Empowering people with impaired hand function

BIOSERVO

A Carbonhand® Hero

Long

Medium

Short

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Our mission
We empower people with impaired hand function through innovative and lifechanging solutions.
We Increase independence, improve quality of life, and enable a new Standard of Care.
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The Carbonhand® system

- A 3-finger glove, with state-of-the-art technology using embedded pressure sensors to enhance grip
- Artificial tendons control the force of each finger to improve grip response and strength
- The Glove can be worn to suit different users and situations
- An App allows for programming of multiple user profiles to fit all user needs and situations
- Battery capacity to facilitate daily activities for a whole day

- Carbonhand provides increased independence and quality of life for the user!

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Who can benefit from using Carbonhand?

Indication for Use: People with reduced grip strength and/or impaired hand function.

Examples of patient groups:

Stroke	Stroke
Neurological Injuries	Spinal Cord Injury
	Traumatic Brain Injury
	Brachial Plexus Injury
	Peripheral Nerve Injury
Neurological Illness	Amyotrophic Lateral Sclerosis
	Multiple Sclerosis
	Neuromuscular disorders
Age Related Weakness	Hand Osteoarthritis
	Age related Sarcopenia
	Rheumatoid Arthritis
Musculoskeletal disorders	Carpal Tunnel Syndrome
	Epicondylitis
	Other: Myositis

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General Guidelines for Identifying Patients

Inclusion criteria

- Individuals suffering from weakness in hand, wrist and forearm
- Individuals with impaired hand function

Exclusion criteria

- Individuals presenting open wounds or swollen hand before disappearance
- Individuals with severe spasticity in the hand, wrist and forearm

Consider

- Range of Motion (active and passive)
- Voluntary movement and functional ability
- Sensory function
- Pain

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User examples

Peter

- Spinal Cord Injury
- Limited functionality in right hand

- Carbonhand provides a firm grip and helps him during daily activities

Helen

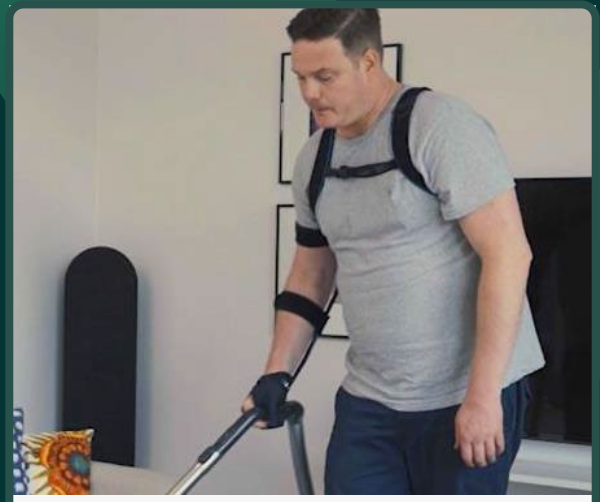
- Multiple Sclerosis (MS)
- Weakness and a limited possibility to perform ADL

- Carbonhand gives her better grip and endurance during activities of daily living

Scott

- Post-traumatic hand injury
- Reduced muscle function in the right hand

- Carbonhand makes it possible for Scott to continue his active lifestyle.



Mats

- Peripheral nerve injury
- Impaired functionality of right hand

- Carbonhand gives him a chance to continue to work and play with his kids

Improved grip strength, hand function, and quality of life!

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Real Life Examples

Bryan

Diagnosis:
Spinal Cord Injury

Challenge:
Has a weak grip in his right hand and can’t hold objects

John

Diagnosis:
Inclusion Body Myositis

Challenge:
Has a weak grip and can’t hold objects

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Real Life Examples

Daniel

Diagnosis:
ALS

Challenge:
Weak grip and tremor

Ingrid

Diagnosis:
Multiple Sclerosis

Challenge:
Weak grip

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Two Wearing Options For Personalized Support

- You can choose to select support for either the index and middle fingers, or the middle and ring fingers
- Enables individuals with varying hand impairments to benefit from the glove
- Wearing options allow flexibility to support different activities

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Supports Varying Functional Grip Patterns







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Carbonhand - how the system works

- The sensors in the glove provide input when pressure is applied
- The power from the motors is transferred through artificial tendons in the glove
- The behavior of the glove is controlled by a sophisticated control system
- The behavior can be customized for each individual user

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Carbonhand® – The Glove

1: Pressure sensors

Dynamic pressure sensors that detects when the user grips an object

2: Artificial tendons

Transfers the forces from the power unit to the fingers in a natural grip movement

3: Control pad

Let the user easily select the preferred profile or initiate lock assist, if this is required by the user

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Carbonhand® – The system

1. Glove

   Soft, lightweight, and flexible glove with pressure sensors, artificial tendons, and control pad

2. Power unit

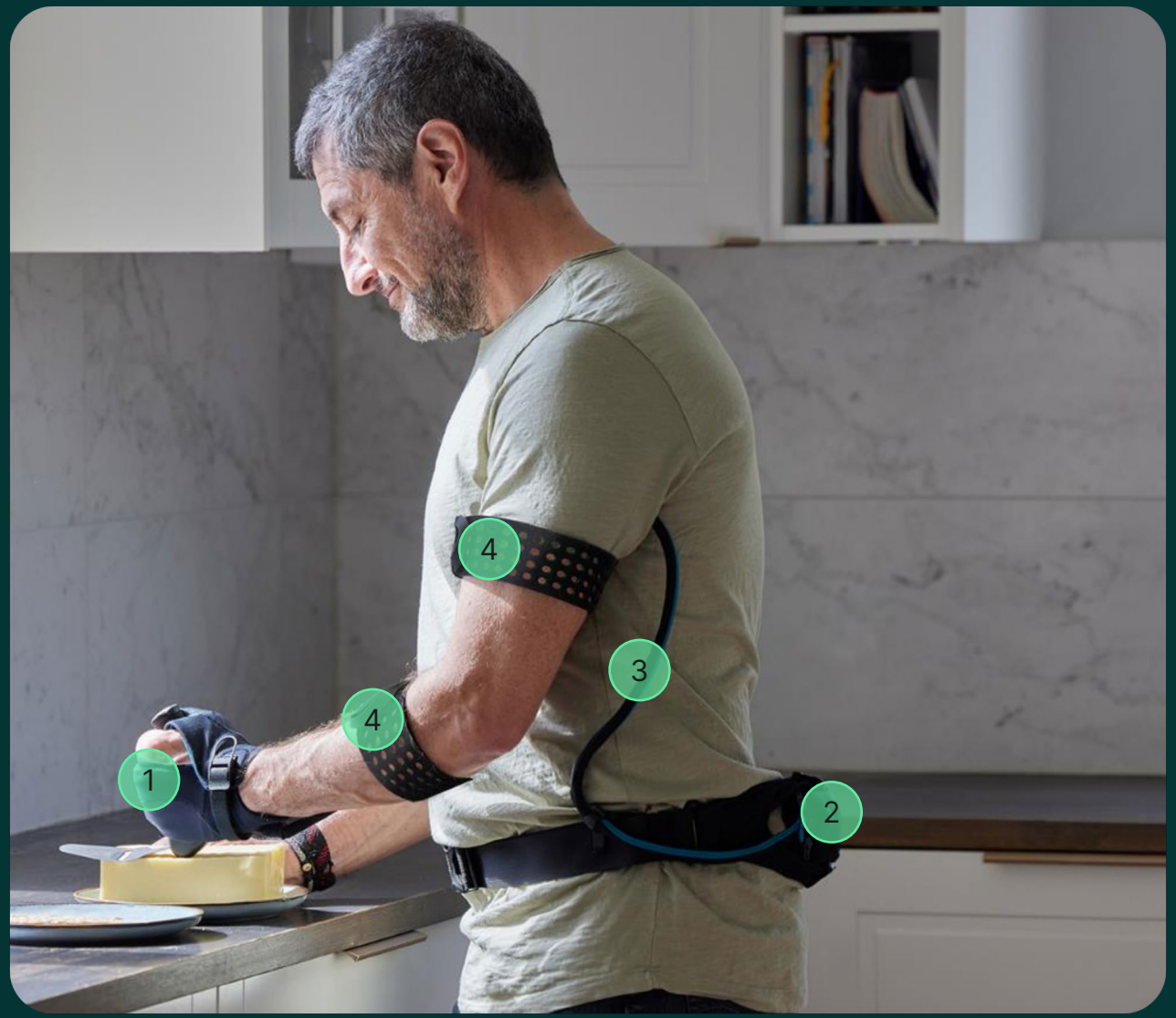
   Includes battery (8 h), power actuators, control system and glove connector

3. Cord

   Contains electrical and bowden cables to transfer sensor signals and forces between the glove and power unit

4. Arm straps

   Keeps the cord close to the user in order to avoid entanglement



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Ease of use

Open design

And made of flexible material to fit different anatomies and impaired hand function

Magnetic buckle

Makes it easy to don and doff the glove

Control pad

Allows selection of user profiles, initiate lock assist, or calibration

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Adaptable Anywhere, Ready Anytime

Precision Task

Dynamic

Strong & Steady

Three User Profiles

Each profile offers different settings based on the user's support needs and can be easily adjusted on the control pad.

Further customization and additional profiles are available through the Bioservo App.

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Bioservo App – Personalized setting of functionality

Carbonhand comes with three pre-defined profiles, that can be personally adjusted to fit the user's needs:

Max force

The maximum force provided by Carbonhand

Stickiness

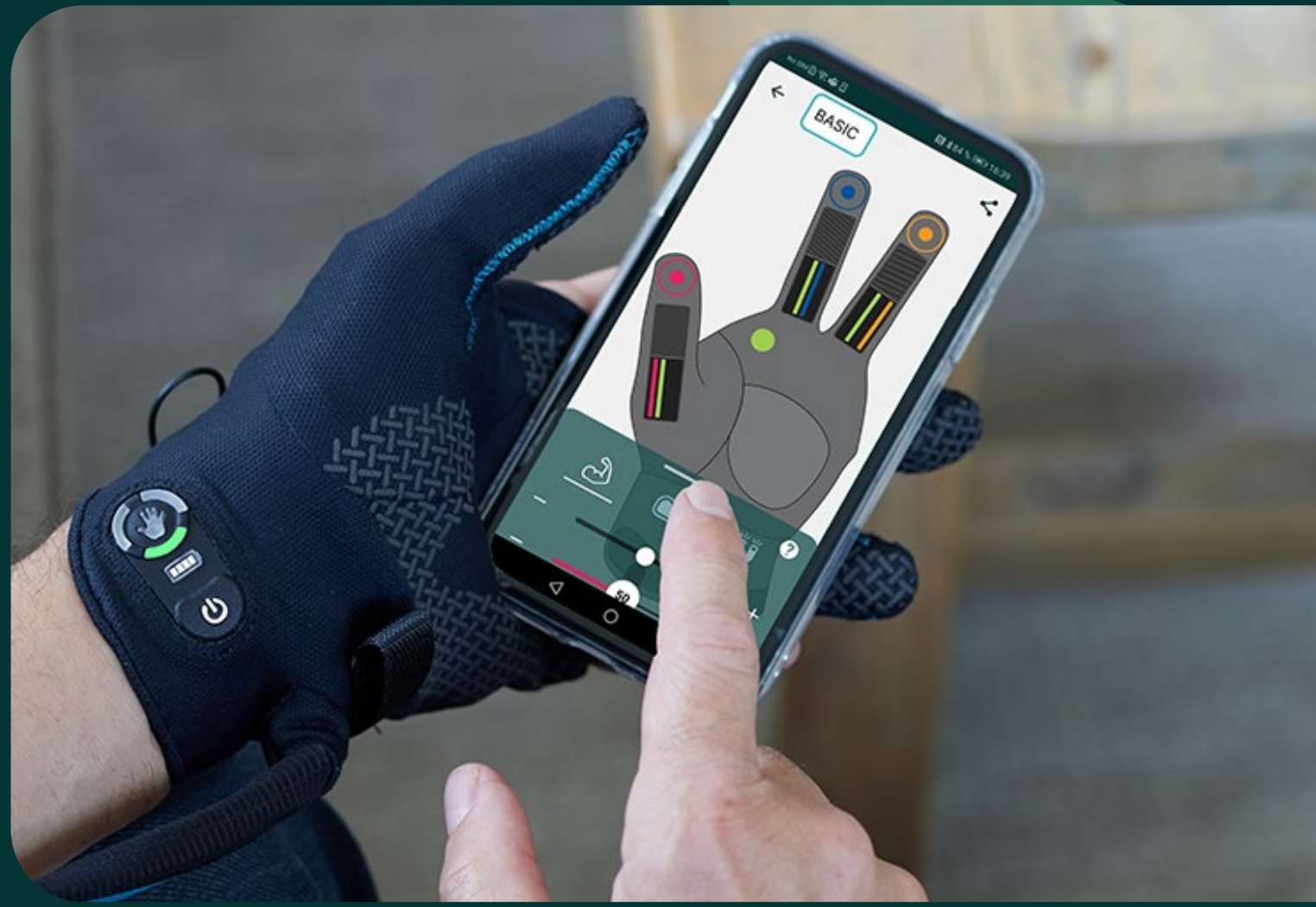
The force required by the user to release the grip

Responsiveness

The speed between sensor input and force output

Sensor synergies

Linking sensors to multiple fingers



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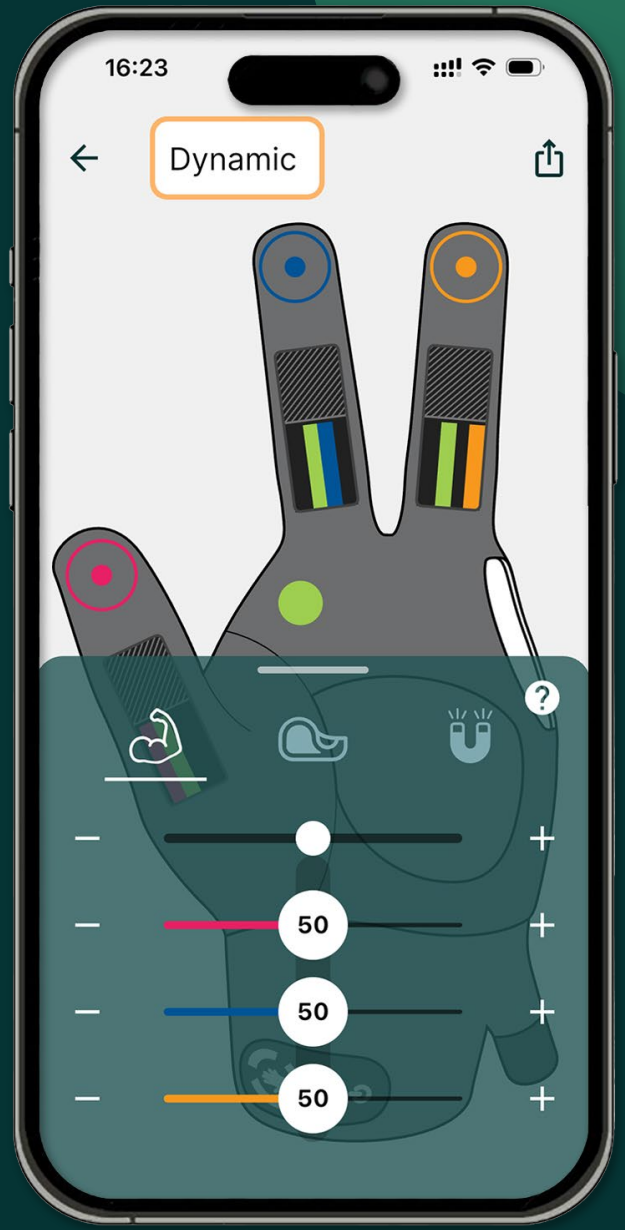
Max Force

- Decides how much force is applied by Carbonhand.
- Can be adjusted for each finger individually to compensate for impairments in specific fingers, or combined if needed equally for all fingers.
- Create specific profiles tailored to your activities and timing, for example, less Max Force in the morning and more in the evening.



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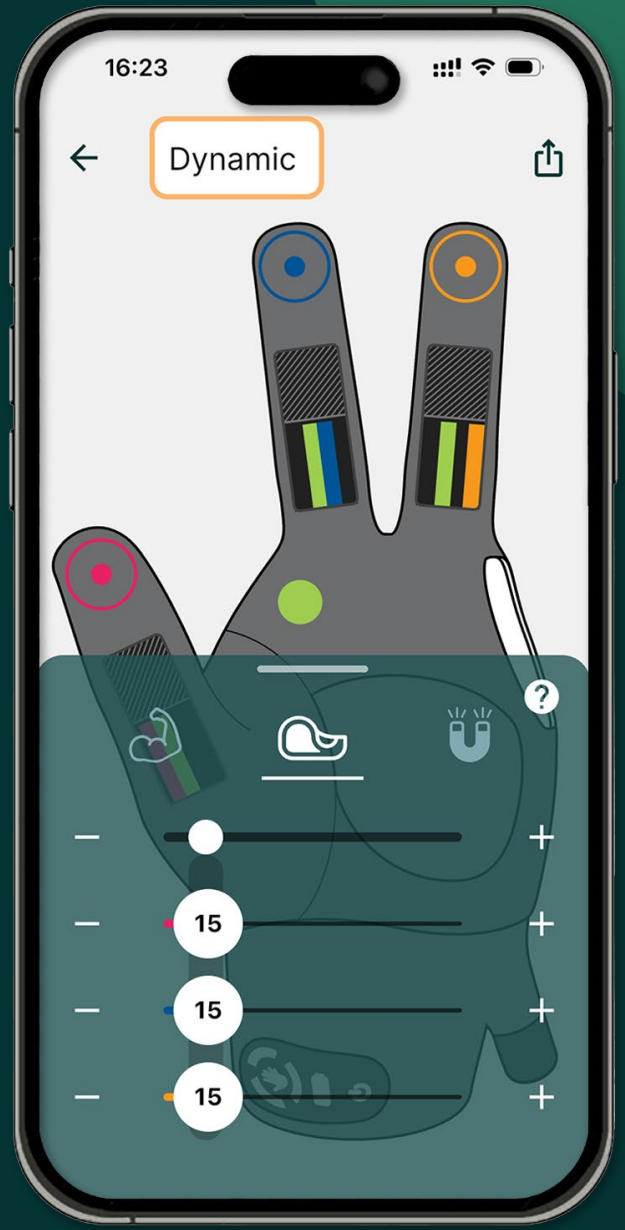
Stickiness

- The stickiness helps the user to hold on to objects, but requires more effort to release grip
- At the maximum setting, Carbonhand provides maximum holding stability
- Consider low stickiness setting in patients with weak finger extension
- The grip can also be completely locked by activating the Lock Assist function from the Control Pad



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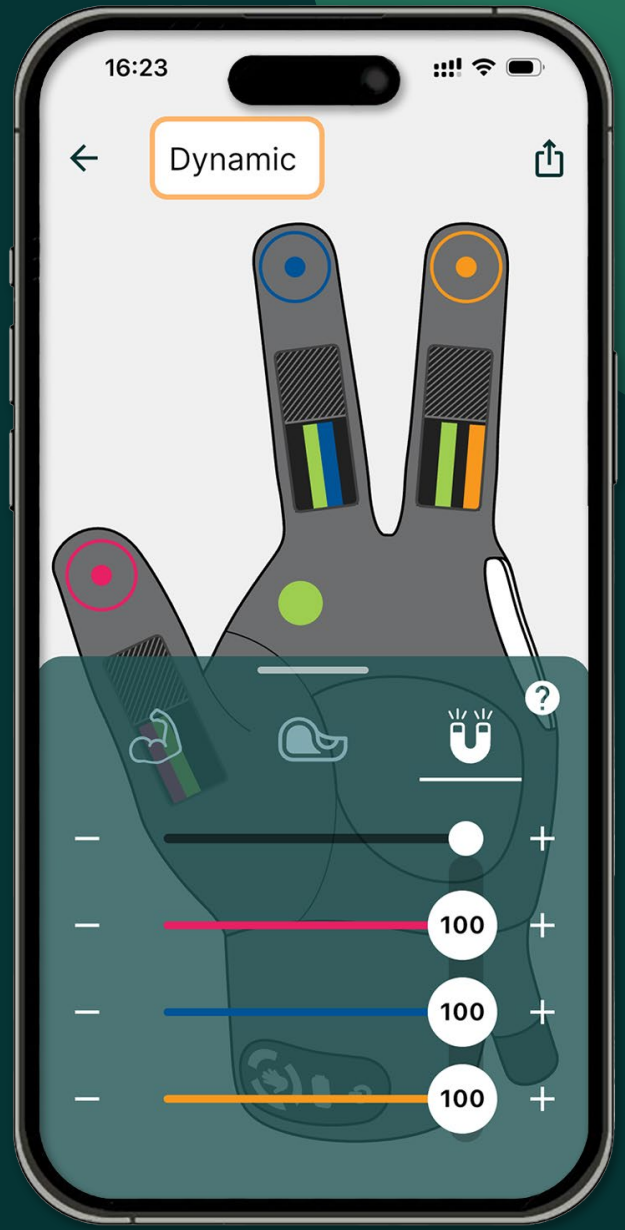
Responsiveness

- Users can adjust how quickly the system responds once a sensor is activated
- An increased responsiveness provides a “magnetic” feeling
- Assists individuals with decreased grip strength to initiate a grip



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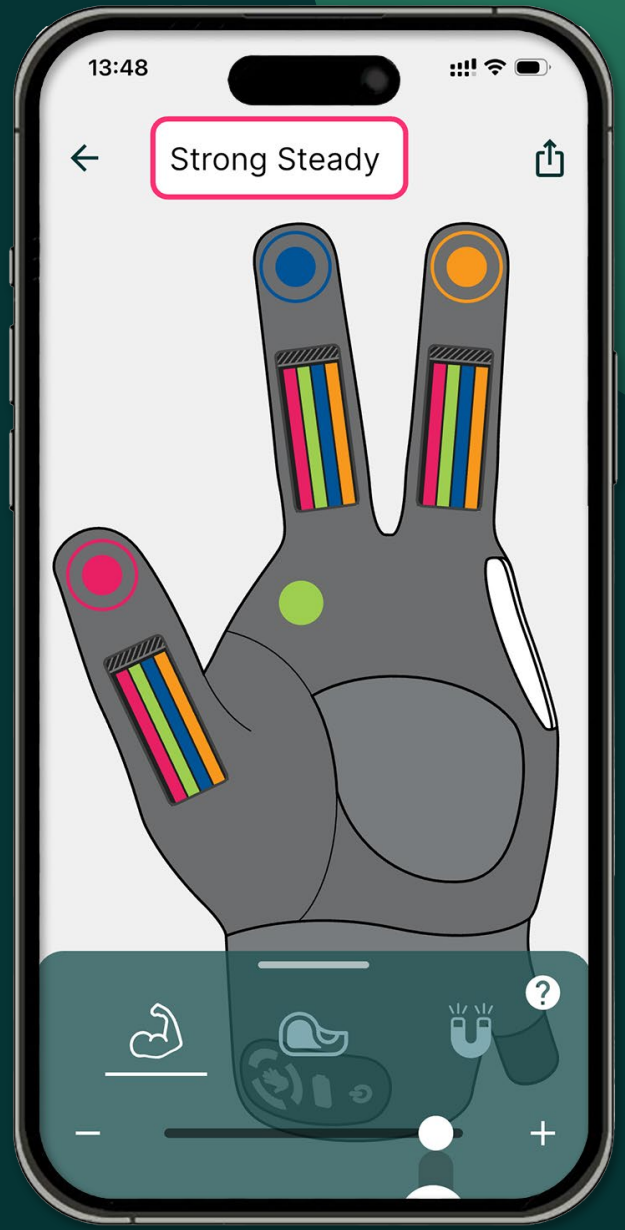
Linking fingers

- Sensors on one finger can be linked to another finger in order to activate also that finger
- The palm sensor can be used to activate any finger or fingers
- This is useful when the user has difficulties initiating a grip



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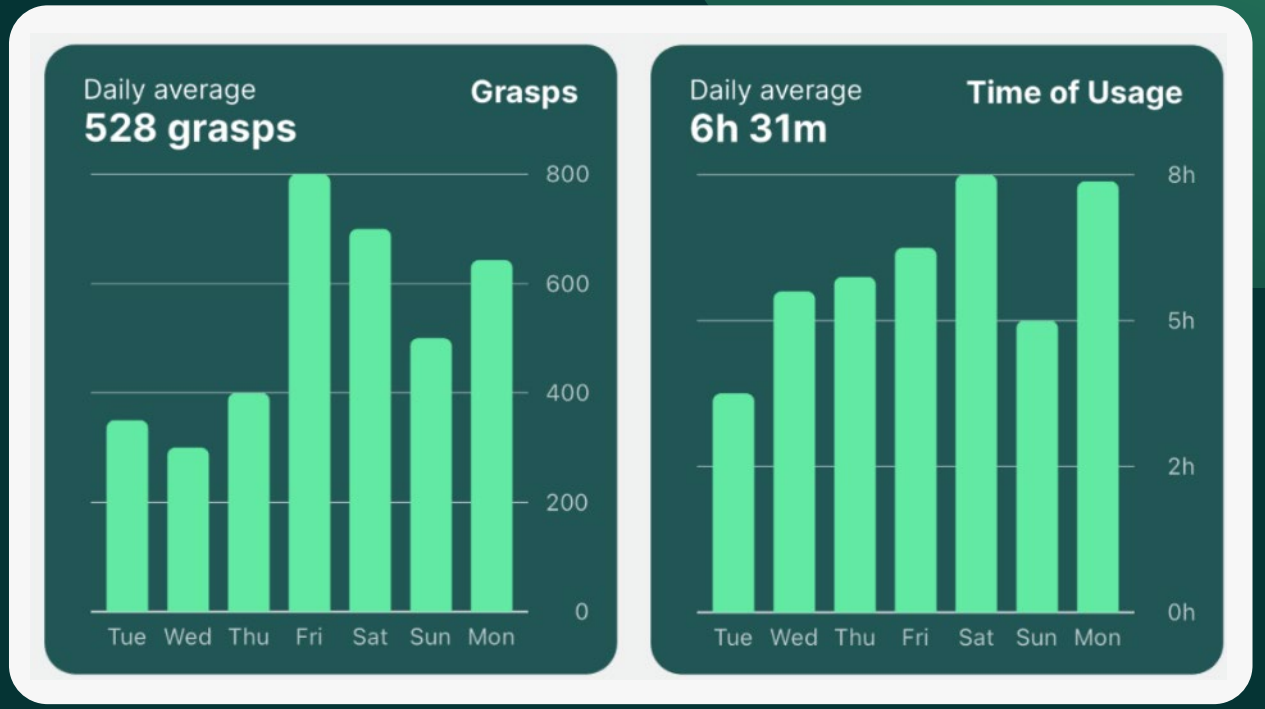
My Activity - Reporting in the APP

- Motivational monitoring and tracking
- Analyze trends and Track activity
- View the information for one day, one week, three months or one year
- Swipe back and forth in time to see how patterns of use differ.



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Remote Connectivity

- Allows clinician or Carbonhand representative to securely log into a patient’s Bioservo APP remotely
- Allows remote configuration of glove
  - Add or adjust grip profiles
  - Troubleshoot
- Enables clinicians to access grip reporting

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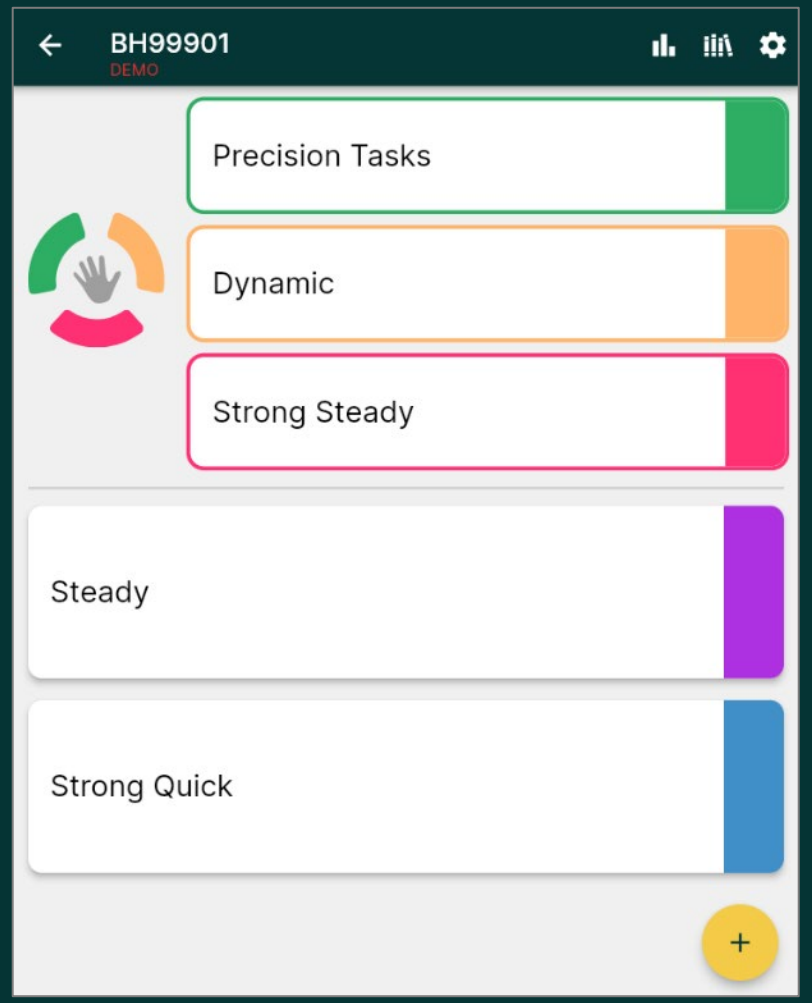
The Bioservo App – Web Demonstration



https://app.bioservo.cloud/

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Several Carrying Options

Carbonhand can be carried in multiple ways, with a foldable design for carrying in a bag, purse, or mounted on a wheelchair

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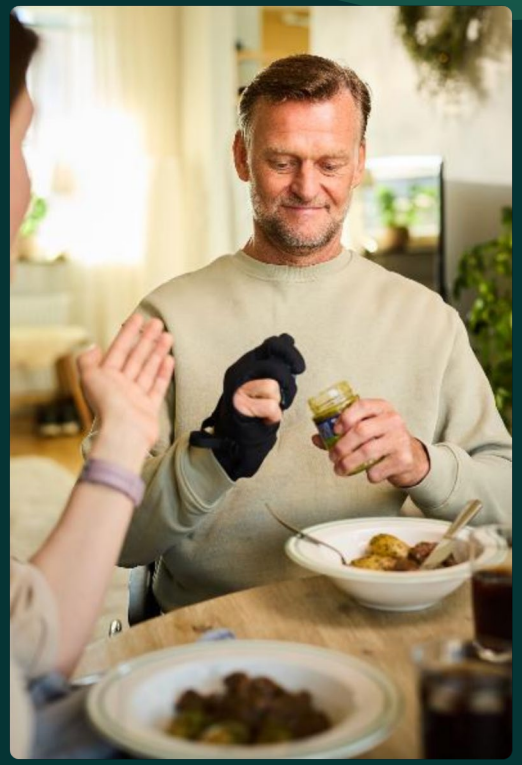
Evidence on Carbonhand as an Assistive Device

In total 367 patients were included in the trials showing the effect of using Carbonhand. People with reduced grip strength and/or impaired hand function due to various reasons and diagnoses were included as study participants. For example; people with Stroke, Spinal Cord Injury, Multiple Sclerosis, Sarcopenia, and Myopathy benefited from using Carbonhand within these trials.



The results show that:

- Manipulation of several objects encountered in ADL was experienced as improved during the use of Carbonhand
- A sustained and strong grip was perceived as the most beneficial effect while using Carbonhand
- The participants experienced an improved grip strength during the use of Carbonhand
- The usability of Carbonhand was rated as high
- Carbonhand is safe to use.

The medical claim based on these studies:
Carbonhand enhances the user's ability to perform activities in daily living.

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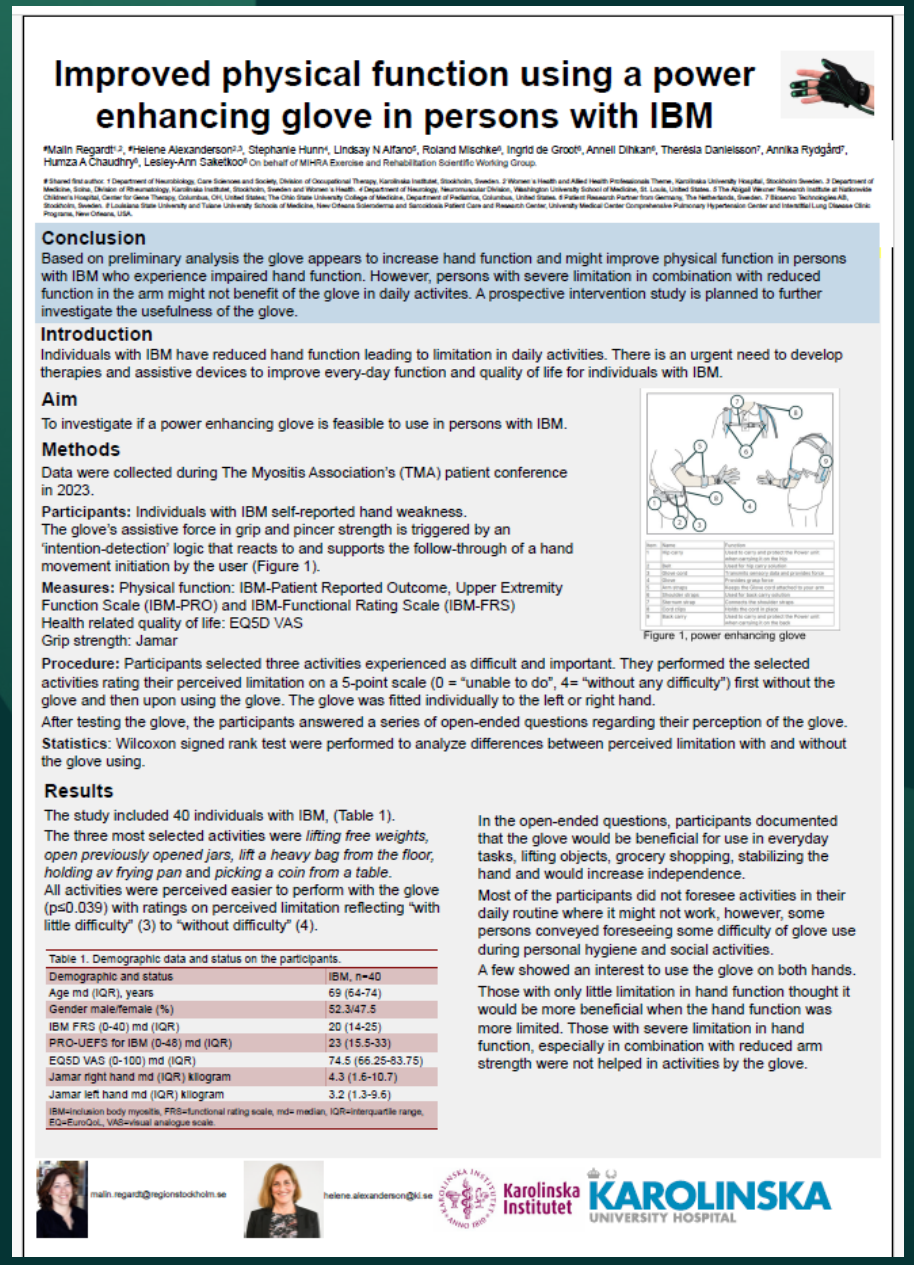
Usability Trial - Carbonhand an Assistive Device

Presented at Global Conference on Myositis in Pittsburgh, USA
March 2024

Table 2. Measures on difficulty in chosen activities without and with the glove, (0 = "unable to do", 4 = "without any difficulty").

Chosen activity	Without the glove	With the glove
Lift free weights, n=16	2 (1-2)	4 (3.25-4)
Open previously open jars, n=16	1 (1-2)	4 (3-4)
Lift a heavy bag from the floor, n=15	2 (2-2)	4 (4-4)
Hold a frying pan, n=11	1 (1-2)	3 (3-4)
Pick a coin from a table, n=8	2 (1.3-3)	3.5 (2.3-4.0)



Improved physical function using a power enhancing glove in persons with IBM

#Malin Regardt[1,2], #Helene Alexanderson[2,3], Stephanie Hunn[4], Lindsay N Alfano[5], Roland Mischke[6], Ingrid de Groot[6], Anneli Dihkan[6], Theresia Danielsson[7], Annika Rydgård[7], Humza A Chaudhry[8], Lesley-Ann Saketkoo[8] On behalf of MHRA Exercise and Rehabilitation Scientific Working Group

Conclusion

Based on preliminary analysis the glove appears to increase hand function and might improve physical function in persons with IBM who experience impaired hand function. However, persons with severe limitation in combination with reduced function in the arm might not benefit of the glove in daily activites. A prospective intervention study is planned to further investigate the usefulness of the glove.

Introduction

Individuals with IBM have reduced hand function leading to limitation in daily activities. There is an urgent need to develop therapies and assistive devices to improve every-day function and quality of life for individuals with IBM.

Aim

To investigate if a power enhancing glove is feasible to use in persons with IBM.

Methods

Data were collected during The Myositis Association's (TMA) patient conference in 2023.

Participants: Individuals with IBM self-reported hand weakness.
The glove's assistive force in grip and pincer strength is triggered by an 'intention-detection' logic that reacts to and supports the follow-through of a hand movement initiation by the user (Figure 1).

Measures: Physical function: IBM-Patient Reported Outcome, Upper Extremity Function Scale (IBM-PRO) and IBM-Functional Rating Scale (IBM-FRS)
Health related quality of life: EQ5D VAS
Grip strength: Jamar

Figure 1, power enhancing glove

Procedure: Participants selected three activities experienced as difficult and important. They performed the selected activities rating their perceived limitation on a 5-point scale (0 = "unable to do", 4= "without any difficulty") first without the glove and then upon using the glove. The glove was fitted individually to the left or right hand.

After testing the glove, the participants answered a series of open-ended questions regarding their perception of the glove.

Statistics: Wilcoxon signed rank test were performed to analyze differences between perceived limitation with and without the glove using.

Results

The study included 40 individuals with IBM, (Table 1).

The three most selected activities were *lifting free weights, open previously opened jars, lift a heavy bag from the floor, holding av frying pan* and *picking a coin from a table.*
All activities were perceived easier to perform with the glove ($p \leq 0.039$) with ratings on perceived limitation reflecting "with little difficulty" (3) to "without difficulty" (4).

Table 1. Demographic data and status on the participants.

Demographic and status	IBM, n=40
Age md (IQR), years	69 (64-74)
Gender male/female (%)	52.3/47.5
IBM FRS (0-40) md (IQR)	20 (14-25)
PRO-UEFS for IBM (0-48) md (IQR)	23 (15.5-33)
EQ5D VAS (0-100) md (IQR)	74.5 (66.25-83.75)
Jamar right hand md (IQR) kilogram	4.3 (1.6-10.7)
Jamar left hand md (IQR) kilogram	3.2 (1.3-9.6)

IBM=Inclusion body myositis, FRS=functional rating scale, md= median, IQR=interquartile range, EQ=EuroQol,, VAS=visual analogue scale.

In the open-ended questions, participants documented that the glove would be beneficial for use in everyday tasks, lifting objects, grocery shopping, stabilizing the hand and would increase independence.

Most of the participants did not foresee activities in their daily routine where it might not work, however, some persons conveyed foreseeing some difficulty of glove use during personal hygiene and social activities.

A few showed an interest to use the glove on both hands.

Those with only little limitation in hand function thought it would be more beneficial when the hand function was more limited. Those with severe limitation in hand function, especially in combination with reduced arm strength were not helped in activities by the glove.

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References for Carbonhand as an Assistive Device

1. Radder B, Prange-Lasonder G, Kottink A, Melendez-Calderon A, Buurke J, Rietman J. Feasibility of a wearable soft-robotic glove to support impaired hand function in stroke patients. J Rehabil Med 2018; 50: 598–606.
2. Radder B, Prange-Lasonder G, Kottink A, Holmberg J, Sletta K, Van Dijk M, Meyer T et al. (2018): The effect of a wearable soft-robotic glove on motor function and functional performance of older adults, Assistive Technology, DOI: 10.1080/10400435.2018.1453888
3. Osuagwu B.A. et al. (2019) Clinical Trial of the Soft Extra Muscle Glove to Assess Orthotic and Long-Term Functional Gain Following Chronic Incomplete Tetraplegia: Preliminary Functional Results. In: Masia L., Micera S., Akay M., Pons J. (eds) Converging Clinical and Engineering Research on Neurorehabilitation III. ICNR 2018. Pp 385-389. doi.org/10.1007/978-3-030-01845-0_77
4. Nilsson M, Fryxell W. A, Wadell C, von Holst H, Borg J. A Helping Hand – On Innovations for Rehabilitation and Assistive Technology. Grip strengthening glove to improve hand function in patients with neuromuscular disorders. Doctoral Theisis. Stockholm: Royal Institute of Technology; 2013. ISBN 978-91-7501-703-7
5. Hermansson L, Gunnarsson M, Lutterman M. Effect of a grip-strengthening glove on persons with reduced hand function. (2014).
6. Palmcrantz S, Plantin J, Borg J. Factors affecting the usability of an assistive soft robotic glove after stroke or multiple sclerosis. Karolinska Institutet, Department of Clinical Sciences, Danderyd Hospital, Division of Rehabilitation Medicine, Stockholm, Sweden. Journal of Rehabilitation Medicine (2020). https://doi.org/10.2340/16501977-2650
7. Hashida R, Matsuse H, Totsugi M, Omoto M, Shinozaki N, Tanaka J, Nago T. (2016). Study on the Effects of Motor-Assisted Gloves (SEM™ Glove) on Functional Disorders of the hand. The Kurume Medical Journal (2018). DOI:10.2739/kurumemedj.MS652007
8. Radder B, Prange-Lasonder GB, Kottink AIR, Holmberg J, Sletta K, Van Dijk M, et al. The effect of a wearable soft-robotic glove on motor function and functional performance of older adults. Assist Technol. 2020;32(1):9–15

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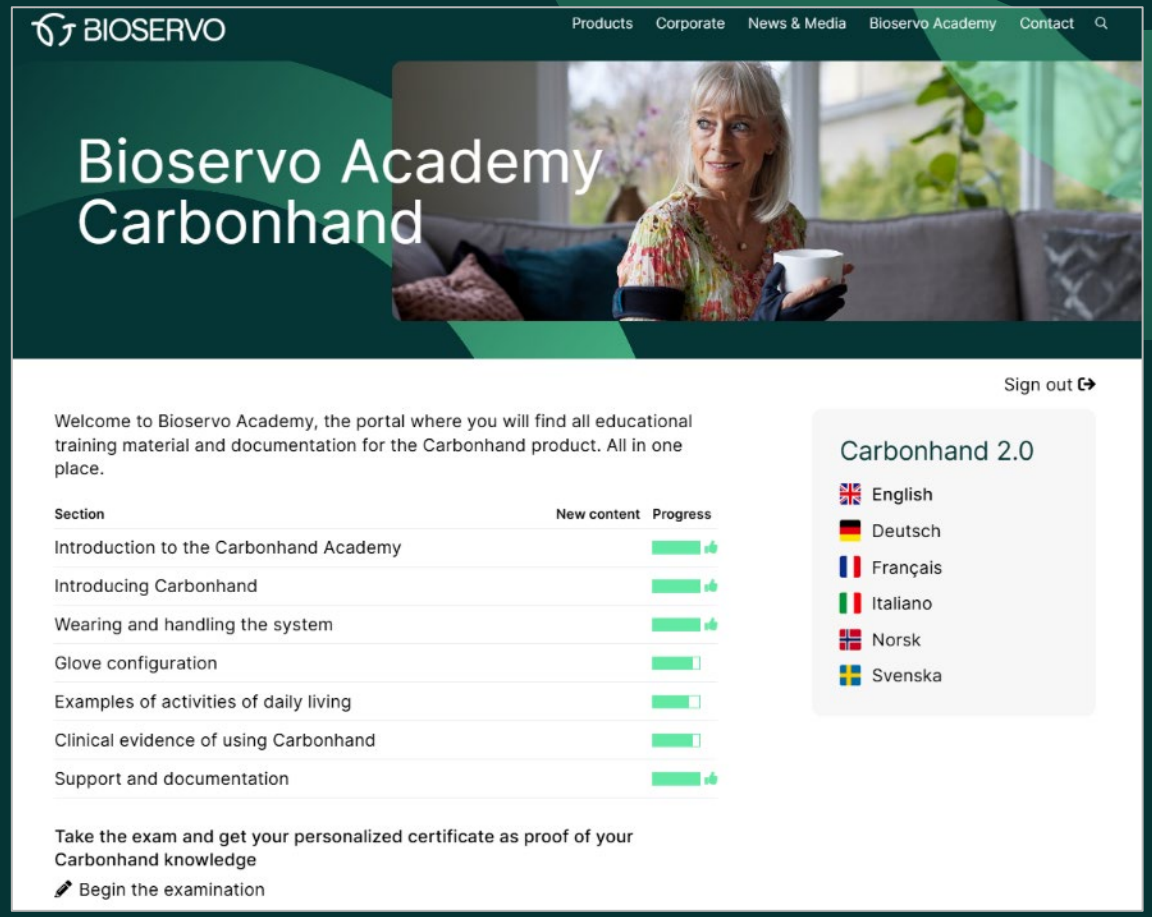
Clinicians: Education and Support

- Carbonhand Academy with Step-by-step video tutorials
- Exam for Carbonhand Certification

- A Center of Excellence program is available including:
  - Product Training
  - Clinical Training
  - Peer-to-peer Consultations
  - Support



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Carbonhand – The Components 1/2

Glove with Glove Connector

Power Unit

Shoulder Straps

Arm straps (3)

2-S/M 1-L

Power Unit Sleeve
(Single or Double Carry)

Belt

(S/L, Med=S+L)

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Carbonhand – The Components 2/2

Charger

Soft Case

Padded Washing bag

External Button (optional)

Wheelchair Attachment Straps (optional)

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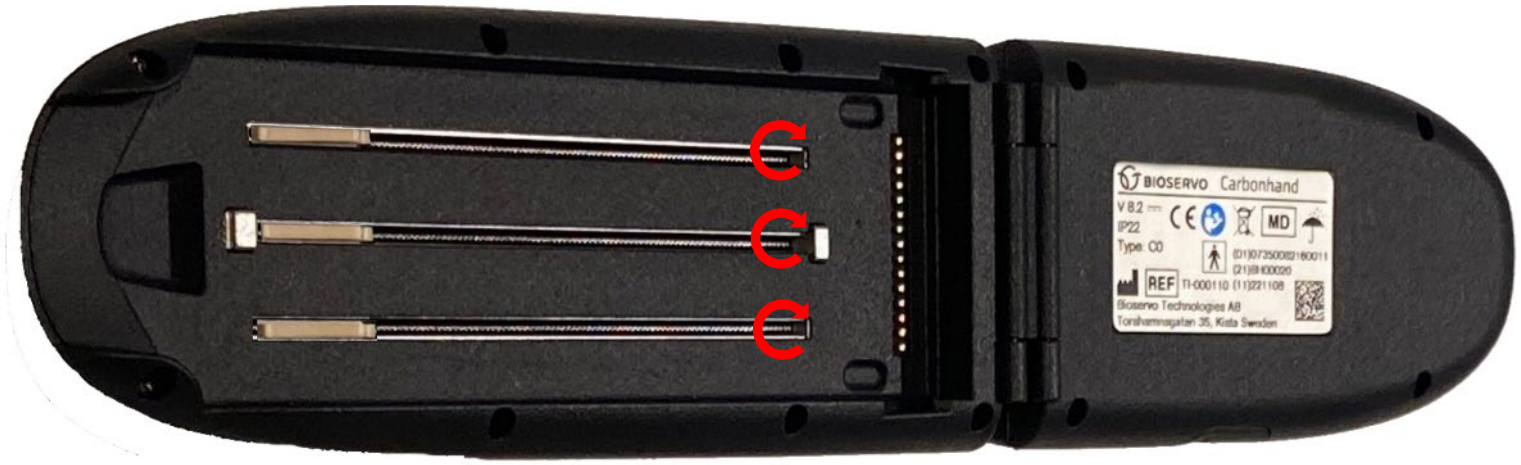
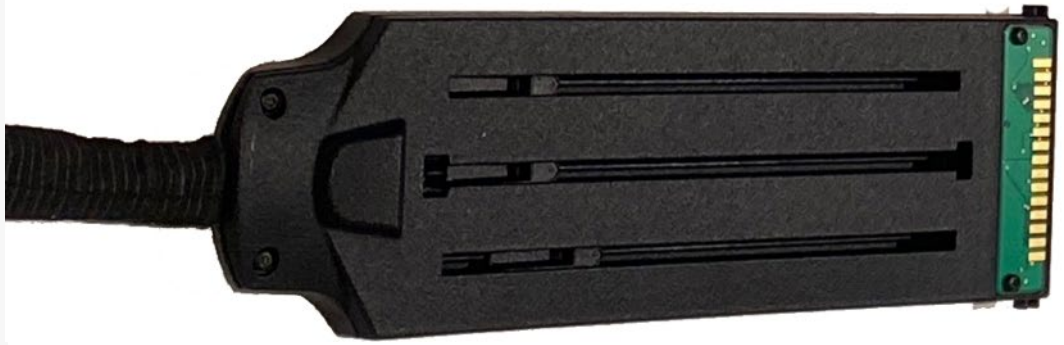
Power transmission





Ball screws

Transfers the rotation from the electrical motors to a linear movement.

Artificial tendons

in the glove connection are pulled with a maximum force of 20 N each.

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