Objective assessment of Parkinson’s disease motor symptoms during leg agility test using motion sensors

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Objective:
To develop and evaluate machine learning methods for assessment of Parkinson’s disease (PD) motor symptoms using leg agility (LA) data collected with motion sensors during a single dose experiment.

Background:
19 advanced PD patients (mean years with PD: 9.7, mean years with levodopa: 9.5) were recruited in a single center, open label, single dose experiment [1].
Leg agility tasks were performed by patients at predefined timepoints up to 15 times while wearing motion sensors on their foot ankle.
The time points were: starting from baseline, at the time of morning dose (150% of the normal levodopa equivalent dose), and at follow-up time points until the medication wore off.
Movement disorders specialists rated the videos of the PD patients on scales of treatment response scale (TRS), UPDRS #26 (leg agility), #27 (arising from chair), #29 (gait), #31 (bradykinesia), and dyskinesia.
Quantitative measures from motion sensors were calculated and the most important features were selected.

Methods:
Machine learning methods of support vector machines (SVM), linear regression, and decision trees used to map the calculated features to rating scales of TRS, UPDRS #31, SUMUPDRS (sum of #26,#27,#29), and dyskinesia.
Validity of the machine learning methods to mean clinical ratings were assessed by Pearson correlation coefficients and Root Mean Squared Error (RMSE).
Test-retest reliability of the methods during baseline measurements were examined by intra-class correlation coefficient (ICCs) and their 95% confidence intervals (CI).
Responsiveness of machine learning-based scores to levodopa effects was assessed by calculating the effect sizes [2].

Results:
Validity: SVM method provided the best validity to clinical ratings.

<table>
<thead>
<tr>
<th></th>
<th>TRS</th>
<th>UPDRS #31</th>
<th>SUMUPDRS</th>
<th>Dyskinesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVM</td>
<td>0.81 (0.77)</td>
<td>0.83 (0.53)</td>
<td>0.78 (1.65)</td>
<td>0.67 (0.50)</td>
</tr>
</tbody>
</table>

Test-retest reliability: The reliability of the scores during first two measurements were high for both clinical rating and SVM scores.

<table>
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<th>UPDRS #31</th>
<th>SUMUPDRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical scores</td>
<td>0.91 (0.78-0.96)</td>
<td>0.81 (0.57-0.92)</td>
<td>0.89 (0.73-0.95)</td>
</tr>
<tr>
<td>SVM</td>
<td>0.85 (0.65-0.94)</td>
<td>0.78 (0.78-0.96)</td>
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</tbody>
</table>

For reliability of the clinical dyskinesia ratings during the first two baseline measurements, all patients were rated with 6.

Responsiveness: The effect sizes from SVM-based scores showed reasonable responsiveness to UPDRS #31 and SUMUPDRS, but small responsiveness to TRS and dyskinesia rating scales.

Conclusions:
The proposed machine learning methods are able to assess motor symptoms in PD comparable to clinical ratings. Leg agility data were not highly responsive to the levodopa related changes.

References: