Published in final edited form as:

Ophthalmology. 2015 May ; 122(5): 1056–1059. doi:10.1016/j.ophtha.2014.12.010.

The Incidence and Clinical Characteristics of Adult-Onset Convergence Insufficiency

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Abstract

Objective—The purpose of this study was to describe the clinical characteristics and natural history of convergence insufficiency (CI) in a population-based cohort of adults.

Design—Retrospectively reviewed population-based cohort.

Participants—Adult (≥ 19 years of age) residents of Olmsted County, Minnesota.

Methods—The medical records of all adults diagnosed with CI over a 20-year period were retrospectively reviewed.

Main outcome measures—Clinical characteristics and outcomes for adult-onset convergence insufficiency.

Results—A total of 118 adults (annual incidence of 8.44 per 100 000 patients older than 19 years) were diagnosed with CI during the 20-year period, comprising 15.7% of all forms of adult-onset strabismus observed in this population. The median age at diagnosis was 68.5 years (range 21.7 to 97.1 years) and 68 (57.6%) were female. The mean initial exodeviation at near was 14.1 PD (range 1 to 30 PD) and 1.7 PD (range 0 to 10 PD) at distance. The Kaplan-Meier rate of exotropia increasing by 7 prism diopters or more at near over time was 4.2% at 5 years, 13.5% at 10 years, and 24.4% at 20 years. Approximately 88% were managed with prisms while less than 5% underwent surgical correction.

Conclusions—Adult-onset convergence insufficiency comprised approximately 1 in 6 adults who were newly diagnosed with strabismus in this 20-year cohort. There was a significant increase in incidence with increasing age. Nearly one-fourth had an increase of their near

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exodeviation of at least 7 PD by 20 years after their diagnosis and most patients were managed conservatively.

Convergence insufficiency (CI) is a common disorder of ocular alignment among both children and adults, characterized by an exophoria at near fixation and complaints of horizontal diplopia and eye strain with prolonged reading.^{1,2} CI is diagnosed on the findings of a remote near point of convergence and decreased fusional convergence at near fixation.³ Patients with CI usually exhibit an exophoria at near and normal alignment at distance; however, they can also be orthophoric and occasionally even esophoric at distance or near³

There is a considerable variability in the reported prevalence of CI, with most estimates ranging from 2.25% to 8.3% among pediatric and young adult populations.⁴⁻⁶ The purpose of this study is to describe the clinical characteristics of CI in a population based cohort of adult patients, 19 years or older, diagnosed over a 20-year period using a medical record retrieval system.

Methods

The medical records of all patients 19 years or older who were newly diagnosed with CI as residents of Olmsted County, Minnesota from January 1, 1985 through December 31, 2004, were reviewed. Institutional review board approval was obtained for this study. Patients were identified based on resources of the Rochester epidemiology Project (REP), a medical record linkage system designed to capture data on any patient-physician encounter in Olmsted County, Minnesota.⁷ The population of this county is relatively isolated from other urban areas and virtually all medical care is provided to its residents by Mayo Clinic, Olmsted Medical Group and their affiliated hospitals. Patients not residing in Olmsted County at the time of their diagnosis were excluded from the study.

Potential cases of new-onset adult strabismus were ascertained by searching the REP database for International Classification of Diseases 9 codes for strabismus and other disorders of binocular eye movements. A trained data abstractor (JMM) reviewed all medical records for subjects with at least one of the diagnostic codes for strabismus entered during the twenty-year period. The data abstractor used pre-determined inclusion criteria to confirm a diagnosis of new-onset strabismus and to classify subjects by the type of strabismus. The diagnosis of CI was based on the following criteria: 1) symptoms of double vision while reading with an exophoria/tropia at near fixation test and an absence of double vision at distance, or by 2) an exophoria/tropia 10 PD at near on PACT with orthophoria or small (<10 PD) phoria at distance. The entire medical record of each patient was carefully reviewed for other ocular or medical conditions.

To determine the incidence of adult onset CI in Olmsted County, annual age- and gender-specific incidence rates were constructed using the age- and gender-specific U.S. white population figures obtained from the United States Census. The 95% confidence intervals for the rates were calculated assuming Poisson error distribution. The rate of progression was estimated using the Kaplan-Meier method. The threshold for change in the angle of exotropia over time was chosen to be 7 prism diopters to minimize any test-retest variability.⁸

Results

A total of 118 patients older than 19 years of age were newly diagnosed with convergence insufficiency in Olmsted County, Minnesota, during the 20-year study period, corresponding to an annual age- and gender-adjusted incidence of 8.44 (95% confidence interval, 6.90–9.99) per 100,000 residents older than 19 years or a prevalence of 1.38%. Table 1 shows the historical and initial clinical characteristics of the 118 study patients. The median age at diagnosis was 68.5 years (range, 21.7 to 97.1 years) with a distribution by decade shown in the figure. Sixty eight (57.6%) were female ($p=0.95$). The mean initial deviation was 14.1 PD of exophoria or intermittent exotropia at near (range, 1 to 30 PD) and 1.7 PD at distance (range 0 to 10 PD), with 6 patients having an esophoria for distance. None of the patients had information regarding near point of accommodation. Thirty eight patients had hyperopia and forty five patients had myopia. Several of the more common ocular and systemic comorbidities were reviewed and are shown in Tables 2 and 3, respectively. Other ocular disorders found in this population were age-related macular degeneration in 17% and glaucoma in 8%. The most prevalent associated systemic conditions included hypertension in 23%, and coronary artery disease, hyperlipidemia, and cancer in approximately 10% each.

The Kaplan-Meier rate of the exotropia increasing by 7 prism diopters or more at near over time was 4.2% at 5 years, 13.5% at 10 years, and 24.4% at 20 years. Management data was unavailable for 13 of the 118 patients. Ninety-two patients (88%) of the 105 were treated with prism spectacles, 9 (9%) were treated with convergence exercises, 4 (3.84%) underwent eye muscle surgery, and 3 (2.8%) elected to occlude one eye. The patients were followed for a mean of 9.3 years (range, no follow up to 23.6 years). Three of the 4 patients who were managed with surgery had resection of a single medial rectus, two of which required prism correction postoperatively to eliminate their diplopia. The fourth patient underwent one lateral rectus recession and had a final deviation of 2 PD of esophoria for both distance and near with no diplopia.

Discussion

Adult-onset convergence insufficiency was diagnosed in 118 patients and compromised approximately 1 in 6 adults who were newly diagnosed with strabismus in this 20-year cohort.⁹ Females in the seventh decade of life were most prevalent. Although progression of the angle was common, with the rate being highest among patients over the age of 70 years, most patients in this cohort were managed conservatively with prisms and convergence exercises, and only 4 patients managed surgically.

There is a considerable variability in the reported prevalence of CI. The prevalence of CI in this study was calculated to be 1.38%. The estimates of prevalence based on population studies, mostly from pediatric or young adult populations, range from 2.25% to 8.3%.^{4–6} In studies that used standardized definitions of CI, investigators have reported a prevalence of 4.2% to 6% in school and pediatric clinic settings.^{5,10,11} There are, however, no known prevalence reports of convergence insufficiency among adult populations with which to compare the findings of the current study.

The difficulty with near convergence among elderly patients, however, has been reported,^{12–14} supporting the findings of this study in which the incidence increased with increasing age. Oguro et al¹³ assessed the convergence and vertical gaze of 113 healthy individuals and found that convergence is reduced with increasing age, affecting approximately 70% of individuals in their eighties. This worsening with age may be due to the effects of presbyopia on the accommodative convergence component of convergence.¹⁴ Wearing a bifocal prescription for the first time may potentially cause CI as a result of relieving the previously sustained accommodative effort. However, Pickwell¹² found that the percentage of individuals in an urban population with convergence insufficiency increased gradually until the age of 60 years, with a marked increase from about 25% at 55 years to over 60% in the elderly with no marked change at the age of presbyopia onset. This change was attributed in part to deterioration in the general health of these patients and not solely to the increase in physiologic exophoria at near. These findings are comparable to this study in which approximately half of the cases were diagnosed over the age of 70 and nearly one-fourth had an increase of their near exodeviation of at least 7 PD by 20 years after their diagnosis. Information regarding the near point of accommodation would also be instructive; although unknown in this cohort, distinguishing accommodative insufficiency from convergence insufficiency would be useful in understanding why elderly adults have difficulty with near reading.

Systemic co-morbidities were fairly common in this cohort of adult patients, which is not surprising given the relatively older age of our study population. Hypertension was diagnosed in 27 (22.9%) of the study patients cancer in 13 (11.0%) patients, and 12 (10.2%) patients each also had CAD and hyperlipidemia. The association of CI with Parkinson's disease has been reported¹⁵; four of our patients (3.4%) were diagnosed with Parkinson's disease. The most common ocular co-morbidity was age related macular degeneration in 20 (17%) patients which is also related to the older age of our study group. The lack of a control group in this study, however, makes it impossible to conclude the presence of an association with any systemic or ocular condition.

Despite the fact that home-based convergence exercises is the most commonly prescribed treatment by both ophthalmologists and optometrists for patients with CI,^{16–18} 3 of 4 adult patients in this study were managed with prism correction and only 9% with convergence exercises. This low rate of exercises may be due in part to the difficulties encountered with exercises with elderly adults and personal preference of treatment by the ophthalmologists. A Cochrane Database Review in 2011 evaluated nonsurgical therapy for convergence insufficiency.¹⁹ The results of multiple studies provide conflicting recommendations for managing convergence insufficiency in adults. For children, outpatient vision therapy/orthoptics has been shown to be more effective than home-based convergence exercises or home-based computer vision therapy/orthoptics. The effectiveness of such therapies in adults have not been consistent between studies.¹⁹

There are several limitations to the findings in this study. As a retrospective chart review, the diagnosis of CI was based primarily on a distance near disparity of the exodeviation. A near point of convergence was rarely documented since many of these patients were seen and managed by the comprehensive ophthalmology clinic and unfortunately did not have

detailed motility exams Second, although a relatively isolated county, some residents of Olmsted County with CI may have sought care outside the region or by care providers other than Mayo Clinic or Olmsted Medical Group, and were therefore excluded from the study, potentially underestimating the true incidence of the disorder. Similarly, the symptoms of some adults may not have been troublesome or obvious enough to seek specialty care, further artificially reducing the observed incidence. The ability to generalize these findings is limited by the demographics of Olmsted County, a relatively homogeneous semi urban white population. Finally, the lack of a control group makes it difficult to draw conclusions for any significant associations with other ocular or systemic diseases.

Adult-onset convergence insufficiency comprised approximately 1 in 6 adults newly diagnosed with strabismus in this 20-year cohort. There was no gender predilection but there was a significant increase in incidence with increasing age. Nearly one-fourth had an increase of their near exodeviation of at least 7 PD by 20 years after their diagnosis and most patients were managed conservatively without surgery.

Acknowledgments

This publication was supported by NIH grants UL1 RR024150, R01 AG034676, and, in part an unrestricted grant from Research to Prevent Blindness, Inc, New York, NY. None of the authors have any proprietary/financial interests to disclose.

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Adult-onset convergence insufficiency is a common form of adult strabismus generally diagnosed beyond the sixth decade of life. Although the near exodeviation progressed for many patients, the majority were successfully managed with prism spectacles.

Figure 1.

Age at diagnosis for 118 Adult Patients Diagnosed with CI in Olmsted County, Minnesota from 1985 to 2004

Table 1

Historical and Initial Clinical Characteristics of 118 patients 19 years Diagnosed in Olmsted County, Minnesota from 1985 through 2004

Median age at diagnosis	68 years (21.7 to 97.1 years)
Gender	50 male (42.4%); 68 female (57.6%)
Exotropic deviation at distance in PD (range)	1.7 (0 to 10 PD)
Exotropic deviation at near in PD (range)	14 (10 to 30 PD)
Refractive error	38 patients (32.2%) hyperopia 45 patients (38.1%) myopia
Diplopia at presentation	37 patients (31.4%)

PD = prism diopters

Table 2

Observed Ocular Comorbidities Among 118 Patients with CI

Ocular Diagnosis	Number of patients (%)
ARMD	20 (17.0%)
Glaucoma	8 (6.8%)
Epiretinal membrane	5 (4.2%)
Corneal dystrophy	3 (2.5%)
Retinal detachment	2 (1.7%)
Scleral buckle	2 (1.7%)

Table 3

Observed Systemic Comorbidities Among 118 Patients with CI

Systemic Diagnosis	Number of patients (%)
Hypertension	27 (22.9%)
Cancer	13 (11.0%)
Coronary artery disease	12 (10.2%)
Hyperlipidemia	12 (10.2%)
Major depressive disorder	11 (9.3%)
Alzheimer's dementia	10 (8.5%)
Thyroid disease	10 (8.5%)
Diabetes mellitus	8 (6.8%)
Parkinson's disease	4 (3.4%)