

# Using Drawing to Evaluate Functionality in Patients with Hand and Wrist Pathology

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## INTRODUCTION:

We developed a custom digital drawing application to assess hand function. We performed an initial validation study of this technique to: 1) assess which drawing features could be good indicators of hand function, 2) differentiate patients from controls for both dominant and non-dominant hands, and 3) assess the correlation of geometric drawing features with previously validated patient-reported outcome scores of upper extremity and global function.

## METHODS:

In this prospective study, participants were asked to draw multiple shapes on an Apple iPad with a digital pen using a custom digital app. Drawings from 142 hands in 73 participants were categorized based on hand dominance and patient/control. Raw data included pen coordinates, pressure, azimuth, and altitude over time. We calculated kinematic and pressure-based features that generalize to any drawn shape from the raw data. Machine learning models were used to statistically classify patients and controls, and to generate our own composite scores. Model performance for classification was assessed using accuracy, precision, recall, F1 score, and area under the curve (AUC). Model performance for predicting composite scores was assessed using absolute error.

## RESULTS:

Patients and controls could not be differentiated by simple visual inspection of drawings; however, many geometric features were significantly different ( $p < 0.01$ ) between patients and controls for both dominant and non-dominant hand drawings. The circle drawings were the most informative and pressure features were the most important. The dominant and non-dominant hand classification metrics for discriminating patients from controls were similar (AUC =  $\sim 0.82$ , Accuracy =  $\sim 0.77$ , F1 =  $\sim 0.80$ ). Composite geometric drawing features were significantly correlated with PRWE, SF12, and qDASH scores ( $p < 0.001$ ).

## DISCUSSION AND CONCLUSION:

We developed a novel technique to objectively measure hand function using drawing. Geometric drawing features were correlated with validated patient-reported outcome scores and could differentiate patients from controls, regardless of hand dominance.

