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The Impact of Artificial Intelligence in pediatric ophthalmology-ROP

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Abstract: The purpose of this paper is to consider information concerning the influence of AI in pediatric ophthalmology (retinopathy- ROP) in newborns. Retinopathy of prematurity (ROP) is a disorder that affects the eyes of premature babies weighing 1250 grams or less born before 31 weeks. A baby born between 39 to 40 weeks is considered a full-term pregnancy. Early diagnosis and suitable medication for eye diseases are of great impact to avoid visual loss. Conventional diagnosis methods depend on Ophthalmologist experience and knowledge. The number of ophthalmologists who are skilled to undertake ROP diagnosing is slowly declining globally. So Artificial Intelligence-based ROP diagnosis arrangement is crucial and it looks to be a safe, dependable, and lucrative complement to the efforts of ROP specialists, proficient in increasing patient access to screening and focusing the resources of the current ophthalmic community on infants with the potentially vision-threatening disease. AI is emerging as a new factor in medical care. AI can positively impact the practice of medicine, whether it's through speeding up the pace of research or helping clinicians make better decisions. In the present pandemic, AI for pediatric ophthalmology applications can address the high demand, prioritize and triage patients, as well as improve at home-monitoring devices and secure data transfers which will help to speed up the screen and ease the workload of clinical resources.

Keywords: Pediatric Ophthalmology, Retinopathy of prematurity, Artificial Intelligence

1. INTRODUCTION

A newborn baby's vision is mostly blurry, vision goes through many changes during the first year of a baby's life. Retinopathy of prematurity (ROP) is a disorder that affects the eyes of premature babies weighing 1250 grams or less born before 31 weeks of gestation. It takes between 38 and 42 weeks for a pregnant woman to reach full term. There is a high risk of ROP developing if the baby's weight is below average [1][2]. Retina converts the rays of light it receives into a picture that a person could see. ROP causes when abnormal blood vessels [3] grow and spread through the retina, these abnormal blood vessels are fragile and can leak the retina and pull it out of position thereby causing a retinal detachment [4]. As a result of ROP, visual impairment and blindness may result from retinal detachment, which is common in childhood and may cause lifelong vision impairment and blindness. In addition to birth weight and how early a baby is born, other factors contributing to ROP risk include anemia, blood transfusions, respiratory distress, breathing difficulties, and the infant's overall health[5].ROP is divided into five stages [6], from mild (stage I) to severe (stage V) .The stages of ROP and its characteristics are outlined in the table below.

Table 1 – Stages of ROP

Stage	Characteristics	Severity
1	Demarcation Line between Avascular and Vascular Retina	Mild
2	Demarcation Line widens and forms a ridge above the plain of the retina	Moderate
3	Fibrovascular tissue formation - Abnormal vessel growth	Severe
4	Partial Retinal Detachment	Severe
5	Retinal detachment - leukocoria	Severe

Babies who have ROP stage 1 or 2 should be treated immediately since there is a risk of the ROP worsening and resulting blindness. When health centers began utilizing high-oxygen incubators to treat premature infants in the 1940sand 1950s, an ROP epidemic erupted[7]. Researchers have investigated this issue all over the world. Scientists supported by the National Institutes of Health discovered in 1954 that the relatively high quantities of oxygen usually supplied to preterm children at the time were a key risk factor and that lowering the level of oxygen given to premature babies reduced the incidence of ROP. With greater technology and ways for monitoring newborns' oxygen levels, the importance of oxygen

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use as a risk factor has waned. The absence of skilled ophthalmologists has contributed to an increase in ROP instances in rural India during the last two decades.

2. AI IN HEALTHCARE

According to the World Health Organization, there is a global shortage [8] of 4.3 million doc-tors and nurses, with poorer nations bearing a disproportionate share of the burden. The use of artificial intelligence technology in medical care[9] is beginning to show AI's potential to im-prove patient care quality. Researchers from all over the world are looking into how artificial intelligence (AI) could become a new tool in the caregiver's toolkit. AI is developing as a key aspect in medical treatment, ranging from diagnosis to tailored medical recommendations to genetic discoveries.

AI can have a positive impact on medical practice [10][24], whether it's via speeding up research or assisting physicians in making better judgments. Artificial intelligence (AI) has become con-sistent with assistance and efficiency in the medical community. AI has grown into the second set of eyes that never need to sleep, from a technology that was looked at with distrust as claims pushed as a replacement for medical professionals. Artificial intelligence in medical diagnostics and healthcare gives dependable support to overburdened medical practitioners and facilities, reducing workload strain while increasing practitioner efficiency [10][11].

Machines can think freely of humans thanks to artificial intelligence. Artificial intelligence (AI) is a broad phrase that refers to anything that makes a machine intelligent. Machine learning is a sort of AI that can learn and develop without being explicitly programmed[12]. Machine learning three categories: supervised, unsupervised, and reinforcement learning. Deep learning is a type of artificial intelligence that can learn from examples and is designed as a convolutional neural network, recurrent neural network, or recursive neural network[13]. Several theories have been proposed to find out ROP, some focusing on Machine learning others on deep learning[24][25].

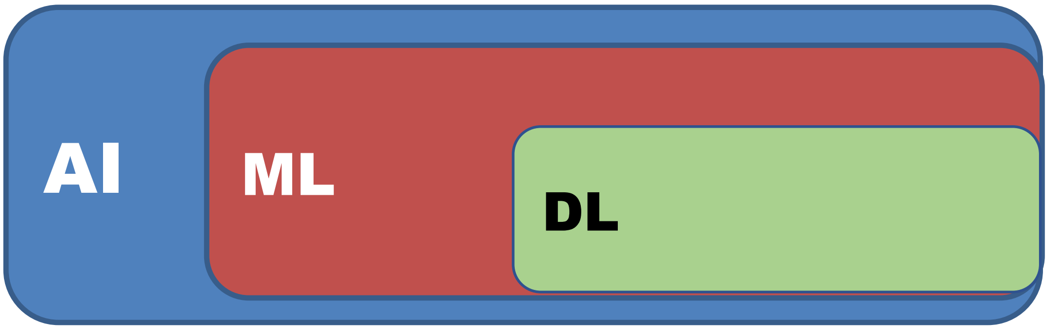

FIGURE 1. Relation Between AI, ML & DL

3.ARTIFICIAL INTELLIGENCE FOR ROP DIAGNOSIS(ML & DL BASED TECHNIQUES)

For more than a decade, computer-based ROP diagnostic techniques have been available. In 2008[14], a novel method for determining the tortuosity of vessels in digital fundus images works by splitting each vessel into segments with constant-sign curvature and then combining each segment's evaluation and number.

This paper [15] introduced an alternate technique of automated tortuosity determination for retinal blood vessels that takes into consideration the number of inflection points and employs the curvature determined using an enhanced chain code algorithm. The suggested method's tortuosity calculation is independent of vascular tree segmentation. This method can classify the image as tortuous or non-tortuous automatically.

Vessel segmentation techniques created for adult fundus images do not perform well in newborn fundus images. To overcome this Researchers introduced a supervised classification[16] strategy for precise segmentation of the infant's retina vascularity.

In 2015, researchers [17] developed and analyzed the performance of a novel computer-based image analysis approach for grading plus disease in retinopathy of prematurity. In this model, a trained support vector machine (SVM) was utilized to find the features and field of view combinations that best corresponded with expert diagnosis. In comparison to the reference standard, the i-ROP system classified pre-plus and illness with 95% accuracy. Despite its expert-level performance, the clinical utility of this system was limited because it required manual vessel tracking and segmentation as an input.

As far as we know, the first entirely automated ROP detection system [18] was proposed by Worrall et al in 2016. For detecting ROP cases vs. healthy cases, their CNN-based method performed comparably to human graders. Studies show that Convolutional neural networks (CNN) are used in two ways to help clinicians diagnose ROP. A pre-trained Google Net as an ROP detector, and produce an approximate Bayesian posterior over disease presence and absence with minor

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changes and second CNN to return innovative feature map visualizations of diseases, learned directly from the data, to help with grading. The findings imply that while ROP identification performed well in the long run, ROP grading did not.
Brown et al. published [19] their findings in 2018 on the outcomes of a fully automated, DL-based system. The performance of the i-ROP DL system for diagnosing ROP using posterior pole fundus pictures is evaluated in this study. The algorithm's sensitivity and specificity for diagnosing plus disease were 93 %and 94 % respectively.
The researchers created and tested a computer-based analytic technique for objective assessment of plus illness in ROP that most closely resembles the clinical manner of disease diagnosis by recognizing unique vessel-based characteristics [20] in 2019. The test results reveal that the proposed segmentation algorithm and vessel-based features are superior in terms of sensitivity (95%) and specificity (93%) in classifying plus disease, indicating the superiority of the suggested segmentation algorithm and vessel-based features.

The ability to accurately recognize the ridge/demarcation line is critical in directing therapists through ROP treatment. In this study, Mulay et al [21], used a Convolutional Neural Network to identify the ridge, an essential feature in ROP diagnosis (CNN). Another DL approach [22] was used to construct a novel automated feature-learning strategy for ROP detection. This leads to a robust solution for ROP identification in a large-scale annotated dataset, with the suggested model demonstrating great efficacy [22][24] in delivering accurate and quick ROP diagnosis.A cloud-based decision-making platform [23] that integrates multidimensional categorization and multilayer referral mechanisms to fulfill clinical requirements for ROP screening.

CONCLUSION

From diagnosis to personalized medical advice, to insights into genetics, AI is emerging as a new factor in medical care .Through the use of AI, features from complex and diverse images can be extracted, enabling the discovery of new biomarkers to broaden our knowledge about diseases .There is a lot of promise for present and future AI applications in pediatric ophthalmology not only for Rop, and several other eye disease such as pediatric cataracts, strabismus, vision screening, reading disability, etc. Other features of this technology, such as illness grading and outcome prediction, are less well-known but have the potential to improve clinical treatment. All AI approaches used in clinical care must eventually match or exceed physician performance while meeting the special needs of doctors. AI for ROP diagnosis will require a huge amount of effort to set standards for data collection, accurate external verification, and proof of feasibility. With this technology, avoidable blindness could be eliminated someday. In the present pandemic, AI for pediatric ophthalmology applications can address the high demand, prioritize and triage patients, as well as improve at home-monitoring devices and secure data transfers which will help to speed up the screen and ease the workload of clinical resources.

AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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