

Exercise Device for child with Spinal Muscular Atrophy

Client: Karen Patterson

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Overview

- Problem Statement
- Background: SMA and treatments
- Product Design Specifications
- Preliminary Designs
- Design Matrix
- Future Work
- Acknowledgements

Problem Statement

- Goal:
 - Exercise device for the legs
 - 10 yr old patient with SMA type I
- Spinal muscular atrophy [1]
 - Autosomal recessive
 - 25% chance
 - One of the most common neuromuscular disorders
 - 1/40 people can be carriers
 - $1/40 * 1/40 * 25\% \approx 1/10000$
 - Four different types
 - Type 1 is most severe

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General SMA Facts

SMA is a motor neuron disease, motor neurons affect the voluntary muscles

Spinal Muscular Atrophy (SMA) refers to a group of inherited diseases of the motor nerves that cause muscle weakness and atrophy (wasting). The motor nerves arise from the spinal cord and control the muscles that are used for activities such as breathing, crawling, walking, head and neck control, and swallowing.

1 in 40 people carries the gene that causes SMA

1 in 4 chance The child of two carriers has a one in four chance of developing SMA

▲ [Click to view General SMA Facts](#)

[2]

Type I SMA

- Atrophy of ventral roots[3]
 - Motor nerve cells in the spinal cord
 - No anti-gravity strength
 - Failure in mechanical ventilation
- Genotype difference [4]
 - Mutation in the survival motor neuron gene 1 (SMN1)
 - Protein helps control muscles
 - SMA patients mostly rely on SMN2
- Current therapy (Spinraza /AceXis)

Product Design Specifications

- Exercise device for the ~~arms~~ legs
- Removable from wheelchair
- Usable in supine position
- Positioned above frame
- Lightweight and easily storable





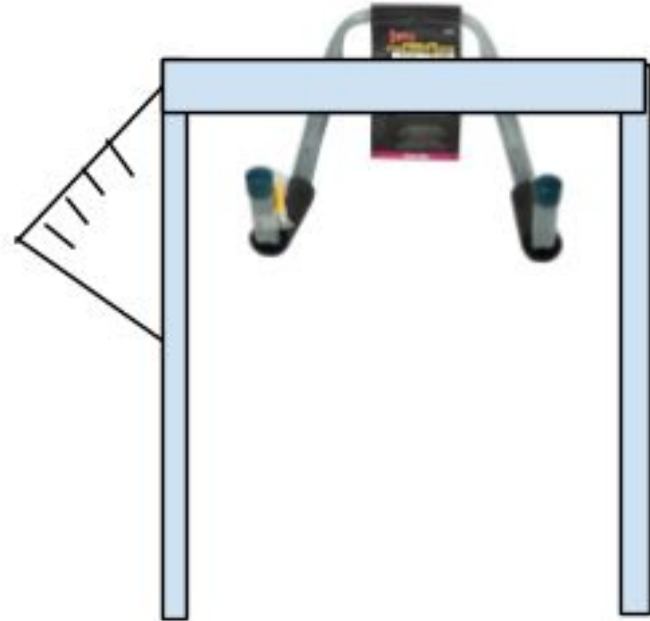
Wrist Spring

- Weak torsional spring
- Works on flexion and extension of wrist



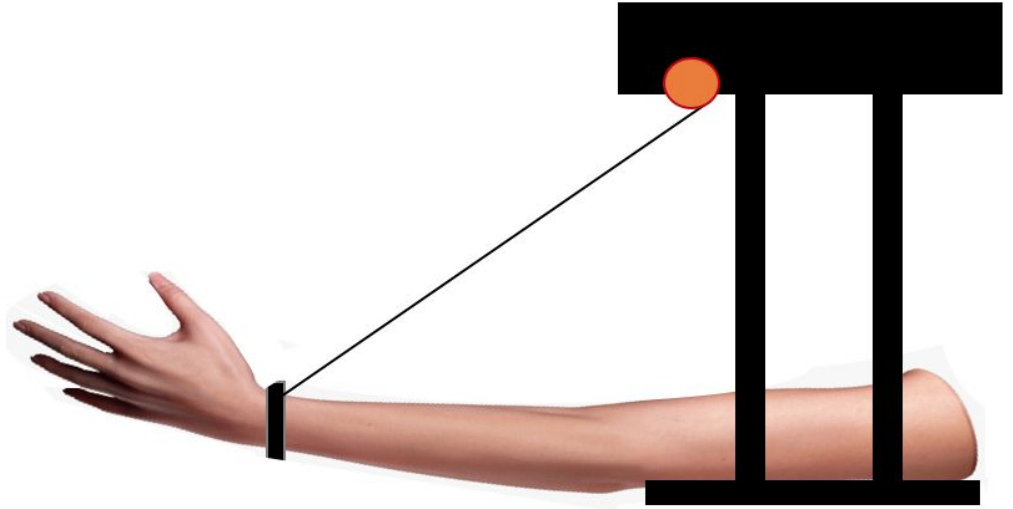
Finger Rockwall

- Arm rests on handles
- Use fingers to climb up the rock wall
- Works on flexion and extension of wrist



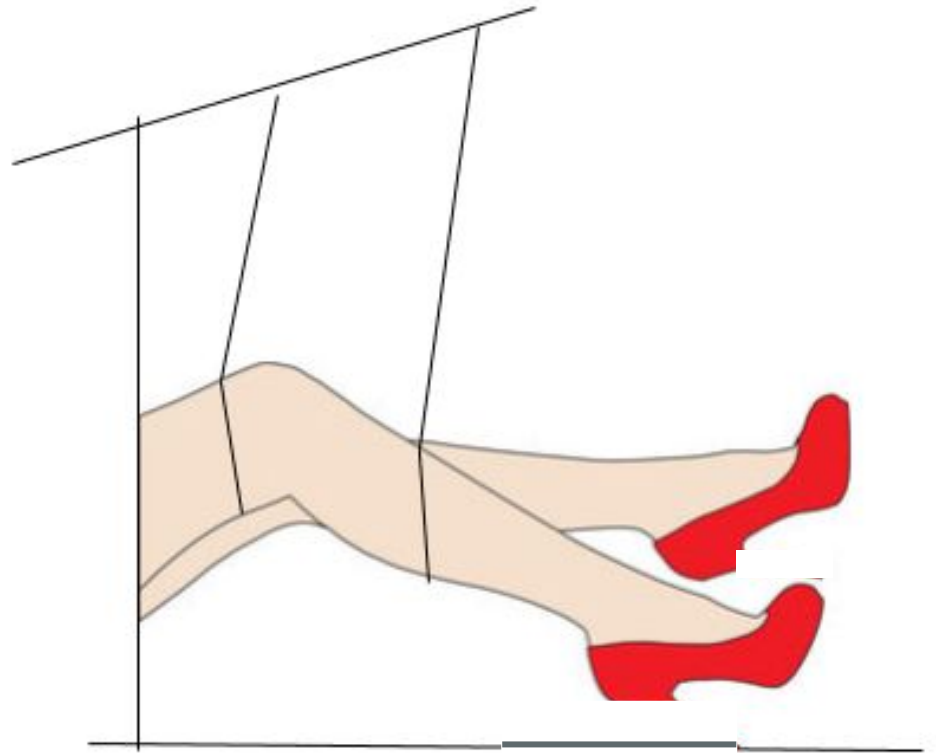
Retractable Arm Exerciser

- Sling type mechanism to fully support the arm
- Works on flexion of the elbow
- Lock type mechanism to keep arm up once it is raised



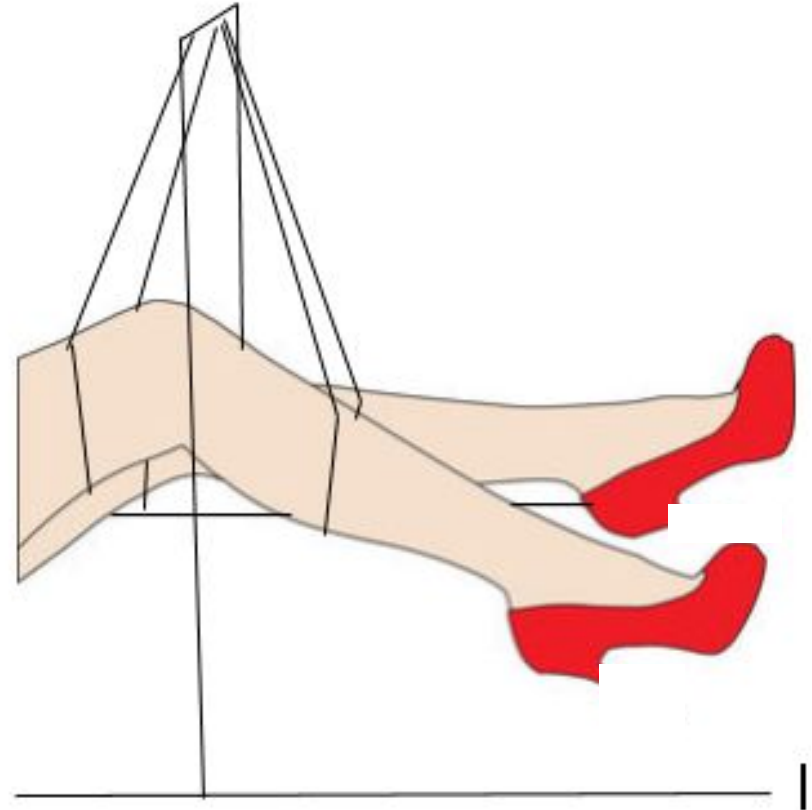
Single Leg Holder

- Two harnesses to support the leg
 - One above knee
 - One at calf
- Exercises one leg at a time
- Antigravity concept
- Abduction/Adduction of legs
- Attaches to one side of Ki Mobility chair



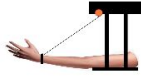
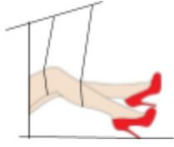
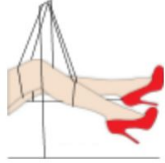


Double Leg Holder

- Two harnesses to support each the leg
 - One above knee
 - One at calf
- Exercises both legs at once
- Antigravity concept
- Abduction/Adduction of legs
- Attaches to both sides of Ki Mobility chair



Design Matrix

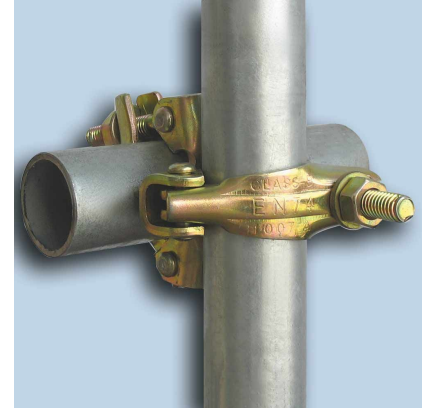
Design	Wrist Spring		Finger Rockwall		Retractable arm exerciser		Single Leg holder		Double Leg Holder	
										
Criteria (weight)										
Ease of Use (20)	4/5	16	2/5	8	5/5	20	4/5	16	5/5	20
Comfortability (20)	2/5	8	5/5	20	4/5	16	4/5	16	4/5	16
Safety (20)	2/5	8	3/5	12	4/5	16	3/5	12	4/5	16
Ease of fabrication (15)	4/5	12	2/5	6	3/5	9	3/5	9	3/5	9
Durability (15)	4/5	12	3/5	9	4/5	12	3/5	9	4/5	12
Weight (5)	4/5	4	2/5	2	3/5	3	4/5	4	3/5	3
Cost (5)	4/5	4	3/5	3	3/5	3	5/5	5	4/5	4
Total (100)	64		60		79		69		80	

Future Work

- Foreseeable challenges
 - How the device will attach to the wheelchair and be removable
 - Device stability
 - Testing the device
 - Keeping the device low in weight.

Fabrication

- Fabrication of device
 - Made out of PVC
 - Find clamp
 - Scaffolding Double Coupler
 - Leg Straps



Scaffolding Double Coupler [5]



Comfy leg brace [7]



Leg Straps [6]

Acknowledgements

- Karen Patterson
- Ed Bersu
- Aubrey and her family

References

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[6] <http://www.bfinternet.co.uk>, "Scaffold Double Coupler (Drop Forged)", *Doughty-usa.com*, 2017. [Online]. Available: http://www.doughty-usa.com/cgi-bin/trolleyed_public.cgi?action=showprod_T24901.

[7] <http://www.bfinternet.co.uk>, "Scaffold Double Coupler (Drop Forged)", *Doughty-usa.com*, 2017. [Online]. Available: http://www.doughty-usa.com/cgi-bin/trolleyed_public.cgi?action=showprod_T24901.

Questions?