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Memory Deficit is Associated with Worse Functional Trajectories Among Older Adults in Low Vision Rehabilitation for Macular Disease

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Abstract

Objectives—Older adults with macular disease are at increased risk of memory decline and incident dementia. Low vision rehabilitation (LVR) aims to preserve independence in people with irreversible vision loss, but comorbid memory problems could limit the success of rehabilitation. This study examined whether performance on a brief memory test is related to functional outcomes among older patients undergoing LVR for macular disease.

Design—Observational cohort study of patients receiving outpatient LVR

Setting—Academic center

Participants—91 seniors (average age 80.1 years) with macular disease

Measurements—Memory was assessed at baseline with a 10-word list; memory deficit was defined as immediate recall of two words. Vision-related function was measured with the 25-item Visual Function Questionnaire (VFQ-25) administered at baseline and during subsequent interviews (mean length of follow up = 115 days). Linear mixed models (LMMs) were constructed

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to compare average trajectories of four VFQ-25 subscales: near activities, distance activities, dependency, and role difficulty.

Results—The 29.7% of patients with memory deficit tended to decline in ability to accomplish activities that involve near vision. Controlling for age, sex, and education, the functional trajectory of participants with memory deficit differed significantly from that of participants with better memory ($p=0.002$), who tended to report improvements in ability to accomplish near activities.

Conclusion—Among older adults receiving LVR for macular disease, those with memory deficit experienced worse functional trajectories in their ability to perform specific visually mediated tasks. A brief memory screen may help explain variability in rehabilitation outcomes and identify patients who might require special accommodations.

Keywords

age-related macular degeneration; comorbidity; disability; cognitive impairment

INTRODUCTION

Cognitive impairment is more prevalent and more rapidly progressive in older adults with vision impairment^{1–3}, and approximately 4% of community dwelling older adults experience both impairments⁴. In particular, age-related macular degeneration (AMD) has been associated with two-fold increased risk of cognitive decline and incident dementia^{5, 6}, and recent studies suggest that macular disease patients tend to perform poorly on tests of memory^{1, 7}. This epidemiologic link between vision impairment and cognitive impairment is significant, in part, because comorbid cognitive impairment further increases a visually impaired older adult's risk of disability⁴.

The functional consequences of vision loss are often addressed by referral to low vision rehabilitation (LVR). LVR is a multi-disciplinary service that incorporates the expertise of optometrists, occupational therapists, orientation and mobility specialists, and assistive technology (AT) specialists to promote independence among visually impaired individuals by equipping them with tools and training to accomplish specific visually mediated tasks⁸. However, if the patient's ability to learn new techniques and adapt to new equipment is affected by comorbid memory problems, the benefits of LVR may be decreased.

Qualitative research has uncovered unmet needs among LVR patients with comorbid deficits in vision and cognition, and LVR providers expressed uncertainty about how to accommodate patients with memory problems⁹. Participants with memory problems may experience different outcomes in LVR either because they are less able to engage in training, or because services are rendered to them at a different pace or manner. The randomized, controlled LOVIT trial demonstrated effectiveness of outpatient LVR in preserving vision-related function, but LOVIT excluded individuals who screened positive for cognitive impairment¹⁰. Thus, the trial did not address whether cognitive deficits (such as memory problems) are associated with LVR outcomes.

This study aims to examine the association between memory deficit and functional outcomes in older adults receiving LVR. The specific objective is to determine whether performance on a simple memory test at baseline relates to longitudinal trajectories of visual function scores among older macular disease patients enrolled in an outpatient LVR program.

METHODS

Population and Setting

Recruited patients were aged 65 years or older with macular disease and initiating LVR in the Duke LVR Clinic between September 2007 and March 2008. Recruitment occurred on specific days during the study period; on recruitment days, all consecutive eligible patients were invited to participate. Of 139 invited patients, 103 (74.1%) signed consent forms and 101 completed memory testing at baseline. Those who declined did not differ significantly from study participants by sex, race, or age. Ten subjects lacked longitudinal functional data (mean age 80.6 ± 6.3 years, 9 female, 10 white, 3 with memory deficit). The remaining 91 subjects were included in this analysis. The study was approved by the Duke University Medical Center Institutional Review Board.

The Duke LVR Clinic coordinates a multi-disciplinary outpatient rehabilitation service within the Duke Eye Center. The LVR team is led by an optometrist and includes an AT specialist, an occupational therapist, and a low vision technician. New patients receive a standardized assessment and then, as is typical in LVR⁸, providers develop an individualized rehabilitation plan, based on participant needs and personal goals. Services may be delivered in the clinic or the patient's home. Typical interventions include refraction, provision of and training for vision assistive equipment (VAE), or educational interventions such as preferred retinal locus (PRL) training or information about lighting. Over time, rehabilitation plans may be refined to suit a participant's changing goals or needs.

Data Collection

Data were collected in person at baseline and during as many as three subsequent telephone interviews, with interviews separated by at least 30 days. Three follow-up interviews were completed by 86 of 91 (94.5%) study participants. The amount of time between interviews varied due to participant availability, such that follow-up periods ranged from 32 to 297 days (mean 115 ± 29 days). Data were collected by investigators who were not involved in the clinical care of the patients; the rehabilitation team was masked to data collected during the study.

Memory Testing

Cognitive testing was completed on the day of enrollment, in private exam rooms by individuals trained and supervised by a neuropsychologist to administer cognitive tests according to standardized instructions. The cognitive battery included several tests of memory, including immediate and delayed recall of a 10-item word list from the Telephone Interview for Cognitive Status – modified (TICS-m)^{11, 12} and Logical Memory tests of prose recall¹³. All memory scores were highly correlated with each other. In order to examine the most easily reproducible measure, memory deficit was defined as the lowest quartile of scores on the immediate recall task from the TICS-m. In this test, a list of ten words is read aloud and subjects are asked to recall as many words as possible immediately after hearing the list. The scores approximated a normal distribution (mean 3.5 ± 1.6 , median and mode = 3, range = 0 to 8). Participants with memory deficit recalled two or fewer words.

Visual Function Tests

Vision-dependent function was assessed with the Version 2000 National Eye Institute Vision Function Questionnaire – 25 (VFQ-25), a well-validated tool for measuring the influence of visual symptoms on generic health domains and tasks of daily living¹⁴. The VFQ-25 was administered aloud to participants at baseline (in person) and during follow-up telephone interviews. Individual items from the VFQ-25 can be combined to derive 11

subscales that reflect the impact of impaired vision on specific domains of health, including activity-related function and psychological well-being. Possible scores on each scale are 0 to 100, with higher scores indicating better function.

Four VFQ-25 subscales were evaluated in this study: near activities, distance activities, role difficulties, and dependency¹⁵. The near activities and distance activities subscales were selected because items in these subscales are particularly sensitive to change through outpatient LVR¹⁶. The role difficulties and dependency subscales were selected because earlier work suggested that the presence of comorbid memory impairment is associated with greater dependency among visually impaired older adults^{4, 9}.

The near activities score is based on responses to questions that assess how much difficulty participants have, as a result of their vision, with reading, cooking, sewing, fixing small things, or finding something on a crowded shelf. The distance activities score is based on responses to similar questions about difficulty seeing movies, plays, sporting events, and reading street signs or store names while riding along in a car. Participants can choose among responses indicating “no difficulty,” “a little difficulty,” “moderate difficulty,” “extreme difficulty,” “stopped doing the activity because of eyesight,” or “stopped doing the activity for other reasons.” The role difficulty score is based on participant response to the questions, “Do you accomplish less than you would like because of your vision?” and “Are you limited in how long you can work or do other activities because of your vision?” Participants choose between responses “all, most, some, a little, none of the time.” The dependency score is derived from participant response to the following statements: “I stay home most of the time because of my eyesight,” “Because of my eyesight, I have to rely too much on what other people tell me,” and “I need a lot of help from others because of my eyesight.” Participants indicate whether they believe these statements are “definitely true,” “mostly true,” “not sure,” “mostly false,” or “definitely false.”

Other Variables Collected—Information on demographics, living status, and physician-diagnosed medical conditions was collected in the baseline interview. The 15-item Geriatric Depression Scale (GDS) was administered to each participant at baseline¹⁷. Information related to ophthalmologic medical history and visual acuity measures were abstracted from the Duke Eye Center chart by a certified ophthalmologic assistant using a standardized case report form.

Analysis

Linear mixed models (LMMs) were constructed to assess whether visual function outcomes differed over time among participants with memory deficit at baseline. LMMs are an appropriate method to compare differences in the longitudinal data from this study for several reasons. First, the time that elapsed between telephone interviews varied between participants. LMMs model rates of change in an outcome, which can be determined from two or more data points regardless of the amount of intervening time. Thus, mixed models are useful when there is high variability in participants' length of follow-up and timing of repeated measurements. Second, mixed models appropriately handle observations that are not independent, such as repeated measurements of function. Finally, function is a dynamic variable and transient declines in function are common in old age and do not always reflect long-term functional trajectories¹⁸. Thus, it may be more appropriate to consider participants' averaged functional trajectories, utilizing all available data on each participant, rather than relying on “change in function” between two arbitrary time points.

Tests of significance were conducted in models that included sex, age, education level, memory group (deficit or no deficit), time, and a memory group by time interaction term. The primary test of interest was whether the memory group by time interaction term was

significant, because this test indicates whether the average functional trajectories are the same over time for participants with and without a memory deficit. A graphical representation of this relationship was obtained by displaying population lines calculated using parameter estimates from models that contained only memory group, time and the interaction term. Analyses were conducted with SAS software version 9.2 (Cary, NC); p value 0.05 indicated statistical significance.

RESULTS

Table 1 summarizes the baseline characteristics of the cohort. Most participants were white, with the most common macular condition being AMD, which has a predilection for Caucasians. Persons with memory deficit tended to be older, less educated, more likely male, less often married and to endorse more comorbid medical diagnoses. A higher proportion of people with memory deficit had dry, as opposed to wet, AMD and a lower proportion had received intra-ocular treatment with steroids, laser, or anti-vascular endothelial growth factor (VEGF) agents.

Memory Deficit as a Predictor of Activities that Require Near or Distance Vision

In models adjusted for age, sex, and education, individuals who had memory deficit experienced significantly worse trajectories on the near vision activities subscale ($p = 0.002$). On average, these individuals' VFQ-25 near vision subscale scores declined over time, whereas their peers with intact memory reported modest improvements in near vision activities (Figure 1). The numbers in Table 2 are derived from the linear mixed model that was fitted to this study's data. Table 2 reports the VFQ-25 near vision activity subscale scores calculated for average study participants, with and without memory deficit, at 30 days, 60 days, and 90 days after beginning the LVR program.

The distance activities subscale scores did not change significantly over time and trajectories did not differ significantly among participants with or without memory deficit.

Memory Deficit as a Predictor of Role Difficulty or Dependency

In models adjusted for age, sex, and education, participants with memory deficit did not differ significantly from the rest of the cohort in their trajectories of the VFQ-25 role difficulty or dependency subscales. Overall, participants perceived an increasing level of difficulty with role performance, whereas VFQ-25 dependency scores did not change significantly over the study period.

DISCUSSION

In this cohort of older patients receiving LVR for macular disease, memory deficit at baseline was associated with worse longitudinal outcomes related to specific tasks that require near vision. A 4- to 6-point change in VFQ-25 subscale score is considered clinically significant^{19, 20}; thus, the functional trajectories observed in this study represent a meaningful difference in visual function between participants with and without memory problems. Consistent with some previous studies of treatment outcomes in LVR^{10, 16}, participants with intact memory tended to report improvements in their ability to perform certain visually mediated tasks. However, this study is the first to demonstrate that older LVR patients with comorbid memory deficits may not experience similar gains in functional ability. This finding is significant, particularly in light of the frequent co-occurrence of memory problems in macular disease patients^{5, 6} and a previous observation that memory deficits are common among seniors receiving outpatient LVR¹. Future research is needed to determine whether the functional outcomes of low vision patients with comorbid memory

impairment might be improved by protocols to detect and accommodate this common comorbidity.

Efforts to promote independence in the face of vision loss – or any chronic condition - could be hindered by comorbid memory deficit. Yet cognitive evaluation is not routinely performed in many subspecialty services, including low vision rehabilitation. While this may be due in part to time constraints or to lack of personnel trained to administer cognitive tests, the current study found that a simple, fast memory screen (10-item word recall) distinguished individuals at risk for worse functional outcomes.

Although this study demonstrates a significant association between memory performance at baseline and subsequent functional trajectories in LVR, it does not determine *why* people with memory deficits experienced worse functional outcomes. One possibility is that memory impaired participants do not gain as much benefit from similar rehabilitation interventions, compared to their peers with intact memory. Another possibility is that people with memory impairments tend to receive a different array of services or their care is delivered in a different manner. LVR, like many rehabilitation services, is intentionally individualized in an effort to meet participant's unique goals and needs. The present study did not assess specific aspects of care delivery or receipt of services that may have contributed to the observed differences in functional outcomes. A third possibility is that the relationship between memory deficit and functional trajectory was influenced by potential confounders (e.g., risk factors for functional decline that were more common among persons with memory deficit). Nonetheless, the finding that a brief memory test identified participants at risk of worse functional outcomes suggests an opportunity for improved care. Future research should investigate factors that contribute to the association described here and whether functional outcomes for LVR patients with memory problems may be improved by targeted accommodations.

Several limitations may impact the interpretation of results. First, although participants with and without memory deficits had similar visual acuity at baseline, the study did not measure or control for visual acuity at later time points. The relatively short duration of the study period (115 ± 29 days) makes it less likely that changes in visual acuity contributed substantially to the differing functional trajectories. Second, the accuracy of self-reported functional outcomes could be influenced by memory impairment. Nevertheless, the finding that memory deficits were associated with differences in perceived vision-related function is itself clinically relevant. Third, the same study personnel administered baseline and follow-up questionnaires and thus were not masked to cognitive status; the use of standardized tools to assess patient-reported functional outcomes should reduce potential bias.

This study found that LVR patients with intact memory experienced improvement in ability to perform specific visually mediated tasks, whereas their peers with poor word recall reported declining function on the same tasks. Future work should focus on rehabilitation strategies that optimize independence and quality of life for patients with comorbid vision loss and memory impairment.

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Figure 1.

Low Vision Rehabilitation Participants with Memory Deficit Experienced Worse Functional Trajectories in Activities that Require Near Vision

In this observational study of 91 older adults with macular disease who were enrolled in outpatient low vision rehabilitation, visual function was assessed at baseline and during one to three follow-up interviews using the National Eye Institute Vision Function Questionnaire (VFQ-25). The near vision activities subscale of the VFQ-25 is based on participant response to questions that assess vision-related difficulty with reading, cooking, sewing, fixing small things, or finding something on a crowded shelf¹⁵. The data were used to construct linear mixed models to estimate average scores over time for participants with and without memory deficit. Memory was tested at baseline with a 10-item word list; memory deficit was present in participants who recalled 2 words immediately after the list was read aloud. Controlling for age, sex, and education level, VFQ-25 near vision activities subscale trajectories were worse among participants with memory deficit, compared to participants without memory deficit (p value 0.002, indicating a difference between groups in the rate of change of the VFQ-25 subscale over time). The VFQ-25 has a possible range of scores from 0 to 100; a 4- to 6-point change in VFQ-25 subscale scores is considered clinically significant^{19, 20}.

Table 1

Characteristics of the Cohort

Baseline Characteristics	Overall Cohort N=91	Participants with Memory Deficit ^a N=27	Participants without Memory Deficit N=64
Age in Years, Mean (SD) ^b	80.1 (8.0)	84.1 (7.6)	78.4 (7.6)
Sex			
Female, N(%)	58 (63.7)	15 (55.6)	43 (67.2)
Race			
Caucasian, N(%)	87 (95.6)	26 (96.3)	61 (95.3)
Education			
High School, N(%)	31 (34.1)	12 (44.4)	19 (29.7)
College, N(%)	42 (46.2)	11 (40.7)	31 (48.4)
Beyond College, N(%)	18 (19.8)	4 (14.8)	14 (21.9)
Marital Status			
Married, N (%)	42 (46.2)	6 (22.2)	36 (56.3)
Depression			
% GDS ^c score ≥ 5	24 (26.4)	8 (29.6)	16 (25.0)
No. of 14 Comorbid Conditions Endorsed ^d			
Mean (SD)	2.7 (1.6)	3.2 (1.7)	2.5 (1.5)
TICS-mScore ^e Mean (SD)	31.1 (5.1)	27.1 (5.4)	32.8 (3.9)
Min, Max	7.0, 44.0	7.0, 35.0	25.0, 44.0
Best Corrected Visual Acuity (ETDRS ^f) in Better Eye			
Median	20/50	20/50	20/50
Interquartile Range	20/40 to 20/100	20/50 to 20/100	20/40 to 20/100
Type of Macular Disease			
Wet AMD ^g , N(%)	48 (52.7)	11 (40.7)	37 (57.8)
Dry AMD, N (%)	18 (19.8)	7 (25.9)	11 (17.2)
Diabetic Macular Edema, N(%)	1 (1.1)	1 (3.7)	0
Epiretinal Membrane, N(%)	2 (2.2)	0	2 (3.1)
Other ^h , N(%)	17 (18.7)	5 (18.5)	12 (18.8)
History of Treatment with Intra-ocular Steroids, Laser, or anti-VEGF ⁱ			
Agents, N(%)	48 (52.8)	10 (37.0)	38 (59.4)
VFQ-25 ^j Near Activities Score, Mean (SD)	45.3 (24.4)	47.5 (22.3)	44.5 (25.3)
VFQ-25 Distance Activities Score, Mean (SD)	49.6 (29.1)	44.7 (32.0)	51.6 (27.8)

Baseline Characteristics	Overall Cohort N=91	Participants with Memory Deficit ^a N=27	Participants without Memory Deficit N=64
VFQ-25 Dependency Score, Mean (SD)	62.8 (29.3)	61.6 (26.5)	63.3 (30.6)
VFQ-25 Role Difficulty Score, Mean (SD)	56.7 (28.0)	52.4 (26.5)	58.5 (28.6)

^aMemory deficit was defined as present in participants who recalled two words from a 10-item word list during the Telephone Interview for Cognitive Status, modified (TICS-m) Immediate Word Recall task.

^bSD = standard deviation

^cDepression defined as geriatric depression screen (GDS) score ≥ 5 ¹⁷

^dParticipants were asked whether a physician had ever diagnosed them with the following conditions: coronary artery disease, congestive heart failure, arthritis, pulmonary disease, stroke, diabetes, hypertension, liver disease, kidney disease, cancer, dementia, Parkinson's disease, hip fractures, ulcers

^eGlobal cognitive status was assessed with the modified Telephone Interview for Cognitive Status, which has a possible score range 0 to 50. A TICS-m score ≥ 27 is considered a positive screen for cognitive impairment.¹²

^fETDRS = Early Treatment Diabetic Retinopathy Study

^gAMD = age-related macular degeneration

^hOther primary macular diagnoses included: non-diabetic macular edema, branch retinal vein occlusion, choroidal neovascularization of the macula, pigment epithelial detachment, Stargardt's Disease, Wagner's Syndrome, myopic macular degeneration, presumed ocular histoplasmosis syndrome, cone degeneration

ⁱVEG-F = vascular endothelial growth factor

^jVFQ-25 = 25-item National Eye Institute Visual Function Questionnaire

Table 2

VFQ-25 Near Activities Subscale Scores Calculated at 30, 60, and 90 days Post-enrollment in Low Vision Rehabilitation

Memory Status	VFQ-25 Near Activities Subscale Scores (Range 0 to 100)* (95% Confidence Interval)		
	Days After Enrollment in LVR		
	30 days	60 days	90 days
No Memory Deficit at Baseline	45.5 (38.9 to 52.1)	46.8 (40.3 to 53.3)	48.0 (41.4 to 54.6)
Memory Deficit at Baseline	41.5 (30.9 to 52.1)	39.9 (29.4 to 50.4)	38.4 (27.8 to 49.0)

* The VFQ-25 score of an average study participant, with or without memory deficit, is calculated from the linear mixed model equation which was derived from the data observed in this study. The equation is:

$$y = 44.5 - 1.21m - 2.64g + 0.26a - 1.32e + 0.04t - 0.09(m \times t)$$

where y = VFQ-25 near activities score; m = 1 if memory deficit, 0 if no memory deficit; g = 1 if female, 0 if male; a = age in years; e = years of education; t = days since enrollment

To calculate the values in this table, we assumed average values of age, gender, and education within the study population: 80 years old, female, 14 years of education. We estimated such a patient's VFQ-25 score at 30, 60, and 90 days following enrollment if she did, or did not, present with memory deficit.