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Digital binocular indirect ophthalmoscopy for screening of retinopathy of prematurity

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数字化双目间接眼底镜检查系统在早产儿视网膜病变筛查中的应用

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摘要

目的:研究番禺区早产儿视网膜病变发病率,探讨带视频录像的双目间接眼底镜在我国基层医院早产儿视网膜筛查中的可行性。

方法:采用前瞻性研究方法,使用带视频录像的双目间接眼底镜对番禺区 2010-01/2011-12 185 例早产儿进行眼底检查。

结果:发现 ROP 者 14 例。其中,ROP Ⅲ区Ⅰ期者 7 例,Ⅲ区Ⅱ期者 3 例,Ⅲ区Ⅲ期者 2 例,Ⅱ区Ⅲ期者 2 例,未发现Ⅳ期及Ⅴ期病变。

结论:我国番禺地区 ROP 的发病率为 7.5%。数字化间接双目检眼镜可用于基层医院筛查早产儿视网膜病变。

关键词:间接双目检眼镜;数字化;早产儿视网膜病变

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Abstract

• AIM: To investigate the incidence of retinopathy of prematurity (ROP) in infants born in the Panyu district of Guangzhou, China, and to determine the applicability of video-incorporated binocular indirect ophthalmoscopy for its screening in primary hospitals.

• METHODS: From January 2010 to December 2011, 185 premature infants were examined with a computer-assisted imaging system, using a digital binocular indirect ophthalmoscope.

• RESULTS: ROP was diagnosed in 14 infants (7.5%). Among them, 7 infants had stage I, 3 had stage 2, and 4 had stage 3 ROP, according to the standard classification of ROP.

• CONCLUSION: This study showed that the incidence of ROP in the Panyu district of Guangzhou, China was 7.5%. Furthermore, the digital binocular indirect ophthalmoscope system is suitable for ocular fundus examination in primary health units.

• KEYWORDS: binocular indirect ophthalmoscope; digital system; retinopathy of prematurity
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INTRODUCTION

Retinopathy of prematurity (ROP) is a proliferative vascular retinopathy, which occurs in low birth weight and premature infants[1]. According to the World Health Organization (WHO), ROP is the main cause of blindness in children, with a prevalence of 6% - 18% in children with blindness[2]. Since the exact pathogenesis of ROP is still unclear, the efficacy of surgery in the advanced stages of ROP is limited and variable[3,4]. Even if retinal surgery appropriately repositions the detached retina, recovery of the patients' visual function remains limited. Therefore, early screening and an appropriate treatment for early ROP is vital to reduce the rate of blindness in low birth weight and premature infants[5,6].

Currently, the binocular indirect ophthalmoscope is recognized as the "golden standard" for ROP screening[7]. This method can be used to obtain the image of the ocular fundus and to record any lesion. However, this technique requires doctors skilled in drawing and writing, who are usually not available in primary hospitals that lack retinal specialists. Furthermore, due to its inherent character, this method cannot provide an objective analysis of the lesions. To overcome these drawbacks, a binocular indirect ophthalmoscope system incorporated with a digital video camera was developed by many manufactories for ROP screening[8,9]. We used this system to screen ROP in premature infants in the Panyu

district of Guangzhou in order to assess its suitability as a economic and accurate tool for widespread computer-based quantification of ROP at primary hospitals.

SUBJECTS AND METHODS

Subjects and Screening Standards This study was conducted at the Second Hospital of Panyu District of Guangzhou at Southern Medical University and approved by the Institutional Review Board. According to the retinal screening criteria for preterm infants in China (Ministry of Health, China, 2004)[10], 185 infants weighing less than 2000g, born in the Second Hospital of Panyu District of Guangzhou, from January 2010 to December 2011 were examined. Informed consent was obtained from the parents of all the infants. The study cohort included 87 male and 98 female infants. Their gestational ages ranged from 28 to 36wk (mean gestational age 29. 2±2. 5wk). Their birth weights ranged from 1000 to 2000 g (mean weight 1655. 2±252g).

Strategy of Retinopathy of Prematurity Screening and Follow-up The first ocular fundus examination for premature infants was performed 4-6wk after birth or after the corrected gestational age was 32wk. If the retina was found to be normal during the first examination, the infant was followed up every 2wk until the peripheral retina became vascularized nasally and temporally to the ora serrata. If ROP was found during the first examination, the follow-up intervals depended on the severity of the disease. A timely treatment was recommended when ROP was either at the plus lesion or pre-plus lesion stage. The follow-up examinations were discontinued if any one of the following situations were encountered: the retina became vascularized to the ora serrata at the nasal side and the diameter of the temporal retinal lesion was less than the pupillary diameter (PD) to the serrate, the infant reached 45wk of corrected gestational age without a pre-plus lesion, or the retinal vessels covered 3 zones without a history of lesions at 2 zones.

Screening Methods Before examination, the infants' pupils were dilated by using tropicamide eye drops 4 to 5 times, and their conjunctival surfaces were anesthetized by using proparacaine hydrochloride eye drops (Alcaine, Alcon Inc., Fort Worth, Texas, USA). Their eyelids were opened by using a small eye speculum. For ROP screening, an experienced ophthalmologist used a 28D convex lens and the HEINE binocular indirect ophthalmoscope that incorporated a video system to examine the right eye and then the left eye from the posterior to the temporal, nasal, superior, and inferior retina, in that order. When necessary, a sclera oppressor was used. During the examination, an assistant turned on the DVD digital video system to commence video recording. The examiner could adjust the distance and angle of the convex lens to achieve the best image. The video data were saved as digital files. After examination, the video was reviewed and typical fundus images were selected and saved.

Retinopathy of Prematurity Classification In this study, ROP was classified according to the International Classification of ROP[11]. According to this classification system, the severity of ROP can be divided into 5 stages, in addition to the plus ROP and pre-plus ROP stages. The location of disease was designated according to 3 zones.

Five stages are used to describe the abnormal vascular responses at the vascularized and avascular retina. Stage 1 is referred to as the "Demarcation Line." This line is a thin but definite structure that separates the avascular retina anteriorly from the vascularized retina posteriorly. Stage 2 is referred to as "Ridge." It arises in the region of the demarcation line, has height and width, and extends above the plane of the retina. Stage 3 is called "extraretinal fibrovascular proliferation." Extraretinal fibrovascular proliferation or neovascularization extends from the ridge to the vitreous. Stage 4 is called "partial retinal detachment," and is divided into extrafoveal (stage 4A) and foveal (stage 4B) partial retinal detachments. Stage 5 is referred to as "total retinal detachment." Retinal detachments are generally tractional and may occasionally be exudative in this stage.

Plus disease Along with the changes described above, additional signs of ROP include increased venous dilation and arteriolar tortuosity of the posterior retinal vessels and may later increase in severity to include iris vascular engorgement, poor pupillary dilatation (rigid pupil), and vitreous haze. These important signs were referred to as plus disease according to the original classification.

Pre-plus disease Pre-plus disease refers to vascular abnormalities of the posterior pole, which are insufficient for the diagnosis of plus disease, but demonstrate more arterial tortuosity andvenous dilatation than is normal.

Location of the disease Three concentric zones of retinal involvement have been identified. Each zone is centered around the optic disc. Zone I (the innermost zone) consists of a circle of 60 degrees, the radius of which extends from the center of the optic disc to twice the distance from the center of the optic disc to the center of the macula. The retinal area defined as zone II extends centrifugally from the edge of zone I to the nasalora serrata (at the 3-o'clock position in the right eye and the 9-o'clock position in the left eye). Zone III is the residual crescent of retina, anterior to zone II.

Principle of Treatment According to the standard of ROP early-treatment group (ET-ROP), lesions of zone III at stages I and II should be regularly followed up, and pre-plus ROP should be closely monitored[12]. For infants with plus ROP, laser thermotherapy or cryotherapy should be administered. Children with ROP stage IV or V need surgical treatment.

RESULTS

Overall, ROP wasidentified in 14 infants. Thus, the incidence of ROP in premature infants in the Panyu district of Guangzhou was 7. 56%. Among them, 7 infants had stage I zone III; 3 had stage II zone III, 2 had stage III zone III, and 2 had stage III zone II ROP (Figure 1). None of the infants had stage IV ROP. According to the protocol, the 2 infants with stage III zone II ROP required immediate treatment. The characteristics of all 14 infants are listed in Table 1.

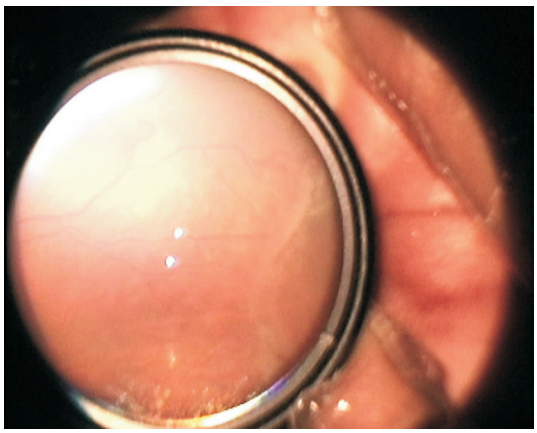

Figure 1 A representative image of retinopathy of prematurity detected in a twin boy of 28 gestational weeks weighing 1200g at birth. On the fundus of his left eye, a lesion of extraretinal fibrovascular proliferation (stage III) was noted in zone III.

Table 1 The information of infants detected with retinopathy of prematurity

Infant	Gestational age (wk)	Weight (g)	Embryo	ROP classification
1	28	1500	Single	ZoneIII, Stage I
2	29^{+2}	1500	Single	ZoneIII, Stage II
3	33	1300	Single	ZoneIII, Stage II
4	35^{+5}	1270	Single	ZoneIII, Stage II
5	31	1500	Single	ZoneIII, Stage I
6	29^{+3}	1300	Single	ZoneIII, Stage III
7	28	1200	Twins	ZoneII, Stage III
8	28	1230	Twins	ZoneII, Stage III
9	28^{+4}	1100	Single	ZoneIII, Stage III
10	32	1500	Twins	ZoneIII, Stage I
11	32	1600	Twins	ZoneIII, Stage I
12	30^{+2}	1500	Single	ZoneIII, Stage I
13	31^{+4}	1600	Single	ZoneIII, Stage I
14	34^{+1}	2100	Single	ZoneIII, Stage I

After examination with an indirect ophthalmoscope, 5 infants were found to have subconjunctival hemorrhage, 2 had subscalpal hemorrhage, and 1 had acute conjunctivitis. During examination, apnea, shock, and other severe complications did not occur in the examined infants.

DISCUSSION

A direct ophthalmoscope, binocular indirect ophthalmoscope, and digital retinal camera (RetCam) have been used for screening of ROP in premature infants[9,13,14]. Most general hospitals, especially primary hospitals, have been using direct ophthalmoscopy for fundus examination in ROP screening due to its simplicity. However, direct ophthalmoscopy can only be used to visualize the ocular fundus of range 17 degrees centrally, and the images are subjectively recorded. Moreover, in ROP, most retinal lesions are present in the peripheral retina, which are relatively difficult to detect by means of direct ophthalmoscopy[15]. Due to these reasons, an accurate and timely diagnosis is often missed by direct ophthalmoscopy.

The results of this study showed that the incidence of ROP in the Panyu district of Guangzhou was 7.5%. No severe adverse events occurred during and after examination of the premature infants. This finding is consistent with that of Weaver and Murdock's study[16]. Jensen *et al*[17] reported extensive retinal hemorrhage during screening with a sclera depressor. In this study, only 5 infants had subconjunctival hemorrhage, and no infants experienced retinal hemorrhage.

Because of its good quality and clear stereoscopic imaging, strong lighting, and wide field of vision, binocular indirect ophthalmoscopy is now acknowledged as the "gold standard" for ROP screening. However, in this technique, a clinician is required to describe and draw the findings manually, leading to subjective documentation. Furthermore, binocular indirect ophthalmoscopy cannot be used for capturing and recording images in real time.

In recent years, a digital retinal camera (RetCam) capable of wide-field imaging has been developed for observing the peripheral retina[18]. It is used to obtain images of the fundus by a special probe placed on the cornea. However, it can only be used to examine a narrow area and is expensive; therefore, it cannot be commonly used in small hospitals in China.

The digital binocular indirect ophthalmoscope system, which incorporates a video camera, is capable of digital photography and is based on the application of the binocular indirect ophthalmoscope. While in use, an assistant is required to turn on the digital video system first (including video software and image processing software) for recording. The system also provides tips for adjusting the angle and distance of the lens during examination in order to obtain clear images. The videos can be stored digitally and edited later.

Our results showed that the digital binocular indirect ophthalmoscope system can reliably and directly provide clear digital images and videos of the peripheral retina. This system has several advantages: it provides accurate high-quality data, it is affordable, and it retains the advantages of the gold standard binocular indirect ophthalmoscope[19,20]. Because of its low price, it is suitable for screening ROP in all small hospitals, especially primary hospitals in China.

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