Leveraging Haptic Sensors for Force Vector Mapping in AIS Braces

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Disclosures


Vorhies: Medical advisory Board: Nsite, NView, Orthopediatrics Speaker: Nuvasive
BRACING IN AIS

- Dose response relationship
  - Increasing brace wear compliance is correlated to treatment success. (Katz et al 2010, Weinstein et al 2013)
  - Thermocron based compliance data considered as binary

- How can we *quantify* if a brace is good enough?
  - Orthotist qualitatively assesses fit
  - In brace Xrays
Project Goal:

Develop a wearable tool that uses flexible force sensor technology to longitudinally measure the force profile of a scoliosis orthotic.
Prior work:

- Chase et al. in Oxford. Labelle et al. in Montreal
- Force mapping in Boston Brace
- Wrapping a pressure-sensitive mat inside a Brace for one-time measurements.
- Related to strap tension, curve correction
Gaps:

- How do brace types differ in force application?
- Do pressure variations relate to patient tolerance of brace wear?
- How does force applied by a brace change over time?
- How might force applied by a brace influence the dose response relationship of bracing in AIS?
Project Aims:

AIM 1: Design and optimize a thin sensor for custom TLSO
  ○ Wearable battery and data storage
  ○ Comfortable

AIM 2: Snapshot pilot clinical testing of sensorized orthoses

AIM 3: Short term longitudinal pilot study of the sensorized orthosis
AIM 1: Sensor Design

First Iteration: In-House Sensor

Pitfalls:

- Trouble Conforming body/brace
- Discomfort from wires
- Discomfort from thickness
- Sensor ghosting limiting accuracy
AIM 1: Sensor Design
Second Iteration - Commercial Sensor
AIM 1: Sensor Design
Third Iteration - In-House Sensel Design

- Thinner
- Higher force ceiling (25-30N)
- Less computationally complex
In-House Sensel Design
Data Acquisition Board

- On Board Storage (SD Card)
- Sensor Input (32 Channels)
- Battery Powered (LIPO Battery / USB)
- Bluetooth Transmitter
Force System Workflow

Commercial Sensor to ID Hotspots
Case: 13 yo M
Sensor Placement
Pilot Testing of In-House Sensel Design
Sensor Exploration and Testing

Piezoresistive in-house sensor matrix fabricated and tested

Oct. 2021

Commercial sensor acquired and tested

Dec. 2021

Clinical Piloting of Commercial Sensor

Jan. 2022

Fabric Sensel Design

Updated design to target ‘hot spots’ in the brace. New design will have a single sensel, 1x1 resolution and high range (up to 16 psi)

Feb. 2022

Clinical Piloting of Fabric Sensel

Spring 2022

Longitudinal Study

Continuous monitoring with sensor-enabled brace over a multiple week period

Nov. 2020
Thank You!
Questions?

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