<u>Jan 1st - Feb 1st, 2026 - Prusa hand splint files review</u>

<u>General Splinting Positions</u>

For most wrist injuries:
- Wrist should be slightly extended (upward)
- About 15 degrees extension
- Knuckles slightly higher than forearm
- Fingers MUST be able to touch thumb to fingertips
  - Especially index, middle, and thumb (These are the most used fingers)
- Splint MUST be below the knuckles
  - Not blocking finger movement

If wrist is flat or bent down:
- Hard to grip
- Hard to twist or turn
- Makes recovery harder

<u>Exception: Tendon (Laceration) Injuries</u>

If there is a deep cut:
- Cut on Palm Side:
  - Wrist and fingers splinted down
  - Prevents pulling torn tendon apart
- Cut on Back of Hand:
  - Wrist splinted up
  - Opposite position

If unsure just assume tendon is torn and splint carefully

<u>Common Injuries</u>

1. Distal Radius Fracture (Most Common)
- Located near wrist
- Very common (20% of ER visits)
- Common in conflict zones
- Main long term issue:
  - Finger stiffness
  - Trouble making a fist

Splint Rules:
- 15 degrees wrist extension
- Thumb must touch fingertips
- Splint below ball of hand
- Avoid blocking finger bending

2. Boxer's Fracture

- Common when someone punches something
- Knuckle looks sunken
- Usually affects ring and pinky finger

Splint Position:

- Ring and pinky bent forward
- About 45-70 degrees
- Not curled, just angled forward
- Wrist should still move (unless fracture requires wrist support)

<u>Printing/ Material Tips</u>

Flat-Printed Splints:

- Easier to print
- Less Stringing
- Less post-processing

PLA Heating

- Heated to 80 degrees Celsius
- Cools quickly
- Can reshape when warm
- Edges can be smoothed with mini blowtorch

IMPORTANT ADJUSTMENT

- Flare edges slightly
- Prevent digging into skin

<u>Padding Advice</u>

- Usually NO padding used, even after surgery (if skin intact)
- Why?
    - Padding traps moisture
    - Moisture attracts bacteria
    - Only use padding for very open wounds

Capillary Refill (circulation check)

What it is:

Test to see if splint is too tight.

How to check:

1. Press fingertip
2. It turns white
3. Should turn pink quickly

Warning Sign:

- If refill takes 4-5 sec or longer
- Slower than uninjured hand
    - Loosen splint immediately

Delayed refill = possible circulation problem

Key Vocabulary

Laceration - Deep cut in skin
DRF - A break in the radius bone near the wrist
Ulna - Forearm bone on the pinky side of your arm
Tendon - A strong cord that connects muscle to bone and helps you move
IP joint - (Interphalangeal joint) The middle joint of a finger that helps it bend
Capillary refill-Test to check blood flow by pressing on a fingertip & seeing how fast the color returns
Aquaplast - A special medical plastic that softens in hot water and is used to make splints

Feb 1st - Feb 27th, 2026 - This Sensor Makes Your Muscles An Input!

What is an EMG Sensor?

An EMG sensor reads muscle activity.

When you flex a muscle:

1. Your brain sends a tiny electrical signal down nerves
2. That signal turns into a chemical signal in the muscle
3. The muscle creates its own electrical signal
4. This creates a very small voltage across the muscle
5. Pads placed on the skin detect this voltage

The sensor converts this into a readable electrical signal for a microcontroller

Science Concept (Must know)

- Muscle voltage is extremely small
- Around 1/1000th of a volt (millivolts)
- The sensor board:
    - Amplifies (scales up) the signal
    - Filters electrical noise
    - Outputs 0-3V or 0-5V signal for a microcontroller

Noise Problem (VERY IMPORTANT)

When amplifying tiny signals:

- Electrical noise is also amplified
- Noise sources:
    - Power outlets
    - Power supplies
    - Studio lights
    - Cables acting like antennas

The board must:

- Amplify muscle signal
- Filter out unwanted noise

Comparison - Recording someone whispering on a busy street

Equipment Needed
1. EMG Sensor

2. Microcontroller
- Watch demo
- Raspberry Pi Pico
- Programmed using MicroPython
- Could also use Arduino or ESP32

3. Electrode Pads
- Disposable
- Usually last 2-3 uses
- Fresh pads = better signal
- Can be bought cheaply in bulk

4. Power Supply
EMG board needs:
- Positive voltage
- Negative voltage

Solution used in the demo:
- 2 9V batteries
- Why batteries?
  - Clean power
  - Very low noise
  - Long life (around 1000 hours estimated)

USB power:
- Usually ok, but may cause noise
- USB isolator can help

Electrode Placement (*IMPORTANT*)

Three electrodes:
- Yellow(Ground)
- Red
- Green

Yellow:

Place on area with little muscle
- Elbow
- Top of wrist
- Mostly bone

Red and Green:

- Place along muscle
- One in middle of muscle
- One a few cm away
- Proper placement = stronger signal
    - Bad placement = weaker signal

<u>Reading the Signal</u>

The Pico:
- Reads ADC (analog pin)
- Displays graph

At rest:
- Signal stays near baseline

When flexing:
- Signal spikes

<u>Environment Matters</u>

Office environment:
- Cleaner signal
- More stable baseline
- Better detection

<u>Behaviour</u>

The sensor:
- Detects initial flex very well
- Harder to detect constant flex

When flexing continuously:
- Signal drops toward baseline
- Even if muscle still flexed

Better for:
- Button press style input

Not good for:
- Sliders
- Continuous control

Threshold Detection

To detect flex:

Ex: If signal > 30,000 = muscle flexed

BUT:

- Threshold changes based on:
  - Room
  - Noise
  - Pad placement
  - Environment

MUST TUNE VALUE EACH TIME

Demo - Scrolling with Muscles

The Pico:

- Acts like a USB keyboard
- When flex detected:
  - Presses down arrow key
  - Scrolls content

Used to scroll - Youtube Shorts, Tiktoks

Concept:

- Flex muscle → scroll down
- No flex → no scroll

Key Vocabulary

EMG (electromyography) - A method used to measure the tiny electrical signals muscles produce when they move

Electrical Signal - A small flow of electricity that carries info

Amplification - making a very small electrical signal bigger so it can be measured

Filtering - Removing unwanted signals so the real signal is clearer

Electrical noise - Unwanted electrical signals that interfere with the real signal

Chemical signal - Message inside the body that tells muscles to contract

ADC (analog to Digital converter) - A device that turns changing voltage signals into numbers a computer can read

Threshold - A set of numbers used as a limit

Baseline - Starting signal level when nothing is happening

Microcontroller - A small computer chip that controls electronic devices

Signal spike - A sudden jump in the signal when a muscle flex is detected

FINAL PROJECT LAYOUT

Project Title

Can a 3D-Printed Smart Wrist Splint with EMG Monitoring and Haptic Reminders Improve Grip Rehabilitation After a Distal Radius Fracture?

Intro/Why I chose this Project

I got this idea because my mom fractured her wrist in the summer after she slipped while mopping the floor and extended her arm to break her fall. The injury was a Distal Radius Fracture, and the hardest thing for her during recovery was gripping objects. Even simple tasks like holding a water bottle or turning a doorknob were difficult. Grip strength is essential for daily activities like eating, carrying objects, and opening containers. After a distal radius fracture, grip weakness is one of the most common long-term problems.

Her doctor told her to do hand exercises at home, so we bought her a kit from amazon that would help her. But she often forgot to do them or didn't feel motivated. I realized that many patients probably experience the same problem, not just weakness, but lack of reminders and consistency.

That's when I started thinking:
What if a wrist splint didn't just support healing, but also helped guide and remind patients to rebuild their grip strength?

Purpose

The purpose of my project is to design and test a smart 3D-printed wrist splint that:

- Supports the wrist in the correct healing position
- Detects muscle activation during gripping
- Provides vibration reminders to encourage exercise
- Helps improve grip strength during recovery

This splint is intended for use during the rehabilitation phase (weeks 4–8 after injury), when patients begin rebuilding strength and mobility.

Hypothesis

If patients recovering from a distal radius fracture use a smart splint with EMG monitoring and haptic reminders, then their grip strength and number of correctly completed grip exercises will improve compared to using a regular splint.

Design

A thermoformable 3D-printed wrist splint that:

- Keeps the wrist about 15 degrees of extension
- Leaves the fingers free for gripping
- Is breathable and waterproof
- Uses velcro straps for adjustable compression
- Is radiolucent, so it can stay on during x-ray scans

This splint is designed to be used during weeks 4-8 of recovery, which is when the patient begins rebuilding strength.

How the system works

The splint includes an EMG (electromyography) sensor that detects electrical signals from the forearm muscles.

When a person performs the programmed grip exercise:

1. The forearm muscles produce a small electrical signal
2. The EMG sensor detects that signal
3. The signal is amplified and filtered to remove electrical noise
4. The signal is converted from analog to digital using an ADC (analog-to-digital-converter)
5. A microcontroller compares the signal to a set threshold value

If the grip is strong enough, the system recognizes it as a successful activation
The splint also includes a small vibration motor that:

- Sends reminders at set time intervals (30 min - 1hr)
- Encourages the user to perform grip exercise
- Can stop vibrating once proper muscle activation is detected

A repetition is only counted when the muscle activation passes the threshold and is held for at least 3 seconds.

Variables

Manipulated Variable (Change)

- Same EMG sensor placement on the forearm

Responding Variable (Measure)

- Grip strength
- Number of correctly completed grip exercises

Controlled Variable (Stays the same)
- Wrist position (15 degree extension)
- Same specific grip movement
- Same splint structure and material
- Same testing and environment

Innovation

My splint adds:
- Muscle monitoring
- Real-time feedback
- Exercise reminders
- Focused rehabilitation support

Most regular wrist splints only hold the wrist in place so it can heal. My design not only supports the wrist, but also helps rebuild strength by monitoring muscle activity and giving reminder vibrations to encourage exercise.

Materials

Structure materials
- 3D printer
- Velcro straps
- Sandpaper
- Hot water for thermoforming
- 3D printer filament

Hardware
- Muscle sensor kit
- Jumper wires
- Breadboard
- Battery pack
- ADC (if not built into microcontroller)
- Arduino
- Vibration motor

Testing
- Timer
- Data recording sheet

Experimental Process

1. Measure baseline grip strength.
2. Have participant perform grip exercises without smart feedback.
3. Record number of correct repetitions.
4. Repeat using smart splint with haptic feedback.
5.Compare grip strength and number of correct repetitions between both conditions
6. Analyze results.

Limitations

- Prototype device, not medically tested
- Tested in controlled environment

GOAL

To improve recovery outcomes by combining physical support with muscle monitoring and behavioral reminders.

What the motor has to do
Turning
2 arm task
What is attached to the motor