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A Review Study on The Analysis of BRUXISM using EEG Signals

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Abstract: In this paper we are working on a brief literature review of bruxism using EEG signals. The Bruxism is a para function, which is an activity that has no utility for the organism.The Electroencephalogram (EEG) is one of the useful bio signals to detect the bruxism.Electroencephalography (EEG) enlighten about the state of the brain i.e. about the electrical bustle going on in the brain. The electrical activity measured as voltage at different points of brain act as basis of EEG. These signals are generally time-varying and non-stationary in nature. These signals can be scrutinized using various signal processing techniques. Generallythe EEG data has been collected from Physio Net database**.**The new detection method can provide clinical support diagnosis of bruxism. These signals can be scrutinized using various signal processing. It is the habitude of tightening and of gnashing one's teeth unconsciously.

Keywords: EEG, Bruxism, Biosignals, EMG.

I. INTRODUCTION

Bruxism is a disorder characterized by grinding or jaw clenching of teeth during sleep [1]. It is an uncontrollable parafunctional activity, which means it istotally irrelevant to normal function like eating or talking. Bruxism is a common oral parafunctional activity found in human or may be animals, according to the reports of prevalence range from 8–31% in the general population [2]. A common symptoms associated with bruxism, including hypersensitive teeth, aching jaw muscles, dull headaches, tooth wear, and damage to dental restorations (e.g. crowns and fillings) to teeth and other stress related habits include smoking, drinking alcohol

[3].Most are unaware that they suffer from bruxism or grinding of teeth, but symptomsmay be minimal, without patient awareness of the condition. Dental attrition is a type of tooth wear caused by tooth to tooth contact [4], resulting in loss of tooth tissues. The pathological wear of tooth surface can be caused by bruxism. Figure:1 shows the typical appearance of attrition.

Fig.1: Typical appearance of attrition[1]

There are two forms of bruxism. First one is sleep bruxism and second is awake bruxism. Dental damage occurs in both type of bruxism, but the symptoms of sleep bruxism tend to be desirable during sleep and better during the course of the day and the symptoms of awakebruxism may not be present during sleep and then desirable over the day. Sleep bruxism is considered as sleep related disorder such as clenching or grinding teeth during sleep, snoring and pauses in breathing, which is also called sleep apnea.Awake bruxism may be due to emotions such as anxiety, stress, anger, frustration or tension. The exact causes of bruxism are not completely understood, but it may be due to a combination of physical, psychological and genetic factor [5]. According to a survey it is found that, awake bruxism is mostly common in females, whereas males and females are equally affected by sleep bruxism [6]. The Electroencephalography (EEG) is one of the useful bio signals to identify the sleep disorder. EEG is a physiological method; it records all of the electrical activity of the human brain from electrodes which are placed on the scalp surface. For rapid application, electrodes are mounted in elastic caps similar to bathing caps, to make sure that the data can be collected from identical scalp positions across all respondents. An electroencephalogram (EEG) is a non-invasive test that records electrical patterns from the brain. EEG testing is used to help diagnose conditions such as seizures, epilepsy, head injuries, dizziness, headaches, brain tumours and sleeping problems. Brain death is also confirmed from EEG signal.

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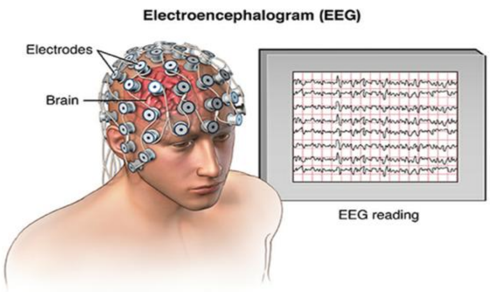

Fig2:Electroencephalogram (EEG)[2]

An electroencephalogram (EEG) is a test, which records the electrical activity from the brain. Brain cells are communicating with each other by electrical impulses. An EEG can be used to help detect potential problems associated with this activity. An EEG also tracks and records brain wave patterns.

II. RELATED APPROACH

Acquisition and analysis of Electromyograms of the human masseter muscle was analysed by **J.L. Ruhland (1988)[7].**His work aim to report the electro myograms from the human masseter muscles of a randomly sampled population were obtained to determine if there was a signal characteristic of these EMC's which could be used to accurately distinguish among the signals generated for some related mechanical activities. A custom designed variable gain EMC preamplifier/signal conditioner was constructed to sense and amplify the signals which were digitally sampled, stored, and analysed. Various time and frequency domain characteristics were estimated and equivalence tests were performed on combinations of the power spectra. Distinctions in the characteristics of different activities on the whole were not clear-cut. However, it was found that the spectra for clenching and chewing activities of the dysfunctional persons in the test group were measurably different from the average statistics of the group. It was found that for the individual data records, definite upward trends in signal strength and mean frequency were apparent for the clenching activity when compared to the other three activities. However, neither of these characteristics were significantly different among the four activity types to facilitate accurate detection of bruxism; that is, the standard deviations for the group of individual statistics were too disperse. The majority of the individual normalized spectra for a given actively tested equivalent to each other at the significant level could be pooled. The spectra which did not test equivalent to the majority were those obtained from the diagnosed and potential bruxers, particularly for the clenching and chewing activity types. This suggests that spectral techniques could be used to detect or evaluate para functional activity in individuals. While the pooled spectra again demonstrated an upward shift in the mean frequency for clenching the equivalence tests performed among the pooled spectra for the four activities indicated that the difference was not statistically significant to allow accurate detection of bruxism.

Christopher J. James and David Lowe(2000) [8],Their work aims to isolate seizure activity in the EEG using independent component analysis. A number of seizure segments from various patients are extracted from the EEG recorded in an Epilepsy Monitoring Unit. We use the method of Independent Component Analysis OCA in order to decompose the recorded scalp EEG into its underlying temporal and spatial components. Seizure-related activity in the independent components is identified by first performing a dynamical embedding on each component. Through a value linked to the dynamic complexity of the EEG segments it is possible to visually analyse the spatiotemporal components. In this proof of principle study, in seizure EEGs analysed we can identify what appear to be the relevant seizure components-there is more than one in each case. We identify seizure related activity by choosing those temporal components that depict a decrease in complexity around seizure onset, coupled with focal activity in the region grossly identified as being the origin from the raw scalp EEG. In addition to seizure related components, art factual components are also adequately isolated by ICA. Decomposing the EEG in this way means that the scalp EEG can either be ‘remapped' using only the identified seizure components, or further in depth analysis on the seizure can be undertaken on the spatio-temporal components directly. Although subjective, these preliminary results indicate that ICA coupled with complexity analysis may be beneficial in processing the epileptic form EEG prior to further in-depth analysis. This preliminary study has shown that it is feasible to use ICA to isolate seizures from a mixture of epileptic and background activities. The use of a complexity measure helps in determining the appropriate seizure components. The strong focal nature of the resulting field distributions of the epileptic components suggests that the estimated spatial components could be used to estimate generator sources. More investigation is warranted to examine the relevance of the multiple independent components related to seizure activity; are the multiple components a product of the ICA algorithm or are they due to separate cerebral activity contributing to the overall seizure development, In

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spatiotemporal source modelling, physiological noise (i.e., the background activity) misleads the computational process. We suggest that applying source modelling to the field distribution of the seizure components isolated by ICA might be better than applying the source analysis to the original EEG data which is heavily, and unavoidably, contaminated. The major drawback of using ICA could be the (in) appropriate choice of the relevant components. In this preliminary study we use the subjective method of looking at both the temporal and spatial components and by looking at the dynamic complexity, given our prior knowledge that the seizure onset occurs roughly mid-way through the data. A method allowing a more objective choice of the relevant seizure components is the focus of our next study. We conclude that ICA could be an invaluable tool in the analysis of the epileptic form EEG and we plan to pursue this study with more real epileptic form data and to perform source analysis on the extracted components allowing us to further corroborate contrast our findings with spatiotemporal source analysis methods.

Multi-sources data analysis with sympatho-vagal balance estimation toward early bruxism episodes was detected by**Pawel S Kostka and Ewaryst J Tkacz (2015) [8]**, Sleep bruxism events detection system is presented, based on integrated, synchronized on-line analysis of EMG signal, heart rave variability (HRV) obtained from ECG recordings as well as sympatho-vagal balance estimated in real time as an possible early indicator of upcoming bruxism episodes. As a relative reliable alternative for very complex systems, only for clinical environment usage with audio and video recordings a pilot study toward elaboration of compact, comfortable for home usage device with early bruxism detection algorithms was carried out, preliminary tested on 10h sleeping registrations from group of 12 patients, clinically characterized by experts as Bruxers. As a result a set of decision rules regarding simultaneous monotonic increase of heart rate with significant increase of EMG signal amplitude during bruxism episode was elaborated.

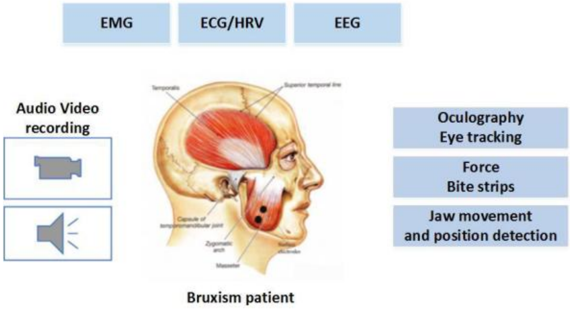

Fig3:Different data sources and signals used for bruxism detection.[4]

But a most promising observation, which can be useful for earlier prediction of upcoming bruxism episodeseems to be a monotonic increase of LF/HF ratio in HRV power spectrum components, expressing sympatho-vagal balance of autonomous nervous system, which according to our assumptions take basic low level role in bruxism phenomena trigger and control. The occurrence of sleep bruxism can be identified during awake and sleep stages by using multiple physiological measurements supplemented with audio and video recordings while clinical investigation in special prepared sleeping rooms. Diagram showing integrated sources of data presented in literature for bruxism episodes detection and analysis is presented in fig.3.. Value of this parameter known, as a good parameter of many hidden for direct measure in central nervous system regulations as can be seen in table 1 increase in several minutes before SB occurrence.

TommasoCastroflorioet.al.(2013)[9]Worked on the use of electromyography and electrocardiographic signals to detect sleep bruxism episodes in a natural environment. Diagnosis of bruxism is difficult because all masticatory muscles doesn't contract during sleeping are bruxism episodes. So, both EMG and ECG signals are proposed for the detection of sleep bruxism. For this detection data have been acquired from 21 healthy volunteers and 21 sleep bruxers. The masseter surface EMGs were detected with bipolar concentric electrodes and the ECG with monopolar electrodes located on the clavicular regions .Recordings were made at the subjects' homes during sleeping. Bruxism episodes were automatically detected as characterized by masseter EMG amplitude greater than 10% of the maximum and heart rate increasing by more than 25% with respect to baseline within 1s before the increase in EMG amplitude above the 10% threshold. Furthermore, the subjects were classified as bruxers and non-bruxers by a neural network. Their analysis shows the number of bruxism episodes per night was 24.6 ± 8.4 for bruxers and 4.3 ± 4.5 for controls (P<0.0001) and the classification error between bruxers and non-bruxers was 1% which was substantially lower than when using EMG only for the classification. These results show that the proposed system, based on the joint analysis of EMG and ECG, can provide support for the clinical diagnosis of bruxism. They have proposed a method for the automatic diagnosis of bruxism based on the analysis of bilateral EMG and ECG signals. The approach provides good classification results according to the SB/DC. The signals were recorded in a natural environment with a portable device. With respect to other portable EMG devices, the system used allows recording the masseter contractions of both sides together with the hearth rate. The joint information on EMG activity and HR provides classification results substantially better than when using EMG alone. It can be said that the system proposed (portable device and signal processing) could be useful as a screening test for those subjects referring to the dental office with signs and symptoms of SB.

Detecting Sleep Disorders based on EEG Signals by Using Discrete Wavelet Transform was analysed by **T.V.K.H. Rao et.al (2014)[10].** They attempts to detect sleep disorder by using EEG signals with discrete wavelet transform (DWT).For this purpose, the Physio Net data was taken as standard data for healthy subject and particular sleep disorder. DWT transform was applied to these EEG signals and db4 is used for decomposing the EEG signal to get wavelet coefficients. After getting this the extracted features were calculated from wavelet coefficient. In this case the energy, variance, waveform length and standard deviation have been taken as the extracted features which strongly verify the deviation of different sleep disorders in the time-frequency analysis which is not possible with the other nonlinear techniques. We can able to give the signature to the particular sleep disorders and classify these disorders among different EEG signals according to the feature extraction with statistical measures. Thus, the time frequency resolution obtained by DWT gives a good detection of sleep disorders. Characterization of the occlusal splints using optical Fibre sensors was presented **by Paula F. Nascimento in 2017 [11],**In this work we report the development of a method to characterize occlusal splints using fibre Bragg grating sensors. The occlusal splints are used to treatment for muscle pain resulting from para functional habit and or occlusal alterations. The gratings are inserted in to the occlusal splints in order to measure the forces applied to the splints. The analyses are performed in a volunteer with bruxism, in order to obtain the sensibility to the applied load. The analyses of the force distribution in the splint are realized in vivo and the results indicate that the proposed method is a powerful tool for the characterization of occlusal splints. The results obtained on both sides of the patient indicate that the proposed method is an efficient tool for the analysis and characterization of occlusal splints. These evaluations will promote the development of optimized occlusal splints, by using different materials and/or dimensions. The aim is to optimize the treatment of the patient, predicting the distribution of bite forces along the splint or even the attenuation of forces at determined points of the mandible.

III. CONCLUSION

This paper present different detection methods of diagnosis of bruxism based on the analysis of bilateral EMG and ECG signals and fibre optics sensors are explained above. It is concluded that the system proposed (portable device and signal processing) could be useful as a screening test for those subjects referring to the dental office with signs and symptoms of Sleep Bruxism. This literature review is very useful, since it brings a better understanding of the fieldof study, and this is an important contribution of this paper. From the literature review it can be concluded that this subject attracts a great deal of interest by researchers and a tremendous algorithms are present related to under modelling and mathematical simulation. We will ensure the usefulness of EEG in the analysis of bruxism.

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