

SUPINE ANKLE-ARM BLOOD PRESSURE MEASUREMENT

1 **Background and Purpose**

The ratio of the ankle to arm systolic blood pressure (BP) is a very specific measure of flow that determines the presence of atherosclerosis in the lower extremities. This measurement will help gauge the degree of obstruction due to atherosclerosis in the lower extremities as a predictor, or modifier, of other outcomes, such as myocardial infarction and stroke. The impact of peripheral vascular disease on mobility and function will also be evaluated. This measurement also can provide objective evidence for intermittent claudication when the Rose questionnaire is positive or equivocal.

2 **Definitions and Alerts**

2.1 Definitions

The participant will be presumed to have lower extremity arterial disease when the ratio of the brachial (arm) to ankle blood pressure is less than 0.9. However, this ratio is a continuous variable and can be analyzed as such.

2.2 Alerts

The Ankle-Arm Blood Pressure Index is primarily a research rather than a clinical instrument; no "alert" levels are defined.

Calculation of the ratio will be done via computer program at the Coordinating Center.

2.3 Equipment

- Penndopplex Pen, 8 megahertz doppler probe made by Huntleigh Tech Inc. or Parks Pocket Doppler Model 840 made by Parks Medical
- Supply of 4.5 volt batteries (Huntleigh Tech Inc.) for Pocket Doppler or 9 volt batteries for Parks Doppler
- Standard stethoscope tubing and earpieces (suggest Litman)
- Doppler conducting jelly
- Double-headed stethoscope capable of being attached to the doppler
- One or two portable standard mercury column sphygmomanometers - Baumanometer or one wall-mounted sphygmomanometer
- BP cuffs in four sizes:

1 large adult cuff
1 thigh cuff
3 pediatric cuffs
3 regular adult cuffs

- Black ball point pen and black eyeliner pencil
- Tissues to remove conducting jelly

3 **Methods**

3.1 Eligibility

All participants enrolled in CHS are eligible for ankle-arm BP measurement with the following exceptions:

Exclusions:

- Persons with venous stasis ulceration, thrombophlebitis, or other pathology that precludes placing a BP cuff around the ankle (e.g., open wounds, etc.).
- Persons with rigid arteries such that an occlusion pressure cannot be reached.
- Persons with bilateral amputations of legs.
- These participants are recorded as "procedure not completed." The reason the procedure was not completed is noted on the form.

3.2 Procedure

- Ask participant to remove shoes and stockings so that the ankles are bare to mid-calf (when not already done).
- Remove the sleeve of the right arm.
- Lay participant supine on the examining table with the right side toward the observer and the feet at the free end of the table.
- Keep participant supine for at least five minutes before measuring BP.
- Place three BP cuffs on the participant:
 - Right arm Same size cuff as for the seated BP measurements.
 - Right ankle Standard adult size cuff
 - Left ankle Standard adult size cuff
- Connect sphygmomanometer to arm cuff at eye level.
- Apply ankle cuffs with midpoint of bladder over posterior tibial artery, with lower end of bladder approximately 3 cm above medial malleolus.

3.3 Determining the Maximal Inflation Level

For each participant determine the maximal inflation level, the pressure to which the cuff is to be inflated for systolic blood pressure measurement. This assures that the cuff pressure at the start of the reading exceeds the systolic blood pressure and thus allows the first Korotkoff sound to be heard.

The procedures for determining Maximal Inflation Level are as follows:

- Attach the brachial cuff tubing to the sphygmomanometer.
- Palpate the radial pulse.
- Inflate the cuff rapidly until the radial pulse is no longer felt (palpated systolic) by inflating rapidly to 70 mm Hg, then inflating by 10 mm Hg increments.
- Deflate the cuff quickly and completely.
- Inflate the cuff to at least 30 mm Hg above the palpated systolic pressure for all readings (maximal inflation level).

3.4 Blood Pressure Readings

The design and operation of the standard mercury sphygmomanometer are based upon the combined principles of compression of the brachial artery under an elastic, inflatable cuff; and direct registration of pressure levels by a mercury manometer. The observer inflates the cuff, listens for the first (systolic) and the last (diastolic) Korotkoff sounds, reads the mercury level in the column, deflates the cuff, and records the readings. The last Korotkoff sound is known as the 5th Phase, DBP.

Valid ranges for blood pressure readings are:

tibial: 40 - 300

brachial: 80 - 250

If a valid blood pressure reading is outside this range, enter "999" and send a data update form with correct value to the Coordinating Center.

Detailed instructions are given below for measuring AB blood pressures with a standard sphygmomanometer.

- Wait at least 30 seconds after complete deflation of the cuff, following any blood pressure measurement. Do not wait after determination of the maximal inflation level.
- Place the earpieces of the stethoscope, with the tips turned forward, into the ears.
- Apply the tip of the Doppler over the brachial artery or posterior tibial artery, just below but not touching the cuff or tubing. The brachial artery is usually found at the crease of the arm, slightly toward the body. The posterior tibial artery is usually found posterior and inferior to the medial malleolus.

- By closing the thumb valve and squeezing the bulb, inflate the cuff at a rapid but smooth, continuous rate to the maximal inflation level. The eyes of the observer should be level with the mid-range of the manometer scale and focused at the level to which the pressure will be raised.
- By opening the thumb valve slightly, and maintaining a constant rate of deflation at approximately 2 mm per second, allow the cuff to deflate, listening throughout the entire range of deflation, from the maximum pressure past the systolic reading (the pressure where the first regular sound is heard), until 10 mm Hg below the level of the diastolic reading (that is, 10 mm Hg below the level where the last regular sound is heard).
- Deflate the cuff fully by opening the thumb valve. Remove the stethoscope earpieces from the ears and enter the systolic readings in the spaces provided on the form.
- Remove the cuff and store the equipment safely after the last reading.

3.5 Initial Preparation

- Locate brachial artery by palpation.
 - Apply appropriate adult-size cuff to arm.
 - Apply ultrasound jelly over brachial artery.
- Locate right posterior tibial artery by palpation.
 - Apply appropriate adult-size cuff to right ankle.
 - Apply ultrasound jelly over right posterior tibial artery.
- Locate left posterior tibial artery by palpation.
 - Apply appropriate adult-size cuff to left ankle.
 - Apply ultrasound jelly over left posterior tibial artery.

3.6 Right Arm Systolic BP Measurement

- Attach cuff tubing to manometer.
- Place stethoscope in ears.
- Locate brachial artery using Doppler stethoscope.
- Sit next to the participant's right arm.
- Measure the systolic blood pressure using the Doppler stethoscope.
 - Inflate cuff quickly to maximal inflation level.
 - Deflate at 2 mm Hg/second to appearance of systolic pressure.
 - Deflate another 10 mm at 2 mm per second.
 - Deflate cuff quickly and completely.
- Record systolic blood pressure.
- Disconnect tubing from manometer.

3.7 Ankle Systolic BP Measurement

- Move to the end of the table and place manometer between participant's ankles or use wall-mounted manometer.
- Hold probe at 60-degree angle to ankle (90-degree angle will obliterate pressure).
- Steady hand on ankle to avoid slipping.

3.7.1 Right Ankle

- Attach right ankle cuff to the manometer.
- Place stethoscope in ears.
- Locate posterior tibial artery using Doppler stethoscope.
- Measure the systolic blood pressure using the Doppler stethoscope.
 - Inflate cuff quickly to maximal inflation level.
 - Deflate at 2 mm Hg/second to appearance of systolic pressure.
 - Deflate another 10 mm at 2 mm per second.
 - Deflate cuff quickly and completely.
- Record right ankle systolic blood pressure.
- Disconnect right ankle cuff from manometer.

3.7.2 Left Ankle

- Attach left ankle cuff to the manometer.
- Place stethoscope in ears.
- Locate posterior tibial artery using Doppler stethoscope.
- Measure the systolic blood pressure using the Doppler stethoscope.
 - Inflate cuff quickly to maximal inflation level.
 - Deflate at 2 mm Hg/second to appearance of systolic pressure.
 - Deflate another 10 mm at 2 mm per second.
 - Deflate cuff quickly and completely.
- Record left ankle systolic blood pressure.
- Disconnect left ankle cuff from manometer.

3.8 Repeat of Ankle-Arm Measurements

- Apply more jelly only if needed
- Repeat the sequence of measures in reverse order:
 - Left ankle
 - Right ankle
 - Right arm

3.9 Completion

- Review form for completeness
- Remove cuffs and ultrasound jell

3.10 Comments

The following points will greatly improve the speed and accuracy of measurements.

1. Mark the maximal pulse or doppler signal on brachial artery and both posterior tibial arteries with an eyeliner pencil to improve the speed and accuracy of localizing them the second time and to help maintain position.
2. Hold the Doppler pen absolutely still while inflating and deflating the cuff. Moving a few millimeters will lose the pulse. Anchoring your hand is very helpful in maintaining position.
3. Always use enough jelly to assure good contact.
4. Hold the Doppler at a 50-60 degree angle to minimize the possibility of obliterating the pulse sound from the artery.
5. In a healthy individual, ankle pressures will be higher than the arm pressure. Therefore, pulse sounds may be heard above the Maximal Inflation Level determined at the radial pulse. The cuff may need to be inflated 30 mm above the Maximal Inflation Level in order to obtain the BP measurement.
6. If sounds are heard immediately after the cuff is inflated, start the procedure over, including the 30 second rest period (5 seconds vertical.)

4 **References**

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