Prevalence of hyperopia and strabismus in a paediatric population with malocclusions

**ABSTRACT**

**Aim** The purpose of this study was to investigate the prevalence of hyperopia and strabismus among a paediatric population with malocclusions.

**Materials and methods** From a total of 322 consecutive patients observed at the department of Orthodontics and Gnathology, Dental Clinic, University of L'Aquila, 176 were selected for the study according to the exclusion criteria. Pretreatment diagnostic data, which included radiographic, cephalometric and dental cast evaluation, were recorded and presence of hyperopia or strabismus was assessed through an ophthalmological examination. Differences in incidence rates of strabismus or hyperopia by sex and malocclusion were analysed by using the $\chi^2$ (Pearson's chi-square test) and Fisher's exact tests.

**Results** According to the sagittal malocclusion, patients were classified as Class I (122), Class II division 1 (26), Class II Division 2 (9), or Class III (19); after ophthalmological examination, hyperopia was detected in 8.6% of patients, while strabismus was present in 3.6% of them. No gender influence was found for hyperopia, strabismus or malocclusion.

**Discussion** Few studies investigated a possible relationship between the ocular and stomatognathic system, and no data are available in the scientific literature; the present study did not highlights differences in the prevalence of hyperopia or strabismus in the three Angle classes malocclusion.

**Conclusion** The findings of the present study did not suggest a possible association between hyperopia or strabismus and sagittal malocclusion, but future studies are needed to confirm and explain this observation.

**Keywords:** Cross-sectional study; Epidemiology; Hyperopia; Malocclusion; Strabismus.

Introduction

Visual defects (myopia, astigmatism, hyperopia, strabismus) can result from many factors, both genetic and environmental. Although defects in certain genes are the most influential, aetiological events in the prenatal and postnatal periods have also been blamed for anomalies in crystalline dimension, morphology and position of foramina structure [Angi et al., 1993; Van Rens, 1991; Zhou et al., 2004]. Hyperopia is the condition of the eye where incoming rays of light reach the retina before they converge into a focused image. The prevalence of hyperopia is not clear. The Eye Diseases Prevalence Research Group [Sharifi et al., 1998] reported hyperopia rates of 9.9% in America, 11.6% in Western Europe and 5.8% in Australia, while other studies reported a higher prevalence [Lam et al., 199; Ricci et al., 2007]; however, in a recent study [Pai et al., 2011] the prevalence of hyperopia, in preschool age children was reported to be 28.9%. The prevalence of this disorder seems to decrease from the youngest age (2-6 years) to the older one (18-35 years), reaching the highest incidence from the age of one year to the age of 9 years [Midelfart et al., 2005], and increases over 60 years of age [Siatowsky et al., 2005].

Strabismus is a condition in which the visual axes of the eyes are not parallel and the eyes appear to be looking in different directions; the cause of strabismus is unknown, but it is believed to be a defect in central nervous system control over the oculomotor system. Morphologic changes are found in extraocular muscles and deviation in the optic nerves occur in most of the patients; some cases remain unexplained, but they are often related to central nervous system developmental or traumatic events (cerebral palsy, birth trauma, toxaemia during late pregnancy, rematurity, low birth weight) [Heikkinen et al., 2002]. The general prevalence of strabismus is around 5% for any age after six years [Stidwil, 1997].

There is a large evidence of studies about prevalence of visual defects in the general population, but there is a lack of studies about the association of visual defects with another highly diffused condition like malocclusion [Monaco et al., 2011]. An anatomical [Saw et al., 2005] and neurological [Hosaka, 1988] link among stomatognathic and ocular systems exists, and the visual input effect on the electromyographic activity of sternocleidomastoid and masseter muscles at rest has been proved too [Zahn et al., 2000].

The aim of this study was to investigate the prevalence of hyperopia and strabismus in a group of caucasian orthodontic patients.

**Materials and methods**

The present study reports data on hyperopia and strabismus in a sample of children, whose characteristics are described in a previous study [Monaco et al. 2011]; the study was performed at the Dental Clinic of the University of L'Aquila, L'Aquila, Italy, on 322 consecutive caucasian patients (155 male, 167 female) of the Department of Gnathology. Patients were enrolled for the study between September 2009 and October 2010. All subjects had pre-treatment panoramic and laterolateral x-rays, made with the same x-ray device (Siemens, OP10E, Palomex Instrumentarium, Tuusula, Finland). Diagnostic records,
anamnestic questionnaires, laterolateral and panoramic x-rays as well as dental casts were evaluated.

Patients with syndromes, severe orthodontic treatment history, and missing any permanent teeth due to extraction were excluded. The patients were all submitted to an ophthalmological examination for evaluation of hyperopia and strabismus. The subjects presenting combined visual defects or visual defects other than hyperopia or strabismus (i.e. myopia, or astigmatism) were excluded from the analysis to avoid any confounding factor about the prevalence of each visual defect. A total of 146 subjects, 65 male and 81 female were excluded for presenting other or combined visual defects, history of severe orthodontic treatment and past extraction of permanent teeth; the remaining 176 subjects (75 male, 101 female), were included in the study. The mean age of the patients was 12.4 ± 2.1 years (range, 10-14 years). The orthodontic conditions were classified as follows: Class I (ANB angle 0° to 4°, Class I molar relationship), Class II division I (ANB angle >4°, Class II molar relationship), Class II division 2 (ANB angle >4°, Class II molar relationship, deep bite), Class III (ANB angle <0°, Class III molar relationship); orthodontic diagnosis was mainly performed on the basis of lateral x-rays.

All records were examined by the same expert clinician (AM), who was blind to patient data and ocular condition, in order to eliminate inter-examiner differences and examiner bias.

The study was approved by the Ethics Committee of the University of L’Aquila (Prot. No. 56/2006) and a signed informed consent was obtained from all the parents of the enrolled subjects.

Statistical analysis

Repeatability was tested on 20 randomly selected subjects examined at least 2 weeks after the initial examination. Cohen’s kappa test coefficient was calculated to determine the reliability of determining each dental anomaly in the 2 evaluation periods. Pearson’s chi-square and Fisher’s exact test were conducted to assess the association between visual defects and malocclusion. An analysis of the influence of sex on the prevalence of visual defects was performed. Then, an analysis for sagittal class of malocclusion was performed. Since the patients was 12.4 ± 2.1 years (range, 10-14 years). The orthodontic conditions were classified as follows: Class I (ANB angle 0° to 4°, Class I molar relationship), Class II division I (ANB angle >4°, Class II molar relationship), Class II division 2 (ANB angle >4°, Class II molar relationship, deep bite), Class III (ANB angle <0°, Class III molar relationship); orthodontic diagnosis was mainly performed on the basis of lateral x-rays.

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**Results**

A kappa score of 0.94, which indicated a high level of agreement between the first and second evaluations, was recorded for each malocclusion. This showed the reliability of the recordings.

Hyperopia was present in 11.4% of males and in 6.7% of females, while strabismus was present in 4.6% of males and in 2% of females (Table 1); no significant differences were detected according to the sex of the subjects. Hyperopia and strabismus were more frequent in subjects with I Class malocclusion (9.7% and 4.2%, respectively); no significant differences were observed for hyperopia and strabismus in sagittal classes of malocclusion (Table 2).

**Discussion**

The refractive error is recognized as one of the most important causes of correctable visual impairment accounting for nearly 80% of the visual impairment in persons aged 12 years and older in the United States [Vitale et al., 2008]. The prevalence of visual defects is highly variable as assessed by the presence of several population studies.

In this study, subjects with Class II division 2 malocclusion were separated from the Class II pool and studied separately, because they have a distinct skeletal dental pattern [Vitale et al., 2008]. The literature indicated strong genetic influences for this malocclusion, which has a low prevalence, between 2.4% and 4.8% [Vitale et al., 2008]. The prevalence of Class II Division 2 malocclusion in our study sample (6.1%) seems to confirm this trend.

Regarding hyperopia, its prevalence, from 5.8% to 11.6% as assessed in several studies, is largely respected [Midelfart et al., 1992; Lam et al., 1991; Shafiri et al., 1998; Siatowsky et al., 2005; Ricci et al., 2007]. In fact we found the presence of this visual defect in 8.6% of the sample. Moreover no statistical differences were found in the prevalence of hyperopia in the various sagittal skeletal malocclusions.

The prevalence of strabismus, 3.2% in the total study sample, confirms data about its prevalence of around 5% for any age after six years [Gautam et al., 2007], though on the other hand this suggests that its prevalence could be further reduced in a non orthodontic population. Interestingly, a recent study found that strabismus was...
associated with an increased mesiodistal size of the crown of deciduous teeth [Heikkinen et al., 2002]; however, this association, as well as the prevalence of this visual defect, were connected with the ethnicity of the investigated subjects; it could be speculated that a specific skeletal pattern could determine an altered development of the structures related to vision, considering the common embryonal origin. For example, recent studies demonstrated that deformational posterior plagiocephaly can affect visual development in a quantifiable manner [Siatkowsky et al., 2005] and that in children with nonsyndromic craniosynostosis the presence and severity of visual impairment is related to the type of craniosynostosis [Ricci et al., 2007]. We can even suppose that the association between visual defects and dental malocclusion could be the result of some global development delay [Vitale et al., 2006] or that a visual defect could affect the growth of skeletal and dental structures by altering the postural system. However the prevalence of environmental rather than genetic factors in the aetiology of visual defects seems to be confirmed [Angi et al., 1998; Teikari et al., 1989]. Further investigations are needed to better understand the mechanisms that could support these findings.

References


