Conservative management of intermittent exotropia to defer or avoid surgery

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BACKGROUND Surgery for intermittent exotropia performed at a very young age has poorer sensory outcomes than surgery performed later; moreover, postoperative recurrence is common, regardless of age. Alternate occlusion decreases the size of the exotropia and improves control. The purpose of this study was to report the long-term effects of part-time alternate occlusion and overminus spectacles combined with prism on delaying or avoiding surgery in intermittent exotropia.

METHODS The study included consecutive patients from 1979 to 2010 who had poorly controlled intermittent exotropia and were treated with alternate occlusion, followed in some cases by overminus spectacles with base-in prism. Outcome measures were initial improvement and subsequent time to surgery, if required.

RESULTS A total of 279 patients had initial control poor enough to otherwise be considered candidates for surgery. After occlusion therapy, 219 (78%) improved their angle and control, and 62 (22%) converted to an exophoria. After 1 year, 9 cases deteriorated, and surgery was recommended. In 207 (74%), conservative treatment delayed surgery for at least 1 year. At 20 years, 42 of 279 patients were still being followed. Of these, 22 of 219 (7%) were known to have not undergone surgery, and 127 (45%) had undergone surgery; 130 (47%) were lost to follow-up.

CONCLUSIONS Part-time alternate occlusion and overminus spectacles with prism can defer the need for surgery in a large percentage of patients with intermittent exotropia; for a small number it may be curative. (J AAPOS 2019;23:256.e1-6)

In 1958 Knapp reported that the magnitude of the deviation often decreased in patients with intermittent exotropia while they were undergoing patching for antisuppression.[1] That observation, combined with the prevailing practice at the time of treating intermittent exotropia preoperatively with antisuppression orthoptics, led to a number of studies on the role of patching in intermittent exotropia.[2-10] Many investigators merely mentioned that patching was part of their routine for antisuppression therapy, without specifically reporting on or investigating the effect of patching[2,4,5]; others specifically investigated the effect of occlusion on the magnitude of the deviation and the depth of suppression, with the dosage for occlusion therapy varying from several hours to 24 hours a day.[3,6-10] These latter studies found that occlusion therapy can decrease the size of the deviation, improve control, convert a constant exotropia to an intermittent exotropia, and decrease the size of the suppression scotoma in some patients with exotropia or intermittent exotropia. These changes could be associated with a better surgical success rate.[11] Most of the studies are at least 40 years old with relatively short follow-up; none investigated the long-term effect of occlusion therapy on delaying or avoiding surgery, which could be useful, because intermittent exotropia often recurs postoperatively.[12,13] Furthermore, surgery at an early age for intermittent exotropia (under 3-4 years of age) has a higher overcorrection rate and poorer sensory outcomes than surgery at an older age.[14-16] The purpose of this study is to report both the short- and long-term results of conservative management of intermittent exotropia.

Subjects and Methods

This study was approved by the Institutional Review Board of the University of Wisconsin, Madison, and complied with the US Health Insurance Portability and Accountability Act of 1996. Study data was collected prospectively from 1979 to 2010 and includes all consecutive patients with intermittent exotropia treated by the author at the University of Wisconsin using a conservative management approach. It includes new patients who had poor

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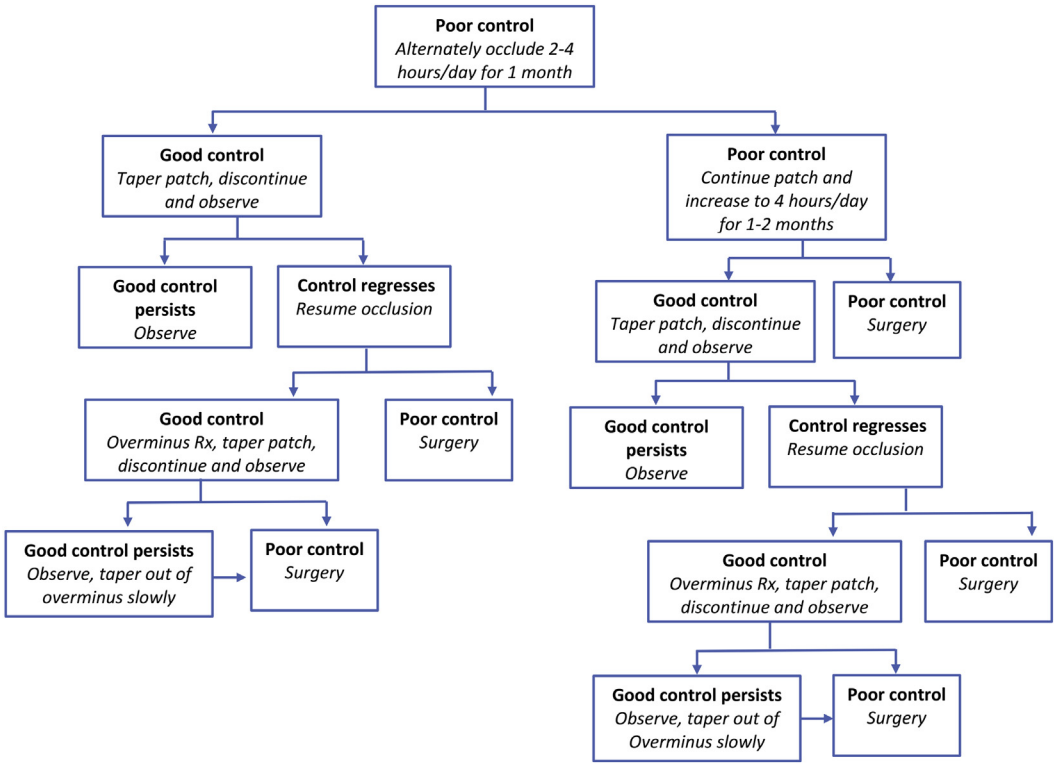

FIG 1. Graphic depiction of algorithm used in this study. Clinical findings are in bold; treatment recommendations, in italics.

control of their intermittent exotropia on presentation as well as patients who were being followed with observation only and who initially manifested good control that subsequently deteriorated.

Patients were excluded if they could not cooperate with prism and alternate cover testing at distance and near. This effectively set the lower limit for inclusion: patients <2 years of age were not included. There was no firm upper limit for inclusion; in general, though, this treatment approach was limited to children <10 years of age. The author's impression was that the treatment's effectiveness paralleled the ages for which patching is effective for amblyopia, that is, quite well at ages 2-5 and gradually decreasing in effectiveness and increasing in the time to improvement up to 9-10 years of age. Patients with major ocular disease in addition to intermittent exotropia, including severe myopia (>−6.00 D), severe hyperopia (>+5.00 D), any neurologic disease, developmental delay, or craniofacial syndrome were excluded, as were those who were seen in consultation only and for whom it was known that follow-up examinations would be performed by the referring ophthalmologist. Patients lost to follow-up during the first year after patching were considered treatment failures in the data analysis.

Treatment Approach

The algorithm used in this study is shown graphically in Figure 1. This approach was instituted in all new patients with intermittent exotropia seen by the author if their control was sufficiently poor to warrant surgical intervention. It was also started in patients who were previously being following with observation only, because they had good control but subsequently showed deterioration. A 4-point scale (poor, fair, good, excellent) was used to assess control (see Table 1). Intervention was considered necessary if control was either poor or fair but deteriorating at either distance or near fixation, whichever was worse. Finally, if there was convincing parental observation of a manifest deviation for at least 50% of the child's waking hours, surgery was deemed to be indicated. Significant anisometropia and/or astigmatism was corrected regardless of the patient's control. For myopic patients, the full cycloplegic refractive correction was prescribed. For hyperopic patients, the plus sphere was not prescribed if it was <2 D unless needed to correct anisometropia. If the hyperopia was >2 D, the plus was cut by 2 D symmetrically. All patients who were prescribed spectacles wore them for a minimum of 1 month before they were reexaminded and a decision was made about further intervention. If intervention was considered, occlusion therapy of 2-4 hours daily commenced, with the lower dose for younger patients.

A patient who freely alternated fixation, a finding that was quite uncommon, was instructed to alternate eyes on alternate days. If there was no amblyopia but a strong fixation preference, a program of 2-3 days on the dominant eye was recommended, followed by 1 day on the nondominant eye, repeatedly. If amblyopia was present, the dominant eye would be patched every day. Once amblyopia was overcome, the patching program would change to 3 days and 1 day, dominant eye and nondominant eye, respectively. The patients were seen in 1 month.

Compliance with patching was assessed by parental history. If there was insufficient improvement in control, the program was

Table 1. Classification of control of intermittent exotropia

Grade	Control
Excellent	Only "breaks" after cover and recovers rapidly, prior to blink or refixation
Good	Briefly tropic only after cover and not spontaneously; recovers in <5 sec and prior to a blink or refixation
Fair	Occasionally spontaneously tropic; recovers in >5 sec or only with blink or change in fixation distance
Poor	Spontaneously tropic frequently or all of the time; may stay exotropic through a blink or with change in fixation distance

continued for another 1-2 months. If the patient had been at the lower dose (eg, 2 hours a day), the dose was increased to a maximum of 4 hours a day. If there was still insufficient improvement, surgery was recommended. All patients for whom surgery was recommended were reevaluated at least 1 month later, and if their control improved, surgery was canceled. However, if control improved to a satisfactory level, patching was tapered over the subsequent 1-2 months, discontinued, and the child would be followed per the usual age-appropriate routine for a well-controlled intermittent exotropia. If control subsequently deteriorated to a level that needed surgical intervention, the aforementioned patching program would again be instituted. However, once good control was obtained, optical management would be added. This consisted of overminusing myopic patients by 2 D and incorporating 2.5^{Δ}-3^{Δ} of base-in prism in each spectacle lens. For children with more that 2.5 D of hyperopia, the plus was still undercorrected by approximately 2 D and the same aforementioned amount of prism was incorporated. For children <2.5 D of hyperopia, approximately 1 D of minus sphere cutting the plus symmetrically combined with any cylinder was prescribed in addition to base-in prism. Patients were kept in these spectacles for several years and gradually weaned from overminus correction and prism, depending on the clinical course. In most cases, patients were taken out of overminus and prism correction by 12 years of age. Patients were rarely overminused for more than 5 years. If control deteriorated, the patient would be put in spectacles without prism or overminus correction, and surgery was recommended.

Results

A total of 279 patients were included. Presenting characteristics and response to occlusion therapy are provided in Tables 2 and 3; a breakdown of response by age, in Table 3. The first course of treatment was considered unsuccessful in 60 patients (21%), because they showed no improvement in their deviation or control score (48 patients [17%]), or worsened (12 [4%]). The 60 patients included 2 who were unable to patch because of poor compliance. Surgery was then recommended for these 60 patients., In 2, improved control on their second examination led to cancelation of surgery, but in both of these, control deteriorated and surgery was needed within a year. The vast majority, 219 patients (78%), improved their control and/or angle of deviation to a degree where observation alone was felt to be prudent. Of the 219, 62 (22%) converted from an intermittent exotropia to a phoria Only 9 patients (4% of the 219) deteriorated and were advised to have surgery after initially having responded to patching in the first follow-up year. This includes 8 patients who underwent surgery and 1 who declined the recommended surgery.

A total of 124 (57%) of the patients who were initially improved with patching needed a second course of patching therapy because of recurrence. All but 3 were subsequently put in overminus spectacles with base-in prism.

Table 2. Patient characteristics (N = 279)

Study parameter	Result[a]
Sex	
Male	113 (41)
Female	166 (59)
Age, years, at onset of patching (I)[b]	4.6 ± 1.96 (2-10)
Occlusion started after appropriate spectacles (if needed)	
On presentation	162 (58)
After decompensation of prior good control	117 (42)
Time, months, first exam to decompensation and start patching (n = 117)	17.9 ± 10.0 (6-36)
Distance deviation at onset of patching (I)	26 ± 8.5 (12-45)
Duration of patching (I) until tapering begun	
1 month	78 (28)
2 months	115 (41)
3 months	86 (30)
Change in distance deviation, PD, after patching (I)[c]	−7.0 ± 5.6 (−15 to +10)
Change in control score after completion of patching (I)[d]	
Improved control score	219 (78)
Changed from IXT to phoria	62[e] (22)
No change	48 (17)
Worsened	12 (4)
Patching (II) for recurrence[e]	
Yes	124 (57)
No	95 (44)
Overminus lenses and prism	
Yes	121 (56)
No	95 (44)
Offered but parent declined	3 (1)
Surgery within 1 year of patching	
Yes	68 (24)
Offered but declined	1 (<1)
Lost to follow-up	3 (1)
No	207 (74)[f]

IXT, intermittent exotropia; *Patching (I)/(II)*, first/second course of patching; *PD*, prism diopter; *SD*, standard deviation.
[a]Results are number (%) or mean ± SD (range).
[b]Rounded to nearest half year.
[c]Negative number denotes decrease in deviation; positive, increase.
[d]Does not include 60 patients who did not improve or worsened with patching (I).
[e]A subset of patients with improved control score.
[f]Does not include patient advised to have surgery and declined or patients lost to follow-up.

Table 3. Response to patching (I) during first year by age (N = 279)

Age, years	Change in distance deviation, PD, immediately after patching (I),[a] mean ± SD (range)	Patients operated on within 1 year of patching (I), no. (% patients in given age category)[b]
2 to <4 (n = 117)	−8.2 ± 6.6	21 (18)
4 to <6 (n = 81)	−7.8 ± 4.4	20 (25)
6 to <8 (n = 54)	−5.3 ± 5.5	20 (37)
8 to <10 (n = 27)	−3.3 ± 2.8	11 (40)

Patching (I), first course of patching; *PD*, prism diopter; *SD*, standard deviation.
[a]Negative number denotes decrease in deviation.
[b]Includes patient advised to have surgery but declined and patients lost to follow-up.

All 3, who otherwise would not have needed spectacles for refractive reasons, were advised to wear overminus lenses with prism, but the parents declined, and the patients underwent surgery.

The 68 patients who underwent surgery within 1 year of the onset of patching consisted of the 60 who either did not improve or worsened with the first course of patching and only 8 patients who initially responded positively to the conservative treatment protocol. Additionally there was the 1 patient who was advised to have surgery and declined and 3 who were lost to follow-up by 1 year (treatment failures for analytical purposes). Thus, of 279 patients who initially met criteria for otherwise needing surgery, 207 (74%) were known to able to defer surgery for at least 1 year.

Table 4 provides long-term follow-up data. Twenty years after the initial occlusion therapy, 42 patients were still being followed, of whom 22 never had strabismus surgery. Thus, at least 7% of the original series were known to not need surgery during 20 years of follow-up. However, this probably does not accurately reflect the total number of the 279 patients who never needed surgery, because many patients were lost to follow-up by 20 years. There were likely more who never needed surgery; unfortunately, the number could not be ascertained. Conversely, there were 127 patients (45% of total) who were known to have ultimately undergone surgery by the 20-year outcome date. For the remaining 130 (47%) the long-term surgery history is unknown.

Table 3 confirms that our treatment approach is more effective in younger patients. A progressive decreased response to occlusion is seen as age increased. The response to the first course of occlusion for each of the 4 age brackets in Table 3 differed significantly from each other bracket ($P < 0.001$ [*t* test]) except for the 2 youngest brackets, in which the response was similar, albeit slightly better in the youngest bracket. Conversely, the percentage of patients needing surgery during the first year after surgery increased with increasing age.

Table 4. Long-term follow-up

Surgical status	Years after patching (I)[a] 1	5	10	15	20
Known to have undergone surgery	69[b]	98	120	126	127
Known to have *not* undergone surgery	207	140	49	32	22
Unknown (lost to follow-up)	3[c]	41	110	121	130

Patching (I), first course of patching.
[a]Results are number of patients in each category at successive time points.
[b]Includes the 1 patient advised to have surgery and declined and the 3 lost to follow-up by 1 year.
[c]For the purpose of data analysis, considered to be treatment failures and to have undergone surgery.

Discussion

Conservative management, consisting of part-time alternate occlusion followed by, if needed, overminus spectacles with base-in prism in children 2-10 years of age with intermittent exotropia seems to delay surgery—sometimes for many years—in the vast majority of cases. In a small percentage of patients it eliminated the need for surgery altogether. Yet delaying surgery may itself be a useful goal in this patient population, with the potential for poor sensory outcomes in very young children and the postoperative deterioration of control over time.[12,13]

Investigations into the effect of occlusion on suppression in intermittent exotropia using both the synoptophore and haploscope have shown that occlusion reduces the depth of suppression as well as the size of the suppression scotoma.[6,7] This can be readily demonstrated using either a Bagolini filter bar or a bar of graduated neutral density filters. Because the depth of suppression in intermittent exotropia is inversely proportional to the brightness of the stimulus to the fixing eye that is the threshold at which the patient to experiences diplopia, a patient with dense suppression will only experience diplopia on a light with a very dense filter before the fixing eye. If the patient undergoes alternate occlusion therapy and is tested regularly during the course of treatment, the threshold for diplopia with the filter bar will become progressively less dense, until ultimately the patient may experience diplopia in free space with no filter. When exotropic, the two eyes experience the visual environment on noncorresponding retinal elements. Because the stimulus to suppress is an active phenomenon, it makes sense that occlusion will eliminate suppression by removing the stimulus to suppress. It seems logical that this in turn will improve control. It is unclear, however, why occlusion decreases the magnitude of the deviation. Possibly as a result of improved control and decreased frequency of the deviation being manifest, sarcomere

adaptation occurs in the extraocular muscles to decrease the deviation.[17]

Jampolsky[18] recommended treating intermittent exotropia with overminus correction of 3 D; however, one can calculate that a total of 5^{Δ}-6^{Δ} of base-in prism should give as much benefit as the accommodative convergence that would result from 1 D of additional overminus, assuming a normal accommodative convergence to accommodation ratio. Thus, incorporating 5^{Δ}-6^{Δ} of base-in prism can achieve the same effect with 2 D of overminus as 3 D of overminus without prism. This is theoretically less likely to cause asthenopia or progressive myopia. Regardless, a prior publication investigating a subset of patients in the present study showed that myopic progression was no greater in patients treated in this manner than in age-matched controls.[19]

Base-out prism would be used as an "exercise" for fusional convergence, and this might seem useful to apply in exotropia. However, base-out prism in effect increases the size of the deviation the patient needs to fuse and thus makes fusion more difficult. It may be useful for dedicated exercise sessions, but also may simply result in the deviation being more frequently manifest on a daily basis. On the other hand, base-in prism decreases the amount of convergence the patient needs to fuse and makes control easier. In theory, spending more time fusing may further decrease suppression and result in adaptations in extraocular muscles, leading to a more optimum length–tension relationship for improved alignment.

Recently the Pediatric Eye Disease Investigator Group (PEDIG) investigated a different use for part-time occlusion in the management of intermittent exotropia.[20,21] Instead of looking at the effect of patching for improving control in poorly controlled patients with intermittent exotropia, they investigated the influence of patching on preventing deterioration in patients with better control. Their outcome criterion was deterioration to a constant exotropia by 6 months. Although untreated intermittent exotropia often deteriorates, it does so slowly; studies have shown that most untreated patients do not need treatment within 1 year.[22,23] It is not surprising, then, that PEDIG found a very small deterioration rate in both their treatment and control groups; the difference between group was not statistically significant. The PEDIG studies do not shed light on the effectiveness of occlusion therapy on improving control.

This study had limitations. Although data were collected prospectively on formal data sheets, the study design was not prospective with respect to outcome criteria and analytical methodology, The 20-year outcome data described 22 patients who had not undergone surgery as comprising 7% of the total. This is a worst-case scenario that assumes that all patients for whom data are unavailable had undergone surgery. This conservative analysis probably underestimates the number who did not need surgery and is still consistent with the study's conclusion that this protocol may be curative in a small number of patients. Also, using parental reporting to estimate treatment compliance probably overestimates patching time. This, however, only strengthens the conclusion that this protocol can be beneficial in delaying or avoiding surgery in this population. If patients actually patched less than the prescribed amount, it is reasonable to conclude the results would have been as good if not better than those reported herein had they patched the prescribed amount. Although it may seem plausible to prescribe overminus lenses with base-in prism prior to recommending surgery in patients who did not improve with patching, my impression was that such an approach was not successful in patients who did not improve with patching, and so it was not adopted in the current study cohort. Similarly, this study did not investigate the use of >4 hours of occlusion daily. Had such an approach resulted in better outcomes, an even stronger case could be made for conservative management.

One rationale for this study was the reported association of poorer sensory outcomes with younger age at surgery,[14-16] and this may have some selection bias. Children who need surgery at a younger age may have a less robust potential for fusion. Although these studies dichotomized age at above or below 3-4 years, it has been suggested that this is most likely the case for children under 2 years of age.[24] The present study did not include children that young, because measurement of the distance deviation in that age group would not be sufficiently reliable for data analysis. Nevertheless, patients in my practice <2 years of age, though not included in this study, were typically treated in the same manner and seemed to respond similarly. The patient population in this study was skewed toward younger patients, with 42% in the 2-4 years age range. Better results were obtained in younger patients, giving rise to selection bias. The overall success rate reported in this study overestimates the success for older patients.

Finally, the long-term assessment of alignment and stereopsis was beyond the scope of this study.

Literature Search

PubMed was searched on February 19, 2019, without date or language restriction, using the following search terms: *intermittent exotropia*, *occlusion*, and *patching*. The reference lists of all relevant articles were also searched.

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References

1. Knapp P. Treatment of divergent deviations. In: Allen H, ed. Strabismus Ophthalmic Symposium II. St. Louis: CV Mosby; 1958:364-76.
2. Moore S. Orthoptic treatment for intermittent exotropia. Am Orthopt J 1964;13:14-20.
3. Iacobucci I, Henderson S. Occlusion in the preoperative treatment of exodeviations. Am Orthoptic J 1965;15:42-7.

4. Luke NE. Antisuppression techniques in exodeviations. Am Orthopt J 1970;20:100-103.
5. Cooper E, Leyman I. The management of intermittent exotropia. comparison of the results of surgical and non-surgical treatment. Am Orthopt J 1971;27:61-7.
6. Flynn J, McKenney S, Rosenhouse M. Eine Behandlungsform des intermittierenden Divergenzschielens. Klin Monatsbl Augenheilkd 1975;167:185-90.
7. Flynn J, McKinney S, Rosenhouse M. Management of intermittent exotropia. In: Moore S, Mein J, Stockbridge L, eds. Orthoptics: past present and future. New York: Stratten Intercontinental; 1976:563-8.
8. Chutter C. Occlusion reatment of intermittent divergent strabismus. Am Orthopt J 1977;27:80-84.
9. Freeman RS, Isenberg SJ. The use of part-time occlusion for early onset unilateral exotropia. J Pediatr Ophthalmol Strabismus 1989; 26:94-6.
10. Suh YW, Kim SH, Lee JY, Cho YA. Conversion of intermittent exotropia types subsequent to part-time occlusion therapy and its sustainability. Graefes Arch Clin Exp Ophthalmol 2006;244:705-8.
11. Kushner BJ. Selective surgery for intermittent exotropia based on distance/near differences. Arch Ophthalmol 1998;116:324-8.
12. Jampolsky A. Ocular divergence mechanisms. Trans Am Ophthalmol Soc 1970;68:703-822.
13. Santiago AP, Ing MR, Kushner BJ, Rosenbaum AL. Intermittent exotropia. In: Rosenbaum AL, Santiago AP, eds. Clinical Strabismus Management. Philadelphia: WB Saunders; 1999:163-75.
14. Pratt-Johnson J, Barlow J, Tilson G. Early surgery for intermittent exotropia. Am J Ophthalmol 1977;84:689-94.
15. Richard JM, Parks MM. Intermittent exotropia. Surgical results in different age groups. Ophthalmology 1983;90:1172-7.
16. Saunders RA, Trevedi RH. Sensory results after lateral rectus muscle recession for intermittent exotropia operated prior to two years of age. JAAPOS 2008;12:132-40.
17. Kushner BJ. Incomitant strabismus: does extraocular muscle form denote function? Arch Ophthalmol 2010;128:1604-9.
18. Caltreider N, Jampolsky A. Overcorrecting minus lens therapy for treatment of intermittent exotropia. Ophthalmol 1983;90:1160-65.
19. Kushner BJ. Does overcorrecting minus lens therapy for intermittent exotropia cause myopia? Arch Ophthalmol 1999;117:638-42.
20. Pediatric Eye Disease Investigator Group; Cotter SA, Mohney BG, Chandler DL, et al. A randomized trial comparing part-time patching with observation for children 3 to 10 years of age with intermittent exotropia. Ophthalmology 2014;121:2299-310.
21. Pediatric Eye Disease Investigator Group; Mohney BG, Cotter SA, et al. A randomized trial comparing part-time patching with observation for intermittent exotropia in children 12 to 35 Months of Age. Ophthalmology 2015;122:1718-25.
22. Buck D, Powell C, Cumberland P, et al. Improving Outcomes in Intermittent Exotropia Study Group. Presenting features and early management of childhood intermittent exotropia in the UK: inception cohort study. Br J Ophthalmol 2009;93:1620-24.
23. Buck D, Powell CJ, Rahi J, et al. The improving outcomes in intermittent exotropia study: outcomes at 2 years after diagnosis in an observational cohort. BMC Ophthalmology 2012;12:1.
24. Kushner BJ. The occurrence of monofixational exotropia after exotropia surgery. Am J Ophthalmol 2009;147:1082-5, 1085.e1.