

# Ophthalmic Evaluation of Children from the Tibet Plateau with Congenital Heart Disease

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## Abstract

**Purpose:** To perform ophthalmic examinations to evaluate the ocular characteristics of children living in the Tibet plateau and diagnosed with congenital heart disease.

**Methods:** Children with congenital heart disease underwent a conventional ocular examination including distant acuity test, slit-lamp examination, fundus examination, non-contact intraocular pressure measurement, measurement of corneal thickness, and fundus photography.

**Results:** Forty-two Tibetan children, aged between 4 and 18 years and diagnosed with congenital heart disease, were enrolled in this study. The percentage of low visual acuity was 4.76%, mean intraocular pressure was (13.67±2.15) mmHg, average corneal thickness was (492.55±33.79) μm, 96.43% had an anterior chamber depth of 1/2 corneal thickness (CT), and 35.7% had an obvious fundus vascular tortuosity.

**Conclusion:** This study adds to the understanding of the ocular status of the population living in the Tibet plateau, thereby offering clinical evidence for the prevention and treatment of eye diseases in this area. (*Eye Science* 2014; 29:134–137)

**Keywords:** plateau; congenital heart disease; ophthalmic test

To achieve the goal of Vision 2020<sup>1-4</sup>, a nationwide survey of eye diseases is being conducted in China and much progress has been made. However, clinical data for the population in plateau areas, and especially the special groups with heart diseases, is extremely rare due to geographic limitations. In total, 42 Tibetan children diagnosed with congenital heart disease underwent routine ocular examination at the Navy General Hospital between September

22, 2012 and January 22, 2013. The aim of the present study was to identify the eye characteristics in this special population and to add clinical evidence for the treatment of eye diseases in the Tibet plateau population.

## Materials and methods

### General data

Forty-two children with congenital heart diseases came from Naqu, Shannan, Rikaze, Ali, Changdu, and Lhasa in Tibet. They ranged in age from 4 to 18 years, (10.47±3.89) years on average; there were 20 males and 22 females.

### Distance acuity examination in bilateral eyes

The distance acuity of bilateral eyes (including corrected visual acuity) was measured at a distance of 5 m using E visual chart. Pinhole visual acuity was measured and recorded: <3/60, 3/60-6/18, 6/15-6/10 and >6/10. According to the World Health Organization (WHO) classification criteria for visual impairment, the best corrected visual acuity (BCVA) of the eye with better vision <3/60 or visual field <10° regarding central fixation point as the center is defined as “blindness.” Low vision was defined as the BCVA of the eye with better visual acuity ranging from 3/60-6/18, or with visual field less than 20° using a central fixation point as the center<sup>5</sup>.

### Non-contact intraocular pressure measurement

The intraocular pressure was measured with a TOPCON CT-80 tonometer with the patients in a sitting position. The measurements were repeated three times and the mean value was calculated (1 mmHg = 0.133 kPa).

### Measurement of corneal thickness

The measurement of corneal thickness was per-

DOI: 10.3969/j.issn.1000-4432.2014.03.002

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formed using a TOPCON SP-200P with the children were in a sitting position.

**Slit-lamp examination**

The anterior segment structure was observed under slit-lamp microscope. The depth of peripheral anterior chamber was measured by using Van Herick grading system<sup>6</sup>. Narrow light source was projected to the temporal side of corneal limbus with an angle of 60° between the microscope and light source. The peripheral anterior chamber depth was expressed as the thickness of the corneal tangential surface to evaluate the potential closure of anterior chamber angle. The peripheral anterior chamber depth was recorded as 1, 1/2, 1/3, and ≤ 1/4 CT.

**Fundus examination**

Fundus examination was performed by direct ophthalmoscopy. Mydriasis tests were conducted as necessary. Slit-lamp biomicroscopy with a +90D pre-

set lens was employed to perform fundus examination and take fundus photography (TOPCON TRC. NW7SF).

**Statistical analysis**

Data input was completed by two participants who were blinded to this study. SPSS 19.0 statistical software was utilized for data analysis and processing.

**Results**

**Distant acuity**

Among the 42 patients with congenital heart disease, 4 had low visual acuity, accounting for 4.76%, as illustrated in Table 1.

**Anterior chamber depth**

The patients with anterior chamber depth of 1/2 CT accounted for 96.43% of all cases, as shown in Table 1.

**Table 1** Characteristics of distribution of visual acuity and anterior chamber depth (number of eyes)

|           | Visual acuity |          |         |       | Anterior chamber depth |        |        |      |
|-----------|---------------|----------|---------|-------|------------------------|--------|--------|------|
|           | <0.05         | 0.05–0.3 | 0.4–0.6 | >0.6  | ≤1/ 4CT                | 1/ 3CT | 1/ 2CT | 1CT  |
| Cases (n) | 0             | 4        | 21      | 59    | 0                      | 1      | 81     | 2    |
| %         | 0.00          | 4.76     | 25.00   | 70.24 | 0.00                   | 1.19   | 96.43  | 2.38 |

**Intraocular pressure**

Except for 1 female case with high intraocular pressure, the mean intraocular pressure of 82 eyes was (13.67±2.15) mmHg; (13.62±2.18) mmHg for 40 eyes (20 males) and (13.71±2.15) mmHg for 42 (21 females), as illustrated in Table 2.

**Table 2** Clinical data of intraocular pressure and corneal thickness (number of eyes)

|          | Intraocular pressure (mmHg) | Corneal thickness(μm) |
|----------|-----------------------------|-----------------------|
| Means±s  | 13.67±2.15                  | 492.55±33.79          |
| Cases(n) | 82                          | 78                    |

**Corneal thickness**

Three young male patients failed to undergo the corneal thickness measurement. The mean corneal thickness of 78 eyes (39 cases) was (492.55±33.79) μm; (494.61±37.53) μm for 17 males (34 eyes) and (490.95 ±30.95) μm for 22 females (44 eyes), as shown in Table 2.

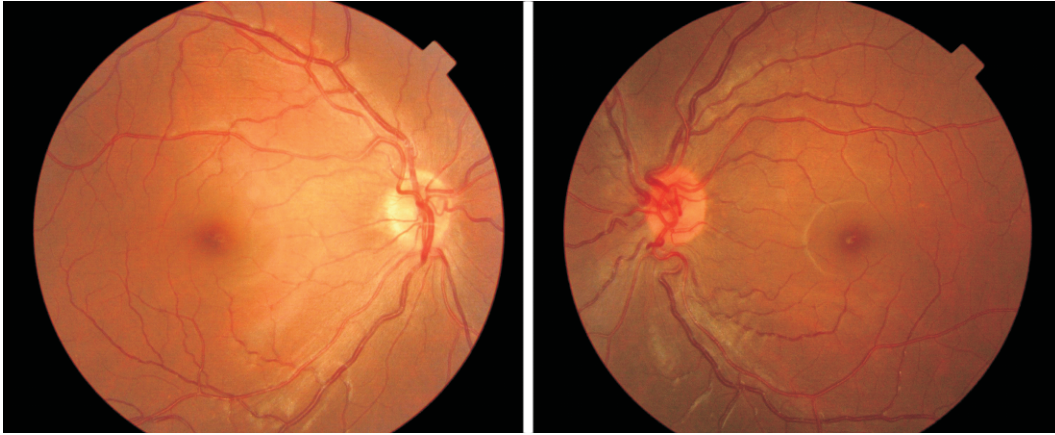
**Ocular diseases**

Among the 42 patients with congenital heart dis-

ease, low visual acuity was detected in 4 eyes. Vision in one eye was restricted by congenital uveal defects, in 2 due to varying degrees of optic atrophy, and in 1 with obvious corneal pannus. One case presented with excessively high intraocular pressure and 15 (35.7%) with evident fundus blood vessel tortuosity, as shown in Figure 1.

**Discussion**

In plateau areas with elevations above 3000 m, the population there may show evident biological responses to altitude<sup>7,8</sup>. The unique geographic and climatic conditions, such as large area, high elevation, low atmospheric pressure, hypoxia, climate dryness, long sunshine time, little precipitation, strong ultraviolet radiation and partially snow cover year round, can exert varying degrees of influence on human eyes<sup>9,10</sup>. Performing a general survey of a disease in a plateau region is a challenging task due to hypoxia, low atmospheric pressure, harsh environment and the scattered distribution of residences, and especially



**Figure 1** Fundus examination in children with congenital heart disease

the poor educational background there. This insufficient information is likely to limit the prevention and treatment of diseases. Our goal is to deliver care to Tibetan children with congenital heart disease living in poverty and to add more evidence to the general survey in plateau areas, especially the children with congenital heart disease; therefore, we conducted routine and special ocular examination in children diagnosed with congenital heart disease. Visual function tests revealed that the percentage of low visual acuity was 4.76%, which is lower than 10.8% provided by nationwide statistical data in China but close to the 5.30% proposed by WHO criteria. However, the population was aged above 50 years in previous findings, but the population enrolled in our study consisted of children with congenital heart disease.

The average intraocular pressure of 82 eyes was  $(13.67 \pm 2.15)$  mmHg, which is approximately 3 mmHg lower than that of the mainland population<sup>12</sup>. The mean corneal thickness of 78 eyes from 39 children with congenital heart disease was  $(492.55 \pm 33.79)$   $\mu\text{m}$ , which is thinner than reported in previous findings<sup>13,14</sup>. The percentage of children with an anterior chamber depth of  $1/2$  CT was 96.43%, suggesting that the anterior chamber depth in Tibetan is deep. The relatively low intraocular pressure is associated with corneal thickness. Consequently, the characteristics of the population in plateau area should be considered when performing diagnosis and treatment of eye diseases. The knowledge related to ophthalmology should be emphasized in plateau areas.

The visual system is second only to the brain in terms of sensitivity to hypoxia; consequently, high-altitude anoxia can cause retinal vascular diseases<sup>15-17</sup>. In the condition of high-altitude anoxia, the number of erythrocytes is increased and the blood viscosity is enhanced to adapt to the increased need for tissue oxygen and this can lead to retinal venous enlargement and filling. Exposure to a hypoxic environment causes contraction and thinning of arteries, slows blood circulation, raises levels of erythrocytes, and increases blood viscosity. Consequently, evident fundus vascular tortuosity was found in this study and the incidence of blood vessel tortuosity in the children with congenital heart disease was 35.7%. Besides plateau factors, the symptoms were also associated with congenital heart disease, indicating that topical ocular examination contributes to the diagnosis and treatment of systemic diseases.

The results of this study indicated that the 42 Tibetan children with congenital heart disease had thin corneas, relatively low intraocular pressure, and deep anterior chambers, which were the characteristics of a plateau population. Individualized prevention and treatment measures should be established for this special population. High-altitude anoxia and ischemia can also cause retinal vessel tortuosity, especially in the Tibetan children with congenital heart disease, suggesting that detailed classification of fundus blood vessel tortuosity and its correlation with plateau ischemia and hypoxia-induced systemic disease should be emphasized in subsequent investigations. This study has certain limitations, such as its

small sample size. However, considering the characteristics of the age structure and composition of population, these data may offer additional information for the prevention of blindness in plateau areas.

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