STUDY OF THE RETINAL NERVE FIBER LAYER IN CHILDHOOD STRABISMUS

ESTUDIO DE LA CAPA DE FIBRAS NERVIOSAS DE LA RETINA EN EL ESTRABISMO INFANTIL

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ABSTRACT

Objective: To assess possible differences in the retinal nerve fiber layer (RNFL) thickness between children with strabismus and controls. This study also compared esotropia with exotropia cases, and dominant eyes with non-dominant eyes.
Method: 31 children with esotropia, 17 children with exotropia and 32 controls were studied. The peripapillary RNFL average thickness was determined in 4 different areas (inferior, superior, nasal and temporal) using optical coherence tomography.
Statistical analysis was performed a) between the strabic children and the control group, b) between the esotropia and exotropia groups, and c) between the dominant eyes and the non-dominant eyes of the strabic children.
Results: No statistically significant differences in RNFL thickness were found in any of these statistical comparisons.
Conclusions: From this study, no evidence of changes in RNFL thickness, associated to the existence

RESUMEN

Objetivo: Comprobar si existen diferencias en el grosor de la capa de fibras nerviosas de la retina (CFNR) entre niños estrábicos y niños con visión binocular normal. Estas diferencias también se estudiaron entre niños con endotropía y exotropía y entre los ojos dominantes y no dominantes de niños estrábicos.
Método: Se incluyeron 31 niños con endotropía, 17 con exotropía y 32 niños controles. Se midió la CFNR peripapilar de ambos ojos mediante tomógrafo óptico de coherencia, obteniéndose los grosores en 4 sectores: superior (S), inferior (I), nasal (N) y temporal (T). Se determinó estadísticamente ($p<0,05$) si existían diferencias de dichos grosores en los siguientes supuestos: a) entre los niños con estrabismo y los niños controles b) entre los niños con endotropía y exotropía c) entre los ojos dominantes y los no dominantes de los niños estrábicos.
Resultados: En ninguna de las comparaciones realizadas, ya sea considerando la totalidad de ojos o

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Key words: Retinal nerve fiber layer, optical coherence tomography, strabismus.

bien sólo los dominantes con los no dominantes, se encontraron diferencias estadísticamente significativas (p>0,05 t de Student).
Conclusiones: Según los casos aquí comparados, no hay variaciones de la capa de fibras nerviosas de la retina que se asocien con la existencia de estrabismo.

Palabras clave: Capa de fibras nerviosas de la retina, tomografía de coherencia óptica, estrabismo.

INTRODUCTION

Strabismus is one of the most prevalent conditions in childhood (2-4%) (1,2). However, its ethiopathogeny continues to be uncertain because the specific anatomic and physiopathological mechanisms which cause strabismus are not known.

On the other hand, Optical Coherence Tomography (OCT) is an easily applied clinical technique which allows to take «in vivo» quantitative measurements of the thickness of the peri-papillar RNFL thickness. The RNFL made up by the axons of the retina ganglyon cells, which group to form the optic nerve and project towards the lateral geniculated body. The retina ganglion cells represent the second neuron of the optic pathway, and thus are an essential afferent link in the visual process. Due to the OCT, it is possible to make a clinical exploration of this retina layer since it is a quick and non-invasive procedure.

This study analyses the existence of a possible «retinal anomaly» of strabismus (variations in the thickness and distribution of RNFL). The RNFL thickness of dominant (DOM) and non-dominant (NO-DOM) eyes in strabic pediatric patients are statistically compared. In addition, said RNFL thickness comparisons are made between endotropy and exotropy.

SUBJECTS, MATERIAL AND METHODS

Strabic children and controls proceeded from the health area No 9 of the Community of Madrid and were included consecutively in this study by order of access to our practice. We only considered children aged four upwards to ensure adequate cooperation in the tests, excluding those with paralitic, restrictive or sensory strabismus and those associated to neurological or malformation disorders. In addition, patients with deep amblyopy (AV < 0,3) were also discarded. Patients with spherical equivalents (EE) under cyclopegic refraction above +5 dioptries (D) of hypermetropy or -4D of myopy, or those presenting anisometropy over 2D were also excluded. None of the selected strabic patients had been submitted to surgery or treated with botulin toxin muscle injections at the time of RNFL measurement, even though they could be under penalizing treatment due to amblyopy.

Accordingly, the groups of patients were established as follows:

GROUP A: 31 children with endotropy (16 boys and 15 girls), average age 9.23, DE 4.54 (range 4-15). The mean strabismus deviation angle was +12.48 Dp and the mean cyclopegic refraction of + 2.10 D for dominant eyes (DOM) and of + 2.48 D for nondominant eyes (NO-DOM). Five of these 31 endotropy cases presented amblyopy, with AV > 0.4 in all cases.

GROUP B: 17 children with exotropy (7 girls and 10 boys), average age 16.33, DE 7.92 (range 7-23). The mean deviation angle was of -16.63 Dp with a mean cyclopegic refraction of -0.76 D for DOM eyes and of -0.66 D for NON-DOM eyes. Only two of these 17 patients presented amblyopy, with AV > 0.7 for all cases.

GROUP C: 32 control children (18 boys and 14 girls) with normal binocular vision, average age 9.75 years, DE 3.39 (range from 4 to 20 years). Mean refraction was + 0.82 D for right eyes and + 0.88 D for left eyes.

In each one of said groups the width of the retina nervous fibre layers was measured by optical coherence tomograph (OCT-3, Carl Zeiss, Meditec, Dublin, CA, USA). RNFL 3.4 mode was utilized for the measurements (three readings per eye) (fig.

1) under mydriasis obtained with 1% cyclepentolate eye wash (Colircusi cycloplegic 1% Alcon Cusí, El Masnou, Barcelona, Spain). The measurements were analyzed using the Thickness Average Analysis protocol which can quantify the mean thickness in microns (µ) in 4 peri-papillar sections: inferior, superior, nasal and temporal (fig. 2).

It was verified whether the perpi-papillar thicknesses of the study matched a normal distribution (Kolmogorov-Smirnov test). Subsequently, through the «t for Student» any statistically significant differences was determined ($p<0.05$) for the mean thicknesses and for each RFNL section (inferior, superior, nasal and temporal) in the following assumptions:

a) Between each one of groups A and B, with the control group C.

b) Between the eyes of group A with the eyes of group B.

c) Between the dominant and nondominant eyes of each group; in the case of group C, the right eyes were compared with the left ones.

For the statistical study, the SPSS programme was used, version 11.0 (SPSS Inc, Chicago, Illinois, EEUU).

RESULTS

All the RNFL thicknesses matched a normal distribution according to the Kolmogorov-Smirnov test ($p>0.15$).

— The mean thickness of RNFL for all the group A eyes was of (102.87 µm DE 32.87) (table I), without finding statistically significant differences (p = 0.4942) between the DOM eyes (102.03 µm DE 33.15) and NON-DOM (102.48 µm DE 32.80). When considering the RNFL thickness for each section: inferior (I), superior (S), nasal (N) and tem-poral (T), no statistically significant differences were evidenced either ($p>0.05$) in the correlative comparison of said sections in DOM and NON-DOM eyes (table II).

— The mean RNFL thickness for all the exotropic eyes was of (102.35 µm DE 35.52) (table I) without finding statistically significant differences (p=0.4856) when comparing the mean thicknesses of DOM (102.15 DE 35.99 µm) and NON-DOM eyes (101.88 DE 33.91 µm). When comparing the thicknesses of said eyes section by section, said differences were not found either (table II).

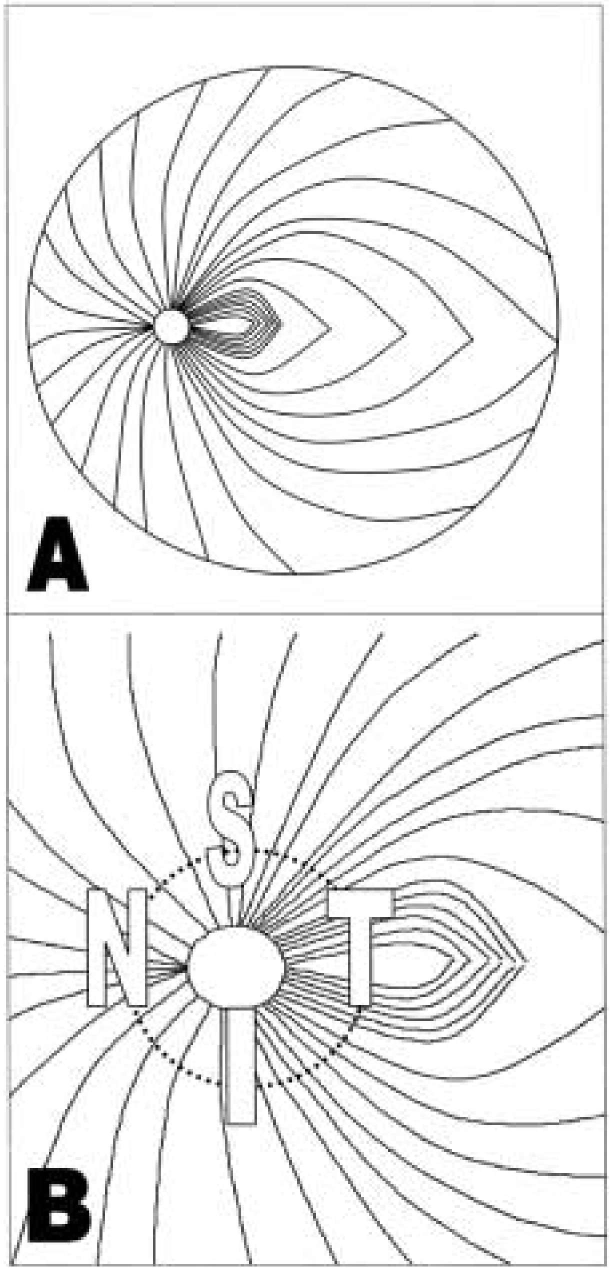

Fig. 1: A: Schematic representation of the fibre layers of the retina. B: Scheme of RNFL mode 3.4 which carries out 512 peri-papillar measurements on a radius of 1.73 mm.

— The mean RNFL thickness for all the control group eyes (group C) was of (104.71 µm DE 30.87) (table I). No statistically significant differences were found (p=0.2756) in the comparison of the mean thicknesses of right eyes (104.42 µm DE

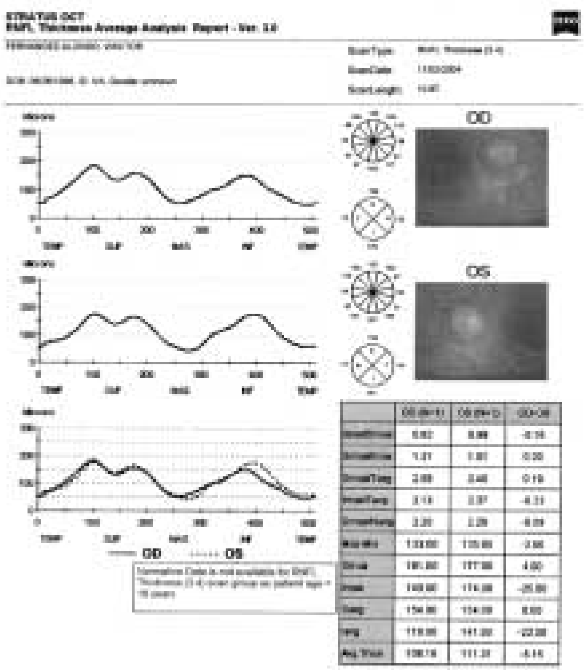

Fig. 2: Analysis report as per «RFNL Thickness Average Analysis» protocol. For this study the mean thicknesses of each section (inferior, superior, nasal and temporal) were considered.

30.31) and left eyes (105.00 µm DE 31.54). No statistically significant differences were found either in the comparison of the thicknesses of peri-papillar sections (table II).

When comparing the mean RNFL thicknesses of the group A and B eyes, no statistically significant differences were found (p= 0.4524). This was also the case when comparing peri-papillar sections, or when comparing the mean and section thicknesses of the group A with group B eyes and of B with C group eyes, with the result that no statistically significant differences were found in all cases (p>0.05) (table I).

DISCUSSION

OCT has represented a considerable technical advance because it allows obtaining high-resolution images of tomographic sections of the retina and the optical papilla. Likewise, its capabilities to carry out quantitative measurements of the retina and RNFL at the peri-papillar level have made OCT a high performing diagnostic tool for macula and optical disk pathologies.

Table I. RNFL thicknesses per section and mean peri-papillar in each one of the groups. Summary of comparisons and levels of significance

	RNFL thicknesses (µ)			Means comparison (p <0.05)		
	GROUP A	GROUP B	GROUP C	A vs C	B vs C	A vs B
Inferior sector	131.63	129.20	136.30	0.145121989	0.104274255	0.379143259
Superior sector	127.61	129.65	128.62	0.39094688	0.4296859	0.37520929
Nasal sector	84.82	85.60	85.03	0.47447353	0.42927408	0.44917653
Temporal sector	67.37	64.95	68.82	0.27991122	0.12867173	0.28714594
Peripapillar av.	102.86	102.35	104.69	0.2577458	0.28092437	0.452480726

t of Student with significance level p<0.05.

Table II. RNFL thicknesses per section and peri-papillar mean in the dominant and nondominant eyes in each one of the groups. Summary of comparisons and levels of significance

	RNFL thickness (µ)						Means comparison (p <0.05)		
	GROUP A		GROUP B		GROUP C		A	B	C
	DOM	NO DOM	DOM	NO DOM	OD	OS	DOM vs NO DOM	DOM vs NO DOM	OD vs OS
Inferior sector	132.22	131.67	130.40	129.10	135.97	136.64	0.437694377	0.455023017	0.422362622
Superior sector	126.16	125.13	126.60	130.80	128.09	129.15	0.370475573	0.340376866	0.38645643
Nasal sector	82.22	87.00	86.70	82.60	84.73	85.33	0.25281659	0.26932173	0.39748208
Temporal sector	67.53	66.20	64.90	65.00	68.85	68.79	0.35658293	0.49277003	0.488944
Peripapillar av.	102.03	102.48	102.15	101.88	104.41	104.98	0.494200009	0.485644652	0.275562608

t of Student with significance level p<0.05.

The cases presented in this study belong mainly to patients in paediatric age. It must be emphasized that for ages below 15 the RNFL normality thickness parameters have not been described (3).

In the case of strabismus, the existence of sensory and motor imbalances between both eyes leads us to think that there may be differences in the density or distribution of the RNFL between the fixating and the deviated eye, but also between the eyes of the different types of strabismus (endotropy and exotropy). In the latter assumption, the differences could be even more feasible because these are conditions having different sensory and vergential significance. However, according to the results obtained in this study, there are no differences between the RNFL thickness in all the comparisons, considering the DOM and NON-DOM eyes of the same time of strabismus or between the eyes of children with strabismus compared to control cases. Therefore, it does not seem there are any differences in the layer of retina nervous fibres in strabismus pathology.

When amblyopy was present, it was moderate or slight in our groups of strabic children. In order to minimize the possible influence of amblyopy in the thickness of RNFL, we excluded from this study cases with deep amblyopy with strabismus, amblyopy without strabismus and the anisometropies over 2 D. In this regard, there are several studies analysing the thickness of RNFL in the case of unilateral amblyopy. Yoon et al (4) found statistically significant differences in the thickness of RNFL (increased thickness) in amblyopic eyes caused by hypermetropic anisometropy vis-a-vis their Adelphian eyes, although this difference was not confirmed in a study made with GDx fibre analyzer (5). In a broader study, Yen et al (6) also found statistically significant differences in the case of amblyopy due to anisometropy (>2D) not in the cases of anisometropy without amblyopy, or in amblyopy due to strabismus. However, it seems that refraction is the decisive factor which explains the different RNFL thickness when comparing amblyopic anisometropic eyes with normal, emetropic eyes. Said differences would disappear if we make a comparison with control eyes which are normal but hypermetropic (7). Therefore, ocular refraction is a factor which has the greatest influence in the creation of the thickness of RNFL and not the mere existence of amblyopy.

In all the patients of our study, the range of refraction carried out under cyclopegy varied between +2,5 and -0,75 D, and therefore the possible variations of RNFL thickness attributable to refraction have been minimized.

By way of conclusion and according to the compared cases, it appears there are no variations in the number or distribution of the fibres of retinal ganglionary cells associated to the existence of strabismus. The possible neuronal variations could be found in other nervous structures of the sensory integration of visual information or the motor efferent path.

REFERENCE

1. *Chew E, Remaley NA, Tamboli A, Zhao J, Podgor MJ, Klebanoff M. Risk factors for esotropia and exotropia. Arch Ophthalmol 1994; 112: 1349-1355.*
2. *Kasmann-Kellner B, Heine M, Pfau B, Singer A, Ruprecht KW. Screening for amblyopia, strabismus and refractive abnormalities in 1,030 kindergarten children. Klin Monatsbl Augenheilkd 1998; 213: 166-173.*
3. *Baquero Aranda IM, Morillo Sánchez MJ, García Campos JM. Estudio de parámetros de normalidad en relación a la edad con el tomógrafo óptico de coherencia. Arch Soc Esp Oftalmol 2005; 80: 225-231.*
4. *Yoon SW, Park WH, Baek SH, Kong SM. Thicknesses of macular retinal layer and peripapillary retinal nerve fiber layer in patients with hyperopic anisometropic amblyopia. Korean J Ophthalmol 2005; 19: 62-67.*
5. *Bozkurt B, Irkec M, Orhan M, Karaagaoglu E. Thickness of the retinal nerve fiber layer in patients with anisometropic and strabismic amblyopia. Strabismus 2003; 11: 1-7.*
6. *Yen MY, Cheng CY, Wang AG. Retinal nerve fiber layer thickness in unilateral amblyopia. Invest Ophthalmol Vis Sci 2004; 45: 2224-2230.*
7. *Atilla H, Batioglu F, Erkam N. Retinal nerve fiber analysis in subjects with hyperopia and anisometropic amblyopia. Binocul Vis Strabismus Q 2005; 20: 33-37.*