

CHARACTERISATION OF THE HOFFMAN REFLEX USING MECHANOMYOGRAPHY

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INTRODUCTION

Mechanomyography (MMG) is a technique for recording mechanical activity in contracting muscle. The MMG signal is low frequency, typically 5-100Hz (Perry *et al.*, 2001). This MMG 'sound' is produced by lateral oscillations of muscle fibres which occur at the resonant frequency of the muscle (Cole and Barry, 1994). The analysis of MMG signals has allowed examination of various aspects of muscle function such as neuromuscular fatigue, muscle fibre type distributions and neuromuscular disorders.

To date, Electromyography (EMG) has been considered the primary non-invasive technique to record and interpret the physiological properties of contracting muscle. The Hoffmann reflex (H-reflex) is the equivalent of the monosynaptic stretch reflex, elicited by electrical stimulation.

The aim of this investigation was to characterise the Hoffman reflex using an MMG system. The system is based on 2-axis MEMS (Micro Electro-Mechanical System) sensors placed on the soleus muscle.

METHODS

The H-reflex can be elicited most conveniently in adults by the electrical stimulation of the posterior tibial nerve in the popliteal fossa. Stimulation was triggered manually in stepped intensities.

This experiment was conducted on an adult male who had both EMG and MMG sensors placed on the belly of the soleus muscle.

Both the sensor and the electrode were placed close together so as to pick up signals from the same muscle contraction area. The x-axis was orientated to pick up lateral movements and the y-axis proximal movement.

RESULTS AND DISCUSSION

The H Reflex was measured simultaneously using EMG and MMG. A sample recording is shown in figure 1. The EMG trace clearly shows both the H Reflex and an M wave response. Note that there is no stimulus artefact evident in the MMG response; an advantage where EMG techniques are not applicable such as functional electrical stimulation studies.

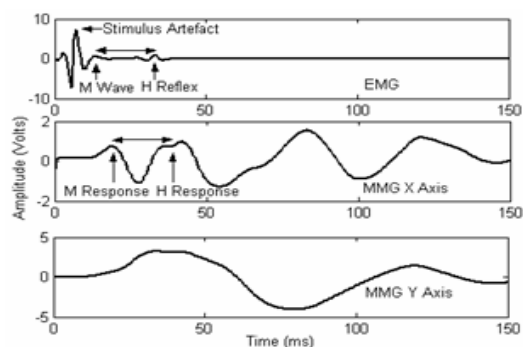


Figure 1: Hoffman response (EMG & MMG).

It is clear that there is a delay between the MMG response and the EMG response. EMG signals are a recording of the motor unit action potentials propagating along the motor units, while the delayed MMG trace is the mechanical response as it builds up as the muscle fibre depolarises (Harba and Chee, 1997).

The latency measured between the H reflex and M wave on the EMG trace is similar to the latency measured between the two responses identified in the MMG x-axis. This is consistent for the duration that events appear in the EMG trace. This would suggest that the EMG and MMG responses share a similar origin.

The acquired EMG recruitment curve is shown in figure 2. While the EMG H reflex starts to roll off due to antidromic activity after 17% stimulation, the MMG responses do not.

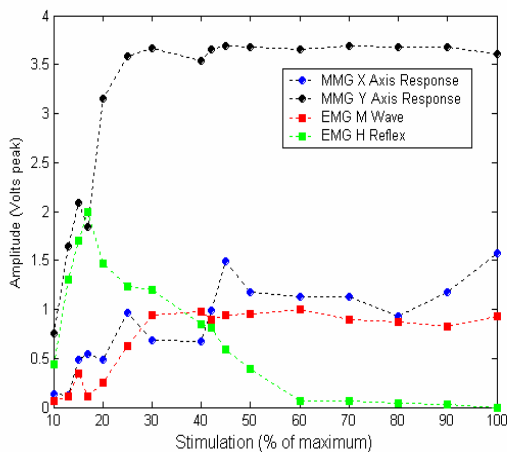


Figure 2: EMG and MMG Recruitment Curve for H Reflex

Note that the MMG x-axis and y-axis trends in the recruitment curve are correlated. The gain on both axes is equal, thus the y-axis demonstrates a response of much greater amplitude. Both MMG responses in figure 2 also appear to correlate with the EMG M response. This is especially evident around

25% stimulation where maximum stimulus is reached.

At lower stimulation intensities those muscle fibres being directly stimulated are furthest from the MMG sensor. It can be observed in figure 3 that as the stimulation increases the latency of the initial MMG response decreases by ~ 34ms. Again, the maximum stimulation is reached at 25%, when all the muscle would appear to have been recruited.

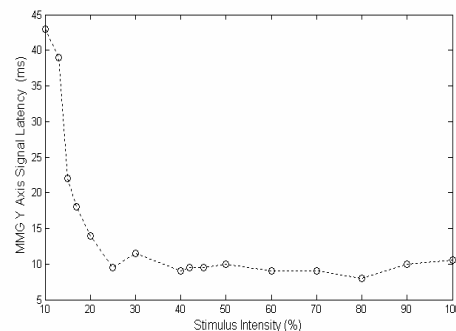


Figure 3: MMG latency compared to Stimulus Intensity

SUMMARY/CONCLUSIONS

This paper outlines a study of the H reflex while recording EMG and MMG signals simultaneously. While the MMG trace is free of electrical artefact there is also evidence that it contains information about the physiological response. The recruitment curve and latency studies provide data that will be used for further studies to investigate their origin.

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