

STUDY OF OSTEOPOROTIC FRACTURES (V2)

Quantitative Vibration Sensitivity Testing

1. Introduction:

The object of this test is to determine the sensitivity of the feet to very small vibrations. Diseases and abnormalities affecting neurological function, such as peripheral neuropathy, can reduce the sensitivity to vibration. Loss of vibration sensitivity in the feet may result in problems with gait and balance, possibly leading to falls. This protocol is adapted from one provided by Joseph C. Arezzo, PhD, Albert Einstein College of Medicine.

2. Equipment:

The Vibratron II is a device developed at Albert Einstein College of Medicine in conjunction with Pfizer Inc., to quantify the ability of human subjects to detect vibratory stimuli at the distal extremes of their upper and lower limbs. The instrument is currently manufactured and distributed by Sensortek Inc., 154 Huron Ave, Clifton N.J., 07013.

The Vibratron II consists of a controller and two vibrating posts. The power supply, switches and digital meter are encased as one unit, while the vibrating rods are located in separate units with adjoining cables. Each vibrating rod protrudes through a metal case and can be contacted by either the hands or the feet. The tandem vibrating surfaces are manufactured from hardened rubber and are identical in appearance. Vibration is achieved by driving the transducers with a variable voltage source. A dual position switch connected in series with the vibrating units, controls which rod vibrates, while a "dummy" switch is used to imitate the sounds and motions of switching. The amplitude of vibration is proportional to the square of the applied voltage and is continuously available on a digital display accurate to the nearest 0.1 units. A switch sets the maximal level of the vibration which ranges from 0 - 6.5 vibration units or 0 - 20 vibration units.

NOTE: Construct a platform large enough for the feet to rest on which is the same height as the tops vibrating posts. Place the platform just in front of the the vibration units. The participant should rest her foot on the platform during the testing.

A heating pad and heater should be available to warm cold feet.

3. Subject Preparation:

The testing is done on bare skin on the center of the bottom of the great toe. Have the subject remove socks, stockings, etc.

All subjects should have spent at least 10 minutes in the clinic before testing in order to become accommodated to room temperature.

Prior to testing, use a heating pad on the foot platform and a small portable space heater with a blower to warm the subject's feet. Test the foot for warmth by touching the side of the foot with your bare forearm. The foot does not have to be the same temperature as your arm, but should be at least tepid, not cool or cold. If the foot is cool, continue warming for

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another 5 minutes. If you are unable to warm the foot adequately before testing, check the box on the form.

Prior to testing, each subject should be given an opportunity to become familiar with the testing apparatus and with the expected vibratory sensations. During this period, the experimenter can instruct the subject as to the appropriate length and force with which to contact the vibrating rod.

"This test measures your ability to feel very small vibrations in your feet. To do this, I'm going to ask you to put your big toe on these vibrating rods and tell me which one is vibrating, A or B. It won't hurt at all. Let's start by getting accustomed to how the vibration feels."

The adaptation period will also allow the experimenter to determine the appropriate intensity level at which to begin testing. A number of vibration intensities should be set and sampled by the subject. For the initial trial, the experimenter should set the intensity at a level detectable by that subject 100% of the time. Also let the subject sample very low intensities, i.e. where she feels nothing.

4. Measurement Procedures:

A. GENERAL

Thresholds should be measured on the great toe.

The methodology of testing is a "two alternative forced choice procedure". For each trial the subject is required to determine which of the two rods is vibrating, and must select either A or B. If she cannot feel anything, she must guess which post is vibrating. The position of vibration is under experimental control, determined by a randomization sequence. The intensity sequence is similarly under the control of the experimenter and is determined by a testing algorithm (see below).

At the beginning of each testing session, have the subject touch the vibrating post (set to a high intensity) with her toe to get the feel of the vibration. Then issue the following instructions:

"What I want you to do is to press your big toe lightly against each rod in sequence for approximately one second. During each trial you will be allowed to **touch each rod only once**. Only one of the rods will be vibrating and you must decide whether it's A or B. Since I will be reducing the vibrations during the testing, it will become increasingly more difficult for you to tell which post is vibrating. I understand that you will be guessing at times."

B. POSITIONING THE GREAT TOE ON THE ROD

During the trials, the bottom of the great toe should be centered over the vibrating post. No other part of the foot or any of the toes should be touching the post or its housing. Place a rubber pad on top of the housing, with a hole for the vibrating post.

An ideal duration for contact is approximately one second and the force should be the minimum necessary to detect vibration. Too great a pressure will numb the toe. Too light a pressure will give spurious results. A slight blanching of the nail of the great toe indicates the correct pressure.

C TESTING ALGORITHM

- a) Test the right great toe. If the right toe is missing, test the left.
- b) Determine the starting intensity level by sampling a selection of intensities in the high and low intensity ranges. Start at an intensity that is likely to give you at least 8 trials without an error. If more than one error occurs during the first eight trials, start over at a higher intensity. Ideally, the subject should start to have difficulty feeling the vibration soon after the eighth trial.
- c) The starting intensity, in vibration units, should be circled on the left hand column of the data entry form. The location of the stimulus (A or B rod) is indicated by the first column in the A/B matrix. For each setting ask, "Which is vibrating, A or B?" Later, abbreviate to just "A or B?"
- d) If the subject is correct on the initial trial at an intensity level, go straight down 1 row to the next intensity (approximately 10% less) for the next trial. This process should be continued until the first error.
- e) When the subject makes her first error, the identical intensity should then be repeated twice, for a total of three trials at that level. For these trials at the same intensity level, the A/B matrix should be followed horizontally.
 - i) If the position of the stimulus is correctly identified on two of the three trials, follow the A/B matrix down diagonally from the last A/B position tested to the adjacent A/B position at the next lower intensity level (below and one to the right).
 - ii) If errors are made on two of the three trials, follow the A/B matrix up diagonally from the last A/B position tested to the A/B position at the next higher intensity level (immediately above and one to the right).
 - iii) If errors are made at two successive settings (A/B setting) at a given level, the third stimulus is not necessary. Follow the matrix up diagonally at that point.
- f) All levels below 1.0 units should be repeated twice - even if the subject selects the correct stimulus position on the first trial.

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g) Testing is completed when the subject has made a total of five errors. A single error often appears early in the testing sequence. This anomalous data point is compensated for in the data analysis procedure (see below).

h) For each trial, both the intensity setting and the subject's choice should be recorded in the appropriate columns on the data sheet.

D. TECHNICAL CONCERNS

To determine accurate vibration thresholds, the experimenter must be concerned with the following details:

a) Sit so that you can see the subject's toe clearly. The subject should be consistent in the location, duration, and force of touch of the vibrating surface. Say things like "please don't press so hard" to insure trial-to-trial consistency.

b) The subject's foot should not be cold. Warm the feet briefly with a heating pad and heater, then test for temperature. If cold, continue warming.

c) Flip switches between every trial, even if the the stimulus position stays the same. Use the dummy switch.

d) The intensity settings should correspond to the levels on the scoring form.

e) Be sure the subject does not touch the metal casing of the vibrating units with her foot during the trials. Construct a high density foam pad for the top of the vibrating unit, with a hole for the vibrating posts, to prevent the other toes from touching the metal casing.

f) The subject should be carefully screened from seeing the instrument settings or the data sheet.

g) The rods should be visually inspected prior to every test to insure that they are "free-standing" and not contacting the metal casing.

h) The threshold level achieved during testing will often be lower than expected from the adaptation period.

i) Care must be taken to start testing at a sufficiently high stimulus intensity so as to provide a statistically valid test. A test must have a minimum of 12 trials with no more than 1 error in the first 8 trials. If there is more than 1 error in the first 8 trials, a test must have a total of 18 trials. If these criteria are not met the test should be redone beginning at a higher initial intensity.

j) Each Vibratron II should be factory calibrated every 6 months. A temporary replacement will be provided by the coordinating center during calibration. Clinic order for calibration: Pittsburgh, Minneapolis, Portland, Baltimore. As soon as you receive your recalibrated machine, send the replacement on to the next clinic.

4. Table of Testing Levels:

This table lists the sequence of testing of levels, which are also listed on the form. Each intensity level after the first one represents a 10% reduction from the previous level.

<u>High range</u>	<u>Low range</u>		
22.0	6.9	2.2	0.7
20.0	6.2	2.0	0.6
18.0	5.6	1.8	0.5
16.2	5.0	1.6	0.4
14.6	4.5	1.4	0.3
13.1	4.1	1.3	0.2
11.8	3.7	1.2	0.1
10.6	3.3	1.1	
9.5	3.0	1.0	
8.6	2.7	0.9	
7.7	2.4	0.8	

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5. Examples

Example 1

	<u>turn on:</u>	<u>subject says:</u>	<u>circle (cross out):</u>
Begin at 8.6	A	A	A
go to 7.7	B	B	B
go to 6.9	B	A	(B)
repeat 6.9	B	B	B
repeat 6.9	A	A	A
go to 6.2	A	A	A
go to 5.6	A	A	A
go to 5.0	B	B	B
go to 4.5			
go to 4.1			
go to 3.7		all correct	
go to 3.3			
go to 3.0	B	A	(B)
repeat 3.0	B	B	B
repeat 3.0	B	B	B
go to 2.7	A	B	(A)
repeat 2.7	B	A	(B)
go up to 3.0	A	A	A
go down to 2.7	A	B	(A) fifth error, test is over

Record 5 errors: 6.9, 3.0, 2.7, 2.7, 2.7
 5 lowest correct: 3.0, 3.0, 3.0, 3.3, 3.7

Example 2

	<u>turn on:</u>	<u>subject says:</u>	<u>circle (cross out):</u>
Begin at 8.6	A	A	A
all correct until			
go to 3.0	B	A	(B)
repeat 3.0	B	B	B
repeat 3.0	A	B	(A)
go up to 3.3	B	A	(B)
repeat 3.3	B	B	B
repeat 3.3	A	B	(A)
go up to 3.7	B	B	B
go down to 3.3	A	A	A
go down to 3.0	A	A	A
go down to 2.7	B	A	(B) fifth error, test is over

Record 5 errors: 2.7, 3.0, 3.0, 3.3, 3.3
 5 lowest correct: 3.0, 3.0, 3.3, 3.3, 3.3