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Identification of possible phenotypes in Parkinson's disease through machine-learning and motion analysis

Giuseppe De Biasi[1] F. Di Filippo[1], C. Ricciardi[2], M. Russo[2], N. Pisani[3], A. Volzone[1], M. Calabrese[1], M. Romano[2], P. Barone[1], M. Amboni[1]

[1,1]*Department of Medicine, Surgery and Dentistry, Center for Neurodegenerative Diseases (CEMAND), University of Salerno, Fisciano, Italy*

[2]*Department of Electrical Engineering and Information Technology, University of Naples "Federico II", Naples, Italy*

[3] *Department of Advanced Biomedical Sciences, University of Naples Federico II, Naples, Italy*

Introduction

Parkinson's disease (PD) is increasingly recognized as a disorder that extends beyond its core diagnostic criteria, encompassing a wide range of motor and non-motor symptoms and signs [1] that variously aggregate in heterogeneous phenotypes with different clinical course [2].

Our objective is to evaluate gait patterns [3,4] in single and dual-tasks in clinical clusters identified by unsupervised machine-learning method.

Methods

A clustering analysis through K-means algorithm was conducted on MDS-UPDRS Parts I&II items scores, after excluding gait-related items, in a cohort of 105 PD patients consecutively enrolled and evaluated with gait analysis acquired in three different conditions (normal gait and two dual-tasks)

Subsequently, univariate statistical analysis (ANOVA test or Kruskal-Wallis test, as appropriate) with post-hoc analysis was carried out to evaluate the differences among groups on spatio-temporal gait variables. Significance was set a $p<0.05$.

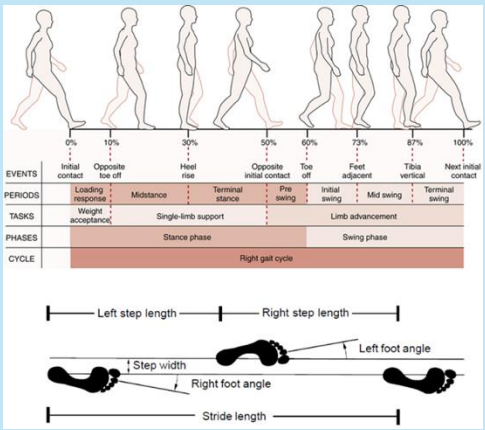

Fig. 1. Spatio-temporal parameters evaluated during gait analysis

Results

The unsupervised machine-learning analysis identified two clusters of which one emerged significantly smaller versus the other one, reflecting asymmetric clustering.

Based on these findings, to better refine the clustering process, a second cluster analysis was conducted, after instructing the algorithm to select three clusters:

- 44 subjects in Cluster 1 (lower symptoms burden)
- 13 subjects in Cluster 2 (greater symptoms burden)
- 48 subjects in Cluster 3 (intermediate symptoms burden).

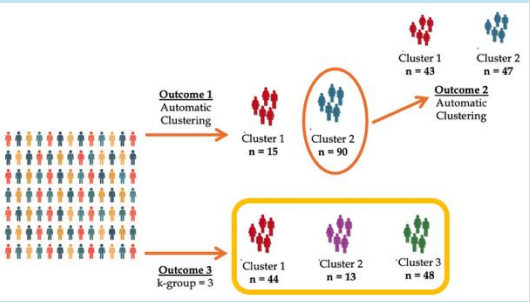

Fig. 2 Clustering models based on unsupervised machine-learining

When comparing spatio-temporal gait features among the three groups, the Cluster 2 exhibited several statistically significant differences with the other two, emerging as the phenotype with the worst gait pattern.

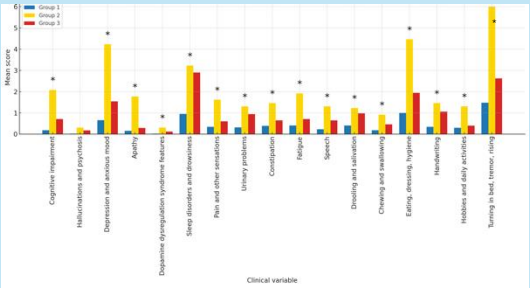

Fig. 3 Group comparison by clinical features

Of note, the extent and statistical significance of gait variables differing in comparison with the other two groups increased from single-task to dual-task, peaking for cognitive dual-task.

Conclusion

- An unsupervised machine learning approach on clinical variables is able to identify discrete clusters. Such clusters exhibit different quantitative gait features mainly under dual task conditions.

The present findings suggest that combining clinical clustering approach and quantitative gait measures may help to identify previously uncharacterized PD phenotypes, possibly predictive of specific trajectories.

References

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