Original article

Medical and surgical treatment of primary divergent strabismus

H. Noguera a,b,c,∗, J.C. Castiella Acha a, M. Anguiano Jimenez a,b

a Instituto Oftalmológico Castiella, IOC, Bilbao, Vizcaya, Spain
b Servicio de Oftalmología, Hospital Galdacano-Usánsolo, Galdacano, Vizcaya, Spain
c Centro Oftalmológico Integral COI-Berri, Bilbao, Vizcaya, Spain

ARTICLE INFO

Article history:
Received 1 August 2013
Accepted 8 March 2014
Available online 13 November 2014

Keywords:
Divergent strabismus
Long term evaluation
Stereopsis
Treatment

ABSTRACT

Purpose: To evaluate the long-term effectiveness of different therapies applied in the past 30 years, both medical and surgical, and results, with the ultimate aim of determining which are the most appropriate criteria to indicate when and how to perform medical and surgical treatment in these patients.

Method: A retrospective randomized study was conducted on 198 patients with primary divergent strabismus first seen in our clinic (IOC) in the last 36 years (1976–2012), with a mean follow-up of 8.38 years. Demographic and clinical characteristics, as well as the various treatments performed, and motor and sensory outcome were collected. They were finally divided into 3 groups of 70, 71 and 56 patients, respectively, according to their first visit, in order to compare the therapies applied.

Results: Half (50%) of our patients debuted before 2 years of age (PSO = 24 months), and 26.3% had optimal binocular vision at the beginning of the study. Medical treatment was used as exclusive therapy in 29.3% of cases (occlusion therapy, applying negative lenses, botulinum toxin), and 70.7% required surgery (61.2% by double retro-insertion of lateral rectus, and 38.8% monolateral retro-resection). There was a recurrence in 26.7% of patients, and 40 re-interventions were performed (70% due to recurrence of divergent strabismus, 12.5% due to surgical over-correction, and 17.5% for other reasons). In the end, 61.1% of patients had perfect binocular vision (TNO = 60°), and the proportion was higher in patients who showed proper control of their strabismus at the beginning (p = 0.003). However, no differences were found in the other variables studied. When the patients were divided into 3 groups (which are demographically comparable), an increased number of patients in Group 3 were found to be treated using negative lenses and botulinum toxin (p < 0.001 and p = 0.003). This group was found to have had a higher proportion of bilateral surgery (p = 0.032), seeking greater immediate postoperative over-correction, thus reducing the number of re-interventions from 40.5 to 19%, although it did not reach statistical significance (p = 0.093). It was also found that there was a significantly increased number of injections of botulinum toxin in the middle rectum.


E-mail address: helennoguera@hotmail.com (H. Noguera).

2173-5794/$ – see front matter © 2013 Sociedad Española de Oftalmología. Published by Elsevier España, S.L.U. All rights reserved.
Tratamiento médico y quirúrgico del estrabismo divergente primario

RESUMEN

Propósito: Evaluar a largo plazo la efectividad de las distintas terapias aplicadas en los últimos 30 años a estos pacientes, tanto médicas como quirúrgicas, y los resultados obtenidos, con el fin último de determinar qué criterios son los más adecuados a la hora de indicar y realizar tratamiento médico y quirúrgico sobre estos pacientes.

Método: Se ha realizado un estudio retrospectivo aleatorizado de 198 pacientes con estrabismo divergente primario vistos por primera vez en nuestra consulta (IOC) en los últimos 36 años (1976-2012), con un seguimiento medio de 8,38 años. Se han recogido sus características demográficas y clínicas, así como los diversos tratamientos realizados y su resultado motor y sensorial. Por último, se han dividido en 3 grupos de 70, 71 y 56 pacientes respectivamente según la fecha en la que realizaron la primera consulta, para poder comparar las distintas terapias aplicadas.

Resultados: En el 50% de nuestros pacientes empezó antes de los 2 años de edad (P50 = 24 meses). El 26,3% presentó una visión binocular óptima al inicio de la exploración. El tratamiento médico funcionó como medida exclusiva en el 29,3% de los casos (oclusiones horarias, aplicación de lentes negativas, toxina botulínica), y un 70,7% precisaron cirugía (61,2% mediante doble retroinserción de rectos laterales y 38,8% de retrorresecciones monolaterales). El 26,7% de los pacientes experimentaron recidivas, con 40 reintervenciones (70% por recidiva del estrabismo divergente, 12,5% por hiperorrección quirúrgica excesiva y el 17,5% por otras causas). Al final del seguimiento, el 61,1% de los pacientes presentaban una visión binocular perfecta (TN0=60°), cuya proporción fue mayor en pacientes en ortotropía espontánea antes de disociarlas (p = 0,003), pero sin diferencias en otras variables estudiadas. Al estudiar a los pacientes divididos en 3 grupos, que son demográficamente comparables entre sí, se ha visto mayor utilización de toxina y lentes negativas en el grupo 3 (p < 0,001 y p = 0,003). Se ha intervenido a los pacientes más frecuentemente con cirugía bilateral en el tercer grupo (p = 0,032), buscando una mayor hiperorrección en el postoperatorio inmediato, logrando así disminuir el número de reintervenciones del 40,5 al 19, aunque no pudo demostrarse su significación estadística (p = 0,093). También aumentó significativamente el número de inyecciones de toxina botulínica en el recto medio como tratamiento de la hiperorrección posquirúrgica excesiva (p = 0,028). No hemos encontrado diferencias en la visión binocular final entre los 3 grupos (p = 0,703).

Conclusiones: En casos de dominancia ocular clara debemos aplicar oclusión horaria 2 veces al día sobre el ojo dominado para fomentar el control del estrabismo divergente y así obtener un mejor resultado desde el punto de vista sensorial. Procuraremos esperar a los 4 años para intervenir quirúrgicamente, salvo en los casos en los que detectemos un empeoramiento significativo del componente sensorial o motor. A la hora de operar, y siempre que las características del paciente lo permitan, intentaremos realizar cirugía bilateral sobre ambos rectos laterales, buscando una ligera hiperorrección posquirúrgica en el postoperatorio inmediato, ya que en estos pacientes hemos disminuido el número total de
reintervenciones. A la hora de actuar sobre un recto medio, conviene recordar que la elasticidad del mismo parece ser el factor clave para el resultado posquirúrgico, aunque por el momento no nos sea posible medirlo de forma fiel. La aplicación de toxina botulínica sobre rectos medios poco elásticos en caso de excesiva corrección posquirúrgica nos ha permitido disminuir el número de reintervenciones.

© 2013 Sociedad Española de Oftalmología. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

**Introduction**

Divergent strabismus or exotropia is an alteration of the oculomotor balance characterized by an outward deviation of ocular axes which prevents convergence on the target of vision. Accordingly, the visual axes would virtually cross behind the patient head.

The incidence of divergent strabismus is of approximately 25–30% of all strabismus patients even though this percentage varies in different series. Its prevalence is greater in Asian individuals as compared to Caucasians or Africans. Typically, intermittent divergent strabismus is considered to have a good prognosis as it rarely exhibits amblyopia and produces only slight sensory alterations, enabling good results after surgery. However, the authors consider that the facts are different. Even though it is true that amblyopia is infrequent, considering the high proportion of intermittent strabismus there is only slight sensory abnormality between these patients. The cases which exhibit sensory changes could be due to late diagnostic, delayed treatment and late and possibly inadequate application thereof.

At present, the most adequate diagnostic, classification, etiology, medical or surgical treatment, timely application thereof as well as clinical tests to establish surgery for a patient remain controversial. For this reason, this study has been developed to assess the demographic and clinical characteristics of primary divergent strabismus amongst our population by means of a randomized study of 198 patients seen and followed up in our practice in the past 36 years (1976–2012). This long-term study aims at assessing the effectiveness and results obtained with various medical and surgical therapies applied to these patients in the course of said period.

**Materials and methods**

A randomized retrospective study of 198 patients with primary divergent strabismus seeing for the first time in the authors’ practice (IOC) in the path 36 years, between 1976 and 2012. The demographic as well as clinical characteristics of the patients were recorded together with the different treatments applied. Subsequently, the patients were divided into 3 groups of 70, 71 and 56 patients respectively according to the date of the first visit. Group 1 comprises patients seen in the practice prior to 1990 (n1 = 70), group 2 is made up of patients seen between 1990 and 2000 (n2 = 71) while the third group comprises patients who visited the practice for the first time from 2000 onwards (n3 = 56).

All patients were explored under identical conditions and by the same health professionals. In addition, all were explored by 2 expert strabologists in each practice (Drs. J.C.C.A. and M.A.J.). Refractions were always carried out by means of retinoscopy by an optician and an expert ophthalmologist. The classification was that proposed by Burian, which considers any strabismus that at some point of the examination exhibits 0° deviation as intermittent, while those which are never seen at said position are classified as constant. Patients who refer intermittent debut of their divergent strabismus but who make a delayed visit to the practice as constant divergent strabismus have been considered as apparently constant divergent strabismus. Even though some patients improved spontaneously with time, the majority of them worsen as this is considered to be a progressive condition. It has been considered that at debut these patients were intermittent divergent strabismus and that their clinical and sensory characteristics are comparable. Even though the study has included patients associating vertical deviation such as IV cranial pair palsy associated to divergent deviation, patients with dissociated horizontal deviation (DHD) have been excluded.

Surgical procedures were always carried out by the same team in the same center (C.V.B.) and the surgeon in charge of executing them was the same in all cases (Dr. J.C.C.A.). The only applicable differences in this study are those related to the various therapeutic options and new techniques which appeared in recent years, such as the pre-and post-surgery use of botulinum toxin.

The action guidelines have been maintained constant. As a general rule, at present ocular dominance is studied in patients with divergent strabismus. In dominant eye cases, we apply 3-h occlusions twice a day on the dominant eye as anti-suppressant treatment seeking binocular cooperation when the dominant eye is not covered, with the ultimate goal of improving motor control of the patient's exotropia. If amblyopia is identified, treatment with occlusions would be a priority over motor control, which means that occlusion treatment is focused on obtaining visual acuity improvement, with motor control occupying second place. If clear eye dominance is not identified or if the patient exhibits ocular alternation, occlusion is not indicated as it does not allow raising of the suppression scotoma during binocularity periods. For this reason, we favor treating by means of correction with negative lenses if allowed by refraction, or by the application of botulinum toxin in the lateral rectus. With these measures, the aim is to improve motor control of divergent strabismus up to age 4, after which the surgical approach is considered.

The decision to apply surgery is based on worsening of motor control or the sensory component of strabismus. The surgical dose would be always applied on the maximum deviation identified in the practice and over the most deviated eye under general anesthesia. According to the characteristics and
control of the exotropia, we would decide to operate by means of retroversio of both lateral recti following the rule: maximum deviation angle in degrees divided by 2 plus 1 mm. (12° maximum deviation: 12/2 + 1 = 7 mm retroversio in both lateral recti); or by means of the same amount of retro-resection in both muscles according to the nomogram: 10° maximum deviation, 5 mm retro-resection, for 15° we do 7 mm, and for 20° we apply 8 mm. These measures have not been modified in the past years.

The statistical analysis was carried out with the SPSS 12.0 statistical analysis application (SPSS Inc., Chicago, USA) by the same expert in statistics (M.G.V.). In all cases, the same statistical power was applied ($P < 0.05$) and the most adequate method was applied for each variable according to generally accepted statistical criteria.

It is important to emphasize that when studying binocular vision, only patients who obtained a value of 60° in the TNO Stereo Test (Lámeris Ootech Bv, Nieuwegein, Holland) were considered to have binocular vision. The rest of values were considered negative in this test. The patients who did not cooperate enough to allow the study of their binocular vision were also taken as negative.

### Results

#### Demographic analysis of the entire group

The mean follow-up time was of 100.66 ± 83.28 months, with a minimum of 4 and a maximum of 420 months (Fig. 1).

Of all patients, 60.6% exhibited ophthalmological familial antecedents: 15.2% had first-degree relatives with divergent strabismus, 16.7% with amblyopia and 27.8% some first-degree relative who was myopic. As regards personal history, 63.6% of cases were negative to anamnesis. Among those exhibiting relevant personal history, 16.7% were born through instrumental or C-section labor, whereas 9% exhibited psychomotor retard or cranial-encephalatic traumatism.

Previously executed nonsurgical treatments were analyzed: 29.3% of our patients (58 cases) had undergone occlusions with various treatments. Half of these had been prescribed inadequate occlusion patterns according to our criterion.

#### Clinical analysis of the entire group

The first noteworthy point is the age of debut of strabismus which in our patients was of 41.74 ± 82.18 months. It is important to point out that the debut occurred before the age of 2 years in 50% of patients, and before 3 years of age in 75% of patients ($P50 = 24$ months and $P75 = 36$ months).

Of all patients, 30.41% had myopic grading, with a mean of $–2.88 ± 2.47$ D in the right eye (RE) and $–2.8 ± 2.64$ D in the left eye (LE), whereas emmetrope or hyper-metrope patients (69.59%) exhibited a mean grading of $1.21 ± 2.64$ for RE and $0.83 ± 4.43$ D for LE. At the end of the follow-up, refraction did not exhibit significant variations, with 39.9% of myopic eyes exhibiting a mean final myopia of $–2.93 ± 2.85$ and $–3.16 ± 2.66$ D respectively. This represents an increase of 9% of new myopics in contrast with reports by other authors.6

The type of debut identified in the practice was intermittent in 85.6% of cases, with the remainder being referred by the patient or relatives as intermittent which, with time, experienced motor control deterioration to the point of exhibiting constant deviation (apparent constant divergent strabismus). The mean visual acuity was of 0.697 ± 0.28 for the RE and 0.67 ± 0.28 for the LE. The mean near deviation angle had an average of $–11.80 ± 7.79°$ (maximum) and $–3.40 ± 6.99°$ (minimum), with 64.65% of patients in orthotropy prior to dissociation. The far deviation angle was similar, with a maximum mean of $–12.75 ± 7.015°$ and a minimum mean of $–4.60 ± 7.77°$, with 60.1% of patients in spontaneous orthotropy.

In what concerns binocular vision (BV), it is important to point out that only 26.2% of patients exhibited correct stereoscopic vision (TNO = 60°). At the end of the follow-up, 61.1% of patients achieved said value.

In addition, 21.7% of patients exhibited alternating dominance at debut while 55.6% suppressed either eye at diagnostic time.

Retinal correspondence was normal in 93.4% of patients, with 93.9% of eyes exhibiting normal fixation. In addition, 30.3% of patients associated vertical deviation ($n = 60$), of which 61.67% (37 cases) corrected their strabismus and 30% (18 patients) achieved perfect binocular vision. Also, 5.1% of our patients associated various types of nystagmus, of which 6 corrected their motor component (60%) though only one achieved adequate stereoscopic vision (1 patient).

Medical treatment was applied in 77.78% of patients, with 29.3% receiving exclusively medical treatment. Occlusions were utilized in 2 differentiated prescriptions: for treating divergent strabismus, 3 h twice a day over the dominant eye in 47.5% of cases, and as treatment for amblyopia in 8.6% of patients. Hypermetropization was applied with placement of negative lenses on the refraction under cyclopegia in 12.1% of patients, application of prisms in 2% and fusion amplitude exercises for 3%. Only 4% of patients were administered botulinum toxin as presurgery treatment.

---

**Fig. 1 – Total time monitoring of 198 patients.**
Overall, 140 patients (70.7%) required surgery after a mean follow-up time of 16.48 ± 18.82 months. Also, 75% of patients were intervened before 2 years of follow-up (P50 = 7 months, P75 = 24 months). In 61.2% of patients the surgical technique was monolateral (reinsertion of lateral rectus with resection of the middle rectus of the same eye) while in the rest of cases (38.8%) double reinsertion of lateral recti was performed (bilateral surgery).

Of the 124 cases that remains with immediate post-surgery convergence ≥0, the mean hypercorrection was of 4.79 ± 3.74° with a mean duration of 10.28 ± 22.8 months (P50 = 2 months, P75 = 9 months), with the frequency distribution detailed in Table 1. Also, 26.7% of patients exhibited relapse, 50% before 18 months after the first intervention (P50 = 18 months, P75 = 36 months).

In all patients who underwent surgery (140 cases), botulinum toxin was applied due to surgical hypercorrection in 8.5% of cases, while 43 patients had to undergo additional surgery (30.7%) within a mean period of 27.52 ± 32.17 months. Of these patients, 50% underwent surgery before 18 months after the first surgery (P50 = 18 months). Of the second surgeries (40 cases), 70% were due to relapse of divergent strabismus (30% by means of middle rectus resection, 22.5% by means of lateral rectus retro-insertion and 17.5% by means of muscular retro-resection). Of all the second surgeries, 12.5% were performed due to excess of post-surgery convergence which did not correct by other means, with middle rectus retro-insertion, while the remaining 17.5% underwent a second surgery for other reasons such as the correction of residual vertical strabismus. Of all patients who underwent a second surgery, 30% (12 cases) had to undergo surgery more than once.

At the end of the follow-up, 61.1% of patients exhibited a TNO = 60" (normal BV), 50% of patients achieved it 24 months from the beginning of the surgical or medical treatments (P50 = 24 months, P75 = 42 months). The range was of 0-132 months. Accordingly, these patients could take up to 11 years to develop optimum stereoscopic vision (Fig. 2). In none of the cases the patients lost BV after the treatment. Comparing final BV with other variables, a range of interesting data were found:

- Patients who alternated ocular dominance at the baseline exploration exhibited a higher proportion of satisfactory final stereoscopic vision than those with fixed dominance, although the difference is not statistically significant (p = 0.127). Of the patients with clear dominance of one eye, 58.7% exhibited TNO = 60", and among those who alternated at the beginning of the follow-up, 69.8% (Table 2).
- Patients with different surgical hyper-corrections did not exhibit differences in final BV. For this purpose, patients were divided into 3 groups according to surgical hyper-correction: 0, 1-5 and >5°, without finding significant differences between them (p = 0.811). Said differences in hypo-correction were not significant either in the number of additional surgeries (p = 0.759).
- Reoperated patients did not exhibit worse final BV than those who only required one surgery (p = 0.659). In addition, the type of second surgery did not statistically affect this variable (p = 0.572).
- The type of surgery (monolateral vs bilateral) did not provide statistically significant differences in what concerns final BV, with p = 0.869. This variable did not affect either the number of reoperations, which were similar in both groups (p = 0.721).

### Demographic and clinical analysis of the 3 groups

The patients were divided into 3 groups based on the date of their first visit to the practice. Group 1 includes patients whose first visit was before 1990 (n1 = 70), group 2 by patients whose first visit was between 1990 and 2000 (n2 = 72) and group 3 by patients examined for the first time as from 2000 (n3 = 56). The 3 groups are demographically comparable, with no significant differences in terms of age or type of debut (p = 0.380 and p = 0.172), ocular suppression (p = 0.253), antecedents, etc.
Table 2 – Relationship between ocular dominance and final binocular vision ($p = 0.127$).

<table>
<thead>
<tr>
<th>Dominance eye</th>
<th>Final VB</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>RE/LE</td>
<td>64</td>
<td>91</td>
</tr>
<tr>
<td>% within dominant eye</td>
<td>41.3</td>
<td>58.7</td>
</tr>
<tr>
<td>Alternate</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>% within dominant eye</td>
<td>30.2</td>
<td>69.8</td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>121</td>
</tr>
<tr>
<td>% within dominant eye</td>
<td>38.9</td>
<td>61.1</td>
</tr>
</tbody>
</table>

In what concerns medical treatment, correction with negative lenses was applied in the majority of cases, and botulinum toxin started to be applied in 2000 (group 3) in a statistically significant manner ($p < 0.0001$ and $p = 0.003$, respectively). No statistically significant differences were found between the 3 groups concerning the application of prisms and occlusions ($p = 0.153$ and $p = 0.173$, respectively).

The proportion of patients which required surgery was very similar between the 3 groups, without statistically significant differences ($p = 0.115$). However, follow-up time up to surgery was lower in group 3. Even though the difference was not statistically significant ($p = 0.087$), a clear reduction was observed in the time elapsed up to surgery (Table 3). As regards the type of surgery, patients of groups 1 and 2 underwent monocular surgery (retro-resection) with more frequency than in group 3, where the most frequent surgery was bilateral, with statistically significant differences ($p = 0.032$).

Due to said differences, it was observed that the number of reoperations has diminished with time. Even though this is not a statistically significant parameter ($p = 0.093$), its clinical relevance is significant as the percentage of reoperations has diminished from 40.5% in group 1 to 19% in group 3. An additional data of clinical relevance is that the time for reoperations has also diminished although without statistical significance ($p = 0.255$). In fact, 36.8% of patients were reoperated before 18 months after the first surgery in group 1, whereas in group 3 this percentage increased to 61.5%. However, no differences were found in post-surgery convergence in each group or the type of reoperations carried out in these patients ($p = 0.403$ and $p = 0.493$, respectively).

In what concerns post-surgery treatments, no differences were found between groups except in the use of toxin as post-surgery treatment for the highest hyper-corrections. In these patients, the most frequent botulinum toxin injection location was the middle rectus, with statistically significant difference ($p = 0.028$).

Finally, statistically significant differences were not found in the final BV achieved by each group ($p = 0.703$). However, the difference in the proportion of patients with satisfactory final BV in group 3 could be clinically relevant (Table 4).

**Discussion**

Some authors prefer early surgery (under the age of 4) for divergent strabismus because they believe that the results could be better. In contrast, others do not find differences and some found a higher rate of reoperations and functional impairments in patients intervened before said age. In our case, we believe that age is not the crucial factor to decide surgery and that the best time for surgery is given by the sensory performance of the patient. However, whenever possible we prefer to wait until they reach at least 4 years because this allows us to consolidate the sensory aspects, diminish the possibility of amblyopia and avoid the transformation of hyper-corrections in authentic convergence strabismus with its characteristic sensory alterations.

When we diagnose divergent strabismus, we are aware that the probability of having to operate the patients is high (70% in our series). The key is in the factors that will be taken into account to determine the time of surgery. Generally these patients exhibit acceptable sensory conditions and therefore the aim is to resolve the condition. In this situation it is logical to think that any impairment in previous conditions which go against said aim will become sufficient reason for surgery. Accordingly, we indicate surgery when there is poor deviation control or the ability to recover said deviation is significantly diminished, as well as when sensory function deteriorates. If the child is under 4 years of age we try to improve the clinical condition with medical treatment in order to defer surgery even though age is not an absolute contraindication for surgery. In general, it can be said that the purpose of surgery in case of intermittent divergent strabismus and divergence secondary to IV cranial pair palsy is to achieve or maintain BV, whereas in the rest of divergent strabismus cases our final objective is purely esthetic.

If we study the type of surgery to be carried out, the key for success is in the amount of resection to be made over the middle rectus of the most divergent eye under general anesthesia or deep narcosis. Said resection must be related to the elasticity of the middle rectus. However, despite attempts by

**Table 3 – Time elapsed from beginning of follow-up until surgery, separated by groups based on date of the first visit ($p = 0.087$).**

<table>
<thead>
<tr>
<th></th>
<th>No.</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>95% mean confidence interval</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Minimum limit</td>
<td>Maximum limit</td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>42</td>
<td>21.60</td>
<td>21.692</td>
<td>3.347</td>
<td>13.84</td>
<td>28.35</td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td>54</td>
<td>15.37</td>
<td>19.063</td>
<td>2.594</td>
<td>10.17</td>
<td>20.57</td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td>43</td>
<td>12.88</td>
<td>14.336</td>
<td>2.186</td>
<td>8.47</td>
<td>17.30</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>139</td>
<td>16.48</td>
<td>18.825</td>
<td>1.597</td>
<td>13.32</td>
<td>19.64</td>
<td></td>
</tr>
</tbody>
</table>
several working groups to obtain this information, at present it is impossible to have a reliable measure for said elasticity. The consequence of this lack of precision is the increasingly frequent post-surgery use of botulinum toxin injections in slightly non-elastic muscles the resection of which could have been excessive, leaving an exaggerated and resistant hyper-correction during the immediate post-surgery period. In addition, this measure might not be efficient, making it necessary in some cases to reoperate for retro-insertion of the middle rectus. On the other hand, the number of reoperations due to divergent strabismus relapses was lower in the most recent groups due to the tendency in recent years to leave patients slightly hyper-corrected. Accordingly, we consider that our objective for the immediate post-surgery period should be to leave a slight endotropia (approximately 1°–5°).

Occlusion with patches utilized in our patients followed two different guidelines: one as treatment for divergent strabismus and the other as treatment for amblyopia. The former consisted in covering the dominant eye during 3h twice a day. This anti-suppressant treatment aims on the one hand at improving patient control over the deviation, remaining longer in orthotropia and thus making it more difficult to dissociate, and on the other to facilitate cooperation between both eyes during the uncovered periods. We consider it does not make sense to implement this treatment in ocular dominance alternation cases and that it should not be applied alternately because it will not overcome suppression under binocular conditions. When the patient has both eyes uncovered, one eye will continue to be suppressed and therefore occlusion will not contribute to improve motor control. The second guideline for occlusions aims at acting on amblyopia and is much more intense and has priority over the first guideline because the main objective is visual acuity above motor control. The mean baseline visual acuity of our group was very similar in both eyes (0.697 ± 0.28 for RE and 0.67 ± 0.28 for LE), which reaffirms the idea that the incidence of amblyopia in these patients is low.

One of the limitations of our study in what concerns significant conclusions could have been the self-imposed requirement of assessing the presence or absence of BV because the only valid data were those obtained with the 60° TNO Stereo Test, while other authors have used near stereopsis or other parameters. In this regard, we have obtained a surprising result because when comparing the final BV of patients with clear dominance of one eye with those who from debut exhibited alternating dominance, we have obtained a result which is not statistically significant although it revealed a higher percentage of final BV in patients who at debut exhibited alternating dominance (69.8% against 58.7% in patients with ocular dominance). These data must be verified in future studies as patients with alternating dominance exhibit much deeper suppression scotomae which are more difficult to recover and, according to current physiopathological knowledge, it is not foreseeable that these patients will achieve a better final BV. Like us, other authors have defended that the number of cases considered as successful diminishes when including the sensory study in the definition.

In summary, we consider that in clear ocular dominance cases hourly occlusion can be applied twice a day over the dominating eye in order to enhance the control of divergent strabismus. It is advisable to wait for the patient to reach 4 years of age before surgical intervention, except when a significant deterioration of the sensory or motor component is identified producing lower capacity to control strabismus, in which case botulinum toxin may be applied. As regards surgery, and provided that the patient characteristics are adequate, we shall endeavor to carry out bilateral surgery on both lateral recti, seeking slight post-surgery hyper-correction in the immediate post-surgery period as, in our experience, this diminishes the number of reoperations. When acting over a middle rectus it must be taken into account that its elasticity is key for the post-surgery result and that when excessive post-surgery correction is identified botulinum toxin can be applied at an early stage in an attempt to overcome the resistance of middle recti with little elasticity in order to diminish the number of reoperations.

**Conflict of interest**

No conflict of interest has been declared by the authors.

**REFERENCES**


