Electro-Encephalogram (EEG) Study Following Prolonged Occlusion of Common Carotid Artery in New Zealand White Rabbits

Dr. Mohammad Muslim Uddin Kabiraj

Dr. Alaa El Din Amin Afifi

Physiology & Neurophysiology Department

King Saud Medical College

ABSTRACT

An electro-encephalogram (EEG) study was done by placing silver cup electrodes over the intact surfaces of both the hemispheres in New Zealand White Rabbits. EEG recordings were made before and 48 hours after the occlusion of the right common carotid artery.

Analysis of the post-occlusion records showed (a) complete disappearance of the organized high frequency alpha like waves in the fronto-central regions bilaterally, (b) gross asymmetry with ipsilateral (on the side of occlusion) low voltage and slow wave activity, (c) disorganized high voltage slow theta-delta like activity in the contralateral side and (d) presence of sharp wave focus in the central region (C3 electrode) contralateral to the occlusion territory.

(Key Words: electro-encephalogram, EEG, brain studies, ischemic stroke, vascular lesion)

INTRODUCTION

The natural course taken by the ischemic stroke has been followed and studied in great detailed by a number investigators (Hutchinson and Acheson, 1975, Furlan et al, 1980, Sacovegna et al, 1982, Poole and Ruseel 1985, Chambers et al, 1987). In some of these typical cases clinical improvement is quite remarkable, however, only a few of the investigators followed them to quantify their improvements (Kaste and Waltino, 1976, Haynes et al, 1987, Wade and Hewer, 1987). The data concerning the changes in EEG, Somatosensory Evoked Potential (SSEP), cerebral blood flow, metabolic aspect and neuronal loss following cerebrovascular ischaemic stroke showed variable results (Tolenen et al, 1981, Veering et al, 1986, De Weerd et al, 1988, Kastner et al, 1989, Jonkman et al, 1985 Jorgensen and Diemer, 1982, Ballotta et al., 1997, Linstedt et al., 1998 and Guerif et al., 1997). In most of the animal experiments cerebral ischaemia lasted from 15 to 30 minutes (Marshall et al, 1978, Pulsinelli and Duffy, 1983, Nordstrom et al, 1978, Hinzen et al, 1972, Monmaureh et al, 1986, Jorgensen and Diemer, 1982). Barnett et al, 1986, studied the effects of Nimodipine on Acute Focal Cerebral Ischaemia by occluding the unilateral middle cerebral artery for 4 hours.

The qualitative and quantitative EEG analysis varies with the severity of the stroke, degree of establishment of re-circulation, metabolic changes and depending on whether the occlusion of the cerebral blood flow is unilateral of bilateral (Kastnet et al, 1986, Jonkman et al, 1985 and DeWeerd et al, 1988). De Weerd et al, 1988 found that in seventy patients, the

EEG and clinical score improved dramatically, but the cerebral blood flow (CBF) values did not change significantly. They also found that a persistent neurological deficit could be predicted by a low CBF. We therefore designed a study where unilateral internal carotid artery was occluded for prolonged period and EEG study was done after 48 hours of occlusion. The aim of the study is to investigate the cortical activity (EEG) following prolonged ischaemia.

MATERIALS AND METHODS

Eleven healthy New Zealand White rabbits were selected for this study (Afifi and Kabiraj, 1991).

EEG recording: A craniotomy was performed over the sagital suture. Both the hemispheres were visualized. The Electroencephalogram (EEG) was recorded with silver cup electrodes placed a few mm apart on the intact dura over the Sensory-motor cortex of both the hemispheres. The signal was fed to a pre-amplifier, which in turn was connected to a chart recorded. Filter settings were 30 Hz. for high and 0.8 Hz for low pass. Analysis of the EEG was made following conventional methods.

RESULTS

EEG recording before occlusion: A distinct synchronous, symmetrical high frequency waves (at 8 Hz) of 75uV amplitude were recorded in the F3-C3 and F4C4 derivations (Fig. 1). Frontal and parieto-central electrodes recorded a mixture of high and low frequency waves superimposed by very low voltage beta waves (more than 13 Hz) bilaterally.

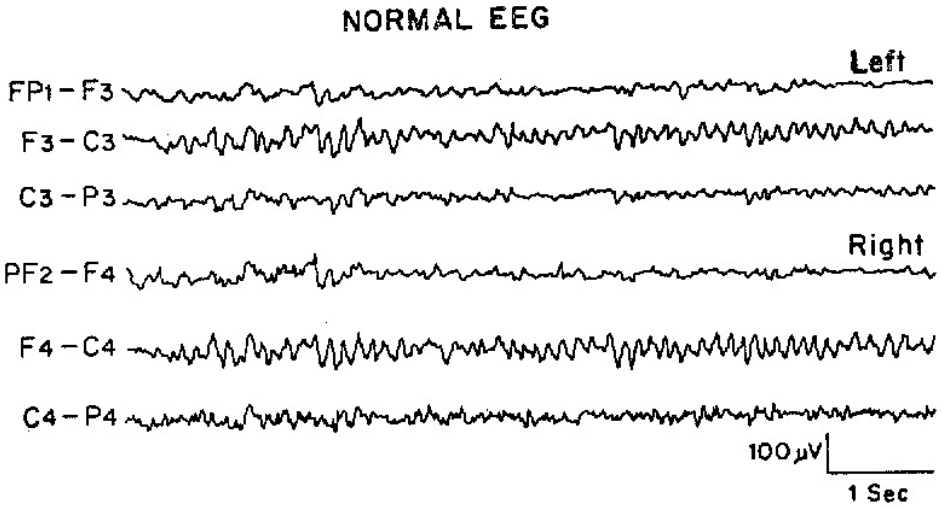

Figure 1 - Shows normal EEG recording of one of the White Rabbits.

Note that the organized high frequency alpha like activity recorded in the fronto-central regions bilaterally prior to right common carotid artery occlusion.

Post-occlusion recording: EEG waves were recorded 24 hours after occlusion. The record was grossly asymmetric. Right side was dominated by low voltage slow waves of theta-delta (3 to 7 HZ) ranges (Fig. 2). The contralateral (left) hemispheres showed disorganized high voltage slow 3 to 6 HZ activity. There are some sharp waves phases reversing in the left central (C3) electrode.

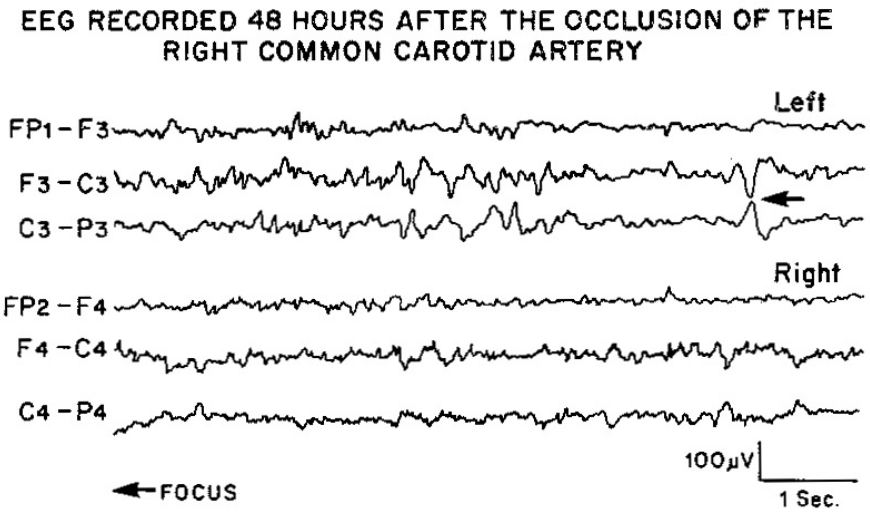

Figure 2 - Shows EEG recordings 48 hours after the occlusion of the right common carotid artery. Note that there is ipsilateral suppression and contralateral slowing with a focus marked by an arrow.

DISCUSSION

In this study EEG of the affected side showed significant ischaemic (anoxic) changes due to prolonged occlusion of the right Common Carotid Artery. A flat and low voltage slow brain activity is a common phenomenon of hypoxic encephalopathy (Al Gotsson et al, 1990, De Weerd et al, 1989, Komatsumoto et al, 1987, Graham et al, 1986, Visser et al., 1999). As EEG reflects the spatial summation of post-synaptic potentials (Speckman and Elger, 1982) and synaptic transmission in turn is an energy dependent process, particularly biosynthesis, release, re-uptake and degradation of neurotransmitters, (Carpenters and Reese, 1981), the slow and low voltage EEG in the affected side may be due to lack of ATP in response to prolonged ischaemia (Maeda et al, 1999).

The more frequent periodic lateralized epilpetiform discharges (PLEDS) usually seen in patients with acute unilateral lesion of vascular origin (Chatrian et al, 1964; Markand and Daly, 1971) is lacking in our animal model study. The reason could be due to the fact that the EEG recording was made 48 hours after occlusion. The slowing and focal changes seen in the non-ischaemic hemispheres may be due to the well-known "Diaschisis" phenomenon (Jonkman et al, 1985). The delayed Somatosensory Evoked Potentials (SSEP) recorded from non-affected hemispheres of the same group of animals further confirms the same possible phenomenon.

This study does not include the gradual changes in EEG with different metabolic and anoxic changes of the cortical neurons or any EEG changes relating to slow recovery to slow recovery from the prolonged periods of hypoxia.

CONCLUSIONS

We conclude that prolonged isolated carotid artery occlusion not only causes anoxic encephalographic changes in the affected side, but also causes mild changes of similar nature in the contra-lateral side. However, a careful continuous EEG monitoring during prolonged ischaemia and subsequent follow up may be of great help to predict the clinical status and appropriate management of patients with isolated vascular lesion of longer duration.

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About the Authors:

Mohammad Kabiraj, M.D. is a Consultant/Neurophysiologist at the Armed Forces Hospital in Riyadh. Dr. Kabiraj earned his MBBS (1969) and his Masters degree (1974) with honors, from Dhaka University, Bangladesh in the field of Physiology. Dr. Kabiraj has conducted physiology studies as a research scholar in Sweden and as an Assistant Professor of Physiology at the King Saud University in Riyadh. His primary research interests lie in the areas of electrodiagnostic medicine and intra-operative monitoring for epilepsy surgery.

Alaa El Din Amin Afifi, MBBS, Ph.D. served as a Visiting Professor of Neurophysiology at King Saud University from 1996-1999. Dr. Afifi presently serves as a Professor and Chairman of the Physiology Department of Cario Medical College, Egypt.

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