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COMPARISON OF PHYSIOLOGICAL AND SHIVERING TREMOR

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INTRODUCTION

Physiological tremor describes the involuntary rhythmical movements that accompany normal muscle activity and is particularly evident in the limbs. Shivering tremor has been described as cold induced enhanced physiological tremor since it occurs in a similar frequency band. An important difference is the higher degree of organisation evident during shivering. It involves action in muscles unrelated at the segmental level. It is reputed to involve coordinated co-contraction of synergist muscle groups which are originally at rest, whereas significant physiological tremor is only manifest in muscles undergoing tonic contraction such as posture maintenance. Unlike physiological tremor, it is subject to a degree of voluntary control. This report summarises parts of a study comparing the characteristics of the two types of tremor with a view to seeking a common mechanism.

METHOD

Measurement of tremor of the outstretched finger and hand was made from 11 thermoneutral subjects (21-40yr) while seated with the forearm supported up to the carpus by an armrest. Tremor was detected by a calibrated, miniature uniaxial accelerometer (BLA2, Pye Dynamics) strapped to the index finger or middle finger of the splinted hand. EMG activity from superficial forearm muscles (extensor digitorum, extensor carpi ulnaris, flexor carpi radialis, flexor carpi ulnaris) was detected with 9mm Ag/AgCl electrodes. Data were monitored and recorded on time-indexed 8 channel digital magnetic tape (PCM8, Medical Systems Corp; VCR HR-D140, JVC Corp) during successive 4min/2min posture maintenance/rest cycles (signal conditioning - acceleration: in-house bridge/amplifier; EMG activity: Neurolog NL104, NL703, Digitimer Ltd). The amplified signals (bandwidth 1-30Hz) were subjected to both on-line and post-recording spectral analysis (ensemble averaging, analysis bandwidth 50Hz & 100Hz) using a 2 channel spectrum analyser (Model 1201, Solartron Instruments) connected to a personal computer. Initial recordings were made on the unloaded hand and finger to determine the characteristic spectral distribution and amplitude of subjects' tremor. Recordings were also made of bilateral finger tremor. The effect of inertial loading of the hand (0 to 500g weights attached distally) was investigated using a balanced beam mechanism to minimise any changes in muscle tension. In a second experiment, an investigation was made of the influence of changes in muscle tension under constant inertial loading, resulting from maintenance of hand position against a range of forces (0 to 800g wt) induced in a long, vertical elastic cord attached between the hand and a force transducer (Force Gauge, Mecmesin Ltd). Long term (6hr) stability of both loaded and unloaded hand tremor frequency was also determined.

Shivering was induced in 6 subjects using a variety of techniques (cold chamber, T_{db} = 4 to 8°C; liquid conditioned suit, T_{water}=2°C). Subject rectal and skin temperatures were monitored as a safety measure. Using the technique described earlier, shivering tremor acceleration of hand, forearm and upper arm was recorded together with EMG signals from appropriate superficial arm flexor/extensor muscles.

RESULTS

No evidence was found of coherence in bilateral finger tremor, whose spectra showed 2 or 3 characteristic peaks; contamination by hand tremor was negligible. Typical hand tremor spectra displayed one peak in a 6-10Hz band. Increased inertial loading of the hand produced a repeatable decrement in mode frequency but the EMG activity peak frequency remained at that of the unloaded hand. The behaviour was well modelled by a passive mass-spring analogue (Fig 1). In contrast, increases in muscle stiffness at constant inertia produced an increasingly monotonic response, but only a small increment in frequency which did not fit the passive model. Also, unlike the response to modified inertia, there was a high degree of correlation between EMG activity and acceleration at the mode frequency (Fig 2). Long term mode frequency of the unloaded hand tremor was shown to vary by as much as 26%. Repeated force loading at 2hr intervals indicated that at higher loads tremor frequency was more stable.

Shivering tremor of the hand and arm was shown to occur with a peak frequency similar to that of postural tremor, though episodic in nature. Bouts of shivering were invariably associated with an increase in mean EMG activity and muscle tone. Clear differences were evident in the frequency of extensor/flexor EMG activity. Because of the difficulty of isolating limb tremor from that occumng in other regions of the body during vigorous shivering, a mass loading effect was successfully demonstrated in only one subject, which was suggestive of the existence of both a mass-dependent and invariant mode of hand tremor frequency (Fig **3). Bilateral** upper arm tremor occurred at different frequencies and with no coherence.

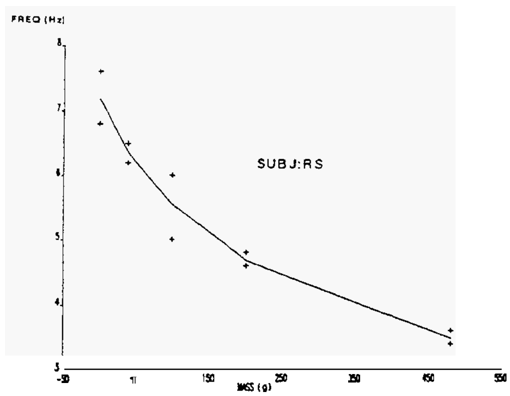

FIGURE 1. Response of hand tremor to inertial loading.

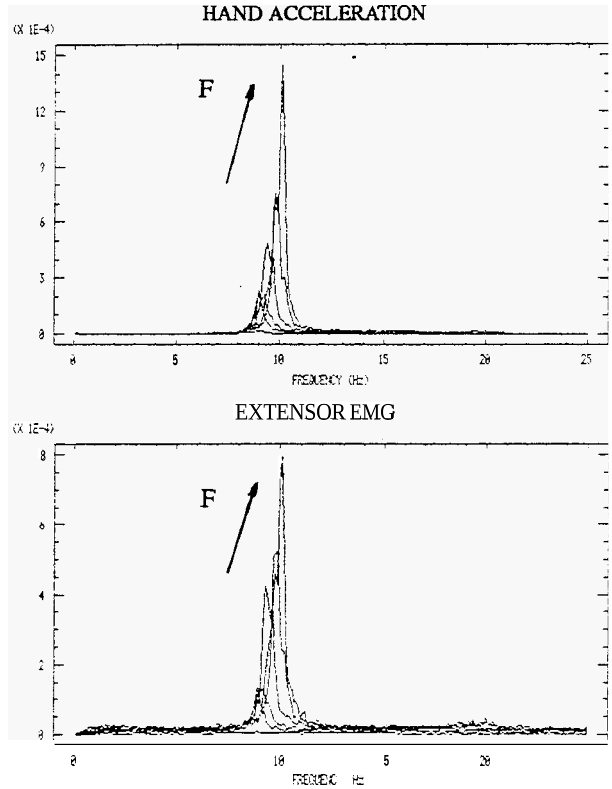

FIGURE 2. Correlated acceleration and emg spectra of hand tremor during force loading.

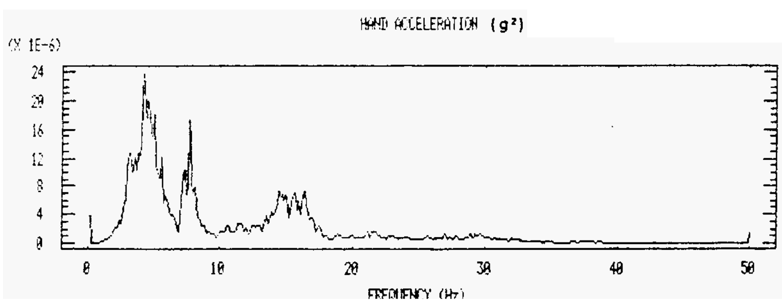

FIGURE 3. Shivering tremor **spectrum** of the hand with 500g added mass.

CONCLUSIONS

The results show that, at increased levels of muscle tone, physiological tremor frequencies become markedly less dependent on the mechanical parameters of the muscle system. Taken together with the increased neural coherence and reduced long term variance, this is suggestive of the appearance of a reflex-determined rhythmicity[1].

There was evidence that shivering tremor resulted from activation of a local myotactic reflex, **similar** to that of enhanced tone physiological tremor. One possible route for this is the gamma innervation and its influence on spindle sensitivity. This study showed that synchronous co-contraction was not universally present during shivering, but **that** an increase in muscle tone was a necessary precursor to episodes of shivering.

REFERENCES

1. Oguztoreli, **M.N.** and Stein, R.B. 1975, *An* analysis of oscillations in neuro-muscular systems, J. Math. Biol 2, 87-105.