Contrast Sensitivity Function in Non-Neovascular Age-Related Macular Degeneration measured with Active Learning

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Disclosures

No disclosures:

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The testing device is FDA-registered

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Summary



- Compared to Visual Acuity, Contrast Sensitivity Function (CSF) may correlate better with subjective functional vision and be more sensitive to subtle changes of visual function earlier in the course of the disease.
- Applying a novel active learning quick method to measure CSF in a cohort of nnAMD patients and healthy controls we sought to investigate the premise of
 - 1. CSF for differentiating nnAMD from healthy eyes
 - 2. CSF for differentiating different stages of AMD
 - 3. CSF a functional endpoint both in the routine clinical practice and potentially in future nnAMD clinical trials too.







Background/Aim

- Intelligent systems are becoming a powerful tool in ophthalmology
- Many emerging applications of artificial intelligence and deep learning to ocular imaging data.
- Yet, these AI/DL algorithms cannot answer a fundamental clinical question:

How well does the patient see?

• Applying intelligent tools to vision testing for a sensitive, precise, timeeffective and personalized testing of contrast sensitivity and acuity to improve clinical decision making and outcomes







Background/Aim

- Good Visual Acuity does not always mean subjectively good functional vision.
- Among metrics of visual function, contrast sensitivity strongly correlates with subjective visual impairment & real world everyday vision-guided activities (functional vision)
- Contrast sensitivity function (CSF):
 - Contrast = brightness difference between an optotype and its background
 - Spatial frequency = thickness of the lines







Why Contrast Sensitivity is not routinely tested in the clinical practice ?

- Laboratory tests not time-effective
- Pelli Robson only l spatial frequency
- Pre-printed paper charts low test-retest repeatability







Legacy approach to testing VA and CS



14 sizes, 1 contrast.10 sampling resolution70 possible letter scores

15 contrasts, 1 size.15 log10 sampling resolution45 possible letter scores

Pelli-Robson





Intelligent Algorithms for Visual Function





- Search library of potential contrast and acuity test items
- **Test** with personalized, optimized items
- Analyze responses with a rich computational model
- **Repeat** until they converge on a test sequence









Search an expansive test bank of >2400 sizecontrast combinations





















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Relative to the 14+15=29 size-contrast combinations used by ETDRS and Pelli-Robson testing....







Quick CSF method

- Active learning algorithms 'personalize' the test based on their previous answers the test provides each patient with the optotypes with the optimal contrast & spatial frequency combination for maximal information extraction
- Reduces trials needed from several hundreds to several dozens 5-10' its practical !
- Tests a wide range of contrast and spatial frequency
- Good sensitivity to subtle changes & great test-retest repeatability







Quick CSF method

- Initially applied to basic studies of vision, the qCSF computational approach was then commercialised in a a novel clinical device, the Manifold Contrast Vision Meter (Adaptive Sensory Technology, San Diego,CA)
- •Tested in various populations including amblyopia, multiple sclerosis, glaucoma, early DR and aging.
- •So far our team has investigated qCSF in RVO, mac-off RD and CSR and high VA maculopathies comparing with unaffected fellow eyes and age-matched controls. Our study design was prospective cross-sectional not enough longitudinal data yet







Methods/Recruitment

- Prospective, observational, IRB approved
- 129 eyes with nnAMD, 31 early, 88 intermediate, 9 advanced compared to 133 healthy controls





Results: BCVA

- controls: 0.00
- early nnAMD: 0.040 in(p>0.05)
- intermediate nnAMD: 0.117 (p<0.0001)
- Advanced nnAMD: 0.448 (p=0.025)











Results: CSF

Multivariate Mixed Effects Regression Analysis:

- •Early nnAMD: CSF thresholds at low spatial frequencies (1, 1.5, 3 cpd) were significantly decreased (B=-0.13, B=-0.13, B=-0.12, all p<0.01) despite no difference in BCVA
- •Intermediate and Advanced nnAMD: CSF thresholds at low spatial frequencies and AULCSF were decreased compared to controls (all p<0.05)

•No significant differences were identified in higher spatial frequencies (12, 18 cpd)

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MGH

1.5

1.0

Normal

Early AMD

Intermediate AMD
Advanced AMD

1.5

2.0



Results: CSF

- Multivariate Mixed Effects Regression Analysis:
- •AULCSF was able to differentiate between nnAMD stages (B=-0.02 vs B=-0.16 vs B=-0.61)







Results: CSF

- Multivariate Mixed Effects Regression Analysis:
- •AULCSF was able to differentiate between nnAMD stages (B=-0.02 vs B=-0.16 vs B=-0.61)









Conclusions

- CSF measured with the novel active learning method was found to be significantly decreased in early nnAMD compared to controls despite no difference in VA and was able to differentiate between nnAMD stages.
- CSF may emerge as a promising visual function endpoint in clinical practice and future nnAMD clinical trials.





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