

COMPARATIVE ANALYSIS OF MUSCLE ACTIVATION DURING STANDING AND SEATED CALF RAISES

Aim:

To compare and analyse the activation of Muscles during standing and seated calf raises.

Objectives:

- To investigate and compare the muscle activation patterns in the calf muscles during standing and seated calf raise exercises.
- To understand how body position affects muscle engagement and can guide exercise selection for specific training goals.

Apparatus required:

- Ag-AgCl foam disc-type surface electrode
- Gauze for skin preparation
- Computer
- Biopac Science lab system (MP36 and software)
- MATLAB software

Theory:

We hypothesize that standing calf raises will primarily activate the gastrocnemius muscles, while seated calf raises will engage both the gastrocnemius and soleus muscles due to the differences in body position and ankle movement.

The calf muscle, often collectively referred to as the "calf muscles," includes several individual muscles, but the two primary muscles of the calf are the gastrocnemius and the soleus. Here's an overview of these calf muscles:

The **gastrocnemius** is the larger and more superficial of the two calf muscles. It has two heads, the medial head and the lateral head. The gastrocnemius is responsible for the visible "bulge" in the calf. It originates from the back of the femur (thigh bone) and inserts into the Achilles tendon, which attaches to the heel bone. The primary function of the gastrocnemius is to plantarflex the foot (point the foot downward), and it also assists in bending the knee joint.

The **soleus** is a deeper and flatter muscle located beneath the gastrocnemius. It originates from the tibia and fibula bones (the two lower leg bones) and also inserts into the Achilles tendon, just like the gastrocnemius. The soleus is primarily responsible for plantarflexion of the foot, and it plays a significant role in maintaining posture and balance, especially when the knee is extended.

These two muscles, the **gastrocnemius and the soleus**, are collectively responsible for the strength and function of the calf. Other smaller muscles in the calf include the plantaris, which assists in plantarflexion and flexing the knee, and various deeper muscles that contribute to ankle and foot movements. Together, these muscles work in coordination to allow for various movements of the ankle and foot, as well as providing stability and power during activities like walking, running, and jumping.



Figure (a): Calf Muscles

Method:

EMG electrode placement:

The Signals are attained from the legs of the subject. The criteria for the selection of subjects include healthy and physically active individuals and it is important to ensure participants have no pre-existing lower limb injuries or conditions that may affect the experiment. The alcohol is widely used for cleaning the skin to eliminate wetness or sweat and reduce skin impedance

EMG signal acquisition:

The participants are advised to stand straight on the insulated platform to isolate from the ground. The EMG signals are acquired with the BIOPAC MP36 data acquisition system which is approved by the Food and Drug Administration (FDA). The signals are acquired using standard Ag/AgCl electrodes in bipolar configuration and at the sampling rate of 1 kHz. The electrode locations and the configuration such as inter-electrode distance are set according to the SENIAM recommendations.

Experimental Procedure:

1. Before commencing the experiment, a five-minute rest period is provided to ensure no exertion prior to the experiment. Meanwhile, the protocol is explained to the subject and an informed consent is collected.
2. Before applying electrodes to the subject, it is first important to properly prepare and clean the electrode sites.
3. Let the areas dry before attaching the electrodes.
4. Place EMG electrodes on the gastrocnemius and soleus muscles of both legs. Ensure proper electrode placement based on anatomical landmarks.
5. Place the reference electrode in the bony part of the leg.
6. We should perform both standing and seated calf raise exercises on separate occasions in a random order to avoid fatigue bias.
7. During each exercise, participants will perform 3 sets of maximal calf raises.
8. Record the EMG signals to measure muscle activation patterns during each repetition.
9. Analyse the EMG data to determine the level of muscle activation in the gastrocnemius and soleus muscles during each exercise.
10. Calculate average and peak muscle activation for each muscle in both exercises.
11. Compare muscle activation between the standing and seated calf raises using statistical tests (e.g., paired t-tests).

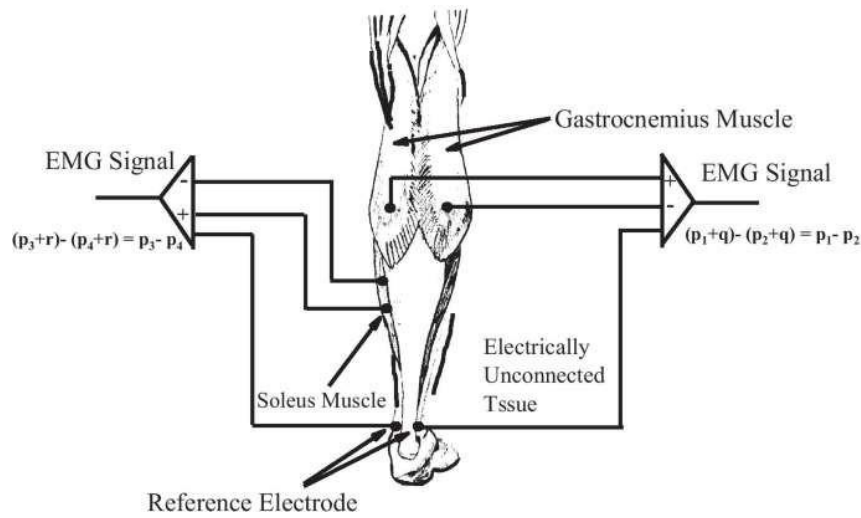


Figure (b): Placements of Electrodes for recording EMG

TABLE 1 (Gastrocnemius Muscle) For Standing position:

SUBJECTS	Peak value		Mean value
Lateral head of Gastrocnemius Muscle	Trial 1	0.4735	0.5559
	Trial 2	0.5133	
	Trial 3	0.6811	
Medial head of Gastrocnemius Muscle	Trial 1	0.5354	0.5020
	Trial 2	0.4235	
	Trial 3	0.5472	

TABLE 2 (Soleus Muscle) For standing position:

SUBJECTS	Peak value		Mean value
Soleus Muscle	Trial 1	0.7875	0.7929
	Trial 2	0.7985	
	Trial 3	0.7927	

Activation ratio = Average Gastrocnemius Mean activity / Soleus Mean Activity = 0.6671

TABLE 3 (Gastrocnemius Muscle) For Sitting position:

SUBJECTS	Peak value		Mean value
Lateral head of Gastrocnemius Muscle	Trial 1	0.3221	0.3498
	Trial 2	0.3517	
	Trial 3	0.3758	
Medial head of Gastrocnemius Muscle	Trial 1	0.1621	0.1467
	Trial 2	0.1459	
	Trial 3	0.1355	

TABLE 4 (Soleus Muscle) For sitting position:

SUBJECTS	Peak value		Mean value
Soleus Muscle	Trial 1	0.1885	0.1958
	Trial 2	0.2015	
	Trial 3	0.1975	

Activation ratio = Average Gastrocnemius Mean activity / Soleus Mean Activity = 1.2896

Expected Outcomes:

Based on the hypothesis, we expect to find that standing calf raises primarily activate the gastrocnemius muscles, while seated calf raises activate both the gastrocnemius and soleus muscles to a greater extent. This experiment will provide insights into the effects of body position on muscle activation during calf raise exercises and help tailor training programs for specific muscle development goals.

Conclusion:

The activation ratios for the two flexor muscles vary between the two different postures during the calf raise exercise.