Clinical Article

CROSS SECTIONAL

Prevalence of Vision Problems in a Hospital-based Pediatric Population With Malocclusion

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Abstract: ***Purpose:*** *The purpose of this study was to evaluate the prevalence of vision defects (myopia, astigmatism, strabismus, and hyperopia) in Class I, Class II, and Class III malocclusions.* ***Methods:*** *A total of 1,326 patients were screened to assess the prevalence of vision defects and malocclusion. All the patients classified as Class I, Class II, and Class III malocclusions were submitted to an ophthalmologic visit for the evaluation of vision problems. The occurrence rates of vision defects were calculated as percentages of the total sample. Differences in incidence rates of each vision defect by sex were analyzed by chi-square test.* ***Results:*** *Myopia was the most common (22 percent), followed by astigmatism (~20 percent), hyperopia (~12 percent), and strabismus (~4 percent). The prevalence of myopia was higher in Class II malocclusions, while the prevalence of astigmatism and hyperopia was higher in Class I malocclusion. No significant difference in vision defects by sex was found.* ***Conclusions:*** *No significant difference in vision defects by sex was found. The prevalence of astigmatism and hyperopia was higher in patients with Class I malocclusion. The prevalence of myopia was higher in patients with Class II malocclusion. (Pediatr Dent 2013;35:272-4) Received November 19, 2011 / Last Revision April 4, 2012 / Accepted April 10, 2012*

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Vision defects (myopia, astigmatism, hyperopia, strabismus) can result from many factors, both genetic and environmental. Although defects in certain genes are the most influential, etiological events in the prenatal and postnatal periods have also been blamed for anomalies in lens dimension, morphology and position of foramina structure.[1-3] The prevalence of myopia, however, has been shown to be highly variable in relation to age as well as ethnicity.[4-8] The prevalence of myopia seems to be lower in European populations than Asian countries. The prevalence rates vary from approximately 30 percent in middle-aged adults and 35 percent to 37 percent in young adults.[9,10]

A study by Jobke[11] on a German population assessed that the prevalence of myopia varied significantly among four age groups, from zero percent in the youngest group (2- to 6-year-olds) to approximately 41 percent in the oldest group (18- to 35-year-olds) with a greater prevalence of myopia in females than in males and a higher incidence of myopia at the age of 15 to 16 years old. The prevalence of hyperopia is not clear.

The Eye Diseases Prevalence Research Group[12] reported hyperopia rates of approximately 10 percent in America, 12 percent in Western Europe, and six percent in Australia, while other studies reported a higher prevalence.[13,14] The prevalence of this disorder seems to decrease from the youngest age (2-6 years old) to the older age (18-35 years old), reaching the highest incidence from the age of one year old to nine years old,[11] and increases over 60 years.[15] Racial variations are known to influence the prevalence and degree of astigmatism.[5] The reported prevalence of this refractive error in children is quite variable, too, and is influenced by age,[16] without any difference in the occurrence of astigmatism between males and females. The general prevalence of strabismus is around five percent for any age after six years old.[17]

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There are many studies about the prevalence of vision defects in the general population, but there is a lack of studies about the association of vision defects with another highly diffused condition like malocclusions. An anatomical[18] and neurological[19,20] link between stomatognathic and ocular systems exists, and the visual input effect on the surface electromyography activity of sternocleidomastoid and masseter muscles at rest has also been proven.[21]

The purpose of this study was to investigate the prevalence of vision defects in a group of Caucasian orthodontic patients.

Methods

This study was approved by the Ethics Committee of the University of L'Aquila, and a signed informed consent was obtained from all parents of the enrolled subjects. The study period occurred from February 2006 to October 2010.

A total of 1,873 Caucasian patients (741 males, 1,132 females; age range=6.5-14.8 years old; mean age=12.4±2.7 years old) who consecutively came to the Department of Orthodontic and Gnathology, Dental Clinic, University of L'Aquila, L'Aquila, Italy, were enlisted for the study. All subjects had pretreatment panoramic and lateral films taken by the same technician using the same X-ray device (Siemens, OP10E, Palomex Instrumentarium, Tuusula, Finland) and the same standardized method.

Diagnostic records—including a self reported patient history questionnaire, lateral cephalogram, and panoramic X-ray—were evaluated. Patients with syndromes and those who had received extensive orthodontic treatment and extractions of any permanent teeth were excluded. The patients were all submitted to an ophthalmologic visit for the evaluation of vision defects. The following ocular defects were investigated:

1. myopia—short-sightedness, a condition of the eye in which parallel rays are focused in front of the retina and the objects can be seen distinctly only when near to the eye;
2. hyperopia—far-sightedness, a condition of the eye in which parallel rays are focused behind the retina and distant objects can be seen more distinctly than near ones;

Table 1. DISTRIBUTION OF VISUAL DEFECTS BY SEX

Visual defect	Distribution in males (N=504)		Distribution in females (N=822)		Total (N=1,326)		Chi-square test results
	N	%	N	%	N	%	*P*-value
Myopia	122	24	170	21	292	22	.23
Hyperopia	71	14	93	11	164	12	.18
Astigmatism	119	24	143	17	262	20	.02
Strabismus	30	6	25	3	55	4	.02

Table 2. DISTRIBUTION OF VISUAL DEFECTS BY MALOCCLUSION GROUP

	Myopia	Hyperopia	Astigmatism	Strabismus
Class 1	113	97	132	17
Class 2	146	29	77	16
Class 3	33	38	53	22

3. astigmatism—a reduced sharpness of vision and refraction error of the eye in which there is a difference in the degree of refraction in different meridians typically characterized by a nonspherical, nonfigure of revolution cornea in which the corneal profile slope and refractive power in one meridian are greater than that of the perpendicular axis; and
4. strabismus—a condition in which the eyes are not properly aligned to each other and are not oriented in the same direction. It typically includes a lack of coordination among the extraocular muscles, which may adversely affect depth perception.

Subjects presenting with more than one vision defect (myopic/astigmatism, hyperopic/astigmatism, myopic/strabismus, hyperopic/strabismus, and astigmatic strabismus) were excluded to avoid any confounding factor about the prevalence of each vision defect.

All subjects were classified into three groups by malocclusion type evaluated on a lateral cephalogram: Class I (ANB angle 0°-4°); Class II (ANB angle >4°); and Class III (ANB angle <0°). All records were examined by the same clinician to eliminate inter-examiner differences.

Repeatability was tested on 20 randomly selected subjects who were examined at least two weeks after the initial examination. Cohen's kappa test coefficient was calculated to determine the reliability of determining each dental anomaly in the two evaluation periods. A chi-square test was conducted to determine the statistical significance of vision defects by sex and malocclusion type. An analysis of the influence of sex on the prevalence of vision defects in the total sample was performed. A statistical analysis was performed with SPSS 11.0 software (SPSS Inc, Chicago, Ill., USA). A statistical significance level of $P<.05$ was assumed.

Results

A Kappa score of 0.98, which indicated perfect agreement between the first and second evaluations, was recorded for each dental anomaly. This showed the reliability of the recordings. Some subjects were excluded for presenting two or more vision defects. The remaining 1,326 subjects available for study (504 male and 822 female) were classified into five categories: (1) no visual defects; (2) myopia; (3) astigmatism; (4) hyperopia; and (5) strabismus. The mean age of the patients was 12.4±2.7 years old.

A total of 773 subjects (~58 percent) had vision defects, and 553 (~42 percent) had no vision defects. The overall distribution of vision defects and the distribution by sex are provided in Table 1. The most prevalent vision defect was myopia, observed in 292 individuals (22 percent of the sample), followed by astigmatism (~20 percent), hyperopia (~12 percent), and strabismus (~four percent). Although each vision defect was more represented in the male population, the difference was not statistically significant. The distribution of each vision defect in the different malocclusion groups is noted in Table 2. The prevalence of: myopia was higher in the Class II malocclusion group; and hyperopia and astigmatism was higher in the Class I malocclusion group (Table 2).

Discussion

Because of the differences in the reported prevalence of vision defects in various racial and ethnic groups, only Caucasian orthodontic patients were considered for the present investigation. In this study, approximately 58 percent of the total study group had vision defects. There were more female subjects in the total sample. While some authors reported significant differences by sex for certain vision defects,[11] others found nonsignificant differences.[16] In our study, no statistically significant correlation was observed between sex and vision defects.

The finding of myopia as the most frequent vision defect (22 percent) is in agreement with the literature.[11,15] According to the classification of malocclusions, our data indicated that the prevalence of myopic defects is higher in Class II malocclusions. The prevalence of astigmatism was higher in Class I malocclusions, and these results are in contrast with those achieved by another study.[22] Also, in our study, the prevalence of hyperopia was found to be higher in Class I malocclusions; unfortunately, no comparison with the results of other studies could be performed, since no study focused on that topic could be found in the literature.

It is hypothesized that a specific skeletal pattern could determine an altered development of the structures linked with the vision. For example, recent studies demonstrated that deformational posterior plagiocephaly can affect visual development in a quantifiable manner[23] and, in children with nonsyndromic craniosynostosis, the presence and severity of visual impairment is related to the type of craniosynostosis.[24] In addition, it can be postulated that the association between vision defects and orthodontic malocclusion can be the result of some global developmental delay[25] and that a vision defect, altering the postural system, can affect the growth of skeletodental structures. The prevalence of environmental rather than genetic factors in the etiology of vision defects, however, seems to be confirmed.[1,3] Further investigations, beyond those recently published[22,26-29], are surely needed to better understand the mechanisms that could support these findings.

Conclusions

Based on this study's results, the following conclusions can be made:

1. The prevalence of myopia was higher in Class II malocclusions.
2. The prevalence of hyperopia and astigmatism was higher in Class I malocclusions.

References

1. Angi MR, Clementi M, Sardei C, Piattelli E, Bisantis C. Heritability of myopic refractive errors in identical and fraternal twins. Graefes Arch Clin Exp Ophtalmol 1993;23: 580-5.
2. Holberg C, Rudzki-Janson I. Stresses at the cranial base induced by rapid maxillary expansion. Angle Orthod 2006;76: 543-50.
3. Teikari JM, O'Donnell JJ. Astigmatism in 72 twin pairs. Cornea 1989;8:263-6.
4. Chung KM, Mohidin N, Yeow PT, Tan LL, O'Leary D. Prevalence of visual disorders in Chinese schoolchildren. Optom Vis Sci 1996;73:695-700.
5. Lam CS, Goh WS. Astigmatism among Chinese schoolchildren. Clin Exp Optom 1991;74:150.
6. Lin LLK, Shih YF, Lee YC, Hung PT, Hou PK. Changes in ocular refraction and its components among medical students: A 5-year-longitudinal study. Optom Vis Sci 1996;73: 495-8.
7. Taylor HR. Racial variations in vision. Am J Epidemiol 1981;113:62-80.
8. Verlee DL. Ophthalmic survey in the Salomon Islands. Am J Ophthalmol 1968;66:304-19.
9. Mavracanas TA, Mandalos A, Peios D, et al. Prevalence of myopia in a sample of Greek students. Acta Ophthalmol Scand 2000;78:656-9.
10. Midelfart A, Kinge B, Midelfart S, Lydersen S. Prevalence of refractive errors in young and middle-aged adults in Norway. Acta Ophthalmol Scand 2002;80:501-5.
11. Jobke S, Kasten E, Vorwerk C. The prevalence rates of refractive errors among children, adolescents, and adults in Germany. Clin Ophthalmol 2008;2:601-7.
12. The Eye Diseases Prevalence Research Group. The prevalence of refractive errors among adults in the United States, Western Europe, and Australia. Arch Ophthalmol 2004;122: 495-505.
13. Kinge B, Midelfart A, Jacobsen G. Refractive errors among young and university students in Norway. Acta Ophthalmol Scand 1998;76:692-5.
14. Wensor M, McCarty CA, Taylor HR. Prevalence and risk factors of myopia in Victoria, Australia. Arch Ophthalmol 1999;117:658-63.
15. Vitale S, Ellwein L, Cotch MF, Ferris III FL, Sperduto R. Prevalence of refractive error in the United States, 1999-2004. Arch Ophthalmol 2008;126:1111-9.
16. Fan DSP, Rao SK, Cheung EYY, Islam M, Chew S, Lam DSC. Astigmatism in Chinese preschool children. Br J Ophthalmol 2004;88:938-941.
17. Stidwill D. Epidemiology of strabismus. Ophthal Physiol 1997;17:536-9.
18. Gautam P, Valiathan A, Adhikaric R. Stress and displacement patterns in the craniofacial skeleton with rapid maxillary expansion: A finite element method study. Am J Orthod Dentofacial Orthop 2007;132:1-11.
19. Diagne M, Valla J, Delfini C, Buisseret-Delmas C, Buisseret P. Trigeminovestibular and trigeminospinal pathways in rats: Retrograde tracing compared with glutamic acid decarboxylase and glutamate immunohistochemistry. J Comp Neurol 2006;496:759-72.
20. Zhou J, Shore S. Projections from the trigeminal nuclear complex to the cochlear nuclei: A retrograde and anterograde tracing study in the guinea pig. J Neurosci Res 2004; 78:901-7.
21. Sharifi Milani R, Deville de Periere D, Micallef JP. Relationship between dental occlusion and visual focusing. Cranio 1998;16:109-18.
22. Monaco A, Spadaro A, Sgolastra F, Petrucci A, D'Andrea PD, Gatto R. Prevalence of astigmatism in a pediatric population with malocclusion. Eur J Paediatr Dent 2011;12:91-4.
23. Siatkowsky RM, Fortney AC, Nazir SA, et al. Visual field defects in deformational posterior plagiocephaly. J AAPOS 2005;9:274-8.
24. Ricci D, Vasco G, Branello G, et al. Visual function in infants with nonsyndromic craniosynostosis. Dev Med Child Neurol 2007;49:574-6.
25. Vitale S, Cotch MF, Sperduto RD. Prevalence of visual impairment in the United States. JAMA 2006;295:2158-63.
26. Monaco A, Sgolastra F, Cattaneo R, Petrucci A, Marci MC, D'Andrea PD, Gatto R. Prevalence of myopia in a population with malocclusions. Eur J Paediatr Dent 2012;13(3 Suppl):256-8.
27. Monaco A, Spadaro A, Sgolastra F, Petrucci A, D'Andrea PD, Gatto R. Prevalence of hyperopia and strabismus in a paediatric population with malocclusions. Eur J Paediatr Dent 2011;12:272-4.
28. Monaco A, Cattaneo R, Spadaro A, Giannoni M, Di Martino S, Gatto R. Visual input effect on EMG activity of masticatory and postural muscles in healthy and in myopic children. Eur J Paediatr Dent 2006;7:18-22
29. Monaco A, Cattaneo R, Spadaro A, D'Andrea P, Marzo G, Gatto R. Ocular correction effects on EMG activity of stomatognathic muscles in children with functional mandibular lateral- deviation: a case control study. Eur J Paediatr Dent 2006 Jun;7(2):81-8.