Imperial College London

Biomechanical Rehabilitation Support Frame for Long Covid

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Introduction

What is the problem we are solving?

- Biomechanical rehabilitation for patients experiencing symptoms of long COVID
- Focusing on rehabilitating chronic muscle fatigue

What is Long Covid?

- Illness experienced by recovered COVID-19 patients – discovered June 2020 [1]
- Symptoms include: chronic fatigue, shortness of breath, joint pain, insomnia [2]

How is the overall design doing this?

- Aims to provide mechanical support for arm abduction and flexion
- Aids patient carry out daily tasks and rebuild strength in the arm/shoulder

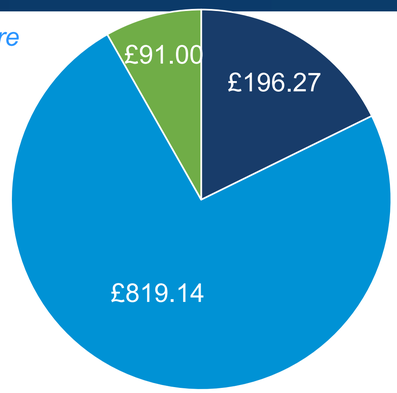
Where does our design fit into the overall design?

- Support frame for the device
- Interface between the moving parts of the device and the patient
- How the device is worn and how to comfortably distribute the forces generated by the device

Overall assembly CAD model

Budget

- Total Expenditure: £1106
- High manufacturing cost (£819) can be reduced when scaled
- Design simplification helped to save £196



Future Improvements

Partial assembly with frame and kinematics

Based on testing several design improvements were proposed: 1) Brass screw thread inserts, 2) Fabric-enclosed backplate 3) Redesign of the shoulder plate adjustment (seen below).

Key Features

Side profile showing thoracic curvature

Laminate Backplate Structure

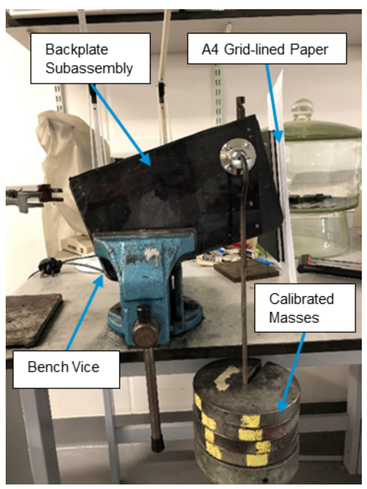
- The polycarbonate backplate has a laminate design with an intermediate foam layer
- On either side of the foam is a segmented polycarbonate plate structure
- External padding provides a comfortable user experience

Vertical Support Bar

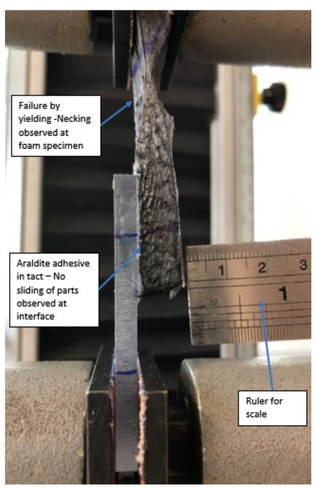
- The aluminium vertical support bar has a height-adjustable design using a quick-release clamping mechanism
- The hollow support bar has a steel cable directed through its core to direct forces between the kinematics and actuation teams
- The base of the support bar is connected to the backplate via a ball and socket joint to replicate flexion and abduction at the shoulder

Vertical support bar parts

Testing



Deflection test



Lap-shear test

Backplate Deflection Test

- No plastic deformation at each loading cycle to 300 N

Lap Shear Test

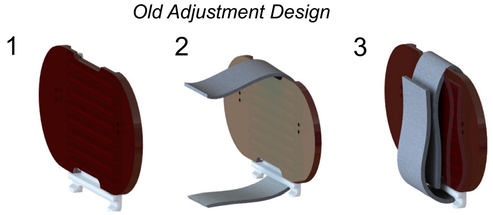
- Araldite adhesive/ polyethylene foam gives suitable shear/yield strength

Comfort/Ergonomics Test

- Minimal forces at shoulder /back, positive user review

Shoulder plate adjustment re-design

Old Adjustment Design



New Adjustment Design

References: *[1]:* E. Perego F. Callard. How and why Patients Made Long Covid. Social Science and Medicine, 268:2–5, Oct 2020. pages 3 *[2]:*Thorsten Rudroff and et al. Post-COVID-19 Fatigue: Potential Contributing Factors. Brain Sciences, 10(12), Dec 2020. pages 3