Robotic Orthosis for Upper Limb Rehabilitation

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Summary

Introduction
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Introduction

Stroke - clinical syndrome
One of the main causes of death and disability

Upper extremity - 70% of individuals
30 to 66% of patients do not have upper limb function on the affected side
5% to 20% demonstrate complete functional recovery
Introduction

Robot-assisted therapy: training in dosage and much higher intensity

Improve the strategies of relearning motor and functional results

- Disadvantages of robotic orthoses for upper limb rehabilitation
- High cost, material, and unfavorable aesthetics
- More effective rehabilitation equipment
What is the aim of this study?

Develop a robotic orthosis

Individuals with motor impairment of the upper limb resulting from a stroke

Help flexion and extension movements of the elbow and fingers

Validate the device in volunteers
Experiments

Figure 1. Schematic representation of the device developed [1].
Experiments

Figure 2. Schematic mechanism representation of (a) closing and (b) opening fingers with artificial phalanx and tendons. Adapted from Rúbio et al. [2].
Experiments

HAND MODULE-MECHANICAL DESIGN

Rigid Lactic Polyacid (PLA)

Artificial phalanges

Artificial tendons

Figure 2. Schematic mechanism representation of (a) closing and (b) opening fingers with artificial phalanx and tendons. Adapted from Rúbio et al. [2].

Artificial phalanges

Fingerstall

Figure 3. Artificial phalanx attached to the fingerstall [1].
Experiments

HAND MODULE-MECHANICAL DESIGN

Figure 4. Hand module [1].
Experiments

HAND MODULE-MECHANICAL DESIGN

- Artificial metacarpal
- Artificial tendons
- Artificial phalanges
- Fingerstall

Fingerstall
Experiments

HAND MODULE-MECHANICAL DESIGN

Fingerstall

Extension and flexion movement
Experiments

HAND MODULE-STATIC STRUCTURE

Figure 5. Static forearm ventral orthosis [1].
Experiments

HAND MODULE-STATIC STRUCTURE

Artificial tendons

Artificial metacarpal

Fingerstall

Linear Rail

Connect the hand module to the elbow module

Second degree of freedom

Figure 4. Hand module [1].
Experiments

Figure 6. The elbow module [1].
Experiments

Figure 7. The elbow joint [1].
Experiments

ELBOW MODULE-MECHANICAL DESIGN

Figure 7. The elbow joint [1].
Experiments

ELBOW MODULE-MECHANICAL DESIGN

Figure 8. The pulley base twisting [1].

Figure 9. Orthosis: old configuration [1].
Experiments

ELBOW MODULE-MECHANICAL DESIGN

Figure 8. The pulley base twisting [1].

Figure 10. Orthosis: new configuration [1].
Experiments

ELBOW MODULE-STATIC STRUCTURE

Figure 9. Orthosis: old configuration [1].  
Figure 11. Thermoplastic arm splint [1].
Experiments

ELBOW MODULE-STATIC STRUCTURE

Figure 9. Orthosis: old configuration [1].

Figure 12. Shoulder pad [1].
Experiments

Figure 13. Motors and electronics responsible for the control [1].
Experiments

\[ T_o = P \cdot R_g \cdot \sin \theta \]

- elbow joint angle
- distance between the elbow joint center and center of gravity of the set
- weight force
- required torque to flex the elbow
Experiments
Experiments

### CLINICAL TEST

<table>
<thead>
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<th>Spasticity Level</th>
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<td>38</td>
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<td>24 months</td>
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Table 1. Participants characteristics

Volunteers

Research Ethics Committee (COEP) - CAAE Registry: 22207213.5.0000.5149
Experiments

CLINICAL TEST - PROCEDURES
Results

Hand opening tests

Elbow movement tests
Results

Grabbing a water bottle task

Grabbing a ball task
Discussion

Perform the movements effectively

The fingers interfered with each other

The elbow module presented relative difficulty in performing

Figure 9. Orthosis: old configuration [1].

Figure 10. Orthosis: new configuration [1].
Discussion

The excessive weight of the elbow module

Clinical test

Proper alignment between the exoskeleton and the user's anatomical joints
Conclusions

- Correct biomechanical functioning
- Prototype effectiveness and safety
- Improve the mechanical structure of the orthosis
- Long-term effect
References

1. Personal file of the authors.

Acknowledgments
Contact information

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