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Case Report

Spontaneous jaw muscle activity in patients with acquired brain injuries—Preliminary findings

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ABSTRACT

Patients: High or excessive parafunctional jaw muscle activity is a frequent complication of acquired braininjury (ABI) and may have some similarities to bruxism. Bruxism has been associated with increased tooth wear, masseter hypertrophy and headaches. The aim of this observational study was to identify the levels of jaw muscle activity from fourteen ABI patients having different functional and cognitive levels in their early phase of neurological rehabilitation (according to their Ranchos Los Amigos Scale (RLAS) score). Nine patients were severely cognitive impairement (RLAS score 1–3): with no or little response to any external stimuli due to low arousal and five patients were with RLAS score 4–8: depending on responses to stimuli and confusion level i.e. defining that patients had enough arousal to respond and react and therefore were able to follow the instructions. A single-channel electromyographic (EMG) device was used to assess the jaw muscle EMG activity in ABI patients for two hours continuously at two different days.
Discussion: The mean ($\pm$SD) jaw muscle activity observed in patients with ABI was 46.9 ± 6.5 EMG events/h with a wide range between 1–163 EMG events/h but with no significant difference between days ($P = 0.230$).
Conclusion: Irrespective of functional and cognitive ability scores patients with ABI had a wide range of EMG activity. The use of ambulatory single-channel EMG devices might open a path for further studies to determine levels of jaw muscle activity associated with potential side effects in ABI patients.

1. Introduction

Bruxism is a repetitive jaw-muscle activity characterized by clenching or grinding of the teeth and/or by bracing or thrusting of the mandible [1]. Bruxism has two distinct circadian manifestations: it can occur during sleep (sleep bruxism: SB) or during wakefulness (awake bruxism: AB) [1]. Descriptive studies using polysomnography (PSG) have indicated an overall prevalence of 7–8% [2], and that SB may be more common in younger populations with an equal frequency in males and females [3]. Central nervous system factors such as stress and anxiety might play a pivotal role in AB [4]. SB is considered to be a 'sleep-related movement disorder' initiated centrally with no evidence of peripheral factors like occlusal discrepancy or craniofacial anatomy to be playing any significant roles [4,5]. Recent surveys of the literature suggest that SB is secondary to sleep-related micro-arousals (rise in autonomic cardiac and respiratory activities) [6].

High or excessive parafunctional jaw muscle activity is a frequent complication of acquired brain injury (ABI) and may have some similarities to bruxism. Bruxism-like behavior have been noted in patients with altered states of consciousness, but its incidence after brain injury is not clear [7]. Bruxism after brain injury was first reported by Pratap-Chand and Gourie-Devi stating that bruxism appeared with the return of a sleep–wake cycle [8]. Resolution of bruxism is often associated with improvement in consciousness in the patients who were severely cognitive impaired [8]. Due to the poor cognition and reduced functional ability, their awareness and arousal are very low and tooth-wear becomes the only visible clinical symptom in comatose patients, which is a irreversible process [9]. Therefore, the diagnosis of parafunctional jaw muscle activity at the early stage becomes a

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consideration in a population with severe cognitive deficits. It is not clear from the literature if a high jaw muscle activity is due to bruxism or parafunctional habits but most of the conducted studies has used the term bruxism [7–9].

It has been also reported that stroke patients have more day time sleep and their subjective sleep cycle quality is correlated with the estimated sleep time, wake time and wake percentage [10]. In critically-ill patients there has been a significant sleep alteration related to greater duration, latency and sleep fragmentation [10–12]. Many studies with behavioural and clinical assessment or even using sleep measurement devices, have reported difficulties to measure sleep irrespective to day or night time in critically-ill patients [10–12]. Because of the unknown sleep cycle in patients with ABI, it is also difficult to assume, if jaw muscle EMG activity in the present study correlates to sleep or awake activity, and as a consequence the term bruxism-like behaviour has been used.

PSG recordings are considered to be the gold standard for diagnosing SB but it requires highly trained professionals, is expensive and time consuming and may not be easily accessible in many cases [13], e.g. ABI. In relation to bruxism, PSG is therefore often considered a research tool [13,14]. A more recent approach is the use of portable single-channel EMG devices (e.g. Grindcare, Sunstar) [15]. In addition to monitoring and quantifying the EMG activity from the anterior temporalis muscle, Grindcare has also introduced a contingent electrical stimulation (CES) paradigm where increase in jaw muscle activity trigger an electrical stimulation through the recording electrodes leading to a reflex suppression of the EMG activity [15]. This principle has so far not been applied to ABI patients.

The aim of this observational study was to identify the levels of jaw muscle activity in fourteen ABI patients having different functional and cognitive levels in their early phase of neurological rehabilitation using a simple, yet reliable portable single-channel EMG recording device.

2. Outline of the cases

The pilot study consisted of fourteen patients with severe brain injury, recruited at the Neurorehabilitation and University Research Clinic, Hammel, Denmark using a convenience sampling method. The patients were recruited in the very first week of their admission to Hammel Neuro-Rehabilitation Centre. The study was approved by the Data protection agency (local regulatory body for clinical projects, equivalent to an Institutional Review Board) under protocol number: 2012-58-006 and performed in accordance with Helsinki declaration II. There were 9 males and 5 females with mean age (±SEM) of 47.8 ± 20.0 years (20–73 years) were included with different functional and cognitive levels in their early phase of neurological rehabilitation. To assess the patients' level of consciousness, functional dependence, functional level and neurological conditions different scales like early functional ability (EFA) [16] and Ranchos Los Amigos Scale (RLAS) [17] routinely used in neurorehabilitation settings, were taken into account in the present study. The EFA scale comprises 20 items in 4 categories (autonomic, oro-facial, sensorimotor and cognitive functions/abilities). Each item is rated on a five-point-scale: 1 = "no function", 2 = "severe disturbance", 3 = "moderate disturbance", 4 = "slight disturbance", 5 = "normal". Thus, EFA total scores may range from 20 to 100 [16]. RLAS is an 1–8 level scale to measure the levels of awareness, cognition, behavior and interaction with the environment [17]. According to the RLAS: 1–3 scores are considered severe cognitive impaired patients — with no or little response to any external stimuli due to low arousal and 4–8 scores indicate responses to stimuli and confusion level, defining that patients have enough arousal to respond and react and therefore are able to follow the instructions at an individual level [17].

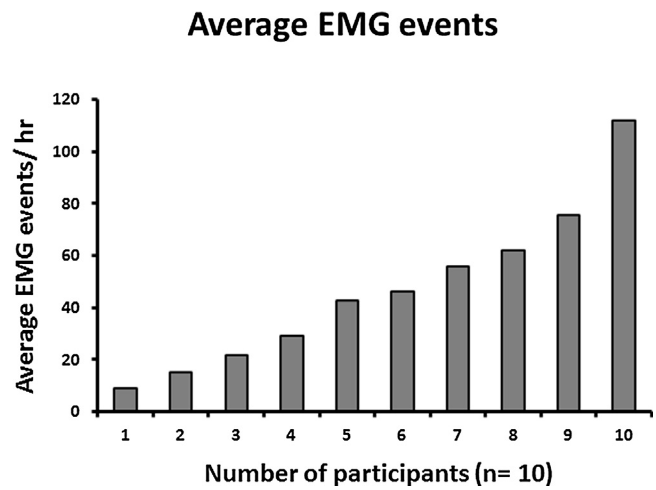

Fig. 1. Average EMG events in patients with acquired brain injury (ABI) for two hours in two different sessions.

The EMG activity from the anterior temporalis muscles was recorded with a single-channel EMG device (Grindcare, Sunstar Suisse SA, Switzerland) for continuous two hours in two different sessions (Day 1 and Day 2). Two hours of the day were chosen where patients were considered to be in the most relaxed and stable situation. This two hours of the day were quite identical tothe nights (usually sleeping) without any external activity (routine clinical staff work). The identical day time were chosen due to various practicalities of the patients' (including sleep time, no physical movements/no rehabilitation program) and clinical staff compliance. Even though, patients were relaxed and sleeping, we acknowledge the fact from previous studies that have reported difficulties to measure sleep irrespective to day or night time in critically-ill patients [10–12], so as a consequences the term 'bruxism-like behavior' was coined irrespective of sleep-cycle pattern. The single-channel EMG device assessed "bruxism-like muscle activity", using a 'moving average' (MA) algorithm. The MA algorithm detects the EMG bursts using a dynamic method for estimation of background EMG noise [18]. Bursts of EMG that exceed the background noise with more than 3 times the background amplitude were detected i.e., an EMG burst must be ≥0.25 s in duration, an EMG burst can be phasic (<2 s) or tonic (>2 s), and an EMG burst must be part of an EMG episode to be counted; an EMG episode consists of either ≥3 phasic EMG bursts and/or one or more tonic EMG bursts; an EMG episode consists of EMG bursts <3 s apart [18,19]. The EMG device also has in-built feature for contingent electrical stimulation (CES), i.e. predefined increases in resting EMG levels will trigger an electrical stimulation through the same EMG electrodes which will lead to an exteroceptive suppression reflex of jaw muscle activity [15,20,21]. The electrical stimulation level in this report was set to 'zero' as the purpose of the study was to only record the EMG activity rather than providing any CES.

EMG data was recorded as an EMG events/h. In 2 patients, the EMG electrode was detached during the session most likely due to excessive sweating and in 2 patients there were baseline problems with high impedance due to excessive sweating/lack of good contact between the skin and EMG electrode which prevented recordings of EMG data. It was possible to record 2 h of continuous EMG data at 2 separate sessions in 10 out of 14 patients (20 sessions in total with each session of 2 h). Participants demographics and clinical features were recorded (Table 1).

The data analysis of the EMG recordings from the 10 ABI patients revealed a substantial variation in numbers of detected