population. (Raschke et al.,2016).

Headache was the most frequent symptom found among patients with VSS, being associated with the onset or worsening of visual disturbance (36%), while migraine aura (seven patients) and illicit drug consumption (five, without hallucinogens) were rare. Migraine (59%), migraine with aura (27%), anxiety, and depression were common comorbidities over time. The assumption of a reduced threshold for the perception of entoptic images cannot fully explain the described symptoms. Several symptoms were associated with the visual snow phenomenon in different proportions: palinopsia (50%), constant blue field entoptic phenomenon (40%), photophobia (30%), migraine (30%). In 20% of cases, an initial ingestion of toxic substances was identified. Zambrowski (2021)

A useful therapeutic option in the treatment of refractory trigeminal neuralgia was well tolerated and effective in follow-up even 6 months after treatment in patients with VSS who used topiramate. A study showed that among patients with VSS, 92% had no response to medication for migraine with aura, with substance abuse being present in 40% of the patients evaluated, with LSD use in 5% of the cases studied. Schankin (2012)

Larger controlled studies, including comparative trials against established agents such as carbamazepine, are indicated. (Bou et al.,2017). one study showed that among patients with VSS, 92% had no response to medication. Substance abuse was present in 40% of patients (LSD in 5%). In the absence of a secondary pharmaceutical indication, some medications do not necessarily result in benefit, and evidence for their use is limited (Brodsky, 2016; Dodick, 2016; White, 2018;). A case study showed that after treatment with lamotrigine, the patient with VSS no longer complained of visual snow, was able to sleep and the migraine frequency decreased to 2 attacks/month, improving cortical hyperexcitability, on magnetic resonance imaging. Unal-Cevik (2015).

DISCUSSION

Visual Snow Syndrome is a disorder with visual changes that affect the ability to see clearly and sharply, requiring a greater number of systematic studies to describe its clinical characteristics, pathophysiology and effective responses to the treatment of the pathology. begin to understand, mainly, treatments related to visual exercises that use eye movements or drug treatments, since no conclusive studies have been found that can generate an effective treatment cure for Visual Snow Syndrome. In this work, only one article related to eye movements and VSS was found, and only one article related to medications and VSS. (Haan J, Sluis P, Sluis LH, Ferrari MD 2000; Schankin, 2014; Barry Tannen, Alina Sample, Kenneth J. Ciuffreda, Noah M. Tannen, 2024).

The difficulty in researching rare diseases, especially eye diseases, occurs due to the lack of diagnosis in patients with the rare syndrome, since these diseases are described as occurring in up to 65 in each group of 100 thousand people, that is, 1. 3 individuals for every 2 thousand people, in addition to the fact that neurological and ophthalmological examinations do not show clinical changes in patients with VSS. (White, 2018; Silva EM, Puledda F., 2023; WHO, 2024).

Studies show that optometric treatments for VSS, including eye movement exercises, deserve further investigation, as they suggest the benefit of using colored filters for daily

use, as a non-pharmacological treatment option for these patients, demonstrating an improvement in quality of life after 6 and 12 weeks of NORT treatment (Neuro-Optometric Visual Rehabilitation Therapy), improving reading difficulties, contrast vision, and ability to perform tasks at work in relation to symptoms before treatment. (Eren, 2020, Tsang, 2022; Ciuffreda, 2023).

Regarding medications and VSS, the best pharmacological evidence was lamotrigine, off- label, with reports that medications were effective at least once: Valproate, propranolol, verapamil baclofen, naproxen and sertraline. According to Unal-Cevik (2015), the characteristics of visual snow are accompanied by migraine, with brain MRI revealing left occipital flexion and in the PVE (Visual Evoked Potential) study, there was a potentiation response. After treatment with lamotrigine, the patient no longer complained of visual snow, was able to sleep and the migraine frequency decreased to 2 attacks/ month, and electrophysiologically, cortical hyperexcitability improved, leading the study to conclude that visual snow and Loss of habituation in migraine can be improved with treatment with lamotrigine .

As pharmacological treatment of visual snow syndrome is largely ineffective, patient management should focus on reassurance, appropriate differential diagnosis, search for possible secondary causes in atypical cases, and optimal treatment of associated comorbidities, therefore, visual and non-visual symptoms are presented as relevant factors for future studies. (Lauschke et al.,2016).

A study using functional brain imaging with magnetic resonance suggests that Visual Snow Syndrome is a brain disorder, where a central visual processing disorder occurs and causes altered perception of binocular vision, generating the perception of images as if they were pixels in the entire visual spectrum. The condition is usually constantly present, including in dreams and when the patient has their eyes closed. There is still no known cure, as viable treatments are still being researched (Schankin, 2015).

The first case study of visual symptoms similar to Visual Snow Syndrome in a patient after coronavirus disease infection was reported in 2019 (COVID-19). He was found to have a transient mild and subtle inflammatory reaction in the vitreous and optic nerve edema that resolved, but the VSS persisted. COVID-19 may precipitate a transient autoimmune response in some patients with ocular inflammation as well as long-term VSS symptoms, providing implications for future studies on the treatment of complications related to COVID-19 and VSS. (Braceros, 2021).

According to Metzler AI, Robertson CE (2018), in addition to pharmacological therapies, there may be a potential role for individualized colored prescription glasses in the treatment of visual snow, but more studies are needed to prove that lenses with filters can really help these patients.

Among the articles found, there are a limited number of studies on VSS and, mainly, few systematic reviews on the topic. When research of this type exists, the studies are based on only a few literatures, despite an increasing number of articles being published after 2014.

FINAL CONSIDERATIONS

Although the term Visual Snow Syndrome appeared for the first time almost 30 years ago, there is still a very small number of literature on VSS and, among the studies found, only half of these works are based on scientific research, not always with a Therefore, visual snow syndrome is still far from being fully understood in relation to its pathophysiology, and it is likely a visual processing disorder.

The literature showed few studies on VSS, with a limited number of systematic reviews, case studies, studies with oculomotor changes; migraine with aura/migraine; buzz; use of medications such as topiramate, cerebral hyperexcitability/or thalamocortical dysrhythmia and pathophysiological aspects. (Bou Ghannam, 2017)

The challenge of rare eye conditions lies in a lack of awareness and understanding, both on the part of healthcare professionals and the general public. There is still no established treatment for VSS and medications used to try to treat the condition include lamotrigine, acetazolamide or verapamil. Although this rare condition does not yet have a cure, research and development of optometric therapies continues to advance, offering hope for maintaining the quality of life for sufferers and their families. The study of 12 participants with VSS used lenses to see if a specific color filter improved their symptoms, with 10 of these patients feeling that their symptoms were partially alleviated with filters in the yellow - blue spectrum. (Ciuffreda, 2023; Metzler AI, Robertson CE, 2018).

VSS is a rare and still little studied syndrome, which is why many health professionals such as physiotherapists, occupational therapists, speech therapists, as well as optometrists and ophthalmologists are beginning to study visual processing, to understand how to stimulate or improve visual perception. of patients with neurological conditions that are often irreversible. (Schankin, 2015),

Research on VSS is still limited by its high cost, lack of funding, and the difficulty in identifying patients and diagnosing cases, as well as restricted access to a significant number of patients for more reliable research, which is why there are some articles that report only clinical case studies. However, advances in genetics and medicine are opening new perspectives for more accurate diagnosis and targeted treatments.

According to Ciuffreda (2023), non-profit institutions focused on multidisciplinary VSS research are being created in several countries with the aim of increasing public awareness and access to specialized pharmacological, optometric, ophthalmological and neurological care that can play a fundamental role in the advancement of understanding and treatment of these uncommon eye diseases.

In conclusion, VSS has received considerable attention in the last decade by clinicians and researchers, with two initial approaches to neuro- optometric rehabilitation partially benefiting the majority of patients with this condition. Studies show the use of colored filters and eye movement procedures to reduce the perception of visual snow and some of the other related visual disturbances such as light sensitivity, showing subjective contrast vision improvement. Despite efforts and advances in research, more studies are still needed in the future, with high scientific rigor that can corroborate these facts.

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DECLARATION OF CONFLICT

There are no competing interests for this article review.

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