Title: Assessing Cataract Surgery Skills Through Machine Learning: A pilot study

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Purpose
Cataract surgery is a common, high volume, and agile procedure with sequential repetitive and reproducible steps. Our goal is to develop a method for quantitative and objective analysis of the reproducible steps in cataract surgery. This will allow future surgeries to be analyzed with a goal of giving unbiased instructional feedback.

Methods
This prospective study consisted of using a total of 387 consecutive cataract procedures performed by a faculty or trainee surgeon in an ophthalmology residency program October 2018 and March 2019. With an artificial intelligence model, an existing image classification network for tool detection in cataract surgery was fine-tuned which allowed for automatic identification of each phase in the surgery. Subsequently, the tool detection results were used to encode each phase in the surgery as a vector. Successively, we examined the relation between vector encodings and perceived skill based on a framewise, trialwise and userwise evaluation scenario. We evaluated the algorithms using area under the receiver operating characteristic curve (AUC) and the classification accuracy.

Results
Our model achieved an AUC ranging from 0.9332 to 0.9977 for surgical step recognition based on tool detection. For skill classification, the framewise AUC was 0.55, Trialwise AUC was 0.57 and userwise AUC was 0.69.

Conclusion
Machine learning research has gathered increased interest in the field of ophthalmology as an aid for diagnosis and management. Our research aims to provide a database of cataract surgery videos and a method by which individual cataract surgeries can be analyzed on a novice to expert scale. This will also allow learners to assess their own surgical skills in relation to their perceived skill based on level of training.