Canadian Journal of
Neurological Sciences
Journal Canadien des
Sciences Neurologiques

Original Article

Detection of Atrial Fibrillation in Routine EEG Recordings

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Abstract: *Background:* A one-channel electrocardiogram (ECG) channel is recommended during electroencephalogram (EEG) recordings principally to help establish ECG or pulse wave contamination of the ECG EEG. However, the ECG recording, in itself, provides useful clinical information, principally the detection of arrhythmias, especially atrial fibrillation (AF), which indicates heart disease that can predispose to embolic stroke and systemic embolism. We sought to determine the prevalence of AF routine recordings in our EEG laboratory in a general hospital. *Methods:* We reviewed the consecutive EEG reports for the past 7 years to determine how often AF was detected in various age groups. *Results:* We found AF in 0–0.2% per decade of life until age 60–69 years, 2.7% for 70–79 years, 5% for 80–89 years, and 8% for 90–99 years. *Conclusion:* We suggest that the ECG trace should be carefully analyzed for AF, especially in patients over 60 years of age. When detected, it should be brought to the referring doctor's attention.

Résumé : **Détecter la fibrillation auriculaire dans des enregistrements électroencéphalographiques de routine**. *Contexte :* Un canal unique d'électrocardiogramme (ECG) est recommandé dans le cas d'enregistrements électroencéphalographiques (EEG), et ce, principalement afin d'aider à établir l'ECG ou encore la contamination par onde pulsatile des enregistrements EEG. Cela dit, les enregistrements de l'ECG fournissent en soi des renseignements cliniques utiles, notamment la détection d'arythmies, des fibrillations auriculaires (FA) par exemple, lesquelles indiquent une maladie cardiaque pouvant prédisposer à un AVC de nature embolique et à une embolie systémique. Nous avons donc cherché à déterminer la prévalence d'enregistrements de routine de cas de FA dans notre laboratoire d'EEG situé dans un hôpital général. *Méthodes :* Nous avons passé en revue les enregistrements consécutifs d'EEG produits au cours des sept dernières années en vue de déterminer à quelle fréquence des cas de FA étaient détectés parmi différents groupes d'âge. *Résultats :* Nous avons identifié des cas de FA dans 0 à 0,2 % des enregistrements par décennie de vie, et ce, jusqu'à l'âge de 60 à 69 ans. Cette fréquence était de 2,7 % pour les 70 à 79 ans, de 5 % pour les 80 à 89 ans et de 8 % pour les 90 à 99 ans. *Conclusion :* En somme, nous suggérons que les enregistrements de l'ECG devraient être soigneusement analysés pour des cas de FA, particulièrement dans le cas de patients âgés de plus de 60 ans. Une fois détectée, une telle arythmie devrait être portée à l'attention d'un médecin traitant.

Keywords: Atrial fibrillation; Electrocardiogram; EEG

Both the American Clinical Neurophysiology Society[1] and the Canadian Society of Clinical Neurophysiologists[2] recommend that a single channel electrocardiogram (ECG) should be included as an extra channel of the electroencephalogram (EEG) recording, principally to detect contamination of EEG by apiculate waveforms, pulse artifact, or movement artifact.

However, another value of recording and interpreting the ECG, as part of the EEG record,[3] is the detection of arrhythmias, notably atrial fibrillation (AF)[4] and pauses, as might occur in sick sinus syndrome or conduction block, which may be relevant in the differentiation of syncope versus seizures.[5]

The detection of AF is of great clinical importance.[6] AF is the commonest cardiac arrhythmia in the general population, and it frequently indicates underlying heart disease and poses an important risk for cardiogenic stroke, other systemic embolism, myocardial infarction, heart failure, and increased mortality.[7,8] Recognition of AF and consequent appropriate therapy can prevent or ameliorate much of its associated morbidity and mortality.[9,10]

The incidence of AF is age-dependent, with an abrupt increase after age 65, rising to over 10% of persons over 80 years.[11] AF can also occur in young adults, especially in those with hypertension, hyperthyroidism, valvular heart disease, and with lifestyle factors such as smoking and abuse of alcohol and recreational pharmaceuticals.[12] Therefore, special attention is needed to record and accurately interpret the ECG channel in high-risk groups.

We undertook a review of the prevalence of AF as recorded and interpreted, as part of the EEG report, by GBY in over 4500 records
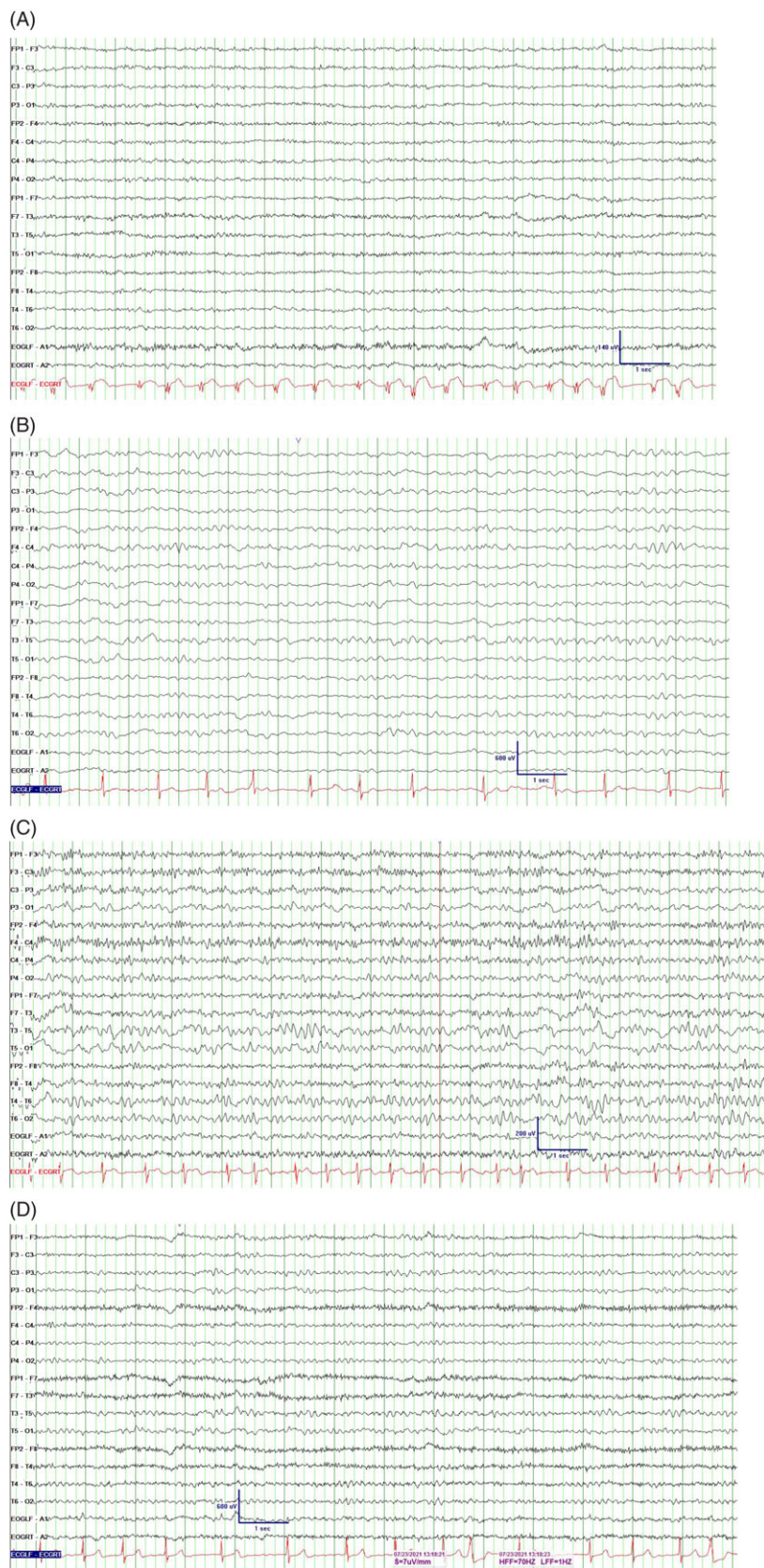
FIGURE 1: (A) is a recording from an 81-year-old man who developed encephalopathy while in hospital. The recording is of low voltage showing a predominance of beta activity and some electrode artifacts related to perspiration. The ECG channel shows atrial fibrillation with a minor interventricular conduction defect. (B) is from an 89-year-old woman with impaired consciousness. The EEG shows diffuse slowing and ECG channel shows atrial fibrillation with an ectopic beat. (C) is of an 89-year-old woman with "confusion." There is excessive beta activity and slowing in the delta range in the left posterior head. The ECG channel shows rapid atrial fibrillation. (D) is of an 82-year-old man with abnormal mental status. There is intermittent focal slowing in the left posterior head. The ECG shows atrial fibrillation with occasional premature ventricular beats.
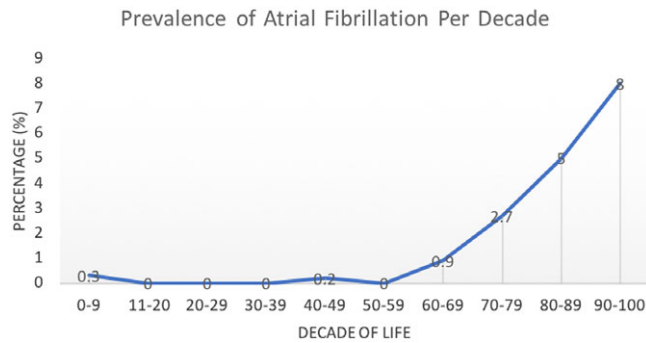
FIGURE 2: The percentage of atrial fibrillation per decade.

from our EEG laboratories over 7 years. The purpose was to show the prevalence of AF in various age groups in patients referred to a community EEG laboratory in Canada.

Table 1: Prevalence of atrial fibrillation in each decade

Decade (age)	Total number of EEG reports	Number of atrial fibrillation incidences	Prevalence of atrial fibrillation in population (%)
0–9	347	1	0.3
10–19	509	0	0
20–29	528	0	0
30–39	424	0	0
40–49	450	1	0.2
50–59	690	0	0
60–69	674	6	0.9
70–79	519	14	2.7
80–89	325	16	5
90–100	62	5	8

Methods

All recordings were done with Natus EEG technology, with 18 channels of EEG and 1 ECG channel (long lead I) recording with a sampling rate of 240 Hz/channel and low and high frequency filter settings at 1 and 70 Hz, respectively. Recordings were 20 min in duration.

The study size of 4529 EEG reports included patients from 0 to 100 years of age, with the first EEG report dating back to early 2013. These included consecutive reports over 7 years reported by GBY. Only one recording per patient was considered. The EEG reports were reviewed, rather than the actual traces. Several recordings were reviewed to select suitable figures for the paper. Grouping of the reports was made based on the decade of age at the time of the EEG recording. For each report, age, gender, and occurrence of AF were noted. With the grouping of the reports based on the decade established, the number of patients noted to have AF was determined and calculated as an overall percentage of each age category.

AF was diagnosed when there were no "p waves" in the ECG trace and the R−R interval was irregularly irregular, compatible with ACC/AHA Guidelines.[13] Atrial flutter was included as AF, as their clinical significance is similar and the two rhythms often occur in the same individual.[13] Examples of recordings showing AF/atrial flutter are shown in Figure 1.

Results

The 7-year spread of EEG reports comprised 4529 patients, 43 of whom had AF. As shown in Table 1, there were a total of two cases of AF between the ages of 0 and 60 out of a total of 2948 EEG reports. The remaining 41 cases of AF were seen in patients above the age of 60, out of the remaining 1580 reports (Figure 2). Of the 43 patients with AF, 29 were male and 14 were female. Note that the female to male ratio increases in older age groups (Figure 3).

Overall prevalence of AF in each grouping of decade is shown in Table 1 and Figure 2. Throughout the first 60 years of life, there is an insignificant prevalence of AF, with a couple of cases in a few of the decades. However, it is seen that past the age of 60, the prevalence of AF rises almost exponentially. The initial notable change in prevalence is seen in the rise from 0% to 0.9% between the (50s) and (60s) age grouping. This figure continues to increase, eventually reaching a value of 8% prevalence in the 90–100 age category.

The most significant increase of AF prevalence is noted in the rise from the 60–69 to the 70–79 age group, with a 200% increase in
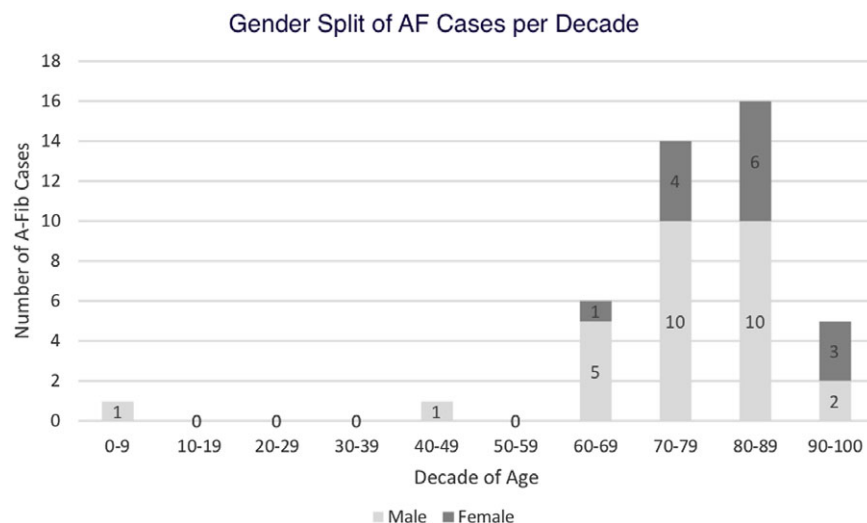

FIGURE 3: The number of cases AF per decade as related to gender.

the 70s decade compared to the 60s decade. However, the decades onwards demonstrate a slower rate of growth with an 85% increase from the 70s to the 80s, and a 60% increase from the 80s to the 90s.

Discussion

Our study confirms the previously noted age dependency of AF in the population.[14] In our study, 1.14% of patients over 20 years of age had AF, similar to 1.12% found in a large prevalence study of the US population, which also showed an exponential rise after age 60 years.[15] Another survey of 8.3 million German patients with insurance claims found a higher prevalence of 2.132%, with a similar rise with age over 70 years and gender breakdown, but this population was more selective and included multiple sampling times.[16]

The finding of AF in routine EEG recordings is more than doubly important, as older patients often have other comorbidities, such as hypertension, congestive heart failure, diabetes mellitus, and prior stroke or transient ischemic attack, which further increase the risk of stroke.[17] AF carries a 4 to 5-fold increase in the risk of ischemic stroke, even in the absence of comorbidities.[18] In patients over 70 years of age, the average risk of stroke/year is about 3.5%, but the risk can vary by 20 times with comorbidities.[18] AF occasionally occurs in individuals under 35 years of age, with or without comorbidities or structural heart disease, with about a 4.5% overall risk, over time, of stroke, or systemic embolism.[19] Once found the risk of stroke can be markedly lowered by the use of anticoagulants, especially the newer oral anticoagulants, and optimal control of comorbidities.[20]

We found AF to be twice as common in men than women, a higher male:female ratio than in other publications.[21–23] This may reflect the fact that we had relatively fewer patients in the >80-year age groups, as in advanced age the rate of AF increases more for women than it does for men and more women than men survive into advanced age.[19]

Limitations

Our study has obvious limitations: it is retrospective and involves a single EEGer supervising two laboratories. The number of patients with AF per decade is small, but this reflects the frequency in the population. It is possible that some cases of AF were missed, for example, if portions of the ECG trace could not be seen and if the AF were truly paroxysmal.

Conclusions and Recommendations

The ECG channel provides useful information in itself, especially for the detection of AF. Thus, the finding of AF is of great importance to the referring physician, and it is vitally important for the EEGer to draw attention to the finding of AF in the report. This should prompt the referring doctor to confirm the findings with 12-lead ECG or Holter monitoring and initiate further investigation and treatment or appropriate referrals, even though the detection of AF is peripheral/incidental to the reason for the EEG request.

While our project was focused on the detection of AF, the ECG channel (most commonly a long lead I) may also show problems in cardiac conduction, such as sinus pauses or heart block, as well as abnormal rates, which may be clinically relevant. It is extremely important that EEGers pay close attention to the ECG trace and to be familiar with the common rhythm disturbances and comment on them when they are found.

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