

Assessment of the Pre and Post Cognitive Function in Patients Undergoing Carotid Artery Stenting

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Research Question

- What is the effect of carotid artery stenting on cognitive function in subjects with high grade carotid artery stenosis? **See Figure 1**

Methods

Design

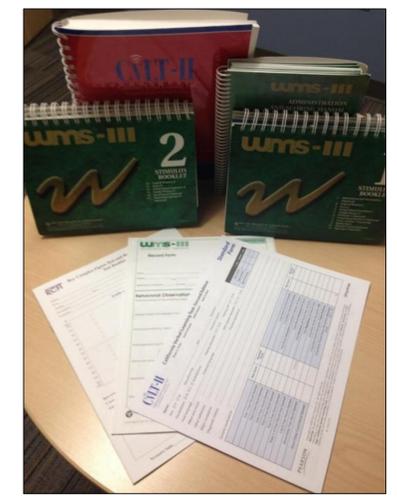
- Prospective, non-randomized, single center study, conducted at Spectrum Health and West Michigan Heart
- Subjects with severe carotid artery stenosis were followed pre and post their clinically indicated carotid artery stenting (CAS) procedure
- A battery of standardized cognitive tests performed pre and post CAS were evaluated by a licensed psychologist
- Other study related data collected for statistical analysis included: medical history, anatomical and procedural information collected during CAS procedures and a neurological evaluation using the National Institute of Health Stroke Scale

Participants

- Convenience sampling method from the investigator's practice
- Key Inclusion Criteria: asymptomatic 40-80 year olds, right hand dominance, > 80% stenosis with a TIMI flow 1-3 and a baseline peak carotid velocity of 380cm/sec.
- Key Exclusion Criteria: history of major stroke within 6 months, Alzheimer's, dementia, cognitive impairment, planned intervention to contralateral carotid artery or any planned major surgery within 2 months post procedure
- Clinically indicated subjects were evaluated for eligibility and voluntarily consented for participation
- 19 enrolled subjects

Outcome Measures

- A series of standardized tests combined into an hour long testing session was performed pre and post CAS procedure
- Tests included: Digit Span and Coding subtests from the Wechsler Adult Intelligence Scale-3rd ed. (WAIS-3), FAS Verbal Fluency Test, Mental Control subtest from the Wechsler Memory Scale, Rey-Osterrieth Complex Figure Test, Trail Making Test parts A & B and the California Verbal Learning Test-2 (CVLT-2)



Procedures

- Approval of this project was granted by the Spectrum Health Institutional Review Board
- Pre procedure research data was captured within 14 days of each subject's CAS procedure
- Post procedure research data was captured at subjects' routine 1 month follow-up visit with the investigator at 40 +/- 14 days
- Additional research data was collected at the hospital just prior to CAS procedure, during CAS procedure and prior to discharge



Figure 1. Imaging from carotid angiograms of subject # 01. The image on the left demonstrates a high grade stenosis of the internal carotid artery. The image on the right displays the same artery immediately following deployment of a carotid stent. The stenosis has significantly been reduced, which in turn increases blood flow to the brain.

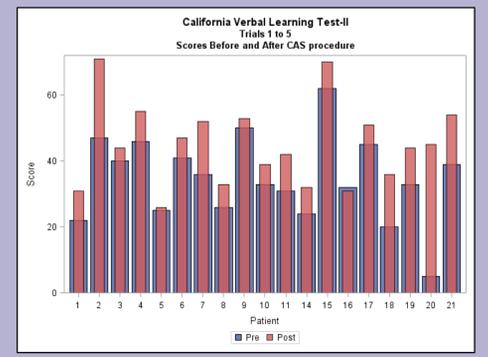


Figure 2. The CVLT-II test is conducted by presenting a subject with a list of 15 words. Overall scores are determined by calculating the average number of verbally recalled words after 5 trials. This figure shows the pre CAS and post CAS CVLT-II test scores for all study participants.

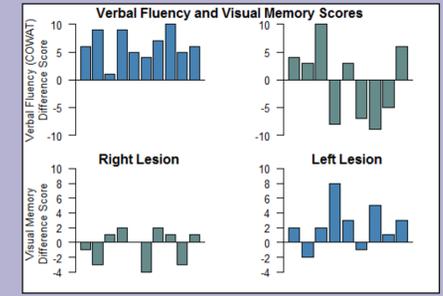


Figure 3. The Controlled Oral Word Association Test (COWAT) measures verbal fluency using a subject's spontaneous production of words beginning with a given letter. Visual memory was assessed through the use of the Rey-Osterrieth Complex Figure Test and was measured by a Recognition Total Correct score. The figures display difference scores (post CAS - pre CAS) and then are separated by left and right hemispheric lesions.

Data Analysis

- Wilcoxon Signed Rank tests were conducted to compare the pre and post cognitive test scores ($\alpha = 0.05$).
 - Bonferroni-Holm adjustment for multiple comparisons
- Fisher's Exact Test was used to investigate if specific medical history variables were associated with pre and post test score differences ($\alpha = 0.05$).
- Mann-Whitney U tests were used to compare verbal fluency and visual memory (via symbol recognition) for subjects identified with a right hemispheric and those with a left hemispheric lesion ($\alpha = 0.05$).

Results

- Results indicated a significant median increase in scores of the Trials 1 to 5 portion of the California Verbal Learning Test-II (CVLT-II; $p = 0.00019$). On average, subjects were able to recall more words from the given list post CAS. This suggests an overall average improvement of short term memory. **See Figure 2**
- Evidence indicates that a subject's degree of stenosis is significantly associated with their improved delayed (30 minutes) and immediate ability to recall a complex figure post CAS ($p = 0.0305$). This suggests that improvement in visual memory post CAS is impacted by the degree of vessel narrowing pre CAS.
- There is a significant association between diabetes mellitus and improved total recognition post CAS ($p = 0.0305$). Through the use of the Rey-Osterrieth Complex Figure Test, subjects were asked to reproduce a complex figure at different time intervals and were asked to identify individual portions of the complex figure from a set of random figures. The data suggests that improvement in visual memory post CAS is impacted by whether the subject has controlled, uncontrolled or no diabetes mellitus.
- Subjects with a right hemispheric lesion showed more improvement on measures of verbal fluency (COWAT) than those with a left hemispheric lesion, on average ($p = 0.0298$). **See Figure 3**
- Subjects with a left hemispheric lesion showed more improvement on measures of visual memory than those with a right hemispheric lesion, on average ($p = 0.0354$). **See Figure 3**

Conclusions

- Our results, as consistent with a number of previous studies, offer support for stable or improved cognitive functioning post CAS procedure.
- Clinically, this may have implications when considering the efficacy and utility of CAS in relation to other available and alternative treatment.
- Secondary analysis suggest trends in the areas of degree of stenosis, diabetic status and lesion location on potential neuro-cognitive outcomes. Further study with more robust sampling is required to better understand the degree of effect these mediating factors have on cognitive function.