PORTABLE AND AFFORDABLE: A COMPACT EMG RECORDER

RAMBARRAN K.K. and ROBERTSON D.G.E.
School of Human Kinetics, University of Ottawa, Canada

INTRODUCTION

In the past, instruments to record electromyography (EMG) data were rather large in size and quite costly. In recent years, portable EMG recorders have become commercially available but their cost ranges in the thousands of dollars. The purpose of this investigation was to determine whether a relatively inexpensive recording device could record EMG data validly and reliably. Surface EMG signals have a frequency spectrum of 5-10 Hz to 400-450 Hz[1,2]. Therefore, it was important that the portable recording device's frequency response be adequate to detect such a spectrum. The *Sony Mini Disk Walkman* ™ (MD, model MZ-R37) reports a frequency response of 20 - 20 000 Hz (± 3 dB).

MATERIAL AND METHODS

To relay the EMG signals to the recorder, it was necessary to produce a signal relay device that included all the required connector types. The input and output ports of the mini disk recorder were mini stereo format. The mega-electrode used a limo connector and the analogue-to-digital converter used BNC connectors. The signal relay box was powered by two 9 V batteries.

The first phase of validation tested frequency response. A *Fluke* Synthesized Signal Generator was used to produce signals with characteristics similar to those of EMG signals. Frequencies of 20, 40, 80, 160, 320 and 400 Hz, with an amplitude of 100 mV were recorded by the MD.

The second phase of the validation tested the recorder's ability to reproduce a range of amplitudes resembling EMG signals. Frequencies of 100 Hz with peak-to-peak amplitudes of 4, 8, 16, 32, 64, 128 and 180 mV were recorded by the Mini Disk. The *BioProc* Software package was used to compare the signals generated by the signal generator to the signals recorded by the MD.

RESULTS

During the frequency response phase of the testing, it was found that the Mini Disk recorder reported an average of 96% of the original amplitude. Because the difference was consistent, at each frequency, it was possible to calculate a scaling factor that reconstructed each respective amplitude. Applying a scaling factor of 1.04 to the mini-disk data restored the amplitudes to those of the signal generator. See Figure 1for normalized amplitudes versus frequencies.

During the amplitude response phase of the testing, it was found that the Mini Disk recorder reported on average 1.03 times higher than the original amplitude. However, using a Pearson correlation, it was found that there was a 0.999 correlation between the Mini Disk data and the original data. It was found that the Mini Disk reported little error between the range of 4 to 128 mV. However, error was greater when reporting the 180 mV amplitude produced by the signal generator. For a relationship between the original signal and the signal reported by the Mini Disk recorder see Figure 2.

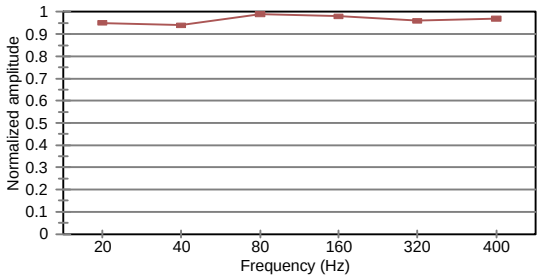

Figure 1. Frequency response of Mini Disk recorder.

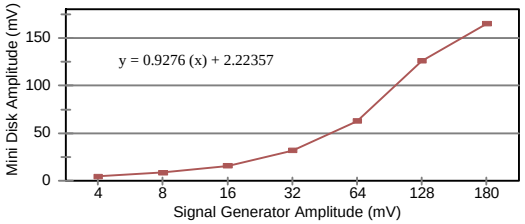

Figure 2. Amplitude response of Mini Disk recorder.

DISCUSSION AND CONCLUSION

The MD demonstrated that it was capable of validly recording the frequency information of EMG signals, however, amplitude information would have to be carefully scrutinized to avoid nonlinearities. Based on the performance of the *Sony Mini Disk Walkman* ™ it can be recommended for use as an inexpensive EMG recording device. The device could be employed in the workplace to record EMG data from two muscle groups (stereo inputs), simultaneously for up to 80 minutes. Multiple trials (up to 256) could also be done but the total recording time cannot exceed 80 minutes. Using such data, it would be possible to perform Fourier analyses to determine the onset of fatigue. The system could also be used to perform amplitude probability distribution functions or to compute integrated EMGs to evaluate hazardous workplace situations.

REFERENCES

[1]DeLuca Carlo (1999) http://www.delsys.com/emg_articles/-EMG.shtml.
[2]Merletti R & di Torino P (1999) *J. Electromyo. Kines.*