


Maximal voluntary isometric contraction (MVIC) testing also known as muscle strength test

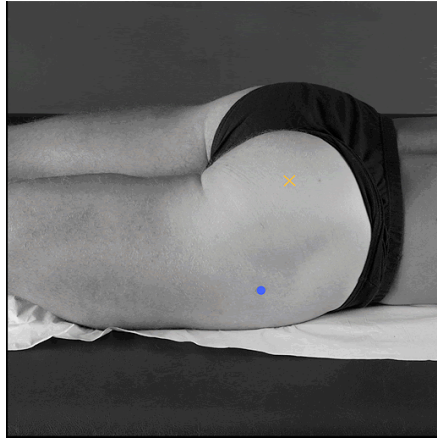
1. Before MVIC testing begins, participant will be given time to warm up and be familiar with the exercise. This is to mitigate the chances of a participant having muscle pain or soreness of the lower limb and back during the test
2. Electromyography (EMG) electrodes will then be placed on the participant's skin for the seven muscle groups on both the left and right side as shown in Table 1.
 - a. Participants with a skin allergy to alcohol or adhesive tape due to the EMG electrode may be a possible risk. If an allergic reaction is triggered due to alcohol, participants' skin will be rinsed with water. If an allergic reaction is due to adhesive tape, the assessor will remove the electrodes immediately.
 - b. Participants may be required to shave the area where the electrode is being placed if it interferes with the EMG signals or if it prevents the adherence of the EMG electrodes to the skin

Table 1

Electrode placements following SENIAM recommendations (Welcome to SENIAM, n.d.)

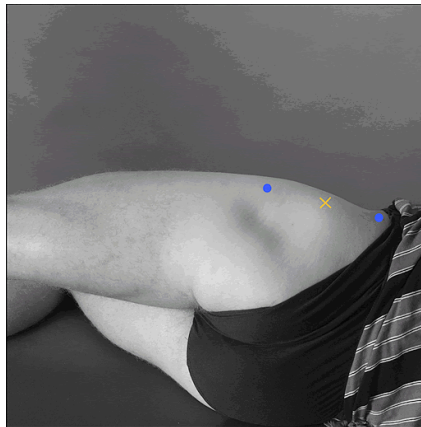
Muscle Group	Image (Blue dot represents the reference landmarks; cross represents the electrode placement)
Longissimus Dorsi (LD)	 <p data-bbox="618 1419 1349 1486">Electrodes will be placed at 2 finger width lateral from L1 spinous process.</p>

Gluteus Maximus (GMax)



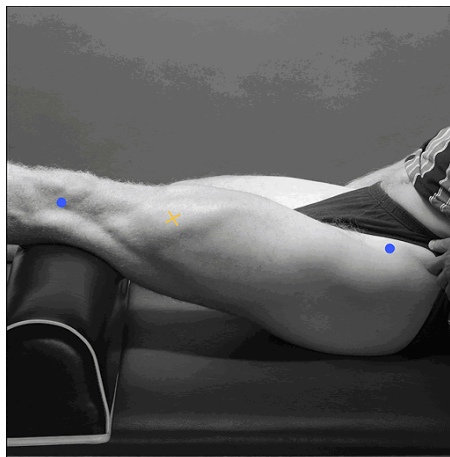
Electrode will be placed at the midpoint between the sacral vertebrae and the greater trochanter, corresponding to the greatest prominence of the middle of the buttocks.

Gluteus Medius (GMed)



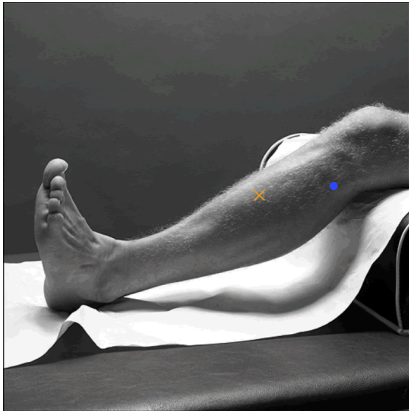
Electrodes will be placed at 50% on the line between the iliac crest and greater trochanter

Vastus Lateralis (VL)



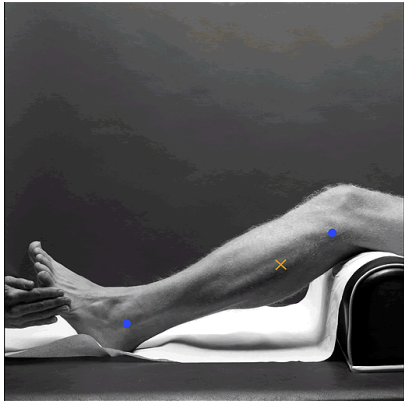
Electrode will be placed on the proximal $\frac{2}{3}$ of the line joining the anterior superior iliac spine and the lateral side of the patella.

Tibialis Anterior (TA)



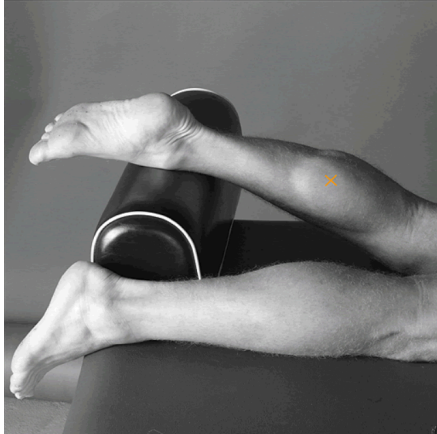
The electrodes will be placed proximal $\frac{1}{3}$ on the line between the fibular head and the tip of medial malleolus

Peroneal longus (PL)



Electrode will be placed on the proximal $\frac{1}{4}$ of the line joining the tip of fibular head and lateral malleolus.

Gastronemius Medialis (GastM)




	The electrode will be placed in the centre of the most prominent muscle bulge on the medial side
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3. To obtain the maximal muscle activity of each muscle group, participant will undergo a series of MVIC tests also known as muscle strength tests. The MVIC test will be performed against manual resistance and the testing position for all muscle groups is shown in Table 2.
4. For each muscle group, participants will perform 3 trials of 5 seconds of MVIC with a minimum of 2 minutes rest between trials to prevent fatigue (Halaki & Ginn, 2012).
5. Participants will perform the MVIC testing in the order of LD, Gmax, GastM, GMed, TA, VL, PL

Table 2

MVIC Testing positions (Ekstrom et al., 2008; Halaki & Ginn, 2012)

Muscle	Test position (measured using goniometer)
GMax	 <p data-bbox="410 1377 850 1409">Prone, with the hip flexed 45 degrees</p>

GMed



Side lying, with hip abducted 10 degrees

VL



Short sitting, with hip flexed 90 degrees and knee flexed 60 degrees

TA





Supine, with ankle, knee, and hip in neutral

PL



Seated, with hip flexed 90 degrees and knee flexed 90 degrees

<p>GastM</p>	 <p>Prone, with ankle, knee, and hip in neutral</p>
<p>LD</p>	 <p>Prone, trunk extension to end range, the resistance will be applied at the upper thoracic area with the lower extremities stabilised</p>

- The participants will be given a 2-minute rest before starting the single-leg stance trial.

Safety protocol:

During the session, if the participant are experiences any muscle pain or discomfort, they should let the researchers on site know immediately. The session will be put on hold for 5 minutes. If the pain and discomfort improves and no longer prevents continuation of the session, the session will continue. However, if the pain and discomfort does not go away, we will cease the session and would recommend participants to monitor their symptoms for 24-48 hours. If the symptoms do not improve, participants should contact the PI and visit the doctor. Do let the participants know that they may experience some muscle pain or soreness in the next 24-48 hours. In the event the muscle pain lasts for longer than 48 hours or limits daily activities, please contact the PI at 65922901 or boonchong.kwok@singaporetech.edu.sg.

Single-leg stance (SLS) trial and test

- Equipment required:
 - A stable plinth
 - A goniometer
 - Foam board

Figure 1

Foam board



1. The participant will be instructed to remove their shoes and socks
2. The assessor will set up the plinth ensuring it is locked and stable
3. The assessor will then raise the plinth to the height of the participant's wrist as shown in Figure 2

SLS practice trial

1. Before the actual test is performed, participants will complete a single practice trial of SLS on both a flat ground and a foam board for 10 seconds on both legs
2. During the trial, the participant will be directed to stand beside the plinth, and the assessor will stand alongside them to prevent any potential falls, as shown in Figure 3
3. The participant will first perform the practice trial on his/her right leg while on flat ground
4. The participant will be instructed to assume the SLS position
5. Before the start of the 10-second SLS, one assessor will use a goniometer to measure the participant's hip and knee angles (Figure 6 & 7), ensuring that they are in neutral positions and at 90-degree flexion, respectively
6. The participant will then be tasked to maintain that position with their hands on their hips and avoid moving them for 10 seconds
7. Upon completion of the 10-second SLS trial, the participant will be given a 60-second break
8. Repeat steps 3-7 for the left leg practice trial while on flat ground
9. For the practice trials on foam board, repeat steps 3-8 with the participant standing on the foam board instead.

SLS Actual Test:

1. After the SLS trial, the participant will be given a 60-second break before commencing the actual test
2. After the participant is prepared, they will begin by performing the SLS test on their right leg while on flat ground. The participant will receive instructions to stand beside the plinth and execute the SLS using their right leg
3. Before the start of the 10-second SLS, the assessor will use a goniometer to measure the participant's hip and knee angles (Figures 6 & 7), ensuring that they are in neutral positions and at 90-degree flexion, respectively
4. Following this, the participant will be tasked to maintain that position for 10 seconds with their hands on their hip and avoid moving them.
5. During the 10 seconds, the assessor will be beside the participant at all times to prevent him/her from falling as shown in Figure 3
6. The participant will then be given a 60-second break
7. After the break, the participant will repeat the procedure two more times
8. Repeat steps 2-7 on the left leg
9. For the actual tests on the foam board, repeat steps 2-8 with the participant standing on the foam board instead.

Things to note during the test:

- If the participant is unable to maintain their balance or loses the standardise hip and knee angles, the EMG results will be excluded and the test will be repeated
- If participants lose their balance, the assessor will support the participant at the shoulder and waist to prevent falls and injuries as shown in Figures 4 and 5.

Figure 2

The plinth will be raised to wrist height



Figure 3

The plinth will be raised to wrist height and placed beside participant



Figure 4

Assessor hand placement, in the event participant falls (Front view)



Figure 5

Assessor hand placement, in the event participant falls (Back view)



Figure 6

Measurement of hip angle using goniometer



Figure 7

Measurement of knee angle using goniometer

