LEG POWER: JUMPING ON AMTI FORCE PLATE

1. Background and rationale

Although muscle strength has been recognized as an important predictor for functional performance, emerging evidence suggests that muscle power (the product of force time velocity or the rate of performing work) may play a more important role for functional independence, falling and motor performance [1-4]. Additionally, muscle power was recently shown to be a predictor for mortality independent of muscle strength and muscle mass [5].

Muscle power has been assessed using different protocols in the older population. Jumping protocols have been recently used in old and very old adults [6-18]. Muscle power is assessed by performing a countermovement jump on a force plate [6-11]. The subject standing on a force plate is asked to perform a rapid downward movement (i.e. bending the knees) immediately followed by a rapid upwards movement (i.e. extending the knees) while trying to jump as high as possible. Muscle power can still be measured in subjects that are unable to jump since muscle power is calculated during the push-off phase, which is independent on the ability to generate an upwards impulse large enough to produce an actual "flight phase". The protocol simply requires that the movement is performed at the subject's maximum velocity, similar to any other protocol to assess maximal power.

The most meaningful variables that can be extracted from the force signal during the whole movement are velocity and peak and mean power. In addition from the post processing analysis, variables can be isolated according to the movement dynamics (e.g. acceleration and deceleration during the eccentric phase, concentric phase) and variables of these specific phases can be calculated (e.g. maximal force, downwards/upwards center of mass displacement) [6-9]. Finally, reproducibility for jumping protocol has been previously assessed in old and very old participants showing a within-subject coefficient of variation for peak and mean power of 2.9 and 5.1%, respectively [9] and a correlation coefficient of 0.99 (peak power) [10].

2. Equipment and supplies

- AMTI AccuPower force plate
- AMTI NetForce Acquisition Software
- Serial to USB converter
- Laptop or desktop
- USB cable connection
- Paper towels or wipes
- Spray Cleaner or Wipe- disinfectant
- AMTI analysis software
- Standard weights for calibration (50 pounds if possible, otherwise any other weight with a certified specific weight)

3. Safety issues and exclusions

- Participants should be excluded if they:
  - Are unable to walk or stand either with or without an aid
  - Have had surgery in their spine or lower extremity in the past 6 months
  - Have had a knee replacement in the past 6 months
  - Have had a hip replacement in the past 6 months
  - Report severe pain either prior to or during the test

- A staff member will act as a spotter during the exam. Use the following safety precautions:
  - Position yourself standing at the participant's side, slightly behind them.
  - Your hands should be positioned very close to either side of the participant's trunk at the hip or waist level but not touching the participant.
  - Be ready to place both hands on the participant to stabilize them if necessary.
  - If the participant loses balance, immediately hold onto the participant with both hands at the trunk and stabilize them.
  - If the participant begins to fall, reach under the participant's shoulders from behind and slowly ease them down to the floor, rather than trying to catch the participant while you are standing still. This will protect the participant and examiner from injury.
  - If the participant falls and is not injured, help them up by first having the participant get on their knees or on all fours, place a chair next to the participant, and have the participant support themselves on the chair as you help lift under the shoulders. Do not try to lift the participant from the floor by yourself. Follow MrOS local site procedures for handling study-related injuries.

4. Calibration

Each week, a calibration test of the plate should be performed with standard known weight.

Procedure:

1. Under Start Up press "Hardware Zero" to zero the force plate prior to starting the testing. Click 'OK' to "Finished zeroing the platform".
2. Press the "Subject button" and "Add record" to enter 'CALIBRATION' in the first name field as a new subject. In the selected protocol field, click "Browse" to select the calibration protocol. Under filename, use the dropdown box to choose '**Calibration.pro'** and then click on "Open". Leave other fields blank.
3. Click "Add" then "Select".
   -When prompted, answer 'Yes' to "Use Patient's Protocol File Calibration.pro instead of MrOS heel rise and jump pro".
4. Click "Start" and then "Tare".
5. After placing the weight on the plate, click "Arm" and then the space to start recording. Note that the weights do not need to be weighed as if you were completing a participant trial. A standard weight of 50 lbs. should be used if possible, otherwise any other weight with a certified specific weight.

6. Save each of the measurements as a calibration file with the following name "Cal_site_weight_date_test#". For example, the first calibration using a 50 lb. weight on 4/9/14 from the Pittsburgh site would be saved as: Cal_PI_50lb_040914_1.
7. Record three separate tests by repeating steps 4-6, taking the weight off the plate between tests.
8. Calibration scans should be transferred using the Coordinating Center secure data transfer site weekly with the participant data.

Note that the clinic staff is not responsible for reviewing the calibration data (i.e. weight of the weight). This data will be reviewed centrally at the Reading Center.

5. Participant and exam room preparation

1. To eliminate the effect of different footwear on test performance and data, this test should be performed in tennis/sports shoes or comfortable walking shoes with minimal or no heels. Orthotic devices should be removed if they interfere with the movement pattern (for example, interfere with the ankle movement). The participant may perform the tests in stocking or bare feet if appropriate footwear is not available. If the test is performed in stockings or bare feet, note this on the data collection form. If the test cannot be performed since the participant cannot or does not want to remove orthotic devices that would interfere with the movements for the tests, note this on the data collection form as well.

2. Specify room set-up instructions. The force plate should be placed an adequate distance from the wall so that a staff member may assist the participant will balance issues if needed. The back and one side of the force plate should be positioned at least 6 inches from a wall. At least one side of the force plate should be positioned so an adequate amount of space is allowed for staff to assist the participant if needed. The floors of the exam room need to be level in order for the force plate to accurately function. A level should be used to check the force plate before use. The legs of the force plate may need to be adjusted if it is not level.

3. The computer should have the "AMTINetForce" program installed and running. Staff do not need to enter participant information until the recorded trials are to begin, though this information may be entered prior to when the test is started.

4. Under Start Up press "Hardware Zero" to zero the force plate prior to starting the testing.

6. Detailed pre-measurement procedures

6.1 Screening Questions

Before attempting the Force Plate Trials, ask participants about the exclusion criteria listed above.

Script:

1. *Are you unable to walk or stand, either with or without an aid?*
2. *In the past 6 months, have you had surgery in spine or lower extremity?*
3. *In the past 6 months, have you had a knee replacement?*
4. *In the past 6 months, have you had a hip replacement?*

If the participant answers "yes" to any of the above questions, do not attempt the Force Place measurement. Record on the data collection form the reason the test was not attempted. Mark all reasons that apply.

Please note that if a participant uses a cane, it is acceptable for the participant to use their cane as they are getting on or off the force plate. However, when the measurements are performed their cane should not be used.

6.2 Other reasons the force plate measurement is not attempted

There are other reasons not specifically outlined in section 6.1 that the participant may not attempt the Force Plate Measurement. Mark the appropriate reason on the data collection form.

Examiner Deems Test Unsafe

If the examiner deems the test unsafe for the participant, for a reason such as poor balance, inability to step onto the plates, or other, such as an injury >6 months ago that would affect the ability to do the test, record "Examiner deems test unsafe" as the reason the force plate measure was not attempted.

Computer/Equipment Failure

If the examiner is not able to get the computer software to work or there are equipment problems that prevent an otherwise able participant from completing the Force Plate Measurement, record "Computer/equipment failure" as the reason the measurement was not attempted.

Participant Refused

If the participant refuses to attempt the measurement, record "Refused" as the reason the Force Place Measurement was not attempted.

Shortened Visit

If the participant only completes a partial visit and the Force Plate Measurement is not attempted before the participant leaves the clinic, record "Shortened clinic visit" as the reason the force plate measurement was not attempted.

Cannot Perform Test without Orthotic Devices
If the participant refuses to remove orthotic devices that would interfere with the movements for the test, record "Cannot perform test without orthotics" as the reason the Force Plate Measurement was not attempted.

6.3 Reporting
The results of the force plate measurements will not be provided to the participants since these are not clinically meaningful.

7. Demonstration and Description of Calf Rises

Script: "This test measures how strong and how fast your legs are. We will be completing two types of tests. First a series of calf rise tests. I will ask you to stand on this plate and go all the way up onto your toes as fast as possible without stopping, and then slowly lower down.

Demonstrate a calf rise trial.
Examiners should ask about severe pain after providing a description and demonstrating the measurement. Participants should be excluded from the Force Plate Measurement if they report severe pain before the test that would prevent them from completing the calf rise trials.

Script: Do you have any severe pain that would prevent you from completing the calf rise trials?

If the calf rises are not attempted because the participant reported severe pain before the calf rise trials were completed, record this on the data collection form as 'Reports severe pain prior to test' for question 1a.

7.1 Practice trials for calf rises

Prepare for the practice trials standing near the participant to spot them if necessary.

Script: "Now I would like you to practice. Stand in the center of the force plate and go all the way up onto your toes as fast as possible without stopping, and then slowly lower down. Once you come back down, try to remain as still as possible until I tell you to step down. Ready, go."

After the practice trials, also ask the participant if they experienced any pain during the practice trials.

Script: "Did you experience any pain during the practice trials?
If yes, "*Does it hurt enough that you want to stop?"*

If the calf rises are not attempted because the participant reported severe pain after the calf rise practice trials were completed, record this on the data collection form as 'Reports severe pain prior to test' for question 1a.

8. Preparing the Computer for Trials

When a participant is ready to move on to force plate measurements, prepare the computer for recording the trials.

1. Prepare the software for actual test trials. If the program is not already open, open the software by selecting the "AMTI NetForce" program from the START menu of the computer.

2. Go to the protocol tab and from the drop down menu choose "Select/View Protocol," to make sure "**MrOS heel rise and jump**" is selected. Make sure the Duration is set to **6** seconds and the "Data Rate" is set to **1000Hz**. Click "Select."

3. Press the "Subject button" and "Add record" to enter a new subject (subject ID number under first name, acrostic under last name, Jump protocol, Examiner's ID). Height and weight should be ´0´. Click on "Add." Make sure that the current participant is listed on the subject name line prior to testing and that the "MrOS heel rise and jump" is the protocol file. If the participant has been entered previously, click on their name and press "Select."

9. Weighing the Participant

Before the participant steps on the force plate, click "Start" and then "Tare". **The force plate should <u>never</u> be tared with the participant standing on it, since this makes the test unusable.**

After the tare completes, which should take a few seconds, ask the participant to step on the force plate to weigh the participant.

<u>Script:</u> First we will be measuring your weight. Please step onto the force plate and stand quietly. I will let you know when you can step down.

Weigh the participant by pressing the "Weigh" button. While the weighing is in process the participant should remain as quiet as possible on the force plate.

You will be asked if you want to save the weight. Press "Yes." After the weight measurement is complete and press "Stop", ask the participant to step off the plate.

You will only need to weigh the participant one time, before starting all of their testing on the force plate.

10. Force Plate Trials

10.1 Calf Rise Trials

Participants will do 3 calf rises in order to understand the correct way to use their calves during the push off from the force plate during the jump. Data from the force plate will be collected during the calf rise, since participants who are unable to perform a jump may still be able to do

the calf rise. Additionally, the calf rise is a way for staff to assess balance issues prior to practicing the jump.

Demonstrate the calf rise to the participant prior to recording the participant doing 3 calf rises. Make sure the participant has no questions before moving on to the measurements by asking "Do you have any questions?"

Please note that the force plate is extremely sensitive to any surrounding movement, so both the participant and examiner/spotter must remain very still.

1. Prepare for a calf rise trial by clicking "Start" and then "Tare". **The force plate should never be tared with the participant standing on it, since this makes the test unusable**.

2. Ask the participant to step onto the force plate.

   Script: *"Please step onto the force plate and stand very still and quietly on the platform".*

3. Prepare for the measure.

   Script: *"When I say 'Ready, Go', without bending your knees, go all the way up onto your toes as fast as possible without stopping, and then slowly lower down. Once you are done with this movement, you need to remain as still as possible until I tell you to step down. Are you ready to start?"*

   Before starting the test, stand near the participant to spot them if necessary.

4. Press the "Arm" button to prepare for data collection.

5. When you are ready to start recording press the space bar. It is very important that you collect 1-2 seconds of baseline data before the participant does the calf rise. After collecting 1-2 seconds of baseline data, tell the participant to do the calf rise:

   Script: *"Ready, go".*

6. Once the participant has completed the movement and the 6 seconds of data collection are completed (the top bar on the screen will stop moving to the right), they should step off the force plate:

   Script: *"You can step down*."

7. To assess the quality of the data from the calf rise trial, look at the top left screen of the AMTI-NetForce program. If it appears that the calf rise occurred too soon and 1-2 seconds of a still baseline was not collected, or if the calf rise did not occur within

the 6-second recording period, please DO NOT save this calf rise and repeat the trial in order to collect data that can be analyzed.

8. Save Data for Calf Rise Trial 1: Press the "Save" button and name the file in the File name window after the participant's MrOS ID, the type of test (Rise) and the number of the trial (1-3) (e.g. XX1234_Rise_1). Press "Save." **If you do not save the data now, you will lose the data.**

   If you do not save a calf rise trial, please repeat the trial as if the trial that was not saved did not happen.

   If you do not save a calf rise trial AND do not repeat the trial, record on the data collection form for question 2 that not all trials were saved and how many trials were saved.

9. Once you have saved the current trial, press "Next" button to proceed to the next calf rise trial.

10. You will repeat the sequence to record 3 trials by repeating steps 1-8, starting with pushing "Start" and then "Tare" with the participant off of the force plate. You do not have to weigh the participant again after the initial trial.

On the data collection form, record form if the participant completed the 3 calf rise trials and is able to continue on to the practice jump trials.

If the participant does not attempt all 3 calf rise tests or reports severe pain during one of the calf rise tests, then **do not complete the practice jump trials or jump test trials.** Record the reason the participant is not moving on to the practice jump trials on the data collection form. Reasons include: refused, unable to understand instructions, unable, other or the participant reported severe pain and could not continue.

Also, record how many trials the participant attempted.

If the test is discontinued during or after the calf rise trials, the examiner should also answer questions 9 and 10 on the third page of the Force Plate TELEforms. Record if any of the calf rise trials were completed wearing stockings or bare feet due to inappropriate footwear. Also note if the participant reports any pain during the calf rise trials and the location and severity of pain.

If the participant completes the three calf rises and does not report severe pain, they should move on to complete the jump trials.

If the participant completes the three calf rises but refuses to move on to the practice jump trials, record on the data collection for question 2a that the participant refused practice jump trial.

10.2 Jump Trials
The goal of the jump trials is to have three trials with no protocol issues.

10.2.1 Demonstration and Description of Jumps
Describe the jump trials.

Script: "Now we will be completing the jump trials. During the jumps, we would like you to try to jump as high as you can. The test will start with you standing as still as possible on the plate. When I say 'Ready, go' you should jump as quickly and high as you can. Please try to jump and land smoothly and without pausing between bending the knees and jumping. After you have landed, stand up straight and remain as still as possible."

Demonstrate a jump trial. Staff should play participant demonstration video.

Script: "There will be between three and five trials. If you need to, you can sit between trials.

We will begin with some practice trials to practice the movement. If you have any pain during the trials, please let me know. If at any time you would like to stop, please tell me and we will stop the test. Do you have any questions?"

Examiners should ask about severe pain after providing a description and demonstrating the measurement. A participant should be excluded from the Force Plate Measurement if they report severe pain that would prevent him from completing the practice jumps trials.

Script: Do you have any severe pain that would prevent you from completing the practice jump trials?

If the jumps are not completed because the participant reported severe pain before the jump practice and test trials were completed, record this on the data collection form for question 3, "Did the participant report any pain after the demonstration of or during the practice trial". Record the response of "Yes, severe and test stopped".

If the participant says that they cannot jump, reassure them that it is acceptable if they cannot get off the group and that we want to see how fast and how strong there are when they extend their legs. Only say this when prompted by the participant. See end of manual of operations for additional responses to participants' concerns.

If the test is discontinued before the practice jump trials are attempted, the examiner should also answer questions 9 and 10 on the third page of the Force Plate TELEforms. Record if any of the trials were completed wearing stockings or bare feet due to inappropriate footwear. Also note if the participant reported pain and the location and severity of the pain.

10.2.2 Practice trials for jumps
Prepare for the practice trials standing near the participant to spot them if necessary. Requiring stabilization from the spotter during the jump is an acceptable practice trial.

Script: "Now I would like you to practice. Stand in the center of the force plate and try to jump up as quickly and high as you can, as just demonstrated. For the practice trials, please focus on performing the jump just like the demonstration showed. Once you land on the plate, try to remain as still as possible until I tell you to step down. Ready, go."

If the participant refuses to complete the practice jump trials after the demonstration, do not complete question 3 on the data collection form and record for question 2a that the participant refused practice jump trial.

The participant should bend their knees in a continuous motion and jump up as high as they can. The whole movement should be performed as fluidly as possible without pausing between bending the knees and jumping. If the participant does not perform the movement as described, provide further instruction and demonstration. Have the participant practice the jumping movement with full effort. If the participant does not perform the jump correctly, provide additional instruction or clarification and ask the participant to perform another practice jump. If the participant does not understand the instructions after the third practice trial, the examiner should continue on to the jump trials provided the participant can complete any type of jumping motion.If the participant does not understand that a jumping motion is required for the measure, the examiner should note that the participant does not understand the directions on data collection form.

After the practice trials, also ask the participant if they experienced any pain during the practice trials.

Script: "Did you experience any pain during the practice trials?
If yes, "*Does it hurt enough that you want to stop?"*

If the participant reports any pain during the practice trials, determine how severe the pain is and whether testing should continue. If the pain is too much for the participant to continue, record this information on the data collection form. For the question, "Did the participant report any pain after the demonstration of or during the practice trial", the response should be "Yes, severe and test stopped".

If the participant reported severe pain during the practice trials or is unable to understand the instructions after the practice trials, the examiner should also answer questions 9 and 10 on the third page of the Force Plate TELEforms. Record if any of the calf rise trials or practice jump trials were completed wearing stockings or bare feet due to inappropriate footwear. Also note if the participant reports any pain during the calf rise or practice jump trials and the location and severity of the pain.

10.2.3 Jump test trials

Please note that the force plate is extremely sensitive to any surrounding movement, so both the participant and examiner/spotter must remain very still.

Script: "Now we will complete the jump test trials.

1. Prepare for the jump trials by clicking "Start" and then "Tare". **The force plate should never be tared with the participant standing on it, since this may make the test unusable**.

2. Ask the participant to step back onto the force plate after the tare completes, which should take a few seconds.

   Script: "Please step onto the force plate and stand very still and quietly on the platform".

   Stand near the participant to spot them if necessary.

3. Prepare for the measure.

4. *Script: "Are you ready to start? Remember to stand quietly until I say 'Ready, Go'. Then jump up like we just practiced. Please remember to jump as high as you can and as quickly as possible. Once you land back on the plate, you need to remain as still as possible."* Press the "Arm" button to prepare for data collection.

5. When you are ready to start recording press the space bar. It is very important that you collect 1-2 seconds of baseline data before the participant does the jump. Once you have pushed start, please turn your head toward the participant to watch how the jump is performed. After collecting 1-2 seconds of baseline data, tell the participant to do the jump test:

   Script: "Ready, go"

6. Once the participant has completed the movement and the 6 seconds of data collection are completed (the top bar on the screen will stop moving to the right), the participant should step off the force plate:

   Script: "You can step down".

   If the participant does not perform the jump correctly, please explain what was done incorrectly and the correct way to complete the jump.

Encourage the participant to perform the jump to their best possible ability:

Script: "That was a great jump, but can you do it better?"
"Do you think you can jump higher than that?"
"Jump like you would when you were young and playing basketball!"

7. To assess the quality of the data from the jump trial, look at the top left screen of the AMTI-NetForce program. If it appears that the jump occurred too soon and 1-2 seconds of a still baseline was not collected, or if the jump did not occur within the 6-second recording period, please DO NOT save this jump and repeat the trial in order to collect data that can be analyzed. (Refer to **Appendix Section 1: Reviewing Curves** for examples of graphs of trials that should not be saved and need to be repeated.)

8. Save the data by pressing the "Save" button and name the file with the participant's MrOS ID, the type of test (Jump) and the number of the trial (1-3) (e.g.XX1234_Jump_1). **If you do not save the data now, you will lose the data.**

   If you do not save a jump trial, please repeat the trial as if the trial that was not saved did not happen. Please update the TELEform so that the information for each jump trial on the TELEform matches the trial number for the data that has been saved.

   If you do not save a jump trial AND do not repeat the trial, then record "Trial not saved" as the reason why a trial was not completed. For example, do not submit a TELEform with information for a trial that was not saved.

9. Once you have saved the current trial, press "Next" button to proceed to the next jump trial.

10. Repeat the sequence above to record additional trials. Have the participant repeat the testing until 3 valid trials are obtained. If after 5 attempts, 3 valid trials have not been obtained, additional jump trials should not be attempted. Once you have completed the necessary trials, press "Next" until the screen shows "Select Next Subject".

Save data for ALL attempted trials, as all data will be transferred to the Coordinating Center even if it was not an ideal trial.

If the examiner does not set-up the computer properly or does not save a given jump trial, please repeat that trial as if the trial that wasn't recorded properly did not happen. Please update the TELEform information so that the information for each jump trial on the TELEform matches the trial number for the data that has been saved. For example, do not submit a TELEform with information for a trial that was not saved.

Before sending TELEforms to the Coordinating Center, please check that the number of trials saved is consistent with the number of trials marked as completed on the TELEform.

10.2.4 Protocol issues for trials: reasons to obtain additional trials

A trial is considered to be optimal and without protocol issues as long as the following types of conditions are not violated. Up to 2 additional trials (e.g., trials 4 and/or 5) should be done until 3 valid trials are obtained if protocol issues occur during any of the first three trials. Record on the data collection from for question 8 as additional trials attempted.

In extreme cases where the examiner feels the participant cannot safely perform the extra trials, these may be skipped even if protocol issues occurred in trials 1-3. Record on the data collection form for question 8 as the examiner deemed the test unsafe.

You can find examples of graphs seen in AMTI-NetForce of normal and problematic trials in Appendix 1, Section 3: Example of AMTI-NetForce curves seen by examiners.

When additional trials (jump 4/jump 5) should be attempted and descriptions of flags:

"Required stabilization from spotter before/during jump"

- When participants need stabilization from the spotter either before or during a jump.

"Required stabilization from spotter after jump"

- When participants need stabilization from the spotter after a jump.

"Broken Movement" (Figues 10a & 10b):

- During the jump, when a participant clearly pauses in the movement, with either a stoppage or intermittent motion, prior to lift off for the jump. Note that broken movement **does not** include slow downward movement prior to a jump or any movement after a jump.

"Failed to maintain a still position prior to 'Go'" (Figure 11):

- Movement prior to the jump: When the test is started and the subject does not maintain a still position prior to you saying '*Ready, Go'*. For example, "Rocking" occurs with a subject swaying back and forth with the trunk and the lower body or moving the arms prior to jumping.

"Lost balance after landing" (Figures 12a & 12b):

- Movement after the jump, with a subject losing balance and was unable to maintain a still position after landing from the jump (this includes taking an extra step or requiring stabilization from the spotter after the jump).

"Testing/technical issue":

Trial should NOT be saved and needs to be repeated if:

- Jump occurred too early without 1-2 seconds of still baseline (Figure 13).

- Jump occurred outside of the 6-second recording period, so the data curve is not captured or visible. Full curve should be able to be viewed on the screen, without being cutoff at the end of the recording period (Figure 14).

- Participant stepped onto the force plate after recording has started (Figure 15).

Trial does not need to be repeated, but "Other" flag is applicable if:

- Participant stepped off the force plate after jump but before examiner said "you may step down" (though stepping off after jump and before recording ends does not require and additional trial) (Figure 16).

"Other" corresponds to any other unusual occurrence during the trial that has not been previously specified.

If the participant performs a trial where a protocol issue is observed, record on the data form in questions 5-8 what the observed protocol issue was. Clarify instructions for the jump with the participant if necessary.

Possible protocol issues that should be noted on the data collection form for each trial:
- Required stabilization from the spotter before/during jump.
- Required stabilization from the spotter after jump.
- Broken movement when a participant clearly pauses in the movement, with either a stoppage or intermittent motion, prior to lift off for the jump. Failed to maintain a still position prior to you saying "Go".
- Lost balance after landing (this does not include taking an extra step).
- Testing technical issues:
    - Jump occurred too early without 1-2 seconds of still baseline.
    - Jump occurred too late so the data curve is not captured or visible.
    - Participant stepped onto the force plate after recording has started.
    - Participant stepped off the force plate before jump (stepping off after jump and before recording ends does not matter).
- Any other unusual occurrence during trials that has not been previously specified.

10.2.5 Reasons additional trials aren't completed.

There are several reasons why the jump trials may not be collected. Always record on the data collection form why a trial wasn't completed.

Reasons a trial was not completed:

Unable

If a trial cannot be completed or scored, record "unable" as the reason the trial was not completed.

Severe Pain
If a participant does not complete additional trials because they report pain severe enough not to continue, record "Severe pain" for why the trial was not completed. See below for more information. .

Refused
If a participant refuses to complete additional trials, record "Refused" for the reason the trial was not completed.

Three Valid Trials
If three trials are obtained without protocol issues, additional trials are not required. Record "3 Valid Trials" as the reason additional trials were not completed. This is only an option for the fifth trial and should only be used if the third successful trial is obtained after the 4th trial.

Examiner Deemed Test Unsafe
If the participant had protocol issues in trials 1-3, but the examiner deems additional trials unsafe, record "Examiner deemed test unsafe" as the reason additional trials were not completed.

Trial not saved
If the trial is not saved, which can be determined before sending TELEforms to the Coordinating Center by checking that the number of trials saved is consistent with the number of trials marked as completed on the TELEform, mark "Triall not saved" as the reason additional trial was not completed.

11. Footwear
For the calf rise and jump trials (recorded or practice), record on the data collection form question 9 if any of the recorded trials were performed with stockings or bare feet due to inappropriate footwear.

12. Pain during exam
There are several locations for which the examiner should ask about any pain the participant may experience during the jump trial (See above). If pain is so severe the participant feels unable to continue the test should be stopped.

If the participant complains of pain during any of the trials (when not specifically asked), determine how severe the pain is and whether testing should continue.

Script: *"Does it hurt enough that you want to stop?"*

If the participant complains of severe pain that hurts enough that they want to stop, discontinue testing.

Question 10 on the third page of the Force Plate TELEforms should be completed for all participants who at least attempt the calf rise trials. The only time it should not be answered is if none of the force plate measurements are not completed. Record the location of the reported pain the participant reports (regardless if it is severe or not to continue) on the data collection form.

Record any location the participant reports pain (more than one location may be marked). If the participant reports any pain (either prompted by a question or not) during the calf rise trials, practice jump trials or recorded jump trials, record the severity of the pain. If the participant has pain in multiple locations, only highest pain severity from the different locations of pain needs to be recorded on the data collection form. Ask the participant which location has the most severe pain, and then have them choose a severity only for this location with the most severe pain.

Script: *"How severe was your pain, with '0' as no pain, '5' as moderate pain and '10' as severe pain?"*

13. Transferring data to the Coordinating Center

- Please send all data files for each trial to the Coordinating Center regardless of the quality of data collected.
- Transfers should be done on a weekly basis unless otherwise specified by the Coordinating Center.
- Transfer of data will occur via the Coordinating Center's secure website. Secure remote access to the website is provided by the Juniper Networks Instant Virtual Extranet (IVE) appliance which sits behind our network firewall.
- Authorized users will be given a login id and password. Please contact the Coordinating Center to request access for clinic staff members.

To save all the new raw data files from the MrOS Force Plate file folder on the computer to a new zipped folder to prepare for transfer, use the following steps:

1. Create a new folder on the computer or a flash drive and name it "*mmddyy*"
   **mmddyy* is the current date
   * The raw '.bsf' files will be pasted into this folder at a later step
2. Go to C:\AMTINetForce\MrOS Force Plate Data (the drive where the '.bsf' files are saved).
   a. Please use this folder as a local archive of the force plate data where all files will be stored. Please make sure this data is backed up on a regular basis.
3. Select **ALL** new '.bsf' files
   Note: This will be all files from participants tested during the time since the last set of data was sent to the coordinating center. This will include the weekly calibration files.
4. Copy all files
5. Paste all files to the *mmddyy* folder created in step 1.
6. Zip the *mmddyy* folder

To transfer '.bsf' files to the Coordinating Center, use the following steps:

1. Go to https://ive2.sfcc-cpmc.net/mros
2. Sign in using your login id and password
3. Click **MROSAccel SFCC**
4. Click on *site specific folder*

5. Click **Force Plate**
6. Click **Upload Files…**
7. Click **Choose File**
    a. Go to the location where the *mmddyy*.zip folder is located (either on the computer or flash drive)
    b. Select *mmddyy*.zip
8. Click **Upload**

14. Frequently asked questions

1. *How deep should I bend my knees?*

   Answers: You should bend your knees as deep as you feel comfortable. Do not bend them too little or too much. Remember to think about bending your knees.

2. *I am sure I cannot jump. What if I cannot take-off?*

   Answers: It does not matter if you cannot "take-off". What is important is that you try to perform the movement as fast as you can. You should bend your knees and extend them as fast as you can.

3. *I haven't jumped since I was a kid. How can I jump?*

   Jump as naturally as it comes to you. I will help you and suggest you some corrections in case you may need them. Please watch my demonstration of the movement which may help you to understand it.

4. *I am not sure I can come up again if I bend my knees.*

   You should bend your knees at the depth you feel comfortable and can come up again. We will do some practice trials and if you feel uncomfortable we can stop the test.

15. Alert values/follow-up/reporting to participants

There are no alert values.

16. Quality assurance

16.1 Training requirements

The examiner requires no special qualifications or experience to perform this assessment. Training should include:

- Read and study manual
- Attend training session on measurement techniques
- Practice measurement protocol on other staff or volunteers

- Recognize jumps of poor quality and identifies a protocol issue with the jump from the graphic output.
- Discuss problems and questions with local expert or external consultants

16.2 Certification requirements

- Complete training requirements
- Conduct test on two volunteers. Volunteers need not be age-eligible for the study:
    - According to protocol, as demonstrated by completed QC checklist

16.3 Quality assurance checklist

- ☐ Checks for exclusion criteria
- ☐ Main points of script correctly and clearly delivered
- ☐ Correctly describes testing procedure
- ☐ Correctly demonstrates the movement
- ☐ Tares the force place without weight on it
- ☐ Corrects and/or records any deviation from the protocol.
- ☐ Reviews form for completeness following completion of test
- ☐ Reports any comments on form concerning test performance

17. References

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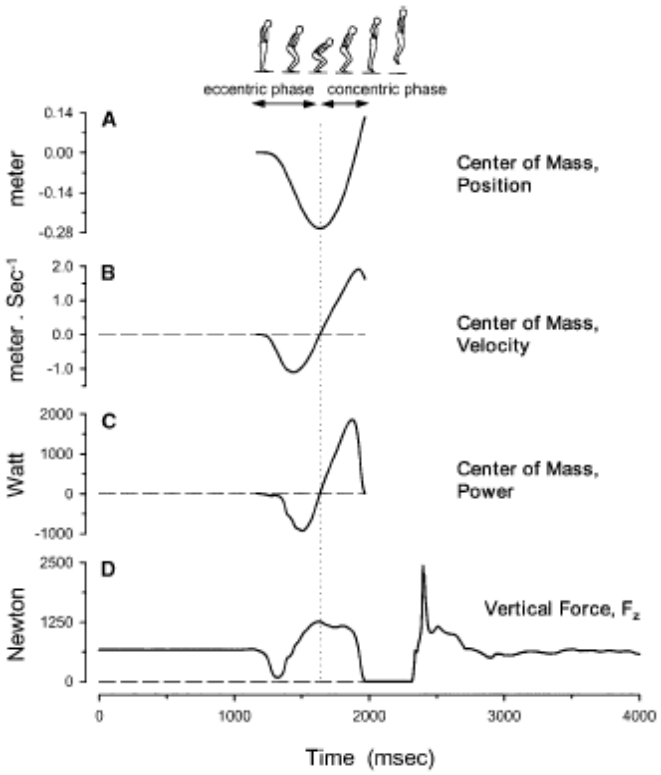
Appendix

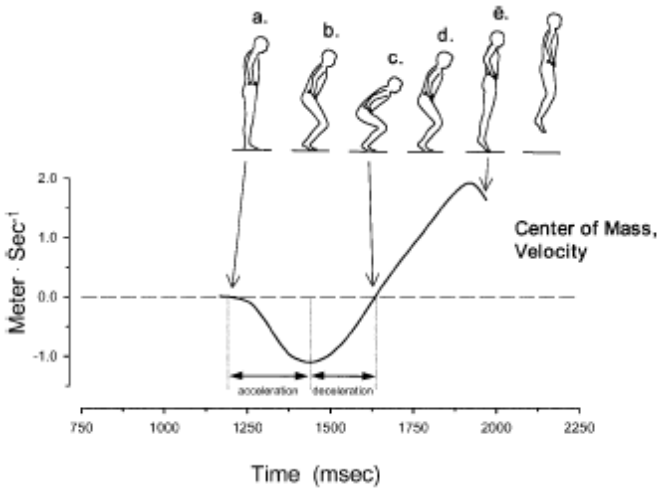
Section 1: Reviewing Curves

Representative counter-movement jump



Caserotti, 2001, Eur J Appl Physiol

Representative counter-movement jump recorded on a force plate in a 75-year old man. The figure indicates the two movement phases of the jump attempt: eccentric (when the subject bends his knees downwards) and concentric phases (when the subjects extend his knees while trying to perform the jump). The figure shows the vertical force signal (Fz) recorded on the force plate on the bottom panel (D). Additionally, the vertical position (A), the movement velocity (B) and power (C) of the center of mass (CoM) are shown. The vertical position (A) indicates how deep the subject lowers his/her body CoM (i.e. how many centimeters). In this example the subject lowers his CoM about 20 cm. The movement velocity (B) indicates how quickly the movement is performed throughout the entire jumping phase (downwards and upwards movement). In this example a maximum velocity of about 2m/s is reached just before take-off. The muscle power panel (C) indicates the power produced throughout the entire jumping phase (maximum power in the example about 2000 W). (Caserotti et al. 2001).



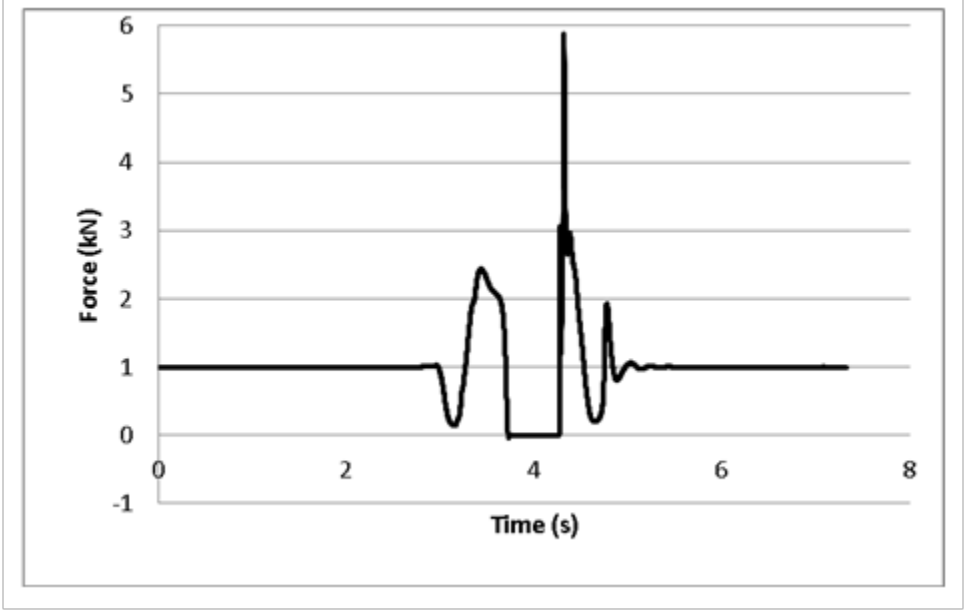
Caserotti, 2001, Eur J Appl Physiol

By recording the velocity of the movement and plotting it against the time it takes to complete the task, each phase of the jump can be identified. These are:

a. Starting position
b. The instant of peak negative velocity – shift in acceleration from negative to positive (from accelerating downwards to decelerating or preparing to accelerate upwards)
c. Point of transition from negative to positive velocity where center of mass is at its lowest
d. --
e. Takeoff

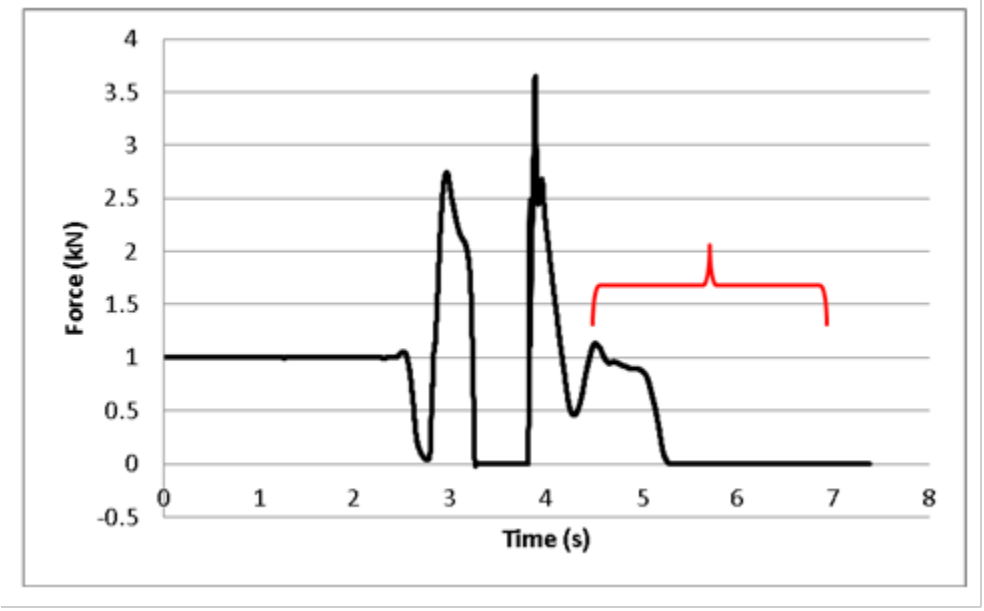
Section 2: Graph Examples

Figure 1: Normal Jump



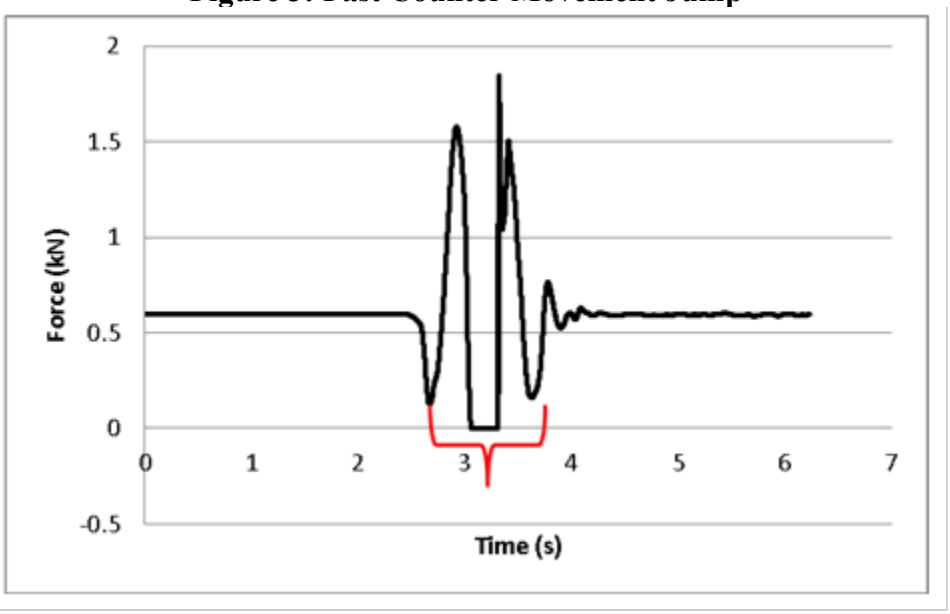
This is a graphical example of normal data.

Figure 2: Valid Data



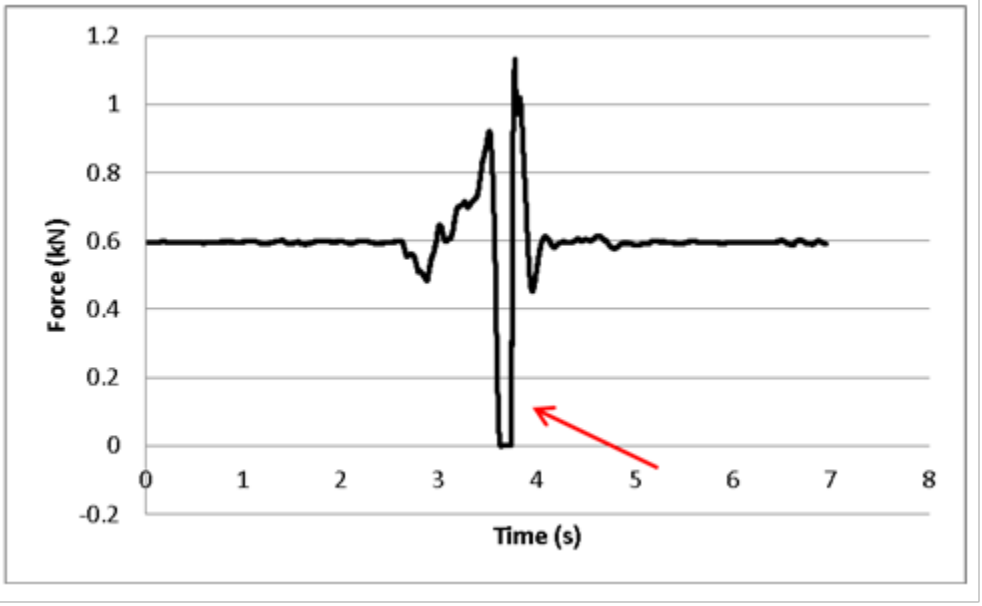
This is an example of a test considered valid but the subject stepped off the plate before the end of recording. The whole movement is recorded and thereby the test is valid.

Figure 3: Fast Counter Movement Jump



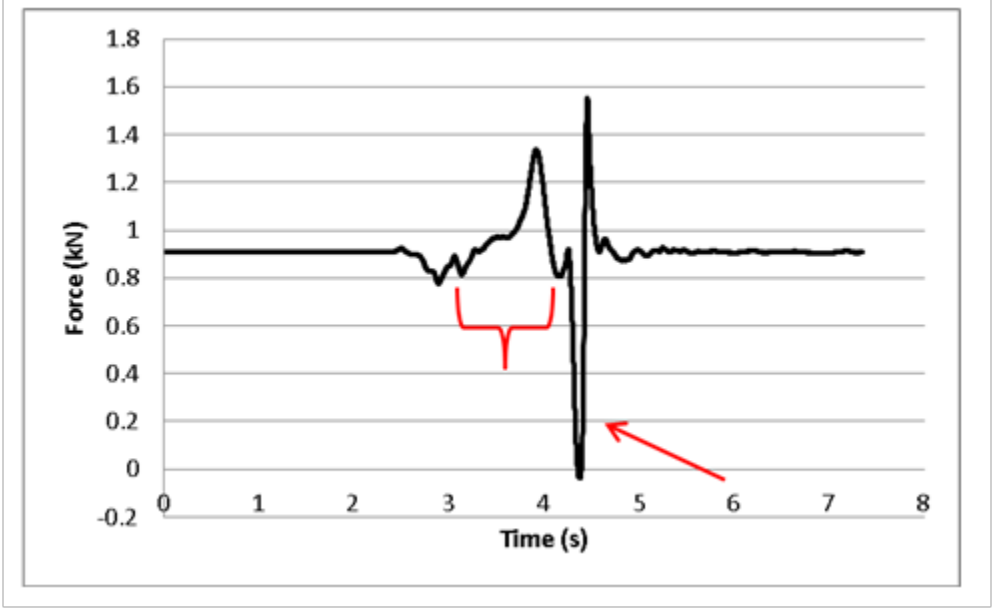
During this test, the participant performed counter movement very quickly (accelerated downward very quickly). Test considered valid.

Figure 4: Slow Jump with broken movement



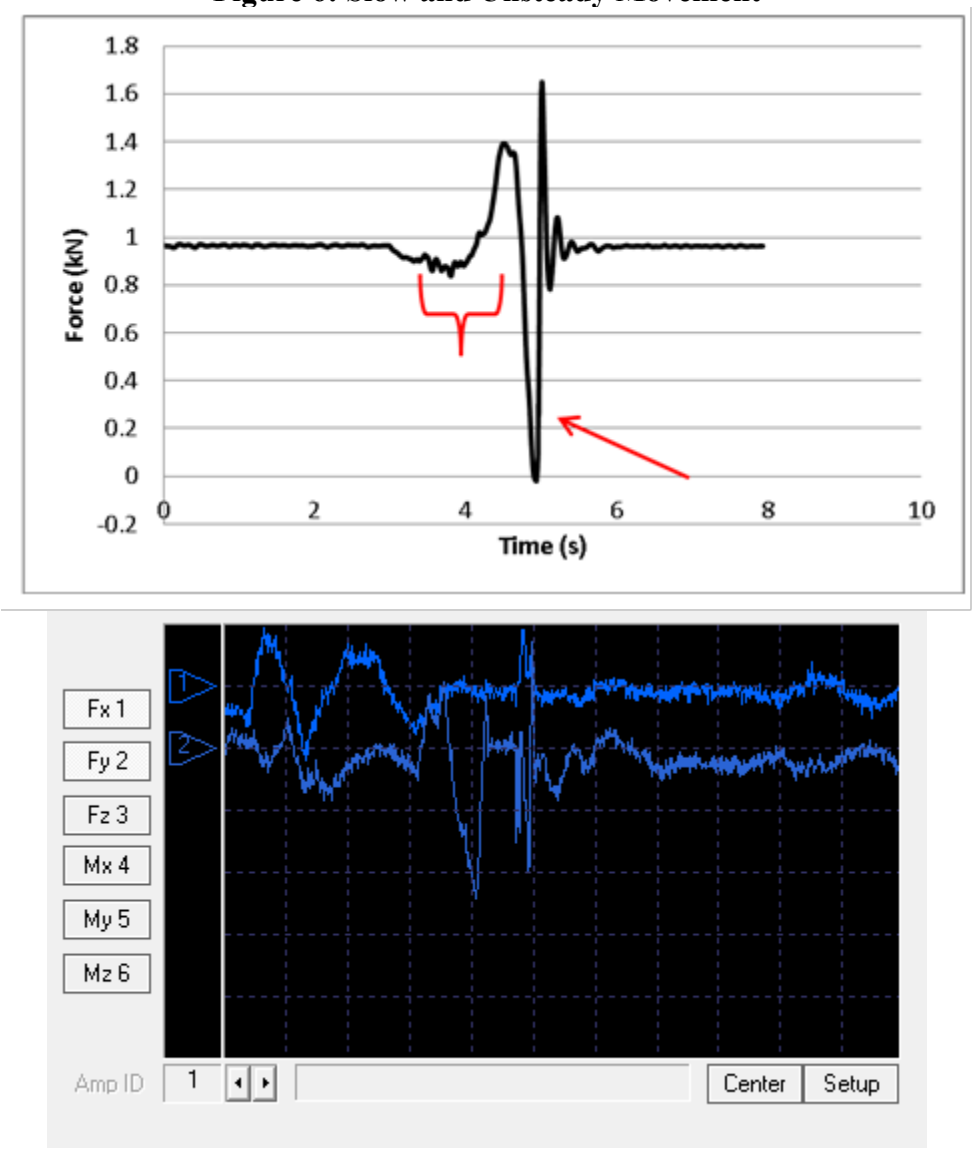
During this test, the participant performed the jump very slowly. Test considered valid; however, the participant should be encouraged to perform the jump as quickly as possible. Note protocol issue on question 5-8.

Figure 5: Leg Extension with no Take Off



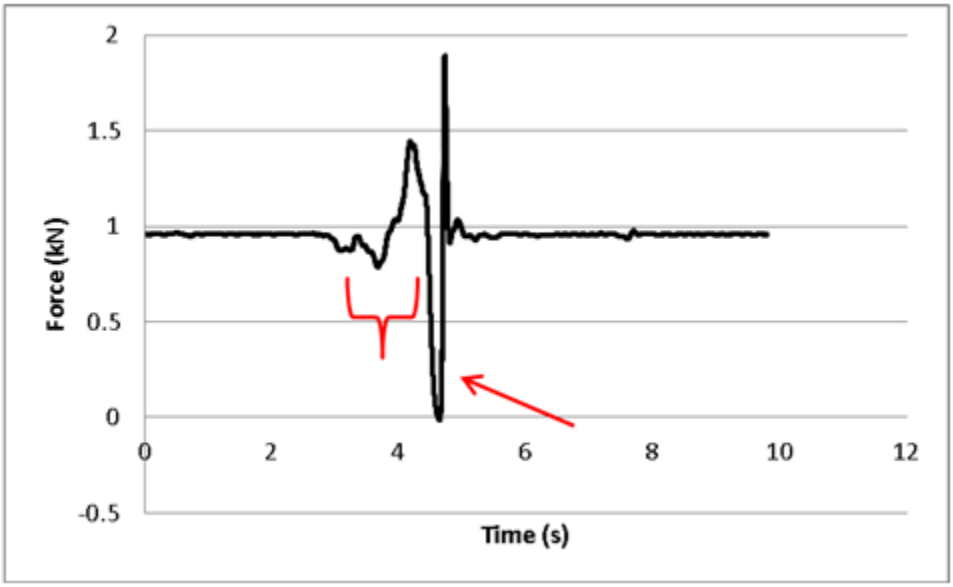
During this test, the participant extended their legs upward after a counter movement but did not take off (feet did not leave the ground). This is a valid test.

Figure 6: Slow and Unsteady Movement



During this test, the jump was performed with a slow and unsteady movement. This test is valid; however, participant should be encouraged to perform the jump as quickly and smoothly as possible. If the participant is unsteady, the bottom graph will look as shown, rather than a straight line.

Figure 7: Slow and Unsteady Movement with Stabilization from Spotter



During this test, the jump was performed with a slow and unsteady movement, while the participant held the spotter's hand for stability. This test is valid.

Section 3: Examples of AMTI-NetForce curves seen by examiners

Figure 8: Normal calf rise that should be saved and does NOT need to be repeated

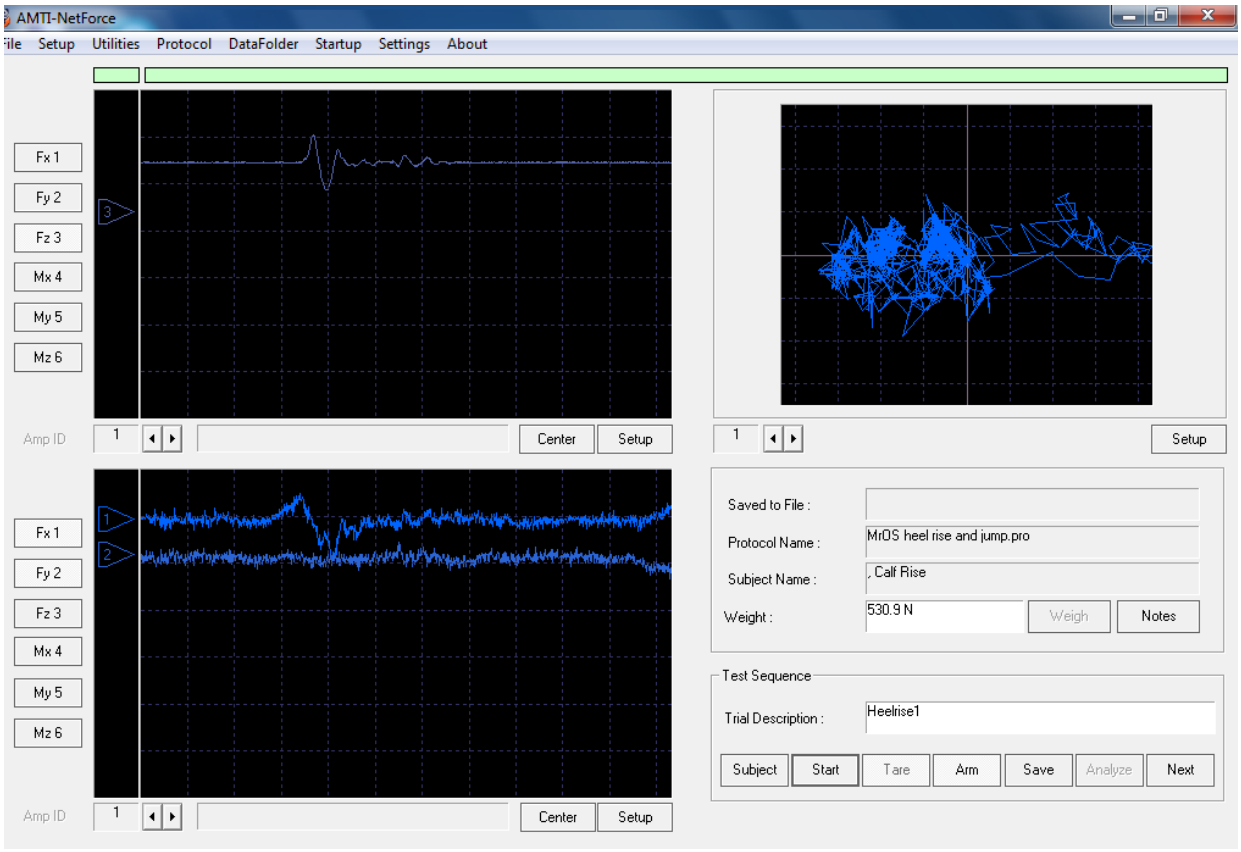


Figure 9: Normal jump that should be saved and does NOT need to be repeated

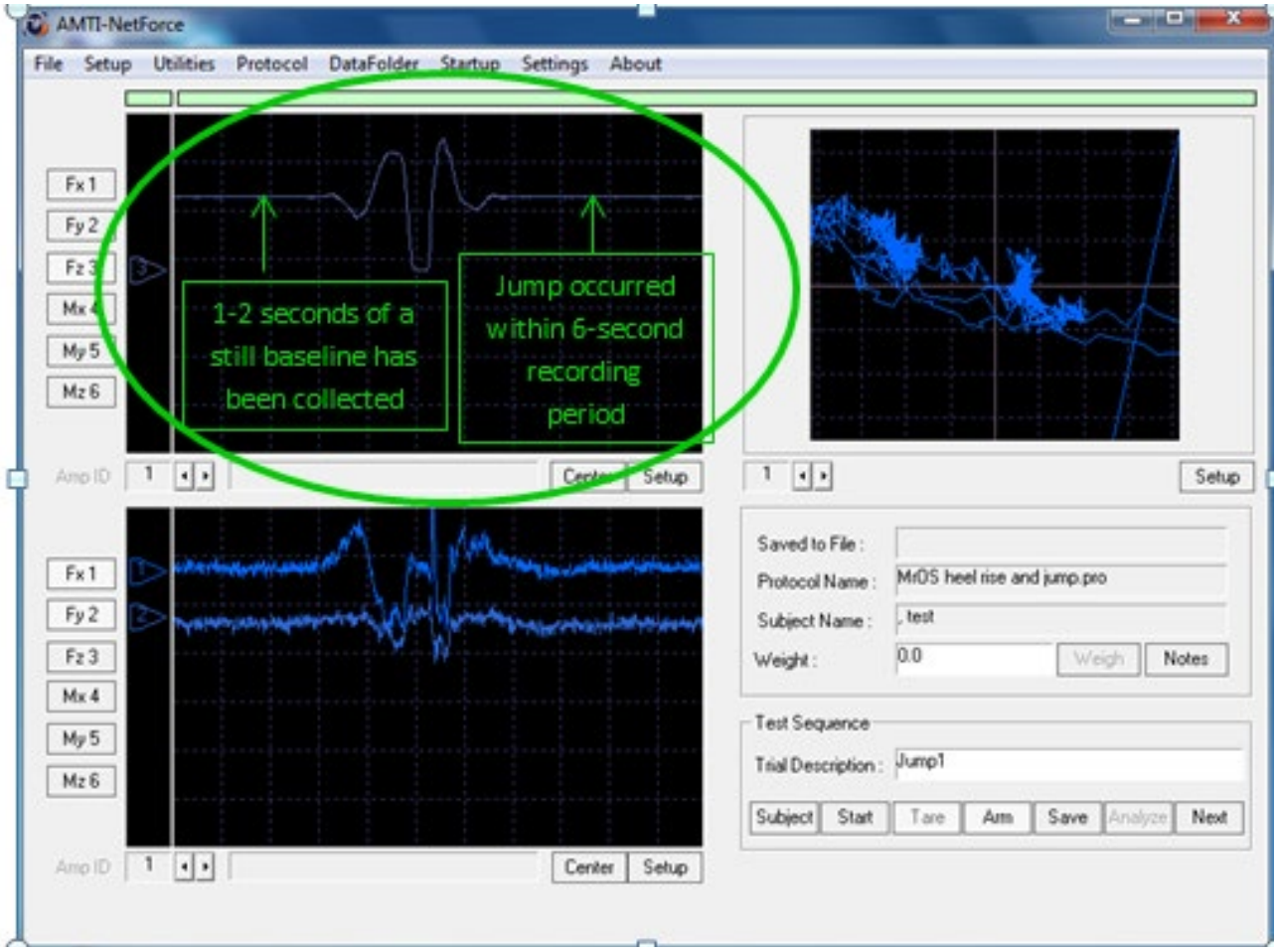


Figure 10a: Broken movement (severe)

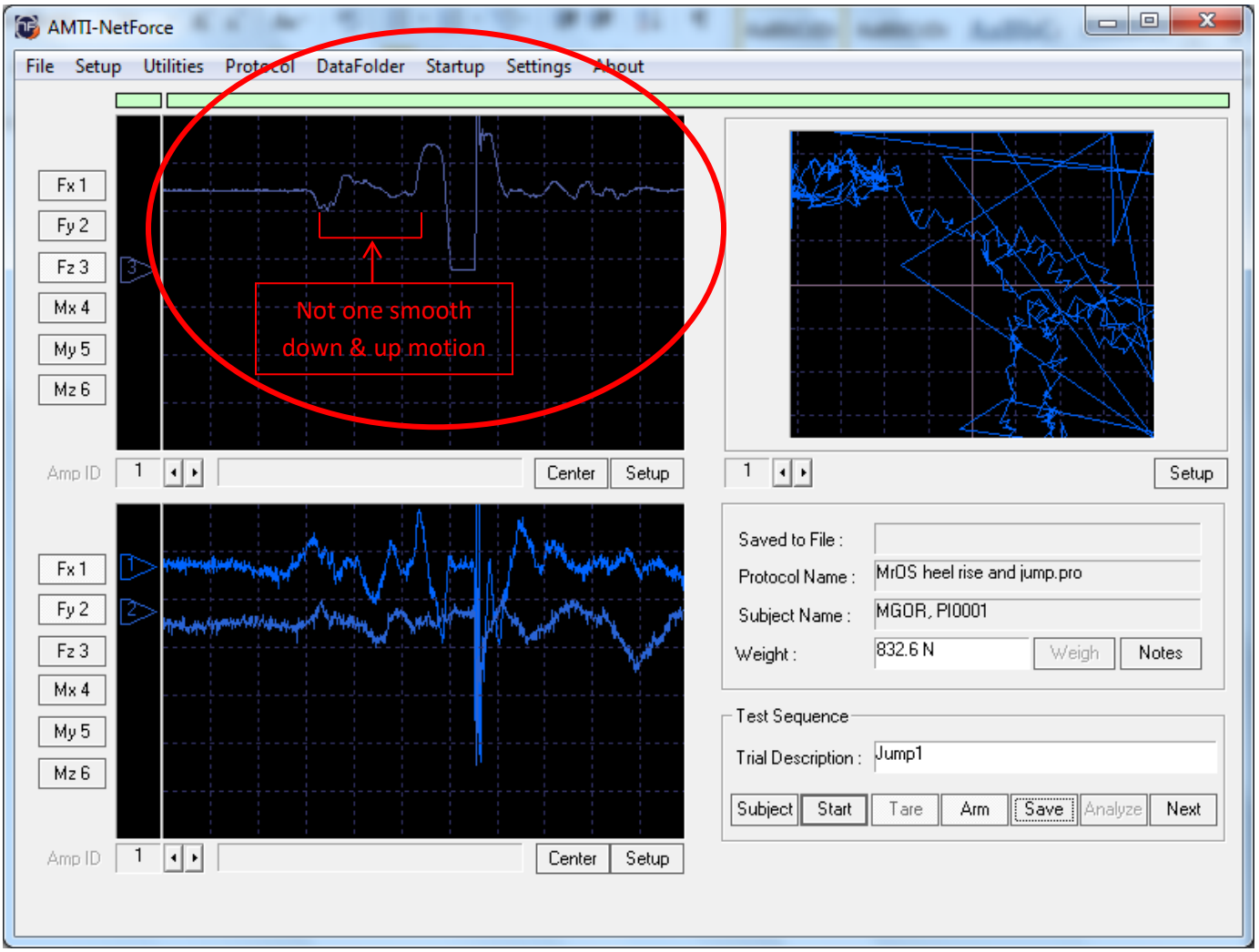


Figure 10b: Broken movement (severe)

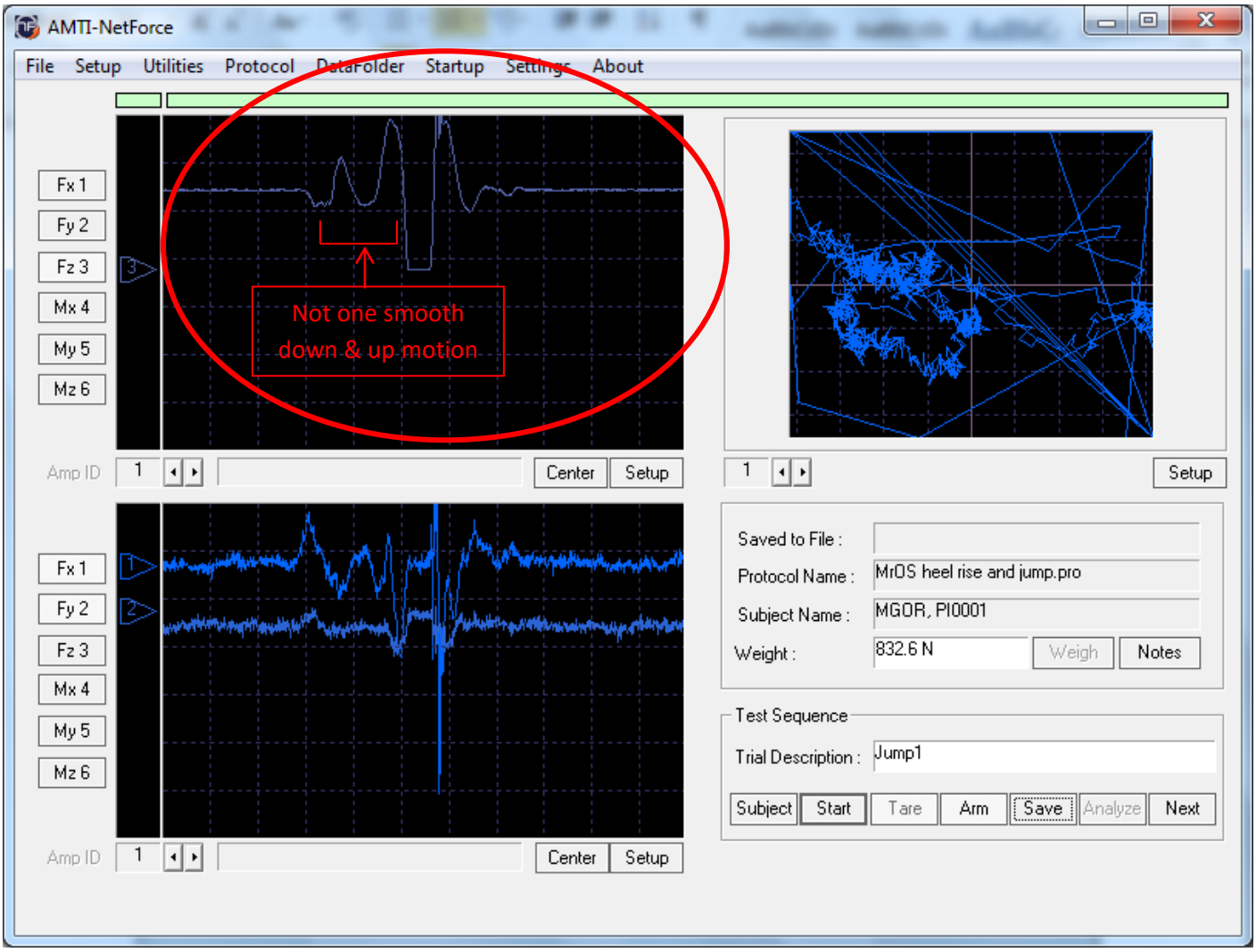


Figure 11: Failed to maintain a still position prior to "Go"

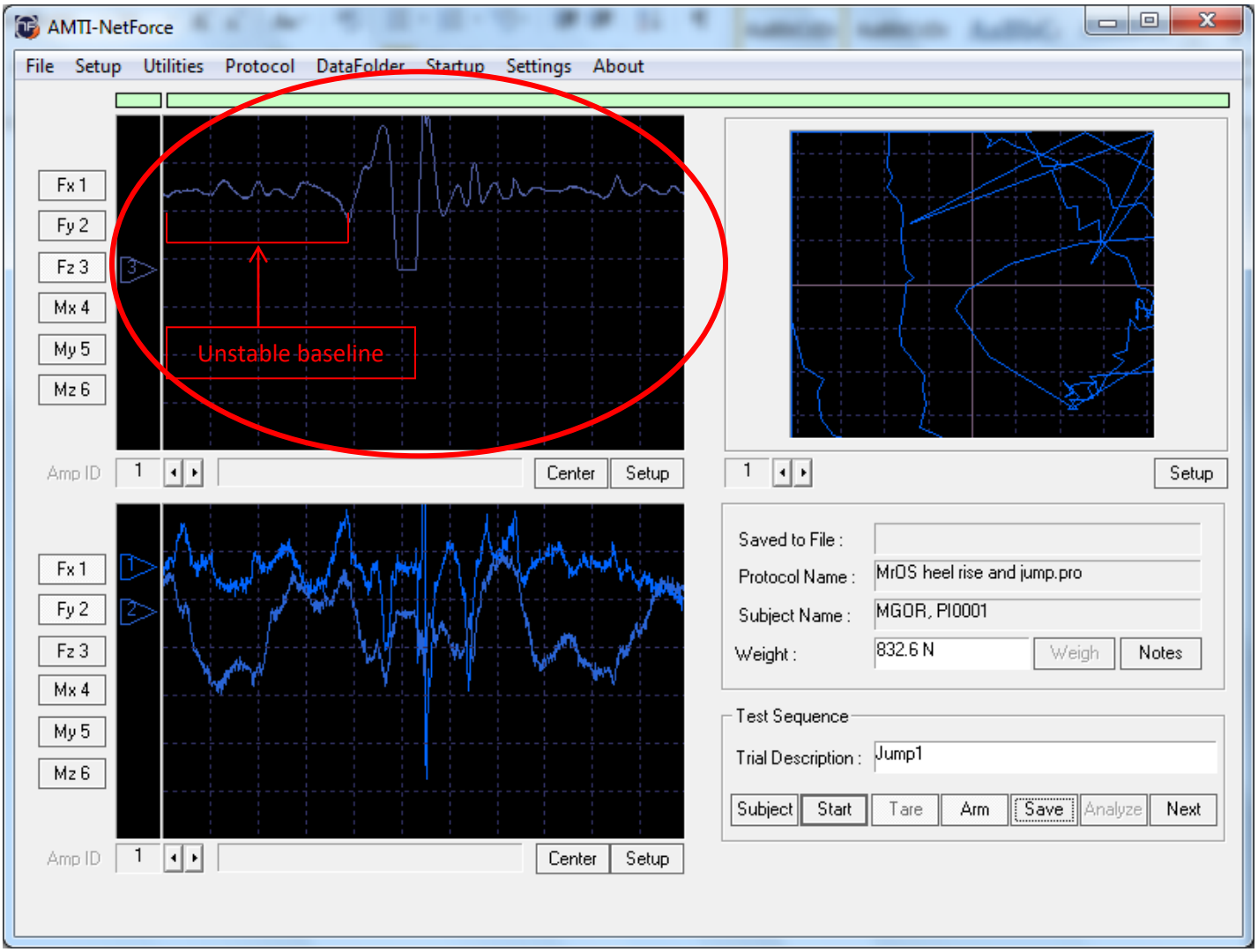


Figure 12a: Lost balance after landing and took a step

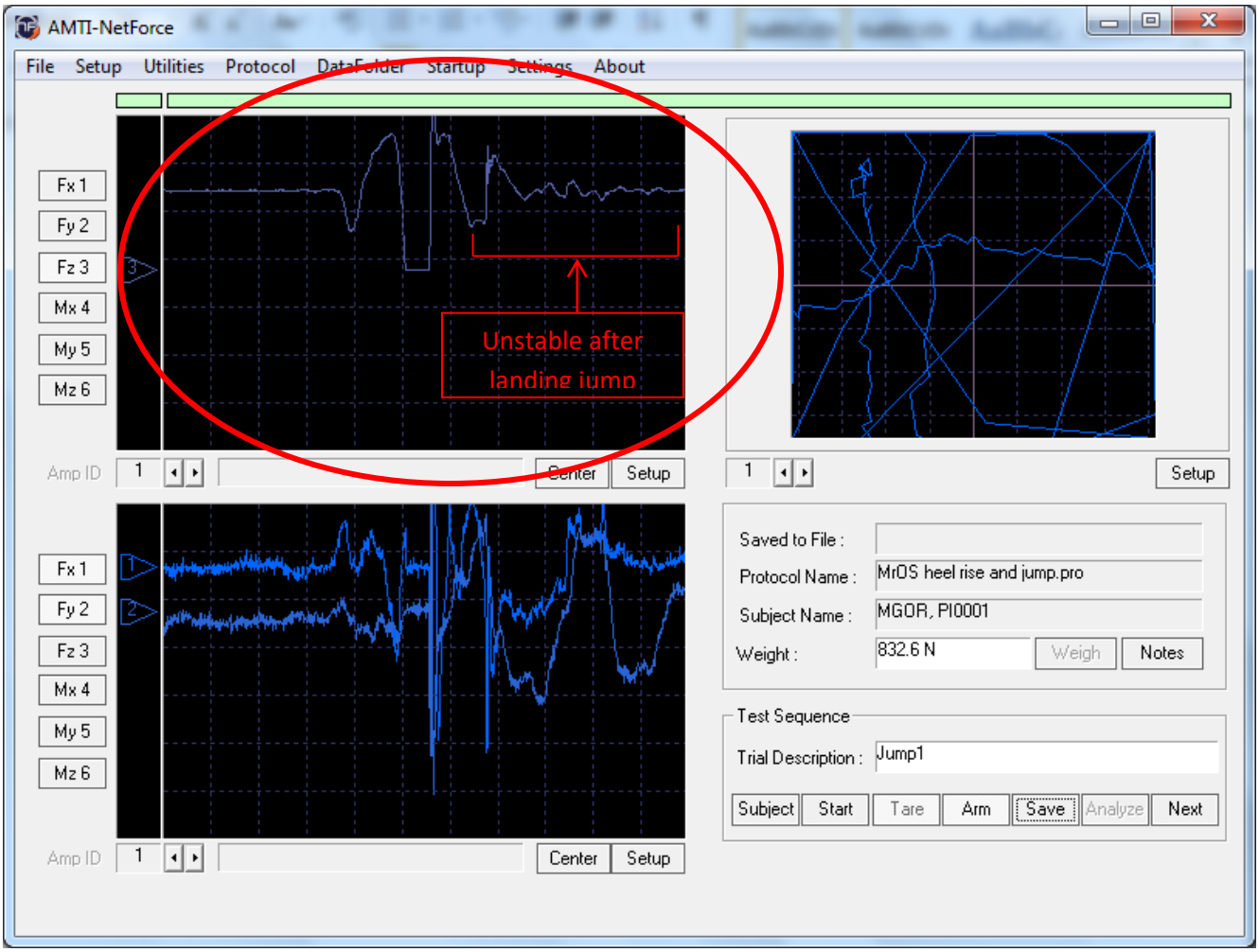


Figure 12b: Lost balance after landing requiring stabilization from the spotter

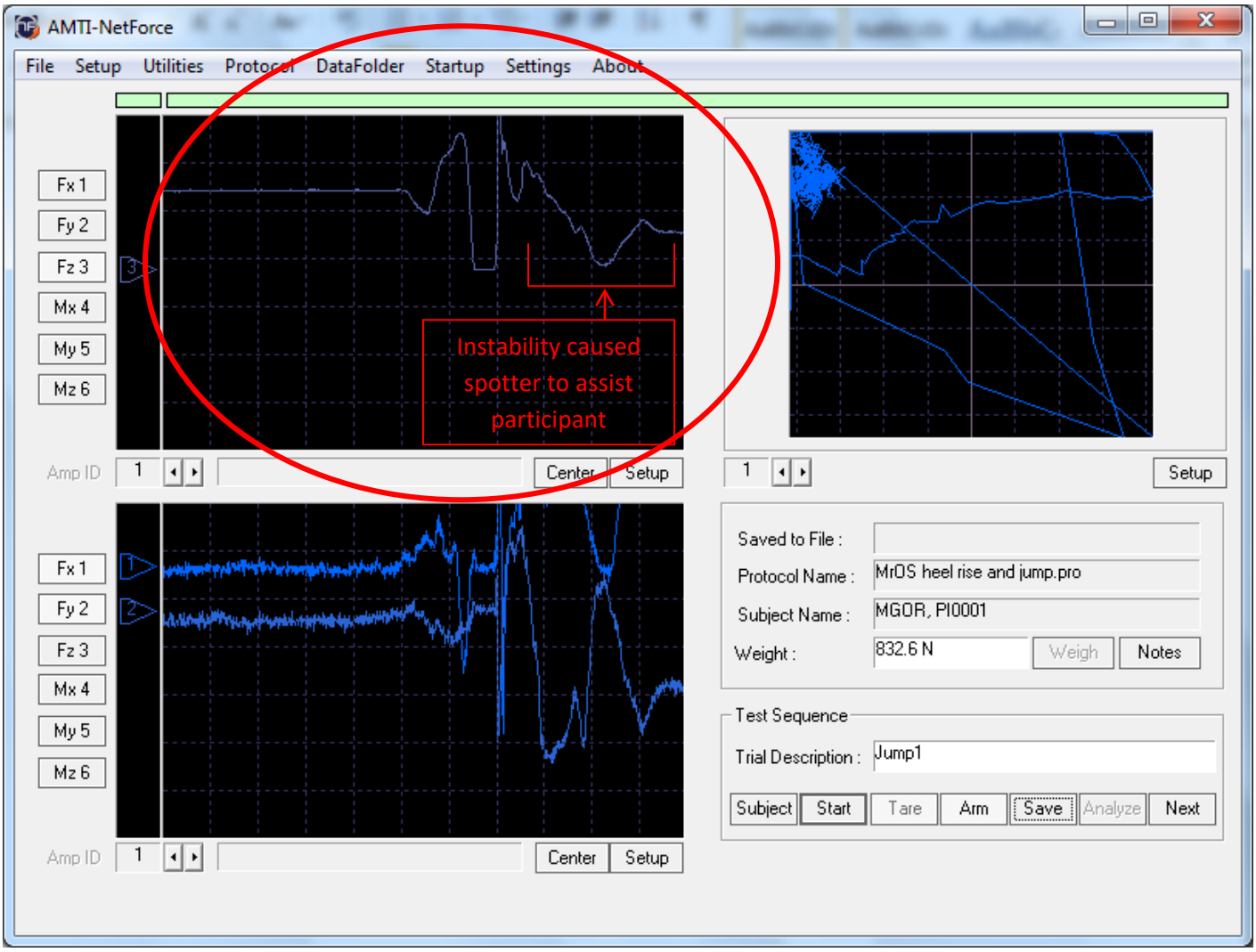


Figure 13: Jump occurred too soon and 1-2 seconds of still baseline not recorded – DO NOT SAVE OR RECORD ON TELEFROM and repeat the trial

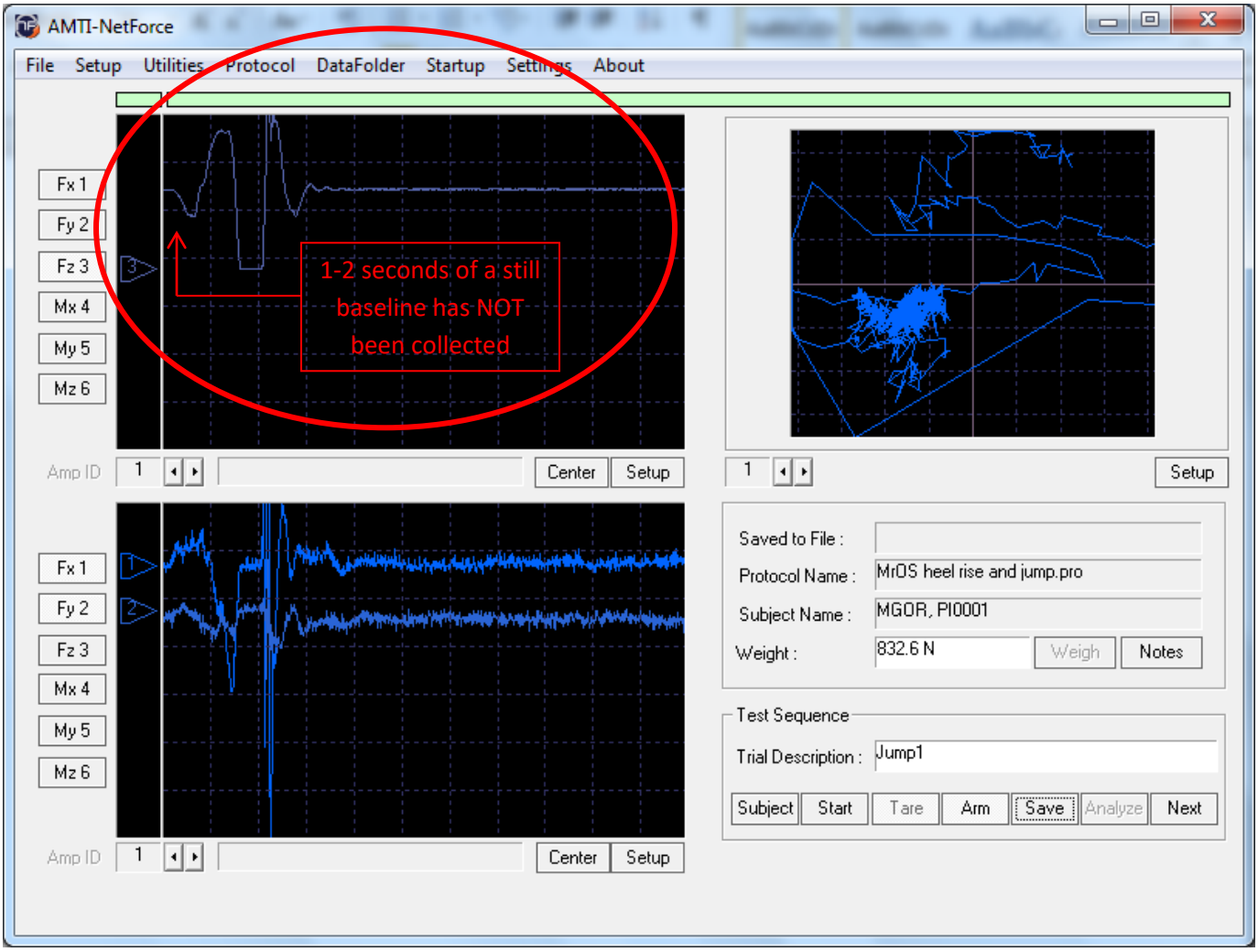


Figure 14: Jump occurred outside of the 6-second recording period, so the data curve is not captured or visible – DO NOT SAVE OR RECORD ON TELEFROM and repeat the trial

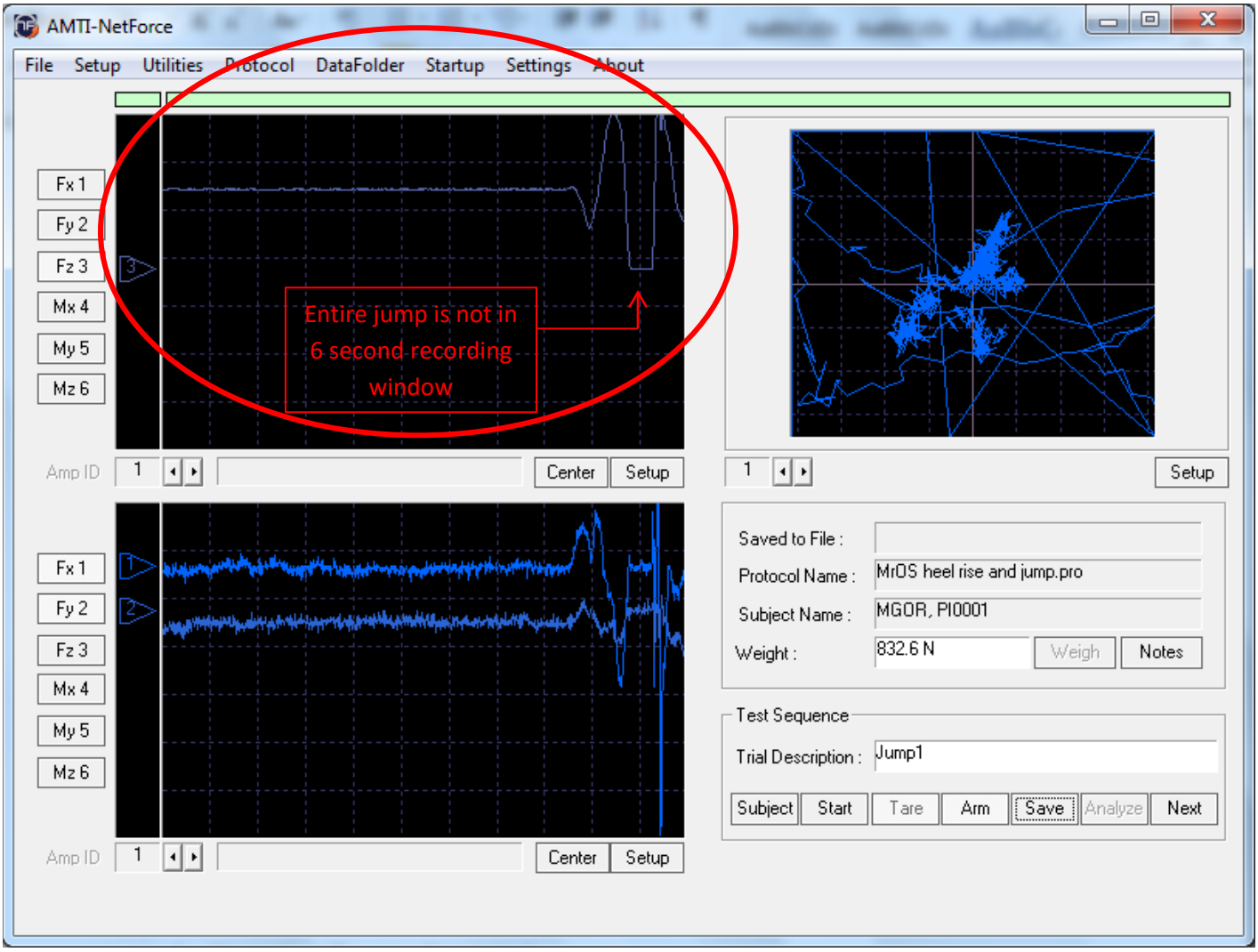


Figure 15: Participant stepped onto the force plate after recording has started – DO NOT SAVE OR RECORD ON TELEFROM and repeat the trial

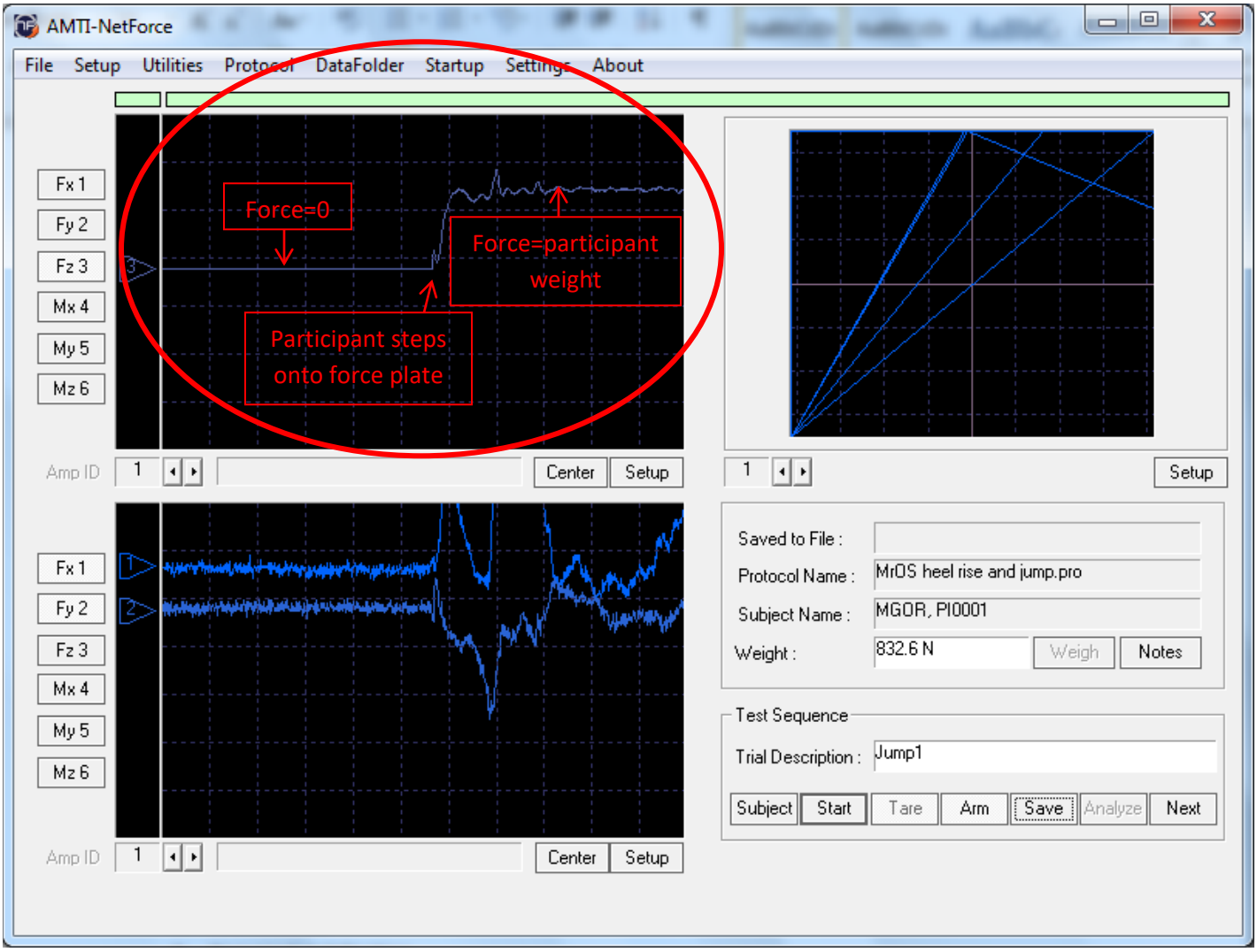


Figure 16: Participant stepped off the force plate after jump but before examiner said "you can step down". (Stepping off after jump and before recording ends does not require an additional trial).