Effect of Age on Ocular Microtremor Activity

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Background. Ocular microtremor (OMT) is a high-frequency tremor of the eyes. It is present in all individuals and is related to brainstem activity. The OMT signal appears as an irregular oscillatory movement with intermittent burst-like components. The clinical interest in OMT has centered on its use in the assessment of the comatose patient, with broad agreement among authors of its prognostic value. The purpose of this study was to examine the changes in OMT activity related to aging.

Methods. OMT was recorded from 72 normal healthy subjects using the piezoelectric strain gauge technique. The subjects ranged in age from 21 to 88 years (54.22 ± 20.43 years, mean ± SD).

Results. Our results show that the overall frequency and frequency content of the bursts falls with age (p < .002 and p < .001, respectively). There is a highly significant drop in all three frequency parameters of OMT (p < .0001) in subjects older than 60 years of age.

Conclusions. These results suggest that different values of normality should operate for subjects over 60 years of age when considering the clinical application of OMT.
Subjects under 21 years of age were not studied because of concern regarding informed consent as defined by the Hospital Ethics Committee. All subjects underwent a full history and clinical examination. Exclusion criteria were any evidence or a history of neurological or ocular disease or trauma. All subjects were free of medication. The subjects were 54.22 ± 2.41 years of age (mean ± SD), with a range of 21 to 88 years. The median was 54.50 years, and the mode was 23 years. The subjects were divided by age into seven groups: 21 to 30 years, 31 to 40 years, 41 to 50 years, 51 to 60 years, 61 to 70 years, 71 to 80 years, and over 80 years. Each group contained 10 subjects except for groups 31 to 40 years and 51 to 60 years, which contained 11 subjects each.

OMT was recorded using the piezoelectric transducer technique. The OMT signal is not a completely deterministic signal but has random elements (18). The piezoelectric transducer technique is described in detail elsewhere (13) and provides a reliable estimate of OMT activity (19). Briefly, the piezoelectric element is mounted in a Perspex rod and its tip is coated with silicone rubber. The subject lies supine in a normally lit room looking straight ahead. The probe is lowered so that the probe is just touching the scleral surface. Probe placement is judged by visual inspection and is not generally checked by means of restraint are used.

The signal from each probe is passed to a conditioning unit and amplifier with a 40-dB common mode rejection ratio. The signal is then stored on audio tape using an adapted Sony Walkman without automatic gain control. The tape is later played back and analyzed on an ECG tape analyzer (Reynolds Medical Pathfinder 3 and a Reynolds Medical Thermal Printer). This system shows a frequency response between 20 and 150 Hz, which deviates less than 2 dB from peak response. The system filters out inputs below 20 Hz, in particular any drift movements. Microsaccades cannot be dealt with as easily because the frequency content of microsaccades overlaps that of OMT (12). Microsaccades occur only intermittently. They are excluded by examining the intervening record during analysis. The system has a signal-to-noise ratio of >23 dB, and the resolution is less than 1% of the dynamic range, or 12 nm.

**Record Analysis**

The peaks occurring per unit time on a printed record are counted. This provides a good estimate of the high-frequency component of any random signal (20), particularly OMT (13).

Peak counting is also the method of obtaining frequency information favored by Coakley (17) who, to date, has published the largest series on OMT.

The parameters measured were (Figure 1):

1. The overall frequency (Hz)
2. The number of bursts occurring per second, calculated by counting the number of bursts in the record and dividing by the record duration.
3. The duration of bursts (milliseconds), calculated by estimating the total duration of record occupied by bursts and dividing by the number of bursts.
4. The percentage of record occupied by baseline (%), calculated as the total duration of baseline divided by the record duration \( \times 100 \).
5. The frequency content of bursts (Hz), calculated by peak counting over the total duration of bursts in a record.
6. The duration of baseline (milliseconds), calculated by taking the total duration of baseline and dividing by the number of baseline segments in any given record.
7. The frequency content of baseline (Hz), calculated by peak counting over the total duration of baseline segments (16).

A least-squares linear regression correlation coefficient was calculated for each parameter. A further comparison was made between subjects younger than 60 years of age and those older than 60 years of age.

**RESULTS**

**Linear Regression**

The values for linear regression correlation coefficient and age are given in Table 1, which shows that two parame-
ters of OMT activity are significantly correlated with age. The overall frequency of OMT is negatively correlated with age, tending to fall in older age groups. Although the correlation coefficient is small at −0.36, it is highly significant ($p < .002$) (Figure 2).

The strongest correlation is that between the frequency content of bursts and age. Once again the correlation is negative, with the frequency tending to fall with age. The value of $r$ is −0.53 and is highly significant ($p < .001$) (Figure 3).

All of the remaining parameters except duration of bursts are negatively correlated with age, but not significantly.

None of the mean values for each parameter for each age group differed significantly from each other (multiple group comparison and ANOVA). However, there was a tendency for the overall frequency, baseline frequency, and frequency content of burst to fall with age.

Figure 2. Age versus ocular microtremor frequency (Hz).

Figure 3. Age and frequency content of bursts (Hz).
Subjects Younger and Older Than 60 Years of Age

Table 2 gives the mean value for each parameter for each group. There is a highly significant drop in the overall frequency, the frequency content of the baseline, and the frequency content of the bursts in subjects older than 60 years of age ($p < .0001$). There is no significant change in the other parameters.

### DISCUSSION

These results indicate a tendency for two of the three frequency parameters of OMT (i.e., the overall frequency and the frequency content of the bursts) to fall with advancing age. Although the strength of the correlation for overall frequency is small ($r = -0.36$), it remains significant ($p < .002$). The negative correlation between the frequency content of the burst and age is stronger ($r = -0.534$). In subjects older than 60 years of age there is a significant fall in all three frequency parameters of OMT activity (i.e., the overall frequency, the frequency content of the baseline, and the frequency content of the bursts). In each case the difference is small, about 5.3 Hz for overall frequency, 9.1 Hz for baseline frequency, and 5.2 Hz for frequency content of bursts. However, all these differences are significant.

However, a previous study by Coakley (17) compared OMT in 26 young adults and 15 subjects older than 70 years of age. He could find no significant change in OMT frequency associated with age. This could be explained by the small number of subjects studied. The analysis of the microtremor record in this study was based on velocity rather than on displacement waveforms, as in our study. Velocity against time analysis will enhance the contribution of higher-frequency components to the overall measured frequency.

A significant change in frequency of either bursts or the baseline will have a concurrent effect on overall frequency, as we have seen. However, the other parameters studied are also affected by age, although not significantly. This would suggest that the overall pattern of OMT activity is not affected significantly by age but that the firing frequency of the extracocular motor neurones that lead to bursts are. These findings are consistent with other noted changes in the ag-

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