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Prevalence and patterns of comorbid cognitive impairment in low vision rehabilitation (LVR) for macular disease

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Abstract

The prevalence of comorbid cognitive impairment among older adults referred to LVR for macular disease is unknown. We performed cognitive testing on 101 adults aged 65 years or older with macular disease who were referred to The Duke LVR Clinic between September 2007 and March 2008. Scores on the telephone interview for cognitive status-modified (TICS-m) ranged from 7 to 44, with 18.8% of scores below an established cutoff for cognitive impairment (≤ 27) and an additional 27.7% of scores considered marginal (28-30). On letter fluency, 46% of participants scored at least 1 × S.D. below the mean for their age, gender, race, and education level, and 18% of participants scored at least 2 × S.D. below their demographic mean. On logical memory, 26% of participants scored at least 1 × S.D. below the mean for their age group and race and 6% scored at least 2 × S.D. below their demographic mean. High prevalence of cognitive impairment, with particular difficulty in verbal fluency and verbal memory, may compromise the success of low vision rehabilitation interventions among macular disease patients. Additional work is needed to develop strategies to maximize function in older adults with this common comorbidity.

Keywords

comorbidity; cognitive impairment; macular disease; vision loss; low vision rehabilitation

1. Introduction

Visual impairment is among the ten leading causes of disability in the United States and it is associated with shorter life expectancy and poorer quality of life (Centers for Disease Control and Prevention, 2001; McCarty et al., 2001; Vu et al., 2005). Already 14 million older Americans are affected by age-related macular degeneration and the prevalence is increasing

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as the population ages (Friedman et al., 2004). Macular disease is the leading cause of incurable blindness in older Americans and it is the most common reason for referral to low vision rehabilitation (Klein et al., 1992; Windsor and Windsor, 2001; Friedman et al., 2004).

LVR incorporates the expertise of optometrists, occupational therapists, orientation and mobility specialists, and assistive device specialists to maximize existing sight and to promote independence despite loss of vision (Edmonds and Edmonds, 2006; Markowitz, 2006). LVR can preserve and restore abilities in seniors with vision loss, but it often requires the patient to master new techniques or devices (Bourla and Young, 2006; Walter et al., 2007). Although LVR can be highly beneficial to patients with irreversible visual impairment, the utility may be limited if a patient's ability to learn new techniques and adapt to new equipment is diminished by comorbid cognitive impairment.

Cognitive impairment, like visual impairment, is common among older adults and is itself an independent risk factor for disability (McGuire et al., 2006). Previous work has demonstrated that the co-occurrence of visual and cognitive impairment in older adults is associated with an even higher risk of disability than either impairment alone (Whitson et al., 2007). Further, there is evidence of an age-associated link between vision and cognitive function. In a cross-sectional study of 687 adults aged 25 to 103 years, controlling for vision led to a 3.9 fold reduction in age-associated differences in cognitive function (Baltes and Lindenberger, 1997). An analysis of data from the Study of Osteoporotic Fractures (SOF) found that visual impairment was associated with greater than expected cognitive decline over approximately four years (Lin et al., 2004). There is evidence that Alzheimer's disease and macular degeneration may share common pathophysiology (Uhlmann et al., 1991; Klaver et al., 1999), and macular disease and cognitive impairment may develop through common underlying conditions, such as atherosclerosis.

Despite the apparent association between visual and cognitive problems and the functional and treatment-related implications of this comorbidity, the prevalence of cognitive impairment in LVR is unknown. Moreover, it is not known whether particular cognitive deficits are especially common among older adults with macular disease. A better understanding of the scope of cognitive impairment among older adults referred to LVR is likely to (1) suggest hypotheses about the possible etiologic link between visual and cognitive impairments, and (2) inform the development of effective LVR treatment strategies for individuals with this disabling comorbidity. The objective of this analysis is to describe the prevalence and patterns of cognitive dysfunction in a population of older adults with macular disease referred to an outpatient low vision rehabilitation program.

2. Study design and methods

2.1. Study population

Eligible participants were patients aged 65 years or older with macular disease diagnoses (age-related macular degeneration, diabetic retinopathy with macular involvement, macular edema, etc) who were evaluated in the Duke LVR Clinic between September 17, 2007 and March 27, 2008. Enrollment was restricted to patients with macular disease because it is the most common indication for referral of older adults to LVR, and the central vision loss of macular disease confers unique functional challenges and rehabilitation needs. Exclusion criteria included hearing impairment or language barriers that were severe enough to prevent in-person administration of cognitive tests. During each week of the study period, all eligible patients were invited to participate until the weekly recruitment goal (3-5 patients) was met.

Data were collected as part of an ongoing observational study to examine the consequences cognitive impairment in LVR, to explore associations between visual and cognitive parameters

in this population, and to enhance LVR to account for important cognitive deficits. The present analysis is limited to data collected at the baseline interview. The study was approved by the Duke University Medical Center Institutional Review Board.

2.2. The Duke LVR Clinic

This clinic coordinates a multi-disciplinary outpatient rehabilitation service within the Duke Eye Center. The LVR team includes an optometrist, a low vision device specialist, and an occupational therapist. The clinic is open three days a week (Monday, Wednesday, Thursday) and evaluates 20-25 patients each week. Referrals are accepted from Duke and community ophthalmologists and primary care physicians.

2.3. Cognitive tests

All cognitive tests were administered in person by one of two individuals trained and supervised by a clinical neuropsychologist to perform the tests under standardized conditions. Testing was performed in private exam rooms in the Duke Eye Center with the participant and test administrator seated across from each other. The tests were completed on the day of enrollment, before or after the participant's appointment in the low vision rehabilitation clinic. None of the tests contained items that require visual ability (e.g., drawing, writing, object recognition, etc).

The TICS-m was chosen as the screen for cognitive impairment because it is a well-validated measure of global cognitive function that does not rely on visual ability (Brandt and Folstein, 1988; Gallo and Breitner, 1995; Ferrucci et al., 1998) and scores are not influenced by visual loss in older populations (Mangione et al., 1993). Scores were adjusted per protocol based on the participant's educational level (five points added if less than 8 years of education, 2 points added if 8 to 10 years of education, 2 points subtracted if 16 or more years of education) (Breitner et al., 1995). Consistent with previous work, the screen was considered positive for cognitive impairment if the education-adjusted TICS-m score was 27 or less (Gallo and Breitner, 1995; Chodosh et al., 2004).

Although it provides a reliable measure of global cognitive function, the TICS-m does not fully assess certain cognitive domains which are likely important for successful LVR, including executive function and contextual memory (Crooks et al., 2006). To better assess these domains, the following tests were administered to each participant: Wechsler memory scale-revised (WMS-R), logical memory I (immediate) and II (delayed) (The Psychological Corporation, 1997; Lucas et al., 2005), WMS-R digit span forward and backwards (The Psychological Corporation, 1997), and letter fluency (FAS) (Spreen, 1977). Logical memory is a test of contextual memory, digit span and FAS test executive function, and FAS further tests verbal fluency. A participant's performance on each of these tests was compared to published, demographic normative data, which are widely used in clinical settings (Ivnik et al., 1992; Heaton et al., 2001). Normative data for digit span scores are stratified by age (Ivnik et al., 1992), logical memory normative data are stratified by age and race (Ivnik et al., 1992), and FAS normative data are stratified by age, race, education level, gender (Heaton et al., 2001). For each test, a participant's score was compared to the reported mean score and standard deviation within his or her demographic stratum.

2.4. Demographic and psychosocial data

Race, education level, marital status, and living status were assessed by self report. The patient's age and sex were obtained from the medical chart. A 15-item version of the geriatric depression scale (GDS) (Yesavage et al., 1982) was administered to each participant.

2.5. Analysis

Univariate statistics were used to describe the cohort with respect to demographics and cognitive test performance. The proportion of participants with TICS-m scores at or below the cognitive impairment cut-off (27 or less) and the proportion of participants with marginal TICS-m scores (28 to 30) are reported. On the other cognitive tests, the proportion of participants scoring at least one or at least two standard deviations below their demographic mean is reported. The binomial test was used to compare the observed proportions to the expected proportions of participants scoring one standard deviation or two standard deviations below a population mean. The binomial test assumed that any participant had a 16.7% chance of scoring one standard deviation below his demographic mean and a 2.5% chance of scoring two standard deviations below the mean. The difference between observed and expected proportions was considered statistically significant if the chance of observing as many or more participants in a given range of test performance was less than or equal to 5 % ($p \leq 0.05$).

3. Results

Of 139 patients who met eligibility criteria and were invited to participate, 103 (74.1%) signed consent forms. Those who declined to participate did not differ significantly from study participants on the basis of sex (58.3% female), race (94.4% Caucasian), or age (80.9 ± 7.9 years). The most common reason for refusal to enroll was that the patient (or the person providing the patient's transportation) did not have time on the day of the LVR appointment to complete in-person cognitive testing and the patient was unable to return on an alternate day due to transportation issues. Of 103 consented patients, two left the LVR clinic without providing baseline data or any cognitive testing and were unable to be reached later. The remaining 101 patients make up the study cohort.

The characteristics of the study cohort are reported in Table 1. The mean age of participants was 80.1 years. Overall, this referral population was well-educated with a mean of 13.8 years of education and 28.7% possessing a college degree. The cohort included 97 Caucasians, three African-Americans, and one Latino. The low representation of minorities in the study reflects the fact that most older adults in LVR are referred for age-related macular degeneration, a disease with a strong predilection for Caucasians.

Scores on the TICS-m, which has a maximal possible score of 50, ranged from 7 to 44. In this cohort of older adults referred for LVR, 19/101 (18.8%) screened positive for cognitive impairment on the TICS-m (score 27 or less). An additional 28/101 (27.7%) had scores very near this cut-off. The remaining 53.5% did not show any impairment. Table 2 reports the proportion of participants who scored at least one and at least two standard deviations below the mean for their demographic stratum. The proportion of patients scoring poorly on logical memory (both immediate and delayed) and FAS was significantly higher than expected. Performance on FAS was particularly poor, with nearly half of the cohort scoring at least one standard deviation below the mean for their demographic stratum.

4. Discussion

In this study, almost one in five older adults receiving LVR for macular disease screened positive for cognitive impairment on a test of global cognitive functioning. While previous population-based studies have suggested similarly high rates of comorbid cognitive impairment among older adults with visual impairment (Whitson et al., 2007), this is the first study to consider the scope of this problem in LVR. It is somewhat surprising that cognitive impairment was so prevalent among individuals referred for a rehabilitative service that relies on the patient's ability to learn and adapt to new techniques and devices. Because comorbid cognitive impairment has practical implications for the successful implementation and

maintenance of LVR strategies, it is important to increase awareness of possible cognitive impairment in this population.

It is possible that cognitively impaired patients are referred to LVR because the referring physician is not aware of the cognitive deficits, but it is also likely that the referral is made despite recognition that some cognitive impairment exists. Indeed, most macular disease patients have little hope of restored vision, and low vision rehabilitation[w3] provides their best chance at regaining function in the face of incurable vision loss. Thus, a better understanding of the nature and consequences of comorbid cognitive impairment in this population is a critical step toward designing enhanced LVR strategies that detect important cognitive deficits and accommodate for them appropriately.

The findings presented here suggest a pattern of cognitive deficits that may be particularly deleterious for older adults receiving training in LVR. First, performance on logical memory tests was worse than expected for the general population. Logical memory tests, which require the participant to recall details from a brief story that is read aloud, indicate the participant's ability to store and retrieve narrative information. The 26% of participants who scored at least 1 × S.D. their demographic mean on this test might have substantial difficulty in processing and remembering the information presented to them orally during LVR sessions. Second, nearly half of the participants in this study struggled with FAS, which assesses initiation as well as verbal retrieval. LVR patients with deficits in these cognitive domains could have difficulty communicating verbally with providers during the training sessions as well as implementing the rehabilitation plan at home.

By revealing such patterns of cognitive impairment in this population, the study raises intriguing questions about the etiology of the supposed link between visual and cognitive functioning. To the authors' knowledge, this is the first study to demonstrate markedly poor performance on the FAS test among older adults with macular disease. One possible explanation for this observation is that the brain structures required for verbal fluency are at risk for similar pathophysiologic insults as the macula, such that these specific impairments in cognition and vision are likely to arise concurrently.

An alternative explanation is that visual impairment diminishes a participant's ability to perform the tasks required by the FAS test. The FAS test is a controlled oral word association test in which the participant is given 60 seconds to name words beginning with a particular letter (F, A, or S), excluding certain types of words such as proper names. Although the task does not directly require visual ability, it is possible that visual impairment affects aptitude for the task. For example, a sighted individual may employ several cognitive pathways to retrieve words that begin with F. He may be reminded of words by thinking of the sound that the letter F makes or by picturing the letter F on a page. On the other hand, a person who has been unable to read for many years due to visual impairment may be less able to retrieve “words that begin with F” by picturing the letter F in written word. In this example, longstanding sensory impairment influences cognitive processing in a specific way. Further research is needed to refine and evaluate hypotheses about the underlying causes of the association between visual and cognitive impairment.

Several limitations of the current study should be noted. First, the study includes a relatively small sample of patients recruited from a single LVR clinic. While the findings require confirmation, the study population was representative of individuals referred to LVR for macular disease and recruitment bias appeared to be minimal. Further, cognitively impaired individuals are generally less likely to participate in research. Thus, recruitment bias would be expected to result in an under-estimate of cognitive deficits in this population. Second, cognitive testing was performed on the same day as participants' appointments in the LVR

clinic and participants may have been fatigued, anxious, or pre-occupied during testing, which may have lowered scores. However, these testing conditions provide an accurate assessment of the participant's cognitive functioning ability at the time of the LVR intervention. Finally, although all participants were required to have macular disease, the participants differ by specific diagnoses and degree of visual impairment. This was done to maximize the generalizability of the findings, but it limits the ability to make inferences about specific etiologic links between visual and cognitive impairment. Future analyses will make use of the participants' visual testing to investigate potential associations between vision-specific and cognition-specific variables.

5. Conclusions

This study is unique in that it evaluates several domains of cognitive functioning among older adults with macular disease who were referred to an LVR service that relies heavily on cognitive ability. The finding that cognitive impairment was common in this population has important clinical implications. Moreover, the results suggest a specific pattern of cognitive deficits in this population, with particularly high rates of difficulty with verbal memory and verbal fluency. This knowledge will be helpful in developing LVR strategies tailored to the needs of older macular disease patients with comorbid cognitive deficits. In addition, it may provide insights about the underlying cause of the high rates of cognitive impairment observed among visually impaired older adults. Additional research is needed to better understand the interface between visual impairment and cognitive impairment and to develop rational interventions that may prevent this disabling comorbidity or lessen its functional consequences.

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Table 1

Characteristics of the cohort

Parameter	
Number	101
Age (years), mean ± S.D.	80.1 ± 7.8
Range (years)	65 - 96
Sex, % female	65.3
Race, % Caucasian	96.0
Living alone, %	29.7
Married, %	43.6
Years of education, mean ± S.D.	13.8 ± 3.4
15-item GDS (number = 98)	
Range of scores	0 - 10
Scoring ≥ 5, %	26.5

Table 2

Performance on specific cognitive tests

Test	% ≥ 1 × S.D. below the mean	% ≥ 2 × S.D. below the mean
Logical memory, immediate, (n = 101)	25.7*	5.9*
Logical memory, delayed, (n = 100)	26.0*	6.0*
Letter fluency (n = 100)	46.0*	18.0*
Digit span (n = 100)	18.0	2.0

* $p < 0.05$ from expected proportion of participants scoring ≥ 1 × (16.7%) or ≥ 2 × (2.5%) S.D. below their demographic mean