Determination of the Correlation Between Types of Strabismus and Certain Medical Conditions

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Abstract

Background: There are several subtypes of strabismus: esotropia, exotropia, hypertropia, concomitant, incomitant strabismus. Adult strabismus can be caused by various conditions including vasculopathic diseases (diabetes, hypertension, and stroke), compressive CNS lesions, myasthenia gravis, sensory strabismus, thyroid ophthalmopathy, multiple sclerosis, trauma, post-surgical strabismus, recurrent childhood strabismus, longstanding adult strabismus without proven cause, syndrome related strabismus, restrictive orbital masses, and congenital fibrosis of the extraocular muscles. It is currently unknown whether any of these underlying conditions correlate with a specific type of strabismus.

Purpose: The purpose of this study is to determine if underlying conditions correlate with a certain misalignment. If there is a statistically significant correlation between a certain misalignment and systemic disease, this could add to the algorithm that physicians use to diagnose these systemic conditions.

Methods: This was a retrospective review of 692 patients >=21 years of age who presented to a pediatric ophthalmologist with adult strabismus from September 2008 to September 2015. The inclusion criteria were: (1) an age of 21 years or older, (2) a confirmed diagnosis of new-onset or recurrent childhood strabismus, (3) any severity and type of deviation, and (4) documentation of diplopia in any field of gaze. The variables that were extracted from the files were: the type of misalignment and the underlying disorder. Interpretation of the data consisted of determining if a correlation between type of misalignment and underlying condition exists.

Results: The average age of the population is 60.5 years with a standard deviation of 16.9, of which 49.6% were male. Results of this study indicate that multiple conditions that cause strabismus have a proclivity to negatively or positively predict a certain type of strabismus. Specifically, post-surgical patients are more likely to have hypertropia than esotropia or exotropia, sensory strabismus patients are more likely to have exotropia. Adult patients with recurrent childhood strabismus are more likely to have exotropia and concomitancy. Compressive CNS lesions, thyroid ophthalmopathy, and traumatic causes of strabismus are more likely to cause incomitant strabismus. Vasculopathic causes of strabismus do not have a tendency to cause any certain type of strabismus.

Conclusion: These findings will assist ophthalmologists in delineating a cause of their patient's strabismus based on which types of strabismus correlate with certain conditions.

Introduction

Strabismus is the misalignment of one eye relative to the other. The misalignment of the eyes can be horizontal, in which case one eye could deviate inward relative, called esotropia, or one eye could deviate outward relative to the other, called exotropia. The eyes could also be vertically misaligned, which is called hypertropia. If the misalignment is present in all gazes, it is said to be concomitant, and if it is not present in all gazes it is said to be incomitant. It has yet to be determined whether certain conditions such as: vasculopathic diseases (diabetes, hypertension, and stroke), compressive CNS lesions, myasthenia gravis, sensory strabismus, thyroid ophthalmopathy, multiple sclerosis, trauma, post-surgical strabismus, recurrent childhood strabismus, longstanding adult strabismus without proven cause, syndrome related strabismus, restrictive orbital mass caused strabismus, and congenital fibrosis are associated with certain types of strabismus such as esotropia, exotropia, hypertropia, concomitant, or incomitant. If there is such a correlation, it could augment the diagnosis criteria for these conditions.

Methods

This was a retrospective chart review of 692 patients at least 21 years of age who present to a pediatric ophthalmologist with adult strabismus from September 2008 through September 2015. The variables that were extracted from the files were: age, gender, the type of misalignment and the underlying disorder. The study had five binary outcomes: esotropia status, exotropia status, hypertropia status, concomitant status, and incomitant status. Furthermore, binary categorical independent predictors of vasculopathic diseases (diabetes, hypertension, and stroke), compressive CNS lesions, myasthenia gravis, sensory strabismus, thyroid ophthalmopathy, multiple sclerosis, trauma, post-surgical strabismus, recurrent childhood strabismus, longstanding adult strabismus without proven cause, syndrome related strabismus, restrictive orbital mass caused strabismus, and congenital fibrosis were assessed in this study. Patient demographic and clinical characteristics were determined using descriptive statistics including means, standard deviations for continuous variables, and frequencies, proportions for categorical variables. The T-test was implemented to assess differences in continuous variables between the presence and non-presence of the outcome. Chi-squared analysis was implemented to assess the differences in proportions. To determine the association between the potential predictors and the outcomes, two models were formed for each outcome by implementing logistic regression to estimate odds ratios and 95% confidence intervals. First, univariate analysis was used to assess each predictor separately with logistic regression. The second model contained all the predictors to assess whether the independent variables predict the outcomes as a group. The second model also was adjusted for the confounders age, gender and race. Since, there were five outcomes in the study, the proposed statistical analysis plan was implemented for each outcome.

Results

Demographics are presented in Table 1. Patients who have had ophthalmic surgery were 72% less likely to have esotropia due to its odds ratio of 0.28 (Table 2). For every one year of increase in age, patients are 2% less likely to develop exotropia. Patients who have had ophthalmic surgery were 76% less likely to develop exotropia with its odds ratio of 0.24; childhood strabismus and sensory strabismus patients were 2.89 and 24 times more likely to have exotropia respectively (Table 3). Sensory and childhood strabismus were protective predictors of hypertropia with sensory and childhood strabismus patients being 96% and 75% less likely to have hypertropia respectively. Patients who have had ophthalmic surgery were 10.5 times more likely to develop hypertropia (Table 4). Compressive lesion patients and thyroid ophthalmopathy patients were 83% and 42% less likely to have concomitant strabismus respectively. Childhood strabismus patients were 1.95 times more likely to have concomitant strabismus (Table 5). Those patients with childhood strabismus were 49% less likely to have incomitant strabismus. Patients with compressive lesions, thyroid ophthalmopathy, and traumatic strabismus were 5.68, 1.70, and 2.28 times more likely to have incomitant strabismus (Table 6).

Table 1: Overall Population Statistics

Variables	Values
Age (mean, SD)	60.5 (16.9)
Gender (male, %)	343 (49.6)
N(%)	
Esotropia	70 (10.1)
Exotropia	295 (42.6)
Hypertropia	383 (55.4)
Concomitant Status	458 (66.2)
Incomitant Status	234 (33.8)
Vascular Event	115 (16.6)
Compressive Lesion	6 (0.87)
Myasthenia Gravis	12 (1.73)
Sensory Strabismus	21 (3.03)
Thyroid Ophthalmopathy	85 (12.3)
Multiple sclerosis	2 (0.29)
Trauma	68 (9.83)
Post-Surgical	96 (13.9)
Childhood Strabismus	98 (14.2)
Long Standing	183 (26.5)
Syndrome	19 (2.75)
Restrictive Orbital Mass	2 (0.29)
Restrictive Fibrosis	2 (0.29)

Table 2: Multivariate Analysis of Esotropia

Variables	Odds Ratio (95% CI)	P-Value[1]
Gender (male)	0.64 (0.38, 1.07)	0.08
Post-Surgical	0.28 (0.09, 0.93)	0.04
Long Standing	1.30 (0.75, 2.24)	0.34
Syndrome	2.25 (0.71, 7.15)	0.16
Area Under the Curve	0.62	

[1]P-Values calculated using Multiple Logistic Regression adjusting for all other variables within the model

Table 3: Multivariate Analysis of Exotropia

Variables	Odds Ratio (95% CI)	P-Value[1]
Age (per 1 year increase)	0.98 (0.97, 0.99)	0.006
Compressive Lesion	0.19 (0.02, 1.70)	0.14
Sensory Strabismus	24.4 (3.21, 185.1)	0.002
Post-Surgical	0.29 (0.16, 0.54)	<0.001
Childhood Strabismus	2.89 (1.72, 4.86)	<0.001
Long Standing	0.84 (0.57, 1.24)	0.40
Area Under the Curve	0.70	

[1]P-Values calculated using Multiple Logistic Regression adjusting for all other variables within the model.

Table 4: Multivariate Analysis of Hypertropia

Variables	Odds Ratio (95% CI)	P-value[1]
Age (per 1 year increase)	1.01 (0.99, 1.02)	0.14
Compressive Lesion	5.86 (0.66, 51.8)	0.11
Sensory strabismus	0.04 (0.005, 0.28)	0.002
Post-Surgical	10.5 (4.46, 24.5)	<0.001
Childhood Strabismus	0.25 (0.15, 0.43)	<0.001
Syndrome	0.39 (0.14, 1.06)	0.06
Area Under the Curve	0.72	

[1]P-Values calculated using Multiple Logistic Regression adjusting for all other variables within the model.

Table 5: Multivariate Analysis of Concomitancy

Variables	Odds Ratio (95% CI)	P-Value[1]
Age (per 1 year increase)	1.01 (0.99, 1.02)	0.07
Compressive Lesions	0.17 (0.03, 0.93)	0.04
Sensory Strabismus	2.51 (0.81, 7.82)	0.11
Thyroid Ophthalmopathy	0.58 (0.35, 0.97)	0.04
Childhood Strabismus	1.95 (1.08, 3.51)	0.03
Long standing	1.29 (0.84, 1.99)	0.23
Area Under the Curve	0.63	

[1]P-Values calculated using Multiple Logistic Regression adjusting for all other variables within the model.

Table 6: Multivariate Analysis of Incomitancy

Variables	Odds Ratio (95% CI)	P-Value[1]
Age (per 1 year increase)	0.99 (0.97, 1.00)	0.07
Compressive Lesion	5.68 (1.06, 30.2)	0.04
Sensory Strabismus	0.39 (0.12, 1.23)	0.11
Thyroid Ophthalmopathy	1.70 (1.02, 2.84)	0.04
Trauma	2.28 (1.28, 4.06)	0.005
Childhood Strabismus	0.51 (0.28 (0.92)	0.03
Long Standing	0.77 (0.50, 1.18)	0.23
Area Under the Curve	0.63	

[1]P-Values calculated using Multiple Logistic Regression adjusting for all other variables within the model

Discussion and Conclusions

Results of this study indicate that multiple conditions that cause strabismus have a proclivity to negatively or positively predict a certain type of strabismus. Specifically, post-surgical patients are more likely to have hypertropia than esotropia or exotropia, and sensory strabismus patients are more likely to have exotropia. Adult patients with recurrent childhood strabismus are more likely to have exotropia and concomitancy. Compressive CNS lesions, thyroid ophthalmopathy, and traumatic causes of strabismus are more likely to cause incomitant strabismus. Vasculopathic causes of strabismus do not have a tendency to cause any certain type of strabismus. These findings will assist ophthalmologists in delineating a cause of their patient's strabismus based on which types of strabismus correlate with certain conditions.

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