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SHORT COMMUNICATION

Developmental EEG hallmark or biological artifact? Glossokinetic artifact mimicking anterior slow dysrhythmia in two full term newborns

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Summary The aim of this paper is to describe an uncommon physiological EEG artifact in newborns caused by tongue movements (TM), mimicking anterior slow dysrhythmia (ASD). The subjects are two full-term newborns (39 weeks gestational age (GA)), admitted to the Neonatal Intensive Care Unit for respiratory distress. Both underwent polygraphic video-EEG recording in order to better characterize tremor-like movements of all four limbs that appeared 48 hours after birth. Multichannel video-EEG polygraphy was performed using the 10—20 electrode montage modified for neonates. Ninety minutes of EEG was recorded for each subject, capturing different behavioral states. Background EEG activity was normal for both subjects. During active sleep (AS), synchronous and symmetric slow activity was recorded over bifrontal head regions. For subject 1, bursts of monomorphic 2 Hz delta waves, with an amplitude between 50—100 μV lasting two seconds, were recorded and identified as anterior slow dysrhythmia. For subject 2, polymorphic 1-2 Hz delta waves, 50—100 μV in amplitude and lasting for 20 seconds, were recorded only during suction. After thorough analysis of simultaneous digital video recording

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synchronized with the EEG trace, this activity was thought to be compatible with glossokinetic artifact. Interpretation of neonatal EEG can be challenging; the background activity is frequently intermixed with physiological artifacts, such as ocular, muscle and movement artifacts, complicating the interpretation. Even continuous video-recording might not make the diagnosis immediately obvious. Therefore, when a rhythmic monomorphic pattern without evolution in amplitude or frequency is seen, we suggest that tongue movement artifact should be considered.

Introduction

While electroencephalography (EEG) has been used in humans since 1929, it remains a technique of tremendous value. Particularly in the neonatal intensive care unit (NICU), EEG is a useful, non-invasive and reliable bedside tool for evaluation of brain function and brain maturation [1]. The NICU can be a technically difficult environment for EEG recording due to various sources of potential artifacts [9], which can be of physiological or non-physiological origin [14]. Distinguishing between normal electrographic maturational patterns and non-cerebral electrographic activity is essential for accurate neonatal EEG analysis and interpretation [10]. Glossokinetic artifact is well described in older children and adults. It is electrographically characterized by slow activity in the delta frequency with changing polarity according to the direction of the tongue movement [5]. The slow waves associated with tongue movements have bilateral distribution, and their localization depends on the type of tongue movements. Vertical tongue movements produce slow wave artifact over anterior head regions, while horizontal tongue movements produce artifact over temporal head regions [3]. On the other hand, anterior slow dysrhythmia (ASD) is a maturational pattern seen in near-term and term infants and characterized by intermittent rhythmic 1.5 to 3 Hz activity of 50 to 150 μV over bifrontal head regions. It can be synchronous or asynchronous, and associated with frontal sharp transients, especially during transitional sleep [8]. Glossokinetic artifact can easily be mistaken for anterior slow dysrhythmia. Here, we describe the differences between the two patterns for electroencephalographers and neurologists interpreting neonatal EEGs.

Methods

Subjects

The subjects were two term newborns, both born at 39 weeks of gestational age following uncomplicated pregnancies. Normal fetal movements were reported. Prenatal ultrasounds were unremarkable. Both subjects were admitted to NICU for assessment of tremor-like limb movements. Neurological examination was otherwise normal. Investigations including complete blood count, plasma amino acids, thyroid hormone, urine organic acid, and infection disease work up were negative. Both subjects had normal head ultrasound.

EEG acquisition

According to our neonatal protocol, polygraphic video-EEG recordings were performed using modified neonatal 10—20 electrode montage[12], on the Nihon Kohden Neurofax EEG 2100 system (Tokyo, Japan) with synchronized color video camera (resolution power of 7.20×5.76). The duration of the recording for each subject was 90 minutes, and behavioral states including wakefulness, quiet and active sleep were captured. A prearranged ready-made electrode cap was used (Fp1, Fp2, C3, C4, T3, T4, O1, O2 and ground lead) with chlorinated silver cup electrodes. Extracephalic leads for the electromyogram (EMG), electrocardiogram (ECG), and pneumogram (PNG) were also used. The ECG lead was placed above the midline on the chest (high pass filter 15 Hz; low pass filter 0.3 and sensitivity 100 μV). The EMG lead was placed over the left deltoid muscle (high pass filter 120 Hz; low pass filter 0.003 and sensitivity 30 μV). The PNG was a piezoelectric breath transducer placed 2 centimeters above the umbilicus (high pass filter 15 Hz; low pass filter 1 and sensitivity 7 μV).

Video-EEG interpretation

Bipolar longitudinal montage and coronal montage were used for EEG recording with the settings as follows: high frequency filter 35 Hz, low frequency filter 0.3 Hz, notch filter off, sensitivity 100 μV for 10 millimeters, display of 20 sec per page. Video EEG traces were independently analyzed by the technologist and pediatric neurologist. Rhythmic delta was evaluated using synchronized video-EEG recording to correlate the appearance and disappearance of the artifact according to the tongue movements.

Results

Background EEG activity was normal during wakefulness and active sleep (AS) for both neonates (Figs. 1 and 2). In both cases, background electrographic activity in wakefulness was continuous, while background in quiet sleep (QS) was characterized by a tracé alternant pattern. The Fig. 1 shows an ASD pattern characterized by bursts of monomorphic 2 Hz delta frequency, with an amplitude between 50—100 μV over both frontal head regions, synchronous and symmetric, lasting three seconds. The Fig. 2 shows a run of polymorphic 1—2 Hz delta frequency of 50—100 μV in AS associated with the baby sucking on a pacifier, as shown in the video.

Figure 1 Anterior slow dysrhythmia.

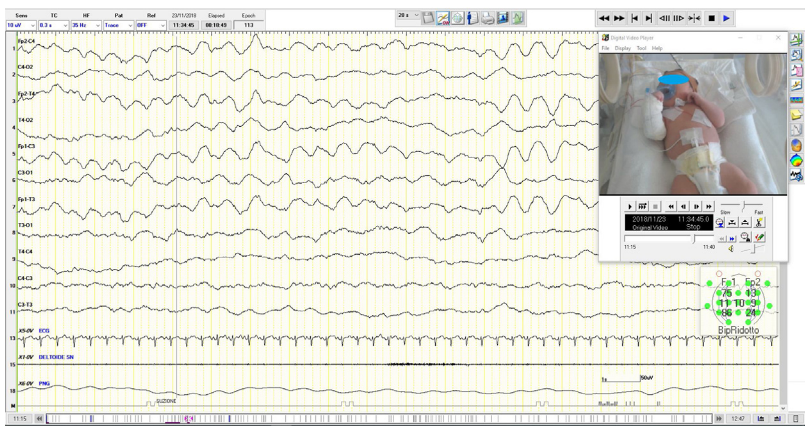

Figure 2 Glossokinetic artifact.

The activity was localized over both frontal head regions, was synchronous and symmetric, and lasted for 15 seconds (Fig. 2). The mean duration of this artifact was of 10 sec (minimum 3 sec to max 20 sec) and it was identified during wakefulness and active sleep. After thorough analysis of the video-EEG recording, we concluded that the activity on Fig. 2 was compatible with the tongue movements, i.e. glossokinetic artifact. Other sources of artifact, such as head movements, eye blinks or facial movements were ruled out.

Discussion

Interpretation of neonatal EEG can be challenging, since the background activity is frequently intermixed with physiological artifacts, such as eye movements, muscle and movement artifacts that may complicate the interpretation [10]. The aim of this paper was to characterize electrographic changes produced by tongue movements in neonates and compare them to a normal physiological pattern, anterior slow dysrhythmia. The Fig. 2 shows a symmetric and synchronous slow electrographic activity over bi-frontal head regions recorded during active sleep, which could be misinterpreted as ASD. Instead, this activity represented a glossokinetic artifact, as demonstrated by time-locked video recording. In adults, glossokinetic artifact is typically identified using a submandibular electrode. However, this would be technically difficult in a neonate. Our protocol does not routinely include submandibular electrode due to the concern of added stress to the neonate and difficulties keeping it in place due to the movements. Therefore, we did not use submandibular electrodes in the subjects presented here. After thorough evaluation of the electrographic tracing and the time-locked video, we concluded that the two patterns can be differentiated by careful analysis of synchronized video-EEG recording. We were thus able to identify that the intermittent frontal slow activity in the second case was related to tongue movements. The slower duration of the ASD was identified as the key difference between two electrographic patterns. The ASD occurred in brief runs lasting for no more than 2—3 seconds, while the glossokinetic artifact lasted longer. ASD is a normal maturational pattern; it usually first appears at 34 weeks of GA and persists until 44 weeks of GA. It is characterized by brief runs of bi-frontal 50 to 100 μV delta waves, lasting 2—3 seconds [2,4,6]. The activity is typically asynchronous between the two hemispheres and is often asymmetric.

Tongue movements in neonates can be subtle, and often masked by a pacifier. Even with a continuous video-recording the diagnosis may not be immediately obvious, and in a near-term or a term neonate, glossokinetic potentials (GKP) can be easily misinterpreted as ASD [14]. Therefore, we suggest that tongue movements should be considered as a source of artifact in a neonate when rhythmic monomorphic patterns without evolution in amplitude and frequency are seen. We would like to highlight this point for electroencephalographers and pediatric neurologists interpreting neonatal EEGs.

It is important to distinguish between ASD and GKA, even although both patterns are considered benign, thus not associated with brain pathology. Mistaking GKA for ASD after 44 weeks of gestational age can lead to an incorrect assumption of brain immaturity, with potential impact on the management of the neonate. GKP are evoked potentials generated by tongue movements [7—13]. Both the appearance of the pattern and the frequency depends on the extent, direction and velocity of the tongue movement [5]. The tongue creates an electric dipole, with the tip of the tongue being electronegative and the posterior part of the tongue electropositive. There when tongue movements are vertical, the delta activity is best seen on the EEG over the bi-frontal head regions. In comparison, delta activity is seen over the temporal head regions when tongue movements are horizontal [3]. In adults, these EEG changes can be differentiated from normal EEG patterns by adding a submandibular electrode [11].

In conclusion, we report GKP artifact in two term neonates. This pattern can be mistakenly considered to be ASD, which can contribute to incorrect assumption of gestational age, or incorrect diagnosis of dysmaturity. Neonatal EEG technicians should be aware of this type of artifact and able to correct it. Electroencephalographers should verify the origin of this pattern on time-locked video recording.

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Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.neucli.2019.07.015.

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