Gift of Sight Clinical Research Award
2021 Winner: Christopher B. Schulz

Title
Automated video assessment of the ocular adnexa using artificial intelligence

Purpose
Advances in artificial intelligence (AI) and computer vision could pave the way for automated video assessment of those sight-threatening ophthalmic and neurological disorders with facial manifestations. The current study aimed to develop and test an AI algorithm to automate the assessment of eyelid position (MRD1 and MRD2), blink lagophthalmos (bLag) and average ocular surface area exposure (OSAE) from video.

Methods
A custom algorithm was designed to read each frame of a video taken of a person's face, and for each frame to detect the periocular region. A convolutional neural network was trained to segment periocular anatomy using 7101 pre-annotated images and cross-validated using 1781 images. The trained network was incorporated into the algorithm with the calculation of key clinical markers of MRD1, MRD2, bLag and OSAE. Using this algorithm, each measure was determined for 75 videos of patients with acute onset facial nerve palsy (FNP) and compared with 75 control videos. For each marker, differences in the 2 groups were compared. Paired t-testing evaluated the difference in measures between baseline and 6-month follow-up from 25 patients with FNP. Test-retest reliability was evaluated using Bland-Altman analysis of videos taken within 48 hours of each other. A further 20 participants underwent in-person clinical assessment of MRD1, MRD2 and bLag by 2 independent clinicians as well as automated video assessment. The agreement between automated and clinician-derived measures was evaluated, along with comparison of the standard error of measurement between each method.

Results
The trained segmentation model achieved 98.6% accuracy. All automated measures were different between FNP and controls ($p<0.001$). At 6-month follow-up, there was no difference in MRD1 and MRD2; bLag and OSAE were significantly different ($p=0.02$). Agreement between automated and clinician-derived measures was good ($R >0.85$; $p<0.01$). Standard error of measurement was comparable between both methods.

Conclusions
Automated video assessment of the ocular adnexa is feasible and demonstrates promising initial indicators of validity and reliability. Such technology might facilitate remote clinical assessment and self-monitoring. It might also facilitate the measurement of novel, more

sensitive and clinically meaningful disease markers e.g. blink lagophthalmos and ocular surface exposure.

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