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Case Report

Novel Use of Optokinetic Chart Stimulation to Restore Muscle Strength and Function in a Bed Bound Traumatic Brain Injury Patient that was in a Vegetative State of Unconsciousness: A Case Study

Abstract

Introduction: Patients with severe traumatic brain injury are known to have poor outcomes. The prognosis is even worse if they remain vegetative or minimally conscious for months. The objective of this case report is to highlight the novel use of optokinetic chart stimulation to improve muscle strength and functional mobility in a patient who was in a vegetative state of unconsciousness for months after sustaining a severe traumatic brain injury and C7 spinal fracture. The patient could not open their eyes and breathed through a tracheostomy tube.

Methodology: An optokinetic chart was moved in front of the patient: from side to side, up and down and finally forwards and backwards. This was supplemented with sensory interaction for balance once the patient could stand with assistance.

Results: Oxford score improved from absent voluntary movements to 410/410 within one month after treatment had begun. GCS improved from 3/15 to 15/15 after treatment. Barthel index improved from 0/100 to 30/100 within 6 weeks and was 50/100 3 months post commencement of intervention.

Conclusion: From having conventional therapy that centred on chest physiotherapy and suctioning of secretions in bed, the patient remarkably improved to mobilising with a wheeled zimmer walking aid and the assistance of one person. This is the first reported use of optokinetic stimulation in vegetative unconscious traumatic brain injury patients. Further research is required on the use of optokinetic chart stimulation in patients who are minimally conscious or vegetative after severe traumatic brain injuries.

Abbreviations

TBI: Traumatic Brain Injury; OKCS: Optokinetic Chart Stimulation; GCS: Glasgow Coma Scale; LOS: Length of Stay; SIB: Sensory Interaction for Balance; OKS: Optokinetic Stimulation; PEG: Percutaneous Endo-Gastric tube

Introduction

Traumatic brain injury (TBI) is one of the most common causes of mortality and disability worldwide [1]. Mortality is common among elderly patients post TBI [2]. Even cerebral contusions are associated with high mortalities in elderly patients with TBI [3]. Predictors of outcome after TBI include admission Glasgow Coma Scale (GCS) [4,5], age [6,7], length of stay (LOS) [5,6], midline shift [4]; haematoma size [4], initial functional status [5,6]; and duration of amnesia [5]. The prognosis of patients with severe TBI is very poor [8] with poor discharge outcomes or death being common. LOS and its associated costs still remain high [9]. Falls may account for up to 59% of TBI in the elderly [7].

Current rehabilitation interventions for improving gait and balance in a standardised manner have poor evidence [10]. Known TBI interventions include repetitive task training, the Bobath approach [6], and other non-aerobic exercise interventions [10]. These approaches have high intensities of 3 hours of rehabilitation daily for 5 days a week [6]. However patients with severe TBI that leads to vegetative and minimally conscious states cannot undergo such intense rehabilitation. They end up with lowest functional gains and longest LOS [6]. Thus it is important to find a rehabilitation intervention that can prevent disability in patients with severe TBI that leads to vegetative and minimally conscious states. This may have the added benefit of reducing LOS in severe TBI.

The motor and cognitive benefits of OKS were first noted in the late 1990s, in stroke patients with neglect [11]. [OKCS has been shown to restore voluntary movements and function in TBI [12] and dense acute strokes [13]. OKCS exerts its effects by afferents to the vestibular nuclei and vestibular-cerebellum through the nucleus of the optic tract [14]. With treatment time of 9 minutes daily, 5 days per week, the OKCS is less intensive [15]. The fact that it can be carried



out in a bed bound patient makes it specifically suited for use in TBI patients in vegetative and minimally conscious states. At present no studies have been carried out to investigate use of optokinetic stimulation in TBI patients that are in vegetative and minimally conscious states. This case study aims to extend preliminary evidence for use of optokinetic chart stimulation in severe TBI by describing the first reported benefits in a severe TBI patient in a vegetative state.

Case Presentation

This is a single case study based in an in-patient ward setting. Written informed consent was obtained from the patient's legal advocate in accordance with institutional review body guidelines for case reports as the patient still lacked the ability to retain and weigh up information hence lacked the mental capacity to consent even though he verbally agreed to be a case study.

The case is that of an 81 year old patient who was admitted following a fall down his stairs at home which resulted in an intracerebral contusion over the right frontal lobe with blood in the lateral ventricle, in keeping with intraventricular flooding. His co-morbidities included a C7 fracture and fracture of the fifth and eighth ribs. He was admitted to ITU to be intubated via surgical tracheostomy, was put under sedation with propofol and fentanyl. He was fitted with a neck brace. After prolonged unconsciousness an EEG was carried out and discussions to switch off mechanical ventilation were held with the family. His theta activity was 5-7Hz. He had symmetric and bilateral fast activity over the anterior region and slow waves, 1-2Hz, over bilateral temporal regions. There was no response to verbal, tactile or nociceptive stimuli with a GCS of 3/15 suggesting severe brain injury. There was diffuse slow background activity with no inter-ictal epileptiform discharges seen and no brain activity to external stimuli. The inter-ictal EEG features were suggestive of encephalopathy which was associated to the TBI. He was taken off sedation within 72 hours. The past medical history consisted of hypertension and benign prostate hyperplasia.

Three months post the TBI he was still vegetative and breathing via a surgical tracheostomy. His rehabilitation by then, mainly centred around clearance of his copious secretions with no functional rehabilitation. He was transferred from ITU to a general medical ward after 53 days in ITU. He was being fed by a PEG tube. A referral to a specialised neuro rehabilitation unit was declined as he was still using the surgical tracheostomy for respiration and his rehabilitation potential was deemed to be poor. A multidisciplinary process to arrange for his discharge to a nursing home in his vegetative state was underway. During this process he was referred for OKCS by the general medical ward physiotherapist who wondered if the patient would benefit from OKCS.

On initial assessment by the authors, the patient was bed bound with eyes kept closed. He had no trunk control. His upper limbs and lower limbs were kept in a flexed foetal position. The limbs occasionally exhibited purposeless reflex movements in the gravity eliminated horizontal plane. He was vegetative with a GCS of 3. GCS is a widely used measure of the level of consciousness with a minimum score of 0 and a maximum of 15. It was chosen as it includes motor and speech elements rather than just eye opening only. His Barthel

index was 0/100. The Barthel Index measures activities of daily living with a minimum score of 0 and a maximum score of 100. The initial Oxford Scale total score could not be accurately measured as there were reflex movements rather than the voluntary movements normally used to test for manual strength throughout range. The Oxford Score measures manual muscle strength with a minimum score of 0 when there are no movements and a maximum of 5 when there are normal movements for each muscle group. There are 41 muscle groups on each side of the body's limbs when upper and lower limbs are combined to give a maximum Oxford Scale total of 205 for each side. He had no purposeful voluntary movements and kept limbs flexed in a foetal position.

His intervention consisted of OKCS, carried out in half-lying in bed. The patient's eyes were manually held open by the first author while an optokinetic chart [13] was moved in front of the patient's face for 3 minutes to and fro laterally, 3 minutes to and fro vertically and 3 minutes to and fro forwards and backwards. In each of the planes, the chart was moved manually at a frequency of one cycle per second as per OKCSIB protocol previously used in dense acute strokes [13] and SDH [12]. This treatment regime has been successfully used in completely paralysed strokes and was developed using a time intensity of 3 minutes widely used in vestibular rehabilitation. As soon as he could stand with assistance SIB was added by standing him on an airex balance pad. As he progressed functional activities were added.

Result

Within a week of commencing OKCS the patient was able to sit out in a chair. Within 2 weeks of OKCS, he was standing with assistance of 2 therapists and was opening eyes and verbalizing. His secretions dried up and within 3 weeks of OKCS his tracheostomy tube was removed and he was able to respire normally. His PEG tube was removed after 12 weeks of OKCS as his swallowing improved to a normal diet. From being vegetative in bed he is now mobile with a wheeled zimmer walking aid and assistance of one. His GCS improved to 15/15 within 6 weeks of OKCS. His speech also remarkably improved and he is now able to speak in English and in his native language. From absent voluntary movements, his Oxford Scale score improved to 205/205 for each side after 12 weeks for a total score of 410/410 bilaterally. His Barthel Index improved from 0/100 to 50/100 after 12 weeks of treatment. His treatment is ongoing to improve balance and will carry on in the community. The 12 week period was used as a final measurement point as the optimum had been reached in terms of GCS and recovery of voluntary movements.

Discussion

Although preliminary beneficial use of OKCS has been reported in severe TBI with subdural haemorrhages [12] and dense strokes [13], this is the first time OKCS has been reported to benefit severe TBI in a vegetative state that progressed to a minimally conscious state and then full consciousness within weeks of commencement of OKCS. Without the use of OKCS, the patient's treatment would have been limited to respiratory intervention only. It would have taken longer to wean him off the tracheostomy tube as sympathetic tone would have remained low for normal functioning of the airways to ensure efficient independent clearance of secretions. The central



vestibular system controls sympathetic tone [16]. It is postulated that OKCS may have led to respiratory and dysphagia improvements by stimulating central visual-vestibular networks which in turn improved sympathetic tone. OKCS may offer a novel way to speed up regaining of consciousness and recovery in vegetative and minimally conscious severe TBI. Indeed the experience from this case study has subsequently been used in another vegetative severe TBI patient who opened eyes within hours of commencement of OKCS.

The prognostic factors for this case study would have been expected to lead to poorer outcomes, as age [6,7] low initial functional status and low GCS [4] are predictors of poor outcome. Most cerebral contusions in severe TBI are associated with high mortalities in elderly patients with TBI [3]. There was no functional progression before commencement of optokinetic chart stimulation. The patient was bed-ridden and was not even appropriate to be hoisted to sit out in specialised tilt in space chairs before commencement of optokinetic chart stimulation.

In severe vegetative and minimally conscious TBI patients OKCS alters outcomes by focusing intervention on the brain's balance system [15] so as to enable the cortex to modulate vestibular-spinal motor output to the extensor muscles [17]. This enhances recovery of balance which is a pre-requisite for function [12], whereas conventional neurophysiotherapy is based on practising specific tasks and functional activities [6]. The range of functional activities and task-specific activities that vegetative and minimally conscious patients with TBI can carry out is limited. This may then leave these patients at the mercy of natural recovery which may not be guaranteed to occur [12]. The fact that OKCS can be carried out in lying in bed as well as its being low intensity makes it more useful to vegetative and minimally conscious severe TBI when compared to conventional neuro rehabilitation approaches. This is in sharp contrast to the high intensities currently used in conventional neuro therapies. Intensities of 3 hours per day for 5 days per week [18] and 2–4 hours per day for 5 days a week [6] have been reported.

The study is limited by the fact that there is no randomized control; hence the temporal contributions of natural recovery alone are unknown. It is difficult to know what would have occurred if the patient had continued with conventional neuro physiotherapy due to lack of controls. The lack of follow-up to evaluate the longevity of the benefits of OKCS also limits this study. It is recommended that further research of OKCS be carried out in vegetative and minimally conscious patients with severe TBI.

Conclusion

OKCS led to remarkable improvement in function in a vegetative severe TBI. More research is needed to robustly evaluate OKCS as a rehabilitative intervention in vegetative and minimally conscious severe TBI who would otherwise be bed bound without participating in active neuro rehabilitation.

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