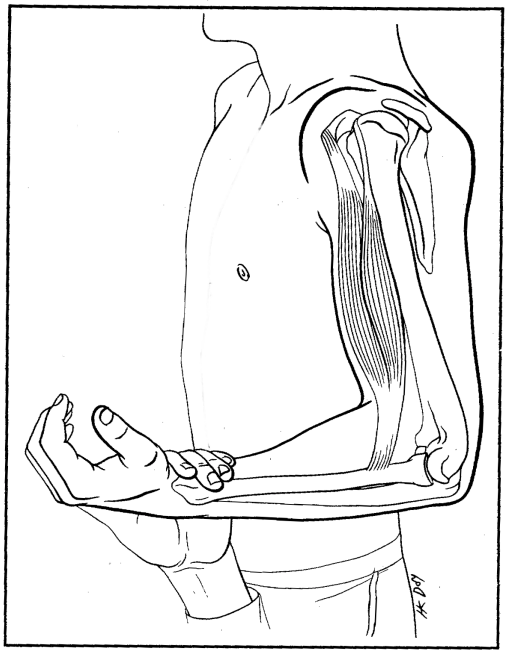
ELBOW FLEXORS HAND-HELD DYNAMOMETER MUSCLE TEST

1. Background and Rationale

The exact relationship between maximal muscle performance and functional ability is not known, but is related to many activities of daily living, such as walking, going down stairs, etc. Fiatarone et al.[1] have postulated that strength is a more important limiting factor than cardiovascular endurance in the ability of older individuals to maintain an independent lifestyle. Muscle strength is an indicator of muscle function and, therefore, an important outcome of the study.

In this assessment elbow flexion strength is measured. Elbow flexion is important in many self-care activities such as brushing teeth, fixing hair, dressing, and lifting objects. The primary flexors of the elbow are the biceps brachii (see figure below).



Biceps Bracchii

The elbow flexion test is a "make" test. The examiner places the muscle tester immediately proximal to the wrist joint (styloid process of the radius) with the elbow flexed to 90° and the palm up. The examiner holds the muscle tester in place while the participant pushes against the tester with maximal effort.

Hand-held dynamometry offers a number of advantages over other strength assessment techniques. It is portable, inexpensive, and the nature of the technology is such that multiple muscle groups can be assessed in a very short time. However, there are also disadvantages to assessing muscles at fixed joint angles, including

ability to test only one kind of muscle contraction (isometric), and the potential influence of examiner strength on the test result.

2. Equipment and Supplies

- Nicholas Manual Muscle Tester (with foam-padded stirrup)
- Force Test Support
- Calibration weights 5, 10, 20 kg
- Calibration check apparatus
- Standard chair with no arms: straight back, flat, level, firm seat; seat height 45 cm at front

2.1 Equipment Features, Maintenance, and Calibration

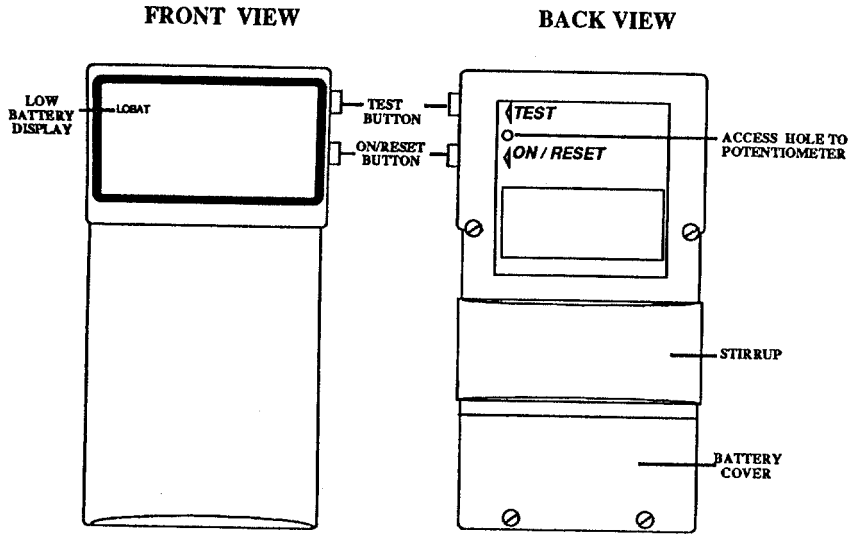
The Nicholas Manual Muscle Tester (MMT) is a hand-held dynamometer used to objectively quantify isometric muscle strength. The MMT features digital accuracy and ranges from 0.0 to 199.9 kilograms, equivalent to approximately 400 pounds.

On/Reset Button: Turn MMT power on and reset display to zero. After each test, hold this button down until display resets to zero. Before testing the device or using it on a participant, hold the "On" button down for 30 seconds to warm up the electronics.

NOTE: If display does not reset to zero, alert the QC officer.

(Instructions for the QC Officer): Adjusting the reset value: This may be necessary due to fluctuations in temperature which affect the electronic strain

gauges. An access hole for the potentiometer which adjusts the "reset" value is located on the back of the MMT in the label area. (See figure below.) Turning the potentiometer with a small-sized, flat-blade screwdriver and only a slight adjustment may be necessary. Hold the reset button in for 30 seconds before making any adjustments to make sure the electronics are warm. If after 30 seconds the "reset" value is greater than zero, turn the potentiometer very slightly in a clockwise direction to decrease the "reset" value. (A counterclockwise direction increases the "reset" value.) Then, check the "reset" value again by depressing the reset button. Repeat this procedure until the display reaches zero.



CAUTION: The display cannot show a negative number. Therefore, if the potentiometer is turned past zero, forces in the 0.5 range will read zero. It is important, therefore, to run the potentiometer in very small increments and recheck the "reset" value after each adjustment. After adjusting the "reset" value to zero, put a light force on the stirrup of the MMT. If the display still reads zero, the potentiometer has been turned past zero into the negative range. Adjust the "reset" value in the positive direction by turning the potentiometer in a counterclockwise direction.

Test Button: Depress button until display reading stabilizes. This provides a built-in self-check mechanism of the electronics. A reading greater than ± 0.5 kg from 50 kg should be checked with a call to the factory.

"LOBAT" Display: Tells operator that battery needs replacement. (See figure above.)

Automatic Shut-off: The MMT shuts itself off after 60 seconds of non-use, eliminating excessive battery drain.

Battery Replacement: Simply remove bottom two screws on back of unit. (See figure above.)

Calibration Check: The MMT is internally calibrated in the factory. Nevertheless, through use the MMT readings may drift. Therefore, the MMT calibration should be checked in the clinic weekly (See calibration table).

To check calibration of the MMT, put the device in the calibration cradle. Put the Force Test Support over the stirrup. Reset the MMT. Load the tester with the 5 kg weight followed by the 10 kg and 20 kg weights. Reset the tester between each reading. Wait 15 seconds after loading the MMT before recording the readings on the calibration log. Repeat the process three times. Record each result, then average the results for the 3 trials.

If the average for any of the individual weights is not within the target range on the calibration log form, report the result to the clinic QC officer.

2.2 Use of the dynamometer

For testing, the examiner places the dynamometer against the surface of the participant's limb. The examiner's downward force is transmitted to the limb through the MMT unit. The dynamometer measures the peak force required to counter an isometric contraction as the examiner applies force against the participant's limb.

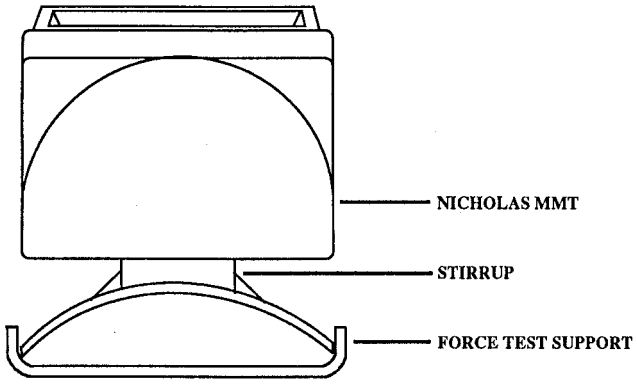
- Position the instrument carefully.
- Attain the correct tester body position.
- Hold the dynamometer in the stronger hand, and brace it with the other hand from behind.
- Slowly build up resistance to the participant's motion while coaching the participant to "push."
- Avoid explosive movements.
- Slowly relieve pressure after the test is complete

When the participant is stronger than the examiner in the position tested, unreliable impression of strength will occur. It is difficult to detect weakness because the participant's deficit may be well above the examiner's maximum strength. Therefore, prior to any testing or evaluation using the Nicholas MMT, the examiner should

identify the extent of his or her strength measurement capabilities. The examiner determines the maximum force s/he can generate with one hand, then with two hands, by pushing the MMT against the Examiner's Force Test Support. (The Force Test Support protects the stirrup of the MMT from excessive flexion during these tests. See figure below.) When testing the examiner's strength, care should be taken to apply force the same way it will be applied to the participant.

Examiner strength should be tested monthly and the result posted in the examination room where this test is performed. If the result from a test of a participant is within ± 2 kgs of the examiner's maximum strength, repeat the test with a stronger examiner.

END VIEW



3. Safety Issues and Exclusions

Do not perform dynamometer test on the affected side if the participant:

- reports a problem with the elbow or arm that would prevent them from performing the test
- has significant pain in a preliminary manual trial with the arm in the test position

If one side has any of the above contraindications, test the arm on the unaffected side. If both sides are affected, do not test.

4. Participant and Exam Room Preparation

The participant should be comfortably seated in a standard chair with no arms: straight back, flat, level, firm seat; seat height 45 cm at front (same chair used in the chair-stand performance test). The participant should sit up as straight as possible. The chair should be positioned in the room to allow the examiner adequate space to approach the participant from behind.

5. Detailed Measurement Procedures

5.1 General Issues/Description

Elbow flexor strength will be assessed in two trials of both the left and right side both manually and using the Nicholas MMT, unless contraindicated.

To obtain a valid test, it is essential that the examiner use the correct technique for application of the hand-held dynamometer. It is also essential for a valid test that the participant have a thorough and accurate understanding of the testing procedure and cooperate fully.

5.2 Administration of Elbow Flexor Strength Test

5.2.1 Explain Test and Determine Exclusions

1) Seat the participant in the designated chair. They should sit up as straight as possible.

Script: "Now, we're going to do a test of the strength of your arm muscles."

2) Model the arm position for the participant (upper arm perpendicular to floor and lying flat against the side of the trunk, elbow flexed to 90°, palm face up, hand in a fist.

Script: "This is the testing position. First, I want ask you to push up against against my hand, and then against the muscle tester, while keeping your upper arm in this position."

Demonstrate by increasing flexion at the elbow while keeping the upper arm still.

Place your hand on the participant's arm (their hand is palm up) just proximal to the styloid process of the radius. Perform a manual test on each side to determine exclusions and confirm that they correctly understand how to perform the test.

Script: "Have you had any problems with either arm that would prevent you from performing this test? "

If yes, determine which arm is affected, and why; do not test that arm. Indicate reason on form.

3) If the participant does not have any problems with the right arm, place your hand on the area of the participant's arm (palm up) just proximal to the styloid process of the radius. Ask them to push up against your hand.

Script: "Now, put your right arm the way I showed you. Push up against my hand. Push hard. Does that cause pain that makes you want to stop pushing?"

If yes, indicate pain on recording form and do not test that arm.

4) Have the participant assume the testing position on the left side.

Script: "Put your left arm the way I showed you. Push up against my hand. Push hard. Does that cause pain that makes you want to stop pushing?"

If yes, indicate pain on recording form, and do not test that arm.

If it appears that the participant does not understand what to do, rocks, moves the upper arm or shoulder, or bends to the left, demonstrate the test again.

5.2.2 Dynamometer Testing

If no exclusions, prepare to perform test starting on the right side.

1) Stand on the right side and just behind the participant. The participant's upper arm is perpendicular to floor and lying flat against the side of the trunk, elbow flexed to 90°, palm face up, hand in a fist. The MMT is held in the examiner's dominant or stronger hand. Lean over the participant's shoulder and place the MMT on the top of the arm (their palm face up), directly proximal to the styloid process of the radius. Brace the dynamometer with the other hand. Stabilize the back of the upper right arm with the front of the examiner's left thigh, with a cushion between the thigh and the participant's arm.

Script: "Put your left hand in your lap. Put your right arm in the position I showed you. When I say go, I want you to push up against the tester as hard as you can. It's very important that you try to push as hard as possible. Do not lift your shoulder or lean to the side. Start by pushing a little bit, then build until you

are pushing as hard as you can. If your arm starts to hurt and you want to stop, let me know."

2) Begin the test. The participant should not rock or try to generate force by lateral flexion of the contralateral trunk (elevating the shoulder or by leaning to the left). If this occurs, ask the participant not do this and repeat the trial.

3) Encourage the participant to push for 5 seconds. Do not let the participant move the MMT.

Script: "Ready, begin. Push, Push! Harder, PUSH! PUSH! Good, now relax."

4) If the participant can overcome the examiner (that is, the examiner cannot keep the MMT from moving) or the reading is within 2 kg of the examiner's maximal force generation, have a stronger examiner repeat the assessment.

5) a. If the participant complains of pain preventing testing, record on the data form and move to the other side.
   b. If only one side is tested, allow 30 seconds of rest between the two trials.

6) a. Record the trial to the nearest tenth of a kilogram.
   b. Record whether the participant was able to overcome your resistance.

7) Reset the dynamometer and assess the left side in a similar manner to the right.

8) Repeat trials on the right and left side, unless contraindicated.

5.2.3 Scoring

Elbow Flexion Strength Screening Test: For each side, enter the results of the screening test:

- Cannot assume the testing position = 1
- Can assume the testing position, has pain during manual test = 2
- Can assume the testing position, no pain during manual test = 3
- Not tested = 4

Dynamometer Testing: For each trial enter the number of kilograms to the nearest tenth of a kilogram. If dynamometer testing is interrupted due to pain, indicate this on the form.

6. Procedures for Performing the Measurements at Home

No modifications required.

7. Alert Values/Follow-up/Reporting to Participants

If the dynamometer test is performed tell the participant how many kilograms were read on the dial and that they did just fine. Record result in the participant test result booklet. (Normative data are not available.)

8. Quality Assurance

8.1 Training Requirements

The technician requires no special qualifications or experience for performing this assessment. The training should include:

- Read and study manual
- Attend Health ABC training session (or observe administration by experienced examiner)
- Practice on study staff (Goal: ± 2 kgs compared to experienced examiner and on repeat assessment)
- Discuss problems or questions with local expert or QC officer

8.2 Certification Requirements

- Complete training requirements
- Demonstrate the proper use of equipment
- Demonstrate the proper adjustment of equipment
- Demonstrate the calibration check procedures
- Recite exclusions
- Conduct exam on 2 volunteers:
  - According to protocol, as demonstrated by completed QC checklist
  - ± 2 kgs compared to experienced examiner and on repeat assessment

8.3 Quality Assurance Checklist

- ☐ Correct, clear explanations given to participant
- ☐ Participant asked if they have any problems with either arm
- ☐ Manual test performed on each side to determine exclusions
- ☐ Dynamometer test not done if participant has pain on manual test
- ☐ Recording dial reset to zero before each dynamometer test
- ☐ Dynamometer held correctly, examiner in correct position
- ☐ Dynamometer placed just proximal to the styloid process of the radius, participant's hand palm up
- ☐ Standard encouragement offered to participant: script delivered verbatim
- ☐ Slowly builds up resistance while coaching participant
- ☐ Test stopped if participant reports pain
- ☐ Examiner strength compared with test result; stronger examiner if needed
- ☐ Dynamometer test results recorded on form
- ☐ Measurement taken twice on alternating sides
- ☐ Reviews form for completeness
- ☐ Correctly completes form
- ☐ Calibration log up to date

9. References

1. Fiatarone MA, Marks EC, Ryan ND, Meredith CN, Lipsitz LA, Evans WJ.: The etiology and reversibility of muscle dysfunction in the aged. JAMA 1990;263:3029-3034.

10. Form