
Research article

**BIOMECHANICS ANALYSIS ON MUSCLE ACTIVATION
DURING JUMPING JACK EXERCISE**

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Abstract

Journal of Sports Science and Physical Education 6(2): 28-35, 2017 – The purpose of this study was to investigate on muscle activities with electromyography (EMG) during jumping jack activity. The EMG sensors were placed on the interest muscle to measure the activity of gastrocnemius and tibialis muscles during jumping jack. Specific thresholds per muscle were applied on the EMG prior comparison. These thresholds were determined by EMG muscle activity. Overall, visual inspection showed comparable activity patterns. The mean absolute value (MAV) and root mean square (RMS) data were collected to show differences activation of both muscle. The results showed that there are distinct differences between gastrocnemius and tibialis anterior during jumping jack. Based on MAV and RMS data, the activation of tibialis anterior muscle is higher than gastrocnemius muscle during jumping jack activity. This conclude that the tibialis anterior muscle had significantly higher electromyography activity on jumping jack.

Keywords: electromyography, gastrocnemius, tibialis muscles, jumping jack

INTRODUCTION

Jumping jack is a physical jumping exercise performed by jumping to a position with the legs spread wide and the hands touching overhead, sometimes in a clap, and the returning to a position with the feet together and the arms at the sides. The ability to generate maximal strength in short periods of time, called explosive strength, is a critical factor that determines the performance in jump, and the evaluation of this ability is widely used by researchers and trainers through the jump test. The jumping jack is an explosive movement important in many sports (Harman, Rosenstein, Frykman, & Rosenstein, 1990).

Closely associated with the generation of force by a muscle, is the generation of an electrical signal that can be observed by placing electrodes on the skin surface to detect underlying electrical activity displaying the associated waveform on a computer monitor. This process is called electromyography (EMG) and the waveform is the electromyogram. EMG is used to evaluate the muscles stretch during isometric or dynamic exercises, or to determine the degree of fatigue (Clarys and Cabri, 1993).

Previous studies have reported activation of the gastrocnemius and tibialis anterior muscle electromyographic (EMG) activity during jumping. Wallmann, Mercer & McWhorter (2005) carried out a study to investigate the effects of static stretching of the gastrocnemius muscle on maximal jumping jack performance using electromyographic activity (EMG) of the gastrocnemius musculature to record muscle activation during jumping jack performance. The result shows that despite increased gastrocnemius muscle activity, static stretching of the gastrocnemius muscles had a negative effect on maximal jumping performance.

A study carried out by Arabantzi, Papadopoulos, Prassas, Komsis, & Gourgoulis, (2000) to investigate about EMG activation patterns of the lower extremity musculature during drop jumping from different heights. They found that it was concluded that activation patterns of the lower extremity musculature varies when the drop height exceeds certain limits.

Furthermore, Coh et al. (2015) carried out a study to investigate about biodynamic analysis of the kinematic, dynamic and EMG parameters of two types of drop jumps (height 25cm and 45cm). The result shows the greatest activity of gastrocnemius and soleus was noticed in the last third of the take-off action. Significantly high EMG activation of vastus medialis and gastrocnemius was already shown in the flight phase prior to the feet making contact with the ground. The purpose of study was to determine the activation of gastrocnemius and tibialis muscle during jumping jack.

Methodology

Participant

Subject were tested with jumping jack activity on electrode on EMG. Participant used right lower part of leg. None of leg injuries or musculoskeletal disorders were reported by participant within 6 months and were mentally and physically healthy. This study mainly to determine

activation of gastrocnemius and tibialis anterior muscle during jumping jack. The demographic parameters as showed in Table 1.

Table 1: Characteristics of the Participant

Variable	Detail
Age (years)	25
Body height (cm)	169
Body weight(kg)	59

Experiment Set-up

The experiment set-up was designed as shown in Figure 1. The measured subjects performed jumping jacks with the electrodes are stick at their muscles. Participant stand with feet together, knees slightly bent, and arms to sides. Jump while raising arms and separating legs to sides. Land on forefoot with legs apart and arms overhead. Jump again while lower arms and returning legs to midline (test posture). Each jump was repeated three times. To procure EMG signals, surface EMG information were recorded utilizing a Trigno wireless EMG framework such as Delsys. EMG information were gathered from the Tibialis Anterior and Gastrocnemius on the dominant side of leg. Cathodes were situated as follows: for the Tibialis Anterior, 2cm from ankle, and for the Gastrocnemius, instantly 2 cm average to the midline. Information examination was performed using the EMGworks software package (ver. 4.0; Delsys). Crude information from the Tibialis Anterior and Gastrocnemius muscles were changed into root mean square (RMS) information and Mean Absolute Value (MAV). The EMG information were gathered during jumping time of 1.4 s in. For the information examination, we utilized 3 s of the 5 s of EMG information, barring the underlying 1s and last 1s.

Figure 1 : Sensor orientation on subject

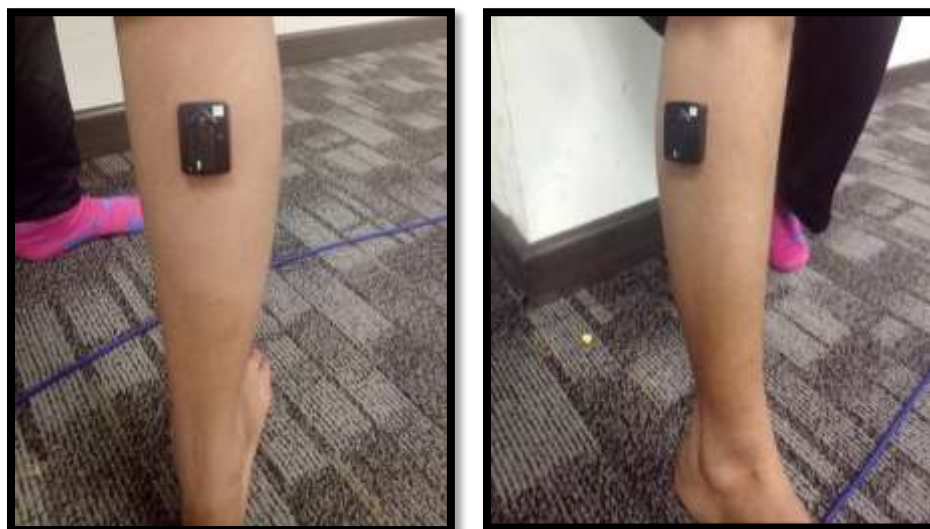
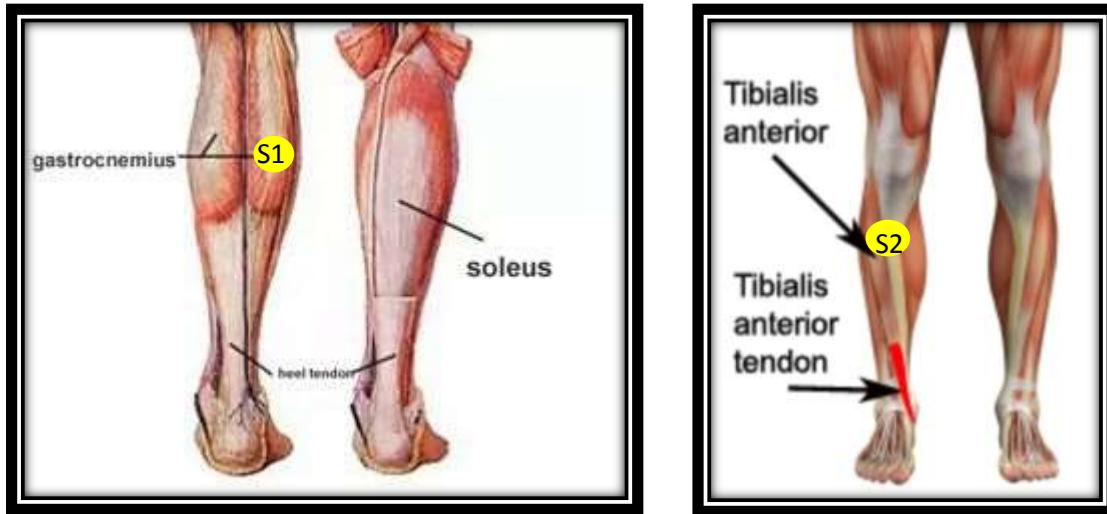


Figure 2 : Sensor location to the muscles



Experimental Procedure

First, participant stand with feet together, knees slightly bent, and arms to sides. Jump while raising arms and separating legs to sides. Land on forefoot with legs apart and arms overhead. Jump again while lower arms and returning legs to midline.

Experiment were performed at room temperature (about 24°C). Participant were asked to wear a short-sleeved t-shirt and track bottom. Jumping jack activity were repeated 3 times with a 1.4s rest between each jump. Test trials were repeated three times, with a rest between trials. The mean values of the normalized EMG activity for tibialis anterior and gastrocnemius were used in the analysis of jumping jack activity. For data analysis purposes, we used 2 of the 3 s of the EMG data recorded for tibialis anterior and gastrocnemius muscle. The window length used is 0.125 with overlap of 0.0625 for the Root Mean Square and Mean Absolute Value (gastrocnemius lateral and tibias anterior) used in this experiment.

Results

The relationship between activation of gastrocnemius and tibialis anterior muscle during jumping jack is shown in Figure 3, the Mean Absolute Value (MAV) is shown in Figure 4(a) and the calculated Root Mean Square (RMS) is shown in Figure 5(a).

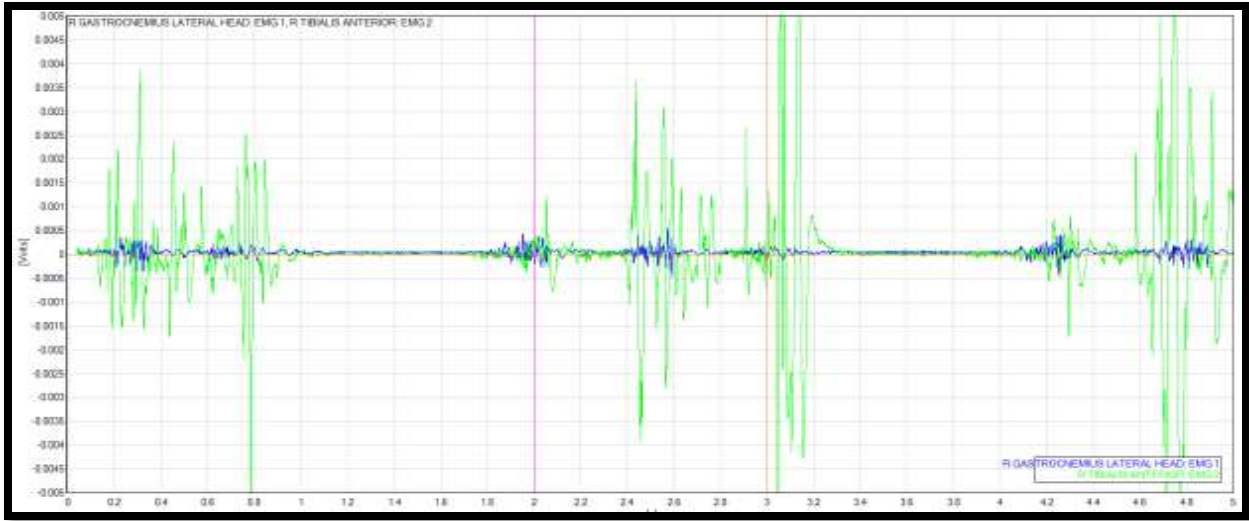


Figure 3: Raw data during jumping jack.

Figure 3 shows that a raw surface recording (sEMG) was done for three static contraction of the gastrocnemius and tibialis anterior. When the muscle is relaxed, a more or less noise-free EMG Baseline can be seen. The raw EMG baseline noise depends on many factors, especially the quality of the EMG amplifier, the environment noise and the quality of the given detection condition. The raw data shows that the activation of tibialis anterior muscle is higher than gastrocnemius muscle during jumping jack activity within 5s. Figure 4(a) shows that Mav data of gastrocnemius and tibialis anterior muscle during jumping jack.

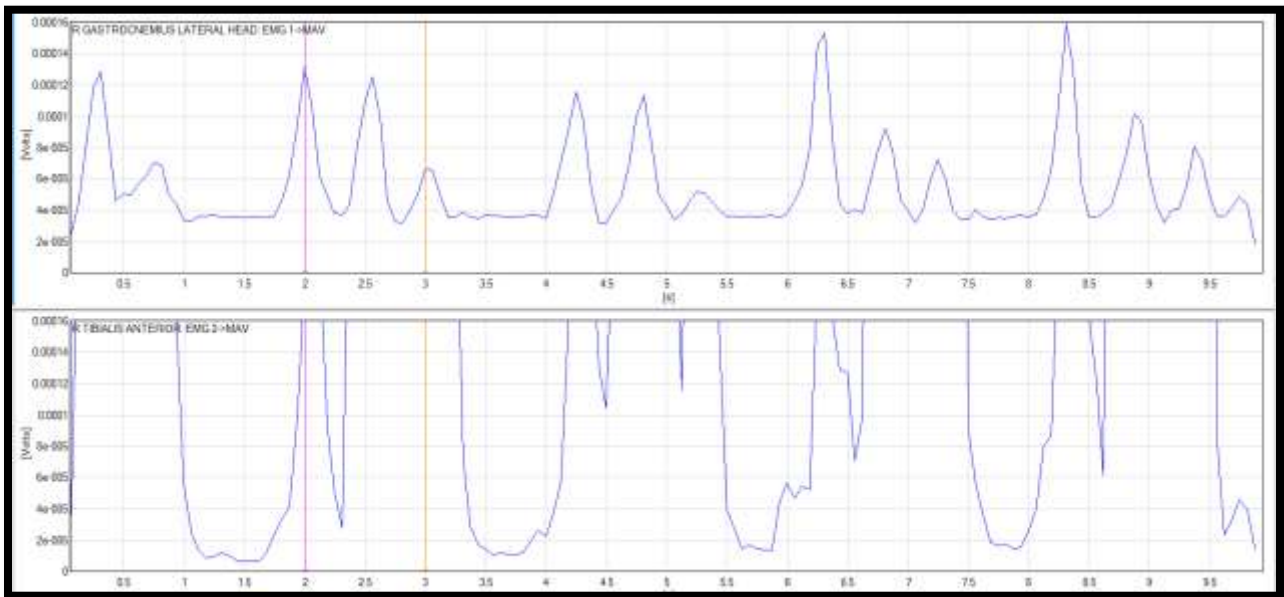


Figure 4 (a): MAV data during jumping jack.

The MAV graph above shows that both muscles are activated during jumping jack activity while tibias anterior muscle is shows that the higher MAV reading compare to gastrocnemius muscle. The overlap data shows in Figure 4(b).

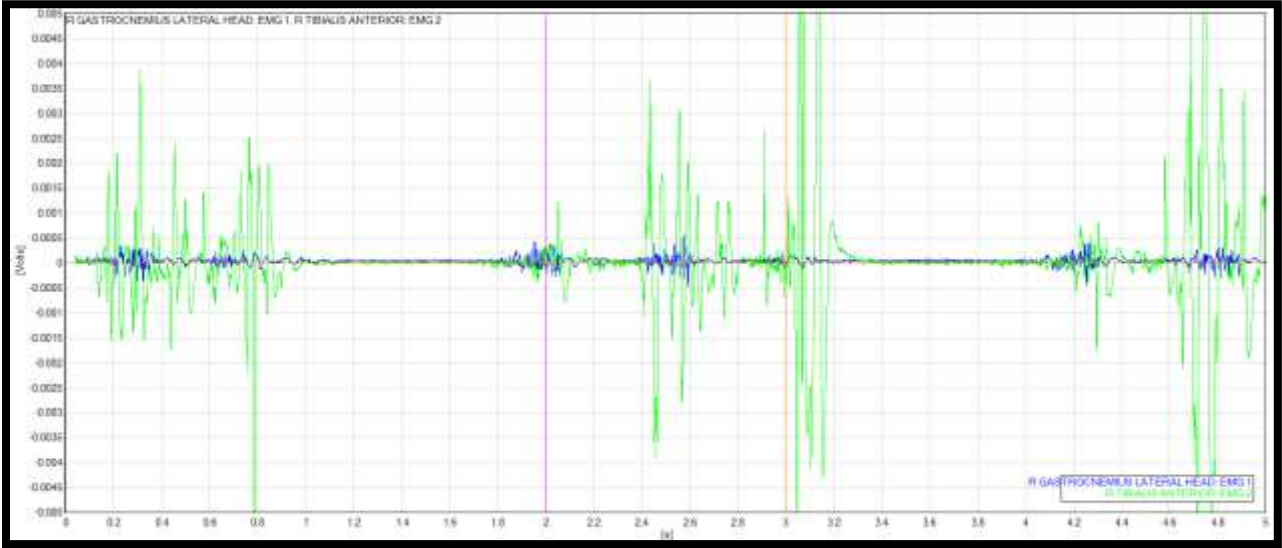


Figure 4(b): Overlap MAV data during jumping jack.

The calculated Root Mean Square (RMS) is shown in Figure 5(a).

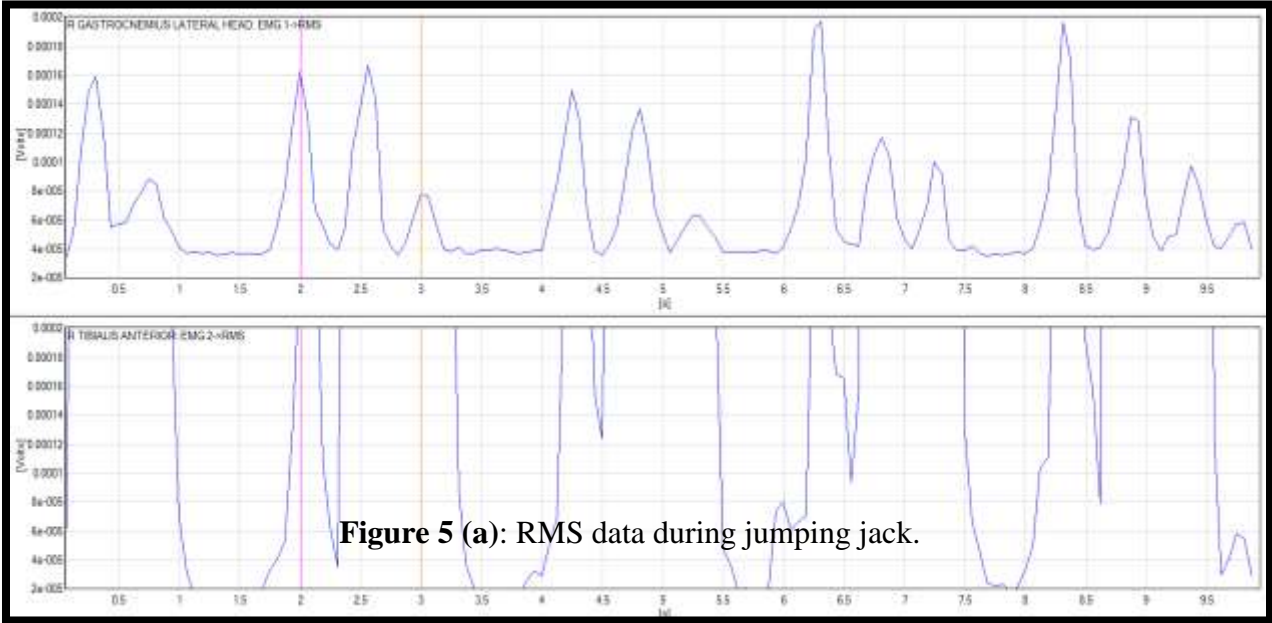


Figure 5 (a): RMS data during jumping jack.

The RMS graph above shows that both muscles are activated during jumping jack activity while tibialis anterior muscle shows that the higher RMS reading compare to gastrocnemius muscle. The overlap data shows in Figure 5(b).

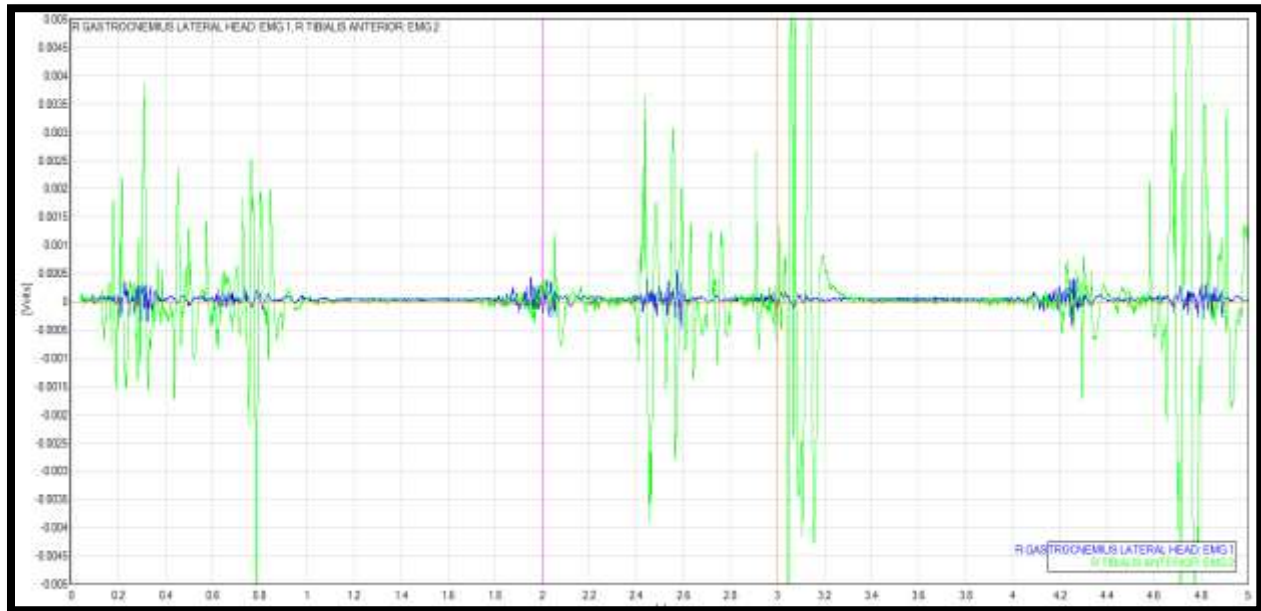


Figure 5(b): Overlap RMS data during jumping jack.

Discussion

Electromyography (EMG) is a non-invasive technique for detecting electrical signals given off during muscle contraction. These signals, on the order of hundreds of mV, are generated by the quasi-random activation of the individual fibers that make up a skeletal muscle. The EMG signal is actually a superposition of the many smaller signals that come from each fibers (Kuriki et al., 2012). During jumping jack activity, two muscles activated such as gastrocnemius and tibialis anterior. MAV and RMS data used to identify the activation of both muscle. The results show that the activation of tibialis anterior is higher than gastrocnemius muscle during jumping jack. This statement supported by Rosen, Swanik, Thomas, Glutting, Knight, & Kaminski, (2013), which stated that have increased EMG activity in tibialis anterior (TA) during jumping jack. These data show the differences of anticipatory muscle activation. In addition, increased EMG activity in the surrounding musculature has been with an increase in jumping. Furthermore, Quartarolo, Yassunaga, Santinha, Gabriel, & Shamus, (2016) also stated that demonstrated an increase of recruitment of the tibialis anterior and the peroneus longus in jumping activity that maybe useful in ankle stability rehabilitation.

Conclusion

In this study, we have explored the relationship between EMG signals and muscle using biomechanical models. EMG signal carries valuable information regarding the both muscle during jumping jack. In conclusion, this study stated that tibialis and anterior muscle activated during jumping jack. However, activation of tibialis anterior is higher than gastrocnemius muscle during jumping jack.

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