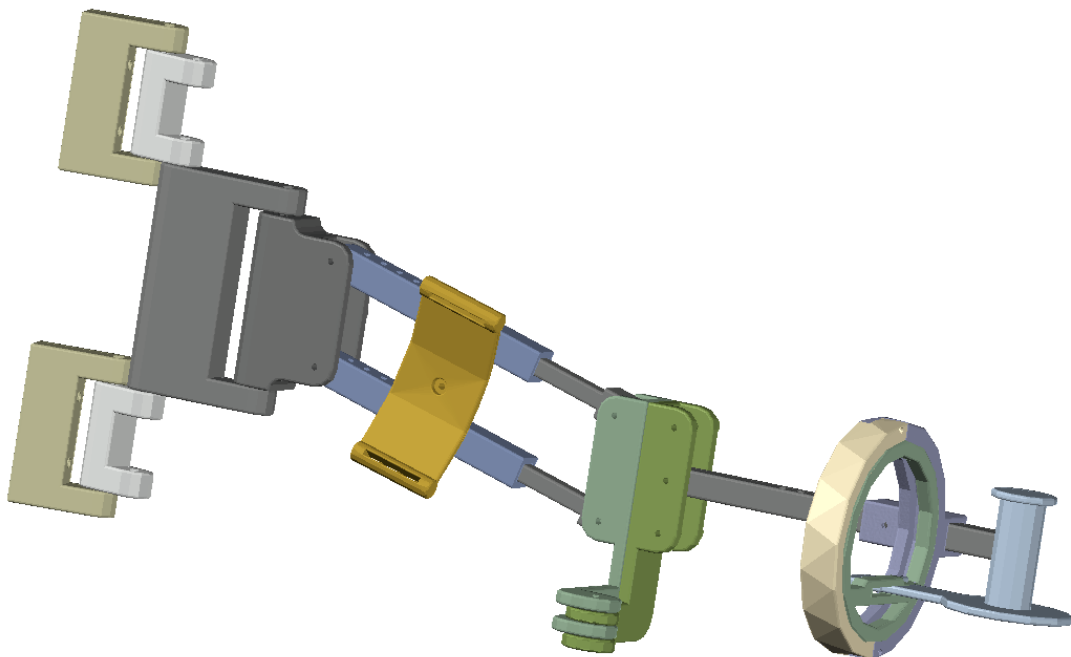


POWERUP

User Manual



The POWERUP platform consists of an orthosis for promoting the upper limb rehabilitation of patients with Cerebral Palsy.

Research project funded by the Spanish Ministry of Science and Innovation and developed by the Bioengineering research team of San Pablo CEU University in Madrid (Spain).

INDEX

1. About the POWERUP exoskeleton	4
1.1 Parts and performance	5
2. How to put on	7
3. How to use	10

1 About the POWERUP exoskeleton

The POWERUP setup consists of an upper-limb exoskeleton designed to enable users with limited motor functions to perform rehabilitative movements and improve their range of motion in daily activities.

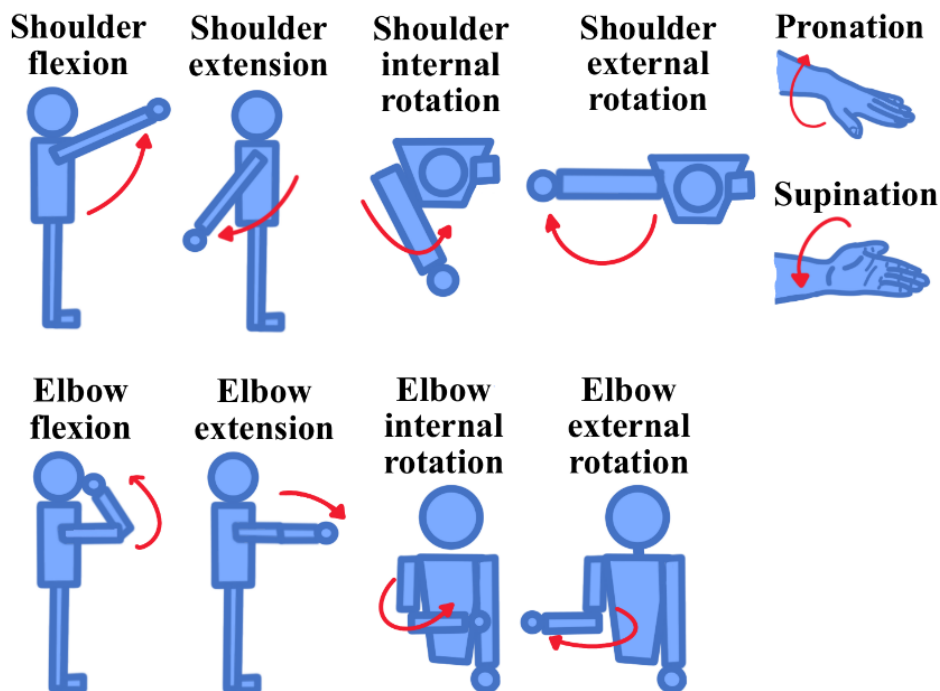
The POWERUP system consists of four modular components: shoulder/back, arm, forearm, and hand.

By utilizing bars, anchors, and elastic straps, physiotherapists can easily customize the device's width, height, and length to match the user's body measurements. Furthermore, the modular design facilitates simple and quick assembly.

The exoskeleton offers five degrees of freedom, enabling the following movements:

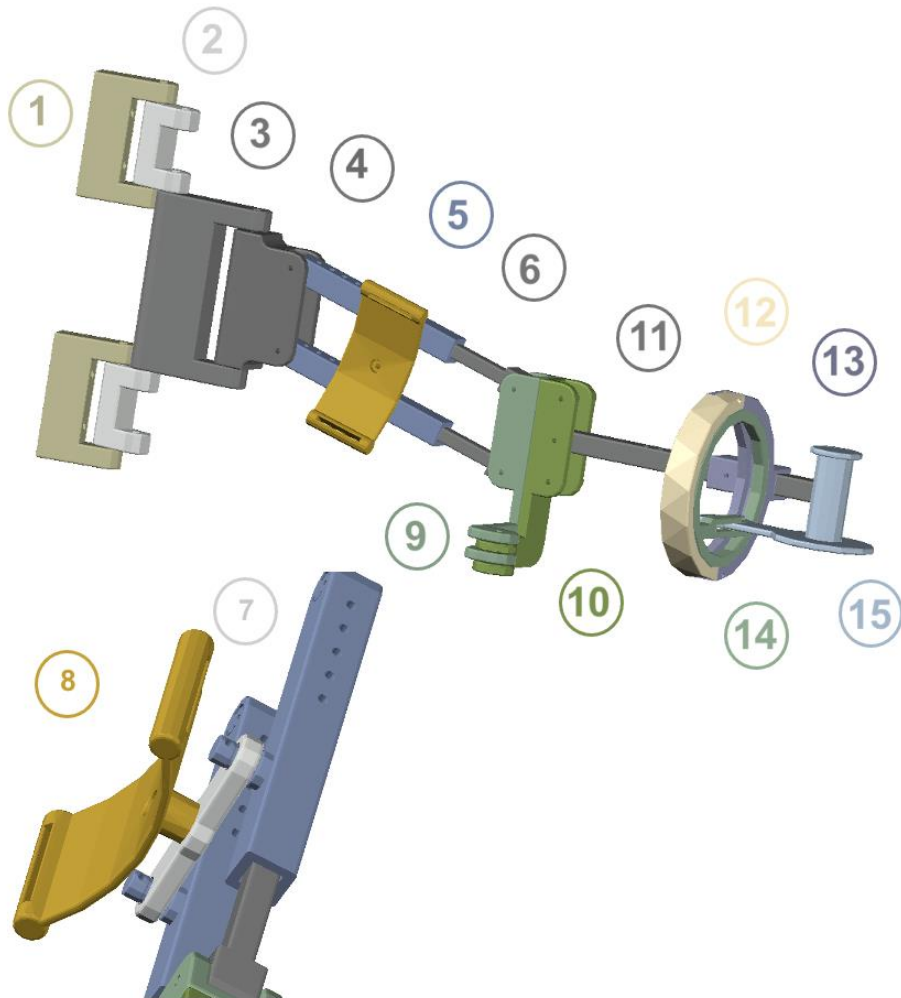
- Shoulder extension and flexion
- Shoulder internal and external rotation
- Pronosupination of the arm
- Elbow flexion and extension
- Elbow internal and external rotation

The device is entirely 3D printed using PLA filament, a lightweight and cost-effective thermoplastic derived from renewable and organic sources. This manufacturing method ensures the exoskeleton is lightweight, affordable, and easy to reproduce.



Movements allowed

1.1 Parts and performance



Parts 5 and 6 are extensible so they can be adapted to any user. Depending on the patient's size, different measurements are required.

Although there are two versions of the exoskeleton, one for the right arm and one for the left arm, the idea is that only one arm can be rehabilitated with the device during a therapy session.

Do not use both exoskeletons at the same time, even if you change the arm later.



2 How to put on

Always, sessions requires from patient:

- Sitted with straighted back
- Knees bent 90 degrees and
- Feet flat on the floor or on a solid and smooth surface

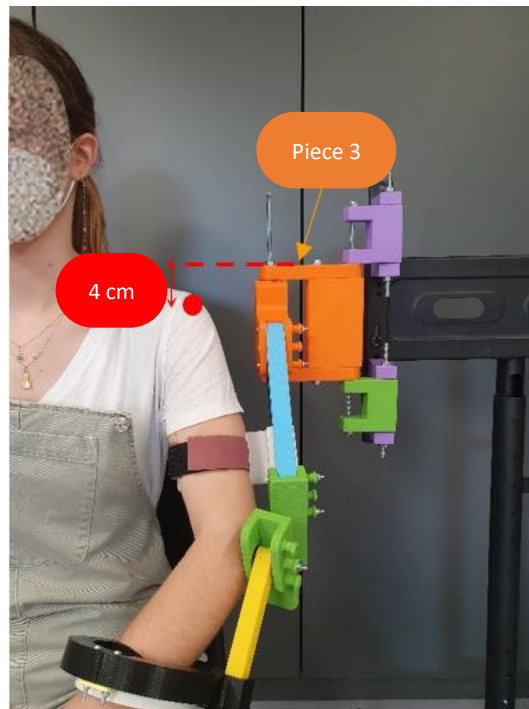
Both arms are symmetric, so references were set to assure comfortability on the posture.



For tesing, if the exoskeleton was correctly attached, patient on resting position should be comfortable and with no shoulders desalignment. Also, comfortability must be present on not resting position when using elastics rubbers to raise arm to the new assisted resting position.



Upper piece 3 should be approximately 4 centimeters above shoulder's height.

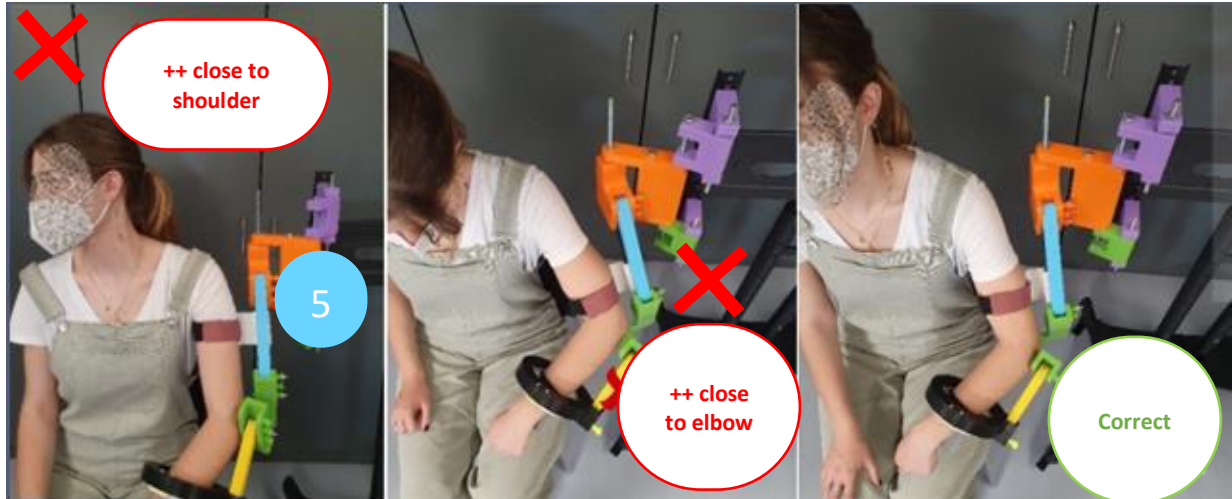


For a good coupling of the exoskeleton with the patient, piece 3, should be aligned with back.



Upper arm support colocation is important for avoid contact between ribs and piece 5 (upper arm support) and for avoid shoulders desalignment.

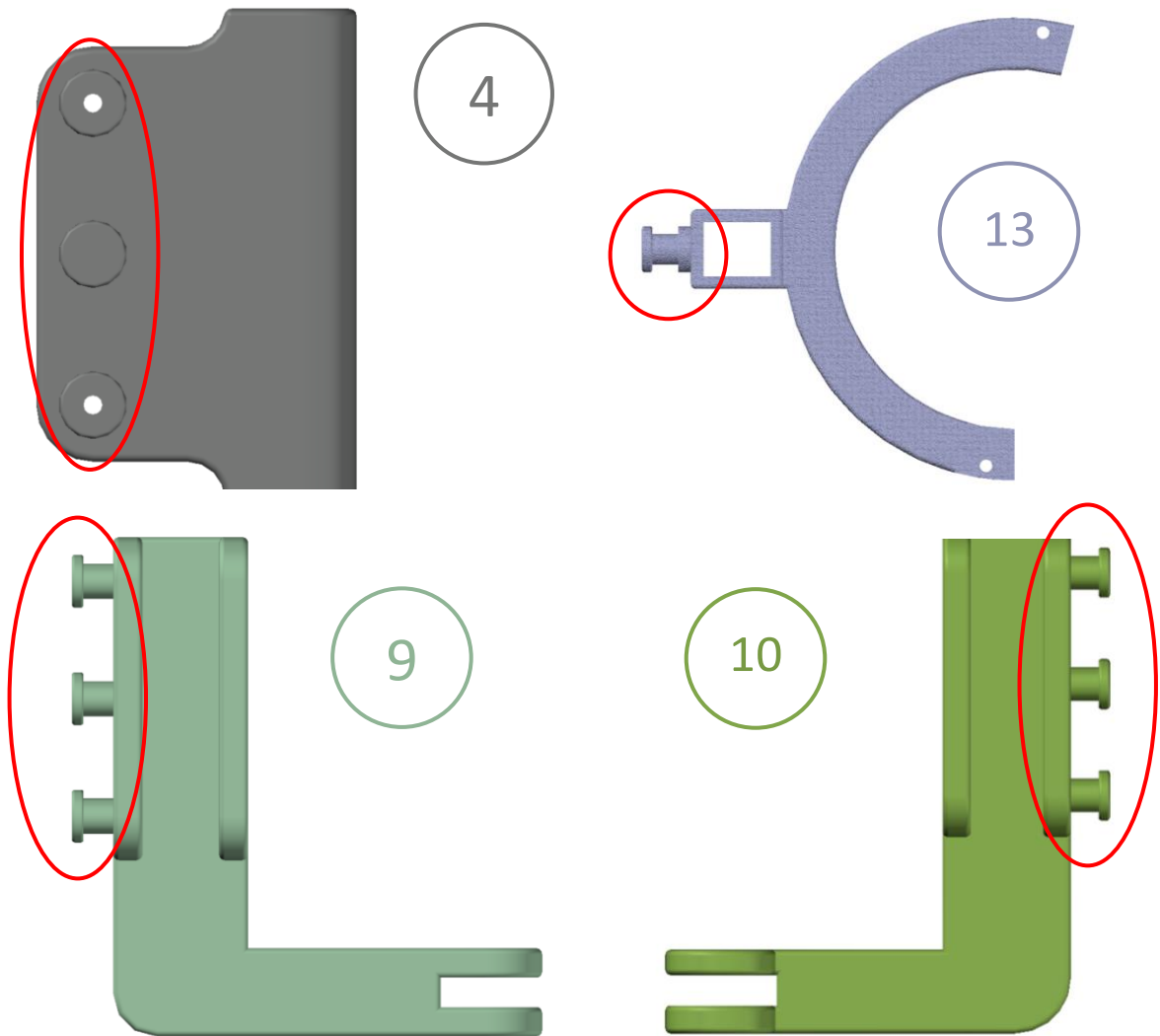
- If velcro attaches are extremely closer to the elbow, lifting movements would result hampered.
- If velcro attached are extremely closer to the shoulder, descending movements would result hampered.



Once exoskeleton was completely attached and patient in a comfortable position, practice exercises could take place.

3 How to use

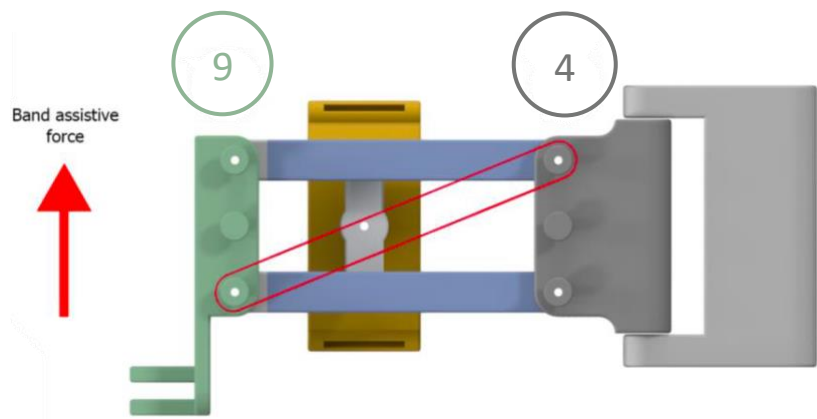
There are multiple settings depending on how the elastic bands are positioned. As we can see, in the pieces 4, 9 and 10 there are three protuberances, and in the piece 13 there is one protuberance.



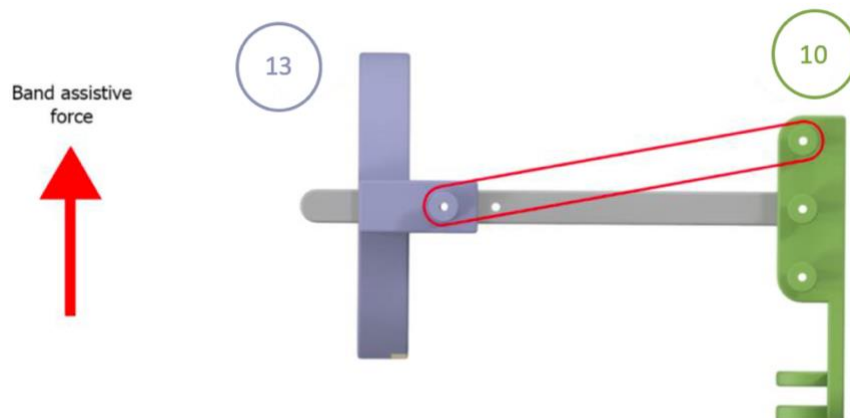
Depending on how the elastic bands are placed around these protrusions, different configurations of the exoskeleton are achieved, these can be assisting or resisting the movement:

- Assistive configuration

- Arm segment: Bands are placed at the upper attachment point of piece 4 and the lower attachment point of piece 9, this will cause an up force opposite to the gravity pull downwards.

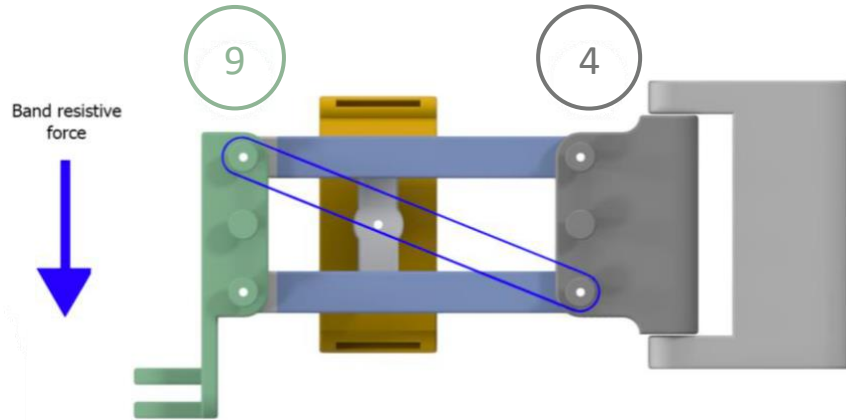


- Forearm segment: Bands are placed on the upper attachment point on piece 10 then an upper force will be produced, at piece 13 in this case there is only a fixed point.

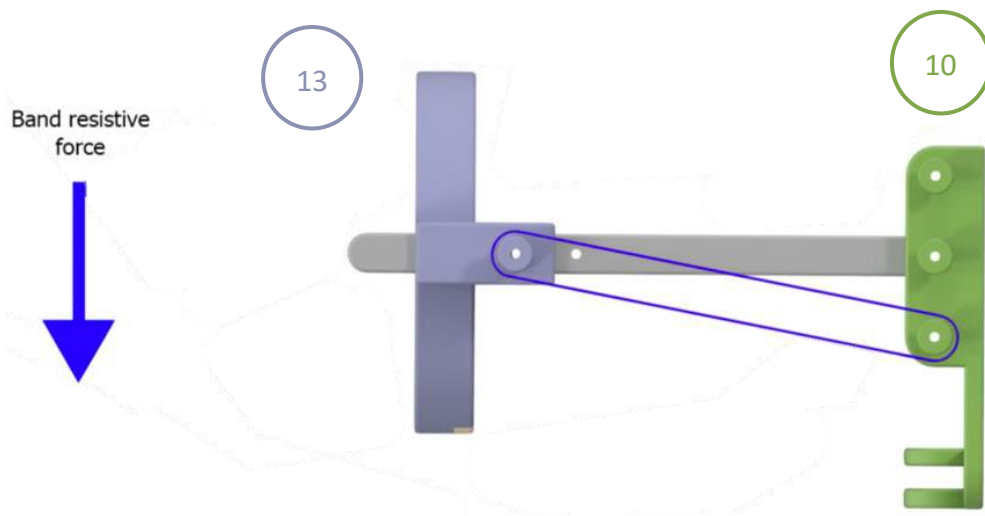


- Resistive configuration:

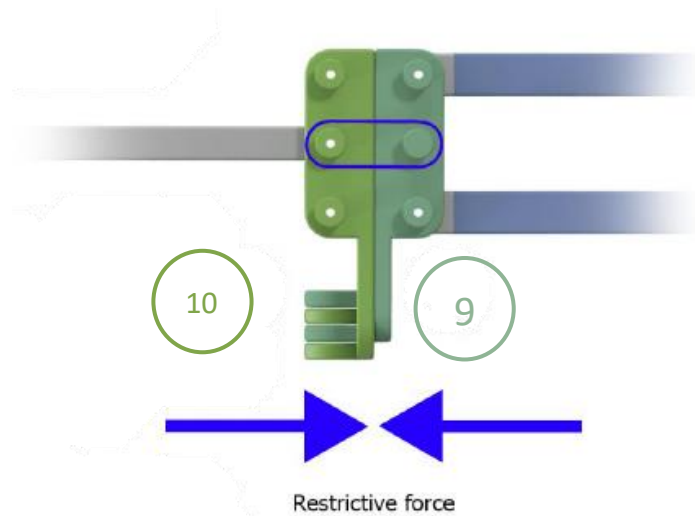
- Arm segment: Bands are placed on the lower attachment point of piece 4 and the upper one of piece 9 then a downward force will be produced which will be added to the gravitational pull increasing the apparent weight of the upper limb.



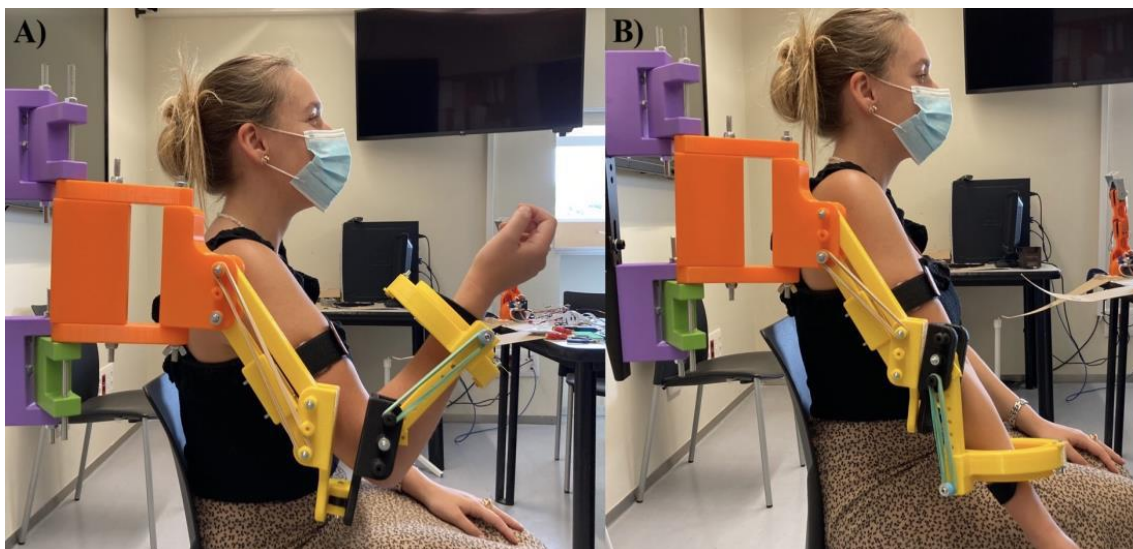
- Forearm segment: Bands are placed on the lower attachment point of piece 10 then a resistive force is produced, the attachment at piece 13 is the same.



- Elbow segment
 - o Assistive configuration to prevent the elbow internal flexion: Middle attachment point in pieces 9 and 10 is used to create an opposite force when flexing the forearm.



It is usually needed to place several elastic bands to be able to assist or resist the patient's arm significantly. But it is **not possible to quantify how many bands are necessary for each activity** a priori, as it depends on external factors, such as the patient's height and weight, the strength of the user, the problem or dysfunction that needs to be worked on. **A physiotherapist is responsible for and supervises the therapeutic prescription of the use of these modes.**



Exoskeleton assisting flexion (left) and Exoskeleton resisting flexion (right)