



ORIGINALES

Investigation of the Efficiency of the TNO Test for the Early Detection of Amblyopia in Primary Care

Estudio de la eficacia del test TNO en la detección precoz de la ambliopía en atención primaria

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ABSTRACT:

Amblyopia is the most common preventable cause of the loss of vision in developed countries, affecting the 2-5% of the population. This may evolve due to an abnormal visual experience, during the phase of visual development. Strabismus is the principal cause of the development of amblyopia, being 30 – 50% of the cases. The early detection of visual alterations causing amblyopia is considered to be of primary importance as the treatment is only effective during infancy, when the visual system becomes mature.

The Health Council of the Canary Island Government a few years ago developed a program for the detection of visual alterations in childhood, and has recently incorporated the introduction of the TNO test to the habitual examinations. This investigation precisely intends to value the efficiency of the TNO Test in the early detection of amblyopia and the comparison with other habitual tests that are carried out in Primary Care.

During the study, an exhaustive revision and comparative analysis is made of the vision tests of 358 medical records in a health centre in the province of Santa Cruz de Tenerife, corresponding to children between 3 and 6 years old.

According to the results obtained, we can surmise that the TNO test is a valid test for the detection of anomalies, which can be used in the early detection of amblyopia, in comparison to the most popular tests used habitually in a health care centre for the detection of strabismus and amblyopia.

Keywords: Amblyopia; strabismus; binocular vision; Test TNO; children; visual acuity.

RESUMEN:

La ambliopía es la causa prevenible más común de pérdida de visión en los países desarrollados, afectando al 2-5% de la población, se puede desarrollar debido a una experiencia visual anómala, durante la fase del crecimiento visual. El estrabismo es la principal causa del desarrollo de la ambliopía, dándose en el 30-50% de los casos. Se considera de primordial importancia la detección temprana de

las alteraciones visuales causales de la ambliopía ya que su tratamiento es sólo efectivo en la infancia, mientras se produce la maduración del sistema visual.

La Consejería de Sanidad del Gobierno de Canarias, en el ánimo de la prevención de la salud, desarrolla desde hace varios años un Programa de Detección de Alteraciones Visuales en la infancia, y recientemente ha incorporado a las exploraciones habituales la implantación del Test TNO. Esta investigación precisamente pretende valorar la eficacia del Test TNO en la detección precoz de la ambliopía y su comparación con las demás pruebas habituales realizadas en Atención Primaria.

En el estudio se realiza una exhaustiva revisión y análisis comparativo de las pruebas de visión de 358 historias clínicas de un centro de salud de la provincia de Santa Cruz de Tenerife, correspondiente a niños entre 3 y 6 años de edad.

Según los resultados obtenidos, se puede conjeturar que el test TNO es una prueba igual o más válida en la detección de anomalías que puedan servir en la detección precoz de la ambliopía, en comparación con los test más populares utilizados habitualmente en un centro de Atención Primaria para la detección de estrabismo y ambliopía.

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Palabras clave: Ambliopía; estrabismo; visión binocular; Test TNO; niños, agudeza visual.

INTRODUCTION

Vision is the capacity to perceive the environment, which surrounds the individual through the interpretation of light rays, which fall upon him, more specifically on the eyes. It is the sensorial ability, which is mostly related to communication and social relations. For this reason the absence or dysfunction of vision entails a serious handicap, which could lead to important difficulties in the capacity to learn and in social relations.

Between the first measurable settings of vision it should be noted that binocular vision, when well developed, permits the stereopsis or profound binocular perception, that is, tridimensional or stereoscopic vision. The visual system reaches maturity in a gradual way, which is nearly completed in the first three years of childhood, although there persists a certain plasticity between three and six years of age¹.

To highlight principal sight alterations, strabismus, ambliopia, defects of refraction discromatopsias and alterations of the fusion. Ambliopia or "lazy eye" is defined as the unilateral reduction (in most cases) of the visual acuity caused by a bad visual stimulus of the brain during the critical period of the brain development of the visual functions. Ambliopia develops due to an abnormal visual experience in early stages of life, it is the most common preventable cause of loss of vision in developed countries, giving a 2-5% percentage of the general population and even 5% in pre-school children.²

Within the types of ambliopia, the strabismus is the most frequently observed, where the eye which is deflected has a certain degree of deprivation of the focused image, due to the mechanism of suppression of the brain to receive images out of focus, which it rejects. In this sense, strabismus is the ocular misalignment, or deviation of the visual axis, brought on by anomalies of the ocular motility or in the binocular vision, strabismus affects from 4-6% of the general population and 30-50% of them will develop ambliopia. In childhood, one of the principal factors of risk of the appearance of strabismus is when there are defects in brain development, meaning that in healthy newborn babies the frequency of strabismus is esteemed at 0.5 – 1%.³

Once visual maturity is completed, around 6-8 years, the risk of the appearance of ambliopia disappears, and likewise, the treatment/correction will be less effective or even ineffective if initiated too late, once the visual development is completed.¹

Success of the treatment depends on an early detection and early medical treatment during childhood.¹⁻⁵ The early detection of visual alterations causing ambliopia is considered to be of primary importance, as the treatment for such is only effective during the maturity of the visual system in childhood, avoiding in this way, negative consequences of an inadequate vision in the adult stage.

The early detection of visual troubles implies using methods of diagnosis like the Hirschberg Test, Cover Test, Visual Acuity with Optotypes and test of stereoscopic vision. Among the most well known stereoscopic vision tests, is TNO test, the first edition of which was designed in 1972 by the Department of Perception of the Netherlands Organization (TNO), based on the investigation of applied science,⁶ its use in Primary Care does not necessarily mean a large extra expense in equipment.

Today in Spain, each autonomous community takes charge of managing their own resources and health programs, and for that reason there are a series of specific procedures for action in each region that the health centres should carry out to control development in childhood, which implies a control of visual evolution. This decentralised measure brings about differences in the management and development of the different programs and health procedures.

The Health Council of the Government of the Canary Islands in the ambit of their competences, and in the aim of health promotion, a few years ago developed a program for the detection of visual alterations in childhood, and recently as from 2012, the introduction of the TNO test has been incorporated in the usual examination or stereoscopical vision.

The principal object of this investigation is to determine the usefulness of the TNO test in the detection of visual alterations in the infantile population younger than six years, in a Primary Care Centre.

As specific objectives it has been decided to:

- Value and compare the most commonly used visual tests in children's periodical revisions in a Primary Health Care Centre.
- Determine which visual tests prove to be more effective in the prevention and detection of possible visual pathologies in childhood.
- Determine the frequency of visual alterations detected in the Primary Care Centre.
- Verify and compare the frequency and nature of pathological visual alterations according to the results of the complete ophthalmological analysis.

MATERIAL AND METHODS

This investigation intends to value the efficiency of the TNO Test in the early detection of ambliopia in a Primary Care Centre in the province of Santa Cruz de Tenerife. An exhaustive examination was carried out on the medical records of the period comprised between the year 2012 and 2014.

The population, object of the investigation, corresponds to the child population between three and six years. This is precisely an age in which the visual pathways are

to be found in one of the most critical periods of growth, in which, to suffer an alteration would condition the correct visual development of childhood.

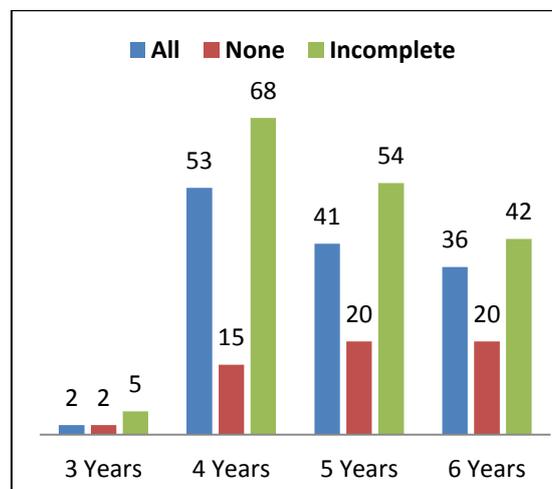
In the medical records of the patients we value and analyse the results of the tests and sections of vision located in the structures anamnesis in the section of valuation, specially in the unit of examination and tests corresponding to the examinations carried out on children. Dealing essentially with the Hirschberg Test, Cover Test, Visual Acuity with Optotypes and TNO Test.

RESULTS

The population studied, 358 children, obtained from the collection of data from three different consulting rooms, each one contributing with a similar percentage of individuals. Specifically, 182 boys (51%) and 176 girls (49%) were studied. To obtain the information and posterior study, they were classified by age, in groups of three, four, five, and six years, with a medium age of 4.84 years.

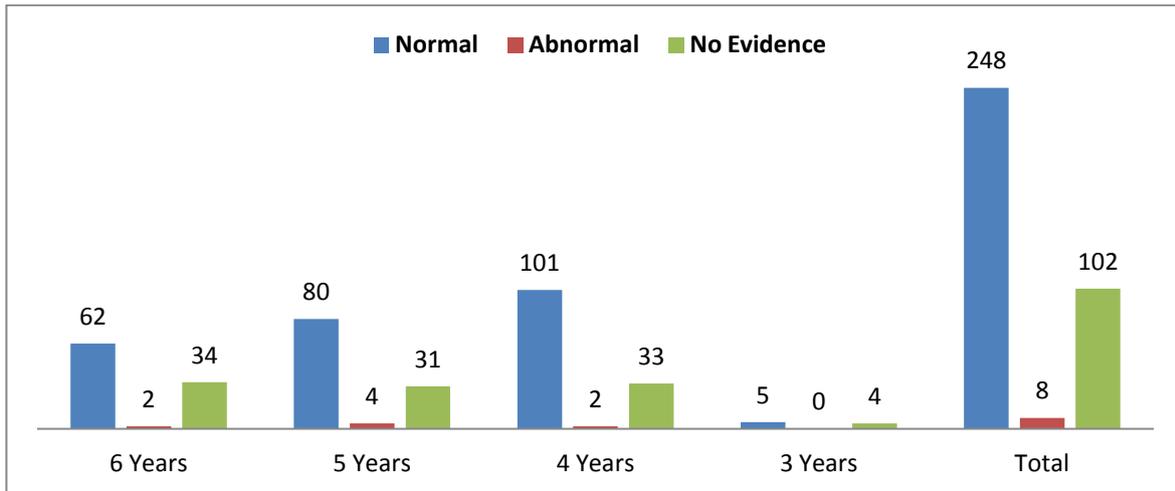
Only for 36% (132 children), was it possible to make all the tests during their health check-ups, due to various reasons: non-attendance at the medical check-ups, lack of collaboration, not carrying out the test or lack of evidence in the records; in 48% of the cases (169 children), the study was incomplete, and in 16% of the cases, (57 children), there was no evidence of examination. In *Figure 1* the tests carried out are distributed by ages.

Figure 1. Diagram of the Tests Effected by Age



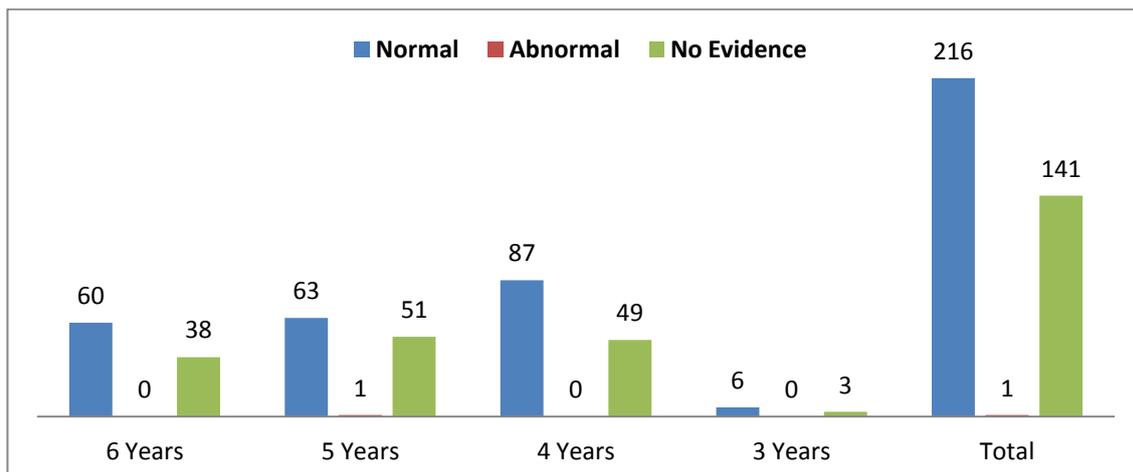
In the medical revisions the first examinations were to see if there existed an apparent deviation of the visual axis, this being generally spontaneous, (which would indicate strabismus). In the total of the three studies made, there was evidence of the existence or not of this ocular deviation in 256 children, in which 8 of them were found to have a possible deviation of the visual axis (tropia); that is to say, that in 248 cases initially this pathology was not detected, and in 102 cases there was no evidence of registry. *Figure 2* reveals the distribution by age as to the determination of strabismus.

Figure 2. Diagram According to Strabismus



The Hirschberg Test, together with the Cover Test, is one of the best well known tests used in the detection of phorias in the eyes, and could indicate a possible Strabismus. A total of 217 children were tested with the Hirschberg Test, because of the 358 cases there was no evidence of testing on 141; of the cases, which were examined, there was only evidence of one abnormality (*figure 3*). The specific case with abnormality when the test was made, also presented an apparent strabismus according to the health record. In comparison to the other tests studied, no relation could be obtained, as there was no evidence of examination on the patient's medical record, (Cover Test, Visual Acuity with Optotypes or TNO). However, a derivation was noted for follow-up by ophthalmology, but there exists no response or correspondence on the health record that this follow-up had taken place.

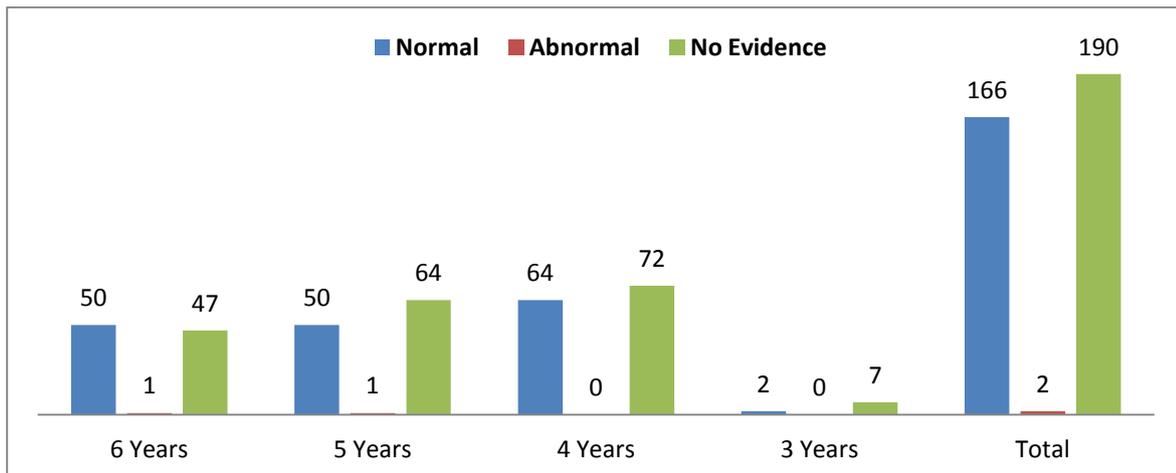
Figure 3. Hirschberg Test



The Cover Test was carried out on a total of 168 children. There was only evidence that two of them presented an anomaly during the test. *Figure 4* represents the result of the test by ages. One of the abnormal cases also presented an apparent Strabismus on examination, declared previously by the parents, in comparison to the other tests studied, a possible anomaly in vision acuity was also detected through measuring with Optotypes, not showing results of the Hirschberg Test and of the TNO

Test. In the said case there was no evidence of deviation for follow-up checking by Ophthalmology, and in the clinical records there appears, according to references declared by the parents, that the child was diagnosed with Hyperopia or farsightedness and Astigmatism, and for this reason uses corrective contact lenses. The second case presented an apparent strabismus on examination and also having given an abnormal result in the TNO Test as well as in the visual acuity with Optotypes, and the Hirschberg Test showing normal. There is no more Ophthalmological information of the patient as it was said before that he was continuing treatment with a private ophthalmologist.

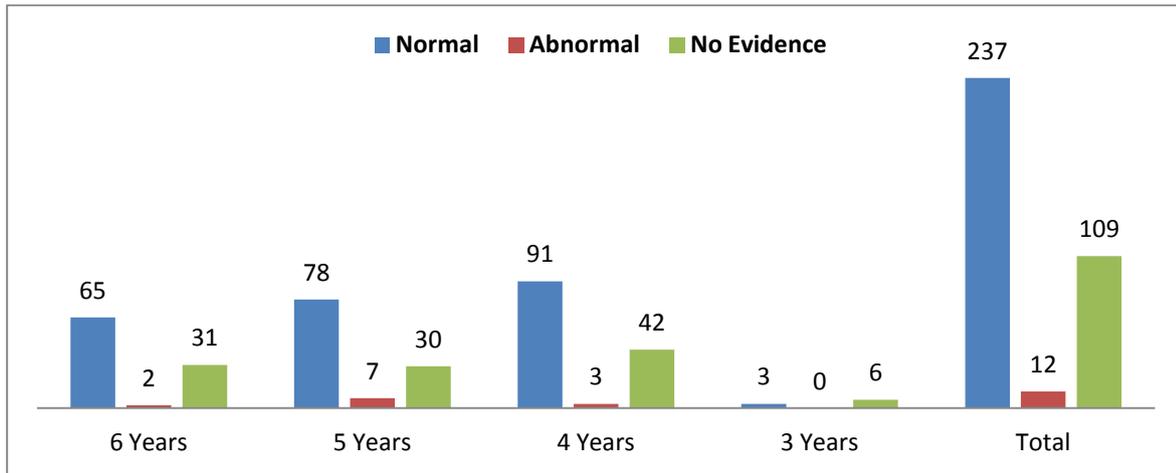
Figure 4. Cover Test



The measurement of visual acuity through Optotypes is a fundamental test to verify if a subject has any complication or problem, which prevents him from seeing correctly by either of his eyes. For this reason this test is indicated as the minimum medical examination among the valuations of the patients. On the other hand, the measuring of visual acuity with Optotypes, although still being the test which allows the detection of more problems of vision, it is also one of the tests which requires maximum collaboration on behalf of the patient, and for this reason very often it is not possible to carry out due to the short ages of the children.

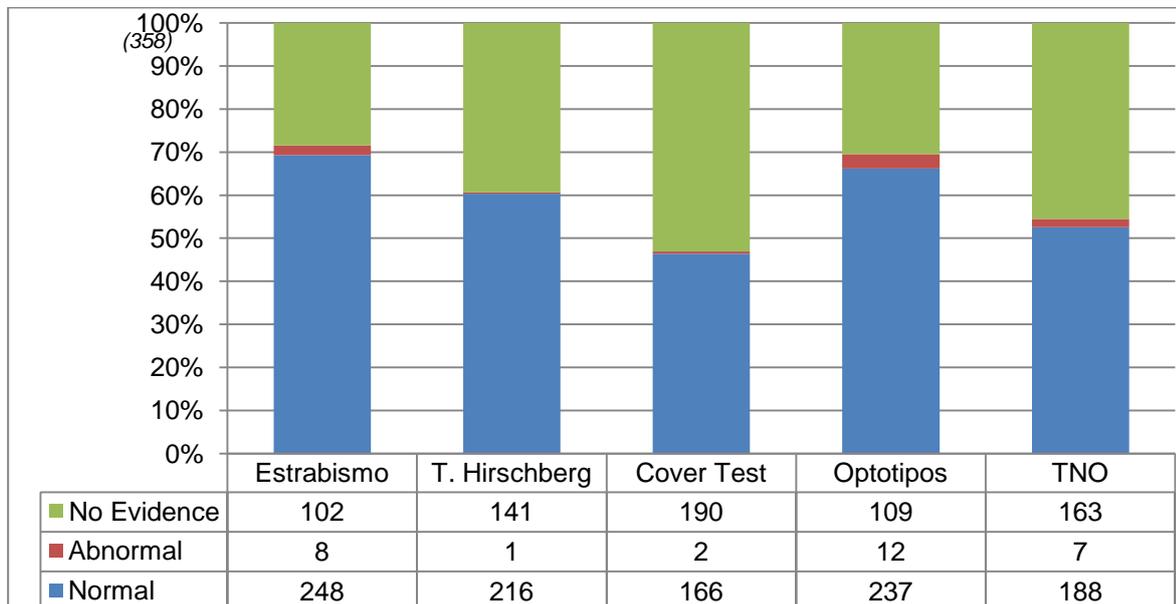
The measurement of visual acuity with Optotypes was effected with 249 children. 12 of them had some complication or anomaly during the test; 9 of them were sent to ophthalmology for their examination, and in the other 3 cases, as they did not show serious complications, they were given a new appointment in a few months time for a new valuation. The *figure 5* shows the valuation for this type of visual test according to age.

Figure 5. Visual Acuity with Optotypes



With regards to the great percentage of the lack of evidence of information and the performance of the tests to study, it was decided to make comparisons of the different degrees of the same, in the different tests as is shown in *figure 6*. In the analysis of the results it can be verified that the measuring of visual acuity with Optotypes is the test, which is mostly used (70%) in spite of being one, which requires maximum collaboration from the patient.

Figure 6. Comparative Percentage of Tests Performed



In comparison with the tests of the analysis, although they do not cover expectations as to the verification of the performances of the same if sufficient cases were analysed so as to detect at least one negative or abnormal case in each one of them, the larger number of abnormal cases is appreciated in the tests of Optotypes (12 cases), Strabismus (8 cases) and TNO (7 cases), detecting only 2 cases in the Cover Test and one case in the Hirschberg Test.

DISCUSSION

In this study the test of visual acuity with Optotypes is the most commonly used. It may be assumed that this occurs in a greater measure because it is the only section/test, in the examination of vision that is noted in medical records as an obligatory test. Also it is believed that, as the same as in other studies,⁷ the lack of equipment in all the consulting rooms has affected the performances and results of the tests. In relation to the other tests studied, the results of the TNO test do not reflect any difficulty in the performing of the test, even being one of the tests in which the collaboration by the patient is necessary in a higher degree.

Emphasize the discoveries in the detection of possible abnormalities, the verification of the measuring of visual acuity with Optotypes. This result may be directly related to the constancy of performance of the test in comparison to the other tests being studied. Also emphasize the low results of the Hirschberg Test and the Cover Test, in spite of these being some of the most popular and recognised tests.

According to the results obtained it can be deduced that the TNO Test is a test equal or more valid in the detection of abnormalities which may be used for the early detection of ambliopia, like the most popular specific tests (Hirschberg Test and Cover Test), for the detection of strabismus and ambliopia.

In this study, it was not possible to verify and compare the frequency of pathological visual alterations according to the result of a complete ophthalmological analysis, as in the medical records of cases derived for their evaluation we did not find information remitted by the ophthalmological service. Consequently there does not exist adequate bilateral communication between Primary Care and their derivations to the ophthalmological consultation. The lack of notification between the different consultations is also the main reason which the nature of visual alterations detected, cannot be correctly specified, as the only conclusive information on this is remitted by the parents during the medical visit. For this reason correspondence between Primary Care and Ophthalmology could not specify an agreement between these services. And so in the same way as in other studies,⁸ a better relation and communication between the services is considered necessary, to favour the accessibility and exchange of information.

One of the problems found in the programs of detection of visual disorders not carried out by ophthalmologists in infancy, is the elevated number of false positives, caused by the lack of collaboration due to the young ages of the patients. This being a percentage near to 75% in some studies.⁹ However, other authors² refer that the degree of relation in Spain among the defects detected in Primary Care and those confirmed by the service of ophthalmology of reference vary between a 93.6% and a 40%.

Even though the TNO test was not performed on around 40% of the participants, there only existed evidence that in the 9% of the total of the cases this occurred because of lack of collaboration in the performing of the test; similar results around 9%, to other studies^{10,11} on the applicability of the stereoscopic vision test.

In other studies¹⁰ on the detection of visual alterations en Primary Care through the stereoscopic vision test, (like the TNO), if those abnormal results reverted to ophthalmology could be contrasted, obtaining a confirmation of a visual alteration in a

73.7% of the cases, which could benefit from early treatment and follow-up. In this study, of the seven cases with abnormal result in the TNO test, it should be noted that one of them until this test was performed all the other initial diagnostic tests were normal; precisely with regard to the anomaly detected in the TNO test and the consequent repetition of the tests, anomalies were found which lead to the reversion to the service of ophthalmology of reference.

Coinciding with other investigations¹⁰ in which the tests of stereoscopic vision, like the TNO test, are applicable as from 3 years in the consulting rooms of Primary Care and in the consulting rooms of paediatric nursing in which an ideal atmosphere is offered for the collaboration by the patient for the performance of these tests. Other authors¹² emphasize that the efficiency of these tests is related to the age, as coming near to the maturity of visual development, the most specific results (in which a higher degree of binocular acuity is necessary, progress considerably.

As in other studies⁹ we coincide in the idea that to introduce a system of confusion of visual alterations managed exclusively by ophthalmologists, would be too costly. In the same way, we consider that the centres of Primary Care, during children medical revisions, are capacitated to manage an important screening in the early detection of visual problems.

CONCLUSIONS

The vision tests used in the consultation room of paediatric nursing and Primary Care constitute a fundamental tool in the early detection of visual abnormalities.

In the Infantile Health Program of the Canary Government, vision acuity by Optotypes is considered to be the fundamental vision test in children's check-ups in Primary Care. For this reason, it represents the test most commonly performed in the 358 cases, which are in accordance with the population in study. The rest of the visual tests, as they are not mentioned with the same importance, have been performed in an unequal manner.

The TNO is a viable test in Centres of Primary Care, applicable from a young age, detecting abnormal cases as from four years of age. This test has proven to be decisive in some of the cases studied.

The tests of the Hirschberg Test and the Cover Test, in spite of being used in more than 45% of the cases, offer a lesser number of abnormal results. On the contrary, the TNO Test shows more efficiency in order of the decision of anomalies in the 35% of the cases studied.

In most of the clinical health records, the direct observation of Strabismus has been referred to, before the visual tests were carried out, showing only a percentage of 3%. Therefore regarding the early detection of the ambliopia, the performing of the visual diagnoses is required.

With the object of assessing the data match between Primary Care and Specialist, it was considered necessary to improve the relationship and communication between the different services, which will favour the accessibility and exchange of information.

REFERENCES

- 1.- García Aguado J. Grupo PrevInfad. Cribado de alteraciones visuales en la infancia. En Recomendaciones PrevInfad/PAPPS [en línea]. Actualizado noviembre de 2013 [fecha de acceso 10 de enero de 2015]. URL disponible en: <http://www.aepap.org/previnfad/Vision.htm>
- 2.- Delgado Domínguez JJ. Grupo PrevInfad/PAPPS. Detección de trastornos visuales (1ª parte). Rev Pediatr Aten Primaria [en línea]. 2008 [fecha de acceso 10 de enero de 2015]. Vol.10 (287-315). URL disponible en: <http://www.pap.es/files/1116-838-pdf/951.pdf>
- 3.- Serrano Camacho JC, Gaviria Bravo ML. Estrabismo y ambliopía, conceptos básicos para el médico de Atención Primaria. Medunab [en línea]. 2011 [fecha de acceso 10 de enero de 2015]. Vol. 14 (2, 108-120). URL disponible en: <http://revistas.unab.edu.co/index.php?journal=medunab&page=article&op=view&path%5B%5D=1561&path%5B%5D=1470>
- 4.- Martín Martín R, Bilbao Sustacha JA, Collado Cucò A. Vision screening in Primary Care: how it is performed?. Rev Pediatr Aten Primaria [en línea]. 2013 [fecha de acceso 30 de enero de 2015]. Vol. 15 (59, 221-227). URL disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1139-76322013000400004&lng=en&nrm=iso&tlng=en
- 5.- Puertas Bordallo D. Oftalmología para pediatras de Atención Primaria. AEPap ed. Curso de Actualización Pediatría [en línea]. 2009 [fecha de acceso 30 de enero de 2015]. Madrid: Exlibris Ediciones. P.167-85. URL disponible en: <https://familiaysalud.es/sites/default/files/oftalmologia.pdf>
- 6.- Van Doorn LA, Evans JW, Edgar DF, Fortuin M. Manufacturer changes lead to clinically important differences between two editions of the TNO stereotest. Ophthalmic and Physiological Optics. [en línea] 2015. [fecha de acceso 20 de febrero de 2015]. Vol. 34(2, 243-249). Doi:10.1111/opo.12101. URL disponible en: <http://openaccess.city.ac.uk/4867/1/OPO%20proof%2016-12-13%20version%20van%20Doorn%20et%20al.pdf>
- 7.- Martín Martín R, Bilbao Sustacha JA, Collado Cucò A. Vision screening in Primary Care: how it is performed?. Rev Pediatr Aten Primaria. [en línea] 2013 [fecha de acceso 3 de marzo de 2015]. Vol.15 (59, 221-227).URL disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1139-76322013000400004&lng=en&nrm=iso&tlng=en
- 8.- Verrone PJ, Simi MR. Prevalencia de agudeza visual baja y trastornos oftalmológicos en niños de seis años de la ciudad de Santa Fe. Arch Argent Pediatr. [en línea] 2008 [fecha de acceso 3 de marzo de 2015]. Vol. 106 (4, 328-333). URL disponible en: <http://www2.sap.org.ar/docs/publicaciones/archivosarg/2008/v106n4a08.pdf>
- 9.- Abreu Reyes JA, Iceta González I, Quintana Herrera C. Estudio de las anomalías oculares en la población infantil de la Comarca de Acentejo (Isla de Tenerife). Arch Soc Canar Oftal. [en línea] 2004 [fecha de acceso 3 de marzo de 2015]. Vol. 15 (17-20). URL disponible en: <http://www.oftalmo.com/sco/revista-15/15sco04.htm>
- 10.- Barriuso Lapresa LM. Función visual (niños de 9 meses a 3 años). Rev Pediatr Aten Primaria. [en línea] 2007 [fecha de acceso 3 de marzo de 2015]; Vol. 9. Suplemento 2; P.121-128. URL disponible en: <http://pap.es/files/1116-673-pdf/702.pdf>
- 11.- Salazar Cuba V, Romanelli Zuazo A. Detección de ambliopía en niños de 3 a 6 años en el "Hospital del Niño Dr.Ovidio Aliaga Uría". Rev Soc Bol Ped. [en línea]

2006 [fecha de acceso 3 de marzo de 2015]. Vol. 45 (3, 148-152). URL disponible en: <http://www.scielo.org.bo/pdf/rbp/v45n3/v45n3a02.pdf>

12.- Arias Díaz A, Bernal Reyes N, Pérez Martinto PC. Medición de agudeza visual estereoscópica en una población infantil sana. Rev. Mex. Oftalmol. [en línea] 2013. [fecha de acceso 30 de enero de 2015]. Vol. 87 (4, 215-219). URL disponible en: http://apps.elsevier.es/watermark/ctl_servlet? f=10&pidet_articulo=90268741&pidet_usuario=0&pcontactid=&pidet_revista=321&ty=64&accion=L&origen=zonadelectura&web=www.elsevier.es&lan=es&fichero=321v87n04a90268741pdf001.pdf

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