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EYE REFRACTION ANOMALIES IN DOWN SYNDROME FAMILIES

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The extra chromosomal material in Down syndrome patients causes a generalised disruption in the genetic balance. From this viewpoint, the non-specific developmental instability following aneuploidy might be also responsible for ocular anomalies in patients with Down syndrome. The aim of this study was to identify the eye refraction anomalies in families having individuals with Down syndrome. A total of 199 Down syndrome patients (average age 17.0 years), 85 their siblings (17.0 years) and 229 their parents (average age 48.9 years) underwent eye refraction examination. In Down syndrome patients ocular refractive findings as spherical equivalent were: emetropia 4.2±1.0%, hypermetropia 70.0±2.3%, and myopia 25.8±2.2%. Astigmatism was diagnosed in 42.8±1.5% of patients. Refraction could not be identified in 3.8±1.0% of patients. In the control group of siblings refractive findings as spherical equivalent were: emmetropia 51.2±3.8%, hypermetropia 39.4±3.7%, and myopia 9.4±2.2%. Astigmatism was diagnosed in 7.6±2.0% of siblings. In parents refractive findings as spherical equivalent were: emmetropia 42.8±2.3%, hypermetropia 40.2±2.3%, and myopia 17±1.8%. Astigmatism was diagnosed in 7.9±1.3% of parents. Refraction could not be identified in 1.1±0.5% of parents. Astigmatism, which is phylogenetically more recent, was found in Down syndrome patients 5.6 times more often than control siblings and 5.4 times more than in the parents group.

Key words: *Down syndrome, hypermetropia, myopia, emmetropia, astigmatism.*

INTRODUCTION

Down syndrome is the most frequent and viable autosomal chromosomal anomaly, which results from trisomy of whole or part of chromosome 21. Trisomy 21 gives rise to a variety of traits, all of which have variable penetrance and expressivity within the Down syndrome population, except for the specific type of mental retardation and neonatal hypotonia that is present in nearly 100% of cases (Hernandez and Fisher, 1996). Much research has been focused on Down syndrome since its first description in 1866 by John Langdon Down. The extra chromosomal material in Down syndrome patients causes a generalised disruption in the genetic balance. From this viewpoint, the non-specific developmental instability following aneuploidy is responsible also for ocular anomalies in patients with Down syndrome.

Children with Down syndrome have a high prevalence of ocular disorders (Stephen *et al*., 2007). The isolated occurrence of any of the main ocular features of Down syndrome is not specific to the disorder (Catalano, 1990). Sixty-one per cent of children with Down syndrome have ophthalmic disorders that require treatment and monitoring. Furthermore, the percentage of children with ophthalmic disorders increases with age, from 38% in the two to 12 month old group to 80% in the five to 12 year old group (Roizen *et al*., 1994). Among children and adults with Down syndrome, refractive errors tend to be far greater than among the normal population (Caputo *et al*., 1989; Pires da Cunha *et al*., 1996; Woodhouse *et al*., 1997; Doyle *et al*., 1998; Cregg *et al*., 2001; 2003; Haugen *et al*., 2001). There is a misconception that most individuals with Down syndrome are myopic; in fact, hypermetropia is much more common. However, in Down syndrome individuals with myopia, the degree of myopia can be extremely high (Pires da Cunha *et al*., 1996; Woodhouse *et al*., 1997).

In healthy children eye refraction emmetropia and hypermetropia is common during childhood. In normally emmetropising eye, a greater initial hypermetropia is associated with a higher the rate of hypermetropia decrease (Saunders *et al*., 1995; Atkinson *et al*., 2000). Children become more emmetropic (about 80% until 6 year old) or even slightly myopic as they become older (Flom and Bedell, 1985; Gwiazda *et al*., 1993). Similarly, myopia and astigmatism in normally developing children decrease during the first four years of life (Ingram and Barr, 1979; Gwiazda *et al*., 1984; Ehrlich *et al*., 1995). Longitudinal studies have confirmed the presence of an emmetropization

process in healthy children (Ehrlich *et al*., 1995; Saunders *et al*., 1995).

The object of this study was to identify eye refraction anomalies in families having individuals with Down syndrome. Healthy parents and siblings were used as the control group.

MATERIALS AND METHODS

A total of 199 Down syndrome patients with average age 17.0 years, 85 of their siblings (average age 17.0 years) and 229 of their parents (average age 48.9 years) underwent the eye refraction examination. To evaluate the efficient eye refraction, Down syndrome patients, siblings and parents were divided into three groups according to their age: from 1 to 15 years old (Down syndrome — 198 eyes, 88 eyes in siblings); 16 to 30 years old (Down syndrome — 151 eyes, 72 eyes in siblings, 32 eyes in parents); over 30 years of age (Down syndrome — 34 eyes, 10 eyes in siblings, 421 eyes in parents).

Eye refraction was investigated in the group of 199 Down syndrome patients with cytogenetically proven additional chromosome 21. As usual in the caryology of this syndrome, the leucocyte culture cells in 180 patients contained 47 chromosomes with additional chromosome 21. Ten patients had a trisomy 21 clone and also cells with normal karyotype (chromosome mosaics 47+21/46). The mosaicism indicates that the clone has postmeiotic origin. The karyotype of nine patients contained 46 chromosomes — the additional material of the chromosome 21 was translocated on an other acrocentric chromosome (the so-called Robertson-type translocation). Five of these Down syndrome patients inherited the translocation from their parents: two from mother and three from father. Two siblings also had a balanced chromosome translocation inherited from parents. These three different chromosome constitutions are important in the theoretical discussion on the origin of trisomy and for the evaluation of repeated risk, but has no influence on the symptoms of the syndrome.

Refraction examination was performed in outpatient departments in Lithuanian district hospitals.

Refraction examination with cycloplegia was performed using cyclopentolate 1% eye drops twice 40 minutes before examination in children younger than 16 years old. For older patients refraction was conducted without cycloplegia. Astigmatism was considered if refraction power differed 0.5D and more of the two principal meridians.

Informed consent was obtained from all patients or their parents in this study.

RESULTS

Among patients with Down syndrome (398 eyes) refraction was diagnosed in 383 (96.2%) eyes. Ocular refractive findings as spherical equivalent were the following in Down syndrome patients: emmetropia in 16 (4.2±1.0%) eyes, hypermetropia in 268 (70.0±2.3%) eyes, and myopia in 99 (25.8±2.2%) eyes. Astigmatism was diagnosed in 164 (42.8±2.5%) eyes of patients. Refraction was observed in 15 (3.8±1.0%) eyes of patients, in all cataract was diagnosed.

In the group of sibling (170 eyes) refractive findings as spherical equivalent were: emmetropia in 87 (51.2±3.8%) eyes, hypermetropia in 67 (39.4±3.7%) eyes, myopia in 16 (9.4±2.2%) eyes. Astigmatism was diagnosed in 13 (7.6±2.0%) eyes of siblings.

In parents (458 eyes) refractive findings as spherical equivalent were: emmetropia in 194 (42.8±2.3%) eyes, hypermetropia in 182 (40.2±2.3%) eyes, myopia in 77 (17±1.8%) eyes. Astigmatism was diagnosed in 36 (7.9±1.3%) eyes of parents. Refraction was not found in 5 (1.1±0.5%) eyes; in 4 cataract was diagnosed, and in one eye anophthalmus was diagnosed.

In the examined 0–16 years old group, the distribution of refractive errors in patients with Down syndrome differed from that of non-disabled siblings. The prevalence of hypermetropia in Down syndrome patients for the 0–16 years old group (82.8±2.7%) was significantly greater than in the normal sibling group (52.3±5.3%) ($P < 0.001$). Hypermetropia in the Down syndrome group was 1.6 times higher. In this age group in Down syndrome patients a very low per cent of emmetropia was found (2.0±1.0%) compared with that in normal infants — (42.1±5.3%) (Fig. 1).

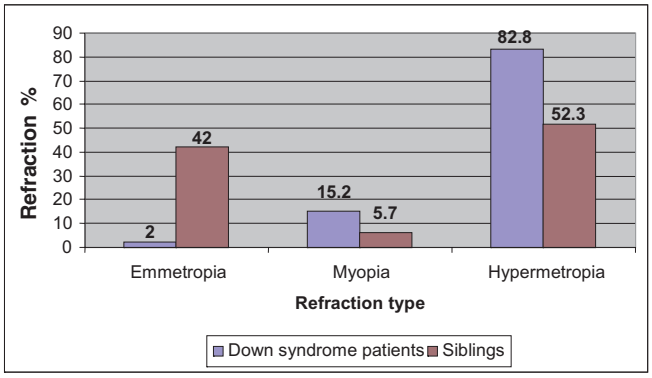

Fig.1. Distribution of eye refraction in the 0–15 years old group.

In the 16–30 years-old age group, emmetropia remained at low level (5.3±1.8%) in Down syndrome patients. The dominant refraction type was hypermetropia (58.3±4.0%), the prevalence of myopia per cent was 36.4±3.9%. Emmetropia in the 16–30 years-old siblings group was 66.7±5.6%, and myopia per cent reached 9.7±3.5%. Myopia in the sibling group was 3.8 times lower than myopia in the Down syndrome patients group ($P < 0.001$). Hypermetropia in the sibling group was 2.5 times lower than in the Down syndrome patients group ($P < 0.001$). Our findings show that emmetropization failed to occur in most individuals with Down syndrome (Fig. 2).

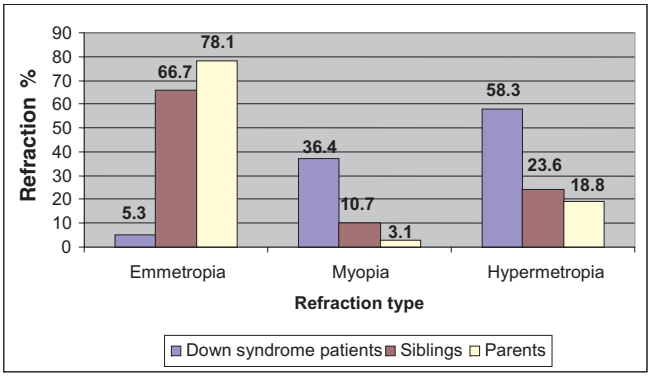

Fig. 2. Distribution of eye refraction types in 16–30 years old group.

Prevalence of hypermetropia in the oldest group (over 30 years old) was similar in the control groups: 40±15.5% in the sibling group and 41.8±2.4% in the parent group. In this age group hypermetropia in the non-disabled group almost reached the hypermetropia level in Down syndrome patients, which decreased (47.1±8.6%) with age. The prevalence of emmetropia in the Down syndrome patients was 11.8±5.5%, almost 3.4 times lower ($P < 0.001$) than in the parent group (Fig. 3).

Occurrence of astigmatism is shown in Figure 4.

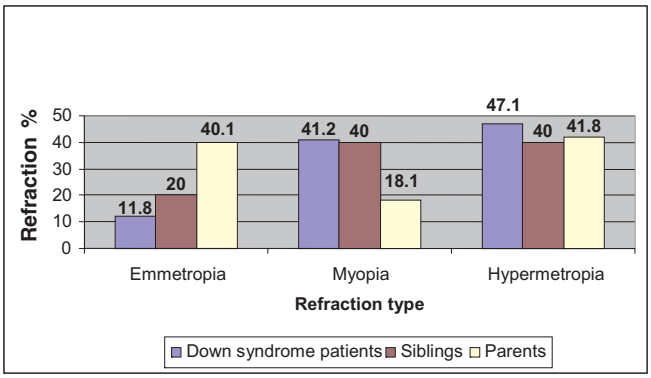

Fig. 3. Distribution of eye refraction in the over 30 years old group.

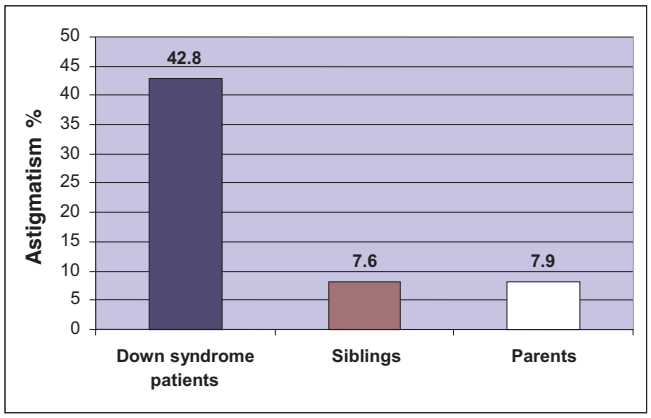

Fig. 4. Occurrence of astigmatism.

DISCUSSION

During physiological refractive development in healthy children, a low to medium grade hypermetropia is common in infancy. The mean refraction normally changes towards slight hypermetropia or emmetropia during the second year of life. Astigmatism also tends to decrease with emmetropization. Normally developing children become more emmetropic with age. The literature indicates that this normal process does not occur in patients with Down syndrome (Doyle *et al*., 1998; Haugen *et al*., 2001). The incidence of refractive errors (including astigmatism) is higher among young children with Down syndrome than among control individuals. The high prevalence of refractive defects cannot be explained by the presence of strabismus or other pathologies (Woodhouse *et al*., 1997). In non-disabled teenagers we would expect about 83% emmetropic (plus or minus 0.25D), 13% myopic, and 4% hypermetropic. Refractive errors became more common with age, and the prevalence of refractive errors increases in children with Down syndrome (Doyle *et al*., 1998).

Healthy children become more emmetropic with age (Dobson *et al*., 1984; Flom and Bedell, 1985; Ehrlich *et al*., 1995; Woodhouse *et al*., 1997; Cregg *et al*., 2001; 2003). Refractive errors increase among children with Down syndrome, while in normally developing children they reduce during early childhood (Cregg *et al*., 2003).

The prevalence of astigmatism in Down syndrome is widely ranging from 22% to 60% (Caputo *et al*., 1989; Pires da Cunha and Moreira, 1996). The astigmatism prevalence (42.8±2.5%) in Down syndrome patients investigated in our study corresponds with that described in literature. However, it is necessary to note that the frequency of astigmatism was significantly higher (5.4 times ($p < 0.001$)) in Down syndrome patients compared with parents. Astigmatism is a phylogenetically more recent feature, and therefore, more sensitive to chromosome disbalance.

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ACU REFRAKCIJAS ANOMĀLIJAS ĢIMENĒS AR DAUNA SINDROMU

Izvērtētas dažādu acu refrakcijas anomāliju biežums 199 Dauna slimniekiem, viņu vecākiem un veseliem brāļiem un māsām.