Upper limbs kinematics analysis for Parkinson's disease characterization

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Abstract

The characterization of the upper limb's kinematics in Parkinsons disease is crucial for the understanding the intricates of motor dysfunction in this exact condition. This research indicates a notable's deviation in reaching, grasping, and manual dexterity among the Parkinson's patients, which is marked by diminishing the movements amplitudes, prolonged durations and heightening variability. These kinematic abnormalities don't only hinder daily activities but also profoundly impact the quality of life. This provides a valuable insight into the limitations experienced by individuals with the disease.

These recent years there have been several advancements such as motion capture, wearables sensors which have revolutionized the quantification of the upper limb's kinematics.

By leveraging these technologies to delineate the intricate kinematic profiles associated with PD, personalized treatment strategies can be developed to target specific motor deficits and enhance overall functional capacity. Ultimately, the characterization of upper limb kinematics in PD serves as a cornerstone for optimizing patient care and improving outcomes in this population.

Introduction

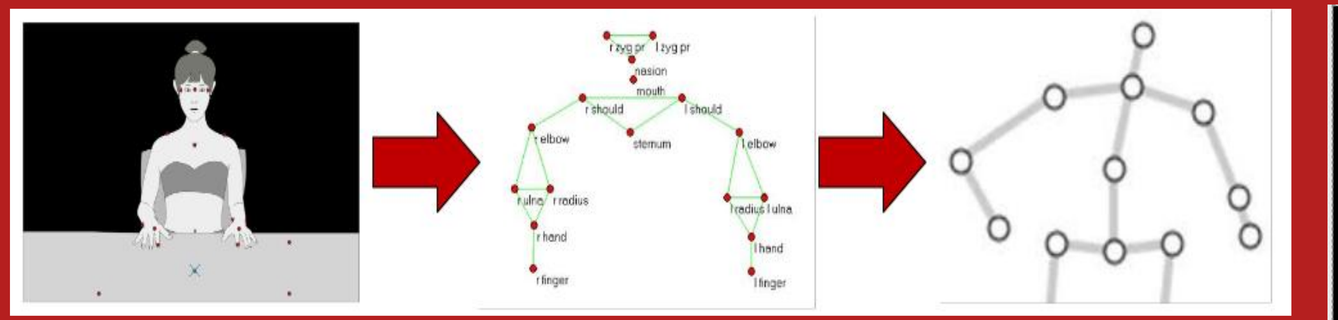
Kinematics studies motion without considering forces. We'll compare upper limb movements of healthy individuals and Parkinson's patients. By tracking markers on their bodies, we can analyze movement patterns. This research aims to understand the kinematic differences between these groups, providing insights into Parkinson's disease and potentially informing future treatments.

Objectives

This study aims to select a Parkinson's disease patient with upper limb involvement as a case study and perform a comprehensive kinematic analysis using a standardized test protocol. The collected data will be processed to generate motion curves and key performance indicators (KPIs). These results will be compared with normative references or other case studies to identify deviations. Finally, the observed differences will be interpreted to better understand the impact of Parkinson's disease on upper limb movement.

Methodology

The study involves selecting two subjects: one healthy individual and one diagnosed with Parkinson's disease. Both subjects undergo biomechanical tests, including static and dynamic assessments. Preparation involves placing motion capture markers on each individual. Two versions of the protocol are utilized: RAB Pointing and Hand to Mouth. The 3D reconstruction process follows, aiming to accurately recover the subjects' 3D geometry. Then the motion curves and key indicators are generated using a specific calculation protocol, with movement identification automatically performed according to the protocol.



Studio Idee Materia. (2023b, April 26). *BTS Bioengineering | Motion capture systems for sport & healthcare*. BTS. https://www.btsbioengineering.com/

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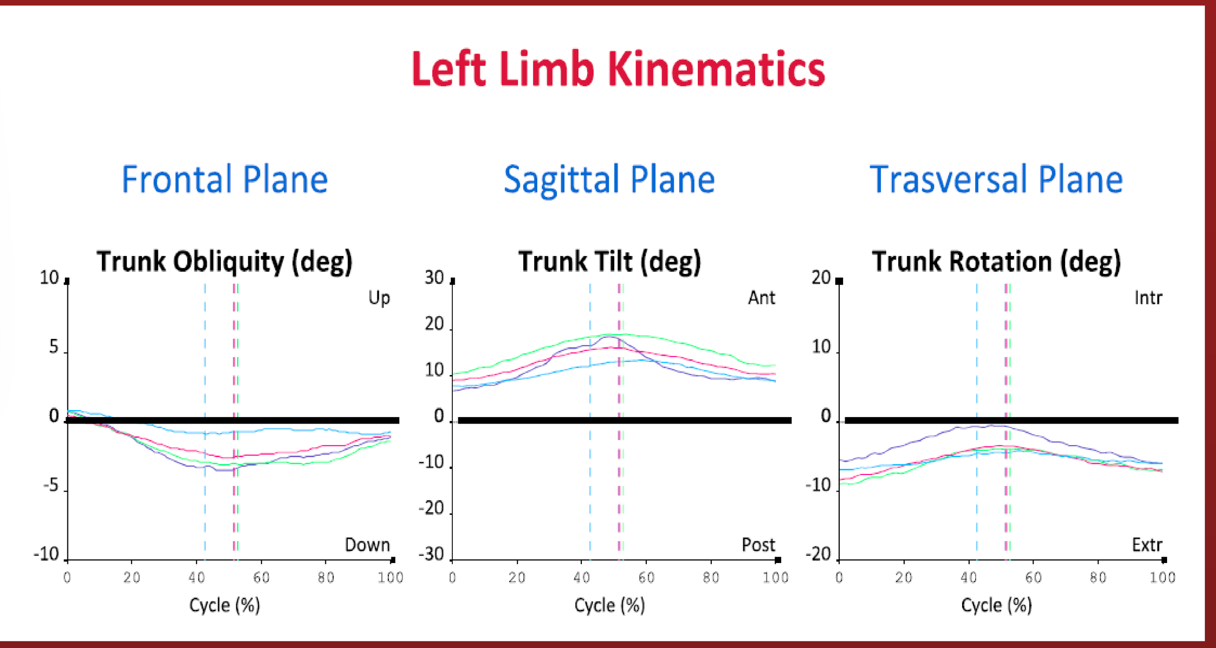
Preparing the subject with Parkinson's Disease

Static testing with the subject

Dynamic testing: Pointing with the subject

Results

The kinematic analysis of the left limb in both subjects revealed notable differences across the three planes of movement. In the Frontal Plane, the individual with Parkinson's disease exhibited a more pronounced downward trunk obliquity compared to the healthy individual, suggesting greater difficulty in maintaining lateral trunk stability. In the Sagittal Plane, trunk tilt was more exaggerated in the Parkinson's subject, indicating increased challenges with controlling forward trunk movement and compensating for postural instability. Finally, in the Transversal Plane it shows a reduced trunk rotation in the Parkinson's subject, particularly in internal rotation, aligning with the characteristic rigidity and reduced mobility seen in Parkinson's disease.



Graph of the left limb with both subject

Conclusion

The results underscore the distinct kinematic deviations between healthy and Parkinson's-affected individual, which emphasizes how Parkinson's disease impacts upper limb movement patterns. The observed differences in trunk stability, range of motion, and movement control highlight the motor impairments associated with Parkinson's, providing valuable insights for understanding disease progression and guiding therapeutic interventions.

Recommendations

To enhance the robustness of this research, one could expand the sample size for greater generalizability and to conduct longitudinal studies to observe the progression of upper limb kinematics over time. One could also optimize the test protocols to capture a wider range of movements and cross-validating results with other diagnostic tools would further validate the effectiveness of kinematic analysis in Parkinson's disease characterization.

Future Works

Future research should focus on expanding the participant demographics to include a more diverse range of individuals. This includes varying age groups, genders, and stages of Parkinson's disease, to better understand how these factors influence upper limb kinematics. By broadening the scope, the findings will become more generalizable and applicable to a wider population.

References

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Acknowledgements

- My mentor Professor Ricardo Bravo for his mentoring and being present for every step of this research
- The URP-HS program for being part of the journey
- The biomedical department for granting me the access to use the laboratories