

Helpful Hairbrush

Assistive hairbrush designed specifically for the limitations of Fibrodysplasia Ossificans Progressiva (FOP)

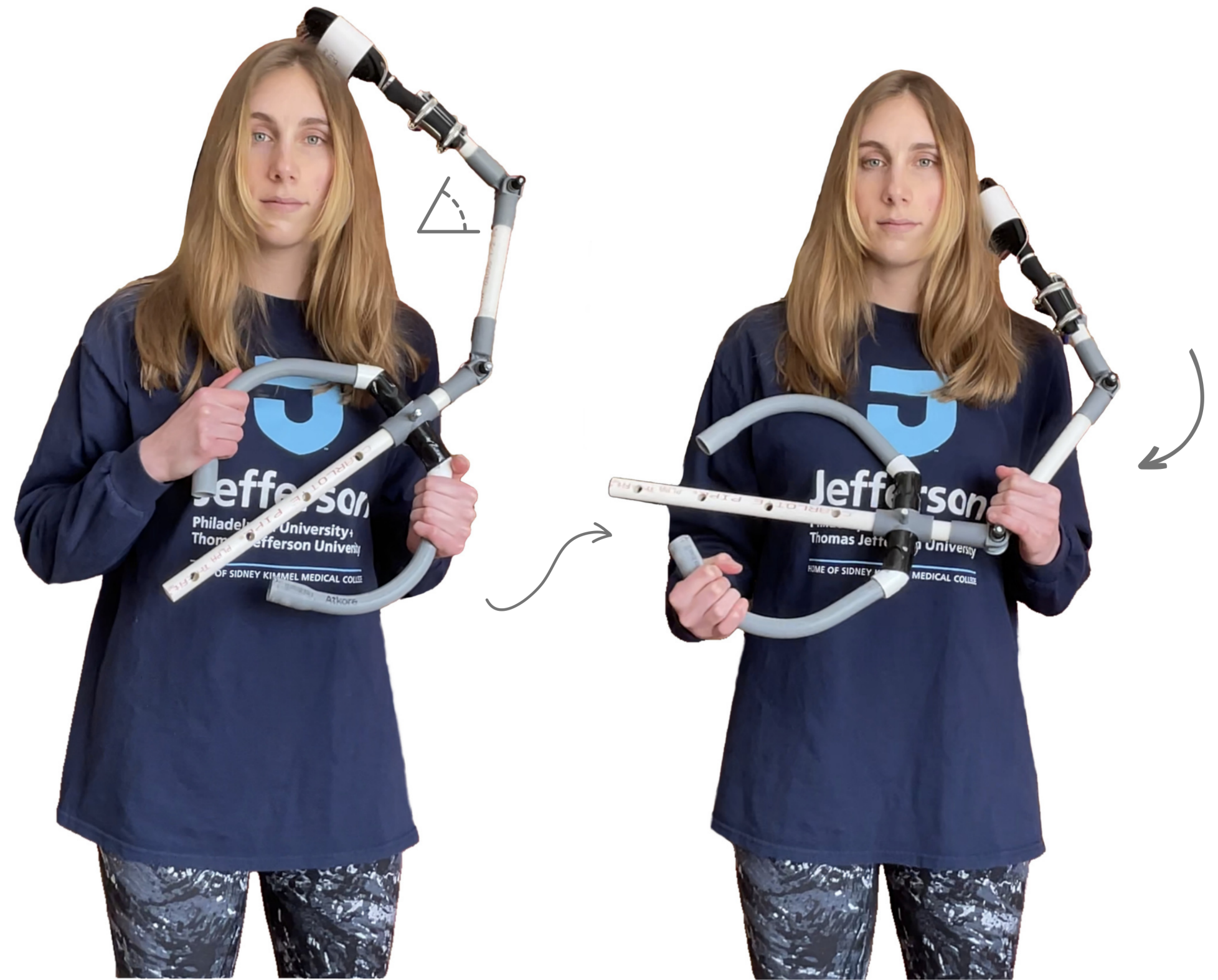
Independently brush hair with reduced mobility

Design Criteria

- Use interdisciplinary teamwork to design a hairbrush specifically for the needs of those with FOP

WILL Project

"We Improve Life & Living with FOP"



What is FOP?

Fibrodysplasia Ossificans Progressiva

Extremely rare
genetic disease

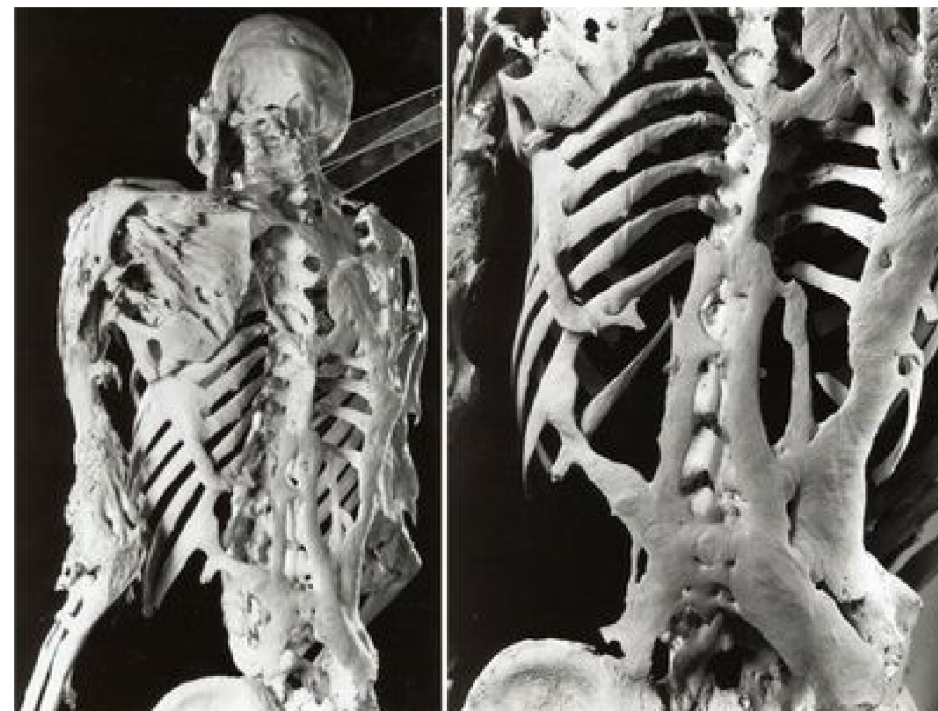
Muscles, tendons, and
ligaments turn to bone

Process of progressive,
uncontrolled bone
growth brought on by
"flare-ups"

Typical Skeleton
Separate bones

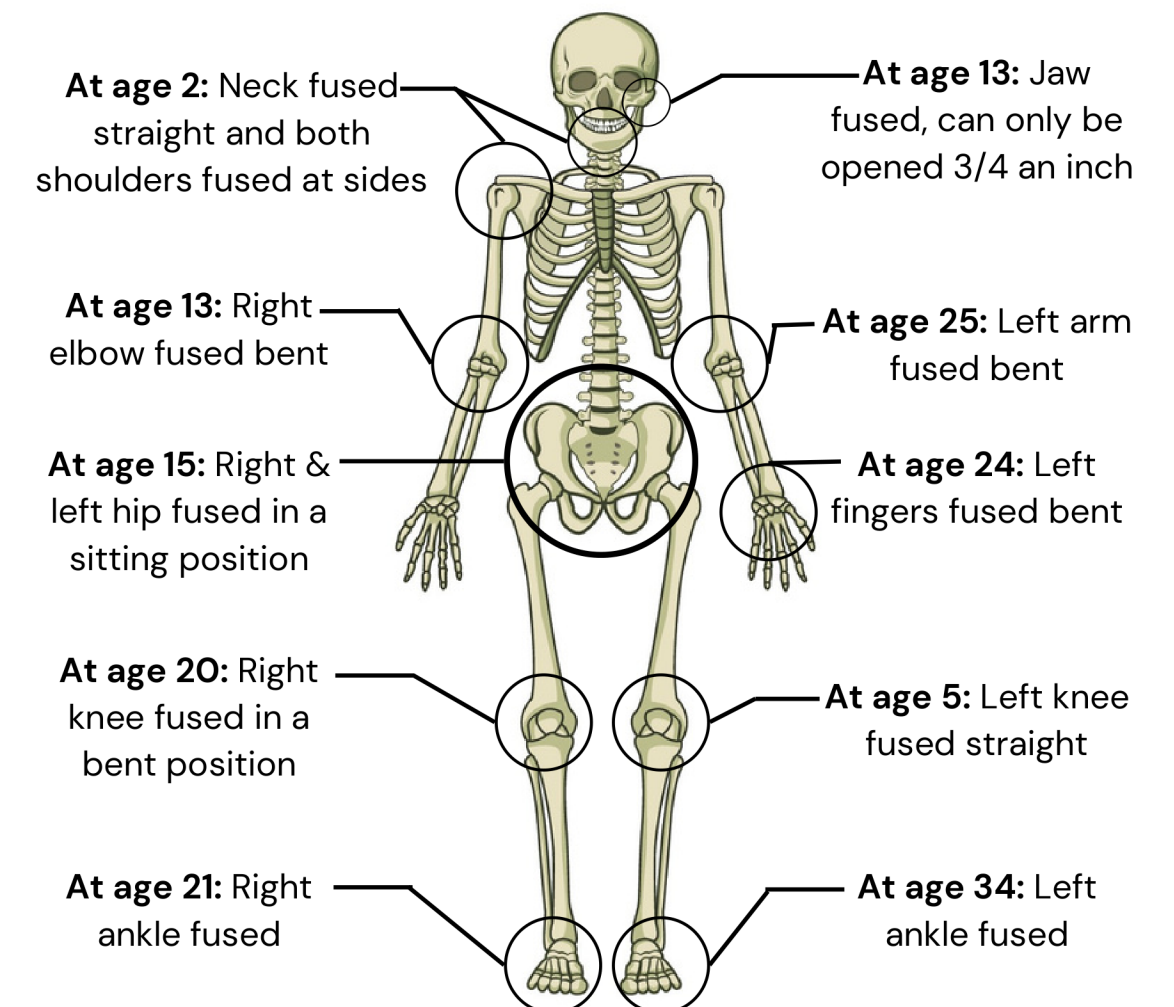


FOP Skeleton
Connective tissues calcify & fuse together



Cycle of flare-ups lead to
**permanent fixation of most
major joints in the body**

Progression Example:



Daily Activities with FOP

Limited Mobility Impacts:

- Reaching
- Toileting
- Oral Hygiene
- Eating
- Dressing
- **Grooming**

Individuals with FOP become fused and locked in positions

Limits independence

Makes daily activities difficult to execute.

The progression and pattern of FOP is **highly variable for each person**. Current assistive devices do a poor job meeting their continual adaptations.

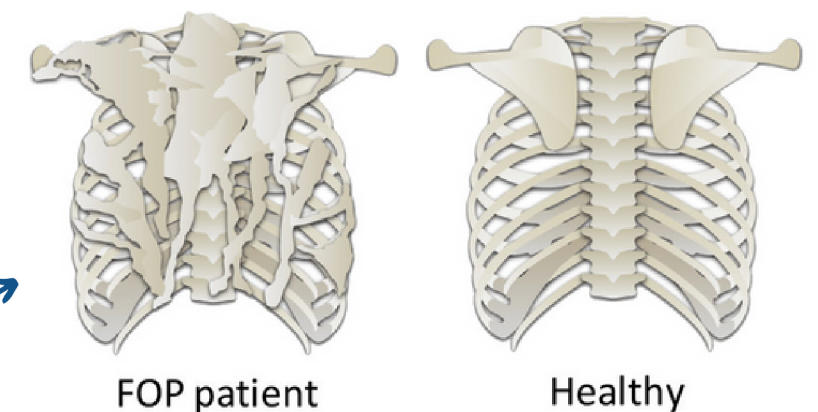
Self-Grooming Market



Current devices lack the necessary range of movement to brush your hair with FOP

- Current assistive hairbrushes replicate an extension of the forearm
- Elongated handles and a slight curve to help reach the back of the head
- **Do not bend, turn, or adjust**

Early in FOP disease progression, the **neck fuses** (fixed looking straight) and the **shoulders fuse** (arms fixed to sides)



Brushing Different Lengths of Hair

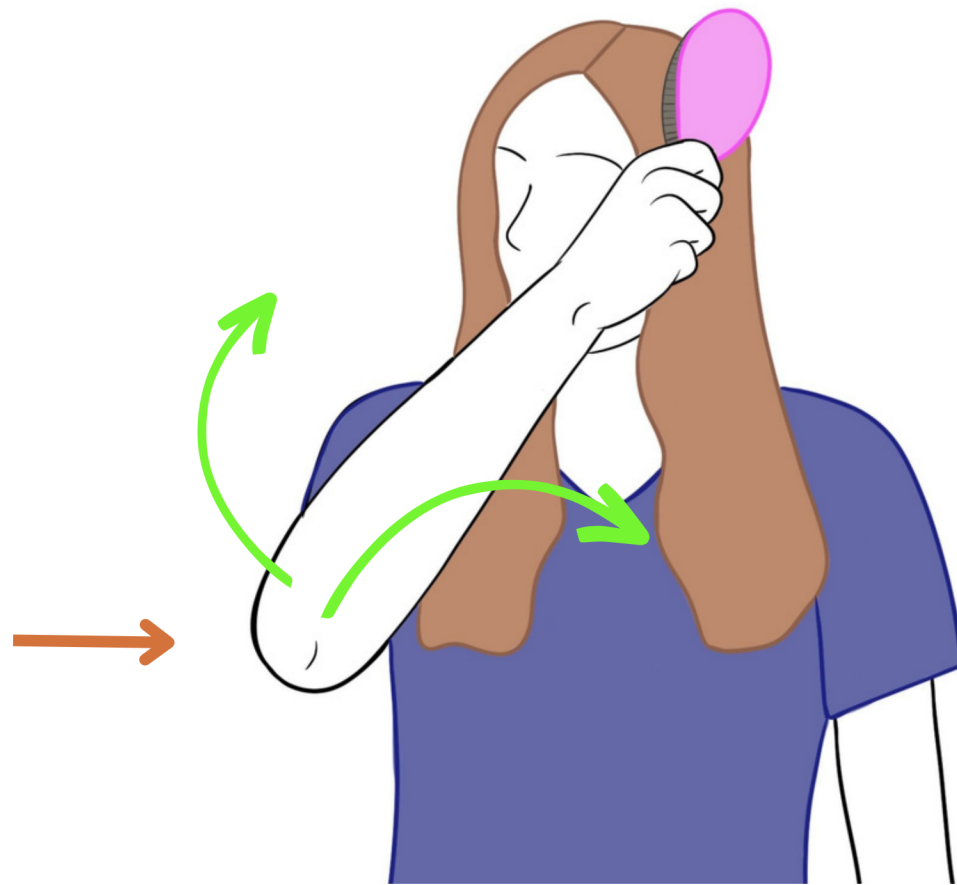
Typical movement has wrist & elbow in opposition:
as wrist brushes down, elbow raises up

**How might we
design a
hairbrush that...**

- Effectively brushes long and short hair
- Can be used with shoulders fused at sides
- Doesn't put strain on the wrist

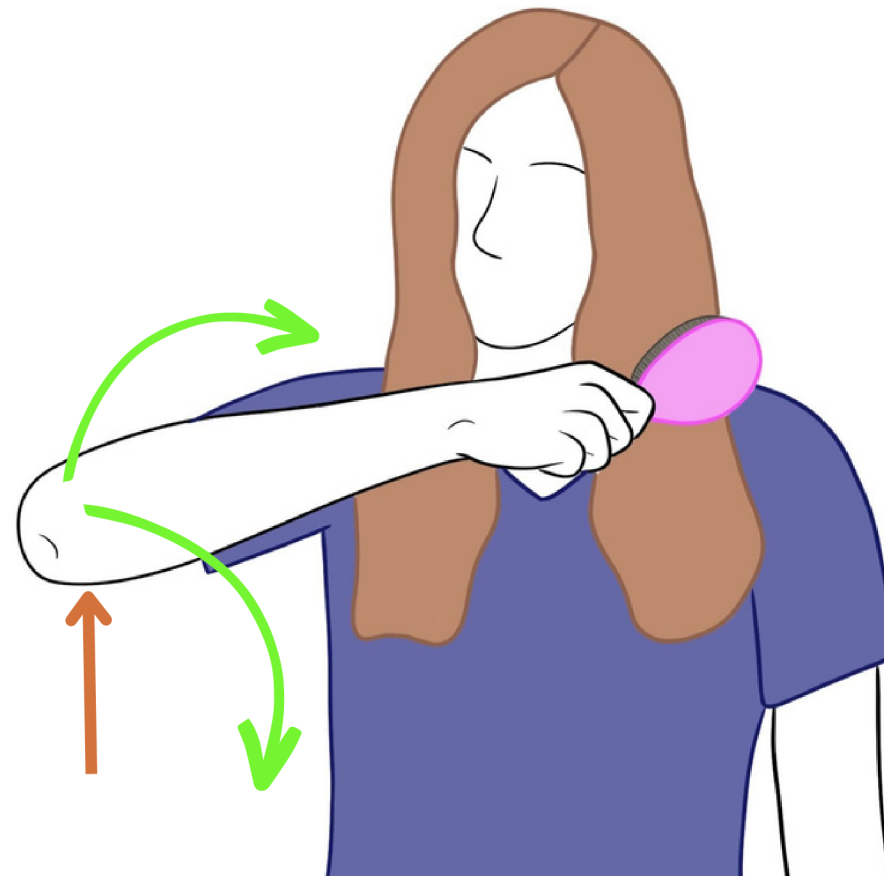
Top of Hair

- Forearm pivots at elbow
- Shoulder in; elbow in



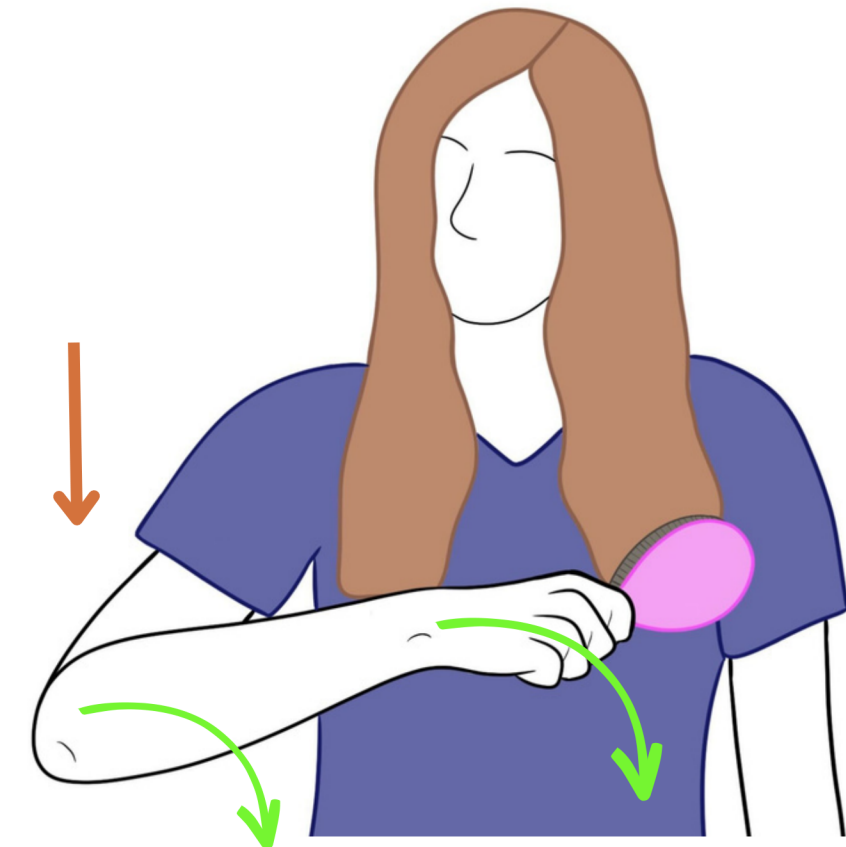
Midsection of Hair

- Forearm pivots at elbow
- Shoulder extended; elbow out



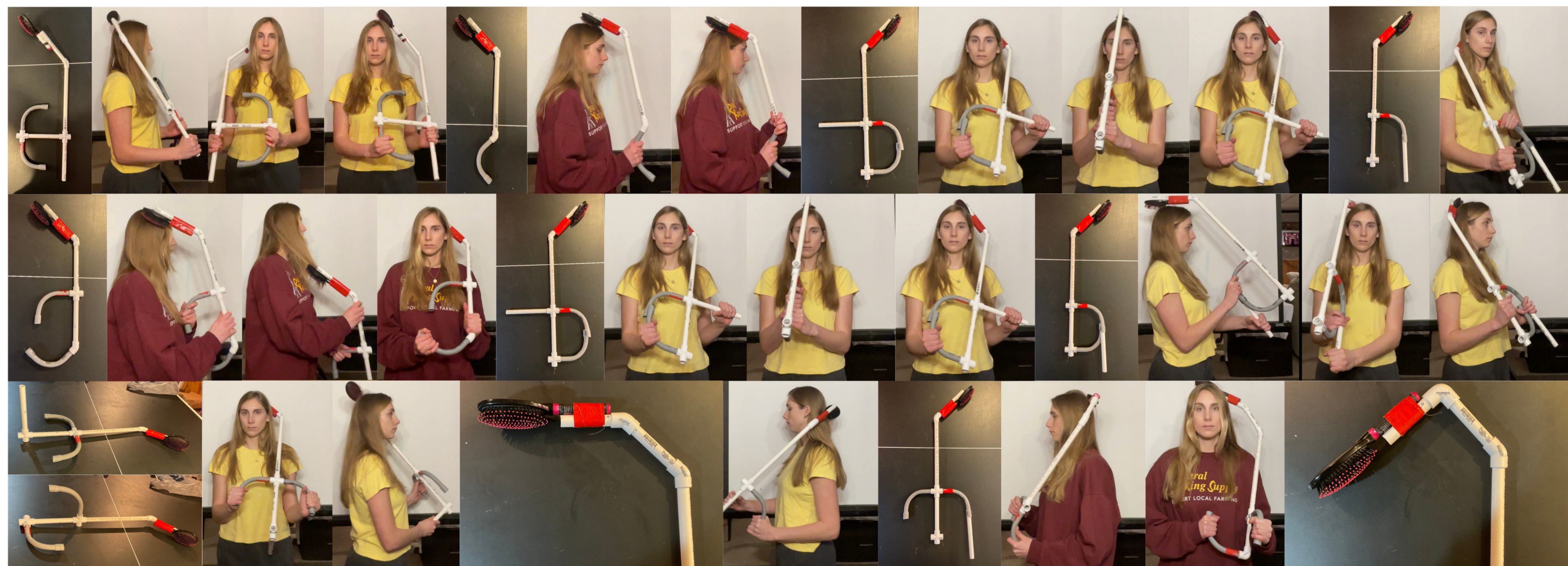
Ends of Long Hair

- Elbow & wrist pivot as user brushes down
- Shoulder & elbow move down with the brush



Exploring Lengths & Angles

- Different ways to brush long hair with FOP constraints, focusing on reaching the back of the head (most difficult spot)

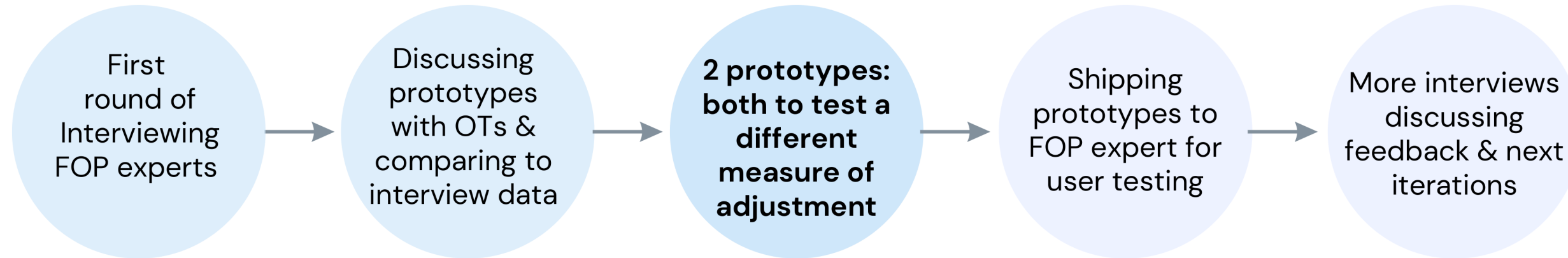


Exploring Grips

- Discovered that a "steering wheel" approach offered the greatest number of possible grip positions
- This design gives patients more options to test, providing more valuable feedback



Sending Prototypes for User Testing



Features



3D printed hinge knuckles for adjustable angles

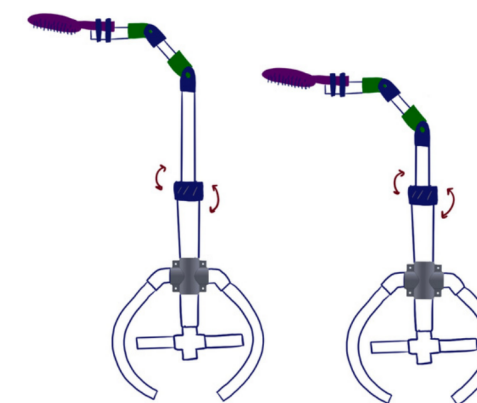
Adapts to PVC & secured with cam clamp



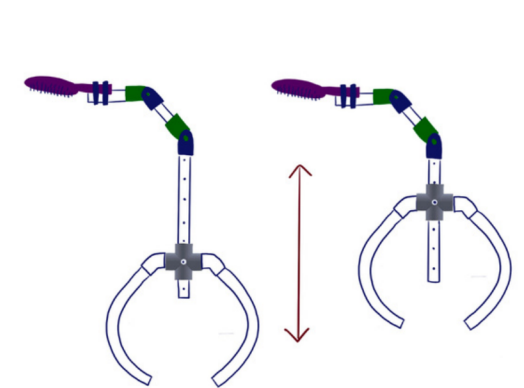
Proof of concept functional prototype

Exploration of heights & angles that accommodates the variable range of angles that the elbows can be fused at

Prototype #1

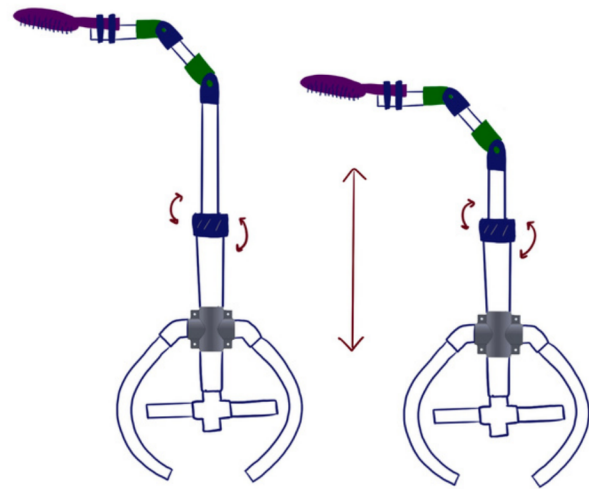


Prototype #2



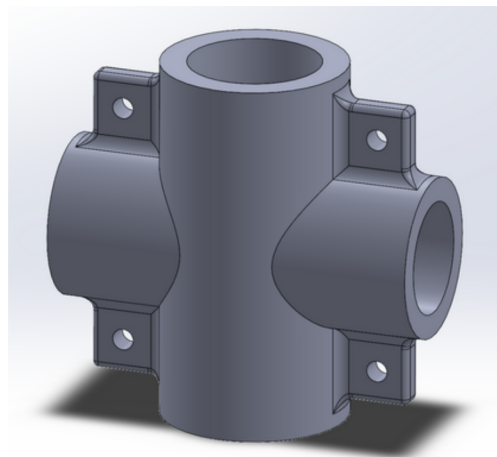
Prototype #1

- "T" shaped handle design to test vertical grip options
- Shaft height adjusts telescopically



Locks & unlocks
with a twist,
infinitely adjustable

3D printed clamp
sandwiching shaft
and handlebars

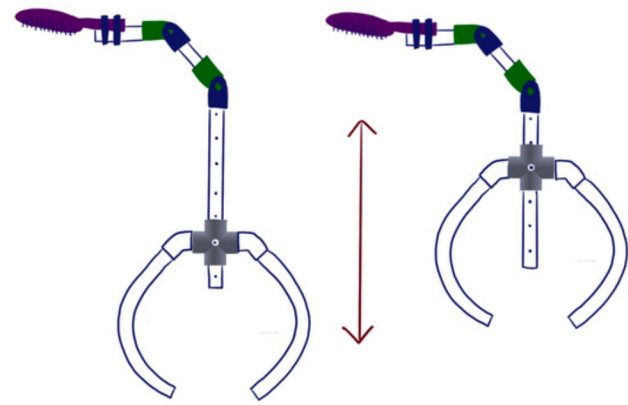


*Occupational Therapist
testing prototype*



Prototype #2

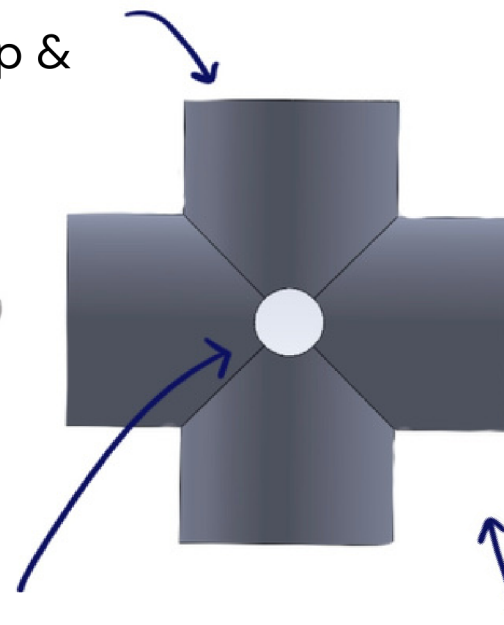
- Testing open handle grip design
- Handle moves relative to the shaft height



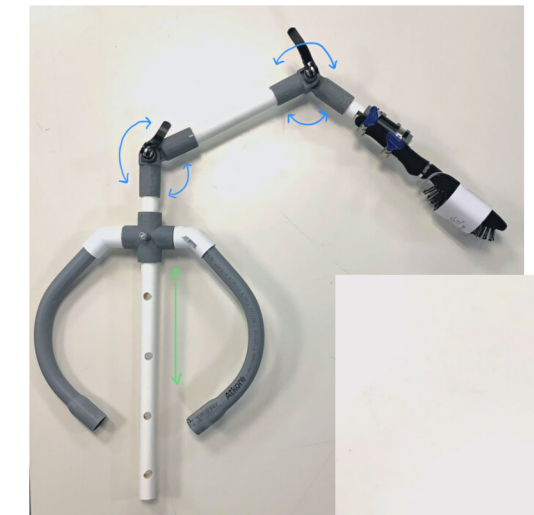
Vertical ends
slide & lock up &
down shaft



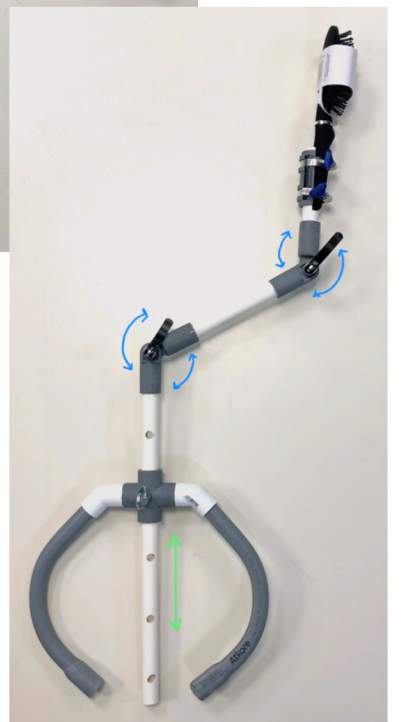
Adjusts in
increments
& locks with
pin



Horizontal openings
fit handles securely



Examples of
possible
range



Feedback from Testing

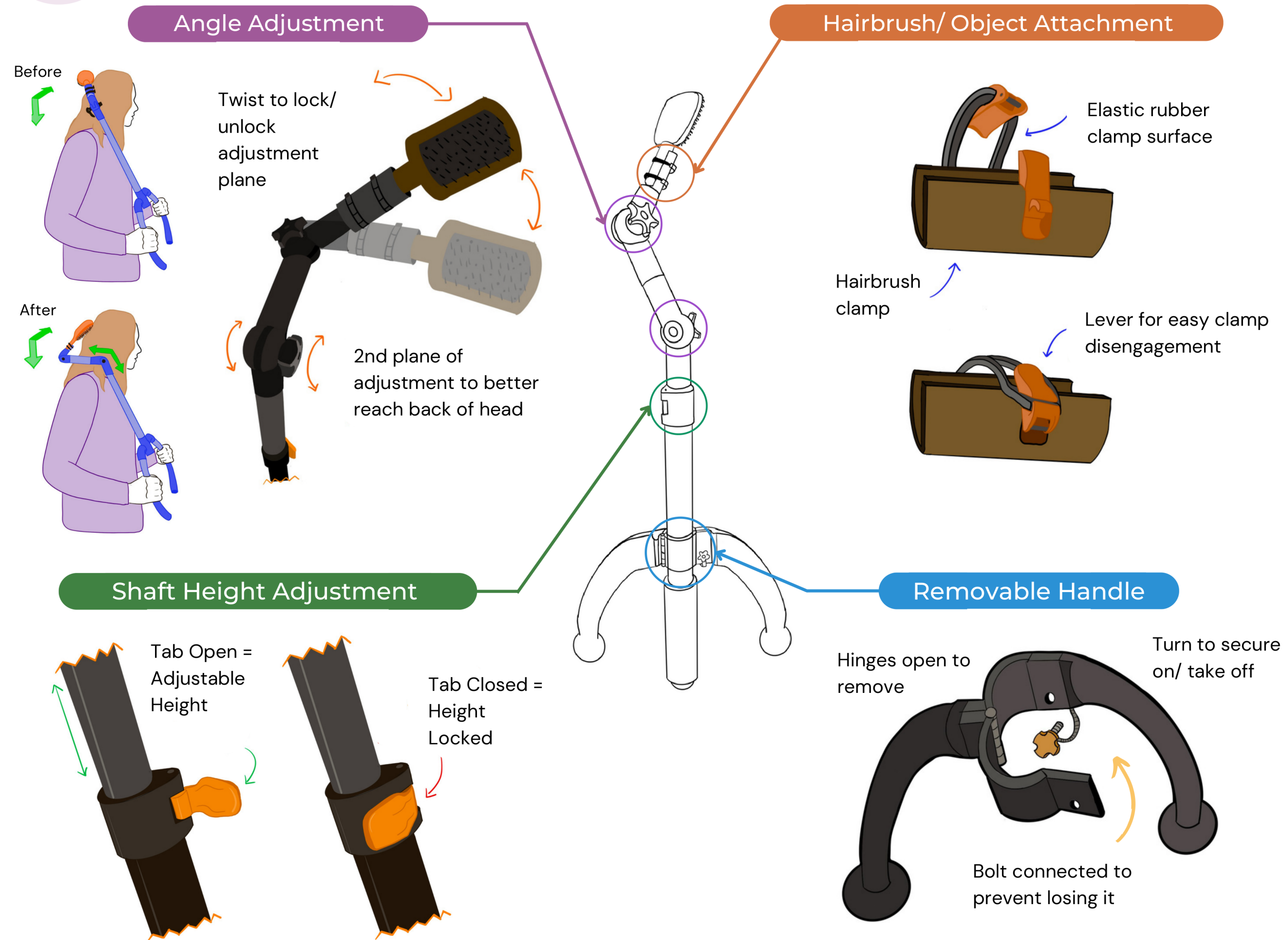
After 1- on-1 feedback and a discussion with a panel of OTs, FOP experts, and the IFOPA, we found these conclusions:



The FOP expert above has her left arm fused by her side, and is able to bend her right forearm up as shown.

The overall height is too large, but she was able to make adjustments to my prototype that worked for her

Next Iteration



Moving Forward

At the end of the year, Jefferson ID faculty selects devices from The WILL Project to continue developing by assigning them to students in the next cohort. This strategy allows the department to work as a team; building upon prior students' work allows the designs to develop much more detail, so they can ultimately be in the hands of the FOP users!

The Assistive Hairbrush is currently in development by the next student, taking my next steps and beyond as they continue testing, iterating, and progressing the device.

WILL Project

"We Improve Life & Living with FOP"

Rendering of my
last iteration
before passing the
project on



Project Background

Importance of Industrial Design (ID) & Occupational Therapy (OT) Collaboration

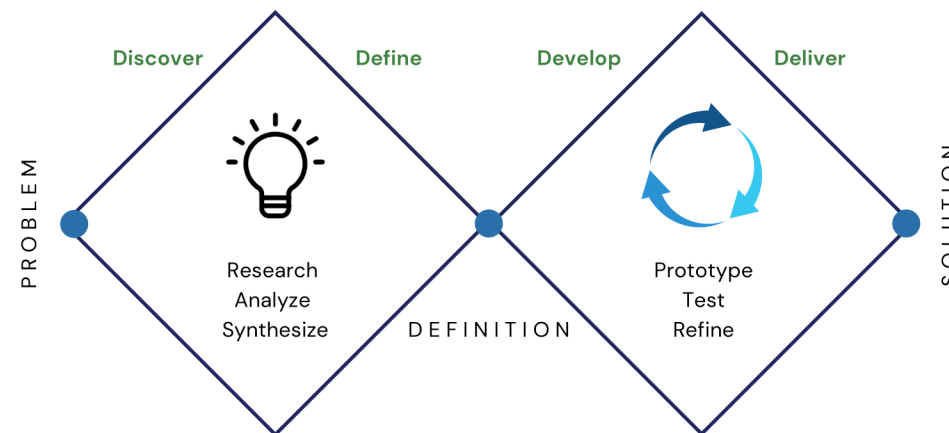
WILL Project

"We Improve Life & Living with FOP"

ID Impact

- Presence of end-user opinions & usability testing procedures
- Knows how to create beyond single user populations

ID Process



OT Impact

- Understand medical & cognitive fundamentals
- Effective solutions for end-users (clients & therapists)

OT Process



Both Disciplines

- Emphasis on a user centered design process
- Strive to make evidence-based decisions
- Attention to making & iterating

Client- Centered

- Understanding of client's current issues & problems
- **Client is the EXPERT**
- Only client can identify goals & priorities that are important to them- with *help* from the therapist

2019: WILL Project is a collaboration between Occupational Therapists & Industrial Designers.

2021: IRB Approved data collection during design process & partnership with Shenkar University, Israel

Jefferson is a worldwide center for FOP treatment, making this connection possible



Together, we have a common emphasis on a user centered design process & strive to make evidence-based decisions with research, feedback, & iterations.