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ADVANCES IN EARLY DETECTION OF OPTICAL NEURITIS DIAGNOSIS SYSTEMS

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Abstract: **Optic neuritis (ON) is an inflammatory demyelinating disorder of the optic nerve, which can be the first manifestation of multiple sclerosis (MS). In this paper we review the recent advances in early diagnosis of the disorder focusing primarily on the techniques : Retinal OCT Texture Analysis, Machine learning based on Color Fundus Images and Optical Coherence Tomography. This review is based on articles retrieved by a selective search of the PubMed database and other related journal articles, on the pertinent guidelines, and on the authors' clinical experience. Throughout, we present tables that summarize and draw distinctions among key ideas and approaches. Where available, we provide comparative analyses, and we make suggestions for analyses yet to be done.**

Keywords: **Optical Coherence Tomography, Demyelinating Diseases, Optical Neuritis, Texture Analysis.**

I. INTRODUCTION

Optic neuritis is a disorder that occurs when swelling (inflammation) damages the optic nerve.Optic nerve is a collection of nerve fibers that transmits visual information from your eye to your brain. Signs and symptoms of Optic Neuritis can eventually lead to Multiple Sclerosis (MS). Multiple Sclerosis is a disease that causes inflammation and damage to nerves in your brain as well as the optic nerve.

Besides MS, optic nerve inflammation can occur with other conditions, including infections or immune diseases, such as lupus. Rarely, another disease called neuromyelitis optica causes inflammation of the optic nerve and spinal cord. Most people who have a single episode of optic neuritis eventually recover their vision without treatment. Sometimes steroid medications may speed the recovery of vision after optic neuritis.

II. LITERATURE REVIEW

Wilhelm H, Schabet M [1] did a review based on the articles from PubMed databaseand came to an conclusion that Optic neuritis can be easily distinguished from other diseases affecting the optic nerve. Atypical forms of this disease and other optic nerve diseases require specific treatment. Patients diagnosed with high risk of developing multiple sclerosis, immune prophylaxis with beta- interferon or glatiramer acetate is recommended.

Polina Dahal, Pradeep Bastola [2] did research on Optic neuritis, patients with Optic neuritis were included in the study for treatment with intravenous methylprednisolone and oral steroids. SPSS version 26 was used to analyze the data entered in a specified proforma. Optic neuritis with sudden onset diminution of vision usually in one eye. It was found that treatment outcome with IV steroids followed by oral steroids when initiated early in cases of optic neuritis have an excellent visual outcome.

Hedieh Hoorbakht, Farid Bagherkashi [3] submitted their work on Optical Neuritis. The majority of patients suffering from Optical Neuritis recovered visual function spontaneously. However, IVMP can accelerate the rate of recovery. Most patients experienced long-term visual defects even after receiving treatment and achieving VA of 6/6. They concluded less expensive IV dexamethasone treatment can be used as an alternative to IVMP. If any demyelinating lesions were found on MRI, the patient should immediately consult a neurologist regarding treatment with DMDs as prophylaxis to decrease the risk of developing MS with close monitoring.

Elke Voss, Peter Raab, Corinna Trebst and Martin Stangel [4] proposed that whenever a patient is suspected with Optical Neuritis, further investigations should be conducted urgently to rule out other etiologies such as corticosteroid responsive optic neuropathies or tumours. For patients with atypical clinical presentation an orbital and brain MRI with gadolinium is mandatory. A careful ophthalmologic examination is also recommended to rule out other differential diagnosis and the measurement of VEP can verify an optic nerve dysfunction. In some cases only a biopsy revealed the correct diagnosis. Therefore, a biopsy should be considered if additional tests are not capable of revealing a correct diagnosis.

Ahmed Toosy, Deborah F Mason, David H Miller [5] studies reveal that clinically distinguishing typical optic neuritis from atypical forms in the acute phase is a complex process. The most common form is typical optic neuritis, probably demyelinating and closely associated with MS, although sometimes occurring in isolation. Typical optic neuritis resolves spontaneously, and provides researchers with a useful in-vivo model with which to study mechanisms of localised damage and recovery due to inflammatory demyelination in the CNS, including the study of neuroprotective and remyelination strategies. If untreated,

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atypical optic neuritis can lead to irreversible visual loss, and often needs urgent treatment with corticosteroids, with slow wean and, sometimes, chronic immunosuppression.

S J Hickman, C M Dalton, D H Miller, G T Plant [6] research revealed that Optic neuritis is a self-limiting condition that can usually be diagnosed on the basis of the clinical picture. Parenteral corticosteroids can help to speed up visual recovery without affecting the long-term prognosis for visual function. An expectant approach to management is therefore reasonable, although if there is suspicion of a different diagnosis or deviation from the expected clinical course then urgent investigations are called for to rule out, in particular, a compressive lesion or a corticosteroid responsive optic neuropathy. Furthermore, optic neuritis can be the first manifestation of multiple sclerosis. An increased risk of multiple sclerosis exists if there are asymptomatic brain lesions on MRI. Serial MRI can provide an early diagnosis of multiple sclerosis in some patients. Although interferons can delay the time to a second relapse, their long-term effect on disability is unknown.

Juan Zhang, Jianhua Wang [7] studies reveal that machine learning approach using wavelet features of thickness maps of GCIPL improves the performance of the traditional thickness analysis on discriminating prior ON in patients with MS, and the machine learning approach may be promising in facilitating the diagnosis of prior Optical Neuritis in patients with Multiple Sclerosis.

Guangzhou An, Yukihiro Shiga [8] concluded that their study used fundus images and extracted quantified images from OCT data, either alone or in combination, as the basis for an automated, objective, machine learning method for glaucoma diagnosis. Results gave a combination method with Accuracy rate of 0.963; it has the vitality to detect glaucoma in its early stages.

III. APPROACHES

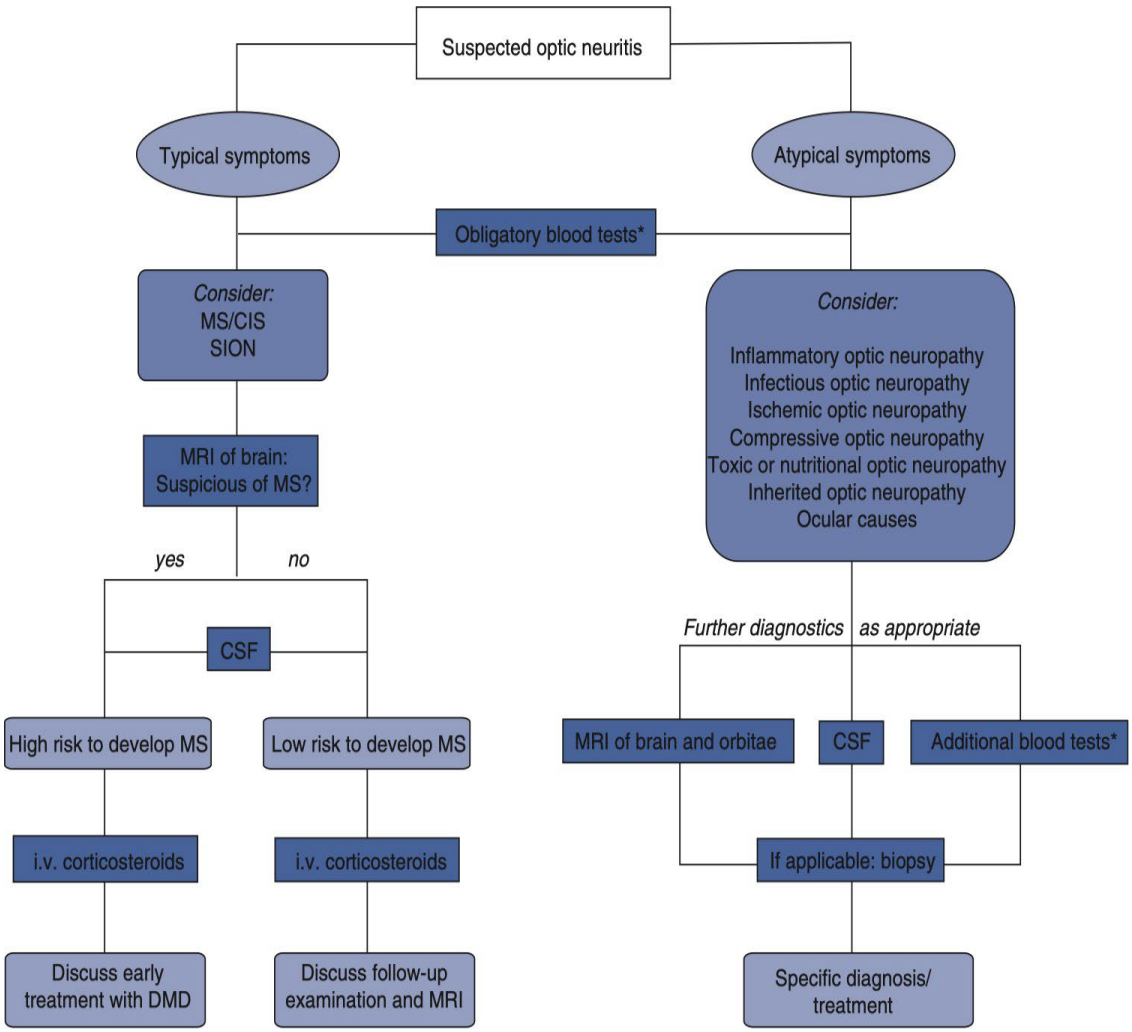

Fig.1 Clinical workflow for patients with diagnosis of suspected optic neuritis.

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Here the patients suspected with Optical Neuritis can be classified with either Typical or Atypical symptoms. If detected with typical symptoms, MRI of the brain is taken. If the result is yes, there is a high risk of developing Multiple Sclerosis (MS). If the result is no there is a low risk of developing Multiple Sclerosis (MS). If detected with atypical symptoms, multiple tests can be taken including MRI, CSF and Blood tests. If applicable then biopsy is done.

Disease	Acute onset?	Pain on eye movement?	Papiledema?	Spontaneous recovery?
Optic neuritis	Always	92%	In about 30% of cases (mild)	Marked improvement of visual acuity in 95%
Tumor of the anterior visual pathway	Almost never	Never	Possible	Very rare
Anterior ischemic optic neuropathy	Always	Never (there may be diffuse ocular pain)	In the acute stage: always*	Usually only slight improvement

Fig .2 The differential diagnosis of optic neuritis and other related diseases

Patients in the Optic Neuritis Treatment Trial (ONTT) who received high-dose intravenous methylprednisolone had fewer Multiple Sclerosis relapses in the ensuing two years than those who received either placebo or low-dose oral prednisone, but there was no further difference after 25 years. This finding led researchers to ask whether the favorable effect could be prolonged by a second steroid infusion. Although some evidence indicates this may be the case, the matter has not yet been studied any further. The patients in the Optic Neuritis Treatment Trial(ONTT) who received intravenous methylprednisolone for 3 days also received oral prednisolone over the ensuing 11 days. It is unclear whether this is necessary, and the guidelines leave the question open.

Trial	Year	Drug	Number of patients	Follow-up (years)	Conversion to clinically definite multiple sclerosis		
					Active drug (%)	Placebo (%)	Relative risk reduction (%)
CHAMPS (40)	2000	IFN-β-1a	383	3	35	50	30
CHAMPS (e1)	2012	IFN-β-1a		5	38	53	28
CHAMPS (e1)	2012	IFN-β-1a		10	76	84	10
ETOMS (e2)	2001	IFN-β-1a	309	2	34	45	24
BENEFIT (e3)	2007	IFN-β-1b	468	3	34	48	29
BENEFIT (e4)	2014	IFN-β-1b		8	56	66	15
PreCISe4 (e5)	2009	Glatiramer acetate	481	3	25	43	42

Fig .3 Clinical trials on prevention of conversion of clinically isolated syndrome to clinically definite multiple sclerosis.

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IV. PERFORMANCE ANALYSIS

Optical neuritis can occur as a recurrent disease or monophasic, either in the same or the contralateral eye especially in patients who develop Multiple Sclerosis thereafter. The Optical Neuritis Treatment Trial (ONTT) reported 28% and 35% of patients with recurrent Optic Neuritis within 5 to 10 years respectively. At the 5 year follow-up, the relapse of Optical Neuritis was 19% for the affected eye, 17% for the fellow eye and 30% for either eye.

Treatmenting the patients with oral prednisone alone in standard doses increased the relapse rate of Optical Neuritis and therefore is not recommended in acute typical Optic Neuritis. Higher doses of oral corticosteroids have shown the same recurrence rate compared to placebo.

Recurrence Rate	Oral Prednisolone	IVMP	Placebo
2 Years	30%	13%	16%
5 Years	41%	25%	25%
10 Years	44%	29%	31%

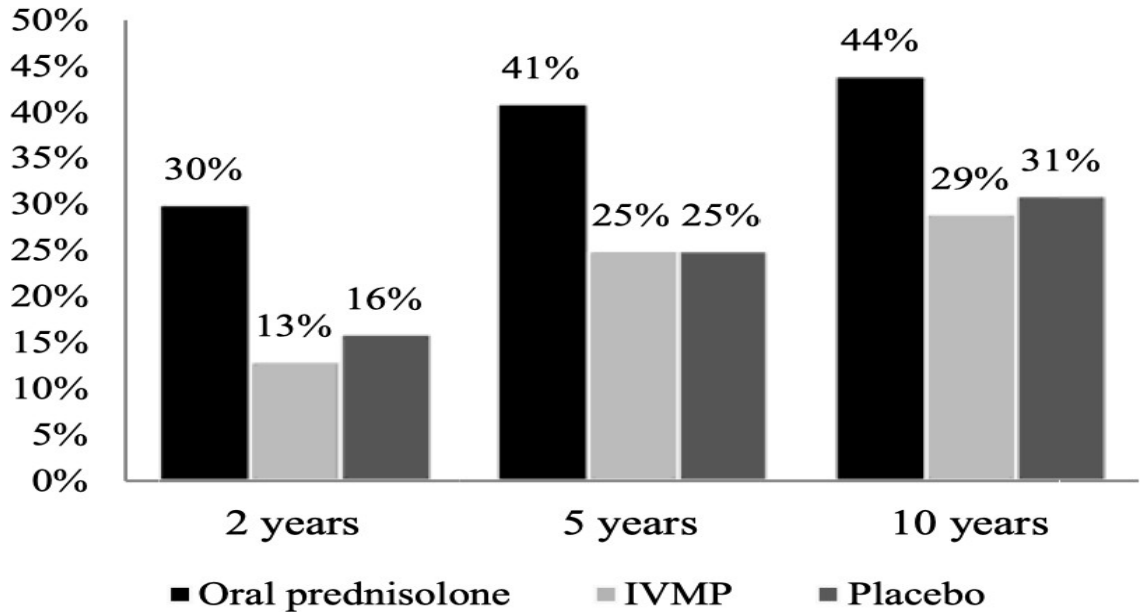

Fig.5 Recurrence rate of Optic Neuritis

V. CONCLUSION

After roughly two decades of research on early detection of Optic Neuritis diagnosis systems, many elements associated with optic neuritis are well understood. In particular, accurate and efficient techniques for optical neuritis are now well known. As a result, during the past few years, we have seen the focus turn from the fundamental identification of Optic Neuritis disorder to more difficult problems such as, whether optic neuritis leads to Multiple Sclerosis and other severe problems have been studied. Few algorithms in this context are available. However, a more comprehensive evaluation and comparison of these advanced algorithms has yet to be done.

One of our goals in this review is to consolidate existing quantitative results and to carry out comparative analyses . We believe that much of the advances in early detection of optical neuritis diagnosis systems will be seen in the decade to come and will be bolstered by more complete quantitative performance analysis. The recent article by Polina Dahal, Pradeep Bastola [2] is a promising first step. Perhaps the most practically significant advance in the last decade has been the appearance of machine learning algorithms in the

diagnosis process. However current implementations of Machine learning algorithms are still relatively simplistic. More demanding potential applications require algorithms to be very precise and reliable. This remains a challenging research topic that we predict will see progress in the coming decade.

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