Neurology Perspectives 4 (2024) 100143

NEUROLOGY PERSPECTIVES

www.journals.elsevier.com/neurology-perspectives

SCIENTIFIC LETTER

Cerebrospinal fluid pulse: A new EEG artefact

Pulsatilidad del LCR: Un nuevo artefacto electroencefalográfico

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Received 22 September 2022; accepted 1 June 2023
Available online 30 November 2023

Dear Editor:

An EEG artefact is defined as any electrical potential that does not originate in the brain. EEG artefacts may be physiological or non-physiological. Physiological EEG artefacts are generated by electrical activity associated with the normal functioning of the body. Non-physiological EEG artefacts, in contrast, are generated by electromagnetic fields outside the body.[1,2]

The presence of EEG artefacts is a common problem in the interpretation of EEG recordings, as well as a significant source of diagnostic errors. This issue is even more significant in intensive care units (ICUs), where the wide variety of electrical equipment and crowded working environment provide the perfect scenario for the generation of external electrical potentials.[3–5]

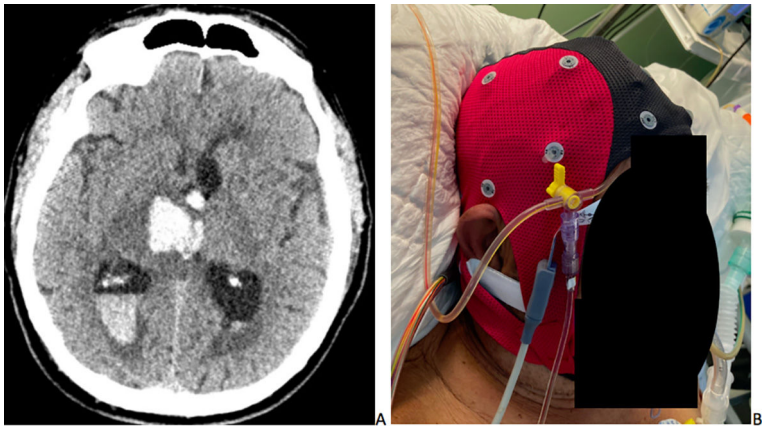

Fig. 1 (A) Haematoma located in the right basal ganglia, with intraventricular extension. (B) EEG electrode cap used in our patient with an external ventricular drain.

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https://doi.org/10.1016/j.neurop.2023.100143

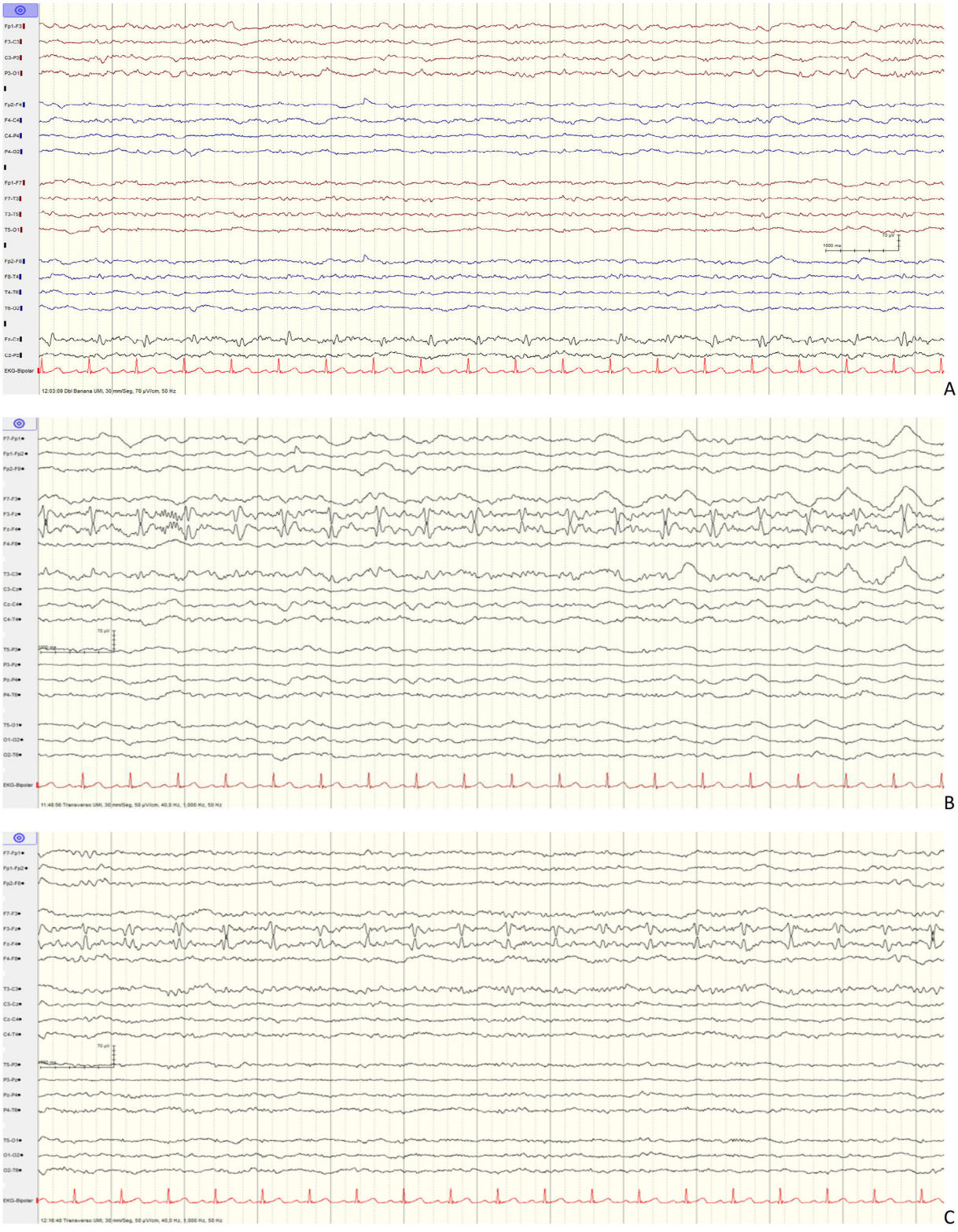

Fig. 2 EEG recording. (A and B) Longitudinal and transverse bipolar montage EEG. Periodic discharges detected only by the Fz electrode, which occur 120 ms after the QRS complex of the ECG channel, rather than synchronously. C) Transverse bipolar montage EEG recording after administration of midazolam. Suppression of background activity, without changes in the abnormal activity shown in the other figures.

We describe a physiological artefact generated by the cerebrospinal fluid (CSF) pulse wave in a patient with an external ventricular drain (EVD).

Our patient, a 67-year-old man with arterial hypertension and diabetes mellitus, was admitted to the ICU due to focal seizures and altered level of consciousness secondary to right intracranial haematoma with intraventricular extension (Fig. 1A). The patient presented hydrocephalus, requiring EVD placement following sedation and orotracheal intubation. An EEG was requested to rule out non-convulsive status epilepticus. The study was performed under the supervision of a neurosurgeon to ensure correct manipulation of the EVD, using an EEG cap with electrodes placed according to the international 10–20 EEG system (VIASYS Nicolet NicVue 2.9; Middleton, WI, USA) (Fig. 1B).

The EEG study revealed continuous, low-voltage background activity, with frequencies predominantly in the delta range, as well as independent periodic discharges on top of background activity. One of these discharges, which was most clearly observed in the left posterior region, presented as sharp waves of low amplitude and constant frequency, and was synchronous with the QRS complex of the ECG channel. Therefore, this was interpreted as an EEG artefact. The remaining discharges also presented a sharp-wave morphology, although they presented greater amplitude and appeared constantly, at a delay of 120 ms after the QRS complex in the ECG channel. This activity seemed to appear exclusively in the Fz electrode (Fig. 2A and B). Upon examination of the electrode cap, the Fz electrode was found to be in close proximity to the EVD and not in direct contact over any blood vessel. Administration of 10 mg midazolam suppressed background activity, with no changes in the periodic discharges (Fig. 2C).

CSF was shown to flow in the brain in the first half of the 20th century. The set of cerebral blood vessels can be considered as a system that oscillates as a result of the alternating contraction and relaxation of the heart. These oscillations, or pulse pressure waves, are propagated to the CSF, which acts as a conduction medium and may be monitored using the appropriate techniques.[6,7] In the case presented here, we hypothesise that surface EEG indirectly detected CSF pulse waves through the EVD tube.

The sharp-wave morphology and moderate amplitude may reflect an increase in intracranial pressure; these changes have been found to be typical of CSF pulse pressure waves recorded by intraventricular pressure transducers in the context of intracranial hypertension.[8,9]

This EEG artefact typically presents similar morphology and a constant periodic pattern, and is usually recorded by a single electrode, with no signal from adjacent electrodes. It is not considered an ECG artefact as, despite the similar morphology, it occurs 120 ms after the QRS complex of the ECG channel, rather than synchronously. Furthermore, it is not generated from arterial pulsation or the movement of the heart itself; these phenomena are known as ballistocardiographic artefacts, and are characterised by a lateralised or diffuse, rhythmic slow waveform. We also confirmed that the electrode recording the greatest amplitude was not placed over any blood vessel, and that this abnormal activity did not change after the patient's head was stabilised (the recommended procedure for correcting ballistocardiographic artefacts).[4,10]

According to our literature search, no report has been made of an artefact with these characteristics.

In summary, one of the most frequent errors in EEG interpretation is mistaking external electrical potentials for potentials originating in the brain. CSF pulsatility artefacts may disrupt background activity, mimicking epileptiform discharges. EEG monitoring in patients with EVD is essential; electrical potential characteristics, the position of electrodes with respect to the catheter, and the temporal association with ECG are key factors to consider in identifying this artefact.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.neurop.2023.100143.

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