Ultrasonic Probe Holder

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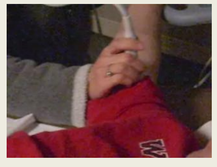
Background

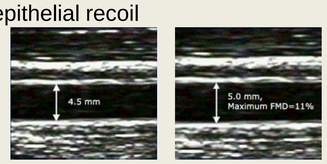
Ultrasonography: Transducer measures sound wave reflections off tissues in the body to measure anatomy and physiology without invasiveness

- Our Application: Use Ultrasonography to image cross-sections of brachial arteries in the arm.
- Measure epithelial response to changes in pressure
- Information gained can be used in diagnosis and treatment of Atherosclerosis.
- Applications are present in both research and clinical settings.

The Study:

- Relaxed Patient with left arm extended and supinated.
- Image artery, constrict blood flow at the forearm, observe response of artery
- Release pressure and observe epithelial recoil





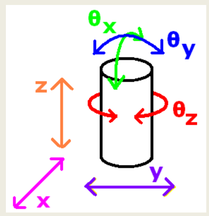
Left: source http://vanha.med.utu.fi/cardio/youngfinnsstudy/ultrasound.html

Motivation

- Availability of holder to position and stabilize the probe in ultrasound studies could improve effectiveness of procedure
- Stabilization can increase image quality and allow for more resolution
- More consistent “Before and After” of same location at artery
- Frees up sonographer for other tasks/patient monitoring
- Ergonomically improves job design for sonographer
- Studies pose stressful working environment for sonographers with increased risk of work related musculo-skeletal disorders.
- With wrist held in deviated position for 5+ minutes, significant pressure on the Ulnar Nerve in the Carpal Tunnel.
- Many clinics currently limit studies to 1/hour due to strain on sonographers.

Design Specifications

- Device must be able to hold a variety of probes
- Able to position the probe with Six Degrees of Freedom (Three Directional and Three Rotational)
- Stabilize the Patient arm for consistent positioning
- Sensitive to fined tuned adjustments during studies



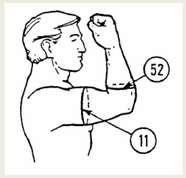
Abstract

Vascular reactivity studies will greatly increase the understanding of Atherosclerosis, an inflammation of the arteries. A possible complication of advanced Atherosclerosis is thrombosis, which in turn may lead to heart attacks or strokes. When examining how the brachial arteries react to occlusion, an ultrasonic probe must be held in the correct orientation for prolonged periods of time. Ultrasonic images are influenced by motion artifact caused by the sonographer’s movements. The development of a probe holder that would stabilize and consistently position the ultrasound probe would improve the quality of the sonogram. A prototype was constructed that enables the probe to be moved in six degrees of freedom while being attached to a table. The positioning of the probe can be adjusted by loosening one knob and moving the entire arm into the correct location before tightening the knob again. The table also contains a comfortable arm rest that stabilizes the patient’s arm. Future work includes testing the prototype to determine if it meets the sonographer’s requirements, looking into having articulated arm translate in three directions and attaching a clamp to the articulated arm in order to hold a variety of different sized probes.

Design Elements

Dimensioning

- Dimensions for arm support determined by calculations from anthropometric data (Data from US Army Anthropometric Survey 1988):
- Cradle Diameter:

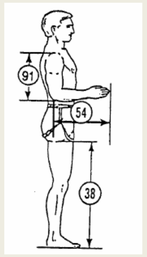


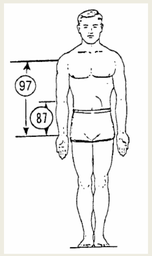
- Designed to a accommodate 95th percentile Male from Bicep Circumference, Fixed (11):
  33.76 + 4.98 (2.72) = 39.7 cm

→Minimum Inner diameter = **12.4 cm**
Selected Cylinder with inner diameter of 14 cm to allow room for foam padding also.

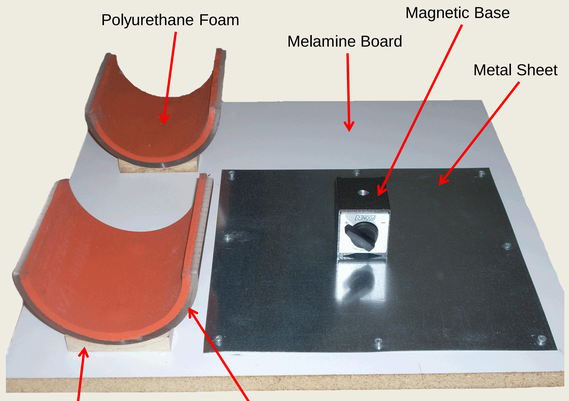
Cradle Lengths

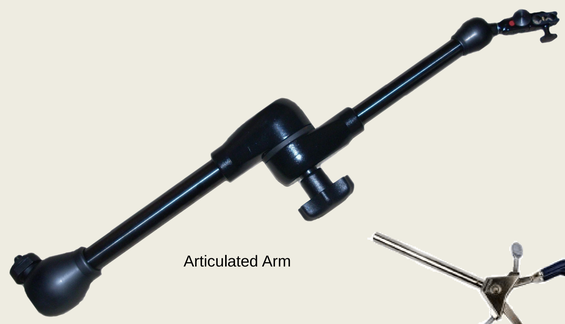
- The maximum length of the cradles were determined from lengths of 5th percentile Females
- Upper Arm from Shoulder-Elbow length (91):
  33.58 – 4.98 (0.68) = 30.18 cm
- Forearm from Radiale-Stylion Length (87):
  24.33 – 4.98 (0.61) = 20.9 cm
- Total Arm Length from Sleeve Outseam Length (97):
  54.81 – 4.98 (1.19) = 48.9 cm.
- For simplicity of construction, the length of each cradle was selected to be 15 cm to stay within the limits calculated.
- A 15 cm gap was added to give a total length of the cradle to be 46 cm, below the calculated minimum arm length





Components





Final Design

1. **Articulated Arm** – Provides 5 degrees of freedom. All joints are controlled by two knobs: one for major movements and the other for fine tuning adjustments. Can be attached securely to the magnetic base.
2. **Magnetic base** – Connects the articulated arm to the metal sheet. The magnet can be turned on and off as needed
3. **Metal sheet** – Provides a magnetic surface for the magnetic base to lock onto to the melamine board.
4. **Melamine board** – Support base that contains the entire prototype as one mobile unit. It is lightweight, sturdy, and easy to clean.
5. **Acrylic cradle** – Provides a support system for the patient’s arm to keep it from moving
6. **Wood supports** – Intermediate material that allows the semi-circular cradle to be securely attached to melamine board
7. **Polyurethane foam** – Used to cushion the patient’s arm from the acrylic cradle and screws. It is made of weather-resistant, closed-cell material.
8. **Three-prong clamp** – Device that holds the probe and connects to the articulated arm.

Future Work

Improvements

- Fine tuning linear adjustments at the base could potentially replace the magnetic base
- Probe clamping mechanism needs to be evaluated for all sizes of probes.
- Determine a method for positioning the device next to the patient’s bed

Testing

- Need to test prototype in a clinical setting and get feedback from sonographer and patient
- Verify the arm padding’s ability to withstand moisture and other clinical liquids

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